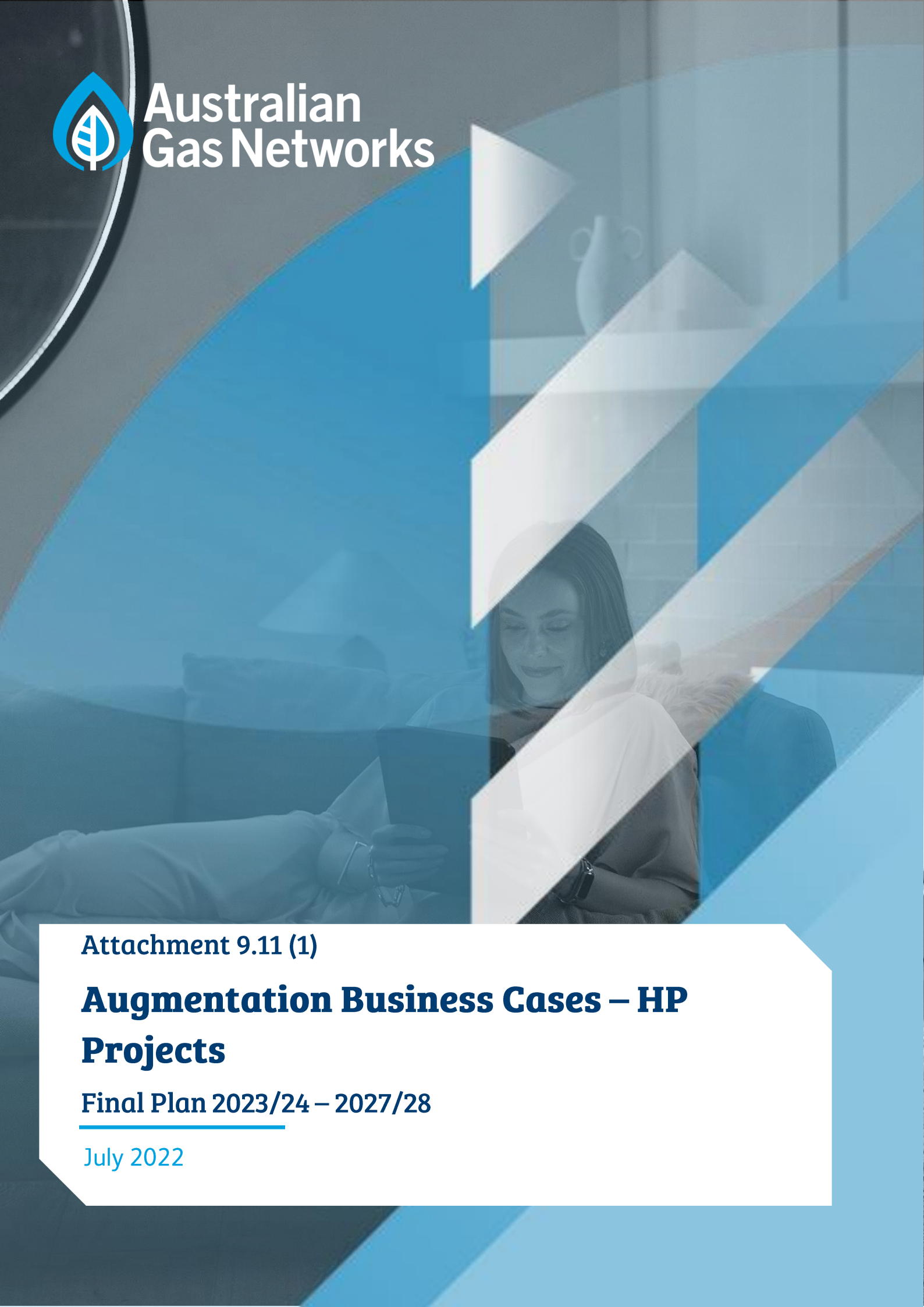

Attachment 9.11 (1)

Augmentation Business Cases – HP Projects

Final Plan 2023/24 – 2027/28

July 2022

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Contents

Executive summary

The purpose of this document is to provide a clear, coherent and consistent explanation of our high pressure (HP) network augmentation program for the next access arrangement (AA) period (July 2023 to June 2028). The program comprises 11 augmentation projects across a number of network growth areas over the period. These are summarised in TableExecSumm 1.

TableExecSumm 1: Summary of proposed high pressure network augmentations 2023/24 to 2027/28

Network growth area	Potential number of customers impacted	Untreated risk	Project description	Cost estimate ($ million)
Cranbourne	52,000	High	Install 6.4 km of HP mains and a new field regulator located on Hall Rd.	9.4
Echuca	9,000	Moderate	Install 1 km of PE main on McKenzie Road, duplicating existing DN200 steel main.	0.8
Thomastown	69,000	High	Install a new City Gate in Wollert near Andrews Rd, 1km of Steel supply main and 1km of PE main in Rockfield St and in Yann Dr.	7.7*
Wallan	5,300	Moderate	Install 720 m of PE mains in the township.	1.3
Traralgon	Up to 10,000	Moderate	Duplicate 4.4 km of main in Firmin St, Latrobe Cres, Davidson St, Gordon St, Burn St, Cross's Rd and Grubbs Ave.	2.2
Wodonga	1,200	Moderate	Install 600 m of PE main from Victoria Cross Parade to Balmoral Dr along Beechworth Rd.	0.6
Berwick	21,000	High	Transfer the Clyde North Network load to the Huckerby Dr City Gate.	1.1
Eltham	Up to 10,000	Moderate	Install 680 m of PE mains within Plenty, Lower Plenty and Montmorency.	1.0
Howlong	1,100	Moderate	Duplicate 5.3 km of existing mains in the township with PE.	2.8
Pakenham	22,300	High	Install a new City Gate central to future growth area near Dore Rd.	6.4
Somerville	6,000	Moderate	Install a new field regulator at Eramosa Road East.	4.0
Total				**37.3**

*Approximately $3.6 million of the Thomastown augmentation will be incurred in the current AA period, with the project total being ~$11.3 million.

The purpose of these eleven projects is essentially the same: mitigating growth-driven delivery pressure decreases in parts of the downstream distribution network.

As the number of customers connected to our network grows, it can cause supply pressures to decline, particularly during peak consumption times. Declining delivery pressures are a particular risk when large numbers of new customers connect in the same area (for example a new housing estate). Put simply, the HP gas supply fed into that section of the network gets spread more thinly, and pressures can fall.

If pressures in the gas distribution fall below the minimum HP supply threshold (140 kPa as specified in the Gas Distribution System Code), the downstream gas supply to customers may be interrupted and/or gas appliances may become inoperable. This causes reliability issues and in extreme cases, safety risks.

Customers at the fringe of the network tend to be most at risk of substandard delivery pressures. This is because their premises are generally located far away from the district regulator station (supply point) and have limited route of supply. However, there is potential for all customers connected to that section of network to be impacted. We must therefore invest in our network to augment the HP systems and mitigate downstream issues.

The two key drivers of the need for network augmentation are:

- peak hourly gas demand; and
- new connections.

Peak hourly demand has remained stable in recent years, despite the decrease in overall gas consumption. New connections to the network have been higher than expected during the current AA period, and are expected to continue to grow over the next period. This combination of consistent peak usage per customer and increasing connections means the overall amount of gas being consumed at the peak is still growing.

We have a duty of care to provide a reliable gas supply and ensure our customers can use their gas appliances safely at all times. This means providing gas at adequate pressures, even during the peak.

The modelling summarised in this document shows that current growth rates indicate the minimum pressure during peak periods will drop below 140 kPa in several parts of our network within the next five years. We must therefore undertake the works outlined in TableExecSumm 1, to make sure existing customers get the service they expect, and new customers can continue to connect.

Our HP network augmentations will see the installation of new HP mains and pressure regulating stations in, and around, high growth northern and southern metropolitan corridors, as well as in regional areas. For each of the 11 HP projects we have considered a primary and a secondary technical solution, as well as the implications of not conducting the works. The main body of this document outlines the overarching augmentation approach and considerations, while the 11 individual business cases and options analysis are included in Addendum A.

In each case, we submit the proposed works meet the requirements of section 79 and 74 of the National Gas Rules and are consistent with promoting the National Gas Objective. The program is also necessary to meet our supply pressure obligations under the Gas Distribution System Code, and associated Australian Standards.

1. Background and context

The Victoria and Albury natural gas distribution network includes over 12,000 km of pipelines, delivering gas to more than 740,000 customers. The majority of our customers are residential and small business consumers, which consume a combined total of 41 Petajoules of gas per year[1].

To ensure our customers receive a reliable gas supply, it is vital gas is delivered to each premises at or above a minimum supply pressure. The pressure at which gas is supplied directly impacts the gas flow to each property, and each customer's ability to use their gas appliances properly and safely.

Minimum delivery pressures for gas distribution networks in Victoria are specified in Schedule 1 of the Gas Distribution System Code.[2]

Figure 1-1: Minimum distribution system pressures for Victorian gas distribution networks

Gas Distribution System Code **Version 14.0**

SCHEDULE 1

PART A DISTRIBUTION SYSTEM PRESSURE

A *Distributor* must use all reasonable endeavours to maintain sufficient *distribution system* pressures to ensure the minimum pressure is maintained at the *distribution supply point*. The typical indicative daily pressure for each category of *distribution system* is as follows:

Distribution System	**Distribution System Pressure (*kPa* gauge)**		
Category	**Maximum**	**Minimum at *Distribution Delivery Point***	
		Fringe Point #	**Outlet of Meter ***
Low Pressure	7	1.4	1.1
Medium Pressure	20-210	15	1.1
High Pressure 1	515	140	1.1
High Pressure 2	1050	600	1.1
Transmission Pressure	Maximum allowable operating pressure under the Pipeline Licence	On application	1.1

* Or other such value where a higher supply pressure has been agreed.

As shown in the figure above, the minimum level necessary to maintain a safe and reliable customer supply from our high pressure (HP) networks is 140 kPa. If pressures in the gas distribution fall below the minimum supply threshold in the HP system, the downstream gas supply to customers may be interrupted and/or gas appliances may become inoperable. This causes reliability issues and in extreme cases, safety risks.

[1] 2021 data, AGN Vic & Albury
[2] https://www.esc.vic.gov.au/sites/default/files/documents/Gas-Distribution-System-Code-version-14.pdf

A drop in distribution pressure can be caused by several things, and pressure drops can be sudden or gradual. Both must be addressed in a timely manner.

A sudden drop in pressure would typically be caused by a mains blockage, break, or regulator set failure. These are addressed through proactive asset replacement and rapid reactive repair upon failure.

However, pressure can also decline gradually over time due to network growth. As more customers connect to the network and more gas is consumed at the same time, delivery pressures in parts of the distribution network can fall, particularly at peak consumption times.

This growth-driven delivery pressure risk is especially pertinent if a large number of new customers connect in the same area (for example a new housing estate). Put simply, the HP gas supply fed into that section of the network gets spread more thinly, and pressures decline.

Customers at the fringe of the network tend to be most at risk of substandard delivery pressures. This is because their premises are generally located far away from the district regulator station (supply point) and have limited route of supply.

Typically, the growth-driven delivery pressure risk is addressed by adding connection points, or extending, trunk mains feeding the affected section of distribution network, or by upgrading regulators to increase supply (or a combination of both).

A further consideration as the network grows is the level of back feeds in the distribution network. As the number of connections increase and new sections of distribution network are built, it is important to provide for the capacity to conduct for critical maintenance work or mains replacement without having to disrupt supply to large numbers of customers due to limited or no back feeds within the network design.

Therefore, as part of our network growth and augmentation plans, we consider the risk of supply interruptions and the ability to mitigate those by supplying a section of distribution network from another point on the HP system or by connecting mains to re-direct gas flows. Where a section of distribution network only has one source of supply, we will consider whether an augmentation is required to install a second supply point.

The series of projects covered by this document are designed to address this risk of growth-driven pressure drop and capacity shortage.

1.1. Network flows and growth

The distribution network must be able to adequately supply all customers during peak consumption times, during normal operating conditions. This ensures alignment with industry good practice, as well as compliance with its obligations under Schedule 1 of the Gas Distribution System Code. Where growth indicates that delivery pressures are likely to fall during peak times, as a prudent service provider we must invest proactively in our network to cater for customer demand. Our aim is to ensure our customers' gas supply remains available and reliable; at the times they need it the most.

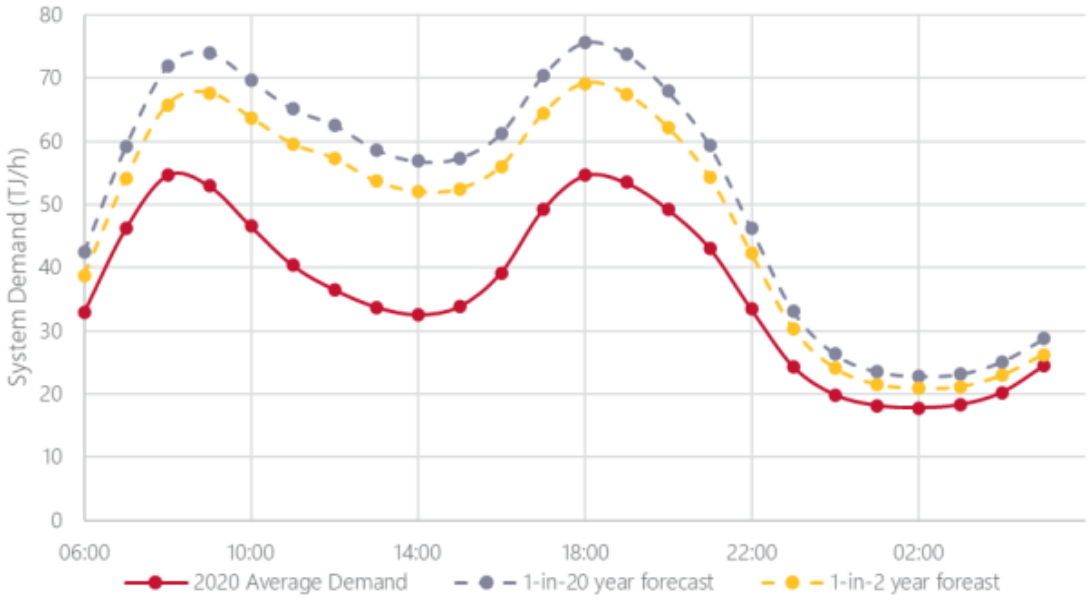
The volume of gas consumption per customer has decreased with time. However, average annual consumption is not the primary driver of distribution network investment with regard to maintaining delivery pressures. The main driver is the hourly peak day demand, as illustrated in the March 2021 Victorian Gas Planning Report in Figure 1-2 below.

Figure 1-2: Hourly peak day demand profile, 2021

2.3.3 Hourly peak day demand

The 2021 forecast hourly winter 1-in-2 and 1-in-20 peak day system demand days are shown as dashed lines in Figure 10, with the average hourly demand in winter 2020. This illustrates the substantial increase in hourly demand that is forecast to occur on peak days over the average demand, particularly prior to 10:00 pm. The forecast hourly peak day system demand reflects changes to the demand profile due to the COVID-19 pandemic, as discussed in Section 2.3.4.

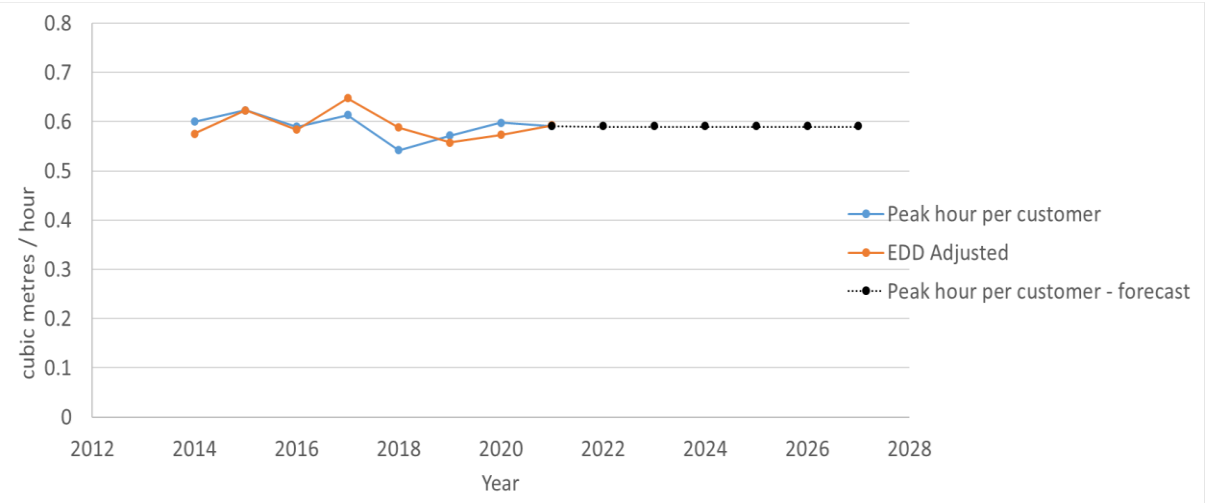
Figure 10 Average hourly winter profile for 2020 and forecast peak day system demand profile for 2021 (TJ/hr)



Peak hourly system demand forecasts over the outlook period, and monthly forecasts for January 2021 to December 2021, are presented in Appendix A2.

As shown in Figure 1-3 below, the peak hourly average load in Victoria has remained relatively stable over the past 6 years (currently 0.6 m^3/hr/customer). Given recent consistent levels, the peak hourly average load has been forecast to continue at a similar level moving forward.

Figure 1-3: Peak use per customer - actuals and forecast



EDD = Effective Degree Days. In Victoria, an EDD is used to quantify the impact of a range of meteorological variables on gas consumption and maximum demand. This is due to Victoria showing a high sensitivity to seasonality, wind speed, and the hours of sunshine with its heating load.

Over the next five years (2023/24 to 2027/28), we expect the number of customer connections to our network to continue to grow by approximately 15,000 per year. Refer to Attachment 13.1 of our Final Plan for an overview of our demand forecasts which include connection growth forecasts.

The growing number of connections, in combination with the stable peak usage per customer, means that the overall amount of gas being consumed at the peak is still growing. This peak growth is driving a requirement to undertake several network augmentations to maintain minimum operating pressures over the next AA period. The proposed augmentations cluster around key growth metropolitan and regional areas where residential and commercial dwellings are being constructed, and new subdivisions are expanding into greenfield areas, thereby putting strain on the existing gas infrastructure.

1.2. Growth areas

The key growth areas in the AGN Victoria & Albury network are:

- Northern corridor – Hume Highway route including Eltham, Wollert and Wallan
- Southern corridor – Cranbourne & Clyde
- Regional areas – Echuca, Wodonga and Traralgon

As a result, augmentation works are planned for these areas over the next AA period. A high level overview of the growth areas and the proposed augmentations is shown in the following maps.

Figure 1-4: AGN Victoria & Albury: Northern growth corridor

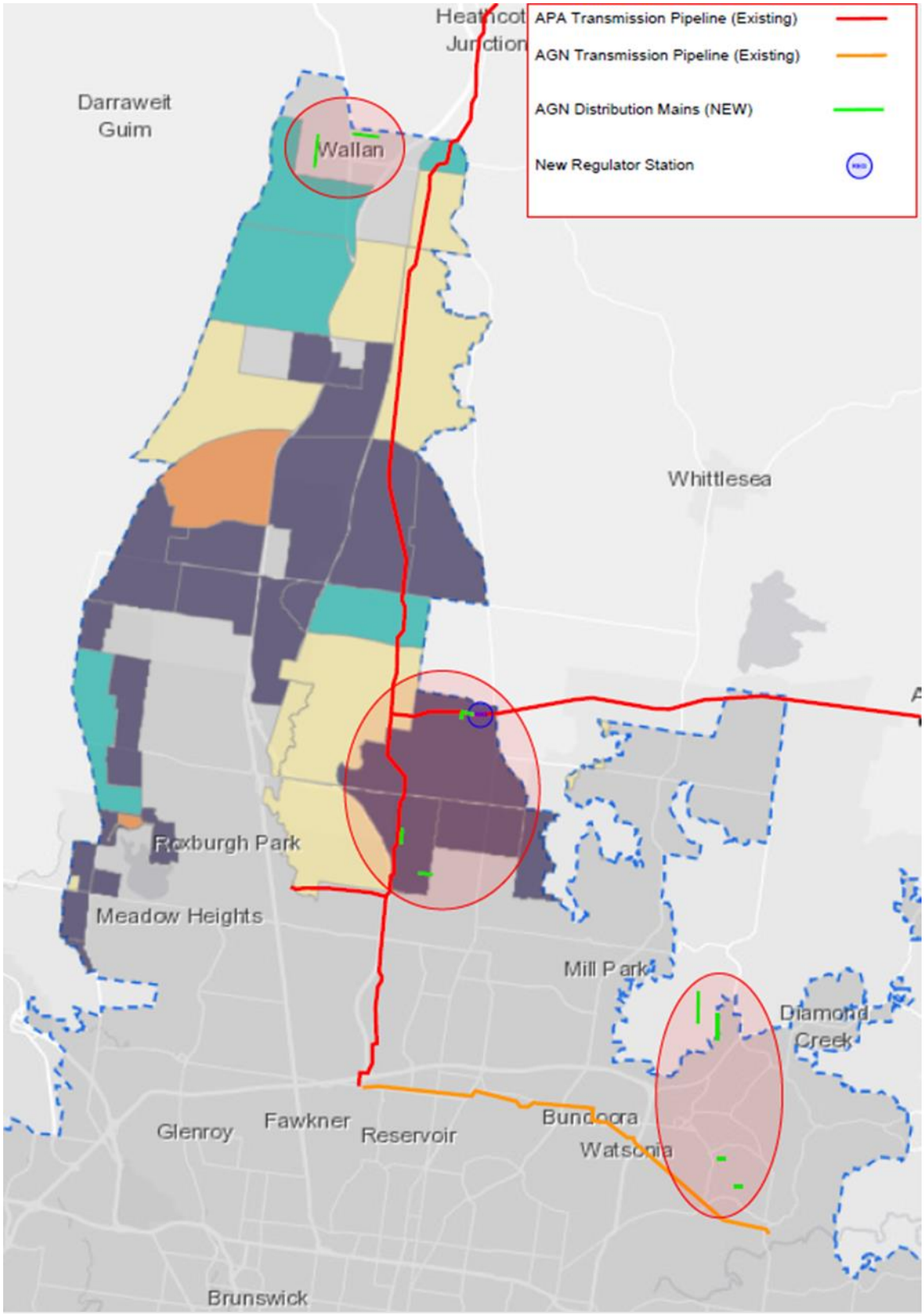


Figure 1-5: AGN Victoria & Albury: Southern growth corridor

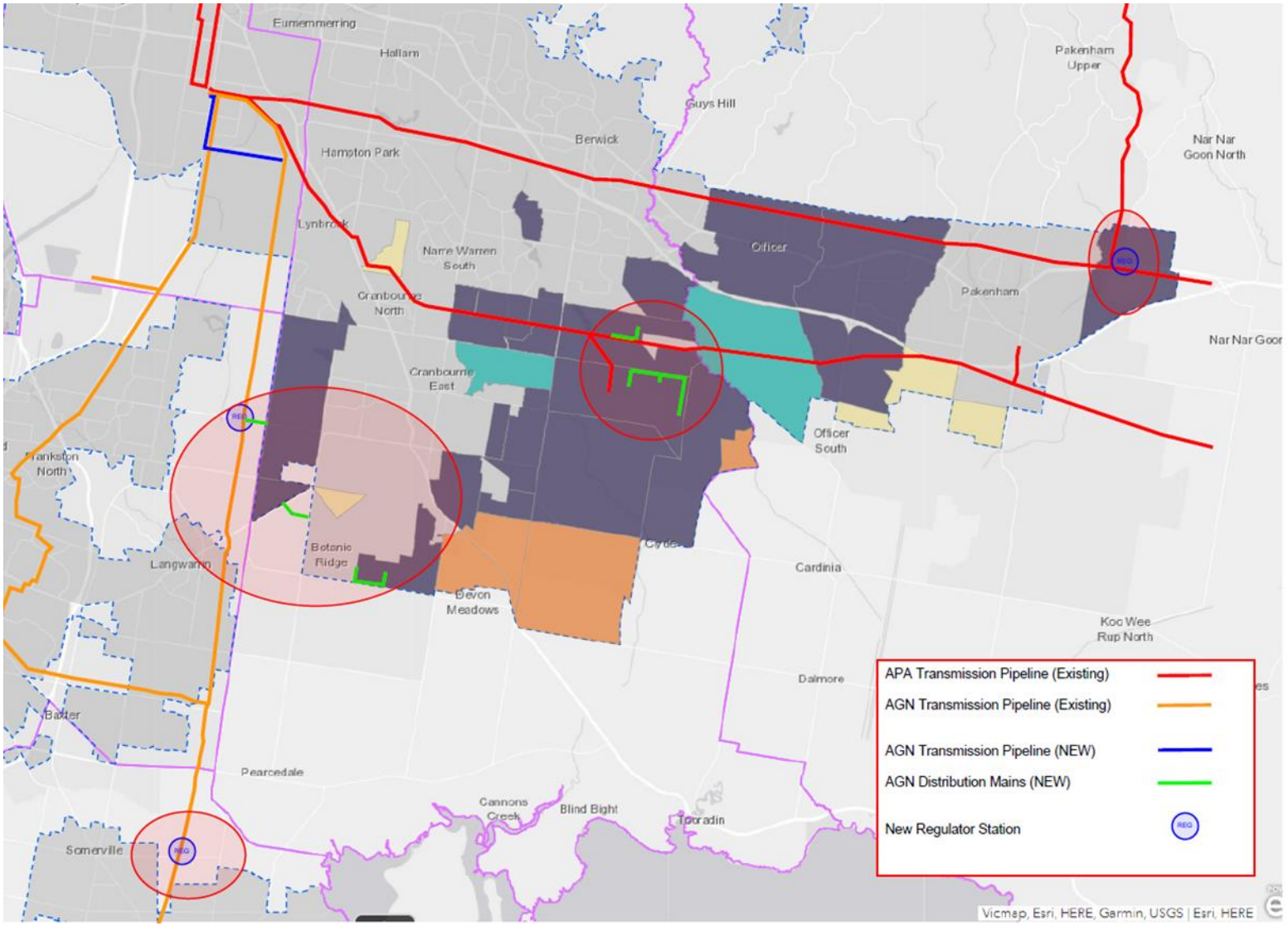


Figure 1-6: AGN Victoria & Albury: Regional growth area - Wodonga

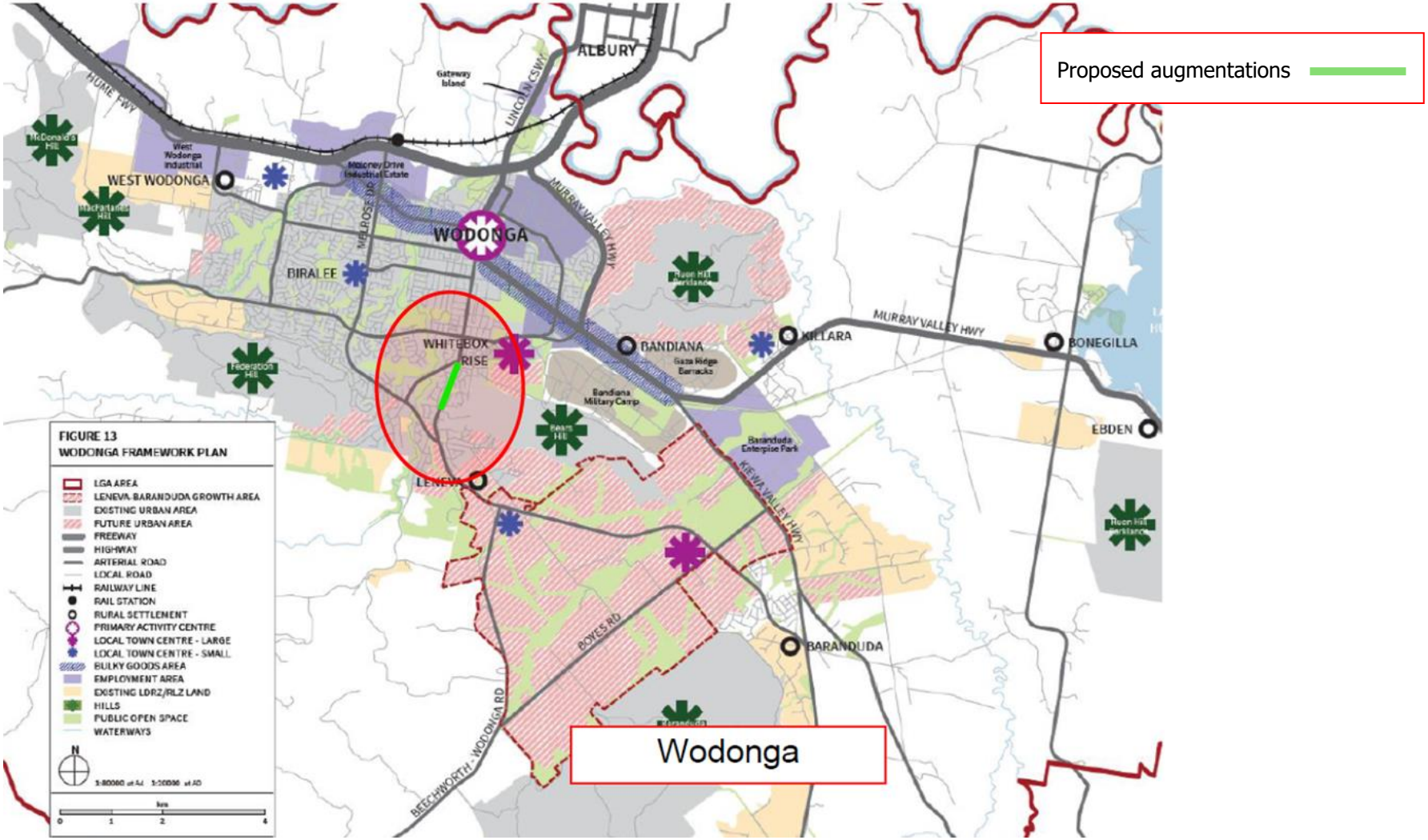


Figure 1-7: AGN Victoria & Albury: Regional growth area - Traralgon

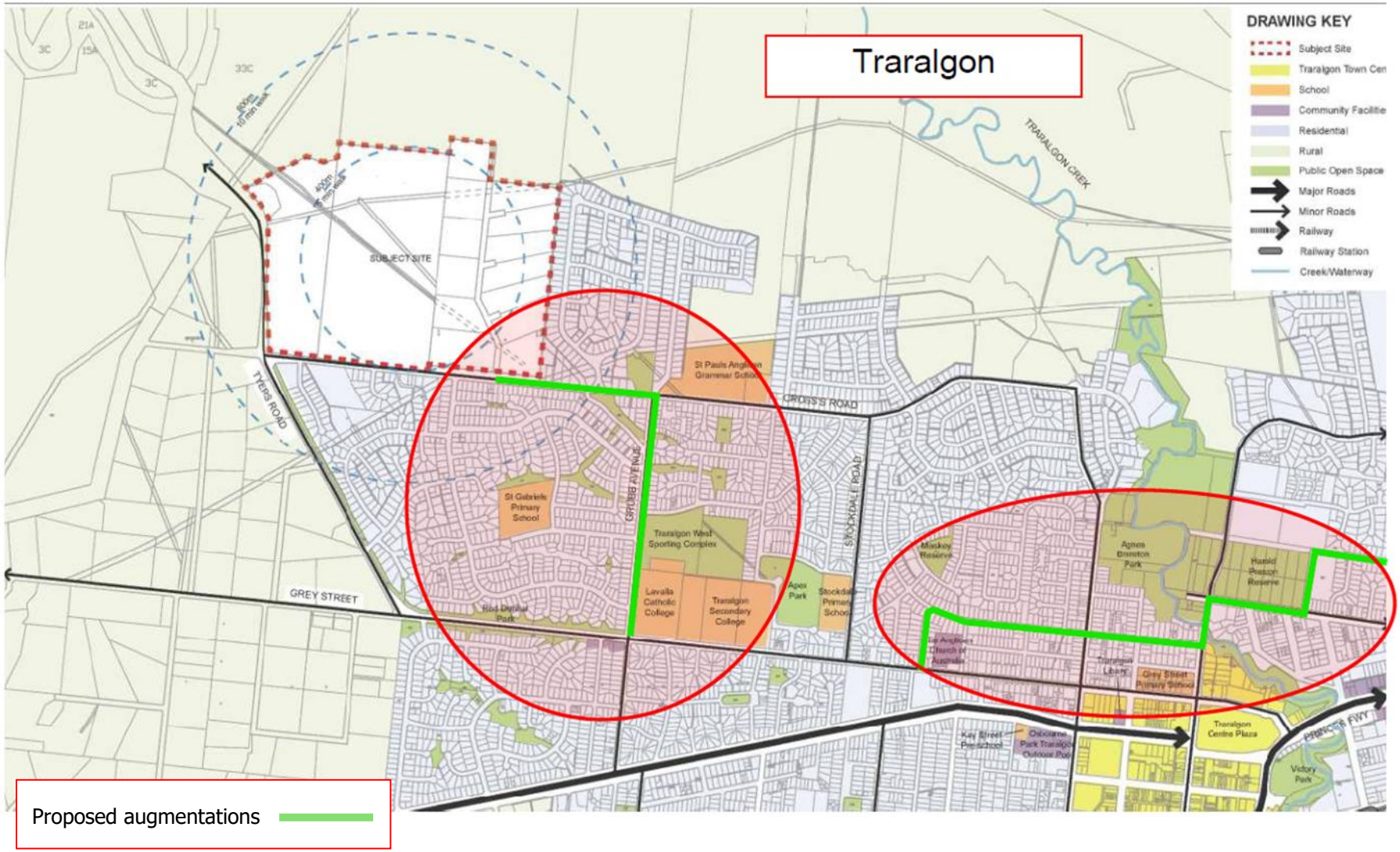


Figure 1-8: AGN Victoria & Albury: Regional growth area - Howlong

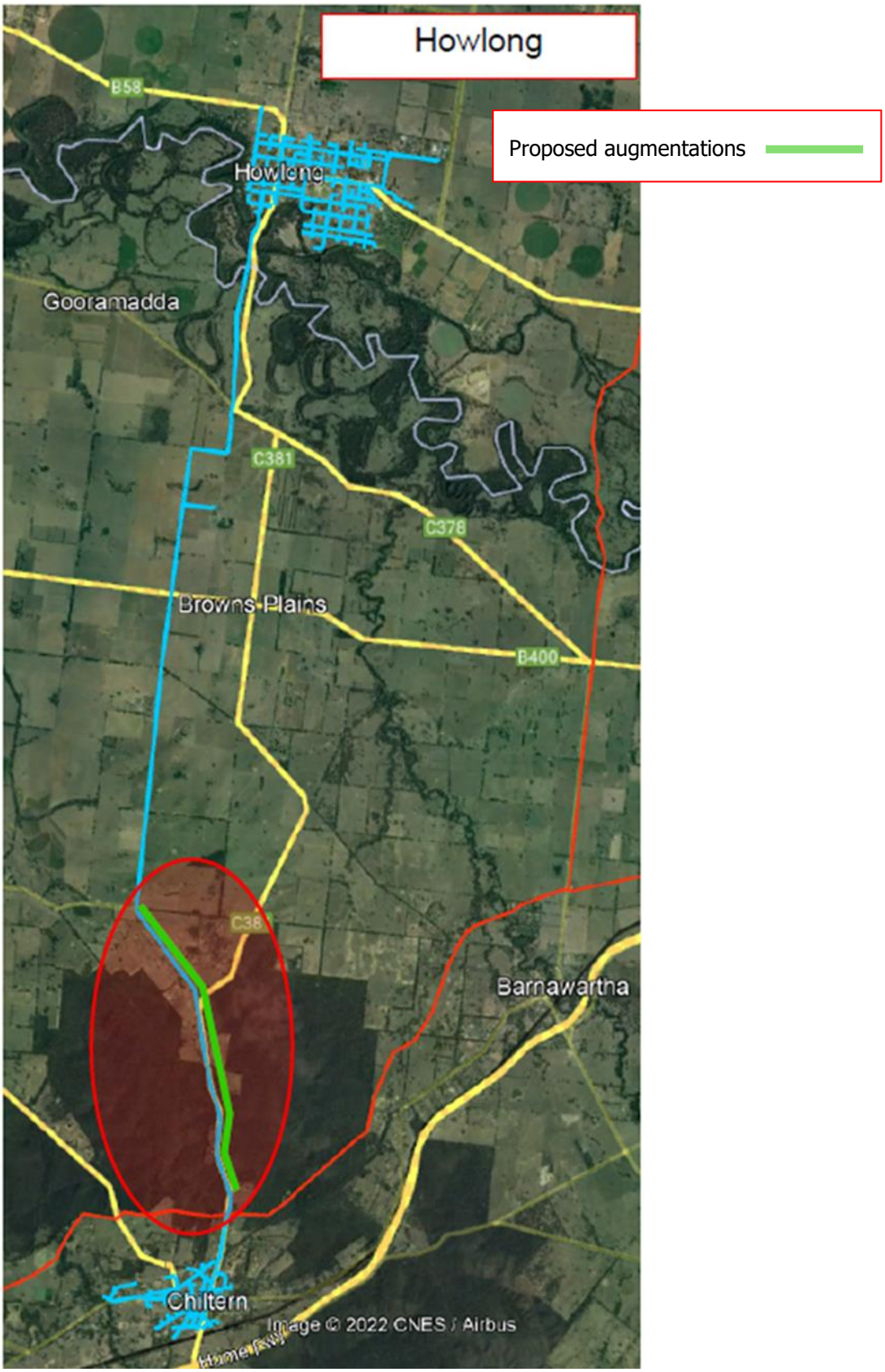
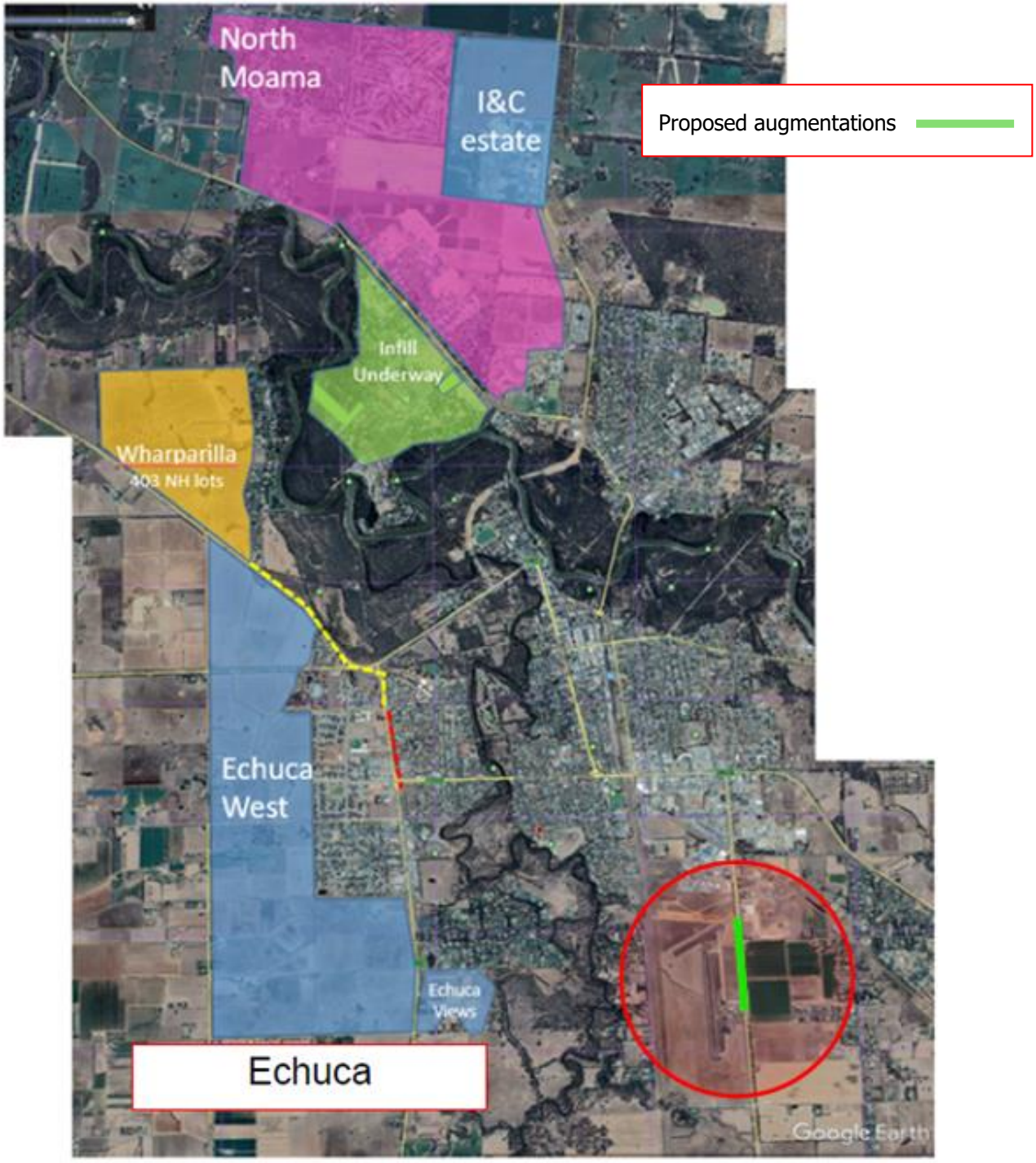


Figure 1-9: AGN Victoria & Albury: Regional growth area - Echuca



1.3. Augmentation project summary

To keep pace with growth and mitigate delivery pressure risks, we need to undertake eleven augmentation projects on parts of our HP network. The proposed projects are summarised in Table 1-1.

Table 1-1: Summary of proposed high pressure network augmentations 2023/24 to 2027/28

Project name	Summary description	Estimated cost in next AA period ($ million)
Cranbourne HP network augmentation	Install 6.4 km of HP mains and a new field regulator located on Hall Rd.	9.4
Echuca HP network augmentation	Install 1 km of PE main on McKenzie Road, duplicating existing DN200 steel main.	0.8
Thomastown HP network augmentation	Install a new City Gate in Wollert near Andrews Rd, 1km of Steel supply main and 1km of PE main in Rockfield St and in Yann Dr.	7.7*
Wallan HP network augmentation	Install 720 m of PE mains in the township.	1.3
Traralgon HP network augmentation	Duplicate 4.4 km of main in Firmin St, Latrobe Cres, Davidson St, Gordon St, Burn St, Cross's Rd and Grubbs Ave.	2.2
Wodonga HP network augmentation	Install 600 m of PE main from Victoria Cross Parade to Balmoral Dr along Beechworth Rd.	0.6
Berwick HP network augmentation	Transfer the Clyde North Network load to the Huckerby Dr City Gate.	1.1
Eltham HP network augmentation	Install 680 m of PE mains within Plenty, Lower Plenty and Montmorency.	1.0
Howlong HP network augmentation	Duplicate 5.3 km of existing mains in the township with PE.	2.8
Pakenham HP network augmentation	Install a new City Gate central to future growth area near Dore Rd.	6.4
Somerville HP network augmentation	Install a new field regulator at Eramosa Road East.	4.0
Total		**37.3**

*Approximately $3.6 million of the Thomastown augmentation will be incurred in the current AA period, with the project total being ~$11.3 million.

The drivers for all these projects are essentially the same. They are each addressing the same type of risk: mitigating growth-driven delivery pressure decreases in parts of the downstream distribution network. The similarities between the projects means our asset

management approach, risk treatments, and engineering options considered for each project are broadly the same. While the projects are discrete, the approach by which we develop the proposed solutions, estimate costs, and assess risk are common to all.

Therefore, to limit repetition and to promote consistency in the documentation and considerations for this suite of similar projects, we have incorporated the eleven standalone business cases into one overarching strategic document. Individual project costings, options analyses and project specifics are provided in Addendum A. Common elements for each project are covered in the main body of this document.

1.4. Values used in this document

All financial values in this document are expressed in real dollars at June 2021, unless otherwise stated.

Asset information is current as at December 2021. Our growth forecasts were independently prepared by Core Energy and are provided in Attachments 13.1 and 13.2 to this Final Plan.

Tables may not sum due to rounding.

1.5. Stakeholder engagement

We are committed to operating our networks in a manner that is consistent with the long-term interests of our customers. To facilitate this, AGN conducts regular stakeholder engagement to understand and respond to the priorities of our customers and stakeholders. Feedback from stakeholders is built into our asset management considerations and is an important input when developing and reviewing our expenditure programs.

Our customers have told us their top three priorities are price/affordability, reliability of supply, and maintaining public safety. They also told us they expect AGN to deliver a high level of public safety.

Consistent with our customers' priorities, the HP network augmentation projects are essential to ensure customers continue to receive a reliable natural gas supply above the minimum acceptable pressure. We have looked at several options to address the pressure drop risk in those sections of the distribution impacted by load growth, and in each case have selected the solution we believe has the lowest cost impact on customers over the long term.

2. Network augmentation planning and design

2.1. Capacity management

We manage network capacity by monitoring network performance, assessing forecast demand and assessing threats to supply. Network capacity issues are addressed according to the risk they present, and are undertaken subject to the requirements of the AGN risk management framework.

The network requires augmentation under two principal circumstances:

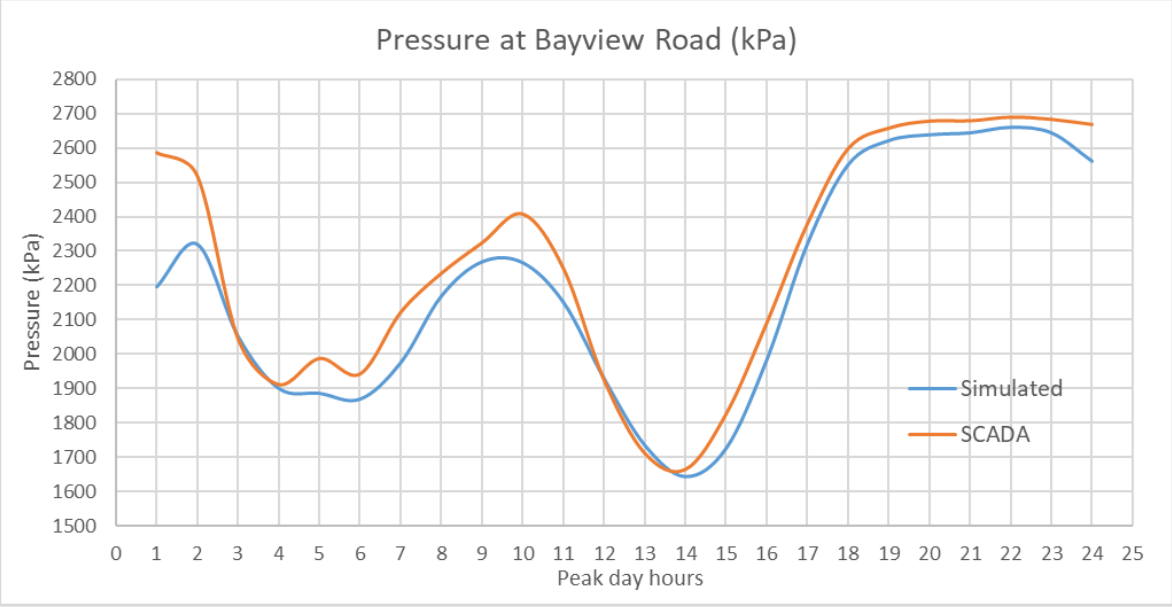
- the minimum pressure in a network falls, or is forecast to fall, below the recommended minimum end of main pressure during design load conditions; or
- there is insufficient redundancy within the network, which adversely affects the security of supply to a large number of customers.

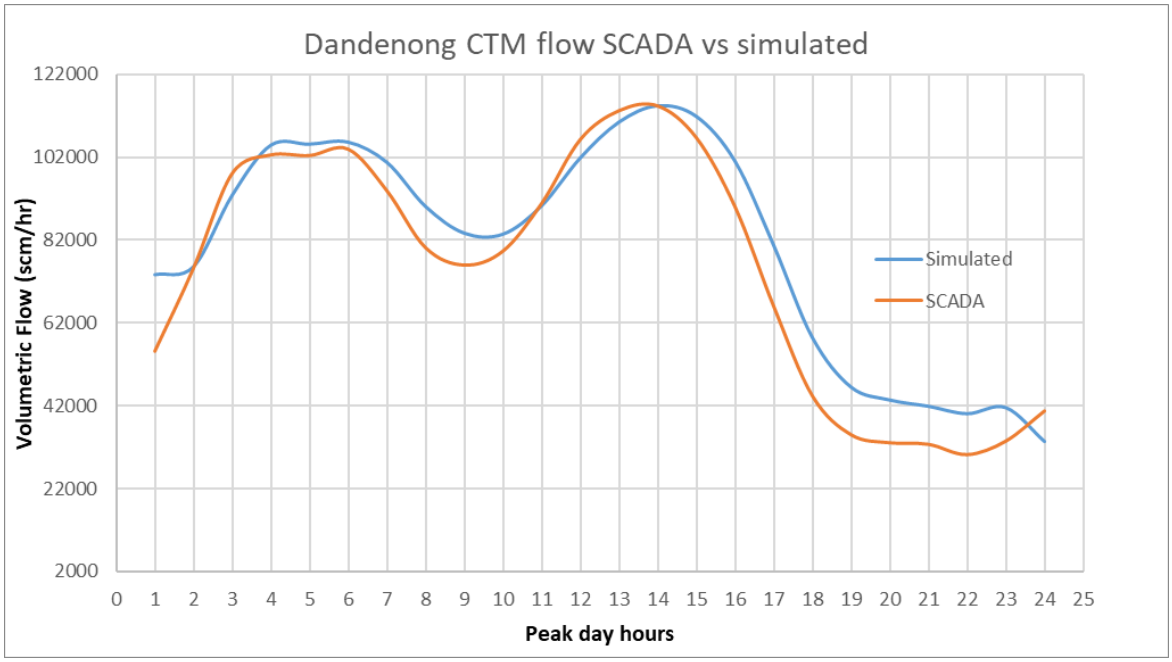
Our capacity management process involves the activities described in the section below.

2.1.1. Maintaining baseline capacity models

Network configurations within the Geospatial Information System (GIS) are exported into capacity modelling software (Synergi). We validate network models against actual field conditions using gate station inputs, large volume customer hourly demand, system pressures, and derived domestic, commercial and industrial loads. Computer models are iteratively balanced so that modelled pressures match those from the field. This methodology and process is industry best practice to ensure accurate network models and hydraulics are forecast.

Figure 2-1: Capacity modelling examples, Synergi software





2.1.2. Design load assessment

We derive domestic, commercial and small industrial design loads from the validated baseline network load, corrected to allow for additional consumption consistent with a one-in-two probability winter's day. Tariff D customer load is normalised based on variation in consumption during the daily peak hour period throughout winter. In each case we base the design load on a peak hourly load, as this is the important parameter for maintaining supply to the network. The current hydraulic model aligns with the most recent dynamics of residential consumption.

2.1.3. Forecasting load growth

We develop a forecast of the number and location of new residential connections using a range of sources, including:

- historical actual trends;
- planning authority publications;
- precinct structure plans;
- publicly available documentation from "forecast.id";
- HIA statistics; and
- internal marketing and business development data.

We use market trend analysis to determine the rate of new connections for industrial and commercial, and demand market sectors.

2.1.3.1. Penetration rates

Penetration rates are an important consideration when estimating the impact of connection growth. While new homes are being built all the time, we rely on historical precedent, coupled with emerging trends, to estimate how many of those new customers will connect to the natural gas network.

While the penetration rate for different areas can vary depending on climate, cost and demographics, the overall penetration rate for natural gas in Victoria is relatively high. The historical average penetration rate for new (greenfield) developments where gas is available is >95%.

2.1.4. Hydraulic modelling

We use hydraulic modelling to understand the impact of new connections on our network. Additional connections are converted to the forecast hourly demand within the network to develop an annual load growth profile, which we superimpose on the network model to identify future capacity constraints.

The industry standard hydraulic computer modelling software, Synergi, is used to evaluate various load scenarios and augmentation options. Capacity shortfalls are identified, and solutions modelled to confirm augmentation requirements.

The first considered solution by our hydraulic asset management engineers is always to rebalance the network through the manipulation of HP regulating equipment to improve the flow dynamics in the network. This may include the changing of network input pressures at multiple locations, or the increasing of supply pressures. However, once the network is operating towards its maximum allowable operating pressure (MAOP), this no longer becomes a viable long-term solution and incremental increase in pressure can no longer be undertaken. At this point addition infrastructure is required.

Once pressure alterations and numerous network flow balancing options have been exhausted, further hydraulic modelling is completed to determine various pipeline and regulating equipment combinations and solutions that could mitigate the low pressure risks.

2.1.5. Project scoping

Once the various capacity, replacement and security of supply issues are reviewed and options considered they are transferred to business cases for formal executive review and consideration. We review projects annually to confirm their timing and scope.

3. Risk assessment

Risk management is a constant cycle of identification, analysis, treatment, monitoring, reporting and then back to identification (as illustrated in Figure 3-1). When considering risk and determining the appropriate mitigation activities, we seek to balance the risk outcome with our delivery capabilities and cost implications. Consistent with stakeholder expectations, safety and reliability of supply are our highest priorities.

Figure 3-1: Risk management principles applied

Our risk assessment approach focuses on understanding the potential severity of failure events associated with each asset and the likelihood that the event will occur. Based on these two key inputs, the risk assessment and derived risk rating then guides the actions required to reduce or manage the risk to an acceptable level.

AGN's risk management framework is based on:

- AS/NZS ISO 31000 Risk Management – Principles and Guidelines;
- AS 2885 Pipelines-Gas and Liquid Petroleum; and
- AS/NZS 4645 Gas Distribution Network Management.

The Gas Act 1997 and Gas Regulations 2012, through their incorporation of AS/NZS 4645 and the Work Health and Safety Act 2012, place a regulatory obligation and requirement on AGN to reduce risks rated high or extreme to low or negligible as soon as possible (immediately if extreme). If it is not possible to reduce the risk to low or negligible, then we must reduce the risk to as low as reasonably practicable (ALARP).

When assessing risk for the purpose of investment decisions, rather than analysing all conceivable risks associated with an asset, we look at a credible, primary risk event to test the level of investment required. Where that credible risk event has an overall risk rating of moderate or higher, we will consider investment options and potential non-capital solutions to reduce the risk.

Seven consequence categories are considered for each type of risk:

1. **Health & safety** – injuries or illness of a temporary or permanent nature, or death, to employees and contractors or members of the public
2. **Environment (including heritage)** – impact on the surroundings in which the asset operates, including natural, built and Aboriginal cultural heritage, soil, water, vegetation, fauna, air and their interrelationships
3. **Operational capability** – disruption in the daily operations and/or the provision of services/supply, impacting customers
4. **People** – impact on engagement, capability or size of our workforce
5. **Compliance** – the impact from non-compliance with operating licences, legal, regulatory, contractual obligations, debt financing covenants or reporting / disclosure requirements
6. **Reputation & customer** – impact on stakeholders' opinion of AGN, including personnel, customers, investors, security holders, regulators and the community

7. **Financial** – financial impact on AGN, measured on a cumulative basis

Note that risk is not the sole determinant of what investment in our network is required. Many other factors such as growth, cost, efficiency, sustainability and the future of the network are also considered when we develop engineering solutions. The risk management framework provides a valuable tool to manage our assets, and prioritise our works program, however it is not designed to provide a binary (yes/no) trigger for investment. As prudent asset managers, we apply our experience and discretion to manage and invest in our distribution networks in the best interests of existing and potential customers.

A summary of our risk management framework, including definitions, has been provided in Attachment 9.5 to the Final Plan.

3.1. Identified primary risk

The identified risk relating to an increasing number of customer connections and associated load growth is as follows:

> *Load growth without network reinforcement or augmentation will cause delivery pressures to drop, leading to substandard supply or loss of supply to customers. This may also lead to customers' gas appliances becoming inoperable or damaged in certain circumstances*

A drop in supply pressures can, in certain circumstances, lead to a gas in building event and ultimately a safety risk. However, a major safety event due to pressure drop is rare. Therefore, the primary risk being addressed in all the HP network augmentation projects is the potential for thousands of customers being without supply.

The consequence ratings for unplanned customer interruptions are determined by our risk management framework, which is aligned to Australian Standards, and fall under the risk category 'Operational capability' (or 'Operations' for short). The risk consequence ratings for disruption to gas supply are outlined in the following table.

Table 3-1: Risk consequence ratings for operational capability risk (disruption to gas supply or services)

Identified risk	Operational capability - disruption to gas supply or services
Consequence ratings	
1. Minimal	Unplanned loss of service to <100 domestic or I&C customers Minor property damage
2. Minor	Unplanned loss of service to: • 100 - 1,000 customers; or • 1 demand customer (>10TJ pa
3. Significant	Unplanned loss of service to: • >1,000 customers; • multiple demand customers (>10TJ pa); or • a single high risk site, without alternate supply options, (hospital, nursing home, home on life support)

Identified risk	**Operational capability - disruption to gas supply or services**
Consequence ratings	
4. Major	Unplanned loss of service to: • a regional area or greater than >10,000 customers; • a demand customer (>10TJ pa) with customer loss of revenue or infrastructure damage; or • to multiple high risk sites without alternate supply options (hospitals, nursing homes, homes on life support). Extensive property damage
5. Catastrophic	Unplanned loss of service to: • a metropolitan area; or • multiple demand customers (>10TJ pa) with customer losses of revenue or infrastructure damage.

The likelihood of the identified risk occurring is considered against the framework outlined in the following table.

Table 3-2: Likelihood assessment

Likelihood	**Description**
Frequent	Expected to occur on a regular basis and many times (many times in 1 year)
Occasional	May occur occasionally or in many circumstances (every 2 years)
Unlikely	Unlikely to occur but possible when certain circumstances prevail (every 5 years)
Remote	Not anticipated but may occur if certain abnormal circumstances prevail (every 20 years)
Rare	Conceivable, but has not been known to arise previously (every 50 years)

The number of and resultant risk rating is determined by the total number of customers affected. By way of example, the disruption to supply risk in the Cranbourne area of our network, which services around 52,000 customers, results in a major consequence rating under the risk matrix.

Given load growth occurs over several years, the likelihood of a major disruption to customer supply will also change over time if no network reinforcement or augmentation is conducted. For example, the likelihood of a supply risk at the beginning of a growth period may be considered occasional, (every couple of years). However, if no action is taken, the likelihood may increase to frequent, pushing the overall risk rating higher.

It is therefore imperative that network reinforcement/augmentation to address the supply risk posed by load growth is undertaken prior to the risk materialising.

The typical untreated risk[3] rating for a pressure drop impacting >10,000 customers is presented in Table 3-3.

[3] Untreated risk is the risk level assuming there are no risk controls currently in place. Also known as the 'absolute risk'.

Table 3-3: Loss of supply risk in distribution networks – Untreated risk

Untreated risk	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Remote	Rare	Occasional	Rare	Occasional	Occasional	Occasional	High
Consequence	Major	Minimal	Major	Minimal	Significant	Significant	Minor	
Risk Level	Moderate	Negligible	High	Negligible	Moderate	Moderate	Low	

Similarly, where the number of customers at risk of loss of supply is less than 10,000, but more than 1,000 (for example in our Echuca network), the overall risk rating would be moderate. Note that a moderate risk rating still requires treatment to reduce it to ALARP, and would therefore signal that network augmentation or a suitable alternative risk treatment is required.

The risk assessments for each of the projects covered in this document follow the same pattern, in that the primary risk is to operations (disruption to supply). Compliance and reputational risks are also key considerations.

The likelihood of a supply disruption if no action is taken is rated occasional in all instances. The severity of risk in each case varies according to the number of customers potentially impacted.

The specific risk ratings for each project (and options considered) are provided in Addendum A. The overall untreated risk ratings are summarised in Table 3-4.

Table 3-4: Summary of risk rating for HP augmentation projects

Project name	Potential number of customers impacted	Untreated risk rating
Cranbourne HP network augmentation	52,000	High
Echuca HP network augmentation	9,000	Moderate
Thomastown HP network augmentation	69,000	High
Wallan HP network augmentation	5,300	Moderate
Traralgon HP network augmentation	Up to 10,000	Moderate
Wodonga HP network augmentation	1,200	Moderate
Berwick HP network augmentation	21,000	High
Eltham HP network augmentation	Up to 10,000	Moderate
Howlong HP network augmentation	1,100	Moderate
Pakenham HP network augmentation	22,300	High
Somerville HP network augmentation	6,000	Moderate

In all instances, we recommend action be taken to address the untreated supply risk within the next five years. Projects will be prioritised by risk rating. Any project currently considered a moderate (not ALARP) risk, must be completed prior to the risk escalating to high due to the increased likelihood of a major supply disruption.

3.2. Key secondary risks

Operational capability and the disruption to gas supply or services is the primary risk identified, however, it is important to also recognise the secondary risks regarding compliance and operations for HP augmentations proposed within this portfolio of work.

3.2.1. Compliance

The compliance requirements for minimum delivery pressures for gas distribution networks in Victoria are specified explicitly in Schedule 1 of the Gas Distribution System Code.[4]

Non-compliance with the Code would be reported to the safety regulator, Energy Safe Victoria. This can result in further external and internal investigations. If AGN were to continue breaching the Code this would ultimately lead to fines. This consequence is assessed as significant.

This risk would occur occasionally, at least every 2 years, and would continue to escalate in frequency with time. This frequency is therefore assessed as occasional. The compliance risk is therefore rated occasional and significant, with the overall untreated risk rating being moderate (non-ALARP).

Augmentations and network reinforcements, by nature, are predominantly in high growth areas. Non-treatment would mean that the number of instances that minimum delivery pressures are breached would therefore escalate quickly, moving the likelihood to frequently and therefore the risk to high.

3.2.2. Health and safety

Life threatening injuries may occur in the scenario that a low-pressure event extinguishes pilot lights, cooktops, heaters or a commercial appliance and gas fills a void, ignites, and causes an explosion that results in life threatening injuries to the public. This consequence is assessed as major as per the AGN risk matrix.

In a conservative assessment of frequency, we have determined that the consequence is not anticipated to occur. However, should these low pressure abnormal conditions be allowed to prevail, the likelihood would be assessed as remote. The health and safety risk is therefore assessed as Remote and Major, with the untreated risk outcome being moderate non-ALARP.

Should the work not be undertaken in a timely manner then the likelihood would increase to occasional, escalating the risk to high.

[4] https://www.esc.vic.gov.au/sites/default/files/documents/Gas-Distribution-System-Code-version-14.pdf

4. Options assessment

Mitigating the risk of pressure drop caused by load growth, typically requires one or more of the following actions:

- installing additional HP polyethylene pipelines to increase the supply of gas to the affected distribution network;
- upgrading or installing new regulating equipment; and
- reinforcing, upsizing or reconfiguring parts of the distribution network.

These potential risk mitigations are considered for each of the HP augmentation projects, and are used to develop credible asset management solutions.

For each of the eleven HP augmentation projects required over the next five years, as a minimum, a primary solution (Option 1) and a secondary solution (Option 2) has been developed, as well as considering the impact of maintaining the status quo (taking no new action to address the risk – Option 3).[5]

Our approach requires at least two credible engineering solutions to be defined and costed, and then assessed according to:

- cost;
- risk reduction;
- consistency with our vision objectives; and
- satisfaction of the tests specified under the National Gas Rules (NGR).

Additional solutions (such as increasing supply pressures or major reconfigurations) may be considered during initial planning stages. However, we aim to distil our HP augmentation business cases down to two fully-costed, credible, engineering options where possible, with the 'status quo' option acting as a baseline for comparison.

[5] Note the options for each business case have been presented in the same order (Option 1 - primary solution, Option 2 - secondary solution, Option 3 – status quo) simply to aid the reader. This does not necessarily reflect the order in which the options were developed by our engineering teams, or the manner in which options are developed/presented in other business cases.

4.1. Comparison of options against cost and risk

For each HP network augmentation project, we compare the various costs and risks to inform which is the most prudent and efficient solution. The individual cost and risk assessments for each project, as well as a description of the proposed solutions, are provided in Addendum A. For convenience, the overall cost and risk comparisons are summarised in the following table.

Table 4-1: Summary of risk rating for HP augmentation projects

Project name	Option 1 – primary		Option 2 - secondary		Option 3 – status quo	
	Cost ($M)	Risk rating	Cost ($M)	Risk rating	Cost ($M)	Risk rating
Cranbourne HP network augmentation	9.4	Low	11.2	Low	-	High
Echuca HP network augmentation	0.8	Low	1.1	Low	-	Moderate
Thomastown HP network augmentation	7.7*	Low	7.7*	Low	-	High
Wallan HP network augmentation	1.3	Low	1.7	Low	-	Moderate
Traralgon HP network augmentation	2.2	Low	2.8	Low	-	Moderate
Wodonga HP network augmentation	0.6	Low	0.9	Low	-	Moderate
Berwick HP network augmentation	1.1	Low	2.2	Low	-	High
Eltham HP network augmentation	1.0	Low	1.6	Low	-	High
Howlong HP network augmentation	2.8	Low	6.8	Low	-	Moderate
Pakenham HP network augmentation	6.4	Low	7.6	Low	-	High
Somerville HP network augmentation	4.0	Low	4.2	Low	-	Moderate

* Approximately $3.6 million of the Thomastown augmentation will be incurred in the current AA period, with the project total being ~$11.3 million.

In all instances, the residual risk rating after implementing either the primary or secondary engineering solutions results in a low risk rating. However, the primary solution would be the preferred option as it typically delivers the required risk reduction for a lower cost.

4.2. Comparison of options against our vision objectives and the NGR

The same risk criteria, vision objectives and NGR assessments are applied to all options across all eleven projects. While the risk assessment and cost of each option may vary between projects, we found that the outcomes of our assessment against our vision objectives and the NGR were consistent across each of the primary, secondary and status quo options for all projects.

Therefore, rather than present vision objective alignment and NGR considerations separately in each business case, the outcomes of the options assessments for each project against our vision objectives and the NGR are summarised in the following sections.

4.2.1. Alignment with vision objectives

The following table provides an overview of how the various options considered align with our vision objectives.

Table 4-2: Summary of how various HP augmentation options align with our vision objectives

Vision objective	Alignment with vision objectives		
	Option 1 (primary)	Option 2 (secondary)	Option 3 (status quo)
Delivering for Customers – Public Safety	Y	Y	N
Delivering for Customers – Reliability	Y	Y	N
Delivering for Customers – Customer Service	Y	Y	N
A Good Employer – Health and Safety	Y	Y	N
A Good Employer – Employee Engagement	-	-	-
A Good Employer – Skills Development	-	-	-
Sustainably Cost Efficient – Environmentally and Socially Responsible	-	-	-
Sustainably Cost Efficient – Delivering Profitable Growth	-	-	-
Sustainably Cost Efficient – Working within Industry Benchmarks	Y	N	N

For each project, both the primary and secondary options satisfy our vision objectives in terms of delivering for customers and being a good employer. As a prudent operator, the engineering solutions put forward in each case provide a credible technical solution, mitigate risks to customers and our employees, and represent a reasonable option.

The key difference between the primary and secondary options is that the secondary option is typically more expensive, and therefore would not be consistent with our objective of being sustainably cost efficient (i.e. delivering a solution for the lowest sustainable cost).

The status quo option does not satisfy our vision objectives, as taking no action will not reduce the risk associated with delivery pressure drop caused by load growth. While 'doing nothing' results in a lower short-term cost, it does not meet our objective of being sustainably cost efficient, as the cost of reactive or piecemeal works in response to a supply failure are typically more expensive over the longer term than proactive works.

4.2.2. Consistency with the National Gas Rules

When considering each of the options against the NGR, specifically rules 74 and 79, the outcomes across the primary, secondary and status quo options are the same. The following table summarises how the various primary, secondary and status quo engineering solutions meet the requirements of the NGR.

Table 4-3: Summary of how various HP augmentation options satisfy NGR 74 and 79

Option	Satisfies NGR 74*	Satisfies NGR 79(1)	Satisfies NGR 79(2)	Comments
Option 1 (primary solution)	Y	Y	Y	**NGR 79(1) –** The primary solution represents a credible engineering solution, consistent with good engineering practice, that addresses the identified risk. Several practicable options have been considered and market rates have been tested. The primary solution will enable AGN to keep pace with load growth and the associated risk for the lowest practicably sustainable cost. **NGR 79(2)** – The proposed capex is justifiable under NGR 79(2)(c)(ii), as it is necessary to maintain the integrity of services.
Option 2 (secondary solution)	Y	N	Y	**NGR 79(1) –** The secondary solution represent a credible engineering solution, consistent with good engineering practice, that addresses the identified risk. Several practicable options have been considered and market rates have been tested. The secondary solution will enable AGN to keep pace with load growth and the associated risk, however, it does so at a higher cost than the primary solution (Option 1). As a result, while Option 2 may represent a reasonable cost, it will not enable us to achieve the lowest practicably sustainable cost of providing services and would therefore not represent the most prudent and efficient solution under NGR 79(1). **NGR 79(2)** – The proposed capex is justifiable under NGR 79(2)(c)(ii), as it is necessary to maintain the integrity of services.
Option 3 (status quo)	Y	N	N	Taking no action to address the delivery pressure drop risk caused by load growth would not meet any of the criteria under NGR 79(2), nor would it represent the actions of prudent service provider as required by NGR 79(1).

* Note all options are developed on a reasonable basis using the best information available at the time of making the forecast. For each augmentation project, the forecast costs are based on the most recent market rate testing, and project options consider the current network condition and risk as per the Asset Management Strategy. The forecasts are therefore consistent with the requirements of NGR 74.

5. Cost estimation method

Given the similar nature of the various engineering solution proposed for each of the HP network augmentation projects, the method we use to estimate the costs of each project is the same. As noted in our Unit Rates Report (provided at Attachment 9.6 to our Final Plan), the unit rates and project forecast costs for all HP network augmentation projects include the internal labour, external labour and materials/other costs forecast.

Cost estimations for augmentation work are based on individual bottom-up builds for each project. This allows each estimate to cater for the unique variables that the project may bring, including the degree of urbanisation, ground conditions and complex junctions and timing.

For installation of a new city gate, external estimating experts are used to compile the estimate. In the case of refurbishment and/or upgrade of an existing city gate, internal cost estimation and expertise is used. In both cases, senior engineers and internal subject matter experts use experience, historical precedent and prevailing economic conditions to provide a top-down challenge to the bottom-up estimate.

The work is delivered by a combination of internal project management and governance practices, as well as the use of contractors with the appropriate capability and skill sets that are procured through market testing tender processes. The unit rates and project forecast costs used in the estimates are based on the following key assumptions:

- **Internal labour** – these costs are based on standard internal labour rates from AGN's operator, APA Group, for direct labour and project management and administration.
- **External labour** – where possible, labour costs have been based on the unit rate achieved as the result of competitive tender between external contractors. This is assumed to reflect the most efficient delivery cost achievable. AGN has a panel of market tested contractors to install the HP mains and to install pressure regulating equipment, who are experienced in delivering the activities and provide the required quality at the most efficient cost. The contractor panel is reviewed every year for changes, as well as a full re-tender completed every 3 to 5 years. The rates utilised in costing these activities are based on current vendor and contractor rates in 2019 and historical costing. For specialist services, the cost estimate is derived from reviewing the cost for similar projects.
- **Materials** – where possible, the cost of the materials required is based on the price achieved for comparable works completed elsewhere in the network. Where a suitable cost estimate from outcomes is unavailable, the material cost is estimated from recent quotes received for other similar works and previous cost experience.

This approach enables us to produce robust cost estimates that are based on an appropriate mix of historical costs, current market pricing and expert external estimation.

Individual cost estimates for each network augmentation project and its constituent options, including a breakdown by labour and material costs, are provided in the business cases in Addendum A.

A summary of the overall proposal capital cost per project of the five-year HP network augmentation program is provided in Table 5-1.

Table 5-1: Summary of proposed HP network augmentation project costs 2023/24 to 2027/28 ($'000 real 2021)

Project	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Cranbourne HP network augmentation	-	359	4,870	3,488	651	**9,368**
Echuca HP network augmentation	768	-	-	-	-	**768**
Thomastown HP network augmentation	5,890	-	962	807	-	**7,659**
Wallan HP network augmentation	473	-	-	524	291	**1,288**
Traralgon HP network augmentation	1,082	-	-	-	1,138	**2,220**
Wodonga HP network augmentation	560	-	-	-	-	**560**
Berwick HP network augmentation	1,141	-	-	-	-	**1,141**
Eltham HP network augmentation	907	-	-	107	-	**1,014**
Howlong HP network augmentation	1,587	-	-	1,245	-	**2,832**
Pakenham HP network augmentation	-	-	6,443	-	-	**6,443**
Somerville HP network augmentation	-	3,996	-	-	-	**3,996**
Total	**12,408**	**4,355**	**12,275**	**6,171**	**2,080**	**37,289**

Addendum A HP network augmentation project

This addendum contains business cases for the eleven HP augmentation projects proposed for the next five-year period.

A.1 Cranbourne HP network augmentation

Project overview

Description of the problem / opportunity

The Cranbourne high pressure (HP) network supplies gas to the broader Cranbourne area located on the southeastern fringe of Melbourne, including the suburbs of Cranbourne, Clyde and Langwarrin. This area is one of the fastest growing residential zones within Australian Gas Networks' (AGN's) network reach. Over the past five years, the number of customer connections in the region has grown by an average of 3,150 new connections per year. We expect growth to continue at a slightly higher rate of 3,558 per year over the forthcoming access arrangement period (2023/24 to 2027/28), due to the opening up of new development areas, with a ten-year average of 2,662 per year from 2022 to 2032.

The historical growth in residential connections has decreased the amount of spare capacity in the Cranbourne HP network. Over this current access arrangement period (2018 to 2023) a number of major projects have been undertaken to keep pace with growth but with continued growth additional works will be required in the next access arrangement period in order to maintain customer supply pressures.

Continued load growth in the region increases the risk of pressures dropping below 140 kPa, which is the minimum level necessary to maintain a safe and reliable customer supply. We estimate that unless action is taken to augment the network, pressures will fall below 140 kPa before 2025.

The load increase will impact on the western, southern and eastern extremities of the Cranbourne HP network, areas where we are forecasting to add 17,100 customers over the access arrangement period.

Network augmentations are therefore required during the access arrangement period to ensure customers' supply is not adversely affected. This business case considers options to augment the Cranbourne network during the next AA period.

Untreated risk

As per risk matrix = **High**

Options considered

- **Option 1** – Install 6.4 km of HP mains and a new Field Regulator located on Hall Rd ($9 million)
- **Option 2** – Install 9.1 km of HP mains and a new field regulator located on McKays Rd ($11 million)
- **Option 3** – Maintain status quo (zero upfront costs, but reactive augmentation will be required post 2025 upon supply/pressure failure)

Proposed solution

Option 1 is the proposed solution, as it will support continued load growth in the various growth areas without impacting existing customers' supply, whilst also being the lowest cost option.

Estimated cost

The forecast direct cost (excluding overhead) during the next five-year period (2023/24 to 2027/28) is $9 million. The projects would be delivered across the years of this period as set out below.

$'000 real 2021	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Cranbourne HP augmentation	-	359	4,870	3,488	651	**9,368**

Basis of costs

All costs in this business case are expressed in real unescalated dollars at June 2021 unless otherwise stated.

Tables may not sum due to rounding.

Treated risk

As per risk matrix = **Low**

Background

The outer metropolitan suburbs of Cranbourne and Clyde, on the south-eastern fringe of Melbourne, are served by one of AGN's fastest growing networks. As of July 2021, the Cranbourne HP network supplies approximately 52,000 customers. Over the past five years, the number of customer connections in the network has grown by just over 15,700 at an average of 3,150 new connections per year.

There has been an ongoing program of works undertaken to service the new residential developments in the area and maintain supply to all customers. Six separate major project have been completed over the current access arrangement period, comprising 4,700 m of DN180 PE, 200 m of DN200 steel, 850 m of DN315 PE and one new city gate.

While these investments have helped maintain supply, further augmentation is required during the next access arrangement period to ensure existing and new customers have a reliable natural gas supply. With the opening up of new development areas, we expect growth will continue at an average rate of 3,420 connections per year over the next five years. Refer to Appendix A Figure A.1 for a network map.

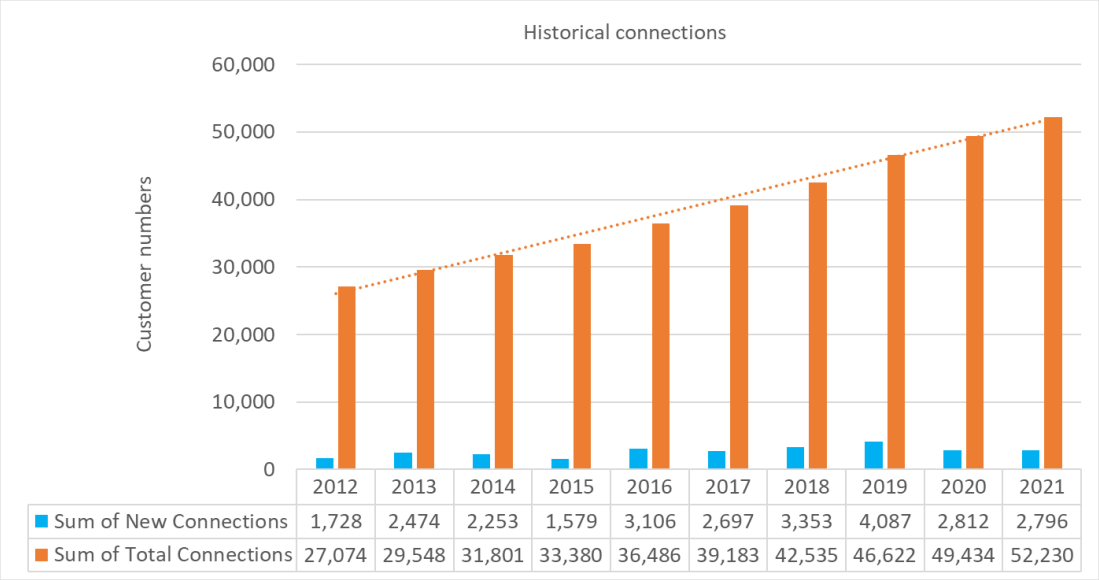
Impact of historical growth

Growth in connections over the last ten years has been high, with an average connection rate of 2,690 per year. This has accelerated over the last five years to an average connection rate of 3,150 per year, connecting a total of 15,750 customers. Most of the growth has occurred in four areas; Western Cranbourne, Southern Cranbourne, Eastern Cranbourne and Clyde. Refer to Appendix A Figure A.2 for map of growth areas.

- Western Cranbourne – this area is covered by a single Precinct Structure Plan (PSP) and has seen relatively constant growth at about 470 connection per year. Growth has moved from the central and northern developments to the southern area, but the totals have remained the same.
- Southern Cranbourne – like the western area, Southern Cranbourne is covered by a single PSP, with growth picking up from 2017 and remaining relatively steady at about 200 connections per year. There has been a slight drop-off over 2020 and 2021 to 90 connections, however, new land is opening up to move it forward again.
- Eastern Cranbourne – this area encompasses four separate PSPs and has seen significant growth for more than ten years. In the last five years there has been a total of about 4,300 connections, with yearly connections dropping off as a number of these areas start to fill up. The southern section of this area is still being developed and we expect continued growth in this area.
- Clyde – this area encompasses four separate PSPs and has seen significant growth for the last five years, with about 7,200 new connections. This is a large area with growth so far being in the western and northern sections of Clyde. More land is being opened up for development in central and eastern section Clyde, and will sustain growth through the next access arrangement period.

The following figure shows historical growth in new connections in the Cranbourne HP network since 2012.

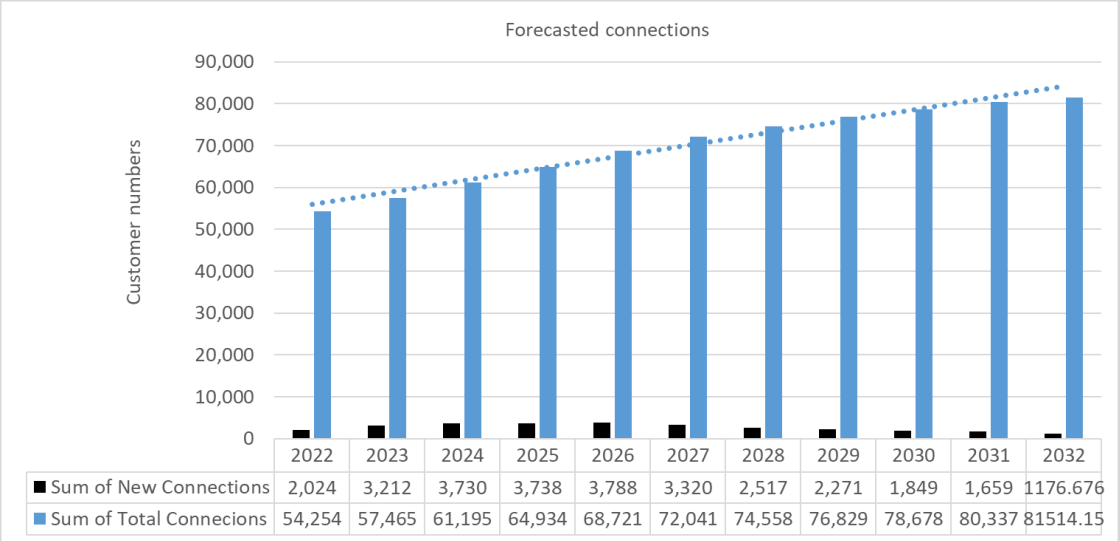
Historical connection growth in Cranbourne HP network, 2012 to 2021



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Sum of New Connections	1,728	2,474	2,253	1,579	3,106	2,697	3,353	4,087	2,812	2,796
Sum of Total Connections	27,074	29,548	31,801	33,380	36,486	39,183	42,535	46,622	49,434	52,230

Based on the historical connection rates for all the Cranbourne and Clyde development areas, and taking into account the new developments scheduled to come online in the next five years, we have developed a bottom up growth forecast for the network. The following figure shows the estimated increase in connections over the next ten years.

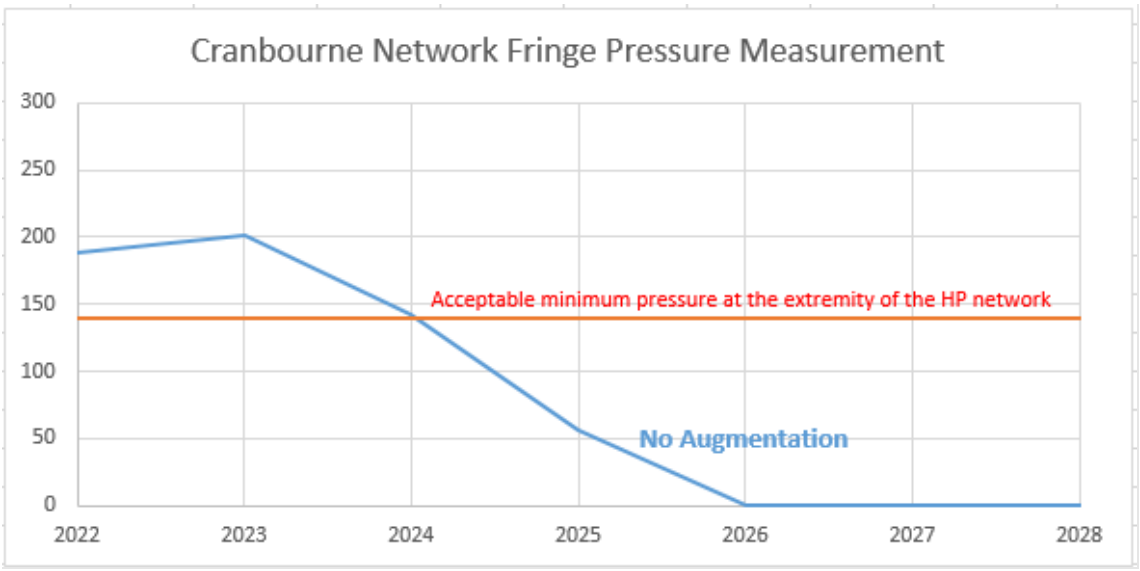
Estimated growth in new connections in the Cranbourne Network, based on historical connections



	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Sum of New Connections	2,024	3,212	3,730	3,738	3,788	3,320	2,517	2,271	1,849	1,659	1176.676
Sum of Total Connecions	54,254	57,465	61,195	64,934	68,721	72,041	74,558	76,829	78,678	80,337	81514.15

Modelling the growth forecast, we estimate pressure levels in the Cranbourne HP network will fall below the minimum acceptable pressure of 140 kPa before winter 2025 if the network is not augmented.

Estimated impact on pressures in the Cranbourne Network if the network is not augmented



NOTE: The pressure increase in 2023 is due to a planned mains extension to a new subdivision that will create a new connection and back feed into the wider network.

If pressures fall below 140 kPa, this has an impact on the downstream pressure at the customers' gas meter and gas appliances, and means we may not be able to supply gas to each customer's premises at the minimum level required to fuel appliances. Substandard pressures can result in gas appliances becoming inoperable and potentially dangerous.

Future growth

There is evidence to suggest overall future growth in connections in the network will continue at similar rates to the historical rate, however the focus is shifting from Cranbourne East to the Clyde area. Cranbourne north, south and west are expected to continue growing at the same current rates.

For example, there are 7 separate developments in the Clyde area that have either just started to be reticulated or have just been approved for reticulation, including the developments of 110 Smiths Lane, Evergreen Estate, Orana Estate, Meridian Estate, Five Farms Estate, Bella Estate and Riverfield Estate. In these developments, there are currently few connections but it is forecast that they will start to see significant connection rates over the next 5-7 years. We expect these areas will see a total of 6,400 connections during the next access arrangement period, making up about 37% of the projected total network growth (around 17,100 lots).

A further 3,150 connections are expected in estates that are yet to open up. This is in addition to the 3,700 connections expected in existing residential developments in Clyde and Clyde North.

This leads to approximately 13,250 connections in the Clyde area. To ensure the most cost effective installation, gas mains are installed during the groundworks phase to ensure gas is available to meet customer demand in the most cost effective manner.

Dwelling increase estimates by forecast.iD also indicate a growth rate similar to the historical average. The following table shows the forecast change in the number of dwellings in areas supplied by the Cranbourne HP network from 2016 to 2041.

Forecast residential development, 2016 to 2041, City of Frankston and City of Casey areas of Cranbourne HP network

Cranbourne HP network area	Forecast change in dwellings between 2016 and 2041	
	Number	%
City of Frankston		
Langwarrin	+1,513	+17.2
Langwarrin South	+341	+86.6
City of Casey		
Botanic Ridge	+3,422	+267.9
Clyde	+24,830	+2,287.50
Clyde North	+27,575	+951.7
Cranbourne	+2,757	+35.8
Cranbourne East	+8,090	+151
Cranbourne North	+3,136	+47.2
Cranbourne South	+89	+15.3
Cranbourne West	+3,615	+70.5
Devon Meadows	+89	+17.6
Junction Village	+896	+200.4
Total growth	**+76,353**	
Growth per year	**+3,054**	

Source: forecast.id, 2020 City of Frankston and City of Casey

The historical average penetration rate for new (greenfield) developments where gas is available is >95%. A forecast of ~2,749 new gas connections per year has been derived. This compares well to the bottom up forecast, that uses historical meter connection rates, profiles of connection from similar estates that have already developed, PSP info, Forecast ID info and any other council or developer information, which estimates an average of 2,683 connections pa over the period 2021 to 2031.

It should be noted that while over the long term the average connection rates are around 2,700 per year, the bottom up detailed forecast indicates the average connection rate will be slightly higher at 3,420 connections per year. This is due to the number of estates that have just started or are just starting now and are expected to hit their maximum connection rates during the next access arrangement period.

Risk assessment

The risk identified for the natural gas distribution network in the Cranbourne HP network region is that load growth without network reinforcement or augmentation will cause delivery pressures to drop, leading to substandard supply or loss of supply to up to 52,000 customers. This may lead to customers' gas appliances becoming inoperable or damaged in certain circumstances.

The primary consequence category affected by this risk is operations, as a pressure drop can cause outages to >10,000 customers, thereby carrying a majo consequence rating under the risk matrix.

Given load growth is ongoing, if the risk is left untreated the likelihood of a pressure drop impacting >10,000 customers is rated occasional (every couple of years), however the frequency of supply interruptions will likely increase the longer the load growth risk is not addressed.

Any significant customer outage would then give rise to a moderate reputational and compliance risk. While there is a moderate health and safety risk posed by falling delivery pressure, safety is not the primary driver of investment in this instance.

The untreated risk rating is presented below.

Loss of supply risk in Cranbourne region – Untreated risk

Untreated risk	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Remote	Rare	Occasional	Rare	Occasional	Occasional	Occasional	High
Consequence	Major	Minimal	Major	Minimal	Significant	Significant	Minor	
Risk Level	Moderate	Negligible	High	Negligible	Moderate	Moderate	Low	

Options considered

We have considered the following options to address the pressure drop risk in the Cranbourne HP distribution network:

- **Option 1** – Install 6.4 km of HP mains and a new Field Regulator located on Hall Rd
- **Option 2** – Install 9.1 km of HP mains and a new field regulator located on McKays Rd
- **Option 3** – Maintain status quo.

Both Options 1 and 2 will take place in multiple stages over the forecast period, and are discussed in the following sections.

Option 1 – Install 6.4 km of HP mains and a new field regulator located on Hall Rd

Option 1 has five stages undertaken over four years (refer to Figure B.1 in Appendix B).

The first is stage is to install 370 m of DN180 PE HP trunk main to duplicate an existing DN125 main and complete a 180 mm connection along Bells Rd south of Thompsons Rd. This will be delivered during 2024/25.

The second stage is to build and commission a new field regulator at the intersection of Dandenong to Crib Point TP pipeline and Hall Rd. It will also involve installing 750 m of DN280 PE HP as the outlet mains to extend east along Hall Rd and tie into the existing DN125 PE HP main just west of Dandenong Hastings Rd. This will be delivered during 2025/26.

The third stage is to install 2,600 m of DN315 PE HP main in Thompsons Rd and Smiths Lane to tie into the DN315 PE HP main at the intersection of Bells Rd and Thompsons Rd and extend it east along Thompsons Rd and south along Smiths Lane, duplicating the existing DN125 PE HP main in Smiths Lane. This will be delivered during 2026/27.

The fourth stage is to install 1,700 m of DN180 PE HP main between the western and eastern sections of the Botanic Ridge estates to provide a back feed into the eastern area. This main will be laid along Smiths Lane and Browns Rd and tie back into the existing DN180 PE HP main in Hummingbird Dr. This will be delivered during 2026/27.

The fifth stage is to install 1,000 m of DN180 PE HP main in Chevron Ave, duplicating the existing DN125 PE HP main between Cranbourne Frankston Rd and Pearcedale Rd. This will be delivered during 2027/28.

The project phasing ensures we stay ahead of the forecast pressure risks across the overall network area, while also having a balanced portfolio of construction works.

Option 1 cost assessment

The direct cost of this option is $9.37 million.

Cost estimate – Option 1, $'000 real 2021

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	-	Install 370 m of DN180 trunk	Install new field reg and 750 m of DN280 trunk	Install 2.6 km of DN315 and 1.7 km of DN180 trunk	Install 1 km of DN180 trunk	Install 2.6 km DN316, 750 m DN280, 3.07 km of DN180 trunk and a new field reg
Labour	-	326	757	2,935	584	**4,602**
Material	-	33	117	553	67	**770**
New field regulator	-	-	3,996	-	-	**3,996**
Total	**-**	**359**	**4,870**	**3,488**	**651**	**9,368**

Option 1 risk assessment

Option 1 would reduce the loss of supply (operational) risk from high to low. This is because having augmentation with the seven stages would reduce the likelihood of a pressure drop impacting >10,000 people from occasional to remote. The risk consequence rating remains unchanged. Option 1 reduces the likelihood of a pressure drop leading to compliance or reputational impacts from unlikely to rare, reducing the risk from moderate to low. It also reduces the likelihood of a major safety incident from remote to rare.

Loss of supply risk in Cranbourne region – Option 1

Option 1	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Rare	Remote	Rare	Rare	Rare	Remote	Low
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Low	Negligible	Low	Negligible	Low	Low	Negligible	

While Option 1 achieves the same risk rating as Option 2, the solution under Option 1 provides this risk reduction at a lower overall cost.

Option 2 – Install 9.1 km of HP mains and a new field regulator located on McKays Rd

Option 2 has 7 stages undertaken over two separate years, 2024/25 and 2027/28. (Refer to Figure B.2 in Appendix B).

Works in 2024/25

The first is stage is to build and commission a new field regulator at the intersection of Dandenong to Crib Point TP pipeline and McKay Rd, as well as 2.8 km of DN315 PE HP as the outlet mains. The supply main will be laid east along McKay Rd and Browns Rd to Pearcedale Rd.

The second stage is to install 320 m of DN180 PE HP main along Pearcedale Rd north from the DN315 main in Stage 1 to tie into the existing DN125 PE HP main at Botanic Ridge Bvd.

The third stage is to install 750 m of DN315 PE HP main in Browns Rd east of Smiths Lane.

The fourth stage is to install 940 m of DN180 PE HP in Smiths Lane and to connect to the end of the eastern development in Hummingbird Dr. When taken with Stage 3 this will provide a back feed into the eastern area of Botanic Ridge.

The fifth stage of to install 800 m of DN180 PE HP main in Thompsons Rd from Bells Rd east to Soldiers Rd.

Works in 2027/28

The sixth stage will be to install 1,650 m of DN315 PE HP main in Browns Rd between the DN315 main laid in Stage 1 at Pearcedale Rd and the DN315 main laid as Stage 3 at Smiths Lane.

The seventh stage will be to install 1800 m of DN180 PE HP main in Thompsons Rd and Smiths Lane, from the end of Stage 5 works at Soldiers Rd, east along Thompsons Rd and then south along Smiths Lane, duplicating the existing DN125 PE HP main in Smith Lane.

The project phasing ensures that we stay ahead of the forecast pressure risks across the overall network area, however the portfolio of stages is not as balanced as in Option 1.

Option 2 cost assessment

The direct cost of this option during the forthcoming access arrangement period is $11.2 million.

Cost estimate – Option 2, $'000 real 2021

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	-	Install 3.55 km DN315, 2.06 km DN180, new field reg	-	-	Install 1.65 km DN315, 1.8 km DN180	Install 5.2 km of DN315, 3.86 km DN180, new field reg
Labour	-	3,890	-	-	2,188	**6,078**
Material	-	739	-	-	396	**1,134**
New field regulator	-	3,996	-	-	-	**3,996**
Total	**-**	**8,625**	**-**	**-**	**2,584**	**11,208**

Option 2 risk assessment

Option 2 addresses the pressure drop issue and results in the same risk outcomes as the primary solution (Option 1). However, it achieves this at a higher cost than Option 1.

Loss of supply risk in Cranbourne region – Option 2

Option 2	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Rare	Remote	Rare	Rare	Rare	Remote	Low
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Low	Negligible	Low	Negligible	Low	Low	Negligible	

Option 3 – Maintain status quo

Under this option we would not incur any proactive capacity expansion capex to reduce the loss of supply risk in the Cranbourne HP Network. Instead, we would manage the network as per current practice, and address any supply issues as and when they occur.

Given the current load growth forecasts, it is likely capital costs to address supply shortfall will be incurred reactively as minimum pressure limits are reached post 2024. As the network is already operating as close as possible to its maximum allowable operating pressure (MAOP) no further network capacity can be enabled through pressure increases.

We consider maintaining the status quo is not a viable solution, as it simply defers capacity expansion expenditure, as well as potentially resulting in high-cost reactive works.

Option 3 cost assessment

There are no additional upfront costs associated if we maintain the status quo. However, as mentioned above, we are likely to incur greater reactive maintenance costs as pressure issues emerge.

While it is not possible to quantify the reactive costs we would incur at this time, in our experience a project conducted reactively is around 3.2 times more expensive than one conducted proactively.[6] This assumption is consistent with the commonly accepted asset management principle that reactive asset maintenance can be around two to five times higher than proactive planned maintenance.[7]

Following the reactive works, if the network continually experiences substandard pressures, one of the solutions described under Option 1 or 2 would need to be applied.

Option 3 risk assessment

Under Option 3, the risk level would remain the same as the untreated risk as there are no controls in place to mitigate the pressure drop risk (other than not connecting new customers, which is not a viable option). The following table shows the risk level if were to maintain the status quo.

Loss of supply risk in Cranbourne region – Option 3

Option 3	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Remote	Rare	Occasional	Rare	Occasional	Occasional	Occasional	High
Consequence	Major	Minimal	Major	Minimal	Significant	Significant	Minor	
Risk Level	Moderate	Negligible	High	Negligible	Moderate	Moderate	Low	

[6] For example, this is typically due to the additional premia for faster acquisition of long lead time materials, emergency response, labour costs, additional traffic management/permit costs, resource scheduling, etc.
[7] Marshall Institute, Omega engineering, ARMS reliability.

Option 3 is therefore not consistent with our risk management framework, which requires action must be taken to reduce any high risks to low or ALARP.

Summary of costs and benefits

The following table presents a summary of how each option compares in terms of the estimated cost, the residual risk rating, and alignment with AGN's objectives. Option 1 is the cheaper option so it is preferred option. Option 3 is not considered because it is not prudent.

Comparison of options - Cranbourne

Option	Estimated cost ($ million)	Treated residual risk rating	Alignment with AGN vision objectives
Option 1	9.4	Low	Aligns with *Delivering for Customers* and *Sustainably Cost Efficient*
Option 2	11.2	Low	Aligns with *Delivering for Customers* but is less *Sustainably Cost Efficient* than Option 1. Higher overall cost within the access arrangement period.
Option 3 – Maintain status quo	Zero upfront capex	High	Does not align with *Delivering for Customers* or *Sustainably Cost Efficient*

Recommended option

Option 1 is the recommended option.

Why is the recommended option prudent?

Options 1 and 2 both solve all the various supply issues across the full breadth of the network area in the following ways:

- The new field regulators in both options removing the need for a full rebuild of the Langwarrin Field Reg and minimise main laying requirements.
- Both options have work along southern boundary along Browns Rd to support the development of the southern Cranbourne growth area. Option 2 has more of this work to make the most of the location of the field regulator in Option 2 at McKay Rd and enable a greater back feed into the southern Clyde area as well. This also slightly reduces the amount of work required in the Clyde North area as opposed to Option 1
- Both options also have work in Thompsons Rd and Smith Lane in Clyde to make use of the new supply source being built during the current AA period at Huckerby Dr in Clyde North. These works will continue on from the supply main to be laid along Bells Rd in 2022 and allow the movement of gas into the estates to the south east along Smiths Lane. Option 2 increases the size of this work and adds a project along Bells Rd to maximize the use of this new supply and minimize the work along Browns Rd.

Option 1 is the preferred option for the following reasons:

- It is the lowest cost option.
- The location of the new field regulator in Option 1 at Hall Rd is more central to ongoing and future development in the western Cranbourne and eastern Skye areas. It is better placed to provide for ongoing growth past the next access arrangement period.

- The location of the new field regulator will also minimise the required main laying needed to connect the new source into the existing reticulation from the 2.8 km of DN315 in Option 1 to 750m of DN280 in Option 2.
- The use of a larger diameter main in Thompsons Rd and Smith Lane in Clyde North (DN315 instead of DN180) will enable greater utilisation of the new supply in Clyde North at Huckerby Dr. It will also allow for better transport of gas to the southeastern development areas of Clyde once the Smith Lane extends south and joins in with Pound Rd and eventually Pattersons Rd. This will also have the effect of back feeding the southern Cranbourne growth area. This fits with the longer term plan for the Clyde PSPs.

Estimating efficient costs

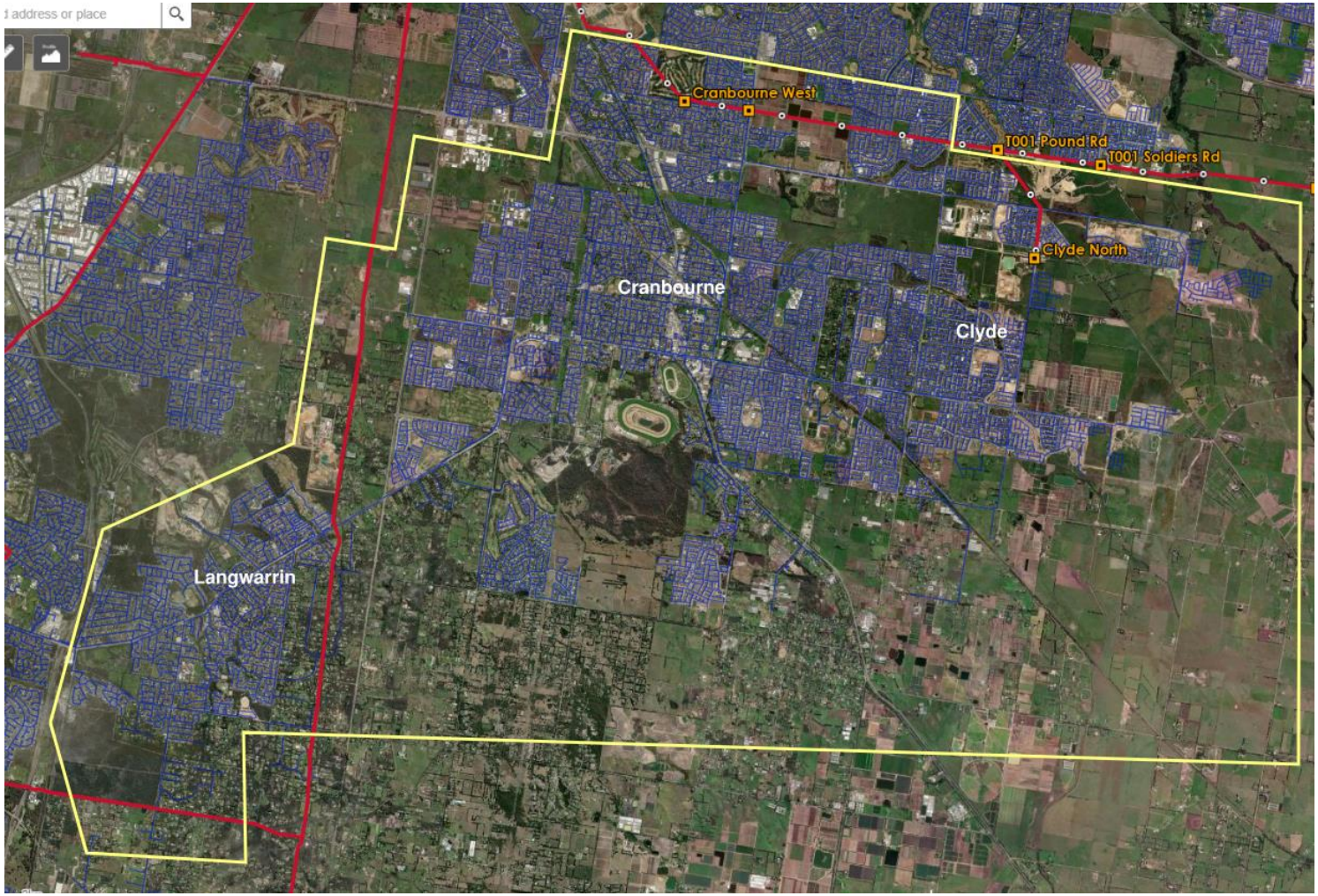
The forecast cost breakdown is shown in the table below.

Cost estimate – $'000 real 2021

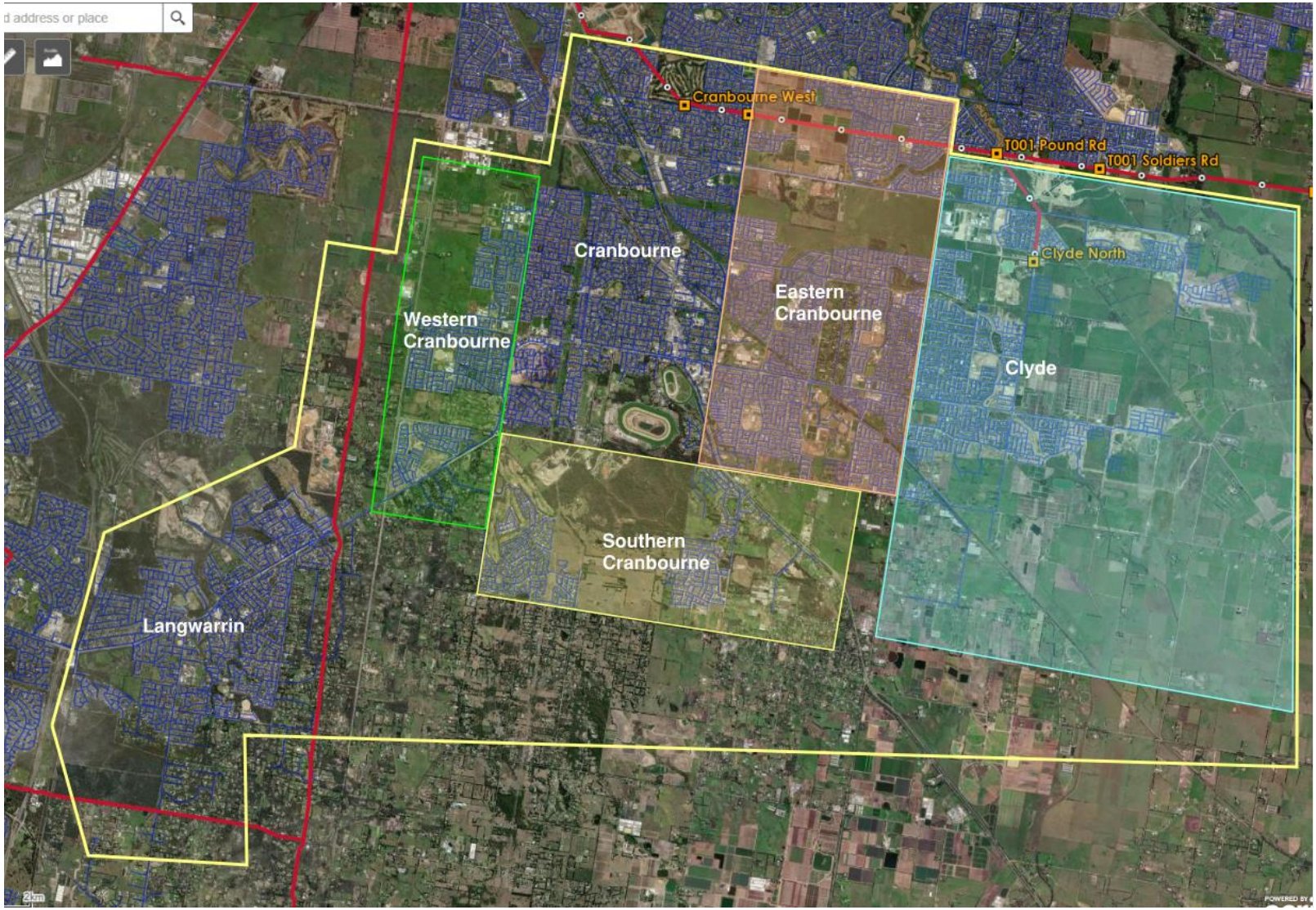
	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	-	Install 370m of DN180 trunk	Install new Field Reg and 750m of DN280 trunk	Install 2.6km of DN315 and 1.7km of DN180 trunk	Install 1 Km of DN180 trunk	Install 2.6 km DN316, 750m DN280, 3.07km of DN180 trunk and a new field reg
Labour	-	326	757	2,935	584	**4,602**
Material	-	33	117	553	67	**770**
New field regulator	-	-	3,996	-	-	**3,996**
Total	**-**	**359**	**4,870**	**3,488**	**651**	**9,368**

Appendix A – Asset location and growth area maps

A.1: Cranbourne HP network map

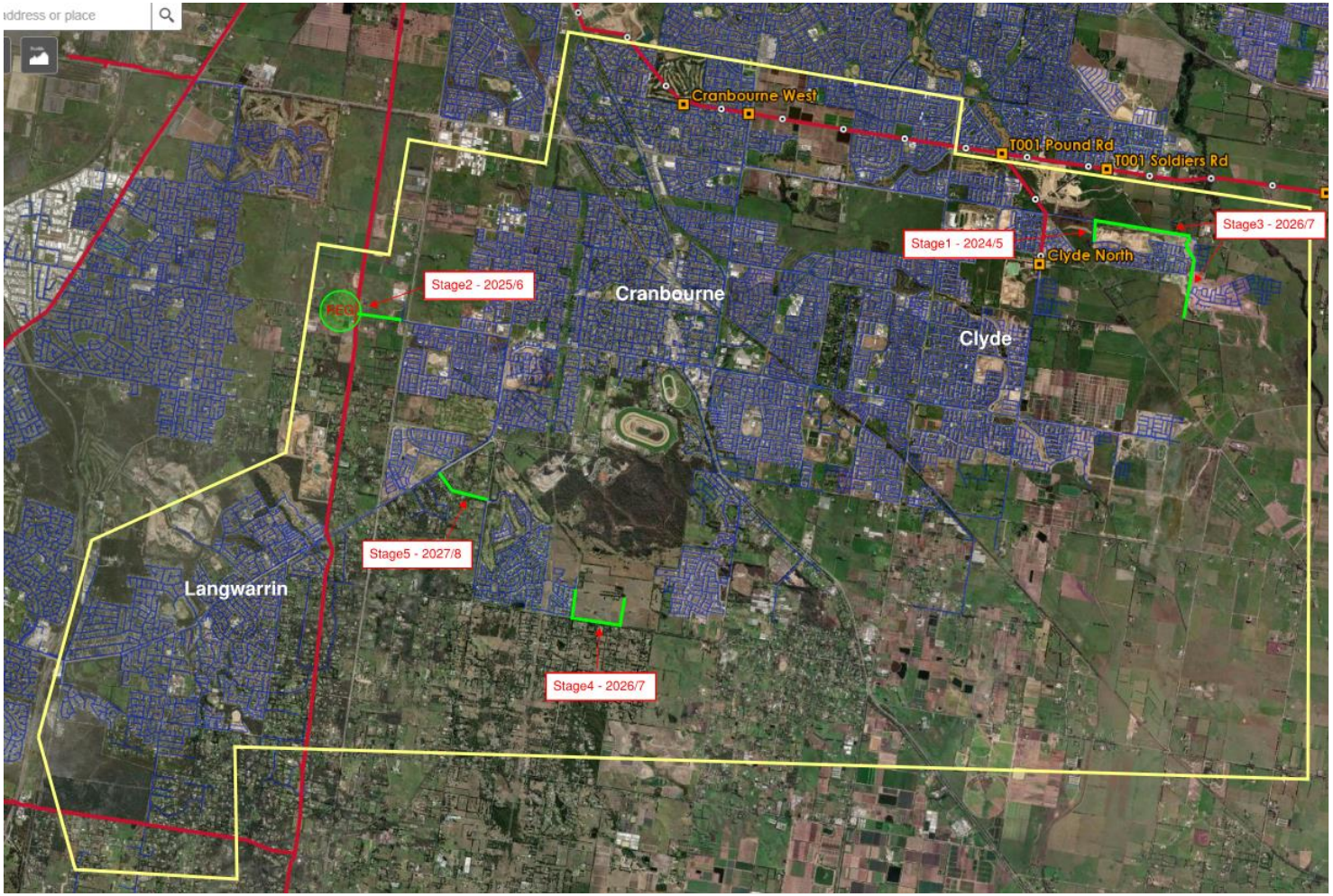


A.2: Growth areas

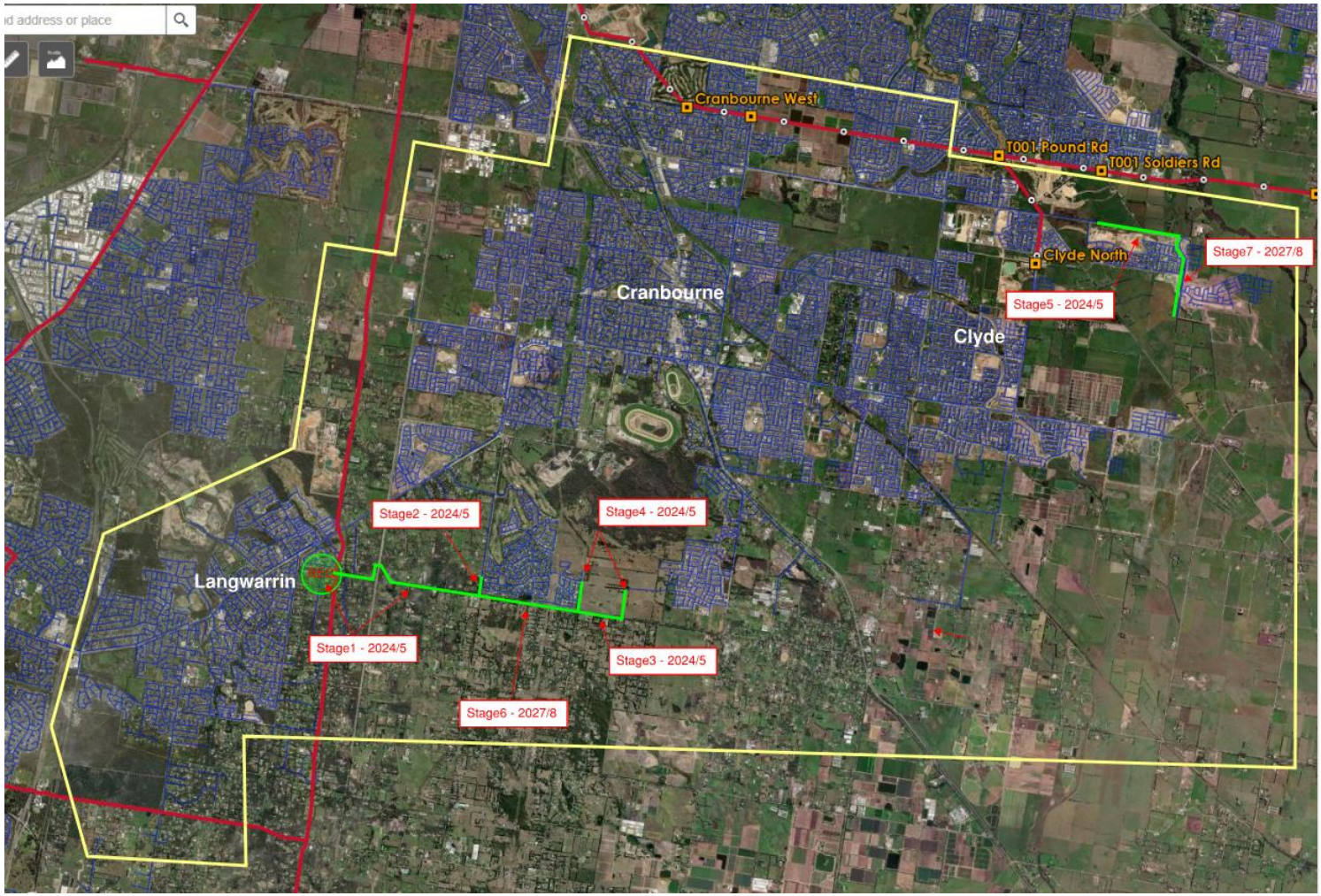


Appendix B – Option 1 and 2 duplication projects

B.1: Option 1 map of augmentations



B.2: Option 2 map of augmentations



A.2 Echuca HP network augmentation

Project overview

Description of the problem / opportunity	The township of Echuca including the NSW town of Moama has strong residential growth. There are numerous developments happening in this region. It is forecast there will be 3,000 new lots build by the year 2035. Part of the forecast growth rate is stated in the Campaspe Shire Council – Echuca West Precinct Structure Plan. This forecast growth in residential connections will decrease the amount of spare capacity in the Echuca HP network, and by year 2026 reaches the point where augmentation is required in order to maintain supply pressures above the minimum acceptable pressure of 140kPa. 9,000 customers are served by the Echuca HP network. There is potential for supply interruptions to all customer connections, however, the load increase will have the greatest impact on the western and northern side of Echuca, which is home to around 2,000 customers. This is because they are the fringe of the network, far away from the district regulator station (supply point) and have limited route of supply. Network augmentation is therefore required before winter 2026 to ensure customers' supply is not affected. This business case considers options to augment the Echuca HP network during 2025/26.
Untreated risk	As per risk matrix = **Moderate**
Options considered	• **Option 1** – Lay 1 km of PE main on McKenzie Road, duplicating existing DN200 steel main ($0.8 million) • **Option 2** - Lay 1.5 km of main on Sturt Street from Murray Valley Highway to Pakenham Street ($1.1 million) • **Option 3** – Maintain status quo
Proposed solution	Option 1 is the proposed solution, as it will support continued load growth in the network without impacting existing customers' supply. In comparison to Option 2, it gives more pressure to the whole network and is cheaper.
Estimated cost	The forecast direct cost (excluding overhead) during the next five-year period (2023/24 to 2027/28) is $0.8 million. The projects would be delivered across the years of this period as set out below.

$'000 real 2021	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Echuca HP augmentation	768	-	-	-	-	**768**

Basis of costs	All costs in this business case are expressed in real unescalated dollars in June 2021 unless otherwise stated. Tables may not sum due to rounding.
Treated risk	As per risk matrix = **Low**

Background

The Echuca HP network has two major growth zones:

1. Around township of Moama (north of Echuca)
2. Echuca West

Over the past five years, the number of customer connections in the entire Echuca network has grown by an average of 200 new residential connections per year. Moama and Echuca West have contributed around 65 and 75 per year respectively and we expect this growth to continue at this rate (as a minimum) over the next five years.

The HP network in Echuca supplies more than 9,000 customers. Refer to Appendix A for a network map.

Impact of historical growth

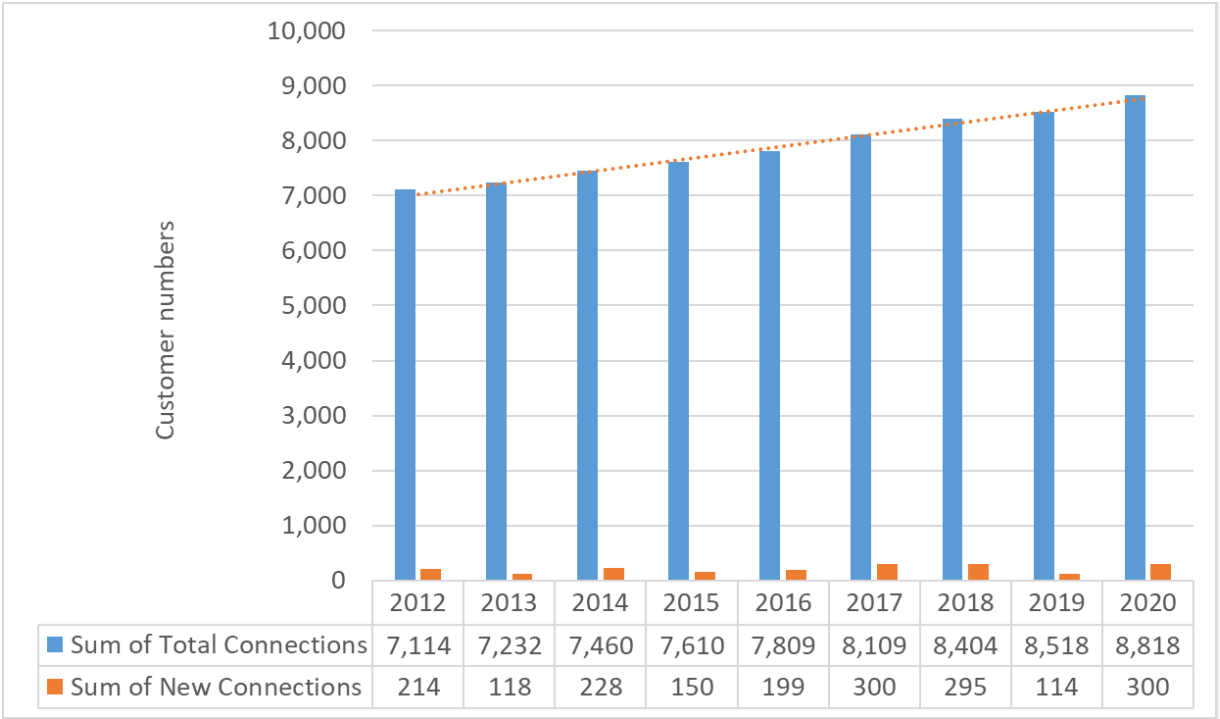
Historical growth in residential connections has decreased the amount of spare capacity in the Echuca network. We are reaching the point where augmentation is required in order to maintain customer supply pressures above minimum acceptable levels.

Moama (north of Echuca) is particularly susceptible to pressure drop due to rapid growth rate, lack of trunk infrastructure and distance away from the supply point. Echuca West requires reinforcement in the future due to high growth rate and limited connection to the supply point.

Moama is connected to the Echuca city gate (supply point) by 10 km trunk main and is home to around 1,400 customers. A combination of DN50/100/200 steel main delivers gas to the area. Apart from the long length of supply trunk main, there is bottleneck created by DN100 steel main throughout town centre of Echuca.

The following figure shows the historical growth in new connections in the Echuca network since 2012.

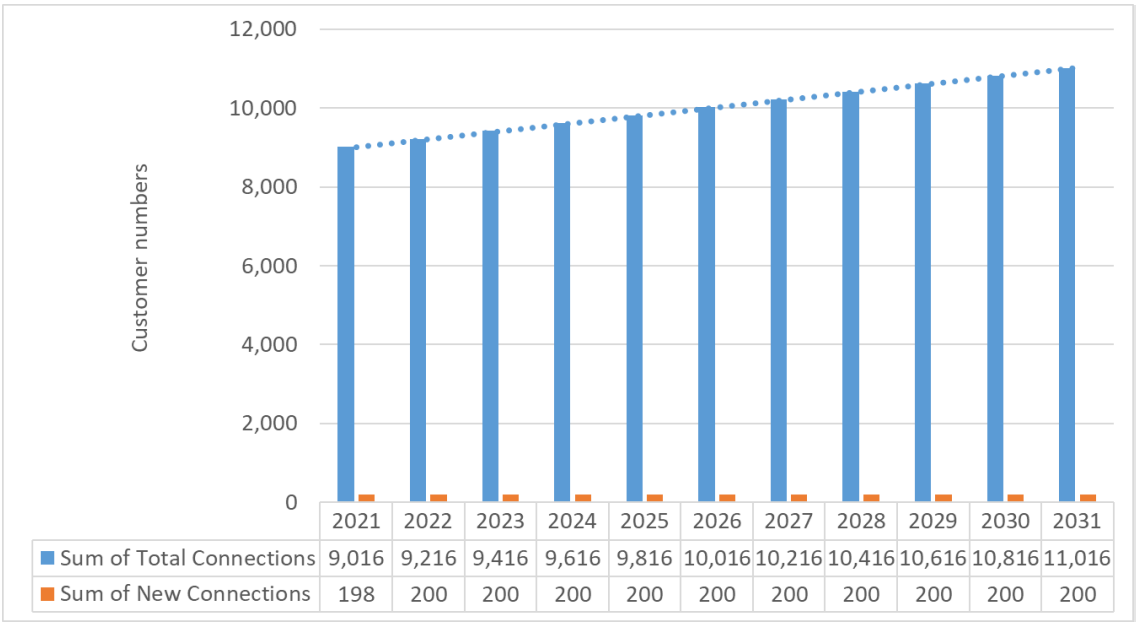
Historical connection growth in Echuca HP network, 2012 to 2020



	2012	2013	2014	2015	2016	2017	2018	2019	2020
Sum of Total Connections	7,114	7,232	7,460	7,610	7,809	8,109	8,404	8,518	8,818
Sum of New Connections	214	118	228	150	199	300	295	114	300

Based on historical growth, the following figure shows the estimated increase in connections over the next ten years.

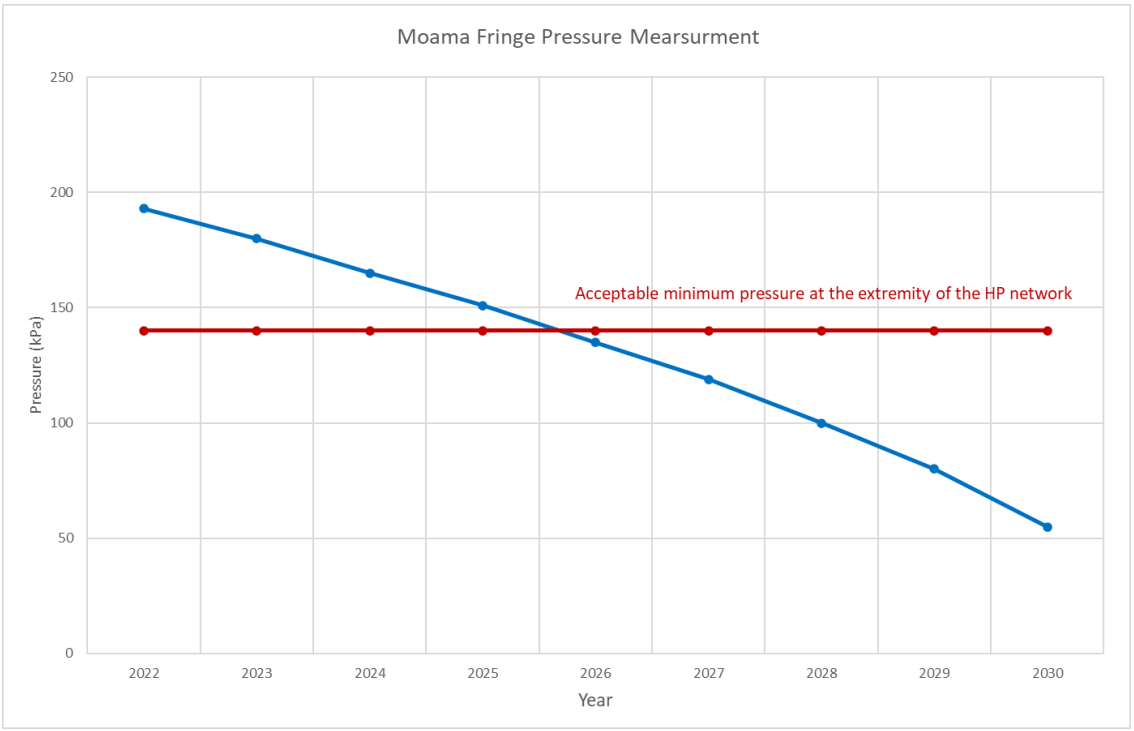
Estimated growth in new connections in Echuca HP network, based on historical connections



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Sum of Total Connections	9,016	9,216	9,416	9,616	9,816	10,016	10,216	10,416	10,616	10,816	11,016
Sum of New Connections	198	200	200	200	200	200	200	200	200	200	200

If we assume this historical average connection rate of 200 new connections per year continues, pressure levels in the Echuca HP network will fall below the minimum acceptable pressure of 140 kPa during winter 2026 if the network is not augmented.

Estimated impact on pressures in Echuca if the network is not augmented



If pressures fall below 140 kPa, this has an impact on the downstream pressure at the customers' gas meter and gas appliances and means we may not be able to supply gas to

each customer's premises at the minimum level required to fuel appliances. Substandard pressures can result in gas appliances becoming inoperable and potentially dangerous.

Future growth

There is evidence to suggest future growth in connections will continue at similar if not faster pace compared to historical growth in the Echuca network. For example, Campaspe Shire Council and Victoria Planning Authority are still finalising the Echuca West Precinct Structure Plan (PSP). In their recent update of June 2019[8].; the document states, "*the primary land use within the Echuca West FUS is for residential purpose and will accommodate up to 5,000 new homes*."

We have also received commercial enquiries for Vines Estate and Lingum Road subdivisions (Moama) in August 2021. These developments will accommodate 750 lots. Development is set to begin in 2022 and last till 2036.

Wharparilla Estate is to the north of Echuca West PSP area, and set to begin developing in 2022, with the final goal of accommodating 400 lots. Dwelling increase estimates by forecast.id for the Campaspe City Council (local council for Echuca) also indicate a growth rate similar to the historical average.[9]

The table below shows the forecast growth from in the number of dwellings in areas supplied by Echuca HP network from 2016 to 2036. Moama is governed by Murray River City Council who is not part of forecast.id so internal forecast data is used instead.

Forecast residential development, 2016 to 2036, City of Echuca

City of Echuca Area	Forecast change in dwellings between 2016 and 2036	
	Number	%
Echuca Centre-East	+182	+6.3
Echuca West (includes Wharparilla Estate)	+1,332	+57.3
Echuca South-East	+222	+18.4
Moama	+1,359	+97.9
Vines and Lingum Rd Development	+750	n/a
Total growth	**+3,845**	**+49.2**
Growth per year	**+200**	

Source: forecast.id, 2021 see: https://forecast.id.com.au/campaspe/dwellings-development-map?WebID=110

The historical average penetration rate for new (greenfield) developments where gas is available is >95%. A forecast of 190 new gas connections per year has been derived. Given this forecast load increase, network augmentation is required by 2023 to ensure customers' supply is not affected. Work is planned to address this. In addition to existing planned work, further reinforcement is required before winter 2026; therefore, this business case considers different options to augment the Echuca network during 2025/26.

[8] https://www.campaspe.vic.gov.au/Plan-build/Strategic-planning/Echuca-West-Precinct-Structure-Plan
[9] https://forecast.id.com.au/campaspe

Risk assessment

The risk identified for the natural gas distribution network in the Echuca-Moama region is that load growth without network reinforcement or augmentation will cause delivery pressures to drop, leading to substandard supply or loss of supply to up to 9,000 customers. This may lead to customers' gas appliances becoming inoperable or damaged in certain circumstances.

The primary consequence category affected by this risk is operations, as a pressure drop can cause outages to >1,000 customers, thereby carrying a significant consequence rating under the risk matrix.

Given load growth is ongoing, if the risk is left untreated the likelihood of a pressure drop impacting >1,000 customers is rated occasional (every couple of years), however the frequency of supply interruptions will likely increase the longer the load growth risk is not addressed.

Any significant customer outage would then give rise to a moderate reputational and compliance risk. While there is a moderate health and safety risk posed by falling delivery pressure, safety is not the primary driver of investment in this instance.

The untreated risk rating is presented below.

Loss of supply risk in Echuca region – Untreated risk

Untreated risk	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Remote	Rare	Occasional	Rare	Occasional	Occasional	Occasional	Moderate
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Moderate	Negligible	Moderate	Negligible	Moderate	Moderate	Low	

Options considered

We have considered the following options to address the pressure drop risk in the Echuca HP distribution network post 2023.

- **Option 1** – Lay 1 km of PE main on McKenzie Road, duplicating existing DN200 steel main
- **Option 2** – Lay 1.45 km of PE main on Sturt Street from Murray Valley Highway to Pakenham Street
- **Option 3** – Maintain status quo, take no action

These options are discussed in the following sections.

Option 1 – Lay 1 km of PE main on McKenzie Road, duplicating existing DN200 steel main

Our primary solution is to lay a new section of DN280 PE main along McKenzie Road duplicating existing assets:

- Starting at end point of 2023 duplication work, around entrance for Echuca Aerodrome
- Ending after 1,000 m in length, 500 m away from Despatch Street

Option 1 duplicates existing DN200 steel trunk supply main with higher capacity and cheaper cost DN280 PE main. This option is a continuation of trunk duplication strategy completed in 2013 and a further section scheduled for completion in 2023. The 1,000 m length is proposed because it would augment the Echuca network to mitigate the pressure drop risk and would sustain forecast growth until 2030.

The advantage of this option is that over the next ten years it offers more capacity than our secondary solution (Option 2) to the whole township at lower capital expenditure (shorter length and lower unit cost). It also provides more capacity to Echuca West area including Wharparilla Estate which is expected to be a high growth zone for the next 20 years.

Option 1 cost assessment

The direct cost of this option during the forthcoming access arrangement period is $0.77 million.

Cost estimate – Option 1, $'000 real 2021

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	Install 600m of DN280 PE main		-	-	-	Install 600m of DN280 PE main
Labour	632		-	-	-	**632**
Material	136		-	-	-	**136**
Total	**768**		**-**	**-**	**-**	**768**

Option 1 risk assessment

Option 1 would reduce the loss of supply (operational) risk from moderate to low. The work would reduce the likelihood of a pressure drop impacting >1,000 people from occasional to remote. The risk consequence rating remains unchanged. Option 1 reduces the likelihood of a pressure drop leading to compliance or reputational impacts from unlikely to rare, reducing the risk from moderate to low. It also reduces the likelihood of a major safety incident from remote to rare.

Loss of supply risk in Echuca region – Option 1

Option 1	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Remote	Remote	Rare	Rare	Rare	Remote	Low
Consequence	Major	Minor	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Low	Negligible	Low	Negligible	Low	Low	Negligible	

Option 2 – Lay 1.45 km of PE main on Sturt Street from Murray Valley Highway to Pakenham Street

Under Option 2, we would lay a new section of DN280 PE main on Sturt Street from intersection with Murray Valley Highway to intersection with Pakenham Street. The new PE main will be approximately 1,450 m long.

This main will mostly duplicate existing assets on Sturt Street. These assets currently include long lengths of DN40 and 50 PE mains, so they create bottleneck in the supply system to Moama region. The new main will remove bottleneck and substantially increase the amount of gas can be delivered to Moama region.

The advantage of this option is that it provides more capacity to Moama region once, albeit at higher unit cost due to construction in Echuca CBD and longer length. However, it does not help to address possible future capacity issue around Echuca West development and therefore can be viewed as a localised solution.

Option 2 cost assessment

The direct cost of this option during the forthcoming access arrangement period is $1.1 million dollars.

Cost estimate – Option 2, $'000 real 2021

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	-	-	Install 1,450m of DN280 PE	-	-	Install 1,450m of DN280 PE
Labour	-	-	885	-	-	**885**
Material	-	-	190	-	-	**190**
Total	**-**	**-**	**1,075**	**-**	**-**	**1,075**

Option 2 risk assessment

Option 2 addresses the pressure drop issue and results in the same risk outcomes as the primary solution (Option 1). However, it achieves this at a higher cost than Option 1.

Loss of supply risk in Echuca region – Option 2

Option 2	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Remote	Remote	Rare	Rare	Rare	Remote	Low
Consequence	Major	Minor	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Low	Negligible	Low	Negligible	Low	Low	Negligible	

Option 3 – Maintain status quo

Under this option we would not incur any proactive capacity expansion capex to reduce the loss of supply risk in Echuca. Instead, we would manage the network as per current practice, and address any supply issues as and when they occur.

Given the current load growth forecasts, it is highly likely capital costs to address supply shortfall will be incurred reactively as minimum pressure limits are reached during winter of 2026. As the network is already operating as close as possible to its maximum allowable operating pressure (MAOP) no further network capacity can be enabled through pressure increases.

We consider maintaining the status quo is not a viable solution, as it simply defers capacity expansion expenditure, as well as potentially resulting in high-cost reactive works.

Option 3 cost assessment

There are no additional upfront costs associated if we maintain the status quo. However, as mentioned above, we are likely to incur greater reactive maintenance costs as pressure issues emerge.

While it is not possible to quantify the reactive costs we would incur at this time, in our experience a project conducted reactively is around 3.2 times more expensive than one conducted proactively.[10] This assumption is consistent with the commonly accepted asset

[10] For example, this is typically due to the additional premia for faster acquisition of long lead time materials, emergency response, labour costs, additional traffic management/permit costs, resource scheduling, etc.

management principle that reactive asset maintenance can be around two to five times higher than proactive planned maintenance.[11]

Following the reactive works, if the network continually experiences substandard pressures, one of the solutions described under Option 1 or 2 would need to be applied.

Option 3 risk assessment

Under Option 3, the risk level would remain the same as the untreated risk as there are no controls in place to mitigate the pressure drop risk (other than not connecting new customers, which is not a viable option).

Loss of supply risk in Echuca region – Option 3

Option 3	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Remote	Rare	Occasional	Rare	Occasional	Occasional	Occasional	Moderate
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Moderate	Negligible	Moderate	Negligible	Moderate	Moderate	Low	

Option 3 is therefore not consistent with our risk management framework, which requires action must be taken to reduce risks to low or ALARP. A moderate rating for operations or safety is not ALARP.

Summary of costs and benefits

The following table presents a summary of how each option compares in terms of the estimated cost, the residual risk rating, and alignment with our vision objectives. Option 1 is the cheaper option so it is the preferred option. Option 3 is not prudent.

Comparison of options - Echuca

Option	Estimated cost ($ million)	Treated residual risk rating	Alignment with vision objectives
Option 1	0.8	Low	Aligns with *Delivering for Customers* and *Sustainably Cost Efficient* Lower cost while providing higher capacity to the whole township
Option 2	1.1	Low	Aligns with *Delivering for Customers* and *Sustainably Cost Efficient* Higher cost while providing to local area
Option 3	Zero upfront capital costs	High	Does not align with *Delivering for Customers* or *Sustainably Cost Efficient*

Recommended option

Option 1, duplicating 1,000 m of duplication trunk main along McKenzie Road is the recommended option.

Why is the recommended option prudent?

- Option 1 is the most prudent option. It provides sufficient capacity to support the forecast organic growth over the remainder of the access arrangement period, enabling

[11] Marshall Institute, Omega engineering, ARMS reliability.

us to defer additional augmentation after 2030. This means the network will have sufficient capacity to support growth over the next 8-9 years.

- Option 1 has lower cost than Option 2, due to lower unit cost and shorter length.
- Option 1 provides additional capacity to the whole network and is a system-wide approach.
- Option 2 does create more capacity for one local area than Option 1, but inferior in other regions. Therefore, it is very much a secondary solution compared with Option 1.
- Option 2 require working in busy town-center and is more likely to incur higher unit cost, due to unforeseen underground infrastructure as well as traffic management, than the remote working area in Option 1.
- Option 3 is not viable as it is not consistent with APA risk management framework, which requires action must be taken to reduce any high risks to low or ALARP.

Estimating efficient costs

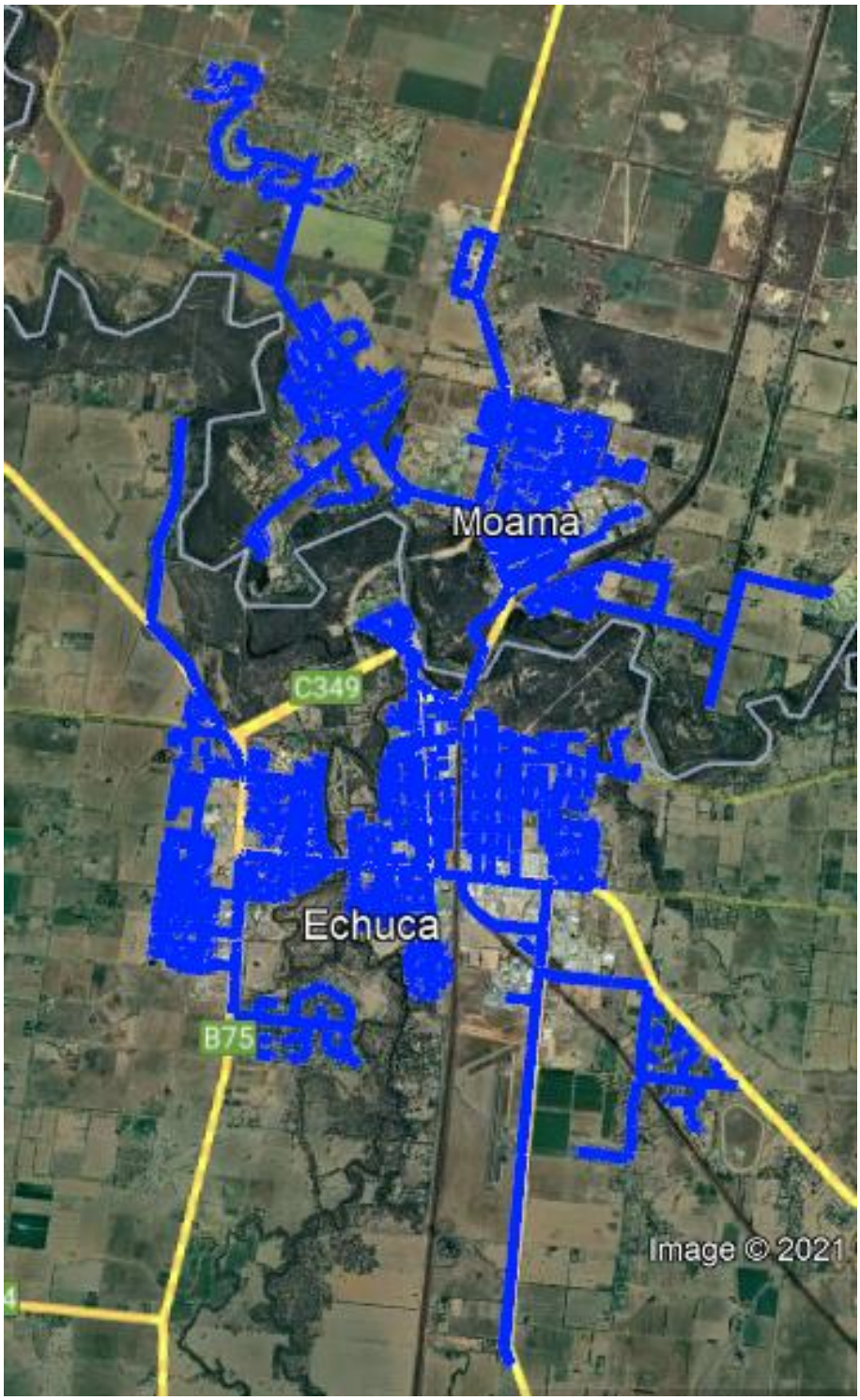
The forecast cost breakdown is shown in the table below.

Cost estimate, $'000 real 2021

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	Install 1,000 m of DN280 PE main	-	-	-	-	Install 1,000 m of DN280 PE main
Labour	632	-	-	-	-	**632**
Material	136	-	-	-	-	**136**
Total	**768**	**-**	**-**	**-**	**-**	**768**

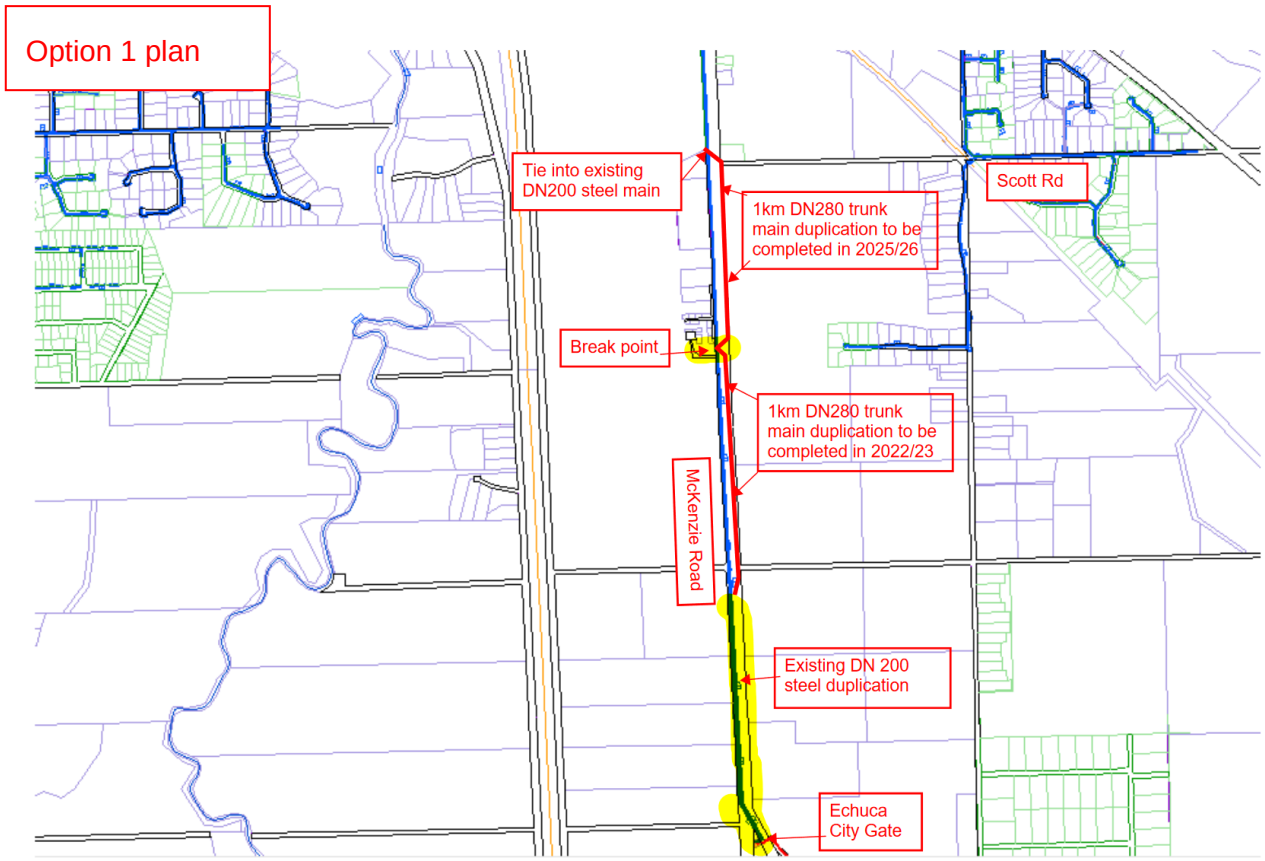
Appendix A – Asset location maps and growth Zone

A.1 Echuca Network Map

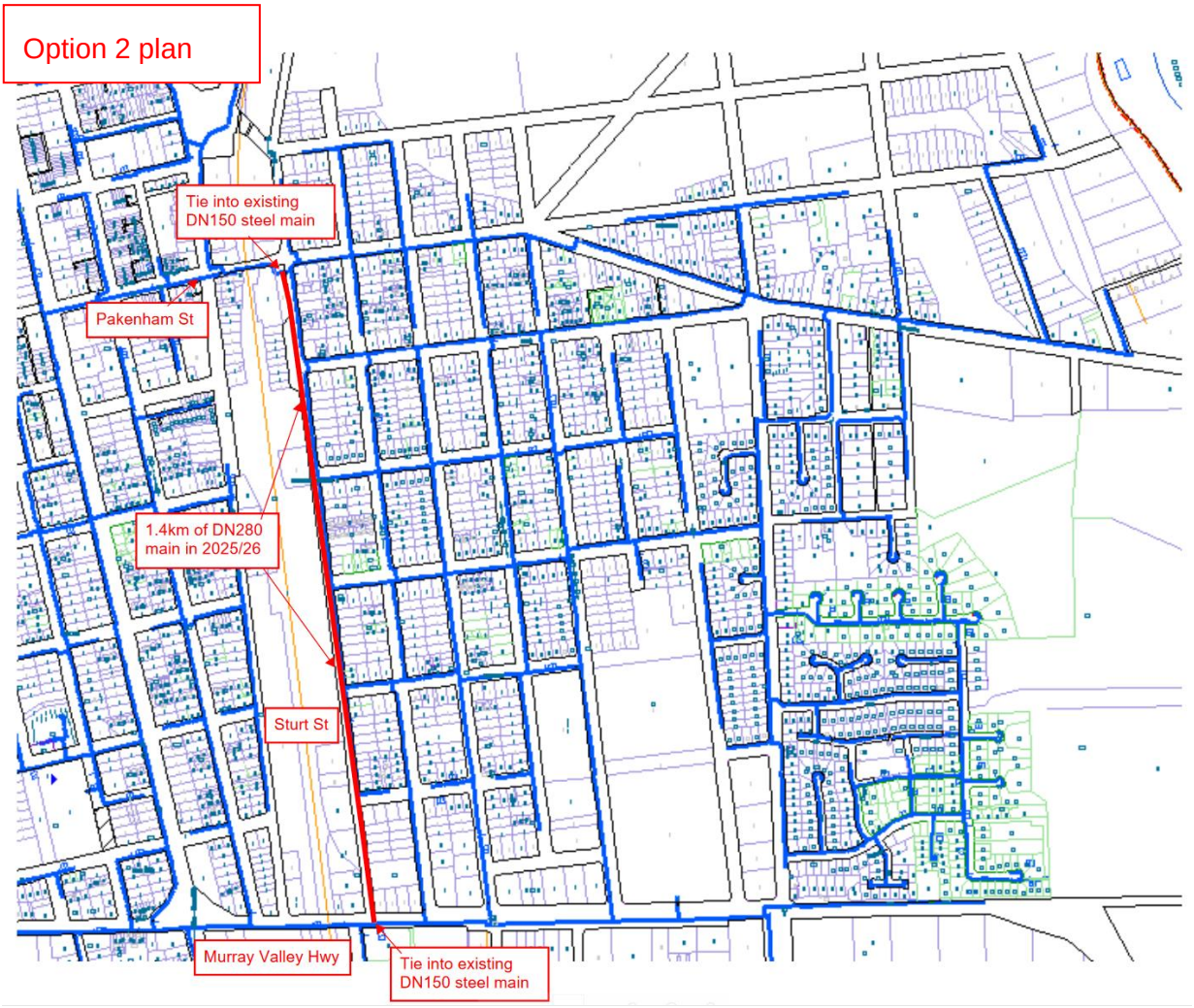


A.2 Echuca West PSP

Appendix B – Option 1 Map



Appendix C – Option 2 Map



A.3 Thomastown HP network augmentation

Project overview

Description of the problem / opportunity	The Thomastown HP network supplies gas to a large area in the northern suburbs of Melbourne, including the suburbs of Preston, Reservoir, Thomastown, Lalor, Epping and Wollert. Most of this network is in well-established suburban areas, however, the northern extremity around Epping North and Wollert are undergoing a rapid development. The Wollert PSP area has started to be developed over the last four years and the Epping North has been experiencing high growth for the last ten years. Over the past five years, the number of customer connections in the network has grown by an average of 1,710 new connections per year, with 1,096 of those in the Epping North and Wollert areas. We expect growth to continue at a slightly higher rate of 1,995 per year for the entire network and 1,243 per year for the Epping North and Wollert areas over 2023/24 to 2027/28, due to the opening up of new development areas identified in the Wollert PSP. The historical growth in residential connections has decreased the amount of spare capacity in the Thomastown HP network. In 2022 a major project involving the construction of a new city gate and outlet main has been initiated with completion taking place in the next access arrangement period by winter 2024. This new city gate will be the main feed into the Wollert area and assist in managing the growth on the northern part of the network. However, the continued growth means some additional works will also be required from 2025 onwards in order to maintain customer delivery pressures. Continued load growth in the region increases the risk of pressures dropping. Based on the projected forecast growth rates we estimate that unless action is taken to augment the network, pressures will fall below minimum acceptable levels, 140 kPa, by 2024. Network augmentations are therefore required to ensure customers' supply is not adversely affected. This business case considers options to augment the Thomastown network during the 2023 to 2028 period.
Untreated risk	As per risk matrix = **High**
Options considered	**Option 1** • A new City Gate (inc. land, regulator skid, heater and CTM) and 1000 m x 300 mm Steel HP main to the existing 300 mm main • Install 1km of PE main in Rockfield St and in Yann Dr ($11.3 million; $3.7 million in current AA and $7.7 million in next AA) **Option 2** • Upgrade of existing O'Herns Rd regulator station, (inc. land, regulator skid, heater and CTM) and 3,700m of 315mm PE in Koukoura Dr, Harvest Home Rd and Edgars Rd. ($13.7 million) **Option 3** • Maintain status quo (no upfront costs, but reactive augmentation will be required post 2024 upon supply/pressure failure)
Proposed solution	Option 1 is the proposed solution, as it will support continued load growth in the various growth areas without impacting existing customers' supply. Option 1 is the lowest direct cost option and has the lowest net present cost it also provides for greater future capacity in the Wollert PSP.

Estimated cost

The forecast direct cost over this current AA period (2018/19 to 2022/23) and over the next AA period (2023/24 to 2027/28) is $11.3 million. The project would be delivered over the two AA periods as set out below.

$'000 real 2021	22/23	23/24	24/25	25/26	26/27	27/28	Total
Thomastown HP augmentation	3,660	5,890	-	962	807	-	**11,319**

Basis of costs

All costs in this business case are expressed in real unescalated dollars at June 2021 unless otherwise stated.

Tables may not sum due to rounding.

Treated risk

As per risk matrix = **Low**

Background

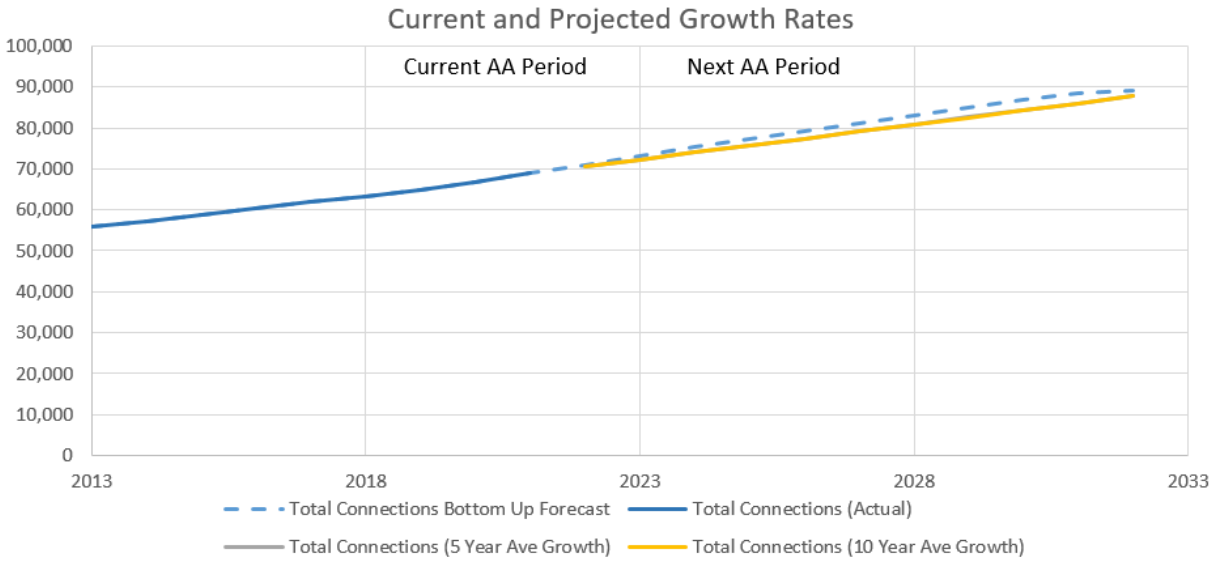
The metropolitan suburbs of Preston, Reservoir, Thomastown, Lalor, Epping and Wollert, on the northern side of Melbourne supplies approximately 69,000 customers as of July 2021. Over the past five years, the number of customer connections in the network has grown by just over 8,550 at an average of 1,710 new connections per year. Most of this growth is occurring in North and Wollert, with 5,480 connections at an average of 1,096 connections per year.

During the current AA period a major project was initiated in order to keep up with growth in the area. This involved the installation of a new city gate located to the north of the developments called Andrews Rd. This work provides a back feed into the area, reduces demand on the existing city gate at O'Herns Rd, and will provide the majority of the supply to the developing area into the future. This project started in 2022 and is expected to be completed by winter 2024 and so will cross over two AA periods.

As part of the overall augmentation strategy the other works proposed for the next (upcoming) AA period will leverage this new city gate to provide for the future development of the network in the area. With the opening up of new development areas, we expect growth will continue at an average rate of 1,995 connections per year over the entire network, and at 1,243 connections per year for the Epping, Epping North and Wollert areas.

The following figure shows the current and projected connection rates for the period 2013 to 2032. Agreement has been reached with four new residential developments in the Wollert area, and they are planned to start connections in late 2022. These are The Patch, Wollert Rise, Elyssia and Bauenort.

Current and projected connection rates in Thomastown HP network, 2013 to 2032

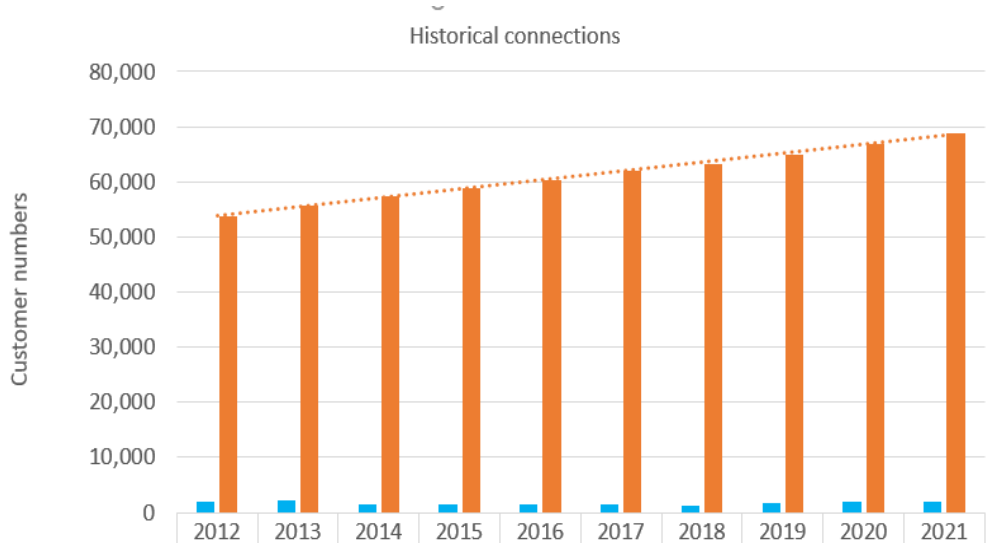


Refer to Appendix A figure A.1 for a network map.

Impact of historical growth

Historical growth in connections has been significant over the last ten years, with an average connection rate of 1,710 per year. This equates to a total of 8,550 customers in the last five years. This has been quite steady for most of this period but we have seen an increase in the last two years (2019 to 2021) to an average of 2,035 connections per year. This has been due to the recent development of estates in the Wollert PSP just north of Craigieburn Rd East. These estates are just hitting their peak connection rates in 2021 and are expected to remain high through the next AA period. The following figure shows the historical growth in new connections in the Thomastown HP network since 2012.

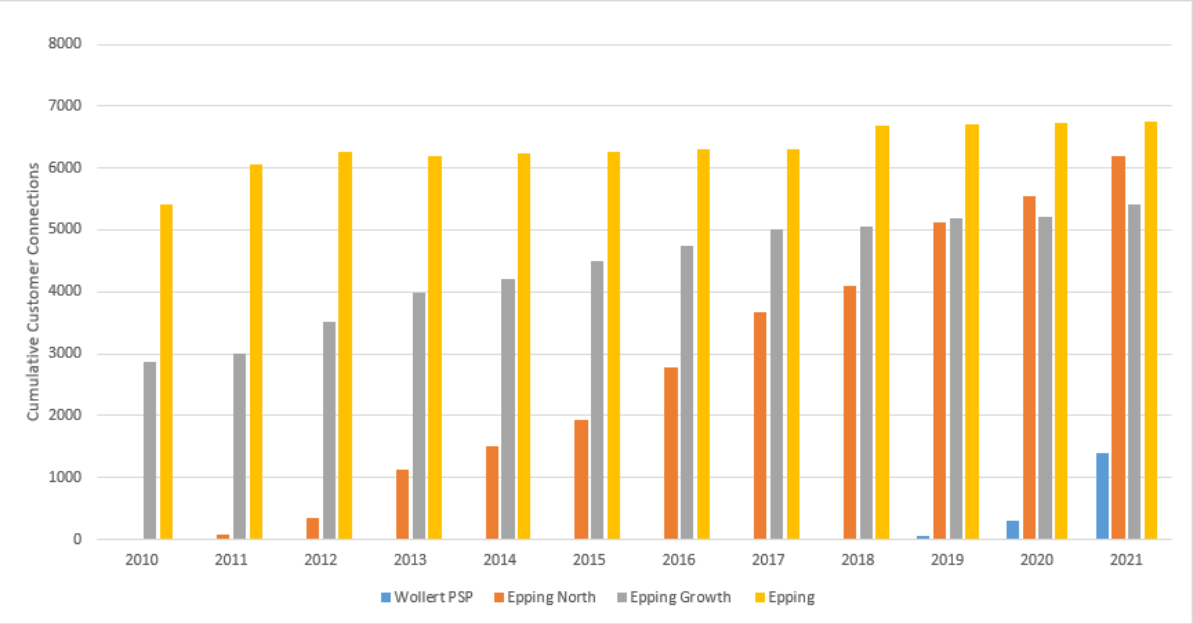
Historical connection growth in Thomastown HP network, 2012 to 2021



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Sum of New Connections	1,863	2,115	1,529	1,491	1,546	1,567	1,277	1,642	2,050	2,020
Sum of Total Connections	53,653	55,768	57,297	58,788	60,334	61,901	63,177	64,819	66,869	68,889

While the overall growth rates are averaged at 1,710 connections per year, most of the growth on the Thomastown network has occurred in the Epping North and Wollert development areas, with an average connection rate of 1,096 per year. See Appendix A for the growth areas map.

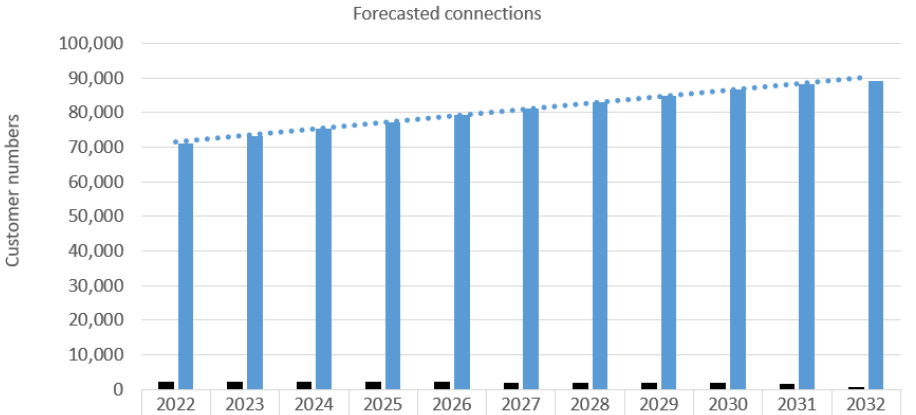
Historical connection growth in major growth areas, 2010 to 2021



Growth has been steadily moving north as the development front progresses, with the Epping growth areas starting to fill up and the Epping North area rapidly expanding from 2012 and now starting to slow down, along with the Wollert PSP just commencing in 2020/21. Preston, Reservoir, Thomastown, Lalor and the southern part of Epping are all following steady growth in the range of 0.5% to 1.5%, a pattern expected to continue through the next AA period.

Based on the historical connection for all the various development areas and taking into account the new developments scheduled to come online in the next access arrangement period, a growth forecast was developed for the network. The following figure shows the estimated increase in connections for the entire Thomastown network over the next ten years.

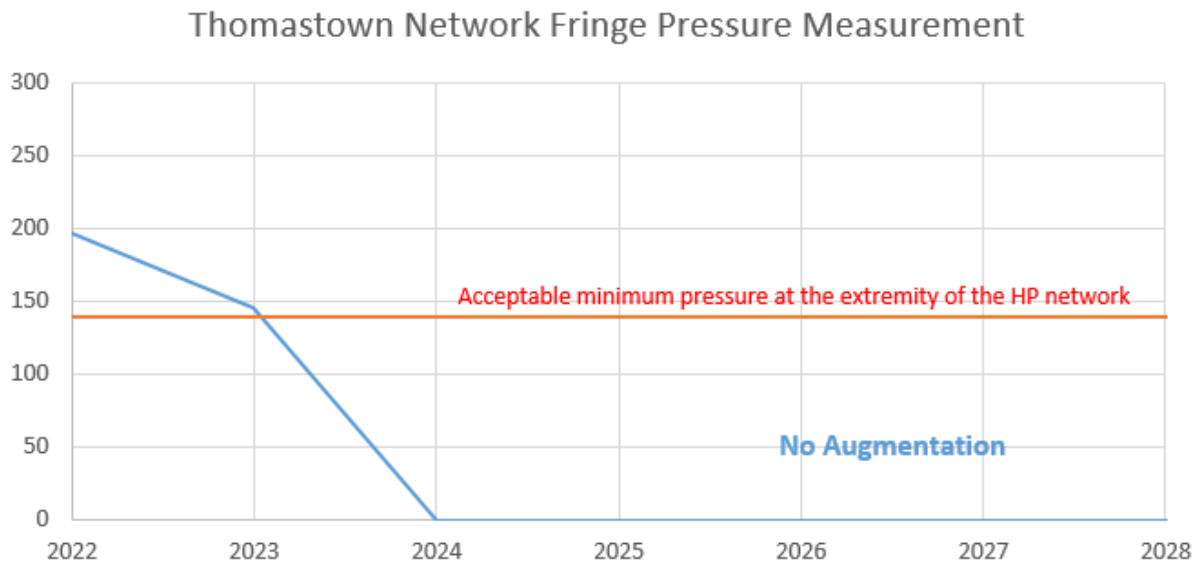
Estimated growth in new connections in the Thomastown network, based on historical connections



	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Sum of New Connections	2,111	2,117	2,133	2,021	2,032	1,887	1,902	1,887	1,769	1,622	624.6764
Sum of Total Connecions	71000	73117	75250	77271	79303	81190	83092	84980	86748	88371	88995

Applying the developed forecast to the modelling, we estimate pressure levels in the Thomastown HP network will fall below the minimum acceptable pressure of 140 kPa before winter 2024 if the network is not augmented. In addition, the current City Gate at O'Herns Rd has a capacity of 27,000 m^3/h and this will be exceeded in 2024 if nothing is done, with flows continuing to rise year on year as growth continues.

Estimated impact on pressures in the Thomastown network if the network is not augmented



Future growth

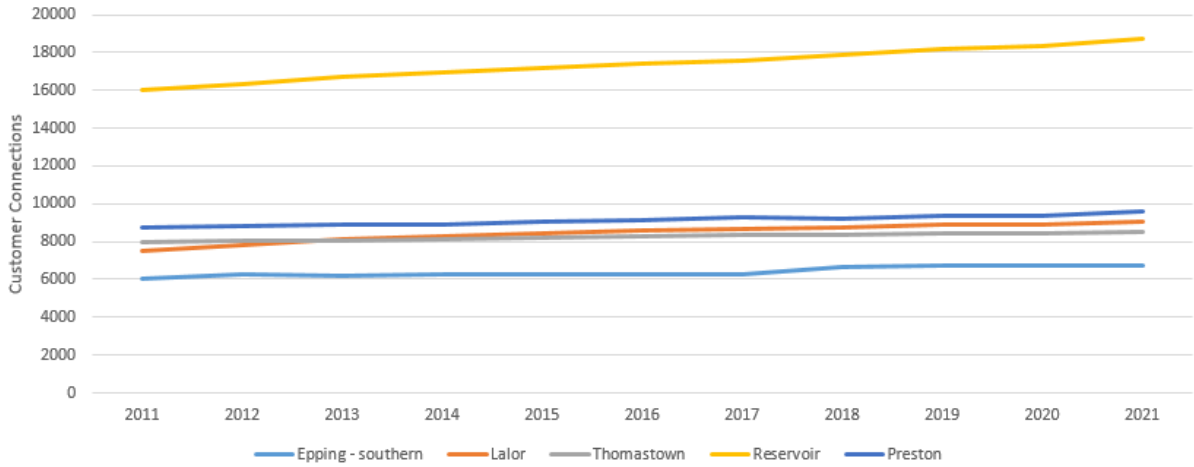
The future growth in the Thomastown network can be split into two categories:

1. Established suburbs of Preston, Reservoir, Thomastown, Lalor and southern Epping
2. High growth areas of the northern half of Epping and Wollert

Established suburbs

An examination of the historical meter connection rates over the last ten years shows a consistent growth in all of these areas.

Gas Connections in established suburbs over ten years 2011 to 2021



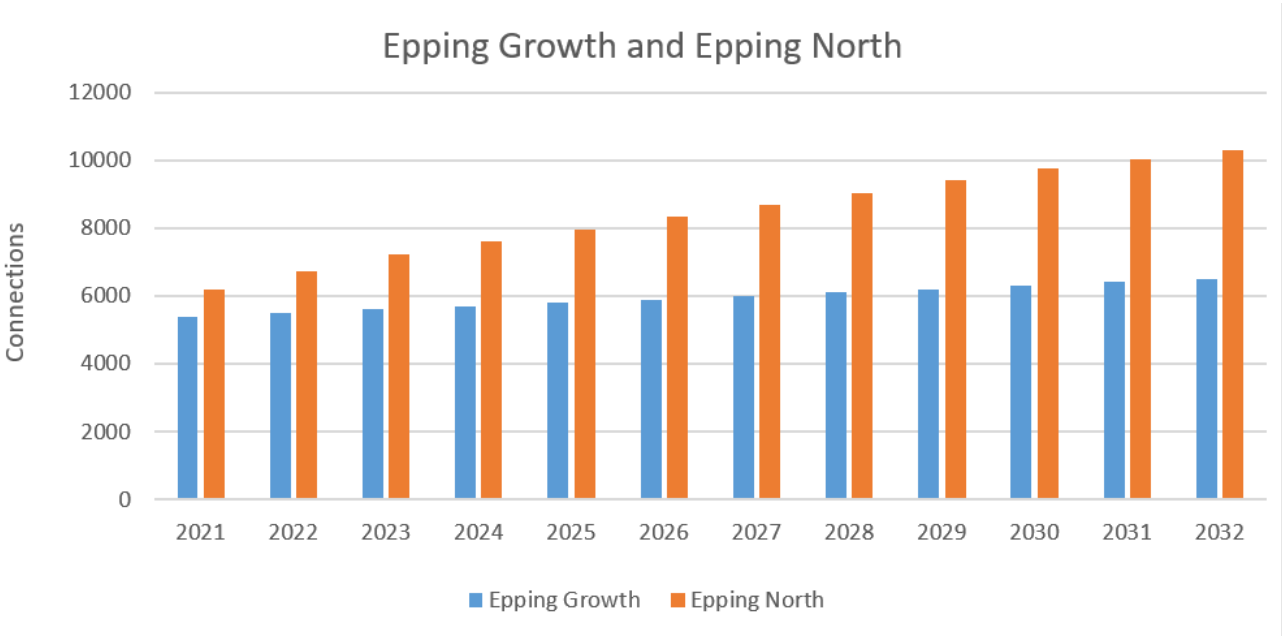
We anticipate this growth in gas connections will continue though the next access arrangement period, with no information to suggest a significant deviation from these rates of connection. We forecast ~3,755 new connections will occur at an average of 750 per year. This is around 1.3% growth per year.

However, this growth has been discounted from the network modelling as it can be accommodated by the extra capacity delivered as part of the current mains renewal project and pressure rationalisation, which is expected to be completed by end of 2022. The mains renewal project will transfer load from the Thomastown network to the Yallambie network to the east.

Growth areas

A bottom-up development of growth for the various areas and estates in the northern Epping and Wollert areas was undertaken. Based on this analysis the following growth forecasts were developed.

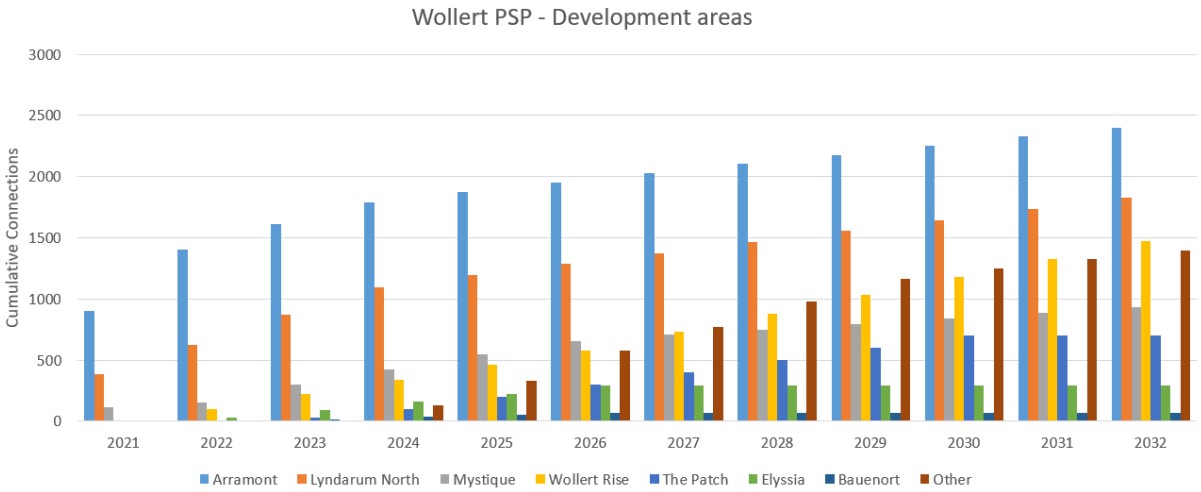
Epping and Epping North areas forecast 2021 to 2032



The Epping rate of growth has decreased, although there is a little land still to open to the west of this area that will drive a continuation of current growth rates. We anticipate there will be 500 new connections over the next AA period at an average of 100 per year.

Epping North is still experiencing strong growth and has a pocket of land to the west where growth is only just commencing. We expect growth will continue in Epping North at an average of 365 connection per year, totalling 1,826 over next the AA period.

Wollert development areas growth forecast 2021 to 2032



The figure above shows the forecast growth for the various known developments in the Wollert PSP. As with the Epping growth and Epping North areas, there is a continued development front pushing northwards to open up new estates around Bodycoats Rd (Wollert Rise, The Patch, Elyssia and Bauenort) as well as continued development of the three estates just north of Craigieburn Rd East (Arromont, Lyndarum North and Mystique).

As there is still significant land in the area, a prudent allowance has been made for opening up additional estates, and a growth allowance applied.

We forecast that there will be 3,894 connections in the next access arrangement period across all these estates at an average of 778 per year.

Comparison to Forecast ID

Forecast residential development, 2021 to 2031, City of Whitlesea and City of Darebin areas part of Thomastown HP Network

Thomastown HP Network area	Forecast change in dwellings between 2021 and 2031	
	Number	%
City of Darebin		
Reservoir	+3,037	+12.8
Preston	+5,640	+33.4
City of Whittlesea		
Wollert	+5,592	+964
Epping North	+4,681	+38.4
Epping	+1,278	+22.7
Lalor	+717	+8
Thomastown	+1,137	+13.9
Total growth	**+22,082**	
Growth per year	**+2,208**	

Source: forecast.id, 2020 City of Whittlesea and City of Darebin

The historical average penetration rate for new (greenfield) developments where gas is available is >95%. A forecast of ~1,987 new gas connections per year has been derived. This compares well to the bottom-up forecast, which estimates an average of 1,948 connections pa over the period 2021 to 2031.

Risk assessment

The risk identified for the natural gas distribution network in the Thomastown HP Network region is that load growth without network reinforcement or augmentation will cause delivery pressures to drop, leading to substandard supply or loss of supply to up to 69,000 customers. This may lead to customers' gas appliances becoming inoperable or damaged in certain circumstances.

The primary consequence category affected by this risk is operations, as a pressure drop can cause outages to >10,000 customers, thereby carrying a major consequence rating under the risk matrix.

Given load growth is ongoing, if the risk is left untreated the likelihood of a pressure drop impacting >10,000 customers is rated occasional (every couple of years), however the frequency of supply interruptions will likely increase the longer the load growth risk is not addressed.

Any significant customer outage would then give rise to a moderate reputational and compliance risk. While there is a moderate health and safety risk posed by falling delivery pressure, safety is not the primary driver of investment in this instance.

The untreated risk rating is presented below.

Loss of supply risk in Thomastown region – Untreated risk

Untreated risk	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Remote	Rare	Occasional	Rare	Occasional	Occasional	Occasional	High
Consequence	Major	Minimal	Major	Minimal	Significant	Significant	Minor	
Risk Level	Moderate	Negligible	High	Negligible	Moderate	Moderate	Low	

Options considered

We have considered the following options to address the pressure drop risk in the Thomastown HP distribution network:

- **Option 1** – A new City Gate (inc. land, regulator skid, heater and CTM) and 1000m x 300mm Steel HP main to the existing 300mm main. Install 1km of PE main in Rockfield St and in Yann Dr ($11.3 million; $3.7 million in the current AA and $7.7 million in next AA)
- **Option 2** – Upgrade of existing O'Herns Rd regulator station, (inc. land, regulator skid, heater and CTM) and 3,700m of 315mm PE in Koukoura Dr, Harvest Home Rd and Edgars Rd. Install 1.9km of PE main on Boundary Rd and 1,150m of DN125 PE in Findon Rd. ($13.7 million; $2.0 million in the current AA and $11.7 million in next AA)
- **Option 3** – Maintain status quo

Option 1 – A new City Gate (inc. land, regulator skid, heater and CTM) and 1000m x 300mm Steel HP main to the existing 300mm main. Install 1km of PE main in Rockfield St and in Yann Dr

Option 1 has three stages. (Refer to the map B.1 in Appendix B).

Option 2 Augmentation Details

Targeted year	Stage	Description
2022-2024	Stage 1	A new City Gate (inc. land, regulator skid, heater and CTM) located at Andews Rd and 1000 m x 300 mm Steel HP outlet main along the Transmission pipeline easement and Bodycoats Rd
2025/26	Stage 2	650 m of DN180 PE HP trunk main in Rockfield St
2026/27	Stage 3	360 m of DN125 PE HP main in Yann Dr

The first stage is to construct a new City Gate at the intersection of Andrews Rd and the existing Pakenham to Wollert transmission pipeline, including a new CTM, Heater and regulator skid. 1000 m of DN300 steel outlet supply main will be required west along the transmission easement to Bodycoats Rd and then south to tie into the existing distribution mains in Bodycoats Rd. This will be delivered during the final year of the current access arrangement period and the first year of the next access arrangement period (2022 to 24).

The second stage is to install 650m of DN180 PE HP trunk main in Rockfield St duplicate an existing 63mm P8 main and complete a 180mm connection between the 180mm mains in Koukoura Dr and Edgars Rd. This will be delivered during the third year of the forthcoming access arrangement period (2025/26).

The third stage is to install 360m of DN125 PE HP main in Yann Dr to complete a 125mm connection between the 180mm main in Koukoura Dr and the existing 125mm main in Yann Dr. This will be delivered during the fourth year of the forthcoming access arrangement period (2026/27).

The advantage of this staged option is that it progressively addresses the pressure drop risk at the lowest practicably sustainable cost. It provides more long term capacity to the Wollert PSP growth area by locating the source of gas central to development and provides for greater security of supply by introducing a new supply point into the Epping / Wollert growth areas.

Option 1 cost assessment

The direct cost of this option is $11.3 million, with $3.6 million of this to be incurred during the current AA period.

Cost estimate – Option 1, $'000 real 2021

	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	New CG and 1000 m of DN300		-	Install 650 m of DN180 Trunk	Install 360 m of DN125 Trunk	-	New CG, Install 1000 m DN 300, 650 m DN180, and 360 m DN125
Land	2,075	109					2,184

	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Labour	1,195	4,407	-	927	785	-	**7,314**
Material	390	1,374	-	35	22	-	**1,821**
Total	**3,660**	**5,890**	**-**	**962**	**807**	**-**	**11,319**

Option 1 risk assessment

Option 1 would reduce the loss of supply (operational) risk from high to low. This is because having augmentation with the three stages would reduce the likelihood of a pressure drop impacting >10,000 people from occasional to remote. The risk consequence rating remains unchanged. Option 1 reduces the likelihood of a pressure drop leading to compliance or reputational impacts from unlikely to 'rare' reducing the risk from moderate to low. It also reduces the likelihood of a major safety incident from 'remote' to 'rare'.

Loss of supply risk in Thomastown region – Option 1

Option 2	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Rare	Remote	Rare	Rare	Rare	Remote	Low
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Low	Negligible	Low	Negligible	Low	Low	Negligible	

While Option 1 achieves the same risk rating as Option 2 (see below), the solution under Option 1 provides this risk reduction at a lower overall cost, a greater capacity benefit for future growth and provides additional security of supply.

Option 2 – Upgrade of existing O'Herns Rd regulator station, (inc. land, regulator skid, heater and CTM) and 3,700m of DN315 PE in Koukoura Dr, Harvest Home Rd and Edgars Rd. Install 1.9km of DN280 PE main on Boundary Rd and 1,150m of DN125 PE in Findon Rd.

Option 2 has three separate stages. (Refer to Figure B.2 in Appendix B).

The first stage is to upgrade the existing O'Herns Rd regulator station and lay a new DN315 PE supply main north from O'Herns Rd to Craigieburn Rd East. The upgrade of the current regulator will require a new CTM, Heater and regulator skid. Given the size of the land the current station is on and that it cannot be shut down, additional land will be required to build the new station. The new supply main will be laid north along Koukoura Dr, Harvest Home Rd and Edgars Rd and will tie into the existing DN300 steel main in O'Herns Rd and the existing DN180 PE main in Craigieburn Rd East. This will be delivered during the final year of the current access arrangement period and the first year of the forthcoming access arrangement period (2022 to 2024).

The second stage is to install 1,900 m of DN280 PE main along Boundary Rd. The proposed main will be from the DN300 steel trunk main at Bodycoats Rd, westwards and tie into the DN180 PE main in Arramont estate (both due for installation in 2022). This would be delivered during the third year of the forthcoming access arrangement period (2025/26).

The third stage will be to install 1,150 m of DN125 PE main along Findon Rd. This proposed main will be from the existing DN125 main at Glendale Ave, east to the existing DN150 steel main. This would be delivered during the fourth year of the forthcoming access arrangement period (2026/27).

Option 2 cost assessment

The direct cost of this option is $13.7 million, with ~$2 million of this to be incurred during the current AA period.

Cost estimate – Option 2, $'000 real 2021

	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	New CG and 3700 m of DN315		-	Install 1900 m DN280	Install 1150 m DN125	-	New CG, Install 3700m DN315, and 1900 m DN280, and 1150 m DN125
Land	1,050	-	-	-	-	-	**1,050**
Labour	607	6,912	-	1,448	1,411	-	**10,378**
Material	321	1,586	-	323	46	-	**2,276**
Total	**1,978**	**8,498**	**-**	**1,771**	**1,457**	**-**	**13,704**

Option 2 risk assessment

Option 2 would reduce the loss of supply (operational) risk from high to low. This is because having augmentation with the three stages would reduce the likelihood of a pressure drop impacting >10,000 people from occasional to remote. The risk consequence rating remains unchanged. Option 2 reduces the likelihood of a pressure drop leading to compliance or reputational impacts from unlikely to rare, reducing the risk from moderate to low. It also reduces the likelihood of a major safety incident from rare to remote.

Loss of supply risk in Thomastown region – Option 2

Option 2	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Rare	Remote	Rare	Rare	Rare	Remote	Low
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Low	Negligible	Low	Negligible	Low	Low	Negligible	

While Option 2 achieves the same risk rating as Option 1, the solution under Option 2 provides this risk reduction at a higher overall cost.

Option 3 – Maintain status quo

Under this option we would not incur any proactive capacity expansion capex to reduce the loss of supply risk in the Thomastown HP Network. Instead, we would manage the network as per current practice, and address any supply issues as and when they occur.

Given the current load growth forecasts, it is highly likely capital costs to address supply shortfall will be incurred reactively as minimum pressure limits are reached in 2024. As the network is already operating as close as possible to its MAOP no further network capacity can be enabled through pressure increases.

We consider maintaining the status quo is not a viable solution, as it inefficiently defers capacity expansion expenditure, putting the Thomastown HP network under strain, impacting our ability to maintain minimum network pressures, causing reliability issues for existing customers and potentially resulting in high-cost reactive works.

Option 3 cost assessment

There are no additional upfront costs associated if we maintain the status quo. However, as mentioned above, we are likely to incur greater reactive maintenance costs as pressure issues emerge.

While it is not possible to quantify the reactive costs we would incur at this time, in our experience a project conducted reactively is around 3.2 times more expensive than one conducted proactively.[12] This assumption is consistent with the commonly accepted asset management principle that reactive asset maintenance can be around two to five times higher than proactive planned maintenance.[13]

Following the reactive works, if the network continually experiences substandard pressures, one of the solutions described under Option 2 or 3 would need to be applied.

Option 3 risk assessment

Under Option 3, the risk level would remain the same as the untreated risk as there are no controls in place to mitigate the pressure drop risk (other than not connecting new customers, which is not a viable option). The following table shows the risk level if were to maintain the status quo.

Loss of supply risk in Thomastown region – Option 3

Option 3	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Remote	Rare	Occasional	Rare	Occasional	Occasional	Occasional	High
Consequence	Major	Minimal	Major	Minimal	Significant	Significant	Minor	
Risk Level	Moderate	Negligible	High	Negligible	Moderate	Moderate	Low	

Option 3 is therefore not consistent with our risk management framework, which requires action must be taken to reduce any high risks to low or ALARP.

Summary of costs and benefits

The following table presents a summary of how each option compares in terms of the estimated cost, the residual risk rating, and alignment with AGN's objectives. Option 1 is preferred as it is the lowest cost option that addresses the operational capability risks of the growing Thomastown HP network.

Comparison of options - Thomastown

Option	Estimated cost ($ million)	Treated residual risk rating	Alignment with AGN vision objectives
Option 1	11.3	Low	Aligns with *Delivering for Customers* and *Sustainably Cost Efficient*
Option 2	13.7	Low	Aligns with *Delivering for Customers* but is less *Sustainably Cost Efficient* than Option 2 as it comes at a higher overall cost
Option 3	Zero upfront capital costs	High	Does not align with *Delivering for Customers* or *Sustainably Cost Efficient*

[12] For example, this is typically due to the additional premia for faster acquisition of long lead time materials, emergency response, labour costs, additional traffic management/permit costs, resource scheduling, etc.
[13] Marshall Institute, Omega engineering, ARMS reliability.

Recommended option

Option 1 is the recommended option.

Why is the recommended option prudent?

The current and forecast growth for the Thomastown Network is going to cause low pressures and supply issues in the Wollert areas, particularly in the Arramont and Lyndarum North estates. It is also going to cause flows through the existing O'Herns Rd City Gate to exceed capacity.

Options 1 and 2 both solve all these supply issues in the following ways:

- Providing for additional supply capacity by building a new City Gate, Option 1 located to the north, central to the future demand and Option 2 by replacing the existing City Gate at O'Herns Rd.
- Providing additional feed into the areas of low pressures.
- Connecting existing trunk infrastructure.

Option 1 is preferred because:

- it is the lowest cost option to achieve the network pressure benefits and manage capacity of existing sources;
- it locates the new source close to the future growth which will better provide for growth for the next 10 to 15 years;
- it avoids a long length of mains duplication in existing roads that will be very costly and disruptive to the local population; and
- the location of the works in Stage 2 of Option 2 is currently an unsealed access way and it may be difficult to get sufficient details on future road construction to lay the main in such a way that there won't need to be alterations in the future if the road does get developed.

Estimating efficient costs

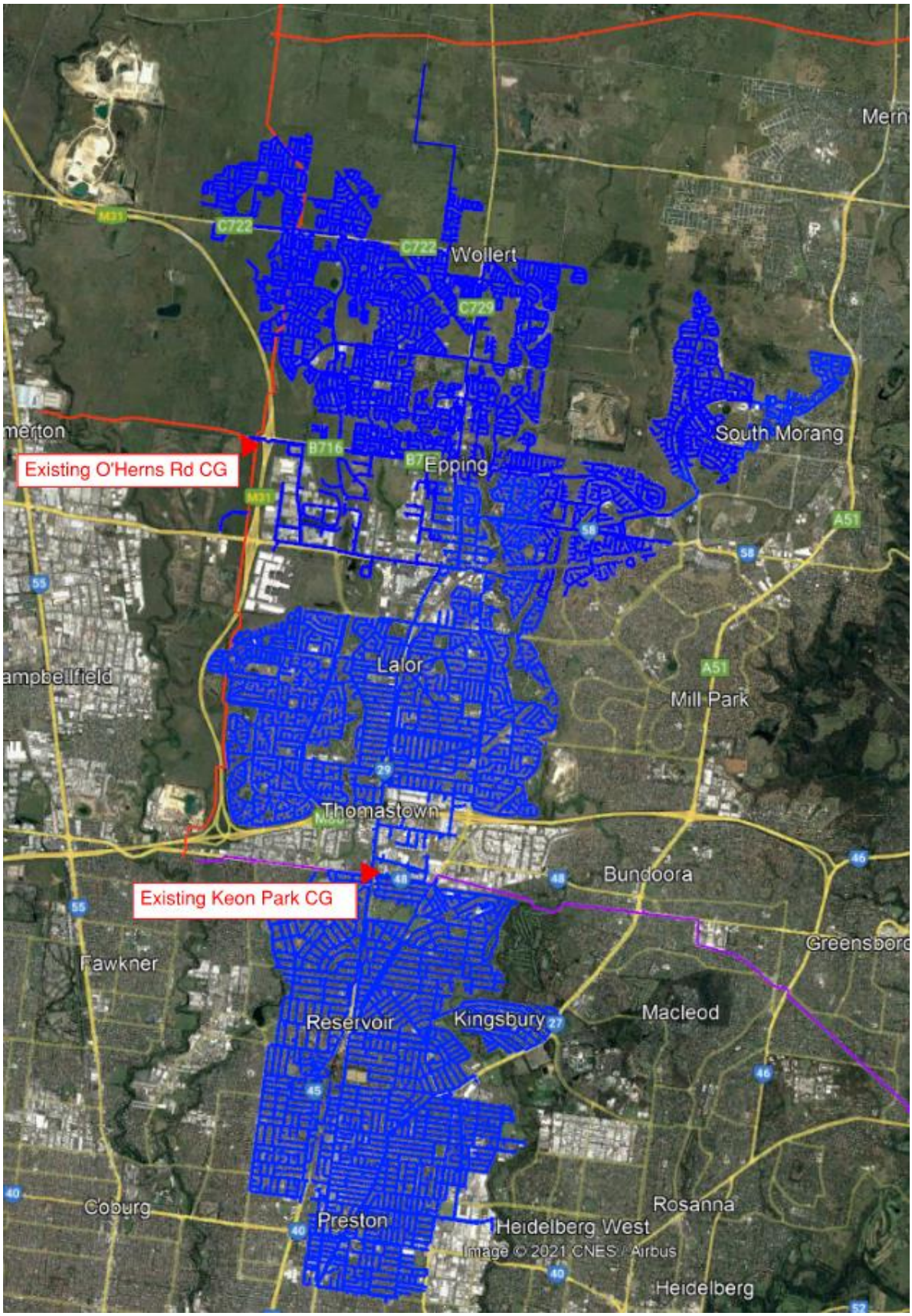
The forecast cost breakdown is shown in the table below.

Cost estimate, $'000 real 2021

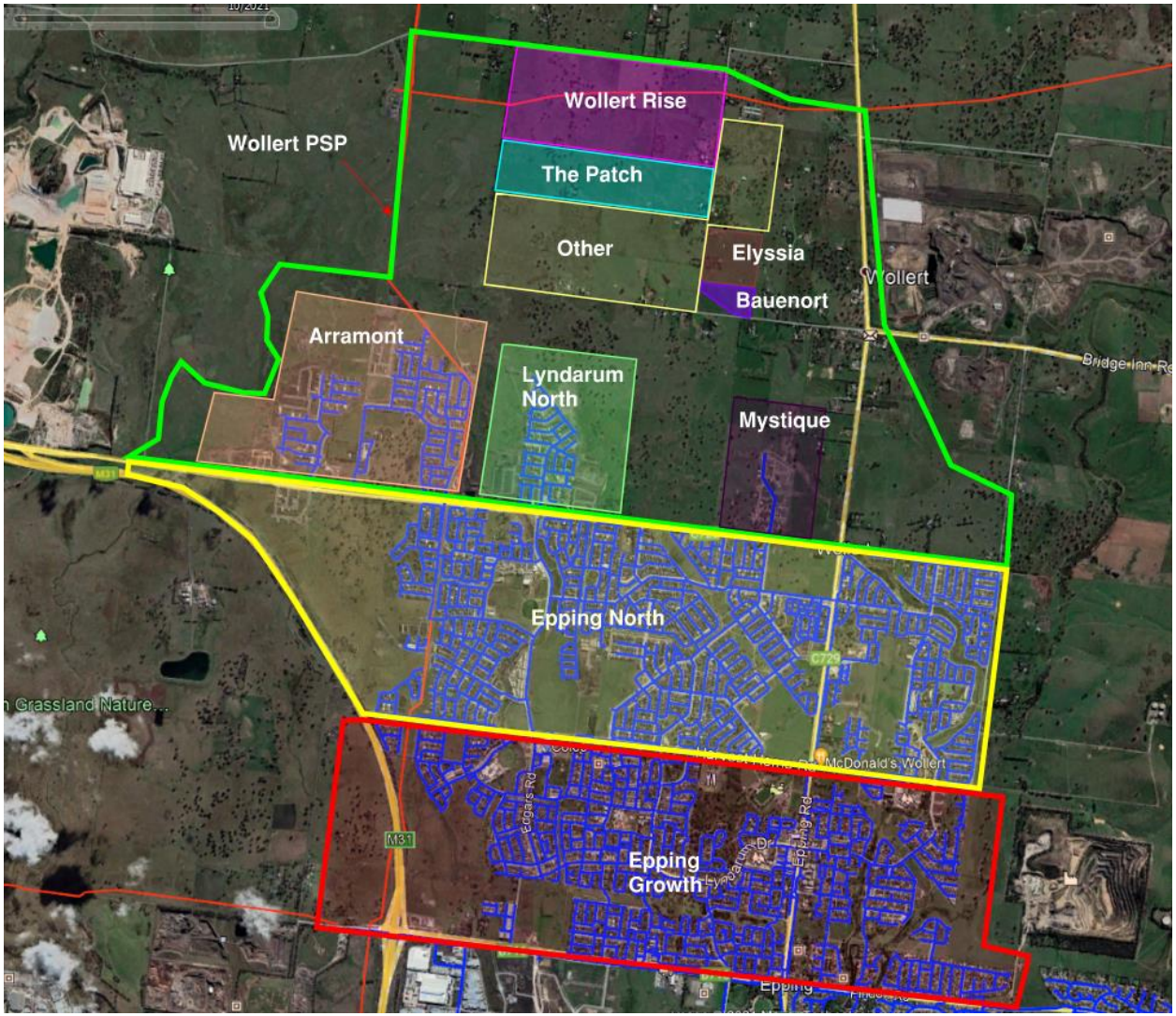
	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	-	-	-	Install 650 m of DN180 Trunk	Install 360 m of DN125 Trunk	-	Install 650 m DN3180, and 360 m DN125
Land	2,075	109					**2,184**
Labour	1,195	4,407	-	927	785	-	**7,314**
Material	390	1,374	-	35	22	-	**1,821**
Total	**3,660**	**5,890**	**-**	**962**	**807**	**-**	**11,319**

Appendix A – Asset location and growth area maps

A.1: Thomastown HP network map

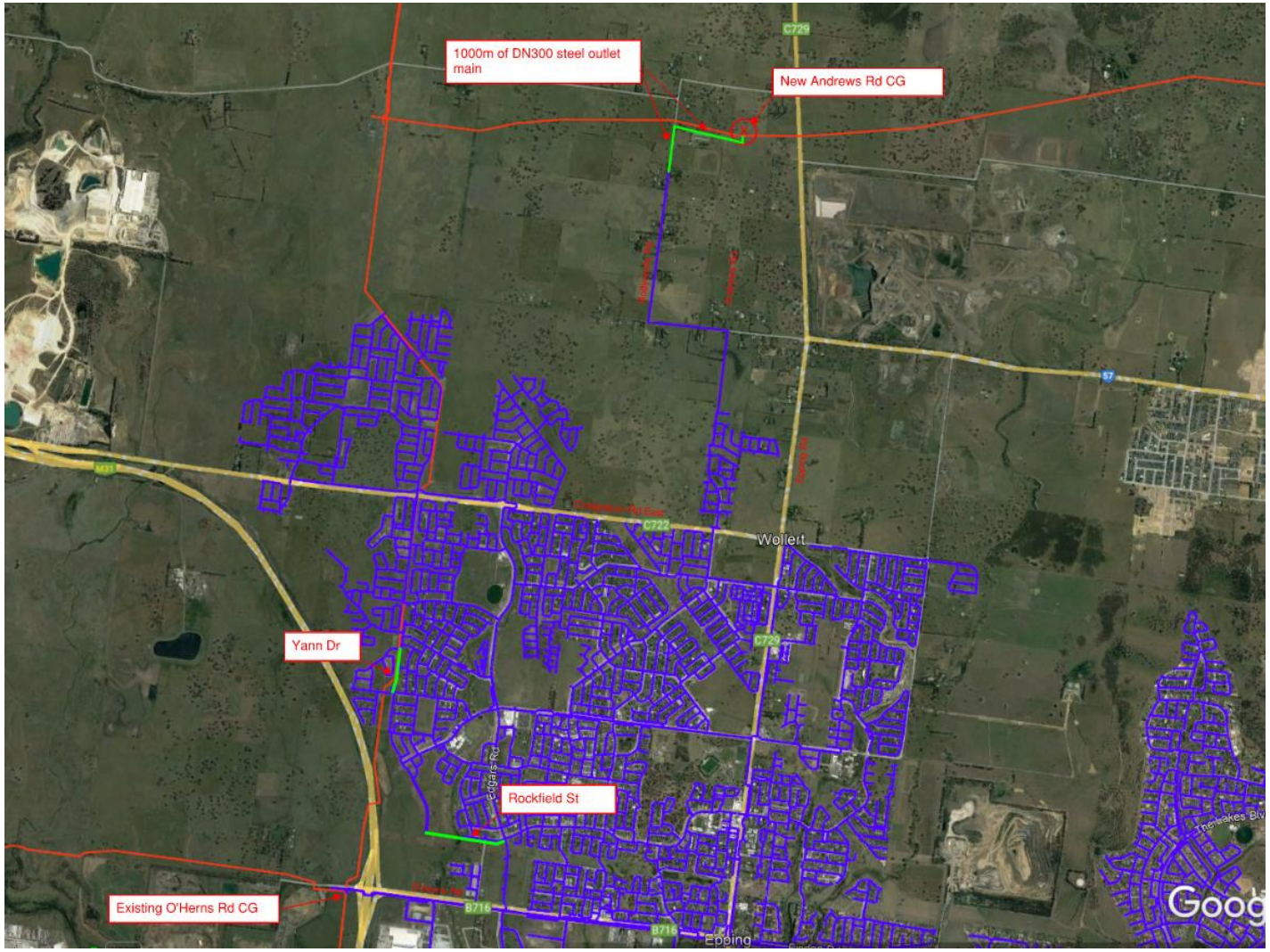


A.2: High Growth Areas for bottom-up forecast development

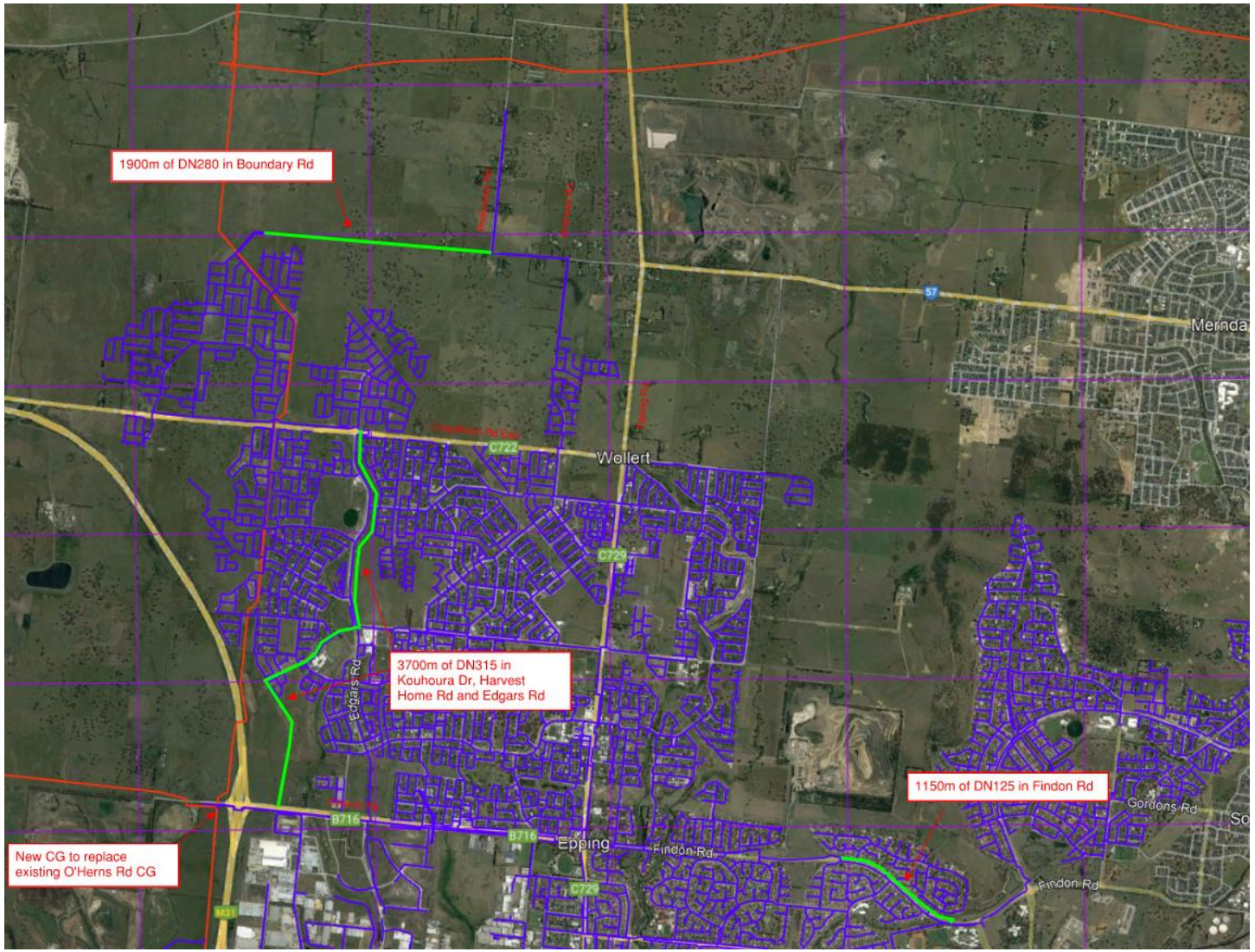


Appendix B – Option 1 and 2 augmentation projects

B.1: Option 1 map of augmentations



B.2: Option 2 map of augmentations



A.4 Wallan HP network augmentation

Project overview

Description of the problem / opportunity

The Wallan HP network (H79) supplies gas to over 5,300 customers in the township of Wallan.

The network is supplied from a city gate station located on the eastern side of Wallan. It extends across Hume Freeway to the west and feeds into the northern and western areas, where most of the population is located. Given the existence of western extremities, the network performance is sensitive to local growth. Over the past five years, the number of customer connections in Wallan has grown by an average of 280 new connections per year. Residential growth has triggered three augmentation projects to maintain customer supply pressures in the network during the current access arrangement period (2018-2022).

Being located within the urban growth boundary of Melbourne, continuing residential growth is expected. Over the next AA period (2023/24-2027/28), we are forecasting a higher rate of 300 new connections per year.

Continuing residential growth increases the risk of pressures dropping below 140 kPa. Based on the projected forecast growth rates and locations, we estimate that unless action is taken to augment the network, pressures on the western fringe pockets will fall below 140 kPa before winter 2024.

Network augmentations are therefore required during the access arrangement period to ensure customer supply is not adversely affected. This business case considers options to augment the Wallan HP network during the next AA period.

Untreated risk

As per risk matrix = **Moderate**

Options considered

- **Option 1** – Install 720 m of PE mains ($1.3 million)
- **Option 2** – Install 500 m of 200 mm ST and 1,000m of PE mains ($1.7 million)
- **Option 3** – Maintain status quo (zero upfront costs, but reactive augmentation will be required post 2024 upon supply/pressure failure)

Proposed solution

Option 1 is the proposed solution, as it is the most cost effective way to support load growth in the network while maintaining a safe and reliable gas supply to existing customers. Although Option 2 achieves the same level of risk reduction as Option 1, the solution is less cost effective and therefore is considered a less prudent course of action. Option 3 does not address the inherent risks of loss of supply pressure within the growing Wallan network, and therefore is inconsistent with our Risk Management Framework.

Estimated Cost

The forecast direct cost (excluding overhead) during the next five-year period (2023/24 to 2027/28) is $1.3 million. The project would be delivered across the years of this period as set out below.

$'000 real 2021	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Wallan HP augmentation	473	-	-	524	291	**1,288**

Basis of costs

All costs in this business case are expressed in real unescalated dollars at June 2021 unless otherwise stated.

Tables may not sum due to rounding.

Treated risk

As per risk matrix = **Low**

Background

The Wallan HP network provides gas to more than 5,300 residential customers (as of September 2021) in the township of Wallan. It is located approximately 40 km north of the Melbourne CBD and is within the Urban Growth Boundary of Melbourne. Over the past five years, the number of residential connections has grown by 1,400 connections at an average of 280 new connections per year. Refer to Appendix A Figure A.1 for a network map.

In this current AA period (2018 to 2022), there have been three augmentations to maintain supply to the current customer base and support the expanding network growth areas.

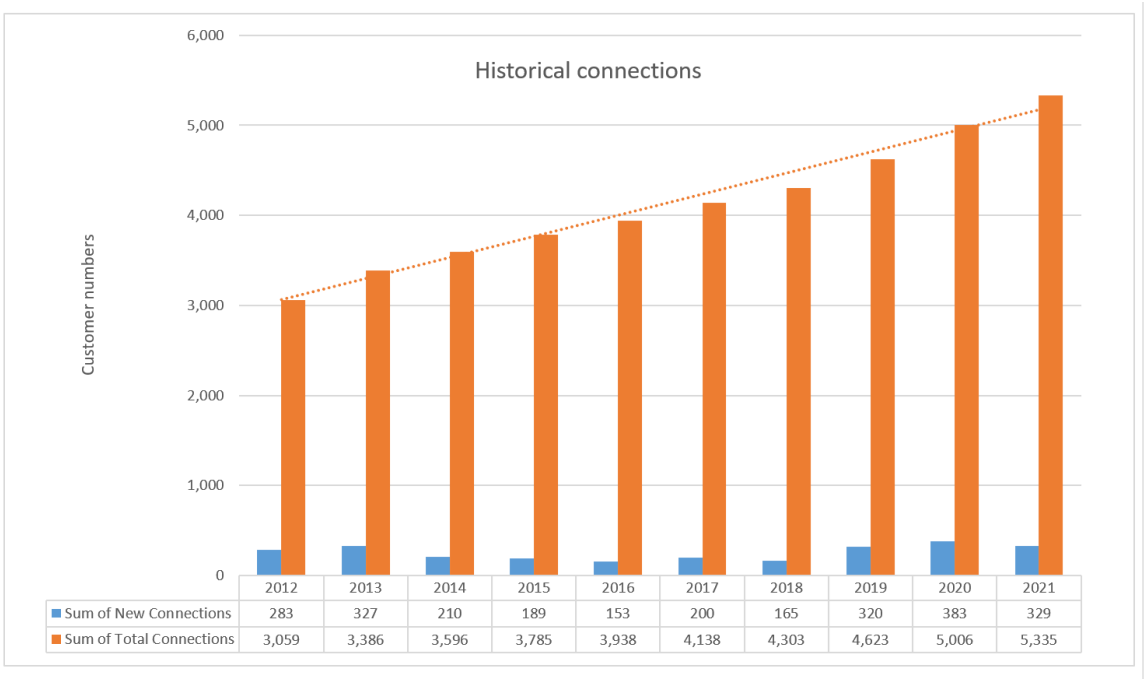
With existing and planned developments in Wallan, it is estimated growth will continue at a slightly higher average rate of 300 connections pa over the forthcoming access arrangement period.

Impact of historical growth

The Wallan HP network is an island network and is supplied by a single source located on the eastern side of Wallan, east of Hume Freeway. The network extends across Hume Freeway to the west, and feeds into the northern and western sides of Wallan.

The figure below shows the historical growth in new connections in the network since 2012.

Historical connection growth in Wallan HP network, 2012 to 2021



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Sum of New Connections	283	327	210	189	153	200	165	320	383	329
Sum of Total Connections	3,059	3,386	3,596	3,785	3,938	4,138	4,303	4,623	5,006	5,335

Historical growth in residential connections has been steady over the last ten years with an average connection rate of 260 pa. This has increased over the last five years to an average connection rate of 280 pa with a total of 1,400 new customers. In reference to the local council's township structure plan[14], there are currently greenfield residential development areas planned for, or approved, in Wallan.

[14] Wallan Structure Plan Analysis, Issues & Opportunities_Residential Development May 2014). A publication by the Mitchell Shire Council. Wallan Structure Plan residential development.

Growth in Wallan is forecast across three areas:

1. Northern Area
2. Western Area
3. Eastern Area

Refer to Appendix A Figure A.2 for map of growth areas and Figure A.3 for map of council planned developments across Wallan.

Northern area – approximately 9% of 1,400 new connections over the last five years have been added in the northern side of the Wallan network. It is well known as Hidden Valley, located north west of Hume Freeway. As of September 2021, there are 850 homes connected in the Northern area.

Western area – approximately 55% of 1,400 new connections over the last five years have been added in the western side of the network, located west of Hume Freeway. As of September 2021, there are 3,520 homes connected in the Western area. The island network layout has resulted in three extremity pockets in the Western area. They are Bedford, Sinclair, and Woodlands Edge. Network performance is notably sensitive to local growth in the extremity pockets, where 1,340 homes are currently connected.

Ongoing and planned greenfield residential developments in the Western area are listed as follows:

- Spring Ridge – approximately 1080 lots, east of Bedford fringe pocket; around 480 lots have been established to date
- King and Queen Streets – ongoing development, in Sinclair fringe pocket
- 165 Rowes Lane – approximately 580 lots, in Woodlands Edge fringe pocket; around 510 lots have been established to date
- 125 Rowes Lane - approximately 180 lots, north of Woodlands Edge fringe pocket; 60 lots have been established to date

To keep pace with the development and maintain supply to customers in the Western area, three separate projects have been completed over the current AA period. These are the Hume Freeway supply main duplication, which installed approximately 200 m of 180 PE, and two other augmentations, approximately 350 m of 63 PE and 204 m of 180 PE.

Eastern area – This area is close to the supply point in the eastern side of the network, located east of Hume Freeway. Approximately 36% of 1,400 new connections over the last five years has been added locally. As of September 2021, there are 965 homes connected in the Eastern area. Ongoing greenfield projects include Wallara Waters and New Bridge residential developments, where thousands of new homes will be built.

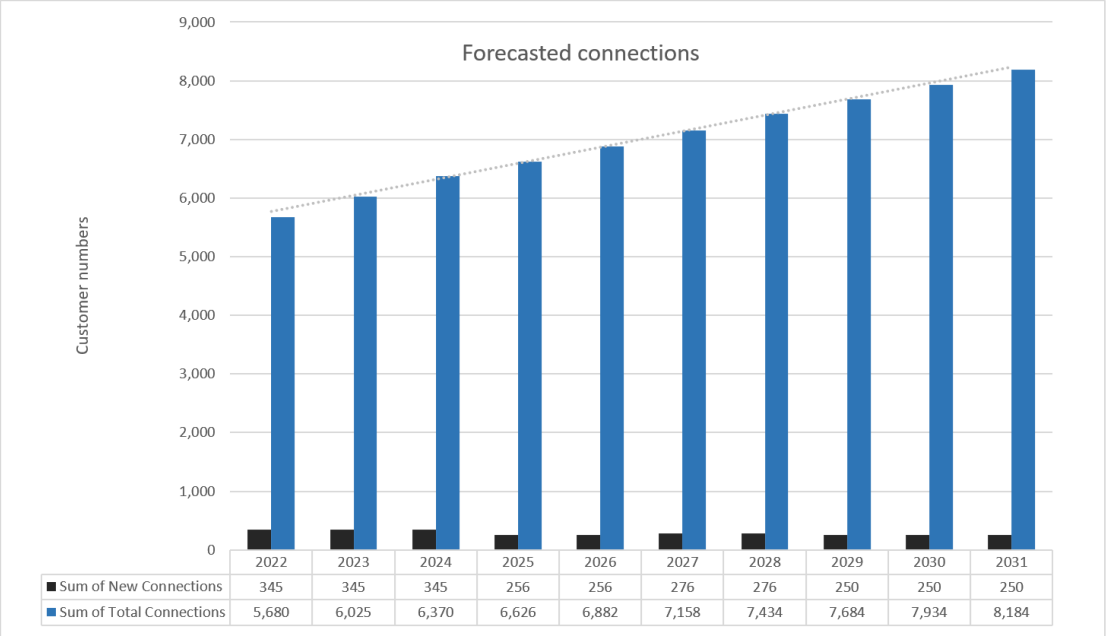
Future growth

While the number of connections in Wallan has averaged 280 in the last 5 years (2017 to 2021), since 2018 we have seen the number of new connections increase to 345 per year. Based on the council planned greenfield residential developments, it is reasonable and expected future growth in the network will continue to be at the growth rate of 345 per year into 2022.

As the council planned greenfield developments continue to fill up, opening new green residential development areas have been identified in the council structure plan and we have considered this as part of our planning. We have therefore taken a conservative approach by adopting an average growth rate of 300 per year for the next five years (2023/24 to 2027/28) in our forecasting assumptions.

Growth distribution in each area is further detailed below. The following figure shows the estimated increase in connections over the next ten years.

Estimated growth in new connections in the Wallan Network, based on historical connections



	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Sum of New Connections	345	345	345	256	256	276	276	250	250	250
Sum of Total Connections	5,680	6,025	6,370	6,626	6,882	7,158	7,434	7,684	7,934	8,184

Northern area – given a golf-club style with large rural property character, development in Hidden Valley will remain steady. It is expected to continue with a similar growth as previously observed. Approximately 9% of the expected 1,500 new connections will be in Hidden Valley in the northern area. By 2027, the number of connections in the northern area will reach 1,020.

Western area – growth in this area is expected to decrease to a lower rate of 45% (from 55%). This reduction is a result of full establishment of 165 Rowes Lane and a gradual filling up of the council planned greenfield in this area. Prior to future precinct structure planning for a new greenfield site in the western area, the focus is shifting to the existing greenfield in the Eastern area.

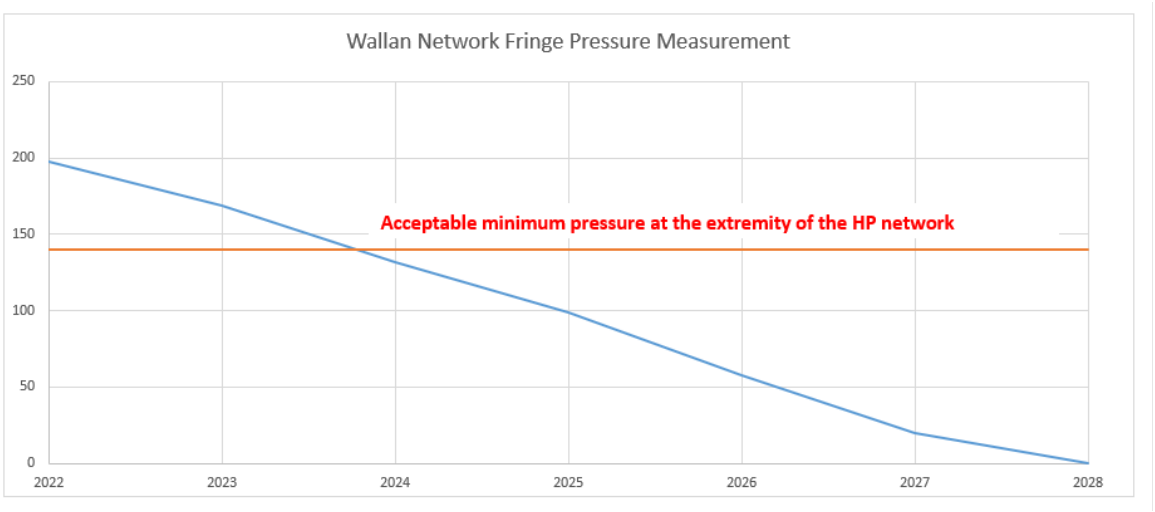
Over the next access arrangement period, existing and planned developments will continue in Spring Ridge, King and Queen Streets, 125 Rowes Lane, and 90 new lots on the Wallanbrae Estate development (south of Bedford pocket). By 2027, the number of connections in the western area will reach 4,360.

Eastern area – growth in this area is expected to increase to a higher rate of 46% (from 36%). Wallara Waters and New Bridge residential developments will continue, and absorb extra growth shifted from the western area. By 2027, the number of connections in the Eastern area will reach 1,780.

We have also assessed recent requests for gas mains extensions in Wallan, which is in line with the council planned greenfield projects detailed above. The continuing growth in the western section of the Wallan HP network combines with the impact of overall growth on the network, pressures in the western extremities will continue to drop year to year.

Our network forecast modelling estimates pressure levels in the western extremities will fall below the minimum acceptable pressure of 140 kPa before winter 2024 if the network is not augmented (see the figure below).

Estimated impact on pressures in the Wallan HP network if the network is not augmented



Risk assessment

The risk identified for the natural gas distribution network in the Wallan HP network region is that load growth without network reinforcement or augmentation will cause delivery pressures to drop, leading to substandard supply or loss of supply to >1,000 customers. This may lead to customers' gas appliances becoming inoperable or damaged in certain circumstances.

The primary consequence category affected by this risk is operations, as a pressure drop can cause outages to >1,000 customers, thereby carrying a significant consequence rating under the risk matrix.

Given load growth is ongoing, if the risk is left untreated the likelihood of a pressure drop impacting >1,000 customers is rated occasional (every couple of years), however the frequency of supply interruptions will likely increase the longer the load growth risk is not addressed.

Any significant customer outage would then give rise to a moderate reputational and compliance risk. While there is a moderate health and safety risk posed by falling delivery pressure, safety is not the primary driver of investment in this instance.

The untreated risk rating is presented in the following table.

Loss of supply risk in Wallan region – Untreated risk

Untreated risk	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Remote	Rare	Occasional	Rare	Occasional	Occasional	Occasional	Moderate
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Moderate	Negligible	Moderate	Negligible	Moderate	Moderate	Low	

Options considered

The following options have been identified to address the risk associated with the pressure drop risk in the Wallan HP network:

- Option 1 – Install 720 m of HP mains
- Option 2 – Install 500 m of 200 mm Steel and 1,000m of PE mains
- Option 3 – Maintain status quo

Both Options 1 and 2 will take place in multiple stages over the forecast period.

Option 1 – Install 720 m of HP mains

Option 1 has three stages over three years. (Refer to Figure B.1 in Appendix B).

- Stage 1 - install 290 m of 180 PE HP trunk main to duplicate an existing 100 mm ST main along William St and to connect an existing 100 mm ST duplication main east of Northern Hwy and 180 mm PE duplication main west of Windham St. This will be delivered during the forthcoming access arrangement period (2023/2024)
- Stage 2 - install 310 m of 125 mm PE HP main to duplicate an existing 63 mm main in Dudley St, between an existing 125 mm PE main just south of Watson St and an existing 63 mm PE main just north of Lauricella Dr. This will be delivered during the forthcoming access arrangement period (2026/2027)
- Stage 3 - install 120 m of 63 mm PE HP main in Watson St, between an existing 63mm PE main east of Bentinck St and an existing 50mm PE main west of Windham St. This will be delivered during the forthcoming access arrangement period (2027/2028)

The advantage of this option is that it progressively addresses the pressure drop risk at a lower cost than other options considered.

Option 1 cost assessment

The direct cost of this option is $1.29 million.

Cost estimate – Option 1, $'000 real 2021

Option 1	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	290 m of 180 mm PE	-	-	310 m of 125 mm PE	120 m of 63 mm PE	290 m of 180 mm, 310 m of 125 mm and 120 m of 63 mm PE
Plant & labour	446	-	-	504	280	**1,230**
Material	27	-	-	20	11	**58**
Total	**473**	**-**	**-**	**524**	**291**	**1,288**

Option 1 risk assessment

Option 1 would reduce the loss of supply (operational) risk from moderate to low. The work would reduce the likelihood of a pressure drop impacting >1,000 people from occasional to remote. The risk consequence rating remains unchanged. Option 1 reduces the likelihood of a pressure drop leading to compliance or reputational impacts from unlikely to rare, reducing the risk from moderate to low. It also reduces the likelihood of a major safety incident from remote to rare.

Loss of supply risk in Wallan region – Option 1

Option 1	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Remote	Remote	Rare	Rare	Rare	Remote	Low
Consequence	Major	Minor	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Low	Negligible	Low	Negligible	Low	Low	Negligible	

While Option 1 achieves the same risk rating as Option 2 (see below), it does so at a lower overall cost. We therefore consider Option 1 to be the more prudent solution to ensuring supply pressure is maintained at acceptable levels within the Wallan network.

Option 2 – Install 500 m of 200 mm Steel and 1,000m of PE mains

Option 2 has three separate stages undertaken over three years. (Refer to Figure B.2 in Appendix B). The three separate stages are to install 500m of 200mm ST and 1,000m of 280mm PE mains to duplicate a section of existing trunk main.

Originally the township was supplied in 1979 by a single 100 mm steel supply main, over the years, most of its length has been duplicated by a combination of 150 mm steel and 180 mm PE mains.

This option involves installing an extra duplication of the existing trunk main from the outlet of gate station locate on the east side, west along Wallan-Whittlesea Rd and north along Station St to tie in to an existing 180mm PE trunk main in Station St.

Timing for this option is outlined as follows:

- Stage 1 – 500 m of 200 mm steel main in the period (2023/2024)
- Stage 2 – 500 m of 280 mm PE main in the period (2024/2025)
- Stage 3 – 500 m of 280 mm PE main in the period (2026/2027)

Option 2 cost assessment

The direct cost of this option is $1.7 million.

Cost estimate – Option 2, $'000 real 2021

Option 2	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	500 m of 200 mm steel	500 m of 280mm PE	-	500 m of 280 mm PE	-	500 m of steel and 1,000 m of PE HP main
Plant & labour	650	381	-	381	-	**1,412**
Material	75	85	-	85	-	**245**
Total	**725**	**466**	**-**	**466**	**-**	**1,657**

Option 2 risk assessment

Option 2 addresses the pressure drop issue and results in the same risk outcomes as the primary solution (Option 1). However, it achieves this at a higher cost than Option 1.

Loss of supply risk in Wallan region – Option 2

Option 2	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Remote	Remote	Rare	Rare	Rare	Remote	Low
Consequence	Major	Minor	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Low	Negligible	Low	Negligible	Low	Low	Negligible	

Option 3 – Maintain status quo

Under this option we would not incur any proactive capacity expansion capex to reduce the loss of supply risk in the Wallan HP Network. Instead, we would manage the network as per current practice, and address any supply issues as and when they occur.

Given the current load growth forecasts, it is highly likely capital costs to address supply shortfall will be incurred reactively as minimum pressure limits are reached during winter of 2024. The network is currently operating at 450 kPa, which is below maximum allowable operating pressure (MAOP).

As the network is already operating as close as possible to its maximum allowable operating pressure (MAOP) no further network capacity can be enabled through pressure increases.

We consider maintaining the status quo is not a viable solution, as it simply defers capacity expansion expenditure, as well as potentially resulting in high-cost reactive works.

Option 3 cost assessment

There are no additional upfront costs associated if we maintain the status quo. However, as mentioned above, we are likely to incur greater reactive maintenance costs as pressure issues emerge.

While it is not possible to quantify the reactive costs we would incur at this time, in our experience a project conducted reactively is around 3.2 times more expensive than one conducted proactively.[15] This assumption is consistent with the commonly accepted asset management principle that reactive asset maintenance can be around two to five times higher than proactive planned maintenance.[16]

Following the reactive works, if the network continually experiences substandard pressures, one of the solutions described under Option 1 or 2 would need to be applied.

Option 3 risk assessment

Under Option 3, the risk level would remain the same as the untreated risk as there are no controls in place to mitigate the pressure drop risk (other than not connecting new customers, which is not a viable option).

[15] For example, this is typically due to the additional premia for faster acquisition of long lead time materials, emergency response, labour costs, additional traffic management/permit costs, resource scheduling, etc.
[16] Marshall Institute, Omega engineering, ARMS reliability.

Loss of supply risk in Wallan region – Option 3

Option 3	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Remote	Rare	Occasional	Rare	Occasional	Occasional	Occasional	Moderate
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Moderate	Negligible	Moderate	Negligible	Moderate	Moderate	Low	

Option 3 is therefore not consistent with our risk management framework, which requires action must be taken to reduce risks to low or ALARP. A moderate rating for operations or safety is not ALARP.

Summary of costs and benefits

The following table presents a summary of how each option compares in terms of the estimated cost, the residual risk rating, and alignment with our vision objectives.

Comparison of options - Wallan

Option	Estimated cost ($ million)	Treated residual risk rating	Alignment with vision objectives
Option 1	1.3	Low	Aligns with *Delivering for Customers* and *Sustainably Cost Efficient*
Option 2	1.7	Low	Aligns with *Delivering for Customers*, but due to the higher cost, does not align with the *Sustainably Cost Efficient* objective
Option 3	Zero upfront capital costs	Moderate (not ALARP)	Does not align with *Delivering for Customers* or *Sustainably Cost Efficient*

Recommended option

Option 1, undertaking the 3 separate stages to augment the Western area in the Wallan HP network, duplicating a couple of the existing mains and adding an interconnection, is the recommended option. Option 1 was selected over Option 2 as it is a more cost effective option while also reducing the residual risk from high to low. Option 3 was not considered viable as it is inconsistent with our risk management framework.

Why is the recommended option prudent?

Option 1 is the most prudent option because:

- the project is required to comply with regulatory obligations under the Gas Distribution Code in order to maintain a safe and reliable supply of gas to customers;
- it is the most cost effective solution that reduces risks to an acceptable level. The proposed augmentation represents the minimum amount of augmentation necessary to sustain growth in the Western area over the next access arrangement period:
    - Option 2 provides a similar improvement in system pressure in the Western extremities and reduces risks from high to low. However, this option would require laying a significantly longer length and larger size of mains, resulting in a considerably higher cost. Steel mains installation are also no longer considered

industry good practice for these pressures due to the ongoing requirements for corrosion protection and maintenance.

- Option 3 allows ongoing growth to decrease the network capacity to the extent that supply loss becomes a more regular event. This option does not contain any upfront costs, however as a result the network minimum required pressures will be breached by an increasing amount and frequency each year. Hence, the number of customers experiencing interrupted or loss of supply will increase year to year;

- it is a low risk, technically simple and proven solution – duplicating existing supply mains and adding more interconnection within the network provide a known capacity improvement that can be relatively accurately quantified; and
- the risk of delivery is minimal, on a time and budget basis.

Estimating efficient costs

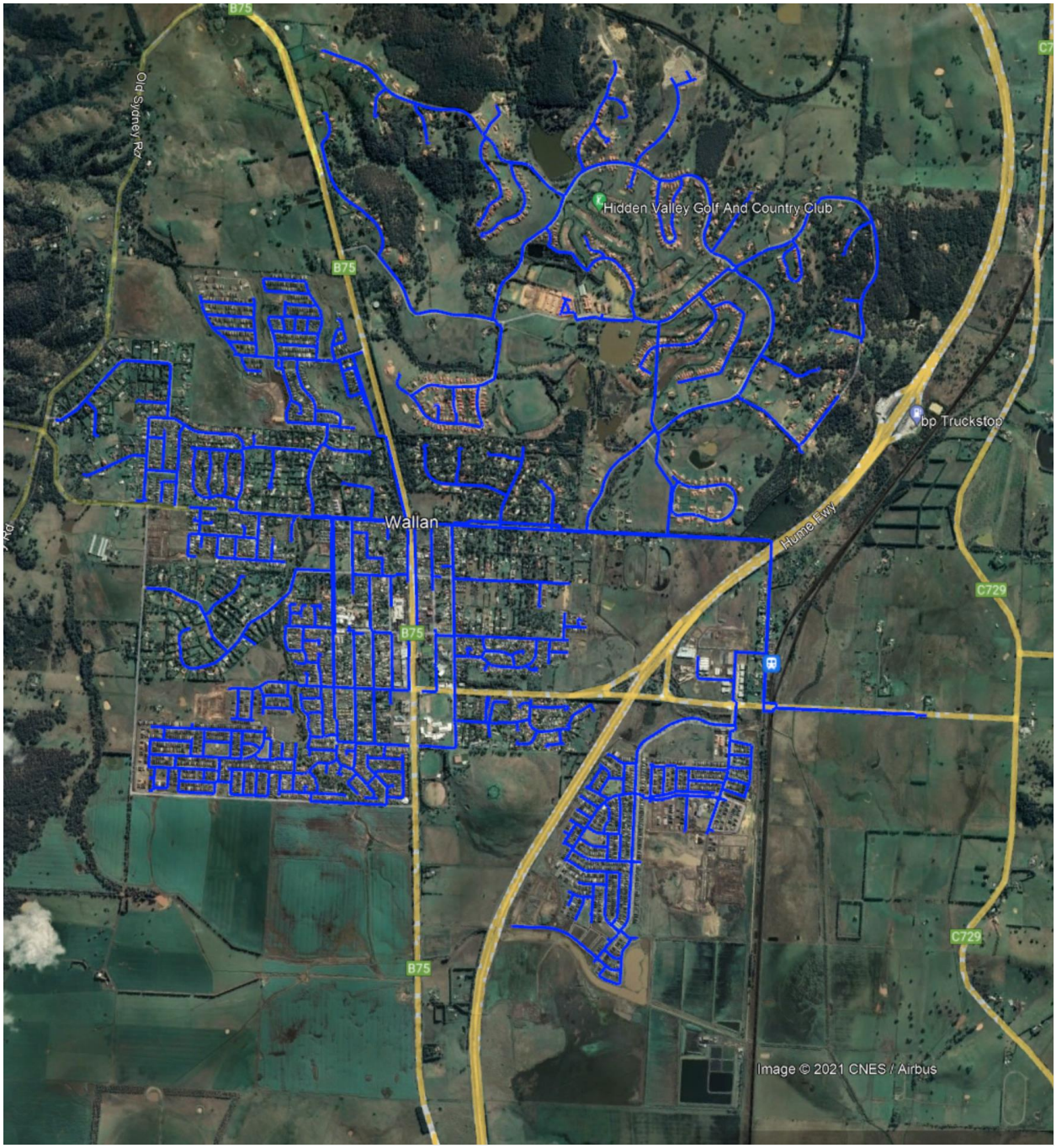
The forecast cost breakdown is shown in the table below.

Cost estimate, $'000 real 2021

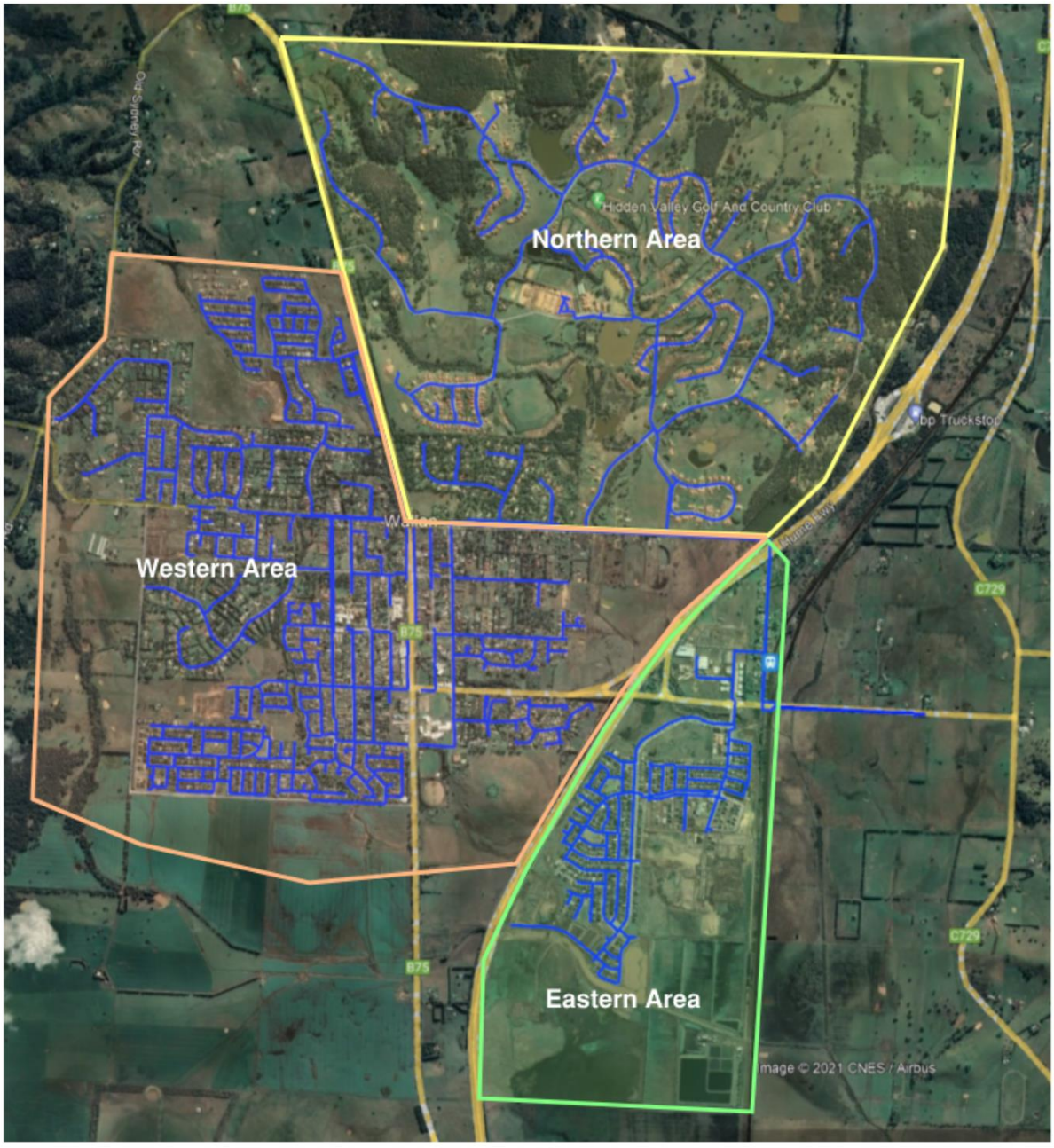
	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	290 m of 180 mm PE	-	-	310 m of125 mm PE	120 m of 63 mm PE	290 m of 180 mm, 310 m of 125 mm and 120 m of 63 mm PE
Plant & labour	446	-	-	504	280	**1,230**
Material	27	-	-	20	11	**58**
Total	**473**	**-**	**-**	**524**	**291**	**1,288**

Appendix A – Asset location and growth area maps

A.1: Wallan HP network map



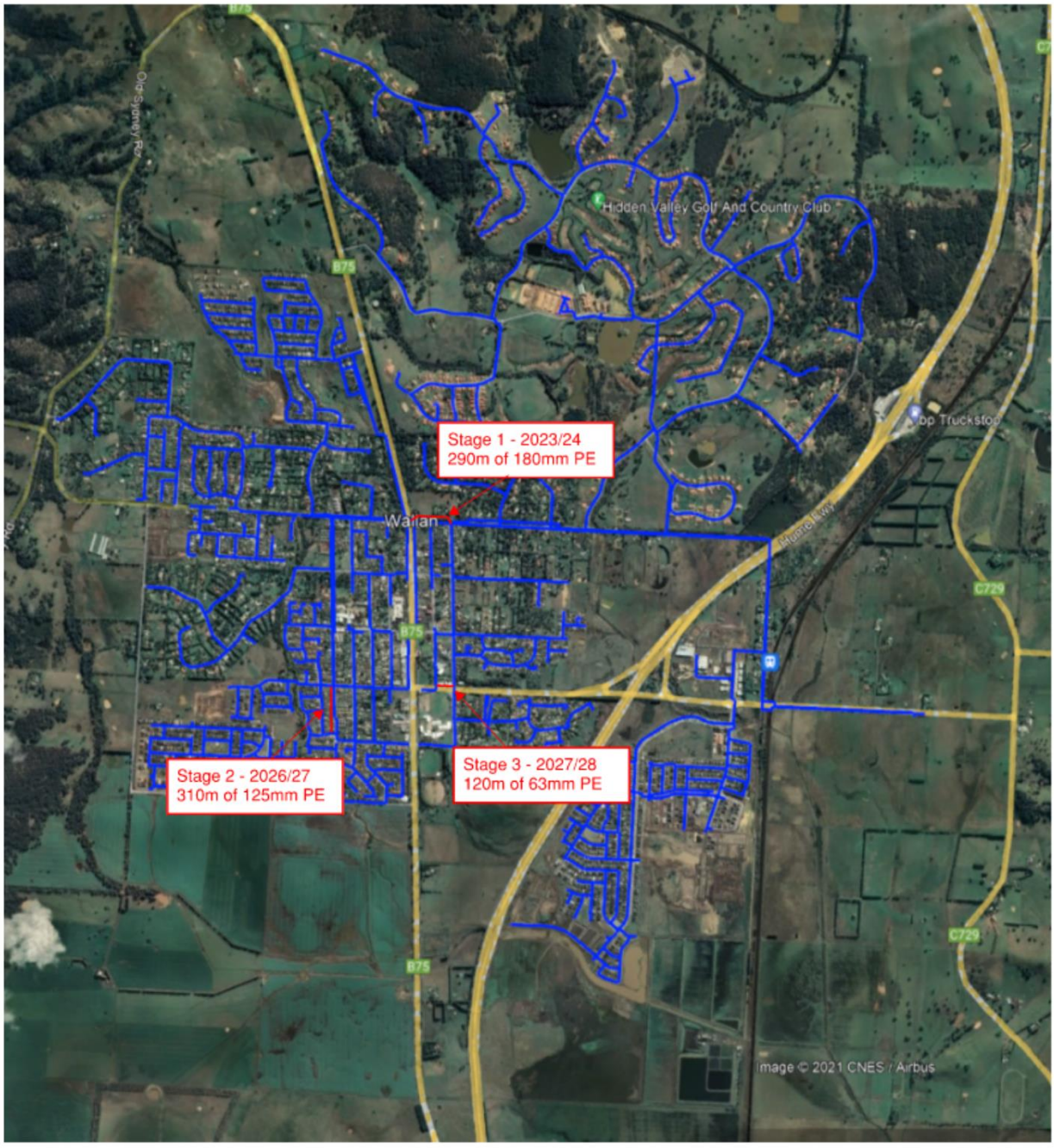
A.2: Growth areas within the Wallan network



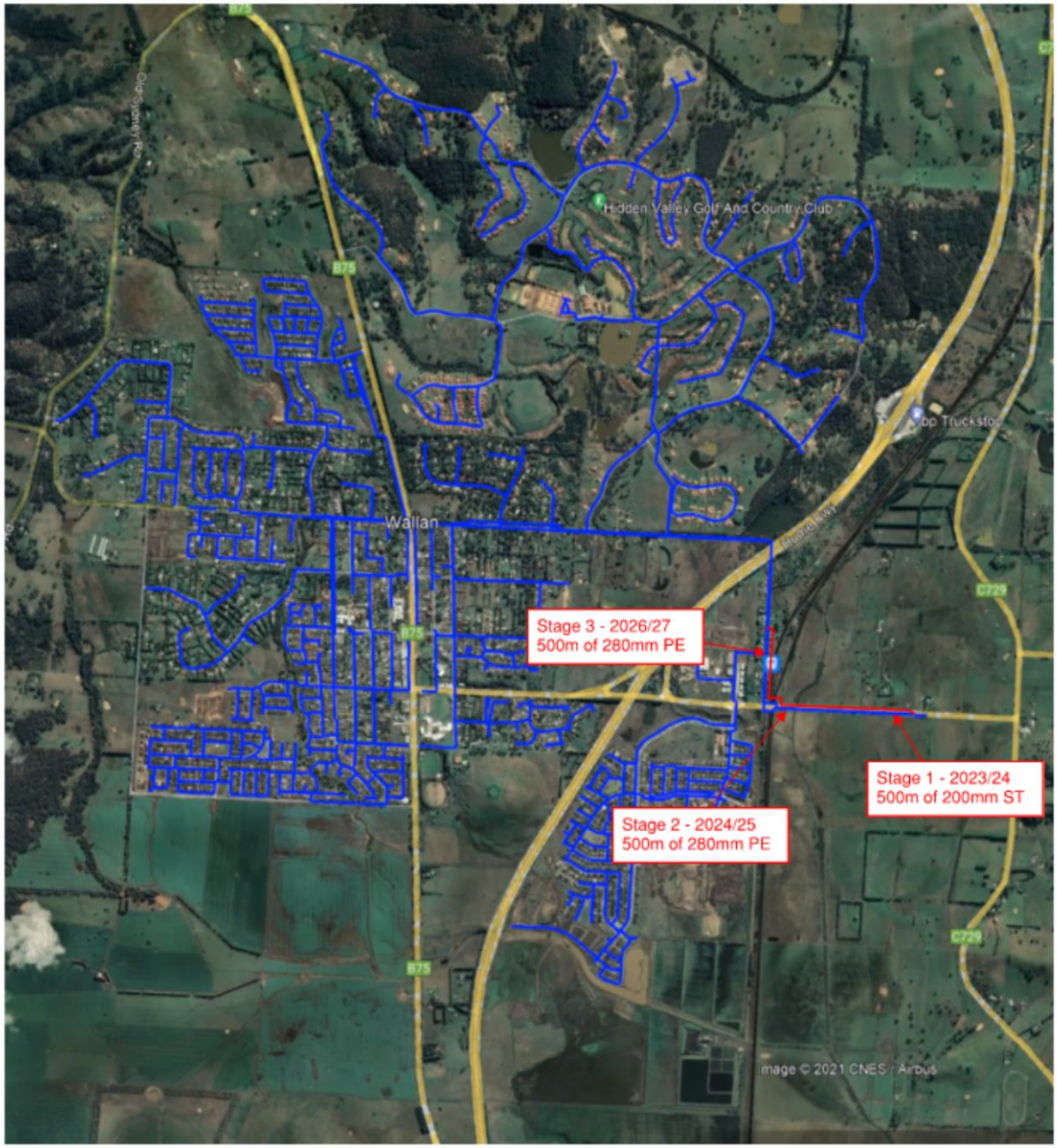
A.3: Council planned residential developments across Wallan

Appendix B – Option 2 and 3 augmentation projects

B.1: Option 2 map of augmentations



B.2: Option 3 map of augmentations



A.5 Traralgon HP network augmentation

Project overview

Description of the problem / opportunity	Traralgon has five growth pockets: Cross's Rd Development Plan, Traralgon East (Ellavale) Development Plan, Erin Park Development Plan, Franklin Place Development Plan and Traralgon North Development Plan. These are expected to contribute a total of 1,759 new residential premises between 2014 to 2034. Over the past ten years, the number of connections in Traralgon has grown by an average of 172 new connections per year. We expect growth to continue at this rate (as a minimum) over the forthcoming access arrangement period (2023/24 to 2027/28). The historical growth in residential connections has decreased the amount of spare capacity in the Traralgon high pressure (HP) network. We are reaching the point where augmentation is required to maintain customer supply pressures. Continued load growth in Traralgon will increases the risk of pressures dropping below 140 kPa, which is the minimum level necessary to maintain a safe and reliable customer supply. Based on the historical growth rates alone, we estimate that unless action is taken to augment the network, pressures will fall below 140 kPa by 2024. Network augmentation is therefore required before 2024 to ensure customers' supply is not affected. This business case considers options to augment the Traralgon HP network during 2023 and 2027.
Untreated risk	As per risk matrix = **Moderate**
Options considered	• **Option 1** – Duplicate 4.4 km of main in Firmin St, Latrobe Cres, Davidson St, Gordon St, Burn St, Cross's Rd and Grubbs Av ($2.2 million) • **Option 2** – Duplicate 3 km of main in Traralgon-Maffra Rd, Cross's Rd and Grubbs Av ($2.8 million) • **Option 3** – Maintain status quo
Proposed solution	Option 1 is the proposed solution, as it will support continued load growth in the 5 growth pockets of Traralgon without impacting existing customers' supply. It has the lowest direct cost option and has the lowest net present cost.
Estimated cost	The forecast direct cost (excluding overhead) during the next five-year period (2023 to 2028) is $2.2 million. The project would be delivered during 2023 and 2027.

Real $'000	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Traralgon HP augmentation	1,082	-	-	-	1,138	**2,220**

Basis of costs	All costs in this business case are expressed in real unescalated dollars at June 2021 unless otherwise stated. Tables may not sum due to rounding.
Treated risk	As per risk matrix = **Low**

Background

In 2020, the HP network in Traralgon had a total of 12,369 connections. The past ten years of connection data shows a yearly average increase of 172 new connections per year.

Development plans in Traralgon endorsed by Latrobe City Council indicates the development of five growth pockets. These are:

- Cross's Rd Development Plan
- Traralgon East (Ellavale) Development Plan
- Erin Park Development Plan
- Franklin Place Development Plan
- Traralgon North Development Plan

Given these development plans, growth is expected to continue past 2029.

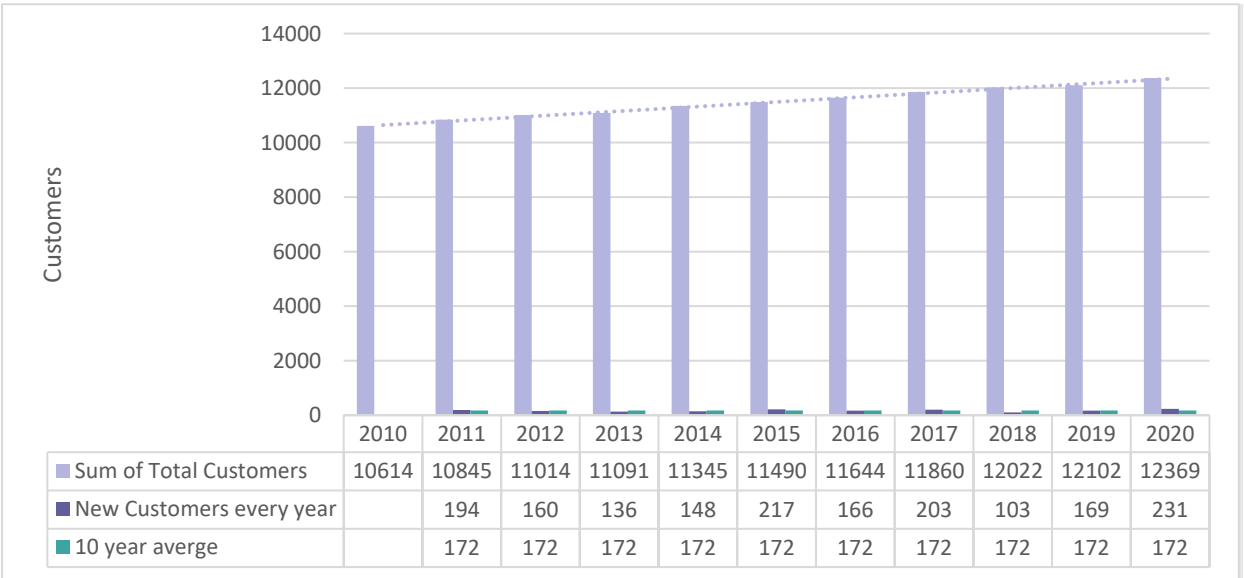
Impact of historical growth

Historical data shows a continual increase in new connections has resulted in the reduction of spare capacity of the Traralgon HP network. Continuation of growth without augmentation will cause pressures to drop to below 140 kPa. Pressures must remain above 140 kPa to meet our obligations of the Gas Distribution System Code and maintain customer supply. Cross's Rd Development and nearby area has been shown to experience pressures below the minimum in 2021.

Traralgon is supplied by a single 200 mm Steel HP main from the Traralgon City Gate. Smaller diameter pipes branch off this main to provide gas to wider Traralgon. The increase in connections when combined with the smaller diameter reticulation is causing the network to reach capacity in the outer areas of Traralgon, especially in the Cross's Rd Development Plan pocket and nearby areas. Consequently, the pressure is lower than minimum in these fringe areas.

The following figure shows the historical growth in new connections in the region from 2010 to 2020.

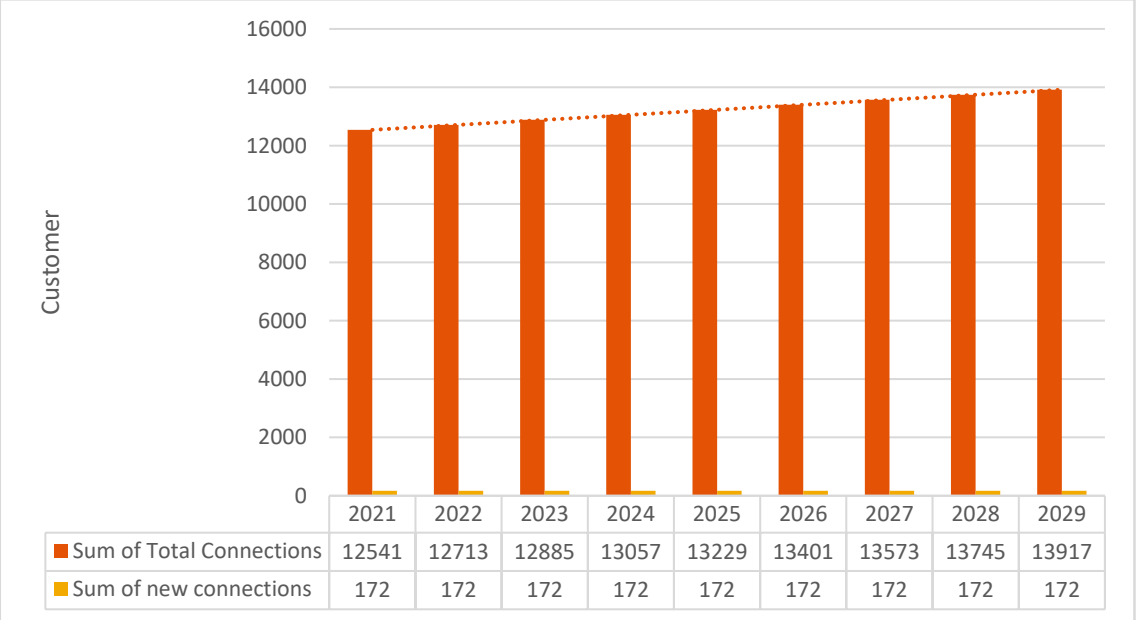
Historical connection growth in the Traralgon HP network, 2010 to 2020



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Sum of Total Customers	10614	10845	11014	11091	11345	11490	11644	11860	12022	12102	12369
New Customers every year		194	160	136	148	217	166	203	103	169	231
10 year averge		172	172	172	172	172	172	172	172	172	172

Based on the historical growth, the following figure shows the estimated increase in connections over the next ten years.

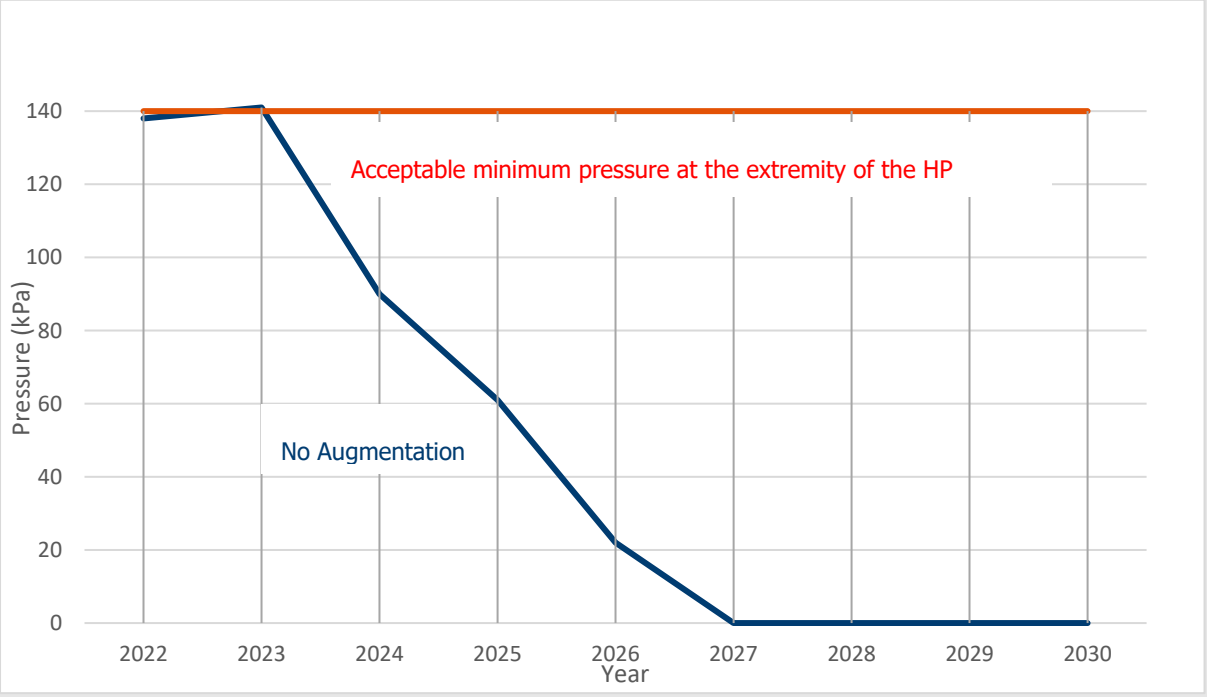
Estimated growth in new connections in Traralgon, based on historical connections



	2021	2022	2023	2024	2025	2026	2027	2028	2029
Sum of Total Connections	12541	12713	12885	13057	13229	13401	13573	13745	13917
Sum of new connections	172	172	172	172	172	172	172	172	172

If we assume this historical average connection rate of 172 new connections per year continues, we estimate pressure levels in the Traralgon HP network will fall below the minimum acceptable pressure of 140 kPa by 2024 if the network is not augmented.

Estimated impact on pressures in Traralgon if the network is not augmented



In 2022, the fringe pressure[17] is slightly less than 140 kPa (138 kPa). We have therefore prioritized this project for early in the regulatory period to avoid further non-compliance and issues regarding integrity of supply.

[17] Fringe pressure: the lowest pressure in the network

Future growth

There is evidence to suggest future growth in connections will continue at similar pace compared to historical growth. For example, Latrobe City Council has published five endorsed development plans (DPs) and precinct structure plans (PSPs) between 2012 to 2020, for the five growth areas. Review of the DPs and PSPs suggest a total of 1,759 new dwellings are expected over the 15 to 20 years from 2014.[18, 19, 20]

Dwelling increase estimates by forecast.iD for City of Latrobe also indicates a growth rate similar to historical average.[21] The following table shows the forecast change in the number of dwellings in areas supplied by the Traralgon gas distribution network from 2016 to 2036.

Forecast residential development, 2016 to 2036, City of Latrobe

City of Latrobe area	Forecast change in dwellings between 2016 and 2036	
	Number	%
Traralgon (Central)	+142	+3.2
Traralgon – Traralgon East (Balance)	+3,437	+44.9
Total growth	**+3,579**	
Growth per year	**+178**	**+48.1**

The historical average penetration rate for new (greenfield) developments where gas is available is >95%. A forecast of ~172 new gas connections per year has been derived. Given the forecast load increase, network augmentation is required to ensure customers' supply is not affected. This business case therefore considers options to augment the Traralgon network during 2023 to 2027.

Risk assessment

The risk identified for the natural gas distribution network in the Traralgon HP network region is that load growth without network reinforcement or augmentation will cause delivery pressures to drop, leading to substandard supply or loss of supply. This may lead to customers' gas appliances becoming inoperable or damaged in certain circumstances.

The primary consequence category affected by this risk is operations, as a pressure drop can cause outages to >1,000 customers, thereby carrying a significant consequence rating under the risk matrix. Given load growth is ongoing, if the risk is left untreated the likelihood of a pressure drop impacting >1,000 customers is rated occasional (every couple of years), however the frequency of supply interruptions will likely increase the longer the load growth risk is not addressed.

Any significant customer outage would give rise to a moderate reputational and compliance risk. While there is a moderate health and safety risk posed by falling delivery pressure, safety is not the primary driver of investment in this instance.

The untreated risk rating is presented in the following table.

[18] Endorsed Development Plans (DPs) and Precinct Structure Plans (PSPs) | Latrobe City Council
[19] Endorsed Addendum to the Traralgon North Development Plan January 2020.pdf (Latrobe .vic.gov.au)
[20] The Rise – Land for sale in Traralgon (therisetraralgon.com.au)
[21] Dwellings and development map | Latrobe City Council | Population forecast (id.com.au)

Loss of supply risk in Traralgon region – Untreated risk

Untreated risk	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Remote	Rare	Occasional	Rare	Occasional	Occasional	Occasional	Moderate
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Moderate	Negligible	Moderate	Negligible	Moderate	Moderate	Low	

The following options have been identified to address the pressure drop risk in the HP Traralgon distribution network:

- Option 1 – Duplicate 4.4 km of main in Firmin St, Latrobe Cres, Davidson St, Gordon St, Burn St, Cross's Rd and Grubbs Av
- Option 2 – Duplicate 3 km of main in Traralgon-Maffra Rd, Cross's Rd and Grubbs Av
- Option 3 – Maintain status quo

Both Option 1 and 2 are stages of long-term solutions to accommodate the 1,759 new connections within Traralgon. The table below lists details of the long-term plan. These options are discussed in the following sections.

Stages of Option 1 and 2

Stages	Targeted year	Option 1	Option 2
Stage 1	2023	1,782 m of 125 PE from existing P7 63 HP main in View Hill Dr along Cross's Rd and Grey St to tie into existing S7 100 main in Grubb Av	1,782 m of 125 PE from existing P7 63 HP main in View Hill Dr along Cross's Rd and Grey St to tie into existing S7 100 main in Grubb Av
Stage 2	2027	2,621 m of 125 PE from existing 100 S7 HP main in Park Ln along Firmin St, Latrobe Cres, Davidson St, Gordon St, Burn St to tie into 100 S7 HP main in Grey St	1,200 m of 200 mm steel HP main from the Traralgon City Gate to Marshalls Rd, duplicating the existing 200 mm main in Traralgon-Maffra Rd

Option 1 – Approximately 4.4 km of main augmentation

Option 1 has two stages. The first stage is to install 1782 m of 125 PE HP main from the existing P7 63 HP main in View Hill Dr along Cross's Rd and Grey St, duplicating the existing HP main, and tie into the existing S7 100 main in Grubb Av. This initial investment will resolve the immediate pressure drop risk, and will be delivered during the first year of the forthcoming AA period (2023).

The second stage is to install 2,621 m of 125 PE from the existing 100 S7 HP main in Park Ln along Firmin St, Latrobe Cres, Davidson St, Gordon St and Burn St and tie into 100 S7 HP main in Grey St, duplicating the existing main in these streets. This would be delivered in the second to last year of the AA period.

The advantage of this option is that it addresses the immediate pressure drop risk at a lower initial cost, and will defer the need for further augmentation to accommodate the growth in Traralgon until 2028, at which point the 2,621 m of duplication is required. This augmentation will accommodate the network growth until 2033.

Option 1 cost assessment

The direct cost of this option during the forthcoming access arrangement period is $2.2 million.

Cost estimate – Option 1, $'000 real 2021

Option 1	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	Install 1,782 m of 125 PE	-	-	-	Install 2,621 m of 125 PE	Install 4.4 km of 125 PE
Labour	994	-	-	-	1,030	**2,024**
Materials	88	-	-	-	108	**196**
Total	**1,082**	**-**	**-**	**-**	**1,138**	**2,220**

Tables may not sum due to rounding

This option is the less expensive than Option 2 due to material and construction cost of 125 PE main compared to 200 mm steel.

Option 1 risk assessment

Option 1 would reduce the loss of supply (operational) risk from moderate to low. The work would reduce the likelihood of a pressure drop impacting >1,000 people from occasional to remote. The risk consequence rating remains unchanged. Option 1 reduces the likelihood of a pressure drop leading to compliance or reputational impacts from unlikely to rare, reducing the risk from moderate to low. It also reduces the likelihood of a major safety incident from remote to rare.

Loss of supply risk in Traralgon region – Option 1

Option 1	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Remote	Remote	Rare	Rare	Rare	Remote	Low
Consequence	Major	Minor	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Low	Negligible	Low	Negligible	Low	Low	Negligible	

While Option 1 achieves the same risk rating as Option 2, the solution under Option 1 provides this risk reduction at a lower overall cost.

Option 2 – Duplicate approximately 3 km of main in Traralgon-Maffra Rd, Cross's and Grubbs A

Option 2 has two stages. The first stage of this option is the same as the first stage in Option 1 (refer to Appendix B.2). This initial investment will resolve the immediate pressure drop risk, and will be delivered during the first year of the forthcoming access arrangement period (2023).

The second stage is to duplicate 1,200 m of 200 mm Steel HP main from the Traralgon City Gate to Marshalls Rd, duplicating the existing 200 mm main in Traralgon-Maffra Rd (Appendix B.3). This would be delivered in the second to last year of the access arrangement period (2027).

This option addresses the immediate pressure drop risk and will defer the need for further augmentation to accommodate the growth in Traralgon until 2028, at which point the 1,200 m of 200 mm steel main duplication is required. An advantage of this secondary solution is that is provides approximately 15 kPa higher pressures. This augmentation will accommodate the network growth until 2034.

Option 2 cost assessment

The direct cost of this option during the forthcoming access arrangement period is $2.8 million.

Cost estimate – Option 2, $'000 real 2021

Option 2	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	Install 1,782 m of 125 PE	-	-	-	Install 1,200 m of 200 PE	Install 1,782 m of 125 PE and 1,200 m of 200 PE
Labour	994	-	-	-	1,560	**2,554**
Materials	88	-	-	-	180	**268**
Total	**1,082**	**-**	**-**	**-**	**1,740**	**2,822**

This option is more expensive than Option 1 due to material and construction cost of 200 mm Steel compared to 125 PE main. This option would also include higher ongoing operational costs due the additional maintenance measures, such as CP, required for steel installations.

Option 2 risk assessment

Option 2 addresses the pressure drop issue and results in the same risk outcomes as the primary solution (Option 1). However, it achieves this at a higher cost than Option 1.

Loss of supply risk in Traralgon region – Option 2

Option 2	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Remote	Remote	Rare	Rare	Rare	Remote	Low
Consequence	Major	Minor	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Low	Negligible	Low	Negligible	Low	Low	Negligible	

Option 3 – Maintain status quo

Under this option we would not incur any proactive capacity expansion capex to reduce the loss of supply risk in Traralgon. Instead, we would manage the network as per current practice, and address any supply issues as and when they occur.

Given the current load growth forecasts, it is highly likely capital costs to address supply shortfall will be incurred reactively as minimum pressure limits are reached during winter 2024. The network is currently operating at 450 kPa. As the network is already operating as close as possible to its maximum allowable operating pressure (MAOP) no further network capacity can be enabled through pressure increases.

We consider maintaining the status quo is not a viable solution, as it simply defers capacity expansion expenditure, as well as potentially resulting in high-cost reactive works.

Option 3 cost assessment

There are no additional upfront costs associated if we maintain the status quo. However, as mentioned above, we are likely to incur greater reactive maintenance costs as pressure issues emerge.

While it is not possible to quantify the reactive costs we would incur at this time, in our experience a project conducted reactively is around 3.2 times more expensive than one

conducted proactively. [22] This assumption is consistent with the commonly accepted asset management principle that reactive asset maintenance can be around two to five times higher than proactive planned maintenance.[23]

Following the reactive works, if the network continually experiences substandard pressures, one of the solutions described under Option 1 or 2 would need to be applied.

Option 3 risk assessment

Under Option 3, the risk level would remain the same as the untreated risk as there are no controls in place to mitigate the pressure drop risk (other than not connecting new customers, which is not a viable option).

Loss of supply risk in Traralgon region – Option 3

Option 3	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Remote	Rare	Occasional	Rare	Occasional	Occasional	Occasional	Moderate
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Moderate	Negligible	Moderate	Negligible	Moderate	Moderate	Low	

Option 3 is therefore not consistent with our risk management framework, which requires action must be taken to reduce risks to low or ALARP. A moderate rating for operations or safety is not ALARP.

Summary of costs and benefits

The table below presents a summary of how each option compares in terms of the estimated cost, the residual risk rating, and alignment with our vision objectives.

Comparison of options - Traralgon

Option	Estimated cost ($ million)	Treated residual risk rating	Alignment with vision objectives
Option 1	2.2	Low	Aligns with *Delivering for Customers* and *Sustainably Cost Efficient*
Option 2	2.8	Low	Aligns with *Delivering for Customers* but does not align with *Sustainably Cost Efficient*
Option 3	Zero upfront capex	Moderate – non ALARP	Does not align with *Delivering for Customers* or *Sustainably Cost Efficient*

Recommended option

Option 1, defined in the table below, is the recommended option.

Stages of Option 1 – recommended option

Stages	Targeted year	Option 3
Stage 1	2023	1,782 m of 125 PE from existing P7 63 HP main in View Hill Dr along Cross's Rd and Grey St to tie into existing S7 100 main in Grubb Av

[22] For example, this is typically due to the additional premia for faster acquisition of long lead time materials, emergency response, labour costs, additional traffic management/permit costs, resource scheduling, etc.

[23] Marshall Institute, Omega engineering, ARMS reliability.

Stages	Targeted year	Option 3
Stage 2	2027	2,621 m of 125 PE from existing 100 S7 HP main in Park Ln along Firmin St, Latrobe Cres, Davidson St, Gordon St, Burn St to tie into 100 S7 HP main in Grey St

Why is the recommended option prudent?

Option 1 is the most prudent option as it addresses the pressure drop risk before the minimum acceptable level arises, while setting an efficient platform for further augmentation when the forecast growth occur in the five development pockets of Traralgon (Cross's Rd, Ellavale East, Erin Park, Franklin Place and Traralgon North).

Option 1 provides sufficient capacity to support the forecast organic growth over the remainder of the access arrangement period. No additional augmentation is forecast until at least 2033.

Stage 1 of Options 1 and 2 are the same and is required to support the growth within the Cross's Road Development. Stage 2 of Option 2 delivers greater pressure benefit to the network in the long run, however at a greater cost to the network. Option 2 provides a 15 kPa benefit, which we do not consider justifies the extra expenditure. Furthermore, the risk reduction of Option 1 and 2 are the same. Option 1 allows for the risk reduction to occur at a lower cost.

Estimating efficient costs

The forecast cost breakdown is shown in the table below.

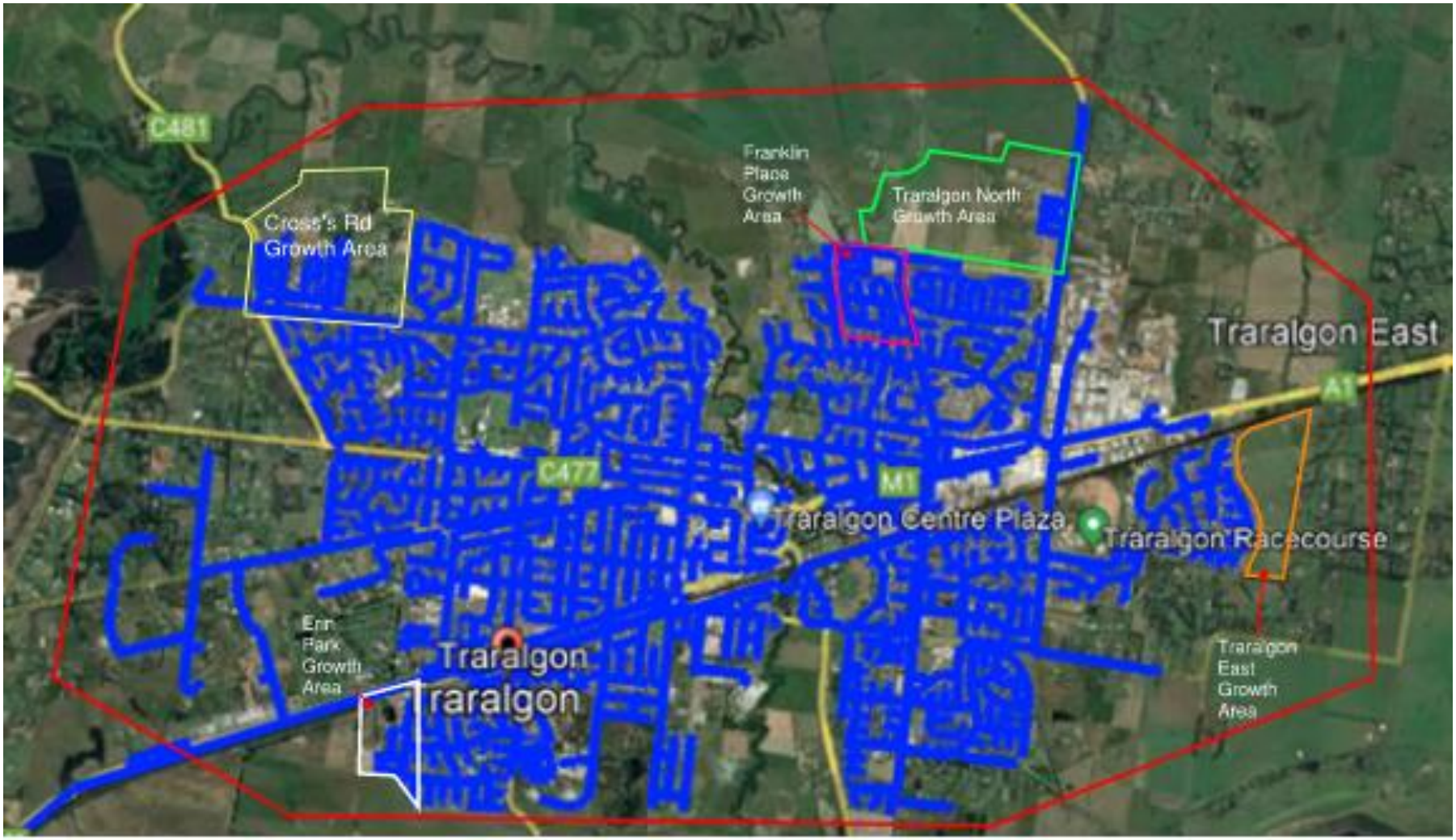
Cost estimate, $'000 real 2021

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	Install 1,782 m of 125 PE	-	-	-	Install 2,621 m of 125 PE	Install 4.4km of 125 PE
Labour	994	-	-	-	1,030	**2,024**
Material	88	-	-	-	108	**196**
Total	**1,082**	**-**	**-**	**-**	**1,138**	**2,220**

Appendix A – Asset location and growth area maps

A.1: Traralgon HP network map

A.2: Growth area



Appendix B – Option 1 and 2 duplication projects

B.1: Option 1 map of augmentations

B.2: Option 2 Map of augmentation

A.6 Wodonga HP network augmentation

Project overview

Description of the problem / opportunity	The southern suburbs of Wodonga, including Leneva-Baranduda, is a major residential growth area. It is forecast there will be 3,000 new lots built in this general area by the year 2035. This development has already begun and will continue to grow over the next access arrangement (AA) period at a rate of roughly 150 to 200 new houses per year. Part of this forecast growth rate is stated in the City of Wodonga and Leneva-Baranduda Precinct Structure Plan. This forecast growth in residential connections will decrease the amount of spare capacity in the Wodonga HP network, and by year 2024 reaches the point where augmentation is required in order to maintain supply pressures above the minimum acceptable pressure of 140 kPa. The load increase will have the greatest impact on the south-eastern extremity of the Wodonga HP network, particularly in and around Leneva itself, which is home to around 1,200 customers currently. This is because it is the fringe of the network, far away from the district regulator station (supply point) and missing sections of trunk infrastructure delivering gas to this area. Network augmentation is therefore required before winter 2024 to ensure customers' supply is not affected. This business case considers options to augment the Wodonga HP network during 2023/24.
Untreated risk	As per risk matrix = **Moderate**
Options considered	• **Option 1** – Lay 600m of PE main from Victoria Cross Parade to Balmoral Dr along Beechworth Rd ($0.6 million) • **Option 2** - Lay 600m of DN150 steel main (1050 kPa grade) from Victoria Cross Parade to Balmoral Dr along Beechworth Rd ($0.9 million) • **Option 3** – Maintain status quo (zero upfront capex)
Proposed solution	Option 1 is the proposed solution, as it will support continued load growth in the network without impacting existing customers' supply. It is also the lowest direct cost option, at a third of the cost of Option 2.
Estimated Cost	The forecast direct cost (excluding overhead) during the next five-year period (2023/24 to 2027/28) is $0.6 million. The projects would be delivered across the years of this period as set out below.

$'000 real 2021	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Wodonga HP augmentation	560	-	-	-	-	**560**

Basis of costs	All costs in this business case are expressed in real unescalated dollars in August 2021 unless otherwise stated. Tables may not sum due to rounding.
Treated risk	As per risk matrix = **Low**

Background

The southern suburbs of Wodonga, from Wodonga South to Leneva, is a major residential growth area. Over the past five years, the number of customer connections in the entire

Wodonga network has grown by an average of 350 new residential connections per year, while the southern suburbs have grown around 150 per year. We expect this growth to continue at this rate (as a minimum) over the forthcoming access arrangement period. It is quite likely this number will increase to 200 per year as Leneva-Baranduda growth zone start developing in 2022.

The HP network in the Wodonga network supplies more than 17,500 customers. Refer to Appendix A for a network map.

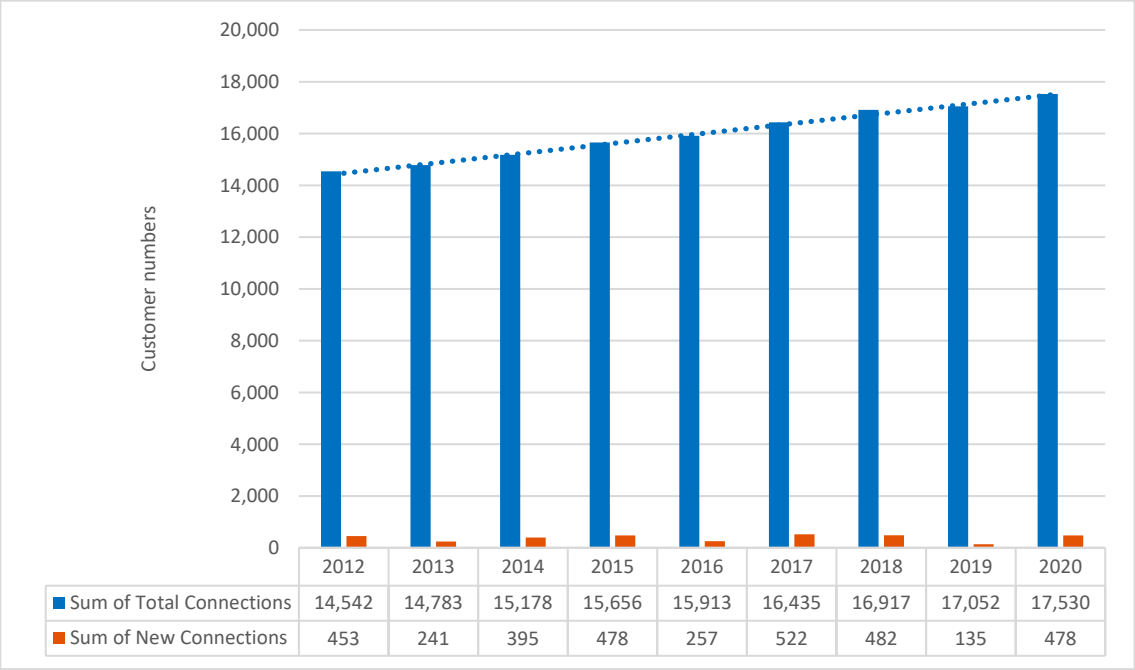
Impact of historical growth

Historical growth in residential connections has decreased the amount of spare capacity in the Wodonga network. We are reaching the point where augmentation is required in order to maintain customer supply pressures above minimum acceptable levels. The southern extremity of the network, in and around Leneva, is particularly susceptible to pressure drop due to rapid growth rate, lack of trunk infrastructure and distance away from the supply point.

Leneva is connected to the nearest district regulator by 3 km trunk main and is home to around 1,200 customers. A combination of DN50/150 steel, DN50/110/125 PE main delivers gas to the area. The larger sized trunks are not continuous, and are broken up by sections of DN50 mains creating bottlenecks. The first 1 km of this trunk main was duplicated with a DN150 steel trunk main along Beechworth Road in 2007. Due to the bottlenecks created by smaller diameter mains that throttle the supply, a relatively minor increase in load can lead to substandard pressures and supply issues.

The following figure shows the historical growth in new connections in the Wodonga network since 2012.

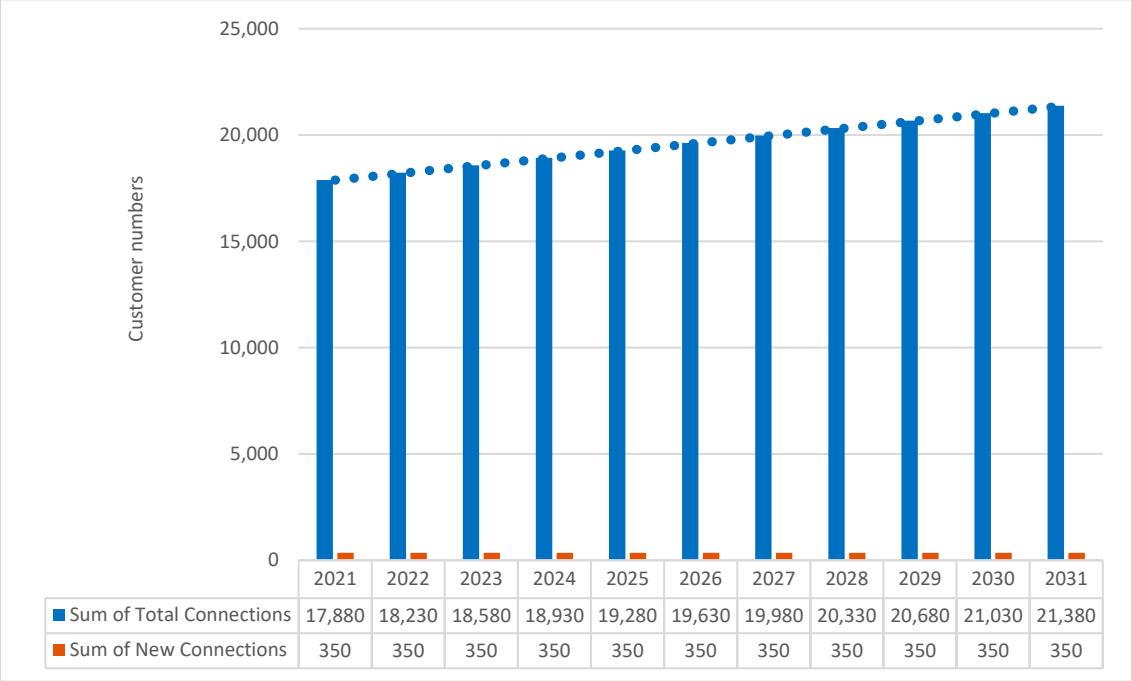
Historical connection growth in Wodonga HP network, 2012 to 2020



	2012	2013	2014	2015	2016	2017	2018	2019	2020
Sum of Total Connections	14,542	14,783	15,178	15,656	15,913	16,435	16,917	17,052	17,530
Sum of New Connections	453	241	395	478	257	522	482	135	478

Based on the historical growth, the following figure shows the estimated increase in connections over the next ten years.

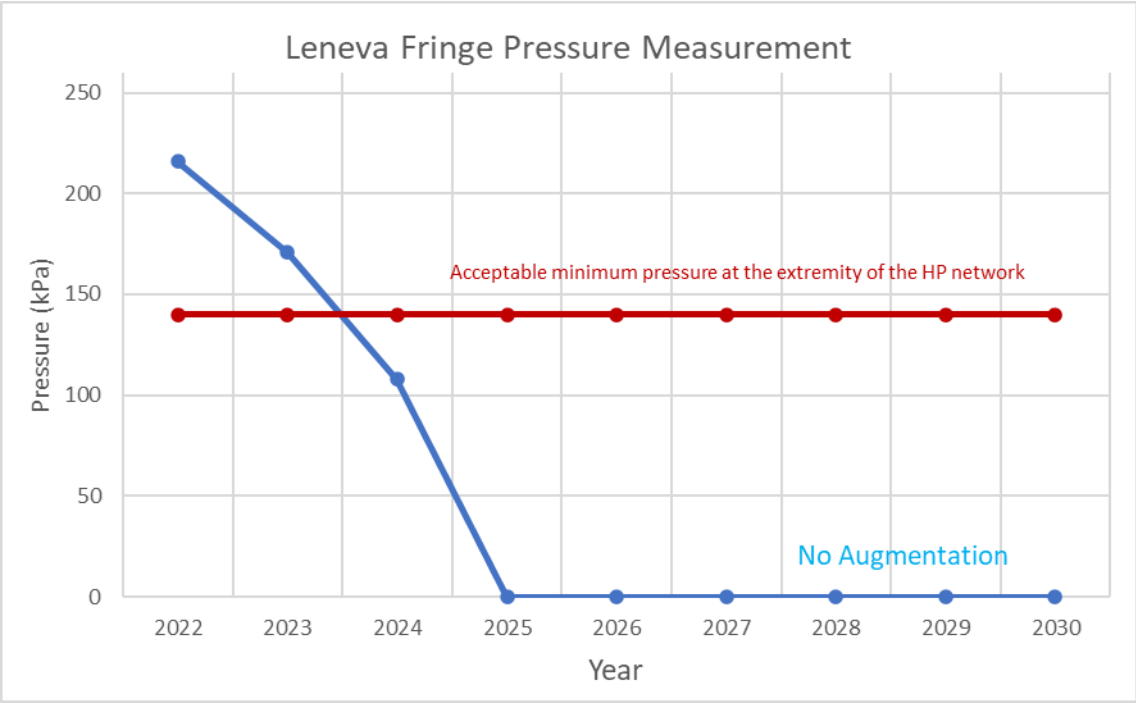
Estimated growth in new connections in the southern suburbs, based on historical connections



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Sum of Total Connections	17,880	18,230	18,580	18,930	19,280	19,630	19,980	20,330	20,680	21,030	21,380
Sum of New Connections	350	350	350	350	350	350	350	350	350	350	350

If we assume this historical average connection rate of 350 new connections per year continues, we estimate pressure levels in the Wodonga HP network will fall below the minimum acceptable pressure of 140 kPa during winter 2024 if the network is not augmented.

Estimated impact on pressures in Wodonga if the network is not augmented



Future growth

There is evidence to suggest future growth in connections will continue at similar if not faster pace compared to historical growth in the Wodonga South – Leneva area.

For example, Wodonga Council and Victoria Planning Authority published Leneva-Baranduda Precinct Structure Plan (PSP) in October 2018[24]. This document states: *The precinct is expected to take 20 to 30 years to fully develop and will house up to 6,037 new dwellings accommodating a population of approximately 15,395 residents*.

Also, the first commercial enquiries from real estate developers for Leneva-Baranduda growth zone have been received and the first two developments with an expected size of 600 and 300 new houses will start in 2022. Further development is expected to start in 2025 and continuing in later years. There also has been 200 new houses recorded in 2021 in this general area.

Dwelling increase estimates by forecast.id for the City of Wodonga also indicate a growth rate similar to the historical average.[25] The table below shows the forecast growth in the number of dwellings in areas supplied by the Wodonga gas distribution network from 2016 to 2036.

Forecast residential development, 2016 to 2036, City of Wodonga

City of Wodonga Area	Forecast change in dwellings between 2016 and 2036	
	Number	%
Baranduda	+732	+85.3
Belvoir	+69	+4.4
Felltimber	+18	+1.6
Killara – Bandiana	+1,192	+274.2
Martin Park	+161	+9.8
Melrose	+60	+1.8
North Leneva	+966	+291.7
Rural Balance	+180	+45.3
White Box Rise	+577	+89.0
Wodonga Central	+274	+17.9
Wodonga East	+790	+59.4
Wodonga South	+970	+49.8
Wodonga West	+636	+40.3
Total growth	**+6,625**	**+39.7**
Growth per year	**+350**	

Source: forecast.id, 2020 see: https://forecast.id.com.au/onkaparinga/residential-development?WebID=10

The historical average penetration rate for new (greenfield) developments where gas is available is >95%. A forecast of ~315 new gas connections per year has been derived. Given this forecast load increase, network augmentation is required to ensure customers' supply is not affected.

Risk assessment

The risk identified for the natural gas distribution network in the Wodonga region is that load growth without network reinforcement or augmentation will cause delivery pressures to drop, leading to substandard supply or loss of supply to up to 1,200 customers. This may

[24] https://www.wodonga.vic.gov.au/Have-your-say/Past-Consultations/Leneva-Baranduda-Precinct-Structure-Plan
[25] https://forecast.id.com.au/wodonga

lead to customers' gas appliances becoming inoperable or damaged in certain circumstances.

The primary consequence category affected by this risk is operations, as a pressure drop can cause outages to >1,000 customers, thereby carrying a significant consequence rating under the risk matrix.

Given load growth is ongoing, if the risk is left untreated the likelihood of a pressure drop impacting >1,000 customers is rated occasional (every couple of years), however the frequency of supply interruptions will likely increase the longer the load growth risk is not addressed.

Any significant customer outage would then give rise to a moderate reputational and compliance risk. While there is a moderate health and safety risk posed by falling delivery pressure, safety is not the primary driver of investment in this instance.

The untreated risk rating is presented below.

Loss of supply risk in Wodonga region – Untreated risk

Untreated risk	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Remote	Rare	Occasional	Rare	Occasional	Occasional	Occasional	Moderate
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Moderate	Negligible	Moderate	Negligible	Moderate	Moderate	Low	

Options considered

The following options have been identified to address the risk associated with the pressure drop risk in the Wodonga high pressure distribution network.

- **Option 1** – 600m of PE mains along Beechworth Rd from Victoria Cross Pde to Balmoral Dr
- **Option 2** – 600m of DN150 steel mains (1050kPa grade), along Beechworth Rd from Victoria Cross Pde to Balmoral Dr
- **Option 3** – Maintain status quo, take no action

Both Option 1 and 2 are stages of long-term solutions to accommodate long-term growth plan for Wodonga South – Leneva area. The table below lists detail of the long-term plan. These options are discussed in the following sections.

Long term plan for Wodonga growth area

Stages	Targeted year	Option 1	Option 2
Stage 1	2007 (completed)	DN150 steel main on Beechworth Road from Brockley St to Pearce St	Same as Option 1
Stage 1	2022/23 (current AA period)	320m of DN280 PE main along Beechworth Rd from Balmoral Dr to Sans Souci Dr	Same as Option 1
Stage 2	2023/24	600m of DN280 PE main along Beechworth Rd from Victoria Cross Pde to Sans Souci Dr	600 m of DN150 steel main, laid at 1050 kPa standard, same path as Option 1
Stage 3	Post-2030	1000 m of DN280 PE main in sections along Beechworth Rd and 190 m of DN280 PE main duplicating existing main from Hume St regulator to Brockley St	550 m of DN280 PE main from Sans Souci Dr to Streets Rd along Beechworth Rd, 450m of DN150 steel main, to be laid at 1050 kPa Standard, connecting the steel main laid in Stage 1 and 2, new TP to 1050 kPa regulator, new 1050 kPa to HP regulator, upgrade steel section laid in previous stages to 1050 kPa operation

Option 1 – 600 m of DN280 PE main along Beechworth Road

Option 1 is stage 2 of the long-term plan. Under this option, we will lay a new piece of DN280 PE main along Beechworth Road that starts at the intersection of Victoria Cross Parade and Beechworth Road, and ends at the intersection of Balmoral Drive and Beechworth Rd. This main is estimated to be around 600 m in length. Note that Option 2 shares the same length and path.

Option 1 utilises cheaper and larger diameter DN280 PE main compared to the DN150 steel, which would be operating at the same pressure until/if Stage 3 needs to be implemented.

Duplicating this section of main will remove the bottleneck in the system. This means the minimal size in the trunk main feeding Wodonga South – Leneva is DN110 PE. This option would augment the Wodonga network to mitigate the pressure drop risk and would sustain forecast growth until 2030.

Given growth is expected to continue, further work is required past 2030 to fully supply the 6,000 lots planned for Leneva-Baranduda growth zone and other developments. See Appendix B for further detail.

The advantage of this option is that prior to Stage 3 (post 2030) it offers more than sufficient capacity at much lower capital expenditure and still sets an efficient platform for further augmentation. It is around a third of the cost of Option 2.

Option 1 cost assessment

The direct cost of this option during the forthcoming AA period is $0.6 million.

Cost estimate – Option 1, $'000 real 2021

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	Install 600 m of DN280 PE main	-	-	-	-	Install 600 m of DN280 PE main
Labour	458	-	-	-	-	**458**
Material	102	-	-	-	-	**102**
Total	**560**	**-**	**-**	**-**	**-**	**560**

Option 1 risk assessment

Option 1 would reduce the loss of supply (operational) risk from moderate to low. The work would reduce the likelihood of a pressure drop impacting >1,000 people from occasional to remote. The risk consequence rating remains unchanged. Option 1 reduces the likelihood of a pressure drop leading to compliance or reputational impacts from unlikely to rare, reducing the risk from moderate to low. It also reduces the likelihood of a major safety incident from remote to rare.

Loss of supply risk in Wodonga region – Option 1

Option 1	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Remote	Remote	Rare	Rare	Rare	Remote	Low
Consequence	Major	Minor	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Low	Negligible	Low	Negligible	Low	Low	Negligible	

Option 2 – 600 m of DN150 steel main (1050 kPa grade) along Beechworth Rd

Under Option 2, we would lay a new section of DN150 steel main (1050 kPa grade) along Beechworth Road. It would follow the same path as proposed in Option 1, starting at the intersection of Victoria Cross Parade and Beechworth Road, and ending at the intersection of Balmoral Drive and Beechworth Rd.

This section of main will operate at PE pressure (450kPa), however it has the potential to be upgraded to 1050 kPa in the future. This is also an extension of 1050 kPa standard steel main laid in 2007.

Similar to Option 1, with continued growth, further work is required past 2030 to fully supply future development. See Appendix C for detail.

The eventual plan would be to have a 1050 kPa system from the center of Wodonga to the Leneva growth zone. This will bring the supply point closer to the fringe resulting in a considerable increase in gas supply to fringe of the network.

In order to achieve this, a new TP to 1050 kPa regulator is required in center of the town and a 1050 kPa to HP regulator will also be required at Castle Height Park. We will therefore need to lay more steel mains and upgrade existing ones to complete the 1050 kPa trunk network connecting these two regulators.

The advantage of this option is that it creates more capacity than Option 1 when all three stages are completed. The additional capacity will support an estimated 5,000 additional connections on top of the existing forecasted growth.

Option 2 cost assessment

The direct cost of this option during the forthcoming access arrangement period is $0.9 million.

Cost estimate – Option 2, $'000 real 2021

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	Install 600m of D150 steel	-	-	-	-	Install 600m of D150 steel
Labour	780	-	-	-	-	**780**
Material	90	-	-	-	-	**90**
Total	**870**	**-**	**-**	**-**	**-**	**870**

Option 2 risk assessment

Option 2 addresses the pressure drop issue and results in the same risk outcomes as the primary solution (Option 1). However, it achieves this at a higher cost than Option 1.

Loss of supply risk in Wodonga region – Option 2

Option 2	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Remote	Remote	Rare	Rare	Rare	Remote	Low
Consequence	Major	Minor	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Low	Negligible	Low	Negligible	Low	Low	Negligible	

Option 3 – Maintain status quo

Under this option we would not incur any proactive capacity expansion capex to reduce the loss of supply risk in Wodonga. Instead, we would manage the network as per current practice, and address any supply issues as and when they occur.

Given the current load growth forecasts, it is highly likely capital costs to address supply shortfall will be incurred reactively as minimum pressure limits are reached during winter of 2024. The network is currently operating at 450 kPa. As the network is already operating as close as possible to its MAOP no further network capacity can be enabled through pressure increases.

We consider maintaining the status quo is not a viable solution, as it simply defers capacity expansion expenditure, as well as potentially resulting in high-cost reactive works.

Option 3 cost assessment

There are no additional upfront costs associated if we maintain the status quo. However, as mentioned above, we are likely to incur greater reactive maintenance costs as pressure issues emerge.

While it is not possible to quantify the reactive costs we would incur at this time, in our experience a project conducted reactively is around 3.2 times more expensive than one conducted proactively.[26] This assumption is consistent with the commonly accepted asset management principle that reactive asset maintenance can be around two to five times higher than proactive planned maintenance.[27]

Following the reactive works, if the network continually experiences substandard pressures, one of the solutions described under Option 1 or 2 would need to be applied.

Option 3 risk assessment

Under Option 3, the risk level would remain the same as the untreated risk as there are no controls in place to mitigate the pressure drop risk (other than not connecting new customers, which is not a viable option).

Loss of supply risk in Wodonga region – Option 3

Option 3	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Remote	Rare	Occasional	Rare	Occasional	Occasional	Occasional	Moderate
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Moderate	Negligible	Moderate	Negligible	Moderate	Moderate	Low	

Option 3 is therefore not consistent with our risk management framework, which requires action must be taken to reduce risks to low or ALARP. A moderate rating for operations or safety is not ALARP.

Summary of costs and benefits

The table below presents a summary of how each option compares in terms of the estimated cost, the residual risk rating, and alignment with our vision objectives.

Comparison of options - Wodonga

Option	Estimated cost ($ million)	Treated residual risk rating	Alignment with vision objectives
Option 1	0.6	Low - ALARP	Aligns with *Delivering for Customers* and *Sustainably Cost Efficient* Lower cost while providing sufficient capacity
Option 2	0.9	Low – ALARP	Aligns with *Delivering for Customers* and *Sustainably Cost Efficient* Higher capacity in the very long future (30 years+)
Option 3	Zero upfront capex	High	Does not align with *Delivering for Customers* or *Sustainably Cost Efficient*

Recommended option

Option 1, 600 m of DN280 PE main along Beechworth Rd, is the recommended option.

[26] For example, this is typically due to the additional premia for faster acquisition of long lead time materials, emergency response, labour costs, additional traffic management/permit costs, resource scheduling, etc.
[27] Marshall Institute, Omega engineering, ARMS reliability.

Why is the recommended option prudent?

- Option 1 is the most prudent option. It provides sufficient capacity to support the forecast organic growth over the remainder of the access arrangement period, enabling us to defer additional augmentation after 2030. This means the network will have sufficient capacity to support growth over the next 10 years.
- Option 1 is a third of the cost of Option 2.
- Option 2 does create more capacity when fully completed but that additional capacity will be available only after finishing stage 3 beyond 2035. As this is more than 10 years in the future the possible capacity benefits are considered too uncertain, especially when Option 1 has laid down the foundations for future cost effective PE expansion.
- Option 3 is not viable as it is not consistent with our risk management framework, which requires action must be taken to reduce any high risks to low or ALARP.

Estimating efficient costs

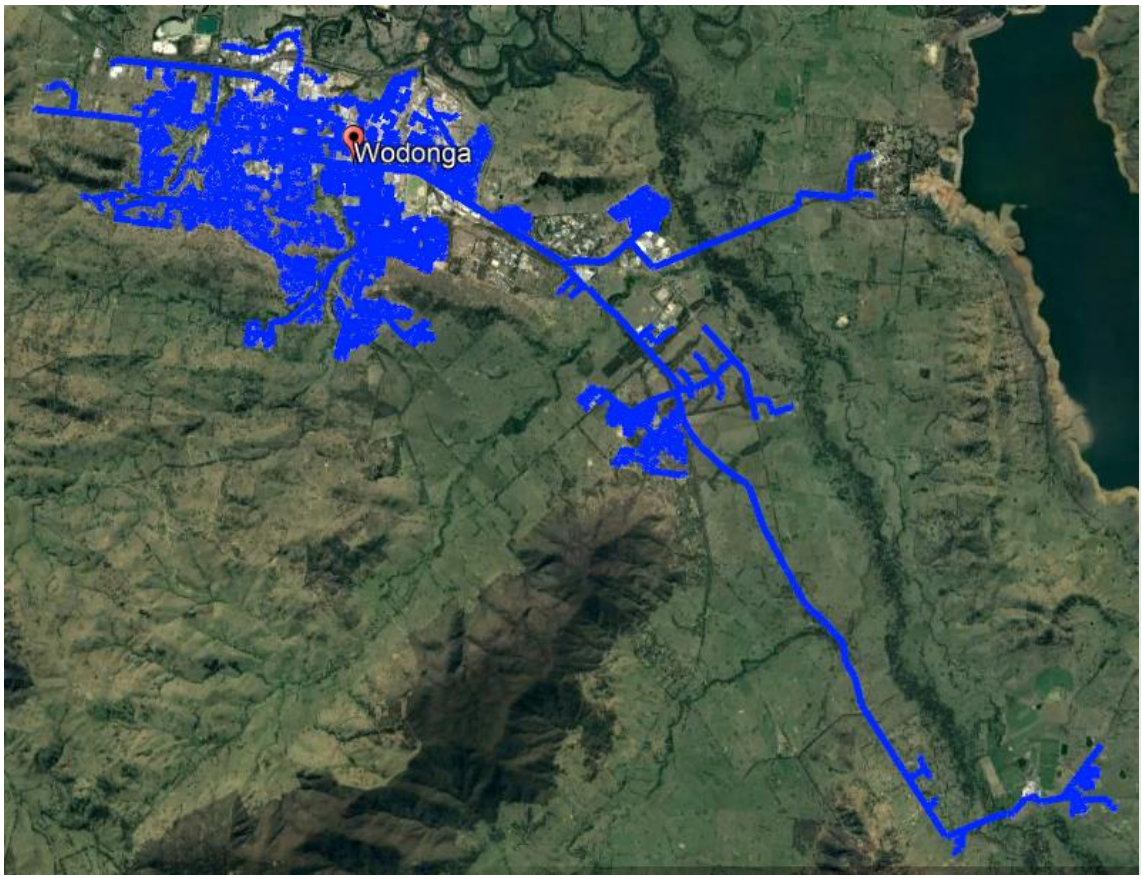
The forecast cost breakdown is shown in the table below.

Cost estimate, $'000 real 2021

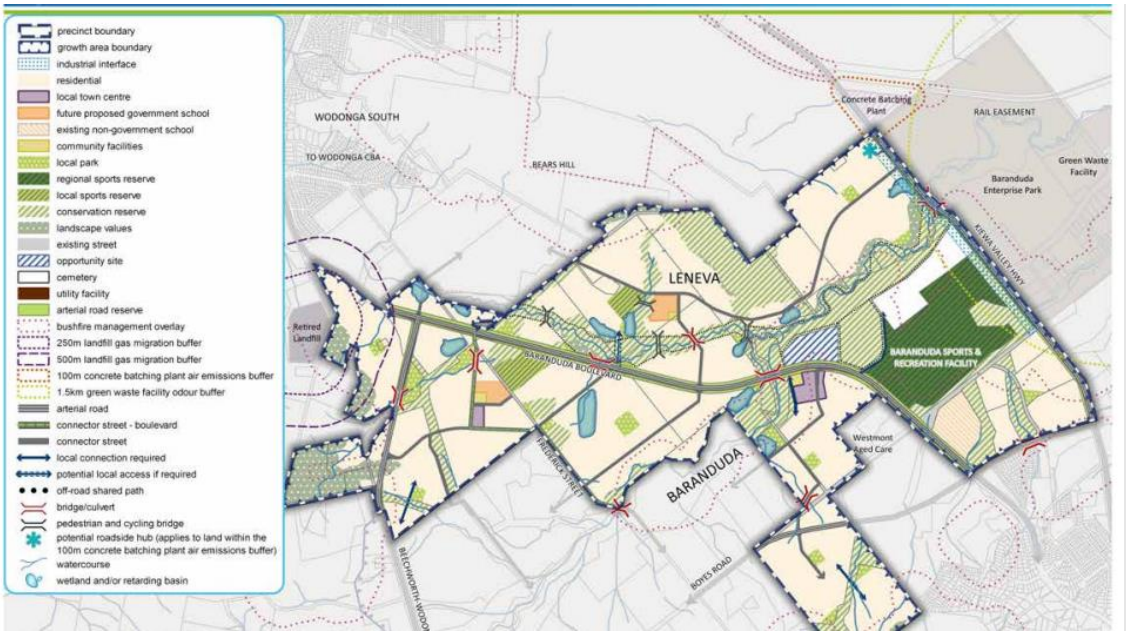
	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	Install 600m of DN280 PE main	-	-	-	-	Install 600m of DN280 PE main
Labour	458	-	-	-	-	**458**
Material	102	-	-	-	-	**102**
Total	**560**	**-**	**-**	**-**	**-**	**560**

Appendix A – Asset location maps and growth zone

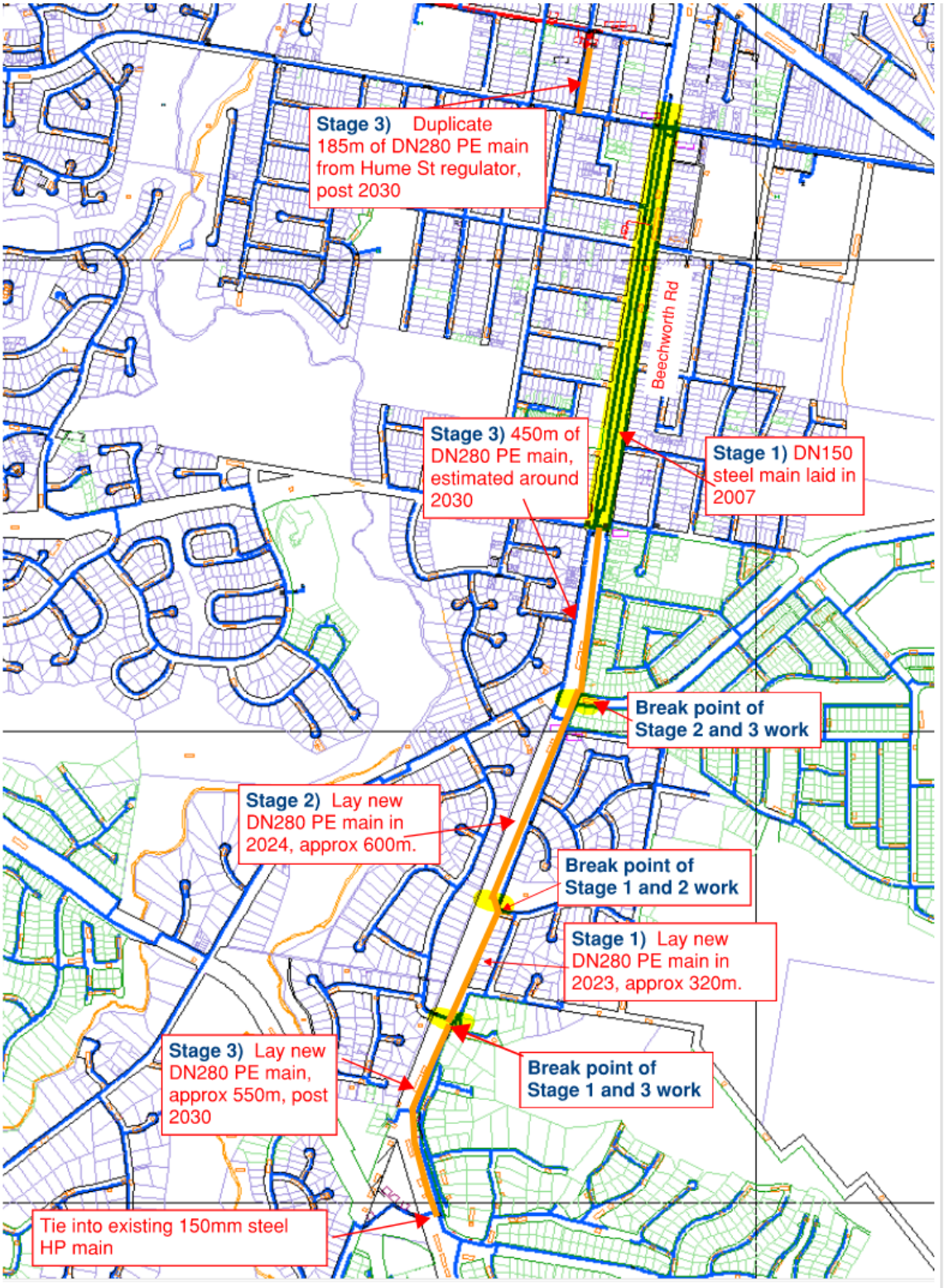
A.1: Wodonga Network Map



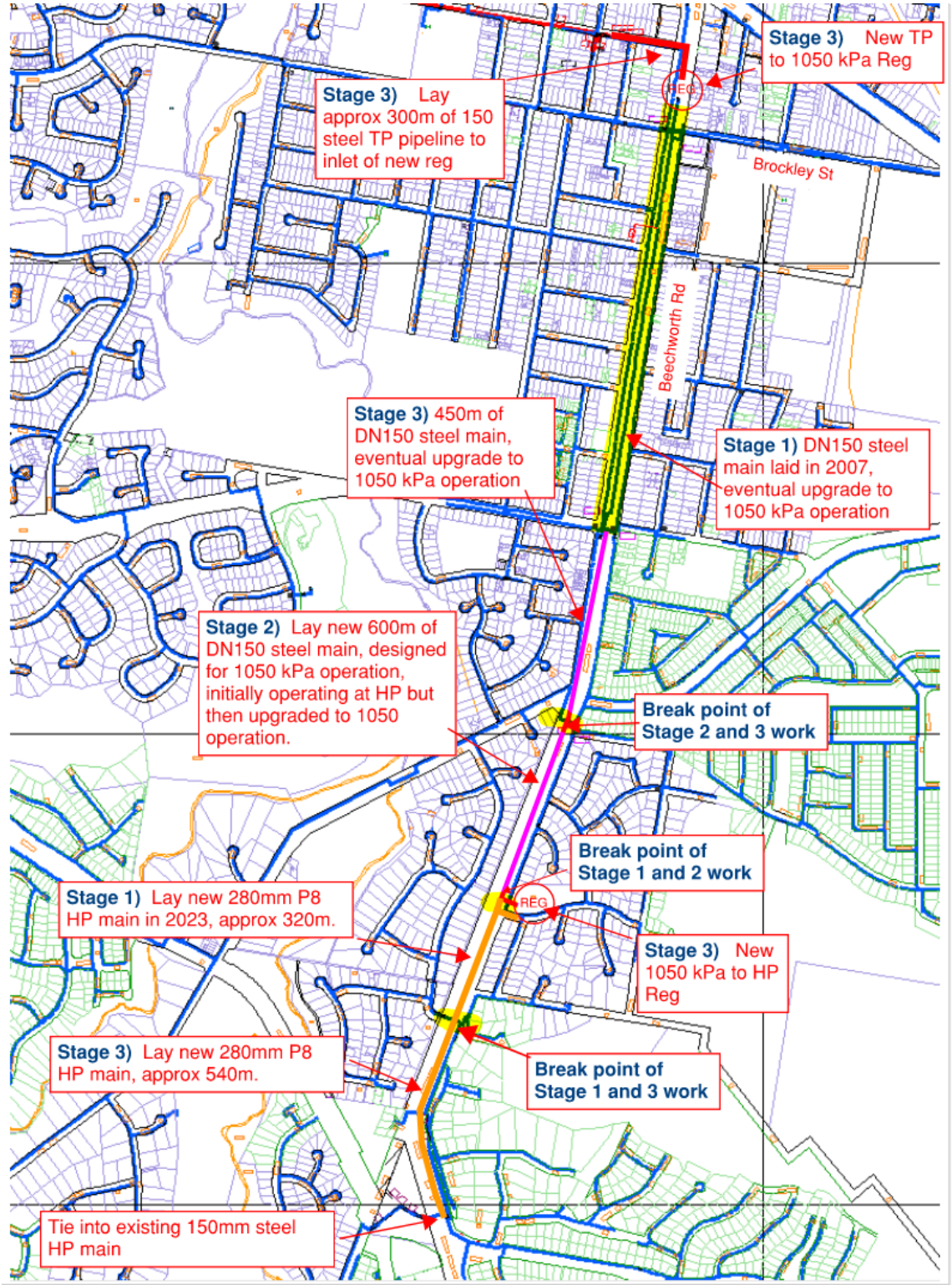
A.2: Leneva-Baranduda Plan



Appendix B – Option 1 long-term plan



Appendix C – Option 2 long term plan



A.7 Berwick HP network augmentation

Project overview

Description of the problem / opportunity

The H22-67 Berwick Network includes the suburbs of Berwick, Clyde North and Minta Farm with a total of 21,000 customers. This network is primarily supplied by the Berwick City Gate Station. Clyde North and Minta Farm are both located at the fringe of the Berwick Network.

Between 2016 and 2021, the Clyde North Network has increased by 333% from 866 to 2887 customers. The network is expected to grow by approximately 780 more customers by 2027. The suburb of Minta Farm is additionally expected to increase from 291 up to 1890 customers by 2027. Berwick has a steady growth rate of 0.5%.

This high growth within the upcoming access arrangement period within these suburbs will decrease the network and Berwick City Gate spare capacity, resulting in customer supply pressure to fall below 140 kPa by 2024.

Directly south of the Berwick Network is the Huckerby Drive City Gate station, which is part of the Cranbourne Network. It is located at the perimeter of the North Clyde Network. Transferring the Clyde North Network load to the Cranbourne Network by connecting to the Huckerby Dr City Gate will increase and maintain the network pressures above 140 kPa until at least 2028 for Clyde North.

Minta Farm and the rest of the Berwick Network will continue to be supplied from the Berwick City Gate. The freed spare capacity from the load transfer of Clyde North to Cranbourne will increase and maintain the network pressures in Minta Farm above 140 kPa until at least 2028.

Untreated risk

As per risk matrix = **High**

Options considered

- **Option 1** – Transfer the Clyde North Network load to the Huckerby Dr City Gate. ($1.1 million)
- **Option 2** – Reinforce the existing networks with connecting trunk mains. ($2.2 million)
- **Option 3** – Maintain Status Quo (zero upfront capex)

Proposed solution

Option 1 is the proposed solution. This involves transferring the Clyde North network to the Huckerby Dr City Gate by laying 1500 meters of 125PE along Honours Ave, laying 400 meters of 125PE from Huckerby Dr City Gate along Soldiers Rd up to Viewbright Rd and Belcam Circuit, and disconnecting the Clyde North Network from the Berwick Network at 9 locations.

This option will mitigate the risk of supply pressure within the Network dropping below 140 kPa, and will cost significantly less than Option 2.

Estimated cost

The forecast direct cost (excluding overhead) during the next five-year period (2023/24 to 2027/28) is $1.1 million. The projects would be delivered across the years of this period as set out below.

$'000 real 2021	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Berwick HP augmentation	1,141	0	0	0	0	**1,141**

Basis of costs

All costs in this business case are expressed in real unescalated dollars at June 2021 unless otherwise stated.

Tables may not sum due to rounding.

Treated risk

As per risk matrix = **Low**

Background

The H22-67 Berwick, Clyde North and Minta Farm Networks in Victoria serve approximately 21,000 customers, most residing within residential areas. Over the past five years the Clyde North Network has experienced substantial growth, increasing by 333% from 866 to 2877 customers. Minta Farm, a new residential development, has seen a growth of zero customers to 291 in 2021. The growth rates in Clyde North and Minta Farm are expected to continue at this high rate, with an estimated total number of customers of 3670 and 1891 respectively in 2027. Additionally, within this network is Berwick, an established suburb with a steady growth rate of 0.5%.

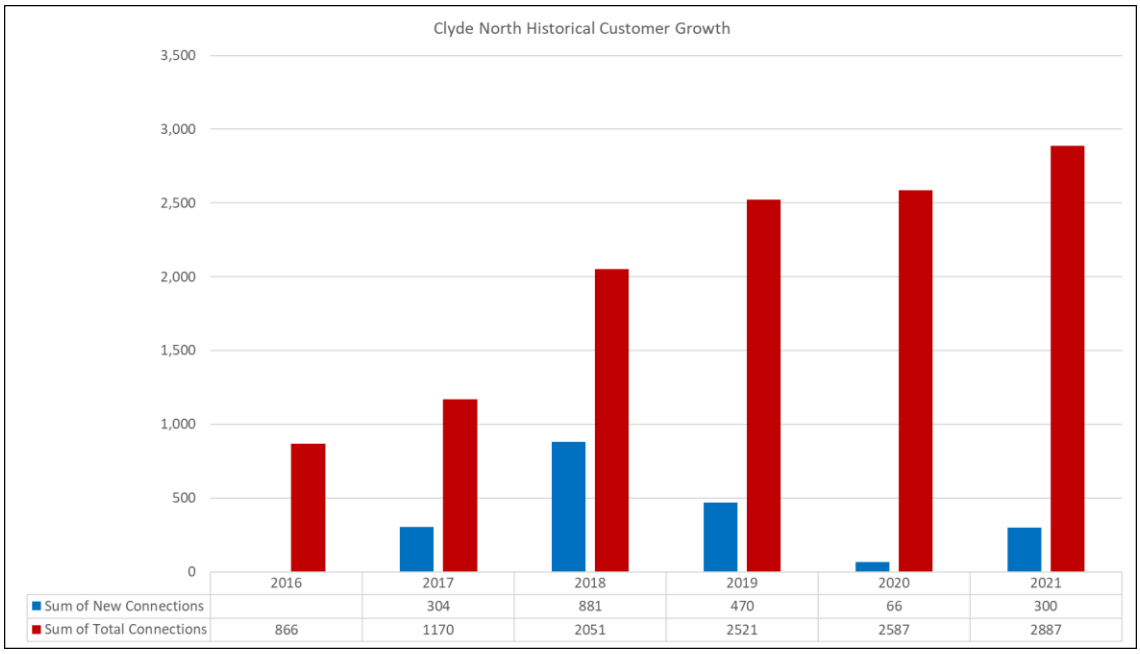
Both Clyde North and Minta Farm are located at the southern fringe of the Berwick Network. There is a combination of 250PE up to 125PE trunk mains from the Berwick City Gate up to these suburbs. The high growth in these suburbs will significantly reduce the spare capacity of the network.

Directly south of Berwick Network is the Cranbourne Network. One of its supply points is the Huckerby Drive City Gate located at the geographical perimeter of the Clyde North Network. It is one of the SCADA-controlled City Gate stations supplying the Cranbourne Network.

Impact of historical growth

The historical growth of customer connections has decreased the spare capacity within the Berwick Network. The figure below shows the historical growth in Clyde North.

Clyde North historical customer growth



The Berwick network is reaching the point where augmentation is required in order to maintain customer supply pressures above 140 kPa. The areas most susceptible to this pressure drop are the fringes in suburbs of Minta Farm and Clyde North. Appendix A shows a network map of this area. Minta Farm has 291 customers, all which connected in 2021.

Both suburbs are located at the fringe of the Berwick network and are directly supplied by the 180PE to 125PE trunk mains from the Berwick City Gate. A full network map of this area is displayed in Appendix A.3.

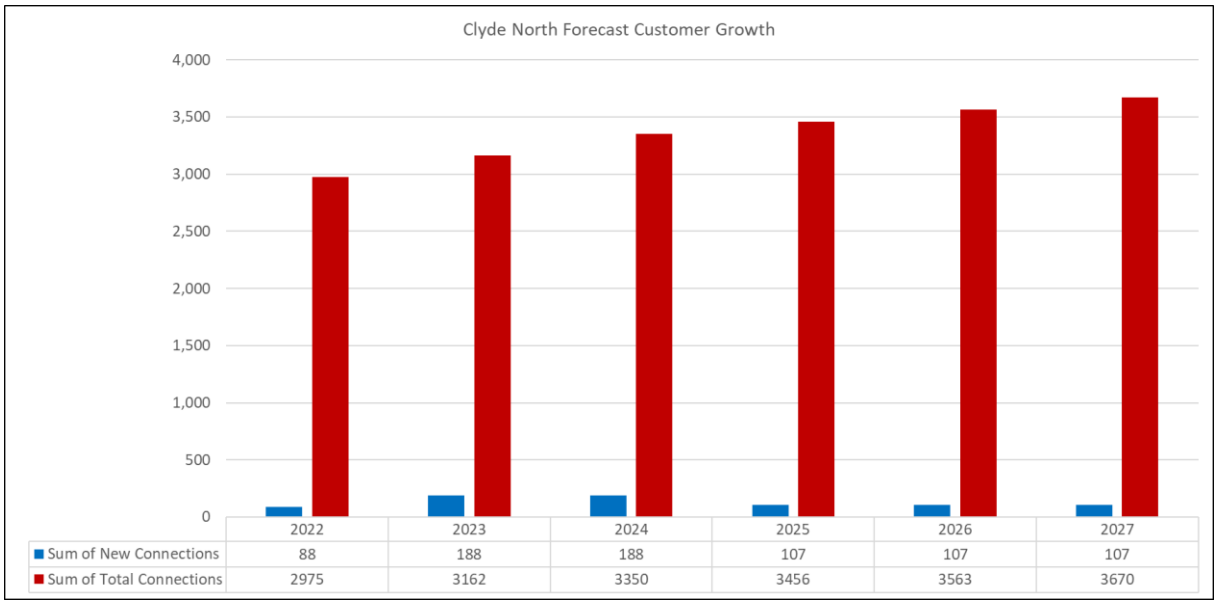
The high growth rate in the past 5 years has reduced the spare capacity of the network. Network pressure in Minta Farm and Clyde North are expected to fall below 140 kPa by 2024 and 2025 respectively.

Future growth

Based on current housing development plans and agreements with developers, we expect the high growth rates in North Clyde and Minta Farm will continue.

The ongoing housing development in Clyde North is forecast to continue at 4% per annum, or an additional 780 customers by 2027. This suburb is estimated to have a total of 3670 houses by 2027. This growth rate is displayed in the figure below, and the proposed and ongoing developments are shown in Appendix A.4 and A.5.

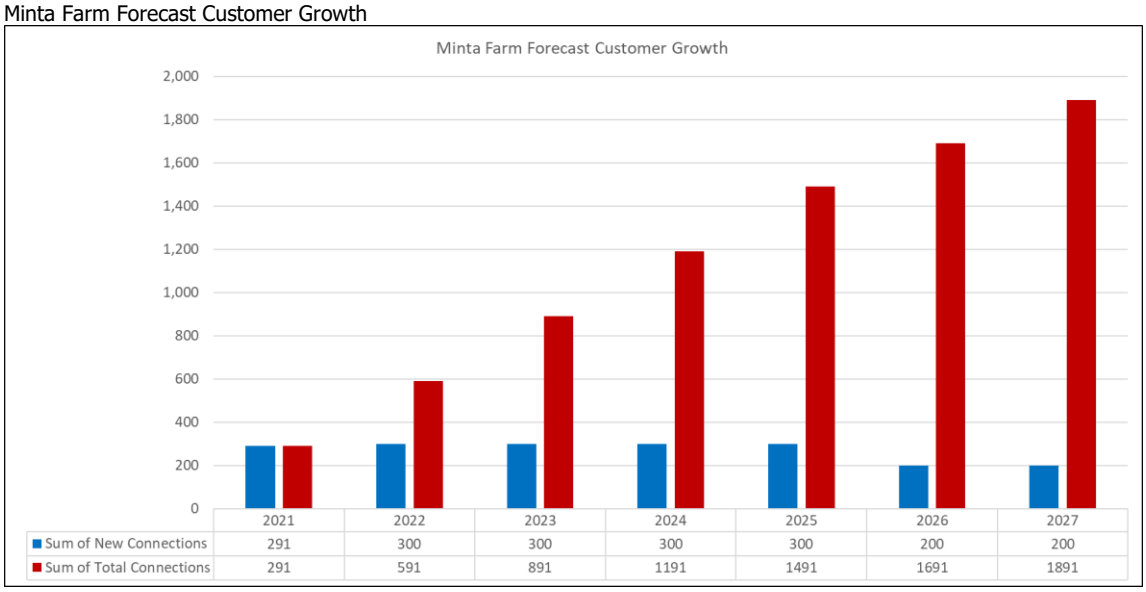
Clyde North forecast customer growth



	2022	2023	2024	2025	2026	2027
Sum of New Connections	88	188	188	107	107	107
Sum of Total Connections	2975	3162	3350	3456	3563	3670

Minta Farm also has an ongoing housing development of up to 1,890 new houses by 2027, growing at an average of 320 customer per year. This forecast customer growth is displayed in the figure below, and the proposed and current developments are shown in Appendix A.6 and A.7.

Minta Farm Forecast Customer Growth



Both developments will continue to reduce the spare capacity of the network unless the network is augmented by 2024 to transfer the North Clyde Network load from Berwick City Gate to the Huckerby Dr City Gate.

Risk assessment

The risk identified for the natural gas distribution network in the Berwick HP network region is that load growth without network reinforcement or augmentation will cause delivery pressures to drop, leading to substandard supply or loss of supply to up to 21,000 customers. This may lead to customers' gas appliances becoming inoperable or damaged in certain circumstances.

The primary consequence category affected by this risk is 'operations', as a pressure drop can cause outages to >10,000 customers, thereby carrying a 'major' consequence rating under the risk matrix.

Given load growth is ongoing, if the risk is left untreated the likelihood of a pressure drop impacting >10,000 customers is rated 'occasional' (every couple of years), however the frequency of supply interruptions will likely increase the longer the load growth risk is not addressed.

Any significant customer outage would then give rise to a moderate reputational and compliance risk. While there is a moderate health and safety risk posed by falling delivery pressure, safety is not the primary driver of investment in this instance.

The untreated risk rating is presented below.

Loss of supply risk in Berwick region – Untreated risk

Untreated risk	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Remote	Rare	Occasional	Rare	Occasional	Occasional	Occasional	High
Consequence	Major	Minimal	Major	Minimal	Significant	Significant	Minor	
Risk Level	Moderate	Negligible	High	Negligible	Moderate	Moderate	Low	

Options considered

The following options have been identified to address the risk associated with capacity and security of supply issues outlined above:

- **Option 1** – Transfer the Clyde North Network load to the Huckerby Dr City Gate
- **Option 2** – Reinforce the existing networks with connecting trunk mains
- **Option 3** – Maintain status quo

Option 1 – Transfer the Clyde North Network load to the Huckerby Dr City Gate

Under this option, a three-stage augmentation plan shall be completed by June 2024 to ensure pressure is maintained above 140 kPa across the Berwick and Clyde North Networks. The stages are as follows:

- Stage 1: Lay 800 meters of 180PE from Huckerby Dr City Gate up to the proposed 125PE approximately 100m east of the intersection of corner of Honour Ave and Riverstone Blvd;
- Stage 2: Lay 502 meters of 125PE from Huckerby Dr City Gate up to Viewbright Rd and Belcam Circuit; and
- Stage 3: Isolate or cut-off the Clyde North Network from the 180PE and 125PE along Grices Rd at nine locations:

  Isolation cut-offs at Riverstone Blvd (125PE), Macumba Dr (125PE) and Como Pde(180PE) shall have isolation valves installed and in the Normally Closed position.

  Isolation cut-offs at Bonnington Blvd (63PE), Glenrose Blvd(63PE), Bellario Cct(63PE) x 2 and Calibre Cct(63PE) x 2 shall be cut-and-capped.

Once completed, the above works will increase the network pressure in 2024 from

- 144 to 438 kPa in Clyde North; and
- 135 to 305 kPa in Minta Farm.

Option 1 cost assessment

The estimated direct capital cost of this option is $1.1 million. This estimate is based on historical costs of materials and labour.

Cost estimate – Option 1, $'000 real 2021

Option 1	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	Insttall 800m of 180PE, 502m of 125PE, and isolate Clyde North Network	-	-	-	-	Insttall 800m of 180PE, 502m of 125PE, and isolate Clyde North Network
Labour	1,058	-	-	-	-	**1,058**
Materials	83	-	-	-	-	**83**
Total	**1,141**	**-**	**-**	**-**	**-**	**1,141**

The key driver for this option is customer growth. This will deliver security and reliability of gas supply to the network. The benefits of this option is it provides the highest increase in the network pressure at less cost.

Option 1 risk assessment

Option 1 would reduce the loss of supply (operational) risk from high to low. This is because having augmentation with the seven stages would reduce the likelihood of a pressure drop impacting >10,000 people from occasional to remote. The risk consequence rating remains unchanged. Option 1 reduces the likelihood of a pressure drop leading to compliance or reputational impacts from unlikely to rare, reducing the risk from moderate to low. It also reduces the likelihood of a major safety incident from remote to rare.

Loss of supply risk in Berwick region – Option 1

Option 1	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Rare	Remote	Rare	Rare	Rare	Remote	Low
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Low	Negligible	Low	Negligible	Low	Low	Negligible	

While Option 1 achieves the same risk rating as Option 2, the solution under Option 1 provides this risk reduction at a lower overall cost.

Option 2 – Reinforce the existing networks with connecting trunk mains

Under Option 2, we would implement a two-stage augmentation plan to be completed by June 2024. The stages are as follows:

- Stage 1: Lay 1200 meters of 180PE from the DN100 high pressure steel along Soldiers Rd and 1300 meters of 180PE from Soldiers Rd heading west to Minta Farm; and
- Stage 2: Lay 350 meters of 63PE from the intersection of O'Shea Rd and Soldiers Rd heading west to Woodworth Dr.

Once completed, the above works will increase the network pressure from

- 144 to 203 kPa in Clyde North; and
- 135 to 203 kPa in Minta Farm.

Due to Stage 1 and the forecast demand in Minta Farm, the spare capacity in the established pocket of the network between Soldiers Rd and Princes Fwy will decrease and pressure will fall below 140 kpa in 2024.

Stage 2 is required to maintain the pressure above 140 kpa in 2024. A diagram of this solution is displayed within Appendix A.9.

This option is less advantageous than Option 1 because it requires more and larger mains to be laid, resulting to higher cost and providing an inferior pressure increase and future capacity compared to Option 1. This comparison of pressure increases between the options is highlighted in Appendix A.10.

Option 2 cost assessment

The estimated direct capital cost of this option is $2.15 million. This estimate is based on historical costs of materials and labour. All work will be completed between July 2024 and June 2025.

Cost estimate – Option 2, $'000 real 2021

Option 1	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	Install 2500m of 180PE, 350m DN63 PE	-	-	-	-	Install 2500m of 180PE, 350m DN63 PE
Labour	1,989	-	-	-	-	**1,989**
Materials	163	-	-	-	-	**163**
Total	**2,152**	**-**	**-**	**-**	**-**	**2,152**

The key driver for this option is customer growth. This will deliver security and reliability of gas supply to the network. This option benefits from extending and providing a secondary trunk main to the network fringe.

Option 2 risk assessment

Option 2 addresses the pressure drop issue and results in the same risk outcomes as the primary solution (Option 1). However, it achieves this at a higher cost than Option 1.

Loss of supply risk in Berwick region – Option 2

Option 2	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Rare	Remote	Rare	Rare	Rare	Remote	Low
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Low	Negligible	Low	Negligible	Low	Low	Negligible	

Option 3 – Maintain status quo

Under this option we would not incur any proactive capacity expansion capex to reduce the loss of supply risk in Clyde North and Minta Farm. Instead, we would manage the network as per current practice, and address any supply issues as and when they occur.

Given the current load growth forecasts, it is highly likely capital costs to address supply shortfall will be incurred reactively as minimum pressure limits are reached post 2024. As the network is already operating close to its MAOP no further network capacity can be enabled through long term pressure increases.

We consider maintaining the status quo is not a viable solution, as it simply defers capacity expansion expenditure, as well as potentially resulting in high-cost reactive works.

Option 3 cost assessment

There is no additional capital expenditure involved. This option increases the likelihood and consequence of low network pressure and losing up to 21,000 customers in the suburbs of Clyde North and Minta Farm.

There are no additional upfront costs associated if we maintain the status quo. However, as mentioned above, we are likely to incur greater reactive maintenance costs as pressure issues emerge.

While it is not possible to quantify the reactive costs we would incur at this time, in our experience a project conducted reactively is around 3.2 times more expensive than one conducted proactively. This assumption is consistent with the commonly accepted asset management principle that reactive asset maintenance can be around two to five times higher than proactive planned maintenance.

Following the reactive works, if the network continually experiences substandard pressures, one of the solutions described under Option 2 or 3 would need to be applied.

Option 3 risk assessment

Under Option 3, the risk level would remain the same as the untreated risk as there are no controls in place to mitigate the pressure drop risk (other than not connecting new customers, which is not a viable option). The following table shows the risk level if were to maintain the status quo.

Loss of supply risk in Berwick region – Option 3

Option 3	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Remote	Rare	Occasional	Rare	Occasional	Occasional	Occasional	High
Consequence	Major	Minimal	Major	Minimal	Significant	Significant	Minor	
Risk Level	Moderate	Negligible	High	Negligible	Moderate	Moderate	Low	

Failing to address a high or moderate risk rating where there is practicable treatment available is not consistent with the requirements of our risk management framework, and does not reflect the actions of a prudent asset manager.

Summary of costs and benefits

The table below summarizes how each option compares in terms of the estimated cost, the residual risk rating, and alignment with our vision objectives.

Comparison of options - Berwick

Option	Estimated cost ($ million)	Treated residual risk rating	Alignment with vision objectives
Option 1	1.14	Low	This option is consistent with our Risk Management Framework and would align with all relevant vision objectives
Option 2	2.15	Low	Aligns with *Delivering for Customers*, however does not align with *Sustainably Cost Efficient*.=
Option 3	Zero upfront capex	High	Does not align with *Delivering for Customers* or *Sustainably Cost Efficient*

Recommended option

Option 1 is the recommended option.

Why is the recommended option prudent?

Option 1 is the most prudent option because:

- it increases and maintains the pressures in the network above 140 kPa within this access arrangement period;
- it is the most cost-effective option that reduces risks to an acceptable level, as Option 2 will reduce the risk of the network pressure falling below 140 kPa, but at a higher cost and with no incremental benefits; and
- it is deliverable, as evidenced by similar work completed in the past.

Option 3 does not reduce the risk of the network pressure falling below 140 kPa and therefore is not consistent with APA risk management framework, which requires action must be taken to reduce any high risks to low or ALARP.

Estimating efficient costs

The forecast cost breakdown is shown in the table below.

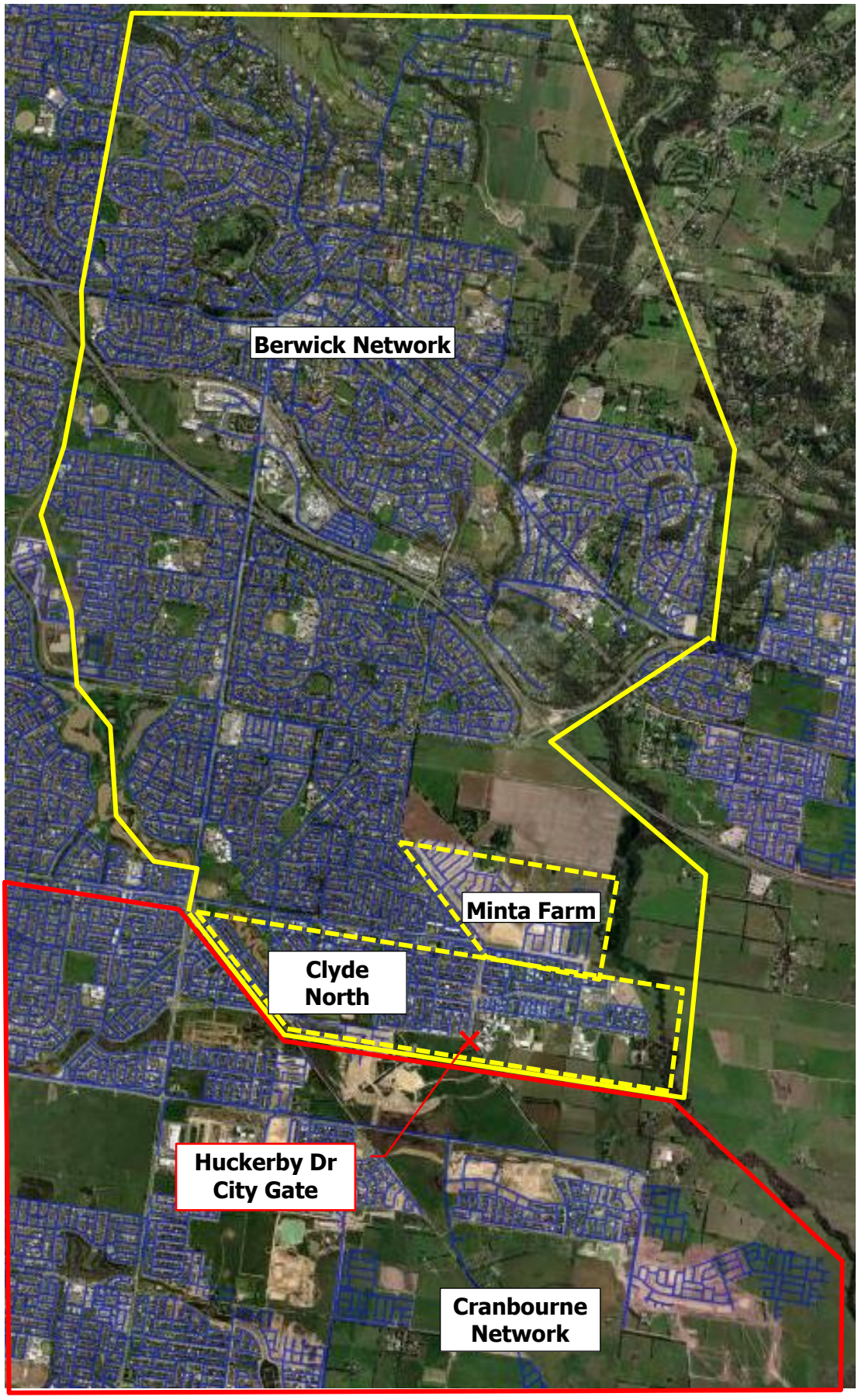
Cost estimate, $'000 real 2021

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	Install 800m of 180PE, 502m of 125PE, and isolate Clyde North Network	-	-	-	-	Install 800m of 180PE, 502m of 125PE, and isolate Clyde North Network
Labour	1,058	-	-	-	-	**1,058**
Material	83	-	-	-	-	**83**
Total	**1,141**	**-**	**-**	**-**	**-**	**1,141**

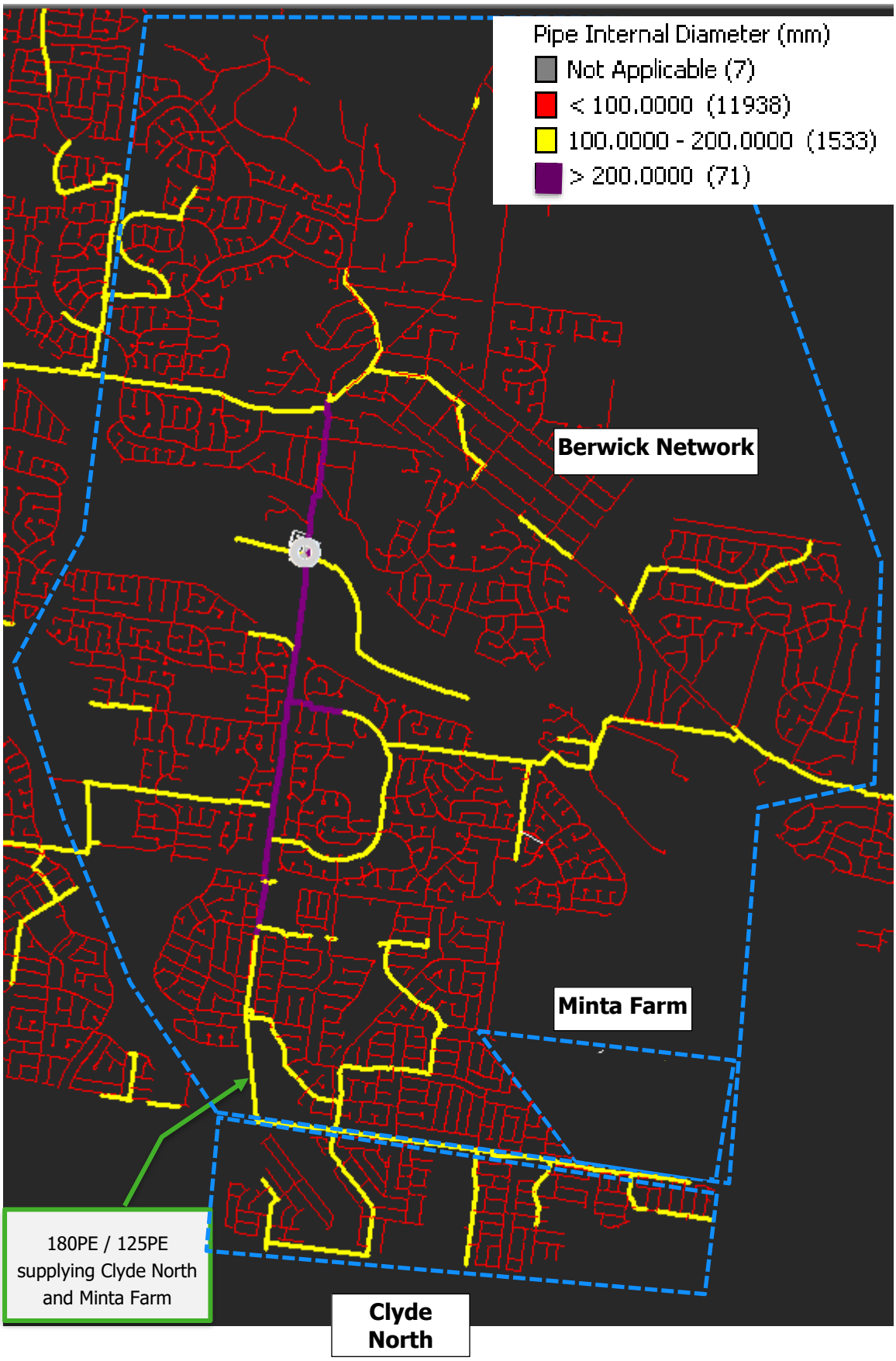
Appendix A – Asset location maps and configuration drawings

A.1: Berwick Network. Minta Farm and Clyde North areas of concern

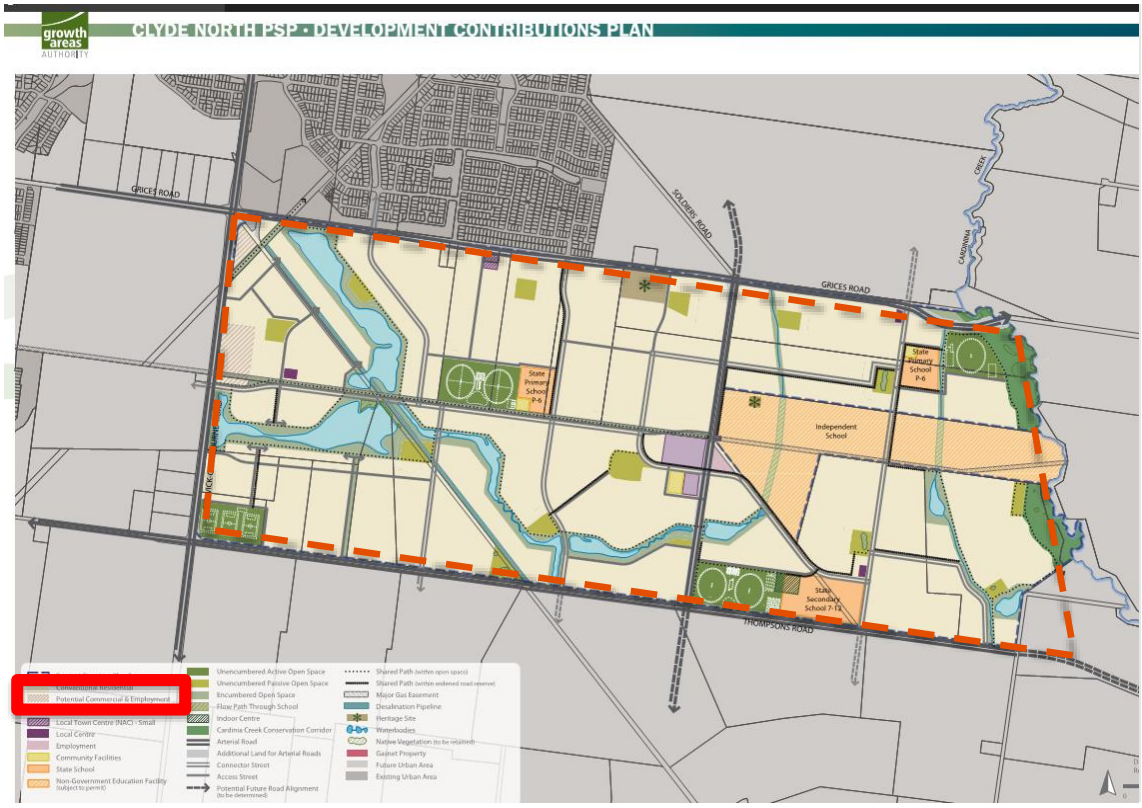
A.2: Berwick and Cranbourne networks



A.3: Berwick network trunk main

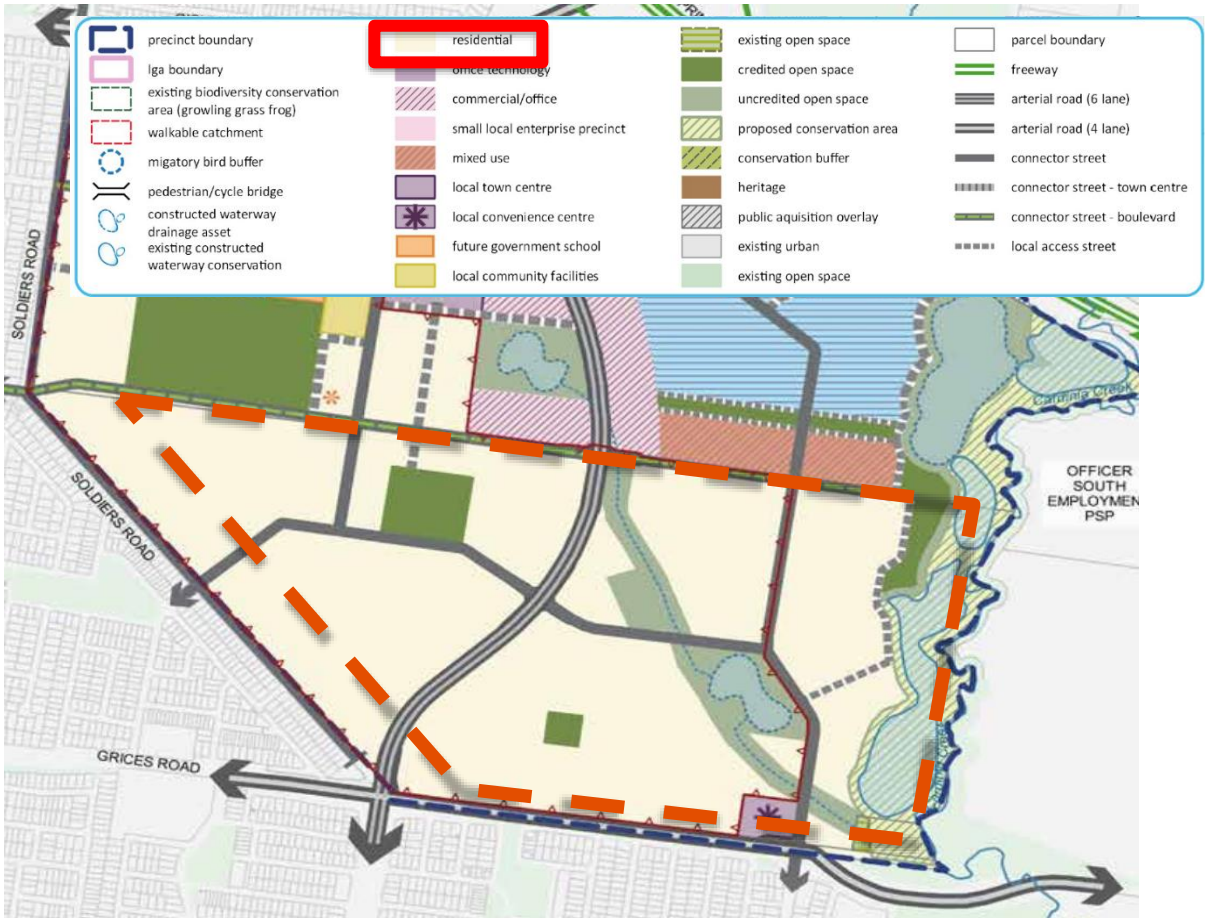


A.4: North Clyde proposed development



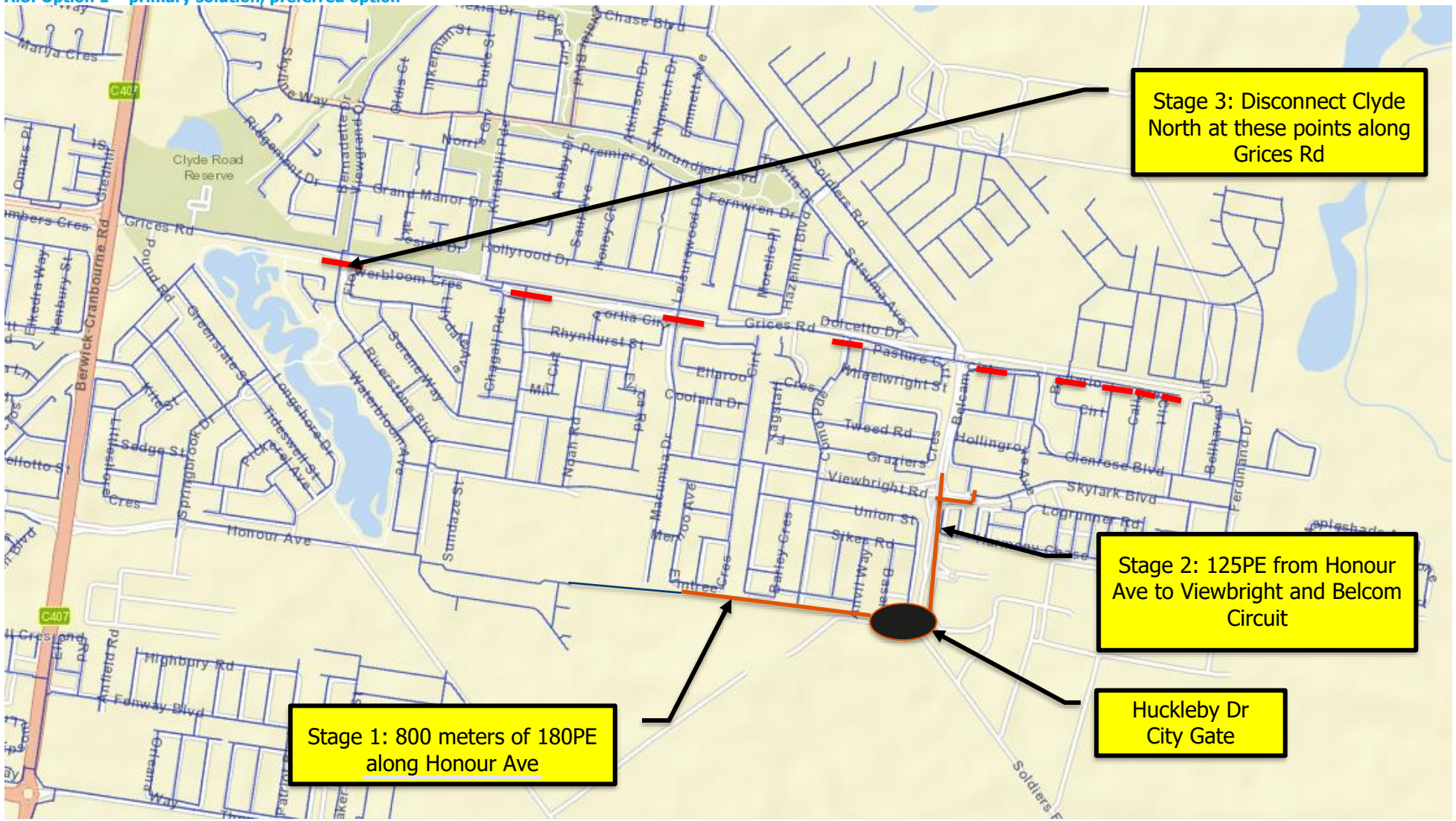
A.5: North Clyde ongoing development

A.6: Minta Farm proposed development

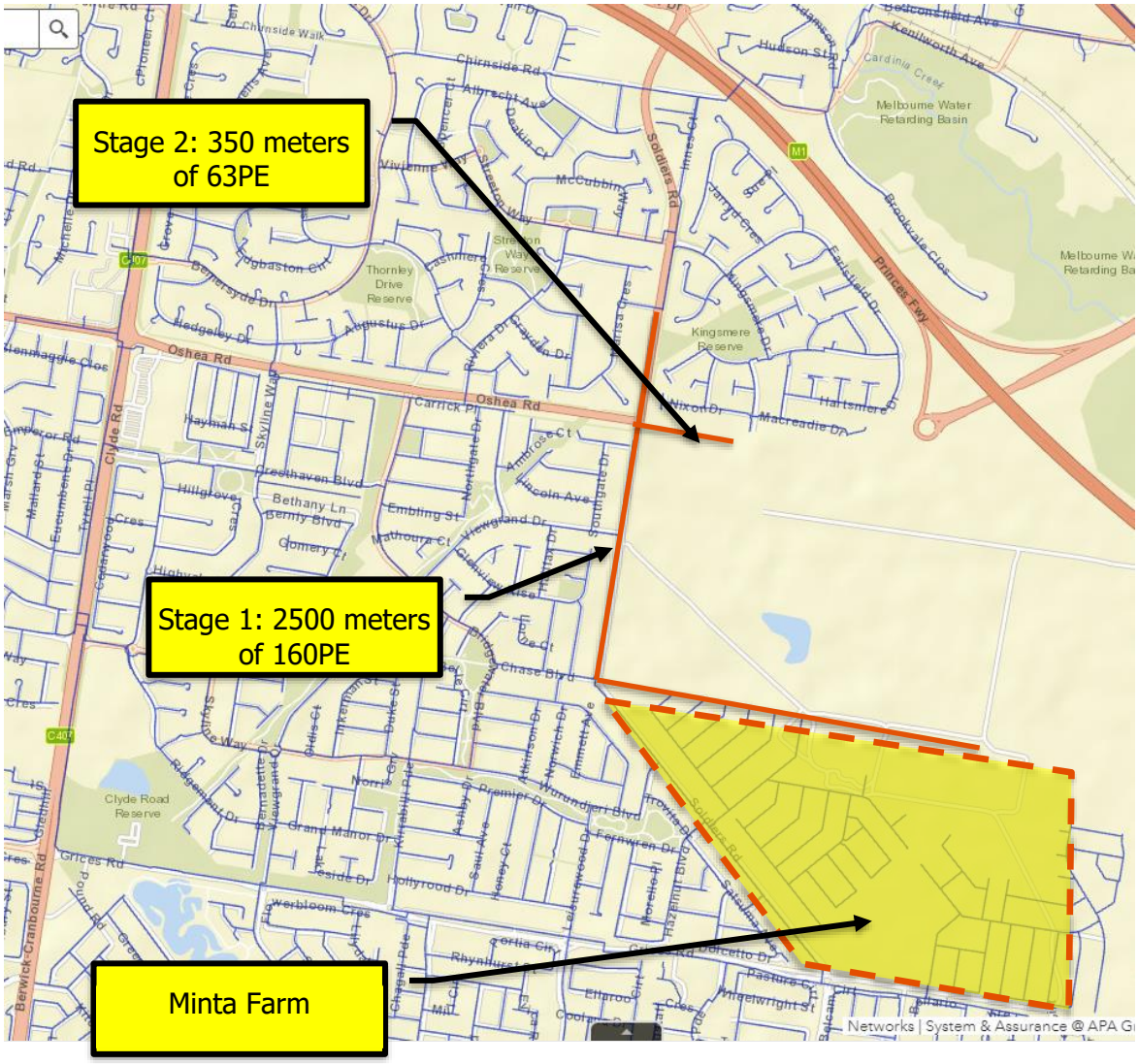


A.7 Minta Farm ongoing development

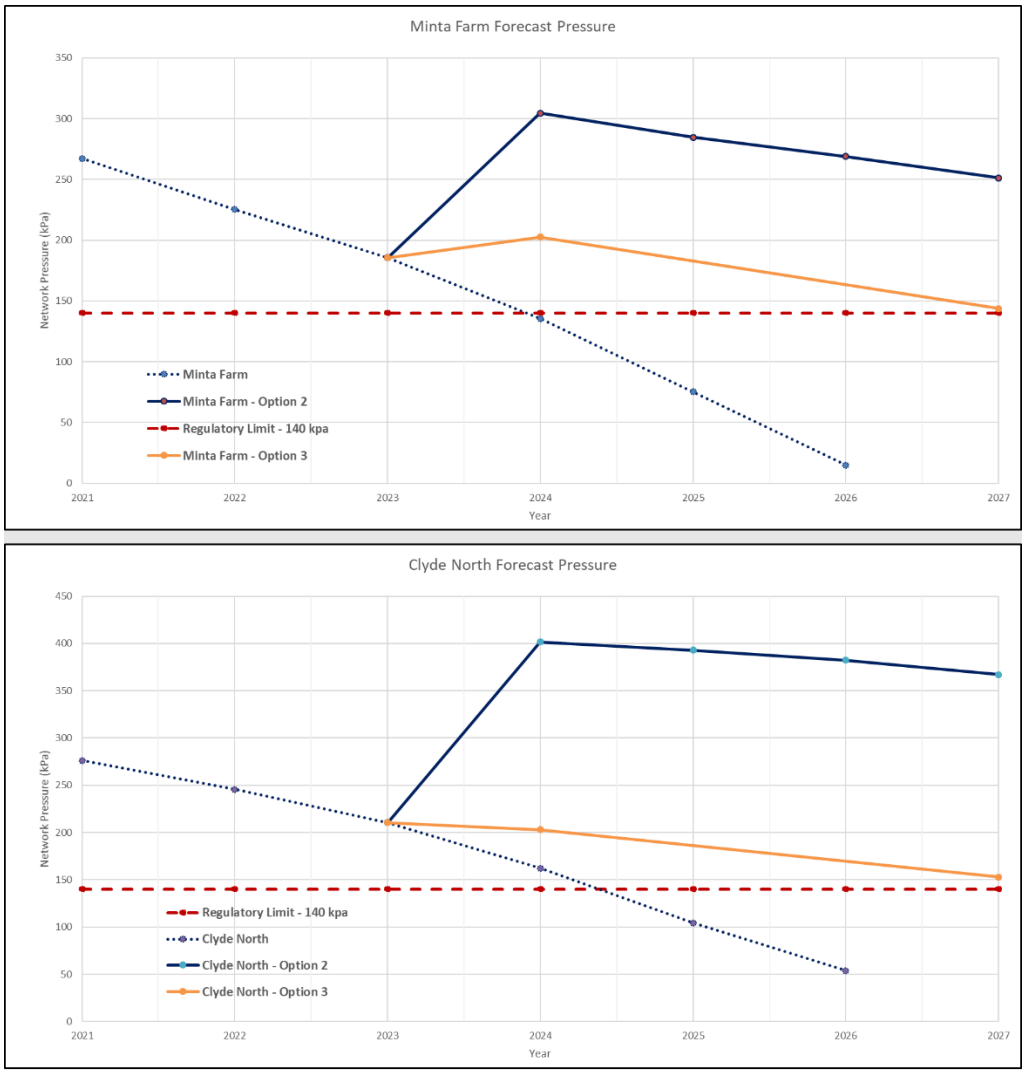
A.8: Option 1 – primary solution, preferred option



A.9: Option 2 – secondary solution



A.10: Comparison of network pressure increase between Option 1 and Option 2



A.8 Eltham HP network augmentation

Project overview

Description of the problem / opportunity	The suburbs of the Eltham Network are mostly composed of residential growth of around 34,700 customers. Over the past five years, the number of customer connections in the network has grown by 0.6%. However, the suburb of Plenty in the northern fringe of the network has a growth rate of 3.1% and is forecast to continue over the forthcoming access arrangement period (2022/23 to 2027/28). This historical growth in Eltham has decreased the network spare capacity impacting the high pressure (HP) network in Plenty, Montmorency and Lower Plenty. These pressures are reaching the point where augmentation is required in order to maintain customer supply pressure of at least 140 kPa which is the minimum level necessary to maintain safe and reliable supply as set out in Schedule 1 of the Gas Distribution System Code. Network augmentations are recommended to be completed in 2024 and 2027 in Plenty, Montmorency and Lower Plenty to significantly increase and maintain the network pressure above 140 kPa until at least 2028 with the least cost.
Untreated risk	As per risk matrix = **Moderate**
Options considered	• **Option 1** – Install 680 m of PE mains within Plenty, Lower Plenty and Montmorency (\$1.0 million) • **Option 2** – Install 965 m of PE mains within Plenty and Montmorency (\$1.6 million) • **Option 3** – Maintain status quo (no upfront capex)
Proposed solution	Option 1 is the proposed solution. This option involves laying 575 meters of 125 Polyethylene (PE) in Plenty and 105 meters of 63 PE in Lower Plenty and Montmorency between 2024 and 2027. This option will provide the highest pressure increase in the network and maintain the pressure above 140 kPa.
Estimated cost	The forecast direct cost (excluding overhead) during the next five-year period (2023/24 to 2026/27) is \$1.0 million. The projects would be delivered across the years of this period as set out below.

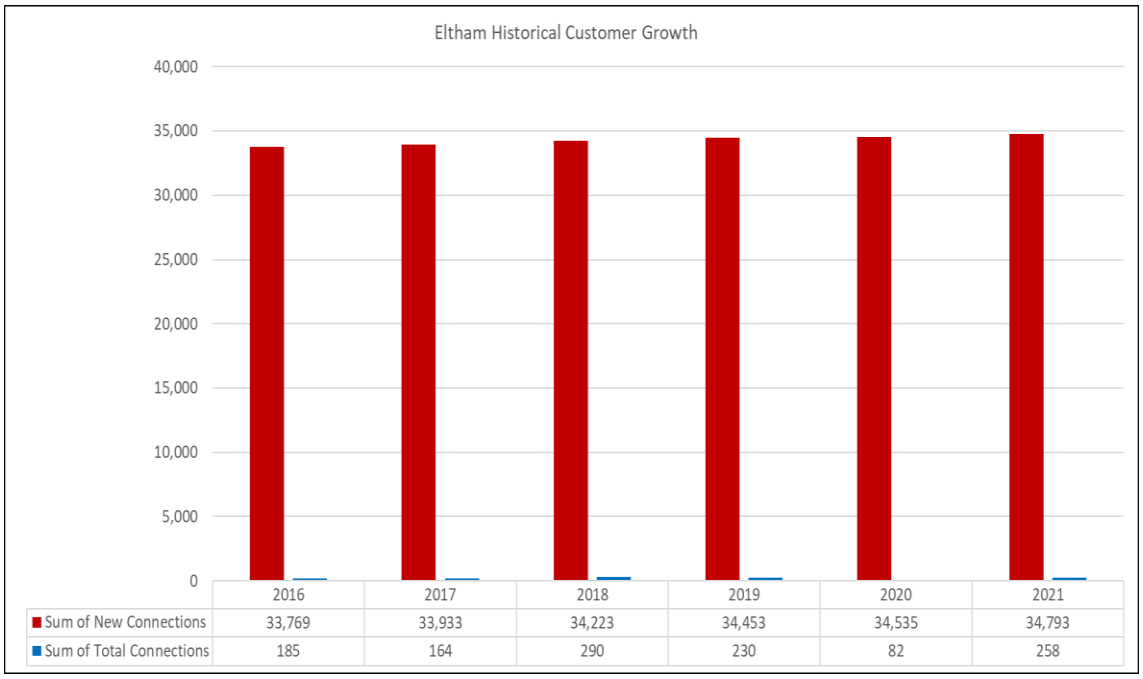
\$'000 real 2021	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Eltham HP augmentation	907	-	-	107	-	**1,014**

Basis of costs	All costs in this business case are expressed in real un-escalated dollars at June 2021 unless otherwise stated. Tables may not sum due to rounding.
Treated risk	As per risk matrix = **Low**

Background

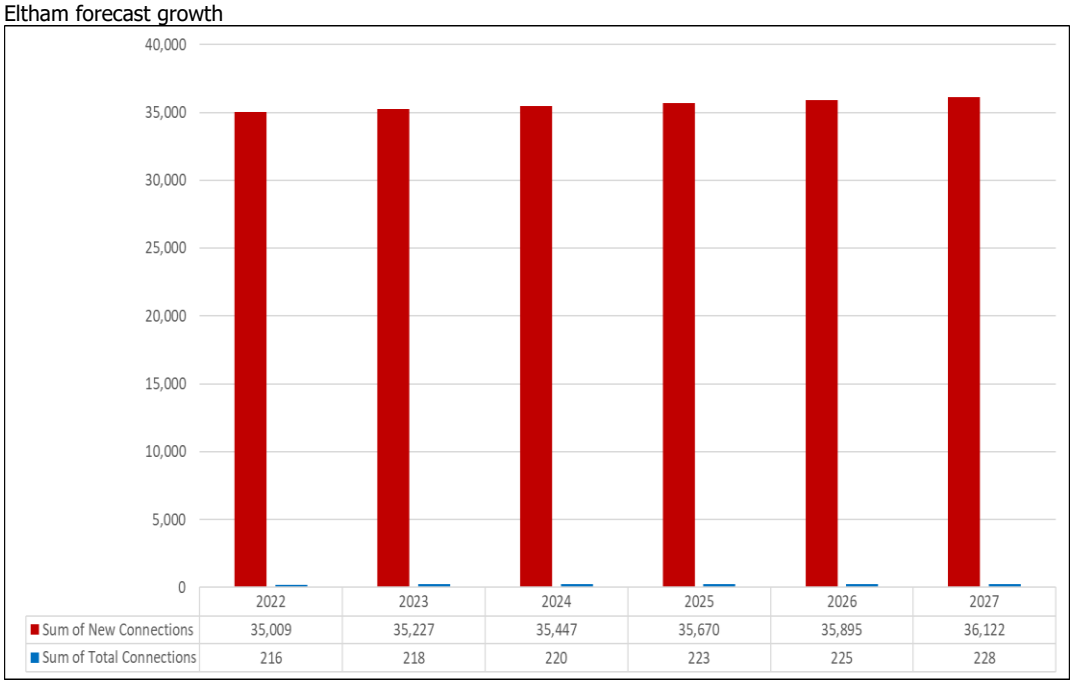
The H87 Eltham Network in Victoria serves approximately 34,700 customers, most residing within residential areas. Over the past five years, the number of residential customer connections in the region has grown by an average of 202 new connections per year (0.6% increase). The highest growth rates occur within the northern suburbs of the network (1.0% to 3.1%), with Plenty experiencing the largest growth.

Eltham historical customer growth



From historical evidence, the growth rate within the Eltham Network is estimated to remain at an average of 0.6% over the forthcoming access arrangement period (2022/23 to 2027/28), as shown in the following figure.

Eltham forecast growth

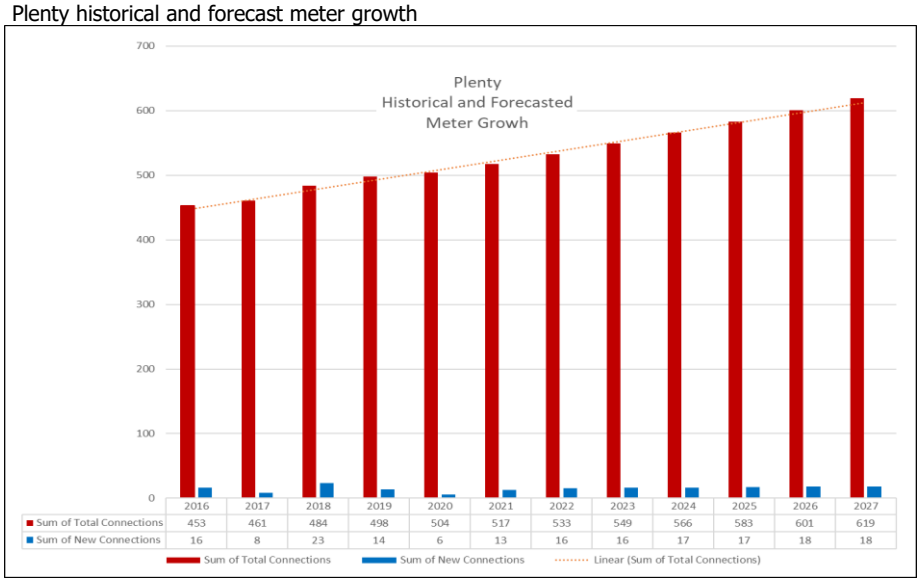


Impact of historical growth

Historical growth in residential connections has decreased the volume of spare capacity within the Eltham Network. We are reaching the point where augmentation is required in order to maintain customer supply pressures above 140 kPa. The areas most susceptible to this drop in pressure are the suburbs of Plenty, Montmorency and Lower Plenty. These locations have been outlined in Appendix A.

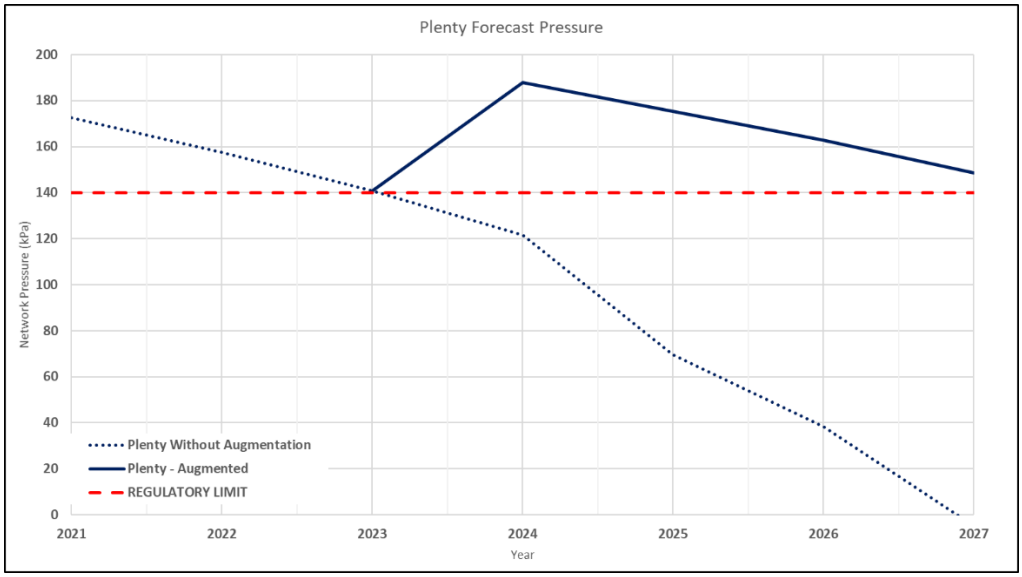
Plenty has seen a growth rate of 3.1%, the highest in the network over the last five years. Through evaluating the historical trends in growth, this growth rate is predicted to continue during the next access arrangement period. The estimated growth within Plenty is summarised in the figure below.

Plenty historical and forecast meter growth



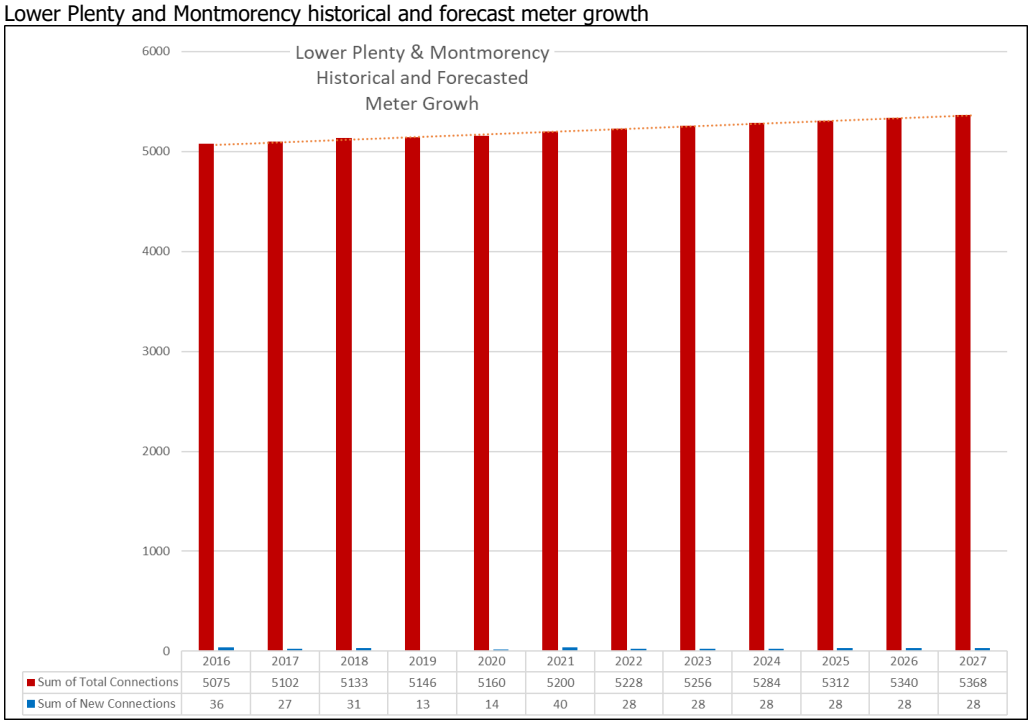
Plenty is located in north western fringe of the network. There is limited trunk infrastructure supplying the area. The combination of high growth and smaller mains extending farther from the trunk mains has reduced the spare capacity in the network, which we forecast will cause pressures to fall below 140 kPa by 2024.

Plenty forecast pressure



The average combined growth rate in Montmorency and Lower Plenty over the last five years is 0.5%. The semi-island network in the suburbs of Lower Plenty and Montmorency has limited connectivity with the surrounding network.

Lower Plenty and Montmorency historical and forecast meter growth

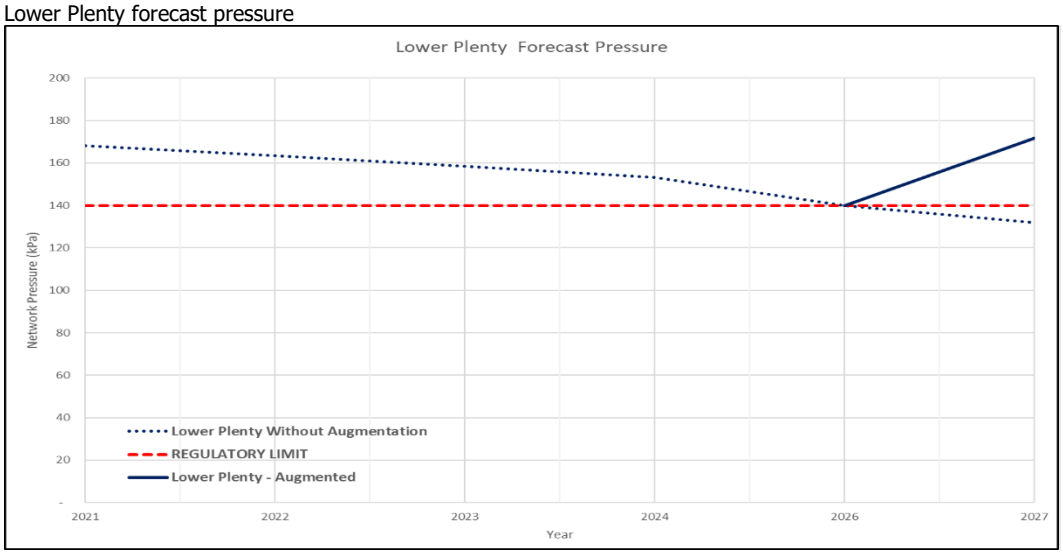


	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Sum of Total Connections	5075	5102	5133	5146	5160	5200	5228	5256	5284	5312	5340	5368
Sum of New Connections	36	27	31	13	14	40	28	28	28	28	28	28

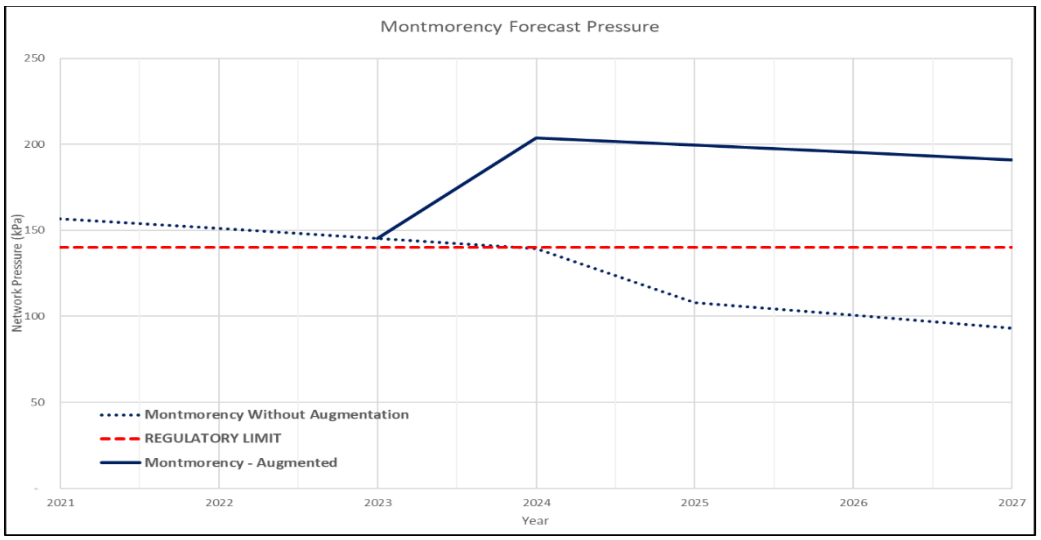
There are only three 63 PE and one DN 80 trunk mains connecting the semi-island area to the broader network and trunk infrastructure (see Appendix A). Due to the limited connectivity, pressures in the area are lower than in the surrounding network.

Continued growth in the broader network has reduced pressures within the trunk system feeding the area, which consequently has reduced pressures in the area itself. This, combined with growth in the area of 0.5%, will cause network pressures to fall below 140 kPa by 2024 and 2026 as shown in the following figures.

Lower Plenty forecast pressure



Montmorency forecast pressure



Future growth

There is evidence to suggest future growth in connections will continue or may be higher than the historical rate. The suburb of Plenty is within the Local Government Area of Nilumbik and has an estimated population growth of 0.4% between 2018 and 2036. The suburbs of Lower Plenty and Montmorency are under the city of Banyule and have an estimated population growth rate of 0.8% within the same period[28]. Further details regarding these figures can be found within Appendix B. Due to the limited spare capacity within the network, the suburbs of Plenty, Montmorency and Lower Plenty are susceptible to pressures below 140 kPa.

In Plenty, the actual meter growth during the same period is significantly higher, at an average of 3.1%. The positive population growth and high meter growth rate suggests that meter growth will continue and therefore will reduce the spare capacity of the network. The network pressure is estimated to fall below 140 kPa unless the network is augmented in 2024 to provide additional paths for the gas to flow from the trunk.

[28] Victoria_in_Future_2019

For Lower Plenty and Montmorency, the average growth within and the surrounding areas will continue to reduce the spare capacity of the network and increase the pressure drops within the small bore pipes of the network. The network pressure is estimated to fall below 140 kPa during this access arrangement period unless the network is augmented during 2024 and 2027 to provide additional connections from the trunk and surrounding networks.

Risk assessment

The risk identified for the natural gas distribution network in the Eltham HP network region is that load growth without network reinforcement or augmentation will cause delivery pressures to drop, leading to substandard supply or loss of supply to >1,000 customers. This may lead to customers' gas appliances becoming inoperable or damaged in certain circumstances.

The primary consequence category affected by this risk is 'operations', as a pressure drop can cause outages to >1,000 customers, thereby carrying a 'significant' consequence rating under the risk matrix.

Given load growth is ongoing, if the risk is left untreated the likelihood of a pressure drop impacting >1,000 customers is rated 'occasional' (every couple of years), however the frequency of supply interruptions will likely increase the longer the load growth risk is not addressed.

Any significant customer outage would then give rise to a moderate reputational and compliance risk. While there is a moderate health and safety risk posed by falling delivery pressure, safety is not the primary driver of investment in this instance.

The untreated risk rating is presented below.

Loss of supply risk in Eltham region – Untreated risk

Untreated risk	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Remote	Rare	Occasional	Rare	Occasional	Occasional	Occasional	Moderate
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Moderate	Negligible	Moderate	Negligible	Moderate	Moderate	Low	

Options considered

The following options have been identified to address the risk associated with capacity and security of supply issues outlined above:

- **Option 1** – Install 680m of PE mains within Plenty and Montmorency
- **Option 2** – Install 965 meters of PE mains within Plenty and Montmorency
- **Option 3** – Maintain status quo

These options are discussed below.

Option 1 – Install 680 meters of augmentations within Lower Plenty and Montmorency

Under this option, we would implement a two-stage augmentation plan to ensure pressure is maintained above 140 kPa. Stage 1 will be completed by June 2024, and performs augmentation within the Plenty and Montmorency suburbs:

- In Plenty, lay 575 meters of 125 PE supply main from McLennans Rd to Rudd Pl. The pressure in the fringe is estimated to increase from 122 to 194 kPa in 2024

- In Montmorency, lay 45 meters of 63 PE in Sherbourne Rd between the 63 PE main in Williams Rd and DN 50 steel main in Starling St. Pressure at the fringe (Mayona Rd) is expected to increase from 139 kPa to 204 kPa in 2024

Stage 2 will be completed by June 2027. This stage increases the pressure at the fringe of Lower Plenty:

- In Montmorency, lay 60 m of 63 PE along Apex Way, between the DN40steel mains in Looker Rd and Grand Blvd. Pressure at the fringe of Lower Plenty (Maida Ct) is expected to increase from 132 to 173 kPa in 2027

Option 1 cost assessment

The estimated direct capital cost of this option is $1.0 million. This estimate is based on historical costs of materials and labour.

Cost estimate – Option 1, $'000 real 2021

Option 1	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	Install 575m of DN125 PE and 45m of DN63 PE	-	-	Install 60m of DN63 PE	-	Install 575 m DN125 PE, and 105m DN63 PE
Labour	881	0	0	103	0	**984**
Material	26	0	0	4	0	**30**
Total	**907**	**0**	**0**	**107**	**0**	**1,014**

The key driver for this option is customer growth. This project will deliver security and reliability of gas supply to the network. The benefit of this option is that it provides the most benefit in network pressure at a lower cost than other options considered.

Option 1 risk assessment

Option 1 would reduce the loss of supply (operational) risk from moderate to low. The work would reduce the likelihood of a pressure drop impacting >1,000 people from occasional to remote. The risk consequence rating remains unchanged. Option 1 reduces the likelihood of a pressure drop leading to compliance or reputational impacts from 'unlikely' to 'rare', reducing the risk from moderate to low. It also reduces the likelihood of a major safety incident from remote to rare.

Loss of supply risk in Eltham region – Option 1

Option 1	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Remote	Remote	Rare	Rare	Rare	Remote	Low
Consequence	Major	Minor	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Low	Negligible	Low	Negligible	Low	Low	Negligible	

While Option 1 achieves the same risk rating as Option 2, the solution under Option 1 provides this risk reduction at a lower overall cost.

Option 2 – Install 965 meters of augmentations within Plenty and Montorency

Under Option 2, we would once again complete the augmentation process within a two-stage plan, both stages requiring augmentation within the Plenty and Montmorency suburbs. Stage 1 will be completed by June 2024 and is as follows:

- In Plenty, lay 460 m of 125 PE along Sheoak Pl and Daviesia Dr from Treetop Tce to Mackelroy Rd. Pressure at the fringe is expected to increase from 120 kPa to 162 kPa in 2024.
- In Montmorency, lay 50 m of 63PE along Sherbourne Rd between 1-5 Porter Rd and 69 Sherbourne. Pressure at the fringe (Mayona) is expected to increase from 138kPa to 155 kPa in 2024.

Stage 2 will be completed by June 2027 and is as follows:

- In Plenty, lay 75 m of 63PE at River Ave to Rotin Ct and R10, lay 320 m of 63PE along Treetop Tce from Sheoak Pl to Mackelroy Rd. Pressure at the fringe is expected to increase from 120 to 140 kPa in 2027.
- In Montmorency, lay 60 m of 63PE to join the network at Mayona and Starling streets. Pressure at the fringe (Mayona) is expected to increase from 138 kPa to 154 kPa in 2027.

Option 2 cost assessment

The estimated direct capital cost of this option is $1.56 million. This estimate is based on historical costs of materials and labour.

Cost estimate – Option 2, $'000 real 2021

Option 2	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	Install 460m of DN125 PE and 50m of DN63 PE	-	-	Install 455m of DN63 PE	-	Install 460m of DN125 PE and 505m of DN63 PE
Labour	729	-	-	781	-	**1,510**
Materials	22	-	-	24	-	**46**
Total	**751**	**-**	**-**	**805**	**-**	**1,556**

The key driver for this option is customer growth. This will deliver security and reliability of gas supply to the network. The benefit of this option is that it provides the highest increase in the network pressure, however, it does this at a higher cost than the primary solution proposed under Option 1.

Option 2 risk assessment

Option 2 addresses the pressure drop issue and results in the same risk outcomes as the primary solution (Option 1). However, it achieves this at a higher cost than Option 1.

Loss of supply risk in Eltham region – Option 2

Option 2	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Rare	Remote	Rare	Rare	Rare	Remote	Low
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Low	Negligible	Low	Negligible	Low	Low	Negligible	

Option 3 – Maintain Status Quo

Under this option we would not incur any proactive capacity expansion capex to reduce the loss of supply risk in Eltham. Instead, we would manage the network as per current practice, and address any supply issues as and when they occur.

Given the current load growth forecasts, it is highly likely capital costs to address supply shortfall will be incurred reactively as minimum pressure limits are reached post 2024. As the network is already operating close to its MAOP no further network capacity can be enabled through long term pressure increases.

We consider maintaining the status quo is not a viable solution, as it simply defers capacity expansion expenditure, as well as potentially resulting in high-cost reactive works.

Option 3 cost assessment

There is no additional capital expenditure involved. This option increases the likelihood and consequence of low network pressure and losing up to 5,720 customers.

There are no additional upfront costs associated if we maintain the status quo. However, as mentioned above, we are likely to incur greater reactive maintenance costs as pressure issues emerge.

While it is not possible to quantify the reactive costs we would incur at this time, in our experience a project conducted reactively is around 3.2 times more expensive than one conducted proactively. This assumption is consistent with the commonly accepted asset management principle that reactive asset maintenance can be around two to five times higher than proactive planned maintenance.

Following the reactive works, if the network continually experiences substandard pressures, one of the solutions described under Option 2 or 3 would need to be applied.

Option 3 risk assessment

Under Option 3, the risk level would remain the same as the untreated risk as there are no controls in place to mitigate the pressure drop risk (other than not connecting new customers, which is not a viable option).

Loss of supply risk in Eltham region – Option 3

Option 3	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Remote	Rare	Occasional	Rare	Occasional	Occasional	Occasional	Moderate
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Moderate	Negligible	Moderate	Negligible	Moderate	Moderate	Low	

Option 3 is therefore not consistent with our risk management framework, which requires action must be taken to reduce risks to low or ALARP. A moderate rating for operations or safety is not ALARP.

Summary of costs and benefits

The following table presents a summary of how each option compares in terms of the estimated cost, the residual risk rating, and alignment with our vision objectives.

Comparison of options

Option	Estimated cost ($ million)	Treated residual risk rating	Alignment with vision objectives
Option 1	1.0	Low	Aligns with *Delivering for Customers* and *Sustainably Cost Efficient*
Option 2	1.6	Low	Aligns with *Delivering for Customers but is not Sustainably Cost Efficient*
Option 3	Zero upfront capital cost	Moderate	Does not align with *Delivering for Customers* or *Sustainably Cost Efficient*

Recommended option

Option 1 is the recommended option.

Why is the recommended option prudent?

Option 1 is the most prudent option because:

- it increases and maintains the pressures in the network above 140 kPa in a timely manner;
- it is the most cost effective option that reduces risks to an acceptable level, Option 2 will reduce the risk of the network pressure falling below 140 kPa at a higher cost, without providing any further incremental benefit;
- it is deliverable, as evidenced by similar work done by AGN in the past; and
- Option 3 does not reduce the risk of the network pressure falling below 140 kPa and therefore is not consistent with APA risk management framework, which requires action must be taken to reduce any high risks to low or ALARP.

Estimating efficient costs

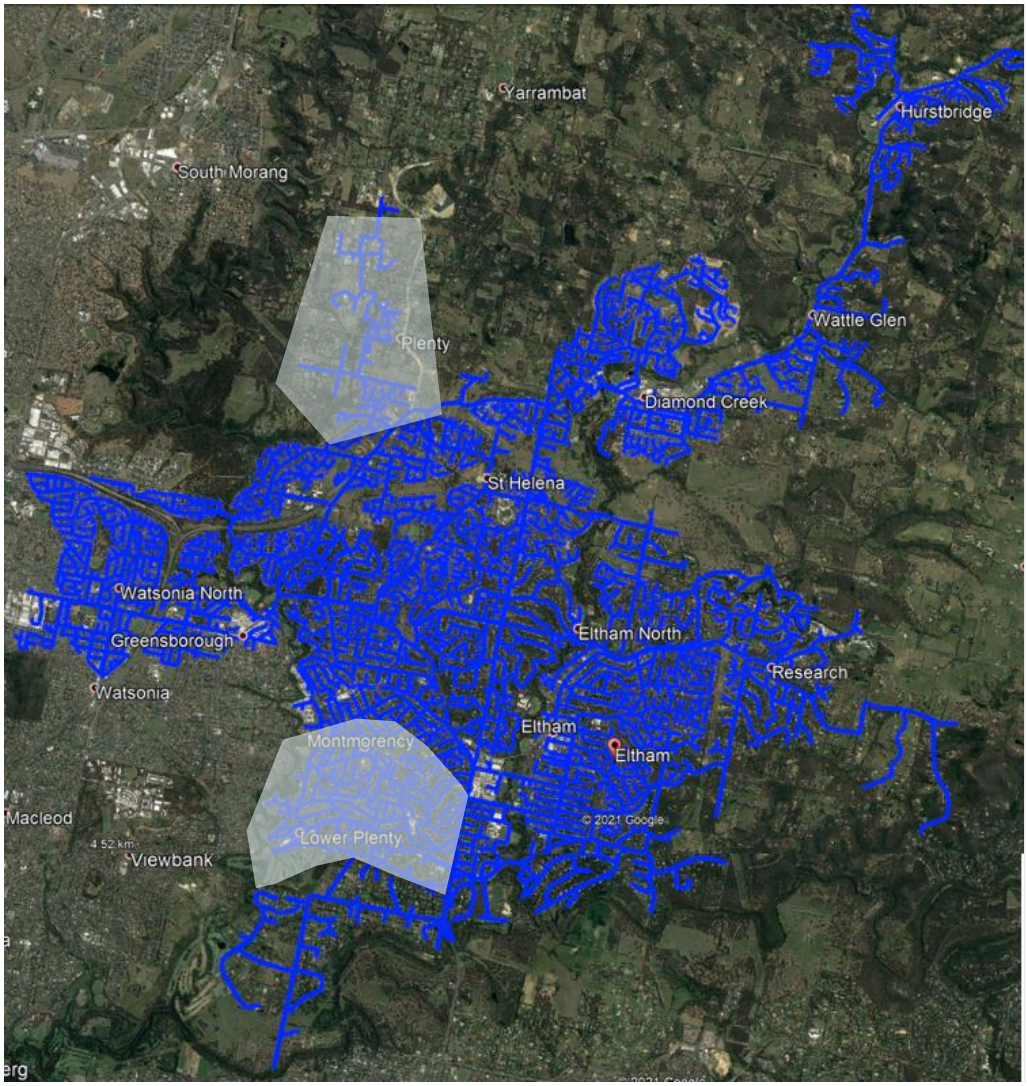
The forecast cost breakdown is shown in the table below.

Cost estimate, $'000 real 2021

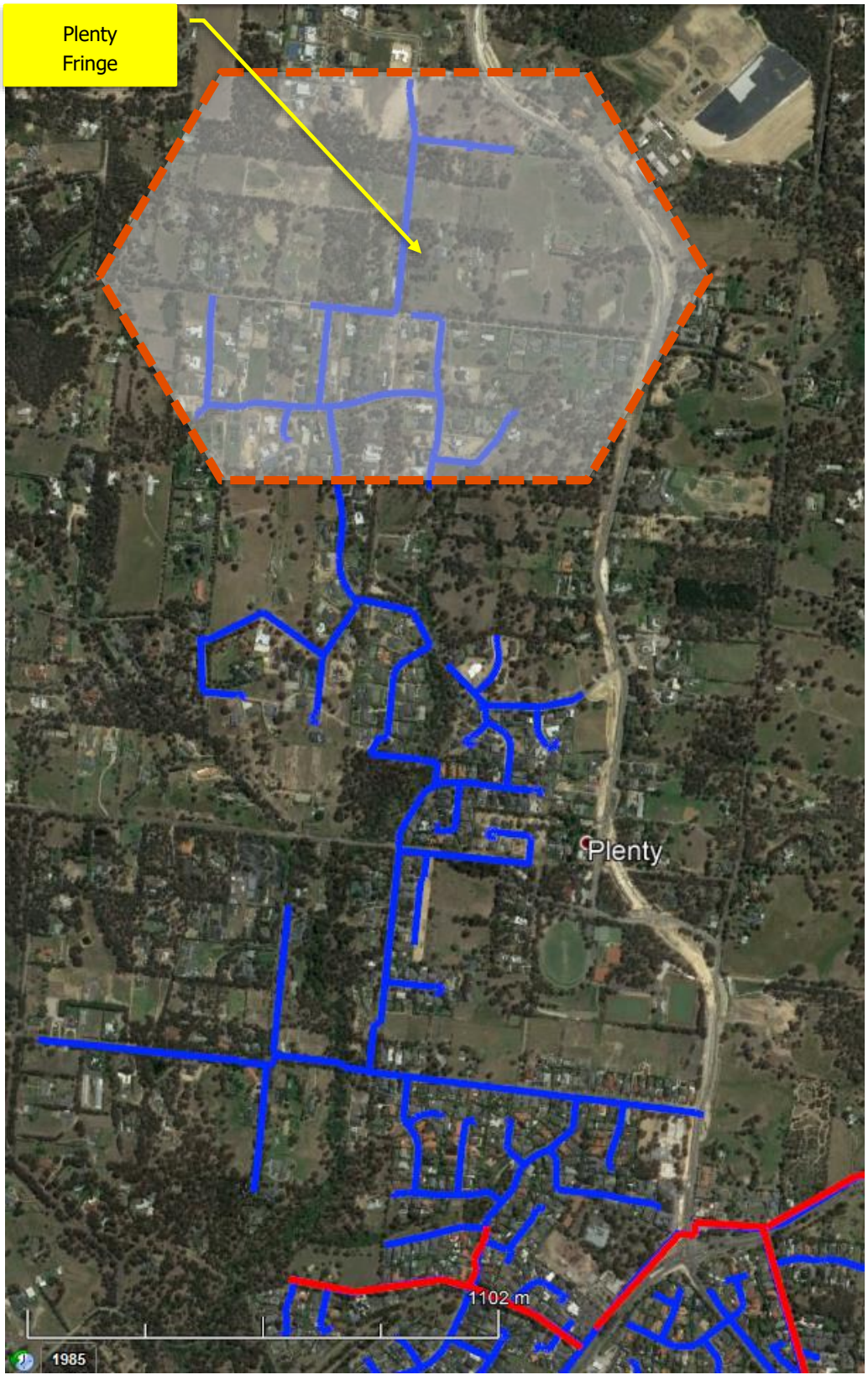
	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	Install 575m of DN125 PE and 45m of DN63 PE	-	-	Install 60m of DN63 PE	-	Install 575 m DN125 PE, and 105m DN63 PE
Labour	881	0	0	103	0	**984**
Material	26	0	0	4	0	**30**
Total	**907**	**0**	**0**	**107**	**0**	**1,014**

Appendix A – Asset location maps and configuration drawings

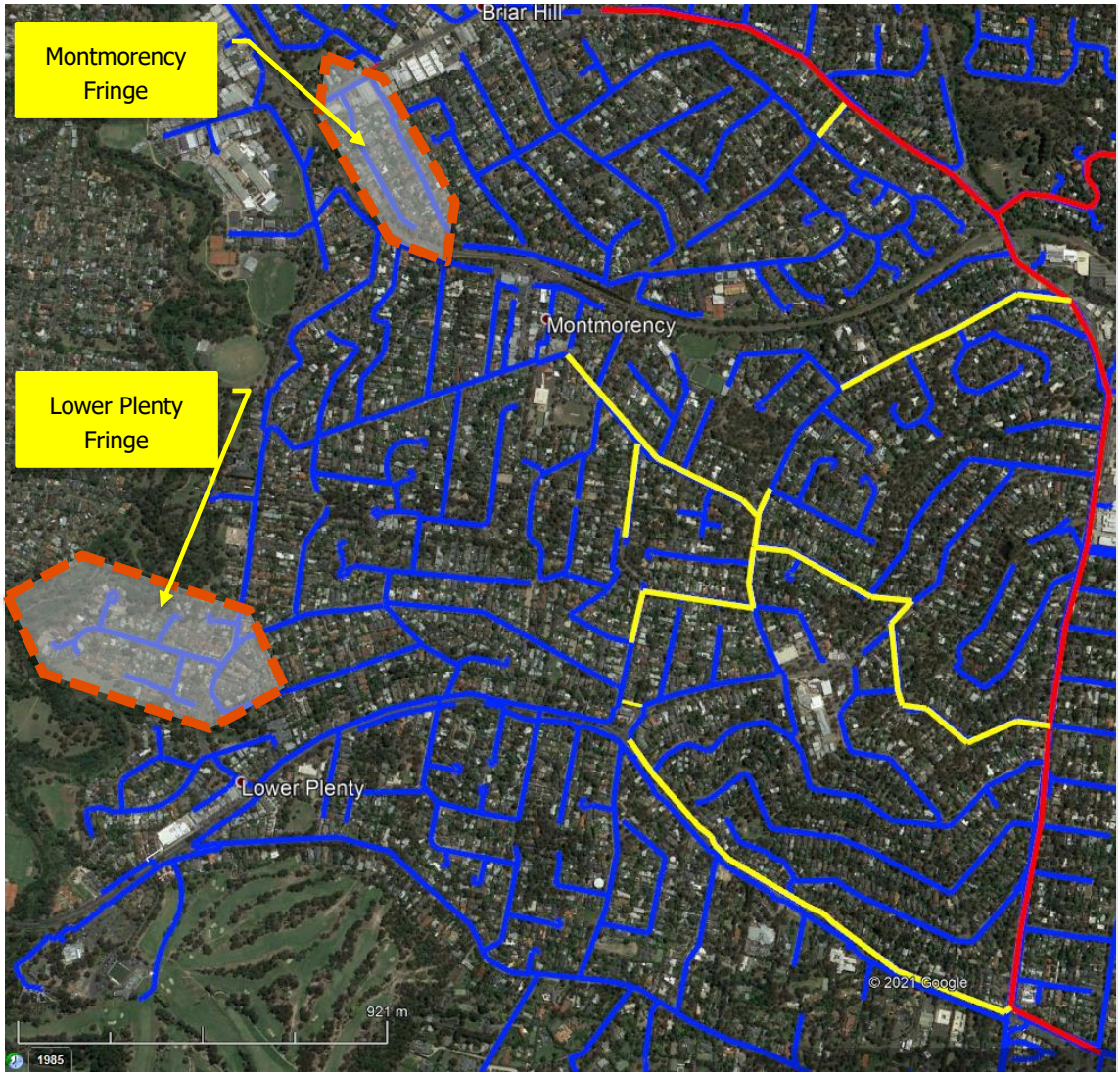
A.1: Eltham Network. Plenty, Montmorency and Lower Plenty areas of concern



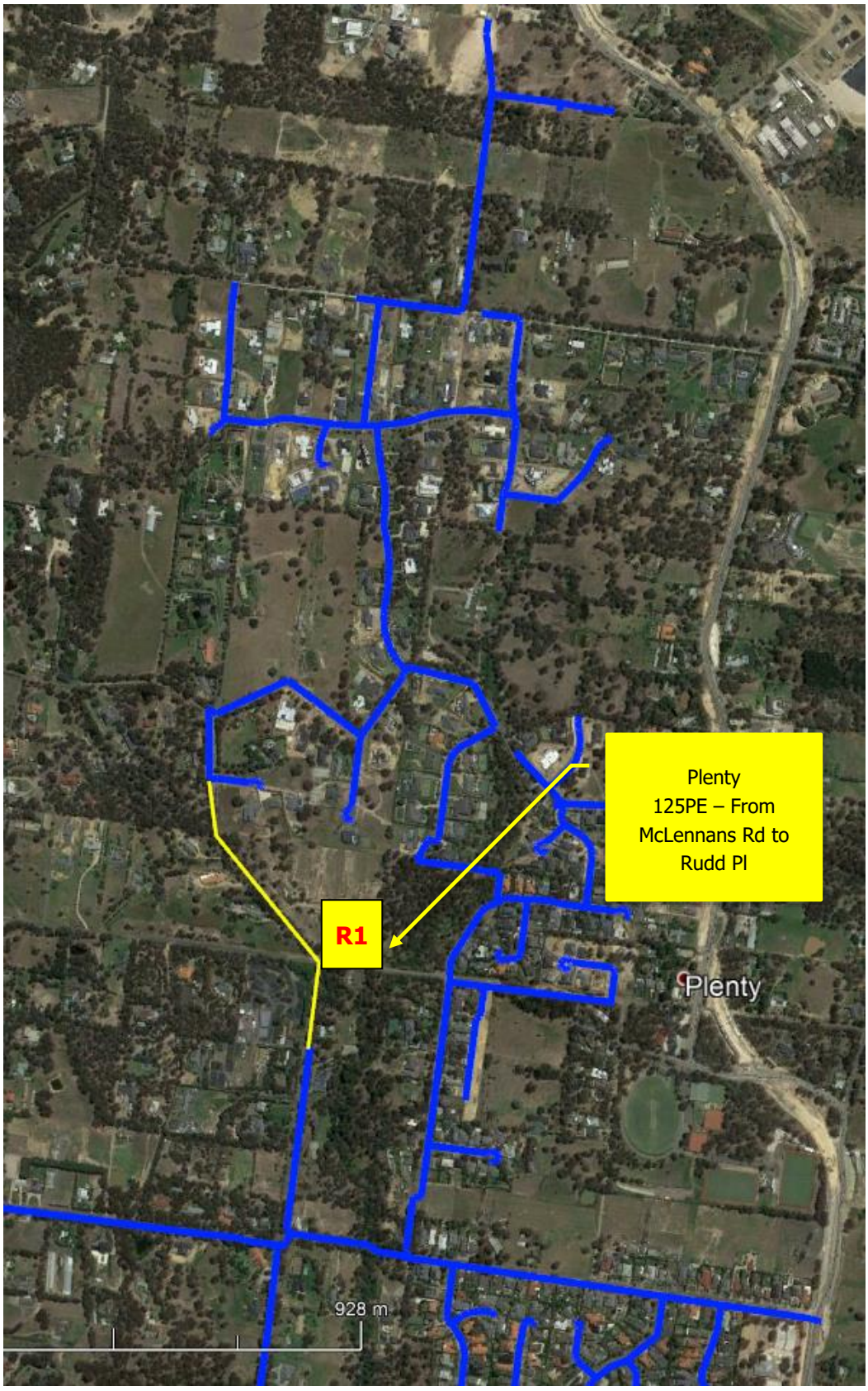
A.2: The Plenty network fringe relative to the DN100 trunk (in red)



A.3: The Lower Plenty and Montmorency fringes relative to the DN80 trunk main (in red) and 63PE (in yellow)

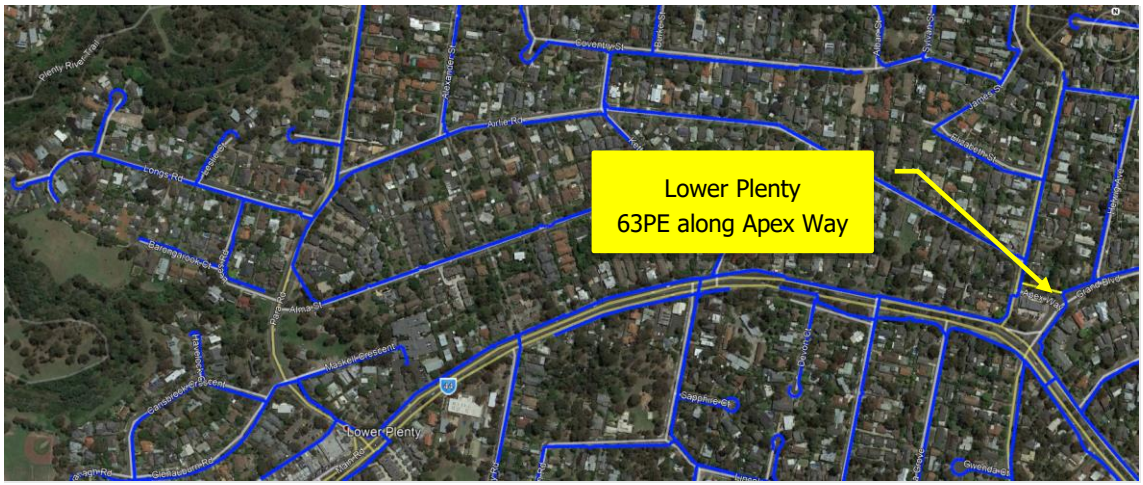


A.4: Option 1, Stage 1 - Plenty



A.5: Option 1, Stage 1 - Montmorency

A.6: Option 1, Stage 2 - Montmorency



Appendix B – Population growth forecast for Banyule City and Nilumbik

Local Government Area Results

Table 3 - Estimated Resident Population by Local Government Area, 2018 to 2036

	Population		Change 2018 - 2036	
	2018	2036	Number	Avg Rate
Inner Metropolitan Melbourne				
Melbourne (C)	169,960	292,630	122,670	3.1%
Port Phillip (C)	113,200	159,450	46,250	1.9%
Yarra (C)	98,520	136,450	37,930	1.8%
Inner South East Melbourne				
Bayside (C)	105,720	122,710	16,990	0.8%
Boroondara (C)	181,290	213,840	32,550	0.9%
Glen Eira (C)	153,860	188,210	34,350	1.1%
Stonnington (C)	116,210	146,890	30,680	1.3%
Eastern Melbourne				
Knox (C)	163,200	191,530	28,330	0.9%
Manningham (C)	125,510	148,410	22,900	0.9%
Maroondah (C)	117,500	143,790	26,300	1.1%
Monash (C)	200,080	248,930	48,850	1.2%
Whitehorse (C)	176,200	220,250	44,050	1.2%
Yarra Ranges (S)	158,170	183,820	25,650	0.8%
Northern Melbourne				
Banyule (C)	130,240	150,760	20,520	0.8%
Darebin (C)	161,610	210,650	49,040	1.5%
Hume (C)	224,390	343,990	119,600	2.4%
Moreland (C)	181,730	241,540	59,820	1.6%
Nillumbik (S)	64,940	70,310	5,370	0.4%
Whittlesea (C)	223,320	364,450	141,130	2.8%

Note: The Northern Metropolitan Region, as defined in Plan Melbourne includes that part of the Mitchell Shire which is within the Metropolitan Melbourne UGB. In these LGA tables, the whole of Mitchell Shire is included in the Hume Region.

Southern Melbourne				
Cardinia (S)	107,120	177,870	70,750	2.9%
Casey (C)	340,420	522,250	181,830	2.4%
Frankston (C)	141,850	165,790	23,940	0.9%
Greater Dandenong (C)	166,090	218,560	52,470	1.5%
Kingston (C) (Vic.)	163,430	201,090	37,660	1.2%
Mornington Peninsula (S)	165,820	200,360	34,540	1.1%

State of Victoria Department of Environment, Land, Water and Planning 2019, *Victoria in Future 2019,* Victoria State Government Planning, viewed 5 October 2021, https://www.planning.vic.gov.au/__data/assets/pdf_file/0032/332996/Victoria_in_Future_2019.pdf

A.9 Howlong HP network augmentation

Project overview

Description of the problem / opportunity	The HP network in Howlong had a total of 1,082 connections in 2021. The town is north of the Chiltern-Howlong City Gate (regulator) and is fed by a single source main measuring approximately 17.5 km. This distance results in a large pressure drop between the Chiltern-Howlong City Gate and Howlong entry point. Over the past ten years, the number of connections in Howlong has grown by an average of 20 new connections per year. We expect the growth to continue at this rate over the forthcoming access arrangement period (2023/24 to 2027/28). The historical growth in residential connections has decreased the amount of spare capacity in the Howlong HP network, and we are reaching the point where augmentation is required in order to maintain customer supply pressures. Continued load growth in Howlong will increase the risk of pressures dropping below 140 kPa, which is the minimum level necessary to maintain a safe and reliable customer supply. Based on the historical growth rates alone, we estimate that unless action is taken to augment the network, pressures will fall below 140 kPa by 2024. Network augmentation is therefore required before 2024 to ensure customers' supply is not affected. This business case considers options to augment the Howlong HP network during 2023 and 2026.
Untreated risk	As per risk matrix = **Moderate**
Options considered	• **Option 1** – Duplicate 5.3 km of existing mains in PE ($2.8 million) • **Option 2** – Construct a new City Gate and install 500m and 4km of steel and PE mains ($6.8 million) • **Option 3** – Maintain status quo (zero upfront capex)
Proposed solution	Option 1 is the proposed solution, as it will support continued load growth within Howlong without impacting existing customers' supply, and is the lowest direct cost option.
Estimated cost	The forecast direct cost (excluding overhead) during the next five-year period (2023 to 2028) is $2.8 million. The project would be delivered during 2023 and 2027.

$'000 real 2021	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Howlong HP augmentation	1,587	-	-	1,245	-	**2,832**

Basis of costs	All costs in this business case are expressed in real unescalated dollars at June 2021 unless otherwise stated. Tables may not sum due to rounding.
Treated risk	As per risk matrix = **Low**

Background

In 2021, the HP network in Howlong had a total of 1,082 connections. The past ten years of connection data show a yearly average increase of 20 new connections per year. Although this growth is small, the large distance (17.5 km of main) between the entry point of the town and the Chiltern-Howlong City Gate results in a significant pressure drop (refer to Appendix B.1). This large pressure drop combined with a network at capacity, results in pressures below the acceptable minimum pressure at the extremities of the network.

Impacts of historical growth

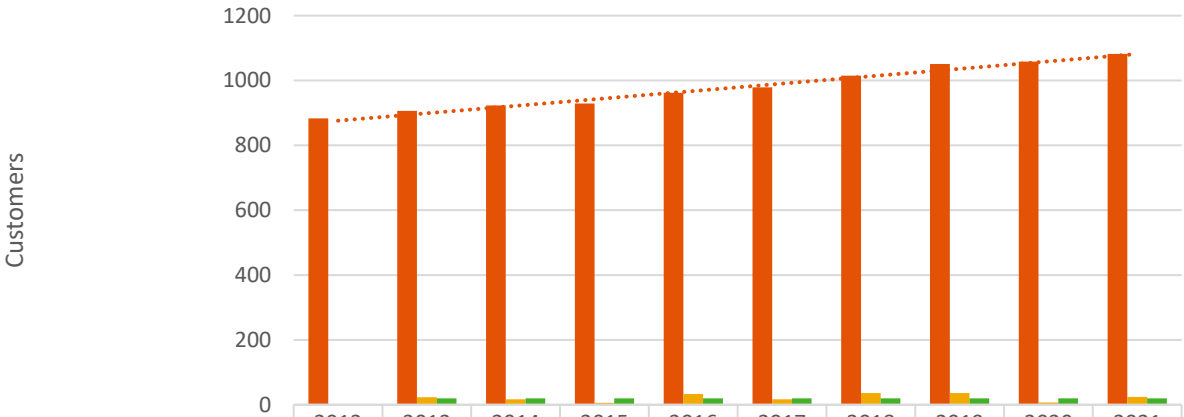
Historical data shows a continual increase in new connections has resulted in the reduction of spare capacity of the Howlong HP network. Continuation of growth without augmentation will cause pressures to drop to below 140 kPa. Pressures must remain above 140 kPa to meet our obligations of the Gas Distribution System Code and maintain customer supply.

Howlong is supplied by a single 100 Steel HP main from the Chiltern-Howlong City Gate. The 100 Steel extends for 500 m and then feeds into a DN125 main for 17 km before reaching the town Howlong (Appendix C.1).

The distance (17.5km) from the Chiltern-Howlong City Gate to the entry point of Howlong combined with the growth is causing the network to reach capacity. Consequently, the pressure will reach lower than minimum in the network.

The following figure shows the historical growth in new connections in the region from 2012 to 2021.

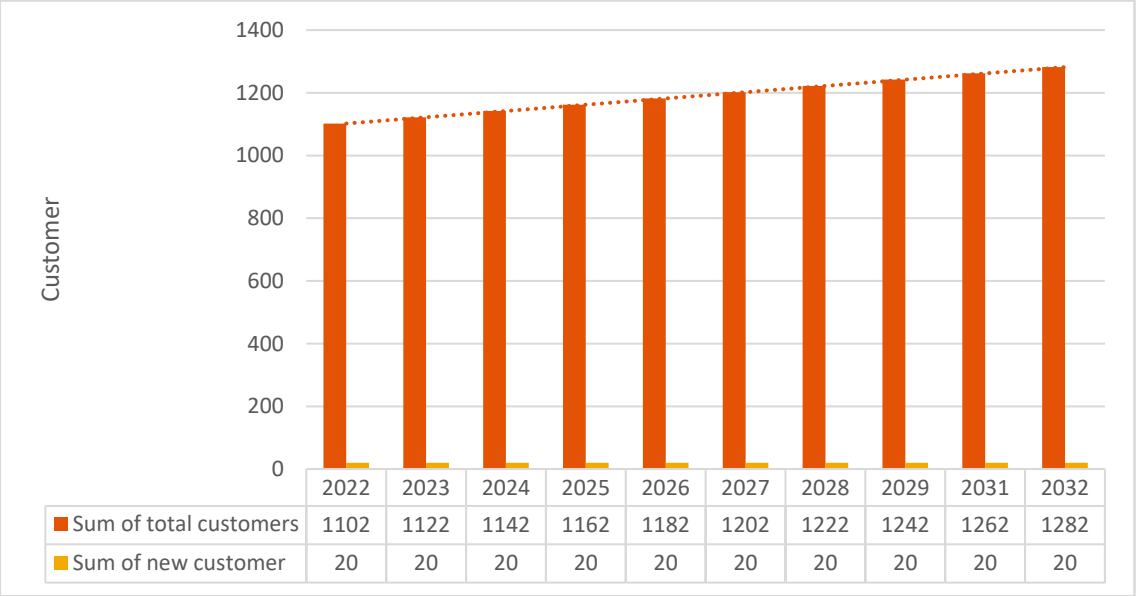
Historical connection growth in the Howlong HP network, 2012 to 2020



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Sum of total customers	883	906	923	929	962	979	1015	1051	1058	1082
New customer every year		23	17	6	33	17	36	36	7	24
10 year average		20	20	20	20	20	20	20	20	20

Based on the historical growth, the following figure shows the estimated increase in connections over the next ten years.

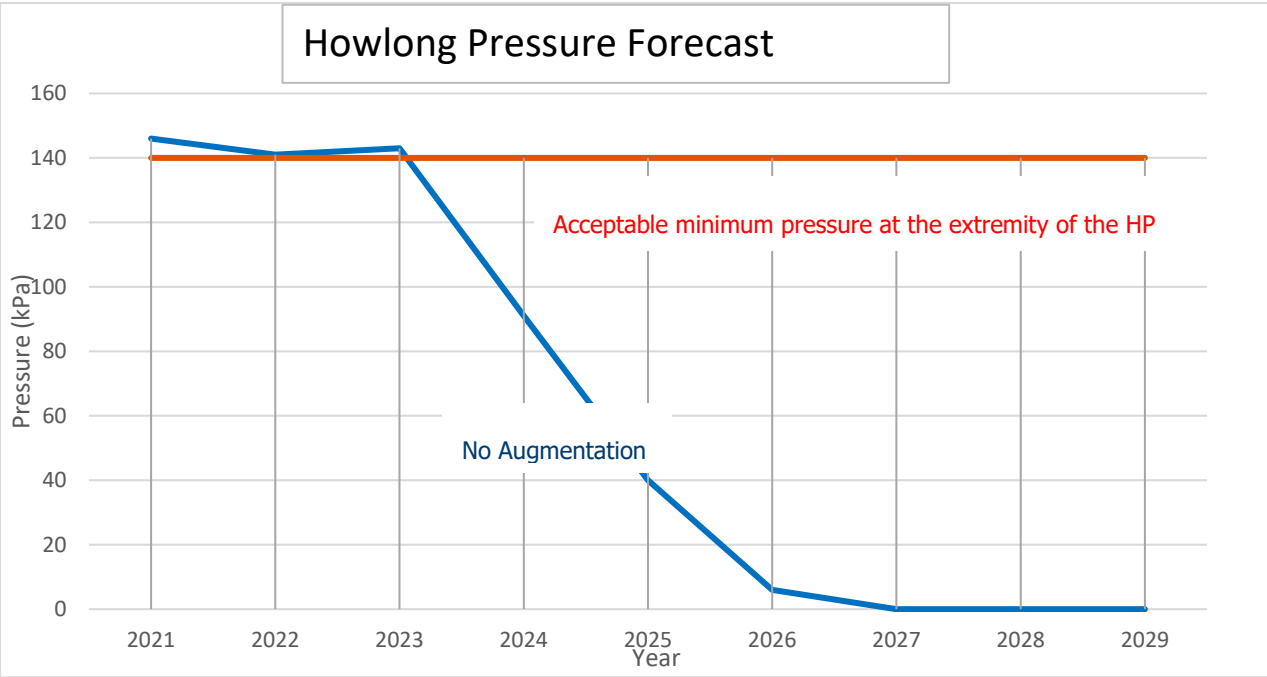
Estimated growth in new connections in Howlong, based on historical connections



	2022	2023	2024	2025	2026	2027	2028	2029	2031	2032
Sum of total customers	1102	1122	1142	1162	1182	1202	1222	1242	1262	1282
Sum of new customer	20	20	20	20	20	20	20	20	20	20

If we assume this historical average connection rate of 20 new connections per year continues, we estimate pressure levels in the Howlong HP network will fall below the minimum acceptable pressure of 140 kPa by 2024 if the network is not augmented.

Estimated impact on pressures in Howlong if the network is not augmented



Risk assessment

The risk identified for the natural gas distribution network in the Howlong HP network region is that load growth without network reinforcement or augmentation will cause delivery pressures to drop, leading to substandard supply or loss of supply to >1,000 customers. This may lead to customers' gas appliances becoming inoperable or damaged in certain circumstances.

The primary consequence category affected by this risk is operations, as a pressure drop can cause outages to >1,000 customers, thereby carrying a significant consequence rating under the risk matrix.

Given load growth is ongoing, if the risk is left untreated the likelihood of a pressure drop impacting >1,000 customers is rated occasional (every couple of years), however the frequency of supply interruptions will likely increase the longer the load growth risk is not addressed.

Any significant customer outage would then give rise to a moderate reputational and compliance risk. While there is a moderate health and safety risk posed by falling delivery pressure, safety is not the primary driver of investment in this instance.

The untreated risk rating is presented below.

Loss of supply risk in Howlong region – Untreated risk

Untreated risk	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Remote	Rare	Occasional	Rare	Occasional	Occasional	Occasional	Moderate
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Moderate	Negligible	Moderate	Negligible	Moderate	Moderate	Low	

Options considered

The following options have been identified to address the pressure drop risk in the HP Howlong distribution network:

- **Option 1** – Duplicate 5.3 km of existing mains in PE
- **Option 2** – Construct a new City Gate and install 500m and 4km of steel and PE mains
- **Option 3** – Maintain status quo

Option 1 has two stages, while Option 2 has one stage to accommodate the 160 new connections over the next ten years within Howlong. These options are discussed in the following sections.

Option 1 – Duplicate 5.3 km of existing mains in PE

Option 1 has two stages. The first stage is to install 3000 m of 180 PE HP main from the existing 125 HP main in Chiltern-Howlong Road and Old Howlong Road. This initial investment will resolve the immediate pressure drop risk, and will be delivered during the first year of the next access arrangement period (2023).

The second stage is to install 2,311 m of 180 PE from the existing 125 HP main in Old Howlong Road, duplicating the existing main. This would be delivered in the third to last year of the access arrangement period (2026).

The advantage of this option is that it addresses the immediate pressure drop risk at a lower cost than other options considered, and will defer the need for further augmentation to accommodate the growth in Howlong until 2026, at which point the 2,311 m of duplication is required. This augmentation will accommodate the network growth until post 2030.

Option 1 cost assessment

The direct cost of this option during the forthcoming AA period is $2.8 million.

Cost estimate – Option 1, $'000 real 2021

Option 1	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	Install 3,000 m of 180 PE	-	-	Install 2,311 m of 180 PE	-	Install 3,000 m of 180 PE, Install 2,311 m of 180 PE
Labour ($)	1,387	-	-	1,092	-	**2,479**
Materials ($)	200	-	-	153	-	**353**
Total	**1,587**	**-**	**-**	**1,245**	**-**	**2,832**

This option costs less than Option 2 (see below) due to material and construction cost of 180 PE main compared to Option 2.

Option 1 risk assessment

Option 1 would reduce the loss of supply (operational) risk from moderate to low. The work would reduce the likelihood of a pressure drop impacting >1,000 people from occasional to remote. The risk consequence rating remains unchanged. Option 1 reduces the likelihood of a pressure drop leading to compliance or reputational impacts from unlikely to rare, reducing the risk from moderate to low. It also reduces the likelihood of a major safety incident from remote to rare.

Loss of supply risk in Howlong region – Option 1

Option 1	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Remote	Remote	Rare	Rare	Rare	Remote	Low
Consequence	Major	Minor	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Low	Negligible	Low	Negligible	Low	Low	Negligible	

While Option 1 achieves the same risk rating as Option 2, the solution under Option 1 provides this risk reduction at a lower overall cost.

Option 2 – Construct a new City Gate and install 500m and 4km of steel and PE mains

Option 2 has one stage, which consists of two components:

1. Installation of a City Gate of the Culcairn-Barnawartha transmission line in Riverina Highway
2. Install 500 m of 200 mm Steel and 4 km of 180 PE from the new City Gate to Howlong

This investment will resolve the immediate and longer-term pressure drop risk, and would be delivered during the first year of the forthcoming access arrangement period (2023). This option will provide supply past the access arrangement period (2023/4 to 2028/9). However, it requires significantly greater expenditure compared to Option 1, to achieve a similar reduction in risk, without justifying the small future incremental benefit.

Option 2 cost assessment

The direct cost of this option during the forthcoming access arrangement period is $6.84 million.

Cost estimate – Option 2, $'000 real 2021

Option 2	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	Construct a City Gate, 500 m of 200 mm Steel, 4 km of 180 PE	-	-	-	-	Construct a City Gate, 500 m of 200 mm Steel, 4 km of 180 PE
Labour	2,499	-	-	-	-	2,499
Materials	341	-	-	-	-	341
New city gate	3,996					3,996
Total	**6,836**	**-**	**-**	**-**	**-**	**6,836**

Tables may not sum due to rounding

This option is more expensive than Option 1 due to material and construction cost of a new City Gate (regulator), 500m of 200mm Steel and 4 km of 180 PE (Option 2) compared to only 180 PE main (Option 1).

Option 2 risk assessment

Option 2 addresses the pressure drop issue and results in the same risk outcomes as the primary solution (Option 1). However, it achieves this at a higher cost than Option 1.

Loss of supply risk in Howlong region – Option 2

Option 2	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Rare	Remote	Rare	Rare	Rare	Remote	Low
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Low	Negligible	Low	Negligible	Low	Low	Negligible	

Option 3 – Maintain status quo

Under this option we would not incur any proactive capacity expansion capex to reduce the loss of supply risk in Howlong. Instead, we would manage the network as per current practice, and address any supply issues as and when they occur.

Given the current load growth forecasts, it is highly likely capital costs to address supply shortfall will be incurred reactively as minimum pressure limits are reached during winter 2024.

The network is currently operating at 450 kPa. As the network is already operating as close as possible to its maximum allowable operating pressure (MAOP) no further network capacity can be enabled through pressure increases.

We consider maintaining the status quo is not a viable solution, as it simply defers capacity expansion expenditure, as well as potentially resulting in high-cost reactive works.

Option 3 cost assessment

There are no additional upfront costs associated if we maintain the status quo. However, as mentioned above, we are likely to incur greater reactive maintenance costs as pressure issues emerge.

While it is not possible to quantify the reactive costs we would incur at this time, in our experience a project conducted reactively is around 3.2 times more expensive than one conducted proactively. [29] This assumption is consistent with the commonly accepted asset management principle that reactive asset maintenance can be around two to five times higher than proactive planned maintenance.[30]

Following the reactive works, if the network continually experiences substandard pressures, one of the solutions described under Option 1 or 2 would need to be applied.

Option 3 risk assessment

Under Option 3, the risk level would remain the same as the untreated risk as there are no controls in place to mitigate the pressure drop risk (other than not connecting new customers, which is not a viable option).

Loss of supply risk in Howlong region – Option 3

Option 3	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Remote	Rare	Occasional	Rare	Occasional	Occasional	Occasional	Moderate
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Moderate	Negligible	Moderate	Negligible	Moderate	Moderate	Low	

Option 3 is therefore not consistent with our risk management framework, which requires action must be taken to reduce risks to low or ALARP. A moderate rating for operations or safety is not ALARP.

Summary of costs and benefits

The following table presents a summary of how each option compares in terms of the estimated cost, the residual risk rating, and alignment with our vision objectives.

Comparison of options - Howlong

Option	Estimated cost ($ million)	Treated residual risk rating	Alignment with vision objectives
Option 1	2.8	Low	Aligns with *Delivering for Customers* and *Sustainably Cost Efficient*
Option 2	6.8	Low	Does not align with *Sustainably Cost Efficient*, but does reduce the risk to Low, thereby aligns with *Delivering for Customers*
Option 3	Zero upfront capex	High	Does not align with *Delivering for Customers* or *Sustainably Cost Efficient*

Recommended option

Option 1 is the recommended option.

[29] For example, this is typically due to the additional premia for faster acquisition of long lead time materials, emergency response, labour costs, additional traffic management/permit costs, resource scheduling, etc.

[30] Marshall Institute, Omega engineering, ARMS reliability.

Why is the recommended option prudent?

Option 1 is the most prudent as it addresses the pressure drop risk before the minimum acceptable level arises, while setting an efficient platform for further cost effective PE augmentation when the forecast growth occurs over the next ten years and beyond.

Option 1 provides sufficient capacity to support the forecast organic growth over the remainder of the access arrangement period. No additional augmentation is forecast until 2030.

Options 2 delivers greater pressure benefit to the network in the long run, however at a much greater cost to the network, which does not justify this incremental benefit. Furthermore, the risk reduction of Option 1 and 2 are the same. Option 1 allows for the risk reduction to occur at a lower cost.

Estimating efficient costs

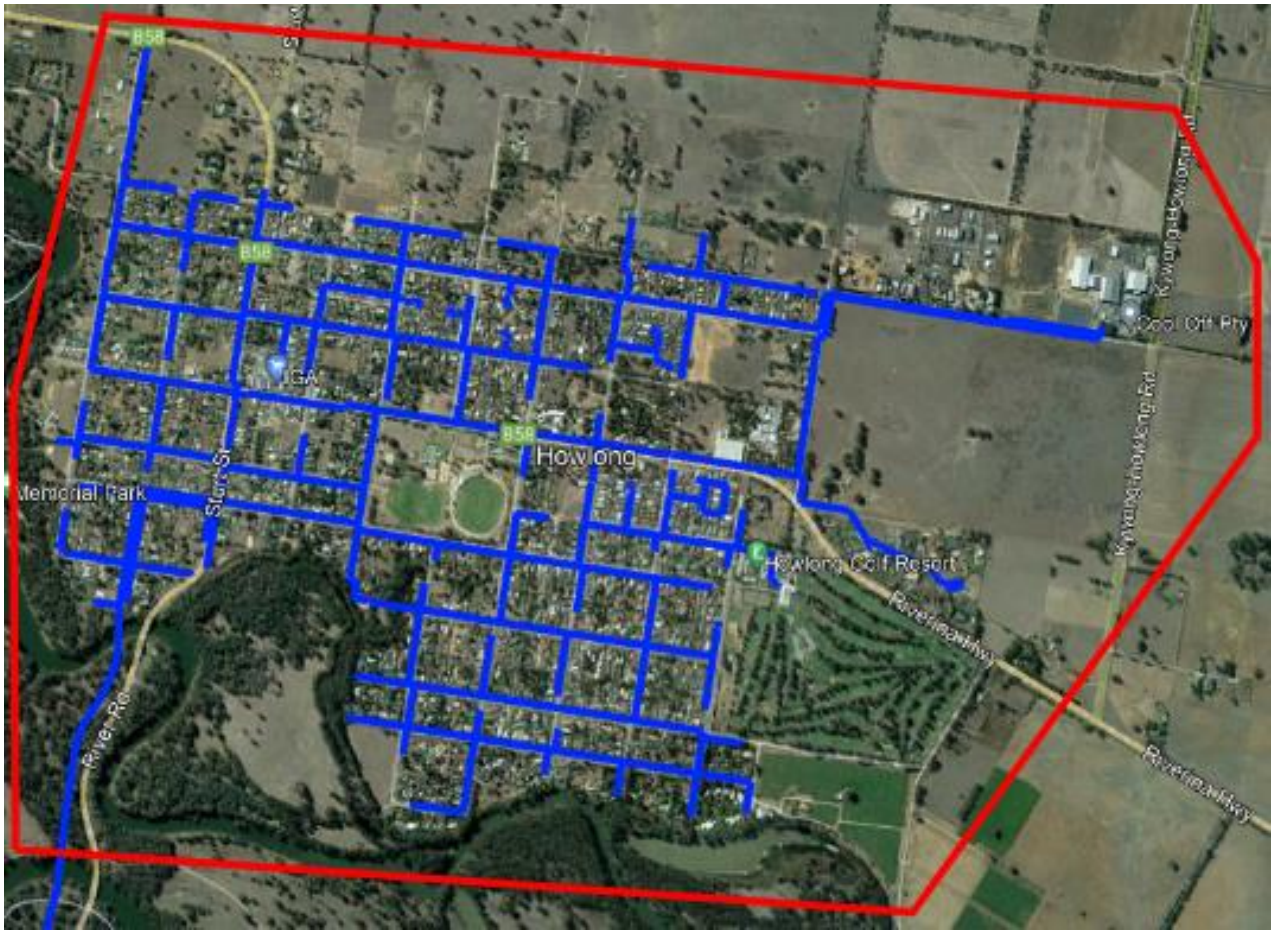
The forecast cost breakdown is shown in the table below.

Cost estimate, $'000 real 2021

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	Install 3,000 m of 180 PE	-	-	Install 2,311 m of 180 PE	-	Install 5,311 m of 180 PE
Labour	1,387	-	-	1,092	-	**2,479**
Material	200	-	-	153	-	**353**
Total	**1,587**	**-**	**-**	**1,245**	**-**	**2,832**

Appendix A – Asset location and Growth area maps

A.1: Howlong HP network map



Appendix B – Option 1 and 2 duplication projects

B.1: Option 1 map of augmentation

B.2: Option 2 map of augmentation

A.10 Pakenham HP network augmentation

Project overview

Description of the problem / opportunity

The Pakenham network supplies gas to the south-eastern fringe of Melbourne. This area is composed of residential growth, servicing over 23,300 customers. Over the past five years, the number of customer connections within the region has grown by an average of 1,080 connections per year, with an average growth rate of 4.6%. This historical growth in residential connections has decreased the amount of space capacity within the Pakenham network, particularly affecting the southern regulator.

Within this upcoming access arrangement, the eastern corridor of Pakenham is undergoing urban development, creating a new residential area on over 400 hectares of land (Victoria State Government 2020). This is an indication the residential growth rate within Pakenham will increase within the upcoming access arrangement period.

Continued load growth in the region increases the risk of pressures dropping below 140 kPa, which is the minimum level necessary to maintain a safe and reliable customer supply as set out in Schedule 1 of the Victorian Gas Distribution System Code. Based on the projected forecast growth rates we estimate that unless action is taken to augment the network, pressures will fall below 140 kPa before 2026.

The load increase will have an impact on the eastern corridor of the Pakenham network where we are forecasting to add 4,865 customers over the access arrangement period.

Network augmentations are therefore required during this access arrangement period to ensure customers' supply is not adversely affected. This business case considers options to augment the Pakenham network during the July 2023 to June 2028 period.

Untreated risk

As per risk matrix = **High**

Options considered

- **Option 1** – Install a new City Gate central to future growth area near Dore Rd ($6.4 million)
- **Option 2** – Build a new City Gate at the location of the current Koo Wee Rup Rd site and duplicate 2.3 km of 280mm PE mains ($7.6 million)
- **Option 3** – Maintain status quo (no upfront capex)

Proposed solution

Option 1 is the proposed solution. This involves the installation of a new City Gate on Dore Rd. This activity will mitigate the high health, safety, and operational risks associated with the growth rates of the Pakenham Network.

Option 1 ensures that supply pressure within the Pakenham Network is maintained above 140 kPa, servicing network growth from the new urban developments at the lowest cost.

Estimated cost

The forecast direct cost (excluding overhead) during the next five-year period (2023/24 to 2027/28) is $6.4 million.

$'000 real 2021	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Regulator installation	-	-	6,443	-	-	**6,443**

Basis of costs

All costs in this business case are expressed in real unescalated dollars at June 2021 unless otherwise stated.

Tables may not sum due to rounding.

Treated risk

As per risk matrix = **Low**

Background

The Pakenham Network in Victoria serves over 23,300 residential customers and 8 high profile Tarrif D customers as of December 2021. Over the last five years, the number of customer connections within the network has grown by approximately 5,400, at an average of 1,080 new connections per year.

Growth in the existing Pakenham areas is expected to decline over the new few years however new urban development is planned within the eastern region of Pakenham within the next five years, creating a new residential area on over 400 hectares of land (Victoria State Government 2020)[31]. It is therefore expected that growth will continue over the forthcoming access arrangement period, shifting eastwards.

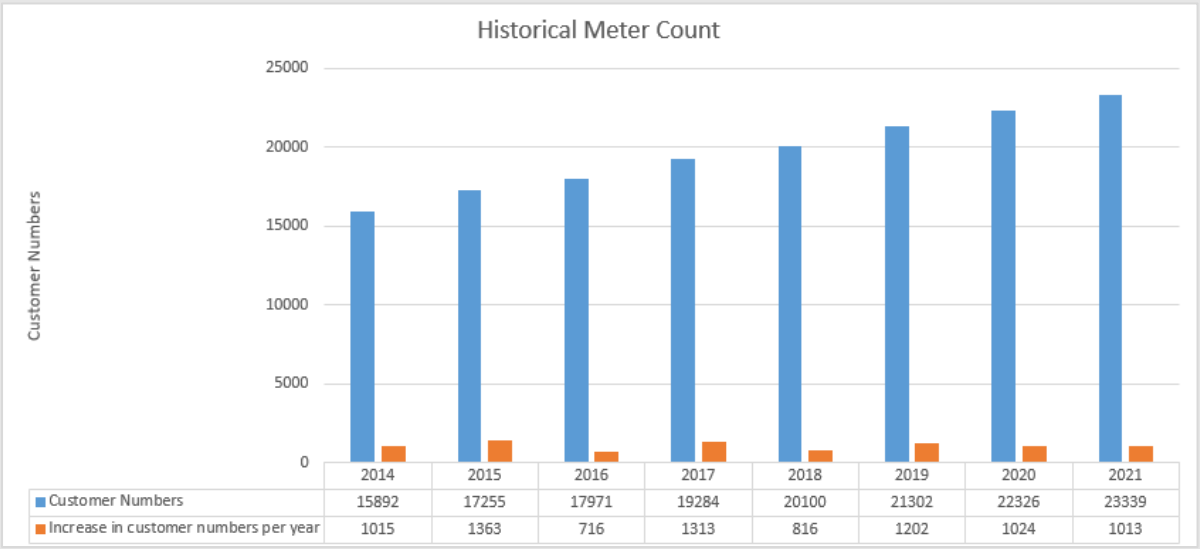
The Koo Wee Rup Rd regulator is the main feed into the southern and eastern Pakenham area and is located within the southern region of Pakenham. This regulator is currently operating close to the maximum capacity of 13,600 scm/hr (12,200 scm/hr in 2021). Without augmentation by 2028 demand on the regulator will have increased to 15,800 scm/hr, well past the capacity of the site.

Koo Wee Rump regulator is currently operating over maximum capacity (over 11,000 scm/hr) and based on current network growth within the existing network, by 2025 fringe networks in Pakenham are expected to be operating below minimum pressure.

Impact of historical growth

The average connection rate over the last six years within the Pakenham Network has been 1,080 new connections per year, which constitutes to an average growth of 4.6%. The total number of new connections over this time period is approximately 5,400. The following figure shows the historical growth in new connections within this network since 2014.

Historical growth within the Pakenham Network



	2014	2015	2016	2017	2018	2019	2020	2021
Customer Numbers	15892	17255	17971	19284	20100	21302	22326	23339
Increase in customer numbers per year	1015	1363	716	1313	816	1202	1024	1013

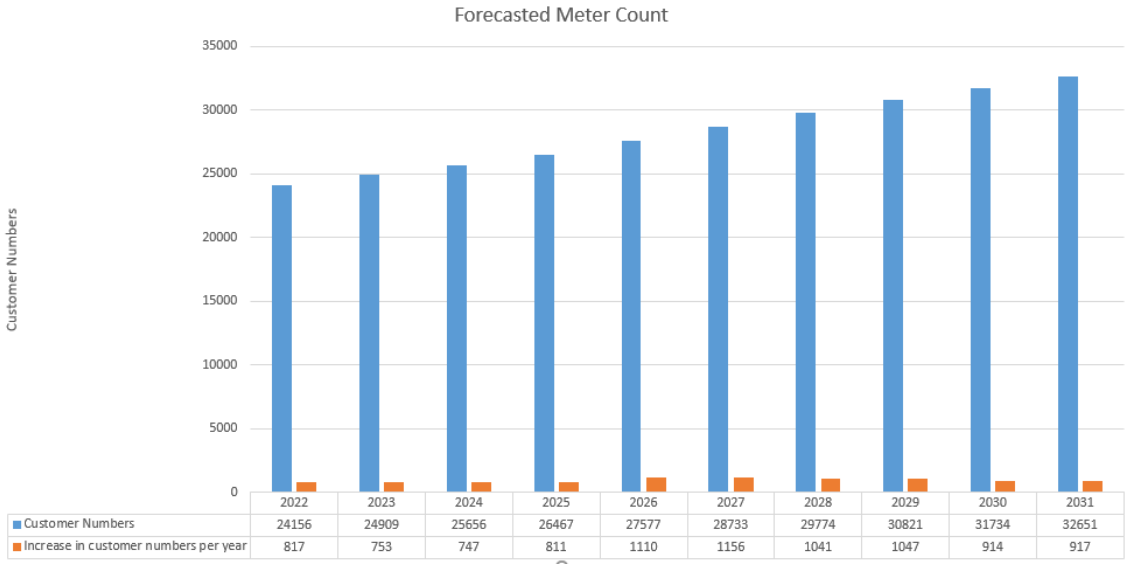
[31] Victoria State Government 2020, *Pakenham East Infrastructure Contributions Plan,* Victoria Planning Authority, viewed 11 October 2021, https://vpa-web.s3.amazonaws.com/wp-content/uploads/2021/01/Pakenham-East-Infrastructure-Contributions-Plan-July-2020-Approved-and-Gazetted.pdf.

Future growth

The current Pakenham area has seen significant growth over the last 5 to 10 years but as the available land fills the forecasted growth will drop off in this area. As that happens the eastern region of Pakenham is about to undergo an urban expansion within the forthcoming access arrangement period, it is expected the growth rate will dip slightly from 2022 to 2024 but then pick back up as the new estates come on line. A map of eastern Pakenham is provided in Appendix A.

Based on the historical connections, and taking into account the new urban development within the eastern region of Pakenham taking place within this access arrangement period, a bottom up growth forecast has been developed for the network. The following figure shows the estimated increase over the next ten years with the majority taking place in Pakenham East by 2028.

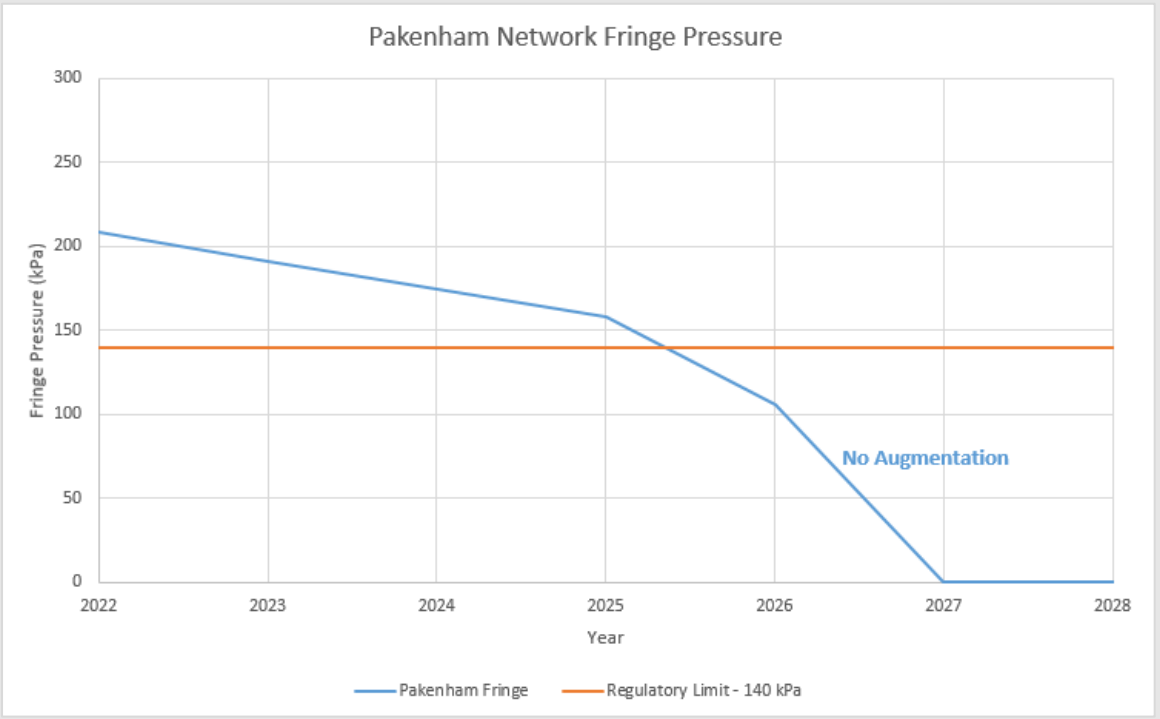
Forecast growth within the Pakenham Network (including Pakenham East development)



	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Customer Numbers	24156	24909	25656	26467	27577	28733	29774	30821	31734	32651
Increase in customer numbers per year	817	753	747	811	1110	1156	1041	1047	914	917

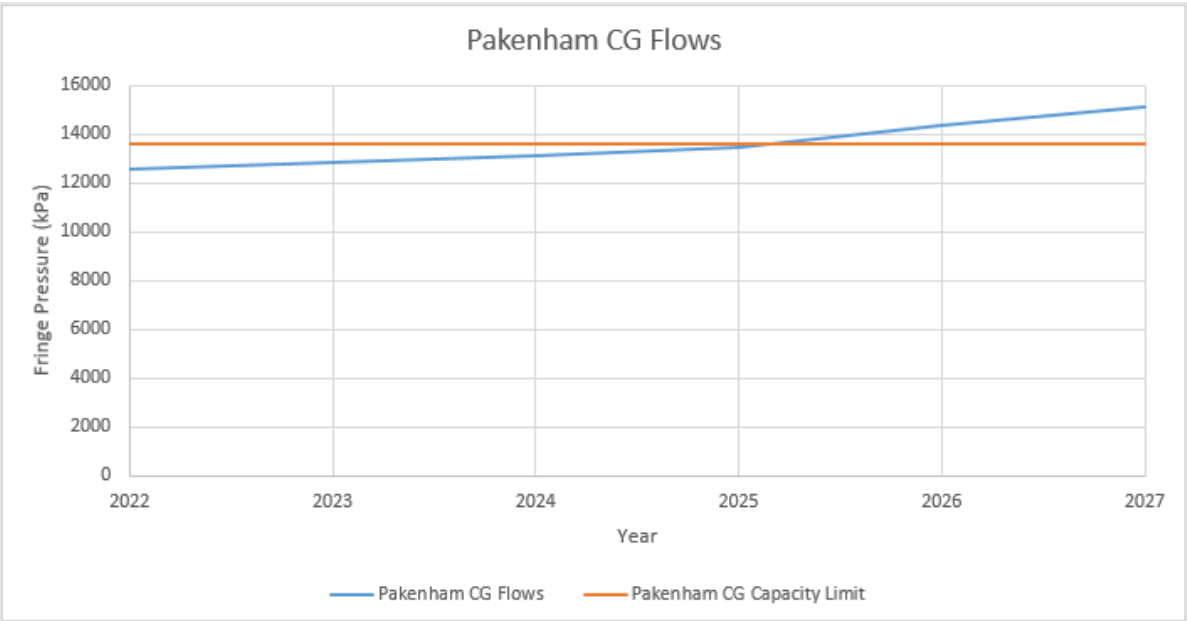
Applying the development forecast to the modelling we estimate pressure levels within the fringes of the Pakenham network will fall below the minimum acceptable pressure of 140 kPa before 2026 if no augmentations are completed.

Estimated impact on pressures in the Pakenham Network if no augmentation is completed



Additionally with no augmentation the current Koo Wee Rup Rd regulator will exceed its capacity in winter 2026. This would have the effect of lowering its outlet pressure and exacerbating the low pressure issues at the fringes, increasing the number of customers experiencing poor supply

Estimated impact on flows in the Koo Wee Rup Rd regulator if no augmentation is completed



Risk assessment

The risk identified for the natural gas distribution network in the Pakenham HP network region is that load growth without network reinforcement or augmentation will cause delivery pressures to drop, leading to substandard supply or loss of supply to up to 22,300

customers. This may lead to customers' gas appliances becoming inoperable or damaged in certain circumstances.

The primary consequence category affected by this risk is operations, as a pressure drop can cause outages to >1,000 customers, thereby carrying a major consequence rating under the risk matrix.

Given load growth is ongoing, if the risk is left untreated the likelihood of a pressure drop impacting >1,000 customers is rated occasional (every couple of years), however the frequency of supply interruptions will likely increase the longer the load growth risk is not addressed, which will lead to a likelihood of frequent.

Any significant customer outage would then give rise to a moderate reputational and compliance risk. While there is a moderate health and safety risk posed by falling delivery pressure, safety is not the primary driver of investment in this instance.

The untreated risk rating is presented below.

Loss of supply risk in Cranbourne region – Untreated risk

Untreated risk	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Remote	Rare	Occasional	Rare	Occasional	Occasional	Occasional	High
Consequence	Major	Minimal	Major	Minimal	Significant	Significant	Minor	
Risk Level	Moderate	Negligible	High	Negligible	Moderate	Moderate	Low	

Options considered

The following options have been identified to address the risk associated with capacity and security of supply within the Pakenham Network:

- **Option 1** – Install a new City Gate at Dore Rd
- **Option 2** – Install a new City Gate at Koo We Rup Rd to replace the existing City Gate and duplicate 2.3 km of pipeline
- **Option 3** – Maintain status quo

Option 1 – Install a new regulator at Dore Rd.

Under Option 1, we would install a new city gate and connect it into the existing network at Dore Rd. Further details of this plan are outlined in Appendix A.

The new city gate will be situated within close proximity to the urban development within eastern Pakenham. This solution must be commissioned and running before winter of 2026 to ensure supply pressure within the Pakenham Network is maintained above 140 kPa. Not only will this solution succeed in catering to the new Pakenham urban development plan, but it will also mitigate network pressures and address the capacity issues present within the Koo Wee Rup Rd regulator.

Option 1 cost assessment

The estimated direct capital cost of this option is $6.4 million. This estimate is based on historical costs of materials and labour.

Cost estimate – Option 1, $'000 real 2021

Option 1	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	-	-	Construct a new city gate	-	-	Construct a new city gate
Total Cost	**-**	**-**	**6,443**	**-**	**-**	**6,443**

The key driver for this option is customer growth within the Pakenham Network. This solution will ensure supply pressure for customers within the Pakenham Network remains above 140 kPa within this access arrangement period. This option ensures the new urban developments within Pakenham are catered for.

Option 1 risk assessment

Option 1 would reduce the loss of supply (operational) risk from high to low. This is because having augmentation would reduce the likelihood of a pressure drop impacting >1,000 people from occasional to remote. The risk consequence rating remains unchanged. Option 1 reduces the likelihood of a pressure drop leading to compliance or reputational impacts from occasional to remote, reducing the risk from moderate to low. It also reduces the likelihood of a major safety incident from remote to rare.

Loss of supply risk in Pakenham region – Option 1

Option 1	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Rare	Remote	Rare	Remote	Remote	Remote	Low
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Low	Negligible	Low	Negligible	Low	Low	Negligible	

While Option 1 achieves the same risk rating as Option 2, the solution under Option 1 provides this risk reduction at a lower overall cost.

Option 2 – Install a new City Gate at Koo We Rup Rd to replace the existing City Gate and duplicate 2.3 km of pipeline

Under Option 2, we would build a new City Gate at Koo Wee Rup Rd to replace the undersized existing site and lay an additional 2.3 km of 280 mm PE main along Healesville-Koo Wee Rup Rd and Princes Hwy duplicating the existing trunk mains.

This solution must be commissioned and running before winter of 2026 to ensure supply pressure within the Pakenham Network is maintained above 140 kPa. While this solution solves the pressure problems it may prove that it is not actually feasible given the space constraints in Koo Wee Rup Rd at the current location. It may be that a new regulator cannot be built at this site. The existing site cannot be simply upgraded as the new site would need to be sized for a flow of 25,000 scm/hr about double the existing site and pipework and fittings needed for such a flow will not fit in the existing Pit. A Kiosk style regulator cannot be used in this location given that it is going to have to be built in the roadway as there is no vacant land in the area unlike in Option 1 at Dore Rd.

Option 2 cost assessment

The estimated direct capital cost of this option is $7.59 million. This estimate is based on historical costs of materials and labour.

Cost estimate – Option 2, $'000 real 2021

Option 2	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	-	Construct a new City Gate	2.3 km of 280 mm PE	-	-	Construct a new city gate, 2.3 km of 280 mm PE
Labour	-	-	1,753	-	-	**1,753**
Material	-	-	391	-	-	**391**
New city gate	-	5,443	-	-	-	**5,443**
Total	**-**	**5,443**	**2,144**	**-**	**-**	**7,587**

The key driver for this option is customer growth within the Pakenham Network. Although this solution ensures supply pressure for customers within the Pakenham Network remains above 140 kPa within this access arrangement period, it operates at a higher cost than Option 1, and introduces further complications regarding a site for the new regulator in Koo Wee Rup Rd.

Option 2 risk assessment

Option 2 addresses the pressure drop issue and results in the same risk outcomes as the primary solution (Option 1). However, it achieves this at a higher cost than Option 1.

Loss of supply risk in Pakenham region – Option 2

Option 2	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Rare	Remote	Rare	Remote	Remote	Remote	Low
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Low	Negligible	Low	Negligible	Low	Low	Negligible	

Option 3 – Maintain status quo

Under this option we would not undergo any augmentation within the Pakenham Network to facilitate the growth within said network. Instead, we would manage the network as per current practice, addressing any supply issues as they arise.

Given the urban development forecasts, it is highly likely capital costs will be incurred to reactively address supply shortages as pressure drops below the minimum supply pressure of 140 kPa. As per the growth forecast, demand within the Pakenham region is set to increase over the long term.

We consider maintaining the status quo is not a viable solution, as it simply defers capacity expansion expenditure, as well as potentially resulting in high-cost reactive works.

Option 3 cost assessment

There are no additional upfront costs associated if we maintain the status quo. However, as mentioned above, we are likely to incur greater reactive maintenance costs as pressure issues emerge.

While it is not possible to quantify the reactive costs we would incur at this time, in our experience a project conducted reactively is around 3.2 times more expensive than one conducted proactively. This assumption is consistent with the commonly accepted asset

management principle that reactive asset maintenance can be around two to five times higher than proactive planned maintenance.

Additionally, in the event the network continues to experience substandard pressures after conducting reactive works, one of the other solutions explored will need to be implemented to ensure pressure is maintained across the Pakenham network.

Option 3 risk assessment

Under Option 3, the risk level would remain the same as the untreated risk as there are no controls in place to mitigate the pressure drop risk (other than not connecting new customers, which is not a viable option). The following table shows the risk level if were to maintain the status quo.

Loss of supply risk in Pakenham region – Option 3

Option 3	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Remote	Rare	Unlikely	Rare	Occasional	Occasional	Occasional	High
Consequence	Major	Minimal	Major	Minimal	Significant	Significant	Minor	
Risk Level	Moderate	Negligible	High	Negligible	Moderate	Moderate	Low	

Option 3 is therefore not consistent with our risk management framework, which requires action must be taken to reduce any high risks to low or ALARP.

Summary of costs and benefits

The table below presents a summary of how each option compares in terms of the estimated cost, the residual risk rating, and alignment with our vision objectives.

Comparison of options - Packenham

Option	Estimated cost ($ million)	Treated residual risk rating	Alignment with vision objectives
Option 1	6.44	Low	This is consistent with our Risk Management Framework and aligns with all relevant vision objectives.
Option 2	7.59	Low	Aligns with *Delivering for Customers*, but does not align with our objective to be *Sustainably Cost Efficient*
Option 3	Zero upfront capex	High	Does not align with *Delivering for Customers* or *Sustainably Cost Efficient*

Recommended option

Option 1 is the proposed solution.

Why is the recommended option prudent?

Option 1 is the most prudent option because:

- it increases and maintains pressure within the Pakenham Network above 140 kPa within this access arrangement period;
- it is the most cost effective option that reduces risks to an acceptable level; Option 2 mitigates capacity issues with the Koo Wee Rump regulator through expansion, but this

solution achieves the same benefits at a higher cost than Option 1, without additional incremental benefits;

- it is deliverable, as evidenced by similar work done by AGN in the past; and
- Option 3 does not reduce the risk of the network pressure falling below 140 kPa and therefore is not consistent with APA risk management framework, which requires action must be taken to reduce any high risks to low or ALARP.

Estimating efficient costs

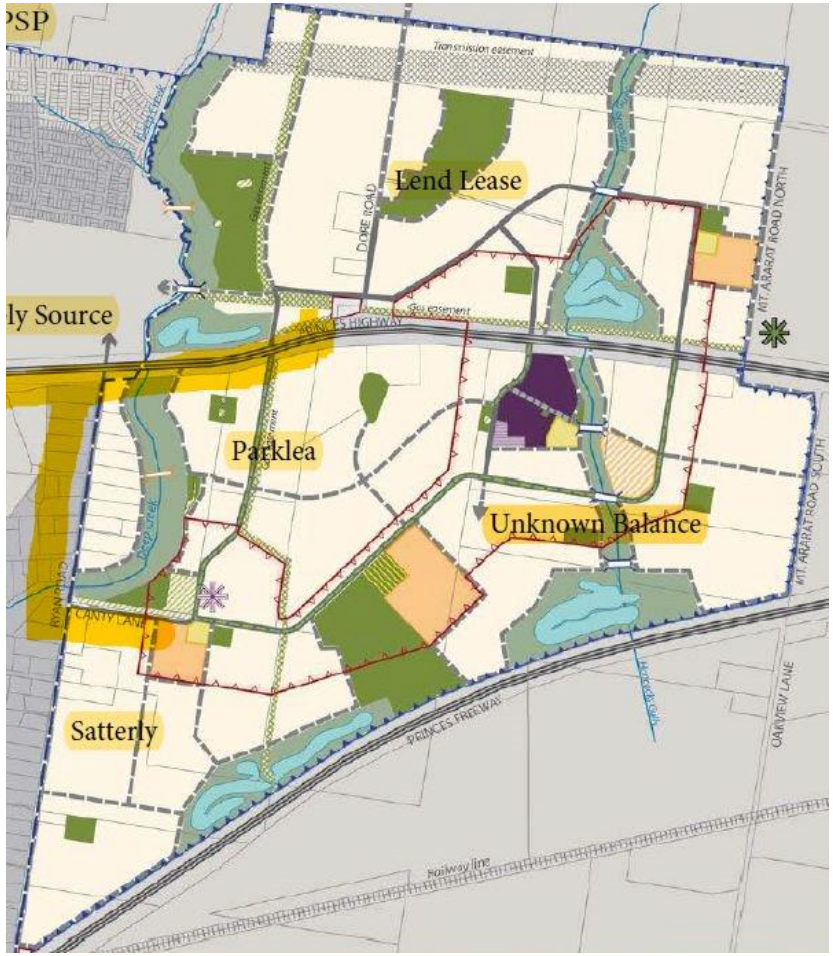
The forecast cost breakdown is shown in the table below.

Cost estimate ($'000 real 2021)

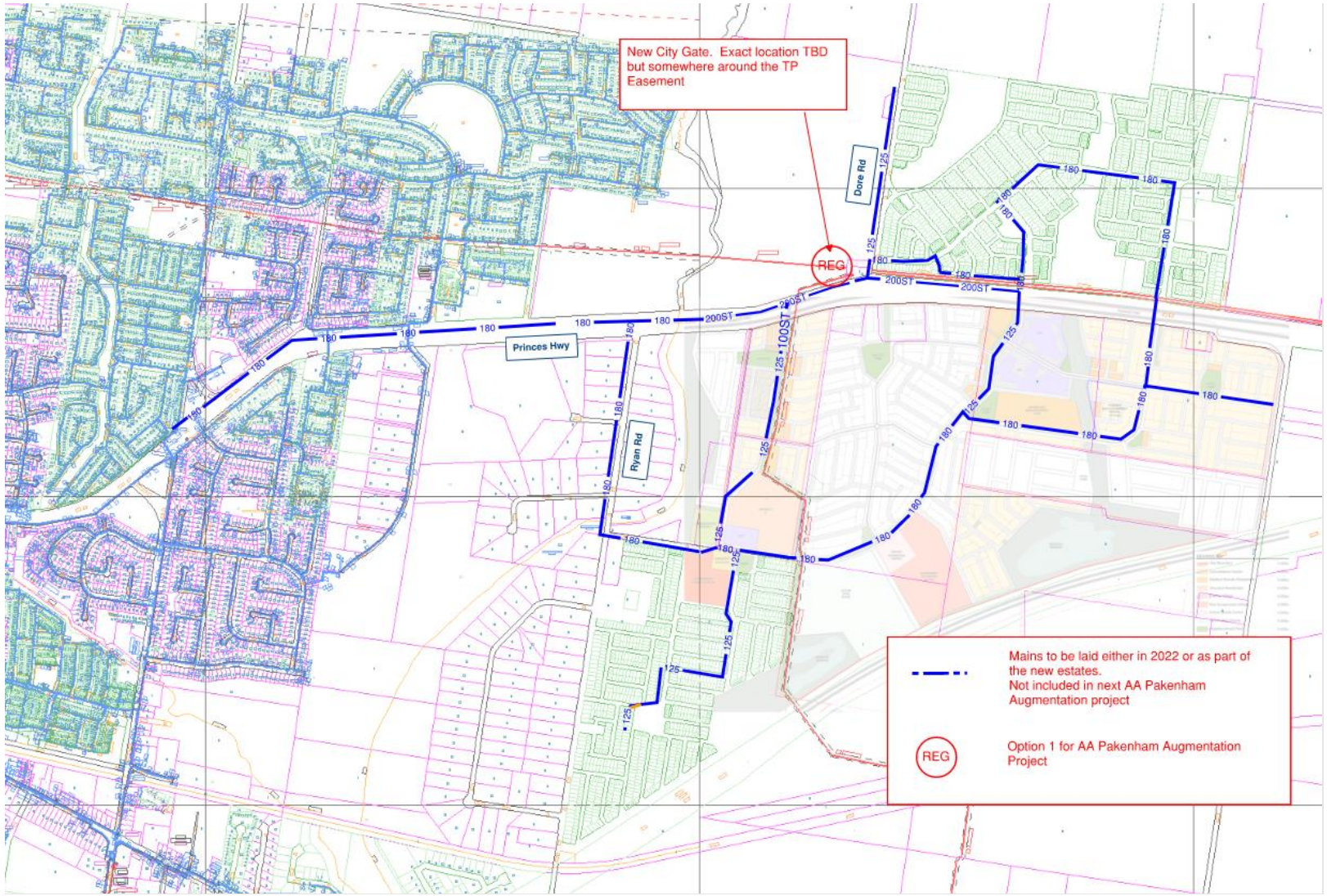
	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	-	-	Construct a new city gate	-	-	Construct a new city gate
Total	-	-	6,443	-	-	6,443

Appendix A – Asset location maps

A.1: Overview of Pakenham East PSP



A.2: Option 1 - Supply infrastructure and overview map



A.11 Somerville HP network augmentation

Project overview

Description of the problem / opportunity	This project is to address capacity shortfalls in Somerville and Pearcedale HP network, after winter testing in 2015 and 2019 highlighted the need for augmentation, which is required before winter 2025. An increase in gas capacity requirements has been forecasted based on historically observed usage, as well as population growth and planning schemes, published by the Mornington Peninsula Shire. Population growth, particularly in the Somerville township is expected to continue at a rate of 1.1% per year, and is driven by: • new estates beyond the boundaries of the neighboring Cranbourne and Frankston networks; and • the availability of land for development, coupled with the local council's strategic growth and improvement initiatives. This network currently supplies over 6,200 customers, including a single large customer at this network's fringe that can instantaneously draw significant capacity, with a potential to reduce the pipeline's operating pressure below the recommended minimum. In addition, this network has a single source of supply that is nearing its limit and is hence a single point of failure in the network. We expect that a combination of continued growth and instantaneous peak demand in this network will reduce pipeline pressure, reducing the ability to maintain a safe and reliable supply to customers. Augmentation of this network is required to maintain network pressures above the distribution supply point minimum specified in the Victorian Distribution System Code (Code). Failure to do so would be considered a breach of AGN's license condition.
Untreated risk	As per risk matrix = **Moderate**
Options considered	The following options were considered: • **Option 1 –** Install a new field regulator at Eramosa Road East ($4.0 million) • **Option 2 –** Upgrade existing regulator and duplicate 1.7km of existing mains in next AA and 0.9km in 2029 ($4.2 million) • **Option 3 –** Maintain status quo (zero upfront capex)
Proposed solution	The proposed solution is Option 1. This would address the following: • Improved security of supply as the existing network regulator would no longer be a single point of failure. • Deferring any need to upgrade the existing regulator as it approaches its design capacity limitations. • Provide a longer term solution where this newly installed regulator would meet any capacity requirements of neighbouring networks as they encroach towards the Somerville and Pearcedale HP network. This option reduces the loss of supply risk from high to low. The reduction of risk is an obligation under Australian Standard AS/NZS 2885 and AS/NZS 4645.

Estimated cost	The forecast direct cost during the next five-year period (2023/24 to 2027/28) is $4.0 million. The projects would be delivered across the period as set out below.

$'000 real 2021	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Somerville HP augmentation	-	3,996	-	-	-	**3,996**

Basis of costs	All costs in this business case are expressed in real unescalated dollars at June 2021 unless otherwise stated. Tables may not sum due to rounding.
Treated risk	As per risk matrix = **Low**

Background

The townships of Somerville, Pearcedale and Tyabb are located approximately 55 km to the south east of Melbourne CBD. These townships form part of the 40 townships within the Mornington Peninsula Shire, with Somerville being close proximity to the port of Hastings. While a large part of the land in Somerville's broader township is set aside for the port's special purpose use, the existing urban area has a mixture of small commercial, residential zoning for future development and new estate planning.

The township's existing natural gas network has a single supply point operating as close to MAOP as possible. This supply regulator feeds off the Dandenong to Crib Point transmission pipeline.

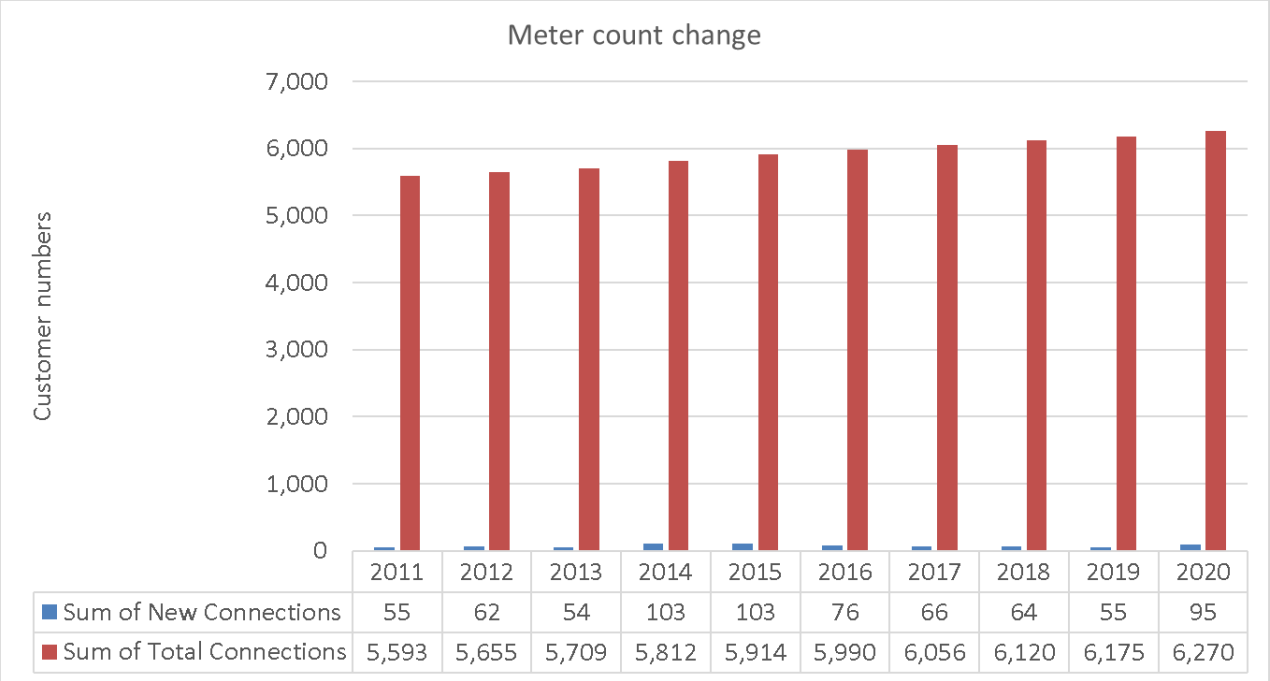
Impact of historical growth

In 2018, there were approximately 11,250 permanent residents in the broader Somerville area. The local council's township structure plan[32] indicates steady growth (population growth of 6.5%) over the period 2018 to 2033.

The number of historical meter connections have been observed as increasing at a rate of 1.0% to 1.5% per year. The total meter count for this network in 2020 was approximately 6,200. The following figure summarises historical meter growth for the period 2011 to 2020.

[32] Somerville Township Structure Plan (20 June 2019). A publication by the Mornington Peninsula Shire. Somerville-Township-Structure-Plan_Final_HighRes_18July2019-A8967553 (1).pdf

Somerville, Pearcedale and Tyabb historical meter growth over the period 2011 to 2020.



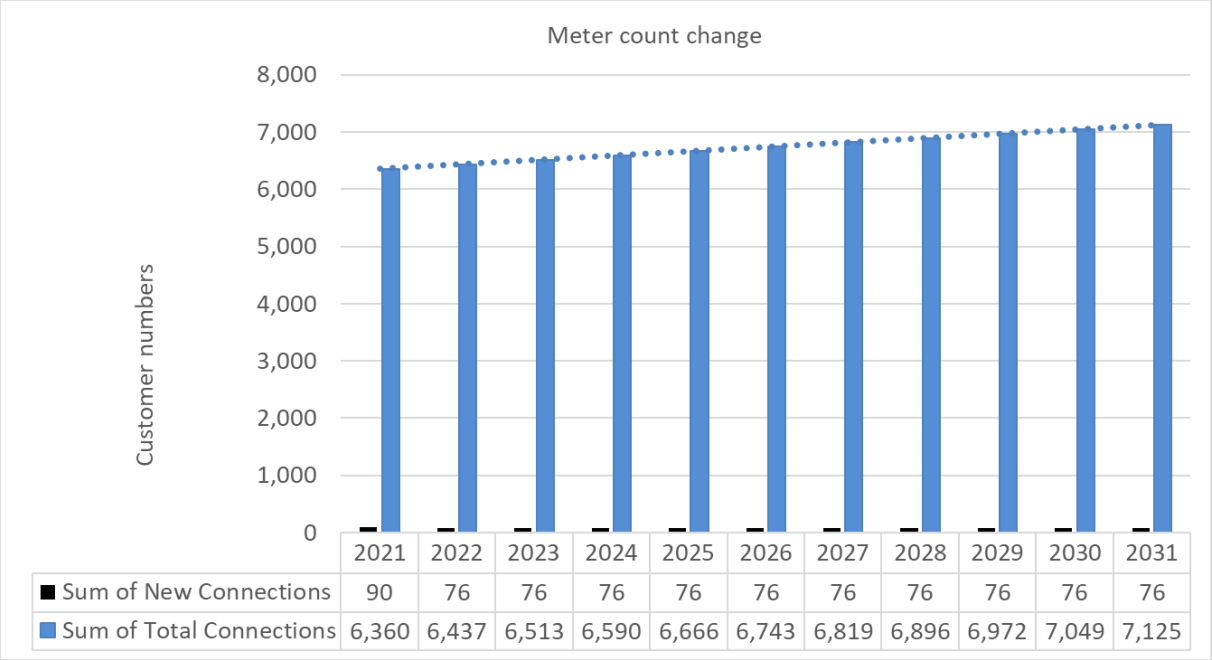
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Sum of New Connections	55	62	54	103	103	76	66	64	55	95
Sum of Total Connections	5,593	5,655	5,709	5,812	5,914	5,990	6,056	6,120	6,175	6,270

Network analysis shows that spare capacity is largely driven by the instantaneous demand of a large Tariff D customer, located in the Pearcedale network. Historically, this customer's demand has peaked at 628 scm/hr during the winter months when capacity requirements in the broader network are coincidentally also at their peak demand. It is hence prudent to consider this network's future capacity requirements under similar peak conditions, along with expected growth over the next regulatory period.

If the historical connection growth rate is used as a conservative estimate, the number of customer connections to the Somerville, Tyabb and Pearcedale networks within the next ten years is forecast to increase to 7,125 by 2031 (an increase of 855 customers). Beyond 2031, growth is expected to continue due to:

- townships within the Mornington peninsula being an attractive option for lifestyle living, while still being within working vicinity of Melbourne's central business district;
- the proximity from the larger neighbouring townships of Frankston and Cranbourne, driving growth of new estates beyond their boundaries, as this encroaches into Somerville; and
- the availability of land for development, coupled with the local council's strategic growth and improvement initiatives.

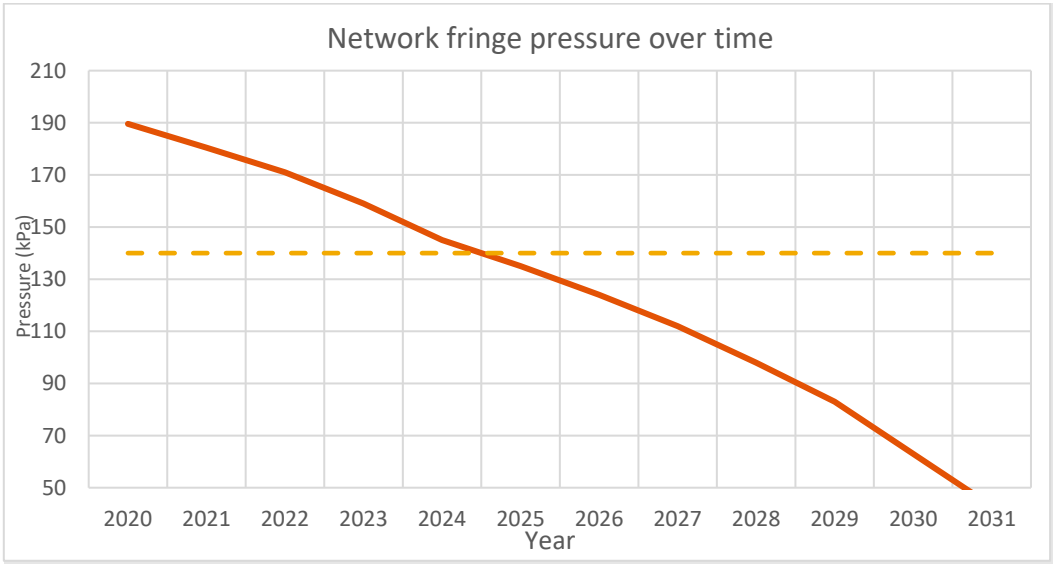
Somerville, Pearcedale and Tyabb forecast customer growth



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Sum of New Connections	90	76	76	76	76	76	76	76	76	76	76
Sum of Total Connections	6,360	6,437	6,513	6,590	6,666	6,743	6,819	6,896	6,972	7,049	7,125

If the ten-year average new meter connection rate of 76 per year continues, we estimate pressures of this network will reduce below 140 kPa before CY 25. If pressures continue to fall, it has an impact on the downstream pressure at the customers' gas meter and gas appliances, and means we may not be able to supply gas to each customer's premises at the minimum level required to fuel appliances. Substandard pressures can result in gas appliances becoming inoperable and potentially dangerous.

Estimated impact on pressures at the fringe of the Pearcedale high pressure network without augmentation



Future growth

There is evidence to suggest future growth in connections will continue at a similar rate of 1.1% per year compared to historical growth. The Somerville township structure plan[33]

[33] Somerville Township Structure Plan (20 June 2019). A publication by the Mornington Peninsula Shire, available at: Somerville-Township-Structure-Plan_Final_HighRes_18July2019-A8967553 (1).pdf.

published by the council of the Mornington Peninsula Shire has outlined a broad and diverse range of projects to continue attracting residents, along with a range of retail, commercial and industrial customers. The objectives set by this plan encompass land availability and housing affordability to meet the broader township's current and future community needs. This plan outlines projects for the enhancement of the town centre, as well as upgrades to infrastructure, recreation and community services.

Specific projects include:

- engaging developers and other relevant agencies to deliver more housing stock within the township to provide for the needs of a growing population. This would making housing affordability more attractive to investors and first home buyers;
- a large redevelopment of Somerville Plaza and Somerville Central;
- engaging with local businesses to support long term economic activity through clustering, promotion and various business support programs;
- engaging with Public Transport Victoria (PTV) for additional public transport options to local community services, and for reliable transportation to the larger neighbouring townships of Frankston and Cranbourne; and
- supporting the Baxter Railway electrification project to increase railway capacity between Somerville and Hastings.

Risk assessment

The risk identified for the natural gas distribution network in Somerville, Tyabb and Pearcedale is that new meter connections, coupled with instantaneous Tariff D customer demand at the fringe will cause network pressures to drop below acceptable pressure, leading to substandard supply or loss of supply to up to 6,000 customers. This may lead to customers' gas appliances becoming inoperable or damaged in certain circumstances.

The primary consequence category affected by this risk is operations, as a pressure drop can cause outages to >1,000 customers, thereby carrying a significant consequence rating under the risk matrix.

Given load growth is ongoing, if the risk is left untreated the likelihood of a pressure drop impacting >1,000 customers is rated occasional (every couple of years), however the frequency of supply interruptions will likely increase the longer the load growth risk is not addressed.

Any significant customer outage would then give rise to a moderate reputational and compliance risk. While there is a moderate health and safety risk posed by falling delivery pressure, safety is not the primary driver of investment in this instance.

The untreated risk rating is presented below.

Loss of supply risk in Somerville region – Untreated risk

Untreated risk	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Remote	Rare	Occasional	Rare	Occasional	Occasional	Occasional	Moderate
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Moderate	Negligible	Moderate	Negligible	Moderate	Moderate	Low	

Options considered

The following options have been identified to address the risk associated with capacity and security of supply issues outlined above:

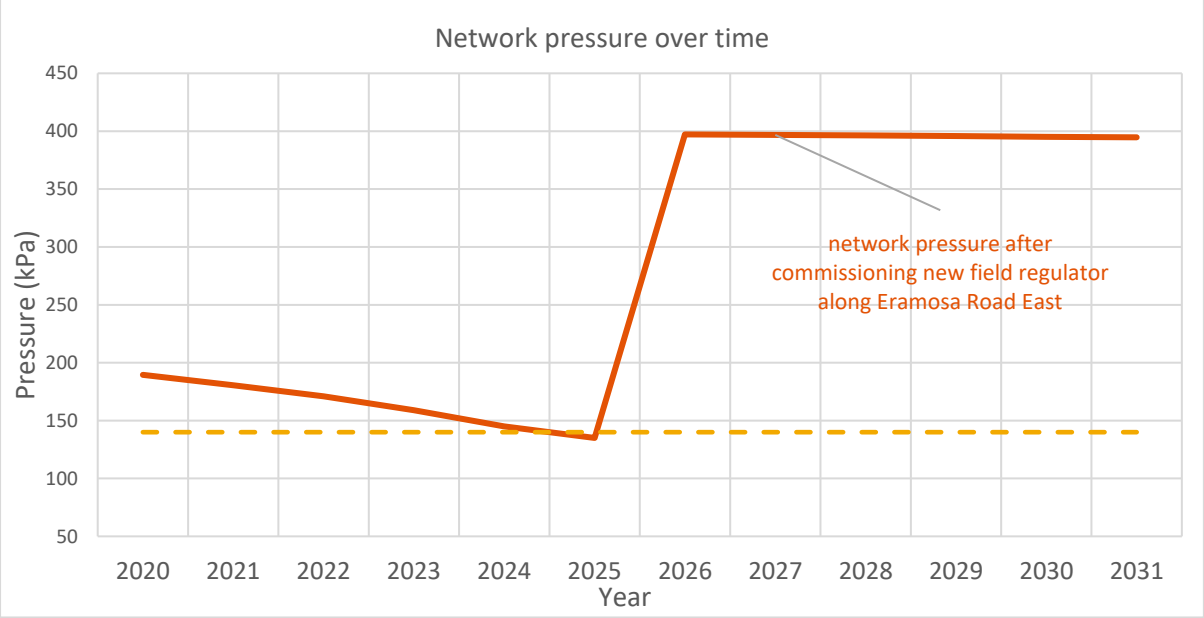
- **Option 1** – New field regulator at Eramosa Road East

- **Option 2** – Duplication of 1.7km of existing mains, upgrade existing regulator and further 900m of duplication in 2030
- **Option 3** – Maintain status quo, take no action

Option 1 - New field regulator at Eramosa Road East

Option 1 entails the construction and commissioning of new field regulator at Eramosa Road East, within the vicinity of the intersection of the existing 300 mm diameter transmission main and 150mm diameter S7 main. The effect of this new regulator (set pressure of 450 kPa) is shown below.

Pressure at the network fringe over time with a new field regulator along Eramosa Road East



Installation of this regulator will have a significant improvement on network pressure beyond 2031. Under current network growth forecasts, this network's existing supply regulator (P4-018) has sufficient capacity up to year 2027/28, however, by installing the new regulator at Eramosa East Road in 2025, the distribution network's capacity as well as the existing regulator's capacity life is extended.

The newly installed regulator would be the primary supply to the majority of network load. The load distribution between the existing and proposed new regulator is driven by:

- the network growing in a northern direction, due to the availability of land for development of new estates;
- proximity to the large neighbouring townships of Frankston and Cranbourne; and
- the existing township regulator being further away from higher density growth areas (existing regulator located in the southern corridor of this network).

Option 1 cost assessment

The direct cost of Option 1 is $4.0 million.

Cost estimate – Option 1, $'000 real 2021

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	Construct a new field regulator		-	-	-	Construct a New Field Regulator
Total	**-**	**3,996**	**-**	**-**	**-**	**3,996**

Option 1 risk assessment

Option 1 would reduce the loss of supply (operational) risk from moderate to low. The work would reduce the likelihood of a pressure drop impacting >1,000 people from occasional to remote. The risk consequence rating remains unchanged. Option 1 reduces the likelihood of a pressure drop leading to compliance or reputational impacts from unlikely to rare, reducing the risk from moderate to low. It also reduces the likelihood of a major safety incident from remote to rare.

Loss of supply risk in Somerville region – Option 1

Option 1	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Remote	Remote	Rare	Rare	Rare	Remote	Low
Consequence	Major	Minor	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Low	Negligible	Low	Negligible	Low	Low	Negligible	

Option 1 improves security of supply to the network's current and forecast growth, as it provides a second source of supply to the distribution network.

While Option 1 achieves the same risk rating as Option 2, the solution under Option 1 provides this risk reduction at a lower overall cost.

Option 2 – Upgrade of existing regulator and duplication of trunk mains

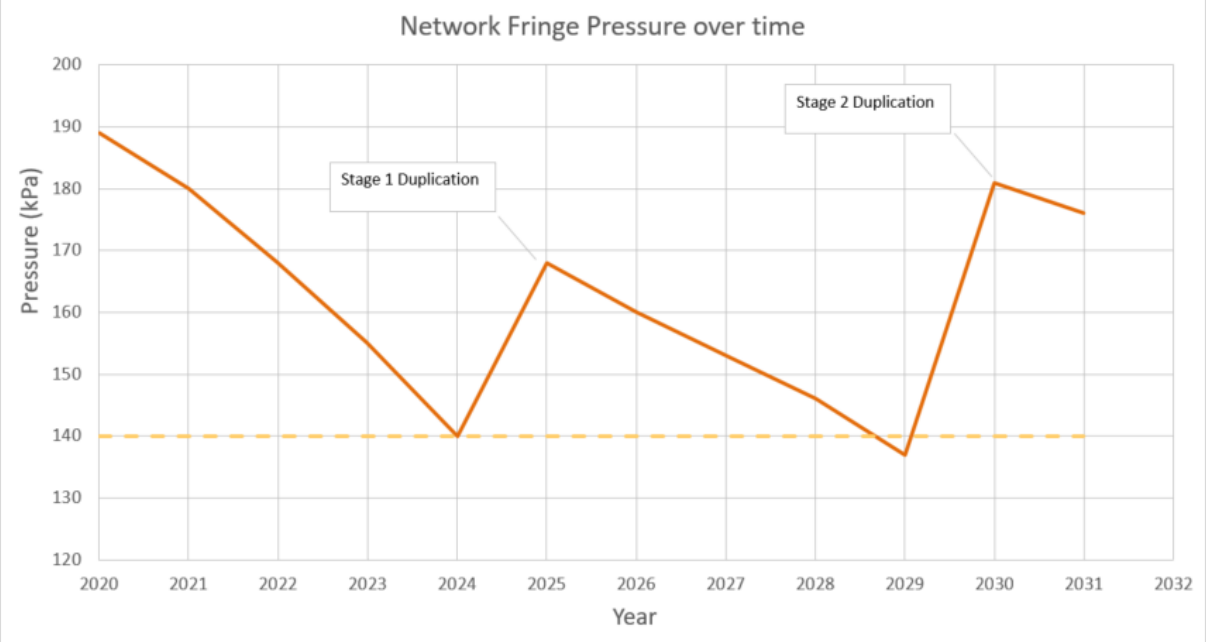
Under this option, we will lay a new DN280 PE main along Jones road from Mornington Tyabb Road to Pottery Road. This main will be 1,700 m in length and installed prior to Winter 2025. Option 2 prolongs the capacity life for the network but is not as effective as Option 1. It can only support the network to around 2029 then a further reinforcement of 900m of 280mm in Jones Rd will be required.

Option 2 will also require upgrade of existing regulator station at Tyabb around 2028. This is because this regulator station will hit its design capacity and work will be required in order to ensure it can keep supplying the network.

Option 2 prolongs the capacity life for the network but is not as effective as Option 1 in the long term. The figure below shows pressure at the fringe over the years with the proposed works for Option 2.

The key difference between Option 1 and Option 2 is That Option 2 makes use of the existing regulator but then has to augment the existing network to deliver the gas from the regulator to the fringe. Option 1 introduces a new source on the other side of the network more central to the lower fringe pressures and where fortunately the existing Transmission pipeline and distribution mains cross so there is virtually no main laying required.

Pressure at the fringe of the network over time after the completion of stages 1 and 2 for Option 2



Option 2 cost assessment

The direct cost of this option, including the work in 2029/30 is $4.2 million. If we look at the two options in terms of NPV we get a cost for Option 1 of $3.9 million and for Option 2 of $3.885 million. These two costs are very similar, however, the option to build a new regulator gives substantially more capacity in the long term.

Cost estimate – Option 2, $'000 real 2021

	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	Total
Scope	-	Install 1.7 km DN280 PE main	-	-	Upgrade the existing regulator station	-	Install 0.9 km DN280 PE main	Install km DN280 PE main and upgrade the existing regulator station
Material	-	1,601	-	-	-	-	848	**2,449**
Labour	-	284	-	-	-	-	150	**434**
Regulator facility upgrade	-	-	-	-	1,312	-	-	**1,312**
Total	**-**	**1,885**	**-**	**-**	**1,312**	**-**	**998**	**4,195**

Option 2 risk assessment

Option 2 addresses the pressure drop issue and results in the same risk outcomes as the primary solution (Option 1). However, it achieves this at a higher cost than Option 1.

Loss of supply risk in Somerville region – Option 2

Option 2	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Rare	Remote	Rare	Rare	Rare	Remote	Low
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Low	Negligible	Low	Negligible	Low	Low	Negligible	

Unlike Option 1, the additional security of supply benefits provided by Option 1 will not be achieved with Option 2, as there will remain only one supply connection into the existing distribution network.

Option 3 – Maintain status quo

Under this option, AGN will continue to accept network connections (as it is required to do under the Code) but do nothing to address the effect on the network design minimum pressures or the single point of failure issue.

Option 3 cost assessment

The benefit of this option is that it does not give rise to any upfront capital costs. This option would however result in AGN contravening its regulatory obligation under the Gas Distribution Code to use all reasonable endeavours to

> *"…ensure the minimum pressure is maintained at the distribution supply point".*

As a result the system design minimum pressures will be breached by an increasing amount and with increasing frequency each year, impacting an increasing number of customers due to new estate growth, coupled with instantaneous demand customer gas use in this network.

While it is not possible to quantify the reactive costs incurred at this time, from previous experience, a project conducted reactively is around 3.2 times more expensive than one conducted proactively.[34] This assumption is consistent with the commonly accepted asset management principle that reactive asset maintenance can be around two to five times higher than proactive planned maintenance.[35]

Option 3 risk assessment

Under Option 3, the risk level would remain the same as the untreated risk as there are no controls in place to mitigate the pressure drop risk (other than not connecting new customers, which is not a viable option).

Loss of supply risk in Somerville region – Option 3

Option 3	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Remote	Rare	Occasional	Rare	Occasional	Occasional	Occasional	Moderate
Consequence	Major	Minimal	Significant	Minimal	Significant	Significant	Minor	
Risk Level	Moderate	Negligible	Moderate	Negligible	Moderate	Moderate	Low	

Option 3 is therefore not consistent with our risk management framework, which requires action must be taken to reduce risks to low or ALARP. A moderate rating for operations in this context is not considered ALARP.

Summary of costs and benefits

The following table presents a summary of how each option compares in terms of the estimated cost, the residual risk rating, and alignment with AGN's objectives.

[34] For example, this is typically due to the additional premiums for faster acquisition of long lead time materials, emergency response, labour costs, additional traffic management/permit costs, resource scheduling, etc.
[35] Marshall Institute, Omega engineering, ARMS reliability.

Comparison of options

Option	Estimated cost ($ million)	Treated residual risk rating	Alignment with AGN vision objectives	NPV ($ million)
Option 1	4.0	Low	Aligns with *Delivering for Customers* and *Sustainably Cost Efficient*	3.879
Option 2	4.2	Low	Aligns with *Delivering for Customers*, but does not align with our objective to be *Sustainably Cost Efficient*	3.885
Option 3	Zero upfront capex	Moderate – non ALARP	Does not align with *Delivering for Customers* or *Sustainably Cost Efficient*	N/A

Recommended option

Option 1, installing a new new field regulator at Eramosa Road East, is the recommended option.

Why is the recommended option prudent?

Option 1 is the most prudent option because:

- Option 1 improves security of supply to the network;
- Option 1 would meet this network's capacity requirements over the 15+ year horizon, and will support lower overall costs of delivering services which is sustainably cost efficient, and in the long-term interests of customers;
- Option 2 requires upgrade of existing regulator station and laying of 1,700 m of mains in the next Access Arrangement period and a further 900 m just after that, making it more expensive than Option 1;
- Option 2 offers significantly less capacity compared to Option 1; and
- Option 3 is not viable since this is not consistent with APA risk management framework, which requires action must be taken to reduce any high risks to low or ALARP.

Estimating efficient costs

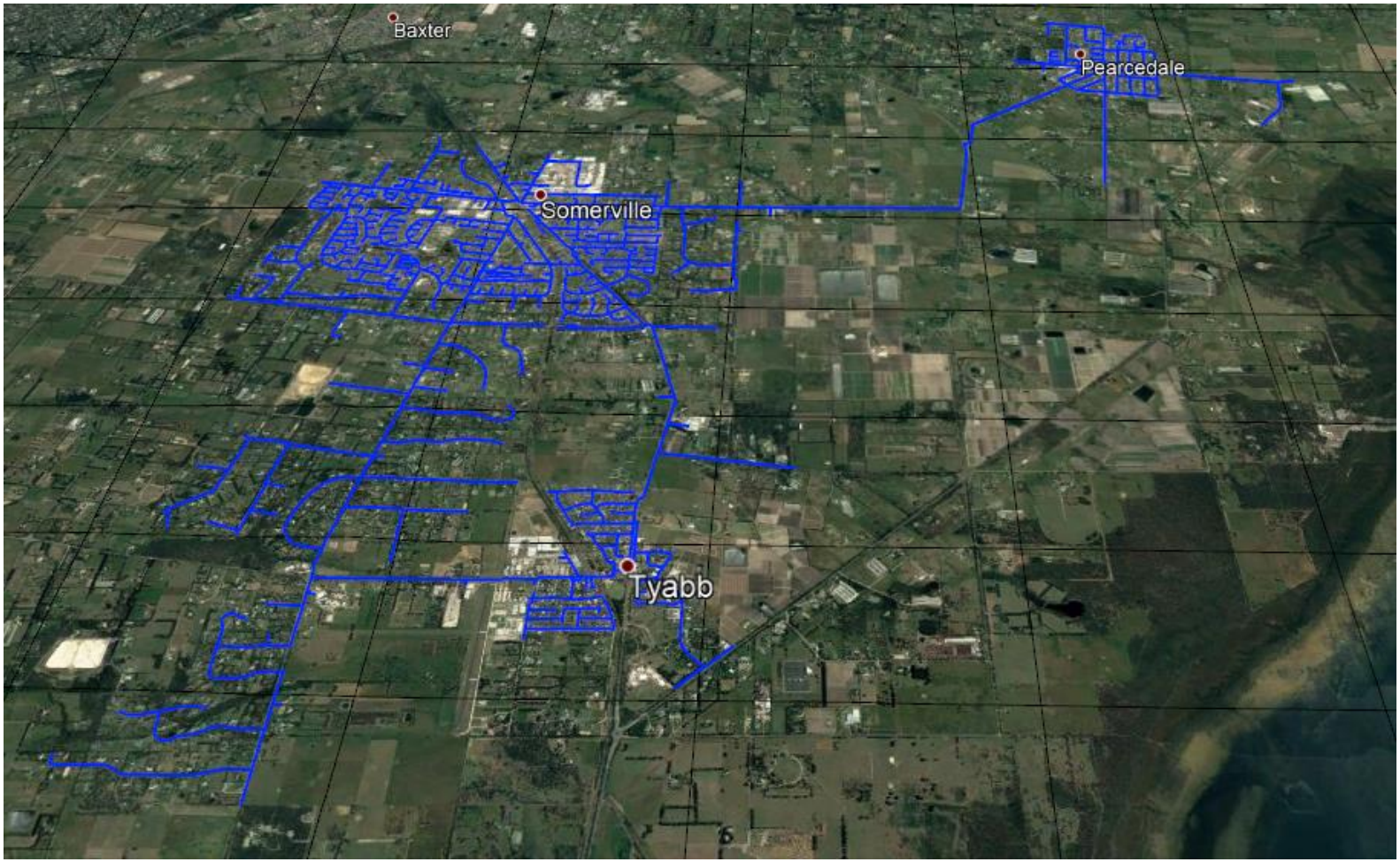
The forecast cost breakdown is shown in the table below.

Cost estimate ($'000 real 2021)

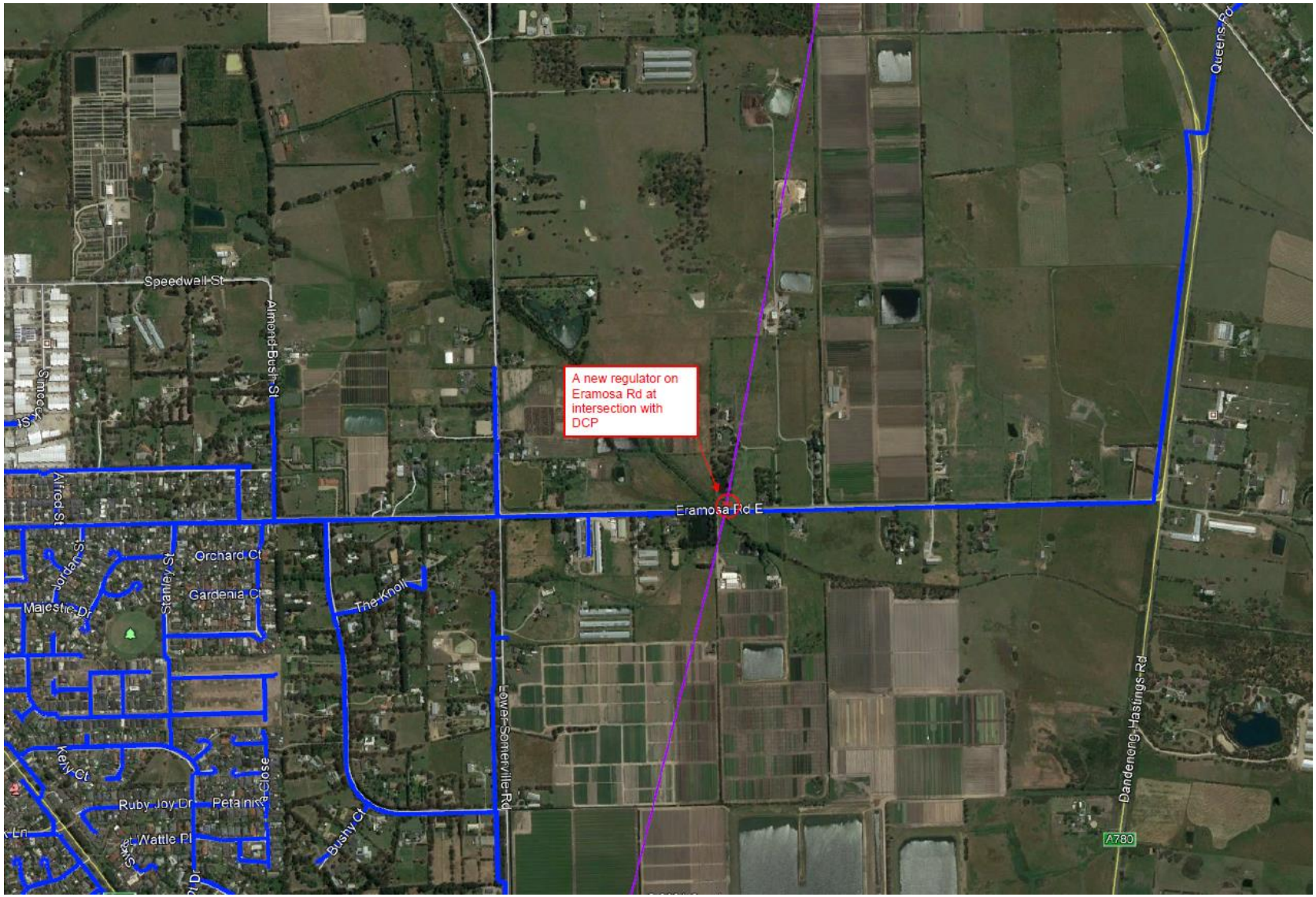
	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Scope	Construct a new field regulator		-	-	-	Construct a new field regulator
Total	-	3,996	-	-	-	**3,996**

Appendix A – Asset location maps

A.1: Pipeline assets for the Somerville, Tyabb and Pearcedale regions



A.5: Proposed location of the new TP-HP regulator (Option 1) along Eramosa East Road



A.6: Option 2 trunk duplication map