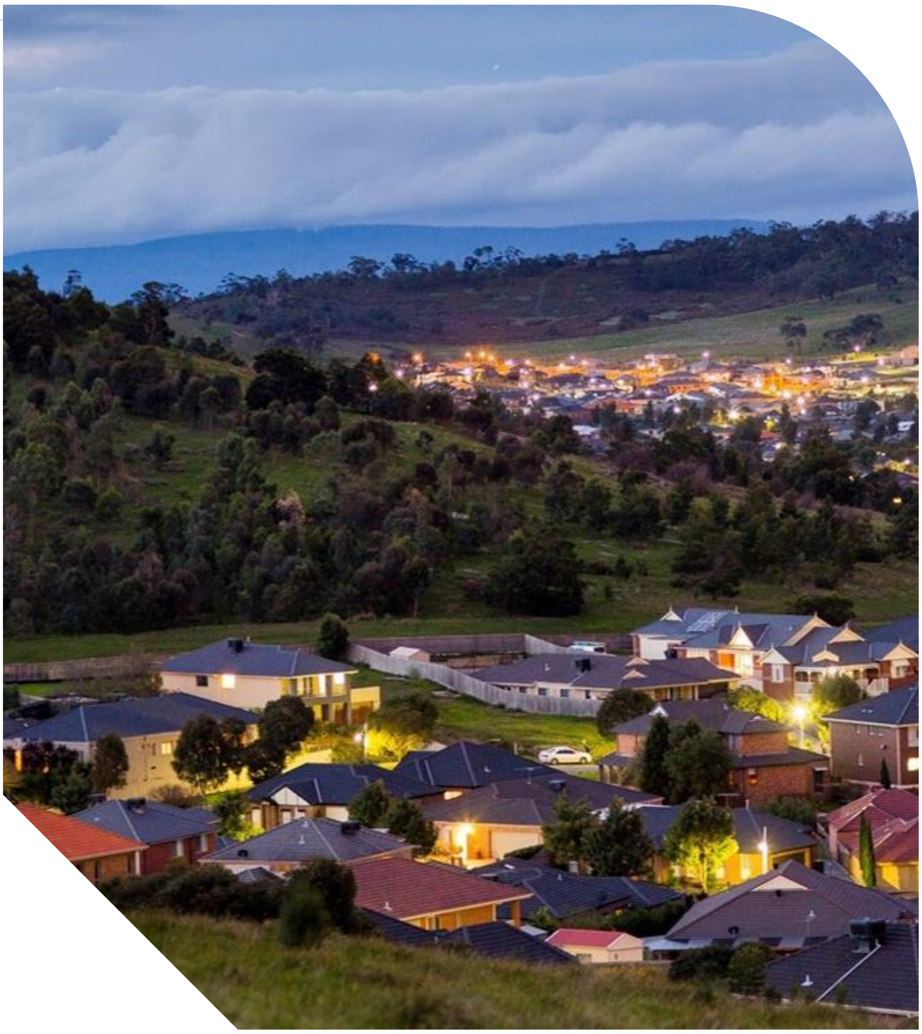
Gas Network

Mains & Services Strategy

PUBLIC

Monday, 23 May 2022

Document number:	AMS 30-52
Issue number:	2.0
Status:	Approved
Approver:	Stuart Dick
Date of approval:	17 December 2021



ISSUE / AMENDMENT STATUS

Issue Number	Date	Description	Author	Approved by
1.0	Nov 2016	Document Finalised	L Burridge	J Dyer
2.0	Dec 2021	Updated for GAAR 2024-28	D Gupta	S Dick

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Executive Summary

This document outlines the strategy for the replacement of gas distribution mains and services relevant to AusNet Service for the 2024 to 2028 access arrangement period.

The majority (99%) of our distribution network operates between 1kPa-515kPa and is comprised primarily of High Pressure (140-515kPa) polyethylene mains. The average age of the network is 23.9 years with the total length of pipe being 12,376km, servicing 750,000 customers. The distribution network spans from the inner Melbourne metropolitan area into Western Victoria.

The replacement programs contained within this strategy include the low, medium and high pressure replacement programs, and the reactive replacement of mains and services.

Safety is the main driver of the mains and services replacement program. The mains and services replacement program can manage risks associated with aged and compromised mains and services. Identifying and prioritising mains and services for replacement enables effective management of AusNet Services' risk profile in the most economically efficient manner.

The mains and services strategy aligns with the gas network objectives:

- *Maintain network safety in accordance with the Gas Safety Case:* The prioritisation and removal of mains and services in high leakage areas maintains the risk level of the distribution network.
- *Maintain top quartile operating efficiency:* The removal of poor performing mains minimise the operational cost associated with high maintenance activities including leak repairs, leakage survey, as well as dealing with poor supply availability.
- *Undertake prudent and sustainable network investment:* Identifying and prioritising mains for replacement enables effective and economically efficient management of AusNet Services' risk and expenditure profiles.
- *Delivery of services valued by our customers:* Through the removal of aged mains and services associated with leaks and blockages that consequently cause consumer outages. The availability of high pressure gas provides the customer with greater reliability to meet customer expectations.
- *Simplify and remove costs by investing in technology and automation:* Reducing the number of leaks will reduce ad hoc operational costs.
- *Provide sector leading customer experiences by improving systems, process and communication:* An upgraded gas distribution network enables HP gas supply and improved reliability, therefore improving the customer experience.
- *Secure future of gas with increased utilisation and renewable gas options:* An upgraded gas distribution network to polyethylene mains enables the future transition to hydrogen.

The proposed Low Pressure (LP) Mains Replacement (LPMR) Program includes a total of 273.3kms across the 2024-2028 access arrangement period. The Medium Pressure (MP) Mains Replacement Program (MPMR) includes a total of 94.5km over the same 5 year period. This program targets the replacement of unprotected steel networks and first generation polyethylene mains. From experience gathered with the maintenance of MP Mains, the commencement of a High Pressure (HP) Mains Replacement Program is also proposed. This is aimed at eliminating the worst performing and oldest sections of the HP Network prioritising the targeted replacement of first generation polyethylene mains. **Error! Reference source not found.** below provides the following capital expenditure profile for the mains and services strategy.

Table 1: Planned Mains and Services Capex Summary ($2022, $'000)

PROGRAM		2023-24	2024-25	2025-26	2026-27	2027-28	2024-28 TOTAL
		[C.I.C]					

1. Document Overview

1.1. Purpose

This document articulates AusNet Services' approach to the management of its gas distribution mains and services. The document is for use by:

- Internal staff and senior management; and
- Regulators – Economic, Technical and Safety.

The Gas Distribution Mains and Service Strategy is one of several plant strategies developed and maintained for the management of AusNet Services' Gas Distribution Network. This strategy has the following objectives:

- Articulate the key areas of focus in relation to asset management, key risks, key programs (CAPEX), costs and service standard outcomes for the asset group.
- Define the linkages of the asset group to the overarching asset management strategy and underpinning asset management plan.

1.2. Scope

This strategy covers all distribution gas mains and services that operate within AusNet Services' gas network. These assets operate at pressure ranges from 1.4kPa to 1050kPa. It is inclusive of the main and service pipework from the main to the service valve. Assets are located in the western region of metropolitan and rural Victoria.

This strategy relates only to AusNet Services' capital requirements in relation to distribution mains and services and excludes operational expenditure requirements.

1.3. Asset Management Framework

Error! Reference source not found. below provides an overview of AusNet Services asset management framework. This framework is centred around the objective to operate the network in top quartile of efficiency benchmarks with an aim to care for customers and strive to make energy more affordable.

The Gas asset management strategy plays a key role in ensuring alignment between asset management objectives, corporate objectives, and stakeholder requirement. This document is one of the strategies providing visibility on network performance, issues, risks, and investment required to support delivery of safe and reliable service and achieve the long-term objectives of the gas distribution network.

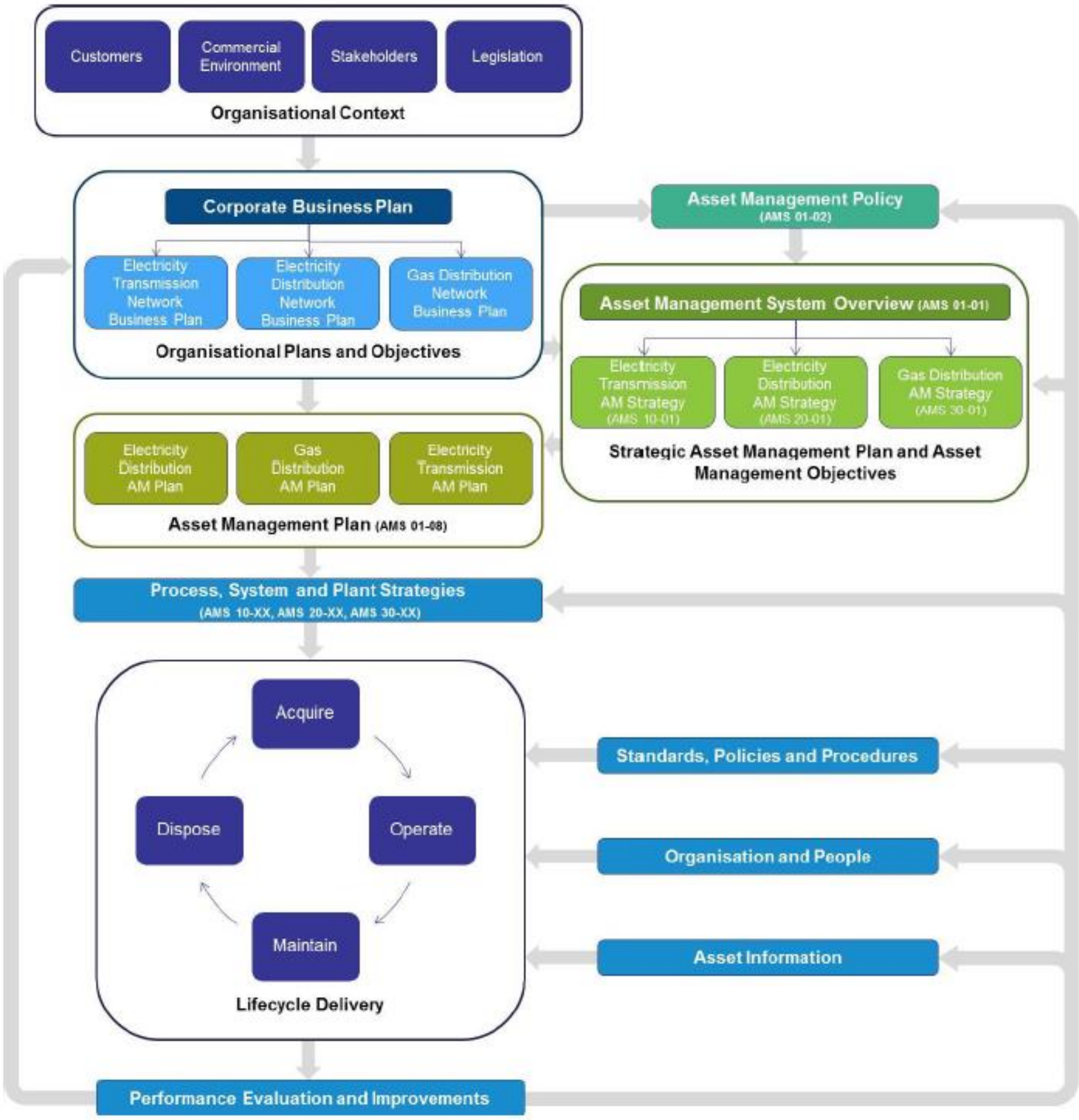


Figure 1: Ausnet Services Asset Management Framework

2. Alignment with Drivers

AusNet Services' purpose statement is "Connecting communities with energy and to accelerate a sustainable future". This statement places the customer (as individuals and communities) at the forefront as a business driver and acknowledges the critical relationship with their energy supply and usage. The following diagrams shows that Customers are a key theme linking the Corporate Business Strategy with the Gas Network Vision and Gas Network Objectives, which influence the key plant strategies forming the basis of the regulatory submission.

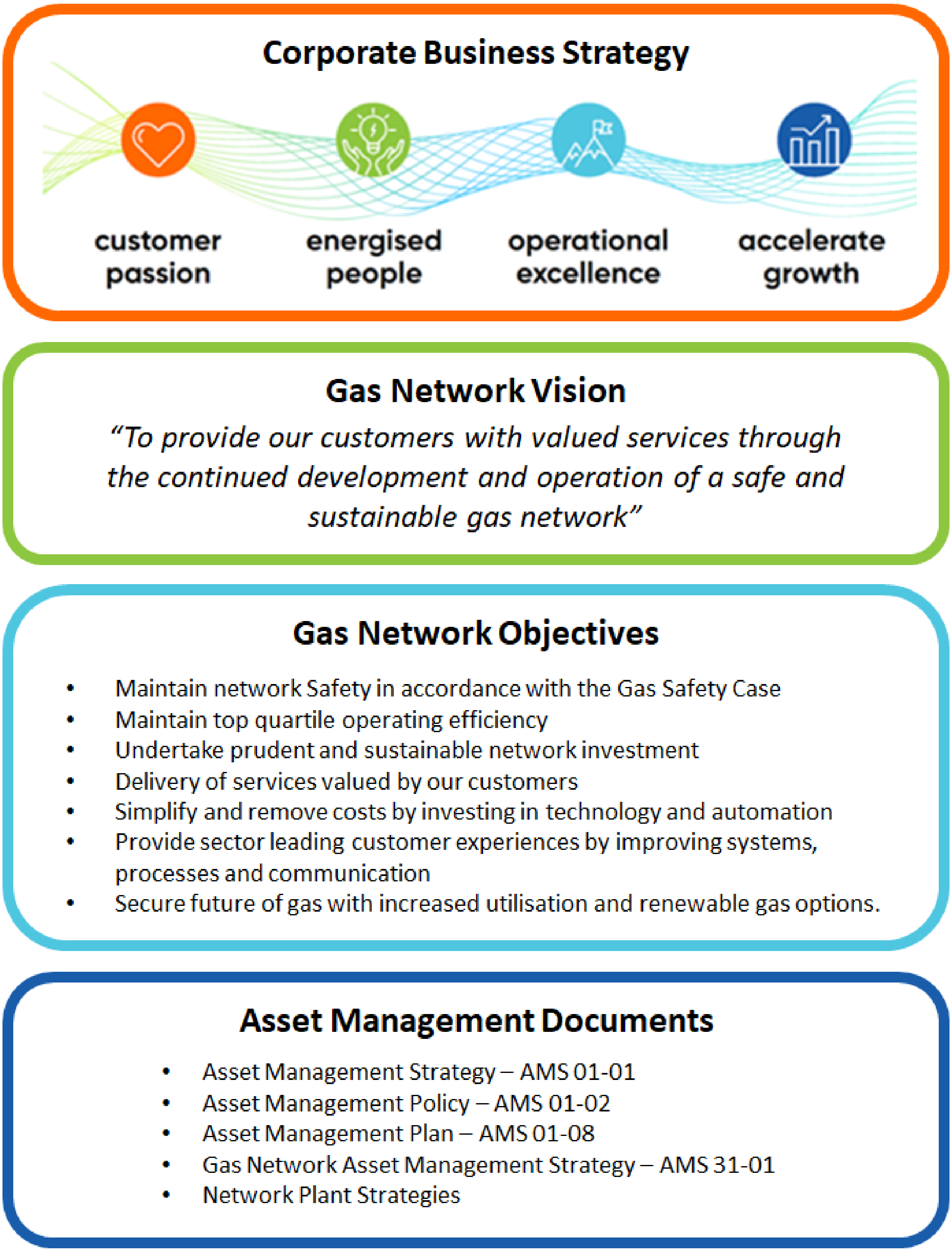


Figure 2: The Business Strategy, Network Vision and Objectives all centre around our customers

The Gas Network Objectives align with the four Corporate Business Objectives as shown below:

Maintain network Safety in accordance with the Gas Safety Case.

Maintaining network safety supports our commitment to "Mission Zero", ensuring our people go home safety at the end of the day. This is one of the strategic priorities of the "energised people" corporate objective.

Maintain top quartile operating efficiency.

AusNet Services aspires to operate all three of its core networks in the top quartile of efficiency benchmarks. This aligns with the "operational excellence" corporate objective.

Undertake prudent and sustainable network investment.

This network objective supports AusNet Services' obligation to undertake prudent and sustainable network investment, as defined in the National Gas Rules and Gas Distribution System Code. This in turn aligns with the "operational excellence" corporate objective.

Delivery of valued services to our customers.

AusNet Services strives to better understand our customers (their needs and behaviours) in order to deliver the services they value. This aligns with the "customer passion" corporate objective.

Simplify and remove costs by investing in technology and automation.

By working more efficiently, AusNet Services improves its "operational excellence" and provides better value for customers.

Provide sector leading customer experiences by improving systems, process and communication.

Similarly, improving how we work increases efficiency, thereby improving "operational excellence".

Secure future of gas with increased utilisation and renewable gas options.

Exploration of renewable gas options and the role gas will play in the energy ecosystem of the future will support the "accelerate growth" corporate objective.

3. Alignment with Network Objectives

This section provides an overview of the alignment of the programs proposed in the Mains & Service Strategy with AusNet Services' gas network objectives which govern how the network is operated and maintained.

Maintain network safety in accordance with the Gas Safety Case;

The replacement of poor performing and compromised mains reduces leaks across the network, and decreases the risk of fire or explosion caused by a leak. Leakage reduction will also reduce the risk exposure to our customers.

Maintain top quartile operating efficiency;

The replacement of poor performing and compromised mains removes the deteriorated assets from the network, and prevents the associated operational expenditure cost compared to other operating networks.

Undertake prudent and sustainable network investment;

This strategy supports an improvement to network reliability and reduces operating expenditure. The following are relevant key drivers of the mains and services replacement programs that relate to a prudent and sustainable network investment:

- reduction to the risk of leaks;
- reduction of blockages;
- improved system capacity and reliability;
- ensure continuous supply; and
- prevention of OPEX increases.

Deliver valued services to customers;

The mains replacement program provides valued service to our customers as demonstrated by improved reliability, a decreased risk profile to the community with the reduction with leaking pipes, and allows customers the options to diversify their appliances.

- **Safety – Reducing risk of gas leaks:** Gas pipes with the highest fracture and leakage incident rate are targeted for replacement. Gas leaking from a pipe has the potential to cause death or injury to the public and property damage. The mains and services replacement program decreases the risk to the community associated with leaking pipes.
- **Enhanced Customer Service to consumers (increased system capacity):** HP upgrades will provide consumers with the option to increase gas metering pressure and a substantial increase in system capacity. The benefits to the customers are the diversification of products that can be managed with an instantaneous load.

Simplify and remove costs by investing in technology and automation

Reducing the number of leaks will reduce ad hoc operational costs and the reactive mains replacement program. Upgrading the LP and MP networks to HP reduces the physical number of District Regulators and their respective maintenance and inspection costs. Reducing district regulators also lowers the overall system risk, as the risk of them failing is removed. In the proposed program thirty nine (39) district regulators will be eliminated with no new addition of any pressure regulator stations.

Provide sector leading customer experiences by improving systems, process and communication

An upgraded gas distribution network enables HP gas supply and improved reliability, therefore improving the customer experience. It will also reduce future OPEX due to required maintenance.

Secure future of gas with increased utilisation and renewable gas options

An upgraded gas distribution network to polyethylene mains enables the future transition to hydrogen; therefore reducing the carbon footprint.

4. Asset Overview

The gas distribution network in accordance with AS/NZS 4645.1 encompasses all facilities between the outlets of city gates, supply points, or equivalent and the outlet of the consumer's meter assemblies. The gas distribution network consists of 12,376[1] km of distribution mains and services operating at high, medium and low pressures.

The majority of the distribution system operates at HP with a minimum allowable pressure of 140kPa to a maximum of 515kPa. Pressures are regulated through major facilities known as 'City Gates' that regulate supply from the principal transmission system to AusNet Services' distribution network.

The MP distribution systems operate between 15kPa to 140kPa, with Field regulators regulating gas supply from AusNet Services' HP networks. The LP distribution systems operate up to 7kPa with District Regulators regulating gas supply for AusNet Services high and medium pressure networks.

The network has been constructed over a period of more than 100 years and consequently consists of a variety of pipe materials. Cast iron and steel were predominantly used until the introduction of polyvinyl chloride (PVC) for LP like-for-like replacement and polyethylene for HP networks in the late 1970's. Today, PVC is no longer installed in the network leaving high density polyethylene as the preferred pipe material.

The type of material dictates the maximum operating pressure of the network. Since cast iron can only be operated at medium and low pressures compared to polyethylene, the continual replacement of cast iron and unprotected steel mains with polyethylene pipe means that the capacity and integrity of the network is maintained and improved, helping to offset some of the natural deterioration of the network.

4.1. Pressure Classification

The distribution system transports gas from the transmission network (>1050 kPa) via three main pressure tiers to consumer service lines. The pressure tiers are referred to as low, medium, and high with a fourth minority pressure tier known as 'High Pressure 2'. High Pressure 2 accounts for less than <1% of the total distribution network. Table 2 and Figure 3 show the distribution of mains assets by pressure. Consumer service lines (services) operate at pressures up to 515kPa. They are predominately constructed from polyethylene with a small percentage constructed in steel, aged wrought iron and PVC.

Table 1: Mains Summary by Pressure

PRESSURE	OPERATING PRESSURE	LENGTH	PROPORTION
Low Pressure (LP)	Up to 3kPa	361 km	2.92%
Medium Pressure (MP)	15 kPa – 140 kPa	615 km	4.97%
High Pressure (HP)	140 kPa – 515 kPa	11,302 km	91.32%
High Pressure (HP2)	515 kPa – 1050 kPa	97 km	0.79%
Total		12,376 km	100.00%

[1] Mains asset data based on GRR (Gas Regulatory Report) extracted December 2021.

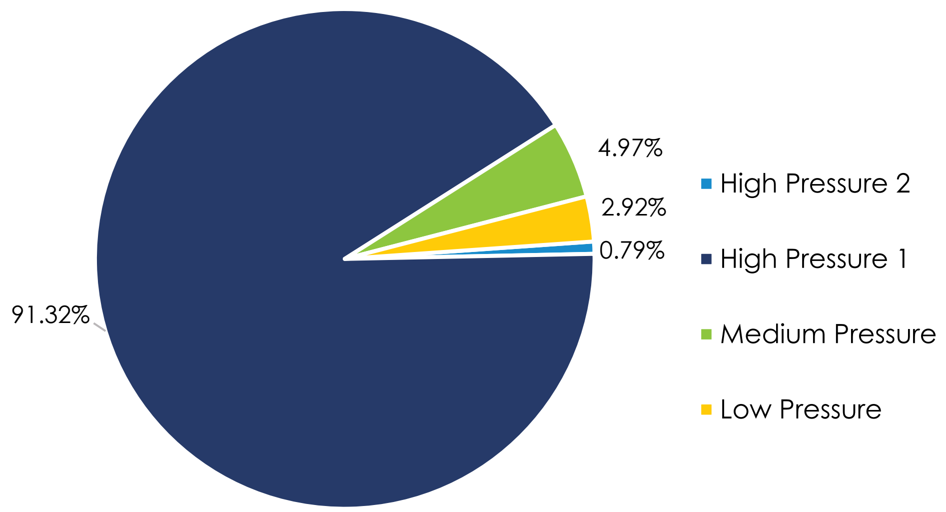


Figure 3: Proportion of Mains by Pressure

AusNet Services' distribution pipeline network length has grown at an average rate of 2.7% since 2015 as shown in Figure 4 below. This is due to the development in growth corridors around Western Victorian.

The gas network contains some of the fastest growing urban and regional locations. Within the Melbourne metropolitan area, the number of occupied dwellings in Wyndham and Melton have grown at 30% and 23% respectively over the past five years. In regional Victoria, AusNet Services covers major population centres such as Geelong, Ballarat and Bendigo. Additionally, regional Local Government Areas experiencing strong growth such as Moorabool, Golden Plains, Macedon Ranges and Surf Coast are all located in AusNet Services network. Customer numbers are expected to grow by approximately 2.1%[2] per annum over the next five years. As growth in customer numbers continue, the length of mains on the distribution network is expected to grow at a similar rate.

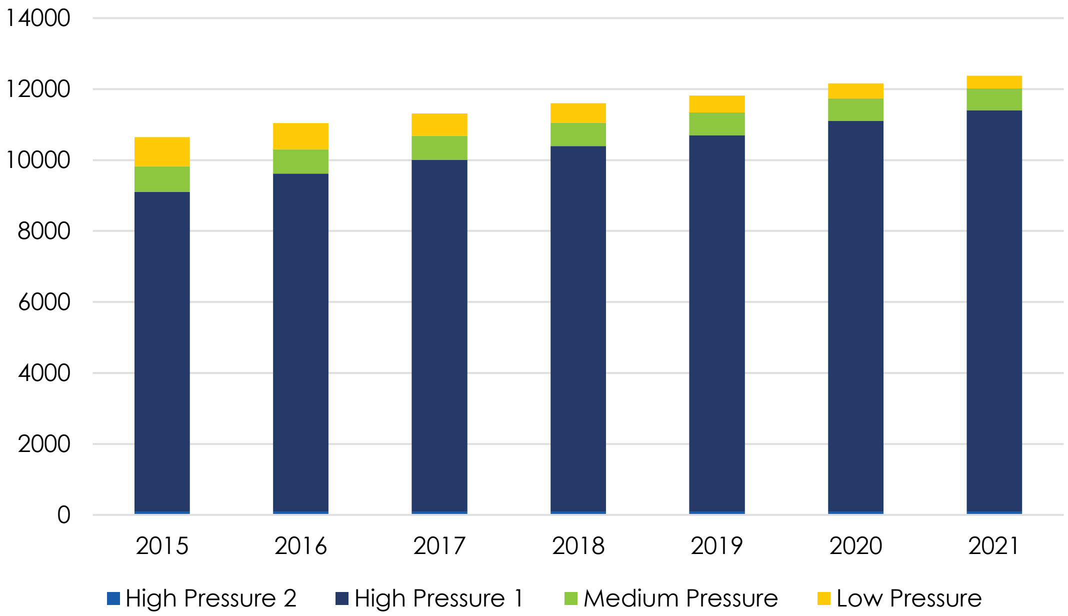


Figure 4: Total Network Length in metres from CY2015 to CY2021

2 Source: AusNet Services' Finance Data Analytics

4.2. Material Classification

The dominant material types utilised on the distribution network are Polyethylene (75.43%) and Protected (coated) Steel (20.17%) which in total account for 95.6% of the network as shown in Figure 5 and Table 3 below.

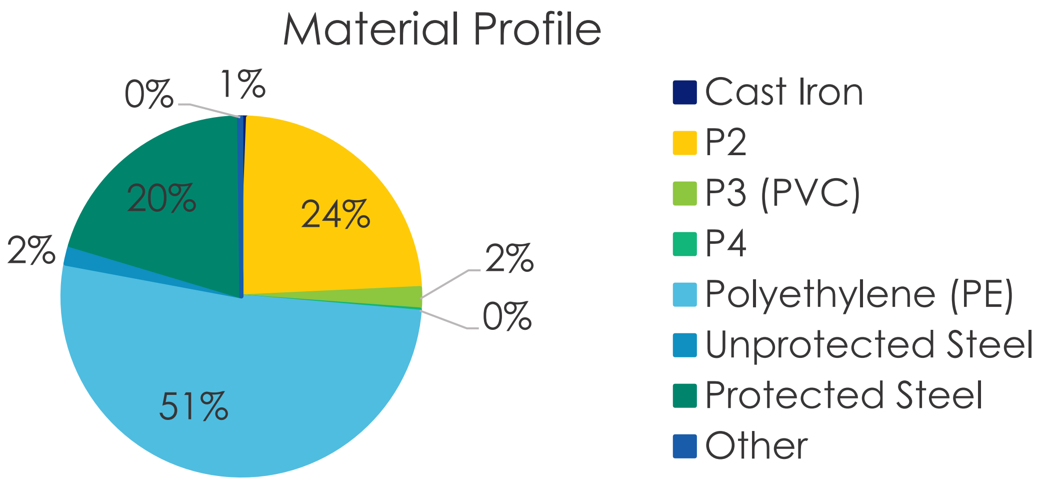


Figure 3: Network Length by Material

Table 3: Mains Summary by Material

MATERIAL	DESCRIPTION	LENGTH	PROPORTION
Cast Iron	Cast iron generally contains more than 2% carbon and is categorised into lead jointed or mechanical jointed.	73 km	0.59%
Polyethylene	Polyethylene mains, introduced in the 1970's, account for more than 50% of the total distribution mains in the network. It can operate at high pressure and is not susceptible to corrosion.	9,335 km	75.43%
PVC	PVC was used extensively from 1970 to 1997 in the replacement of cast iron mains in the "like for like" mains replacement program adopted at the time. PVC is only rated for operation at low pressure.	236 km	1.91%
Unprotected Steel	This piping system is based on bare steel and galvanised iron pipes that have been joined by having threads cut into the ends and screwed into joining couplings. Galvanising will be of considerably reduced effectiveness in reducing corrosion when buried.	209 km	1.69%
Protected Steel	Coated steel using both screwed and welded jointing are dependent on the corrosion protection coating. The coatings are regarded as having an effectively indefinite life. The effective life of this system is determined by the faults in the protection coating.	2,496 km	20.17%
Other		26 km	
Total		12,376 km	

Table 4 below shows the breakdown of Pipe Material Lengths for each Pressure Tier. By the conclusion of the 2024-2028 access arrangement period, the remainder of the LP Network will be completely renewed with HP1 Mains.

Table 4: Length of Mains by Material and Pressure Tier

Material	Low	Medium	High 1	High 2	Total
Cast Iron	72.35	0.46	0.18	-	72.99
P2	3.53	171.36	2,752.95	-	2,927.84
P3 (PVC)	236.31	-	0.17	-	236.48
P4	-	24.74	0.05	-	24.79
Polyethylene (PE)	6.18	24.59	6,289.10	62.46	6,382.33
Unprotected Steel	10.67	197.59	0.66	-	208.92
Protected Steel	6.60	196.43	2,258.60	34.86	2,496.49
Other	25.37	0.32	-	-	25.69
Total	361.01	615.49	11,301.71	97.32	12,375.53

4.3. Age Profile

The age profile of AusNet Services' distribution mains are displayed in Table 5 and Figure 6 below. Ausnet Services' Distribution Network is up to 121 years with an average network age of 23.9 years.[3]

Table 5: Average network age by pressure

PRESSURE	AVERAGE AGE
High 1	21.7 years
Medium	44.6 years
Low	46.4 years

[3] Average age is calculated with Dec 2021 Mains Data as the base.

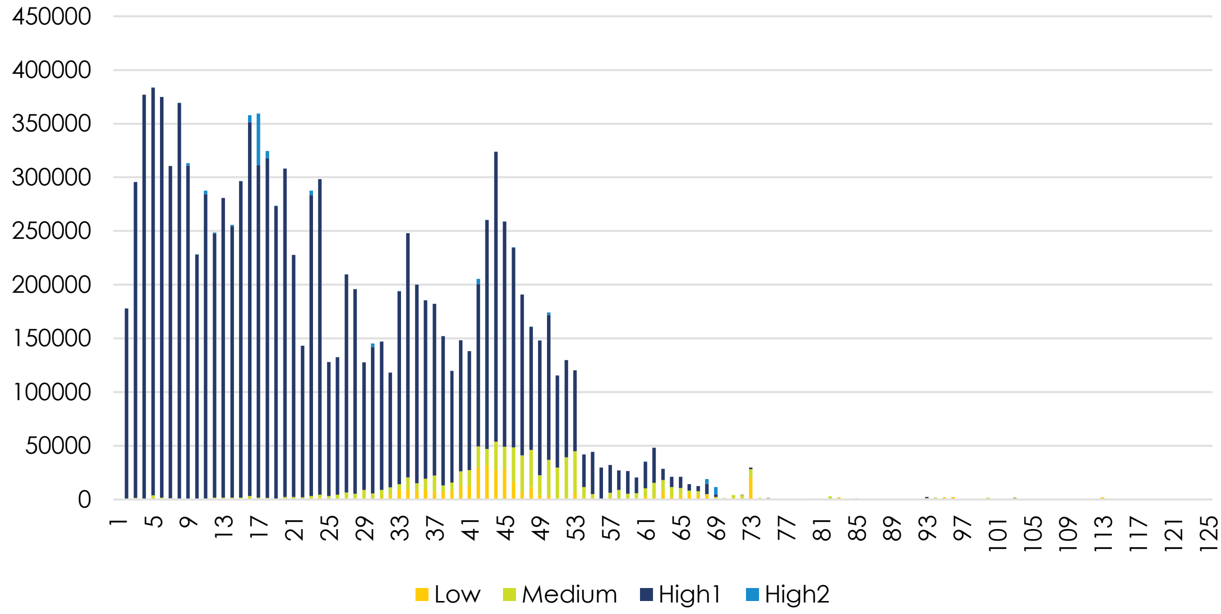


Figure 4: Mains Network Age Profile

Over the past two decades, all new and replacement mains has been completed with HP mains, mainly utilising Polyethylene material. This therefore reduced the average age of HP mains compared to Low and Medium Pressure. However, there are still some sections of the HP network which are reaching the end of their engineering life (~50 years of age).

4.4. Asset Performance

4.4.1. Mains Leakage Rate

Historically, a systematic approach was used for leakage management. Mains were surveyed on a systematic periodical basis, with little differentiation made in regards to mains material or operating pressure. Over time, with increased knowledge of the assets managed, a risk based approach to leakage management has been adopted.

TS-5201: Leakage Management Technical Strategy introduced the concept of 'High Breakage Zones' and 'Trigger Survey'. Leakage management efforts are now targeted to those assets that pose the greatest risk, namely LP cast iron mains.

The work specifications (WS) that are currently used as an indicator of mains and services leaks include:

- WS0022: Repair reported leak on main
- WS0036: Repair leak on main found by leakage survey
- WS0023: Repair reported leak on service
- WS0037: Repair leak on service found by leakage survey

Completion of the above work specifications is defined as a leak incident and is referred to as a leak. The ratio of total leaks over the length of the associated mains is referred to as Leakage Incident Rate (LIR) that is represented by the units of leaks/km.

Figure 7 shows the LIR (rate per km of mains) and the total number of Leaks by Network Pressure over the past 12 years.

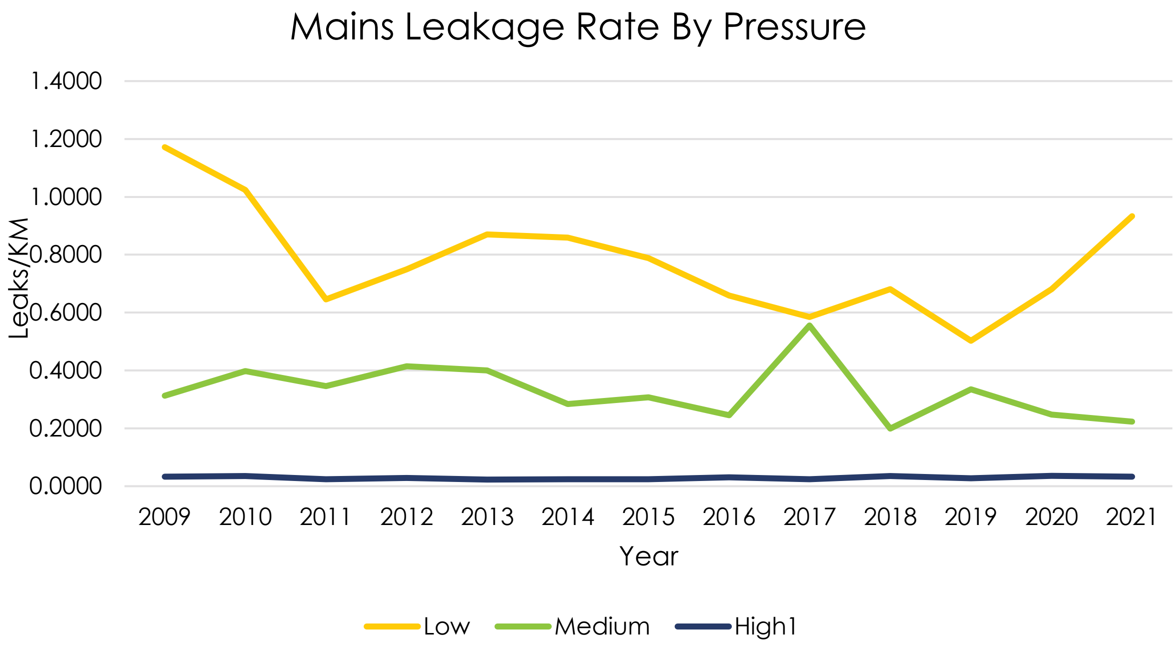


Figure 5: Mains LIR by Pressure Classification

The proactive replacement of LP mains has reduced leakage rates on the network since its introduction. The reduction in LIR also reflects the effective targeting of the worst performing mains in AusNet Services' LP Network. By the end of 2020 only 421 kms of LP mains remained on the gas network. This dropped to 361km by the end of 2021. Current programs will reduce this volume to 274km by the beginning of the next access arrangement period.

The introduction of the MP Mains Replacement Program in 2013 has slightly reduced leakage rates within the MP network due to the targeted approach with removal of high risk cast iron mains. The LIR is the key indicator for network performance and indication of the risk profile.

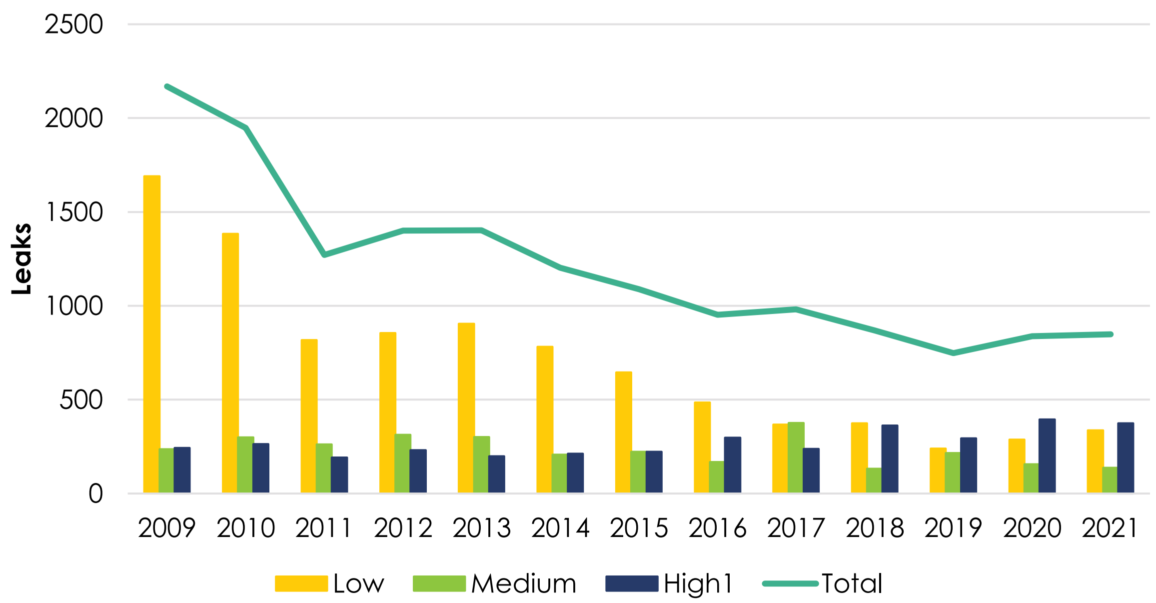


Figure 6: Total Leaks on Mains per year by network pressure

Error! Reference source not found. above shows the 61% reduction in total number of leaks per annum across AusNet Services' gas distribution network from 2009 to 2021. This improves safety and reduce the amount of released gas.

The implementation of the LP and MP Mains Replacement Programs have resulted in a noticeable decrease in leaks in both pressure tiers over the past 12 years. The small increase in number of leaks in the HP1 Network is indicative of the increase in network size and also the deterioration of the older generation HP mains.

The LP mains replacement program and ongoing reduction in the LP network has resulted in 83% reduction in total number of leaks per annum from 1690 leaks in 2009 to only 337 leaks in 2021.

4.4.2. Services Leakage Rate

Leakage rates on the services in the overall distribution network have reduced from 2009 to 2021 and contributed to the greater public safety. The LIR for services in the LP network is increasing as shown in Figure 9 below. This justifies the replacement of the remaining LP network and improving the safety to customers.

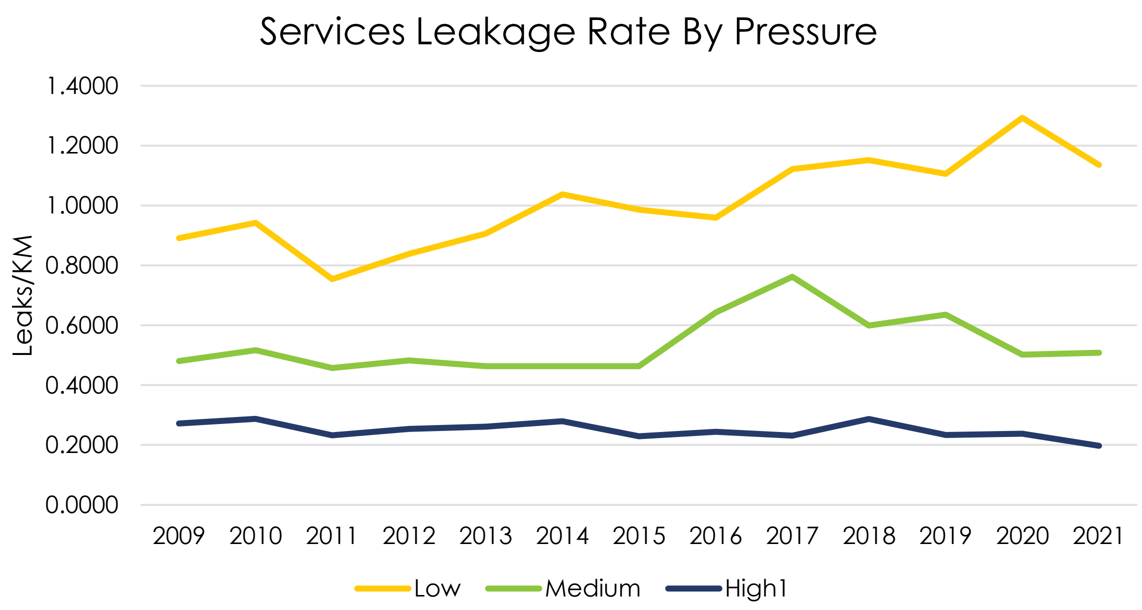


Figure 7: Service Leakage Rate by Pressure classification

Figure 8 shows the number of service leaks in the LP Network. A significant reduction is observed from 1286 leaks in 2009 to 410 in 2021.

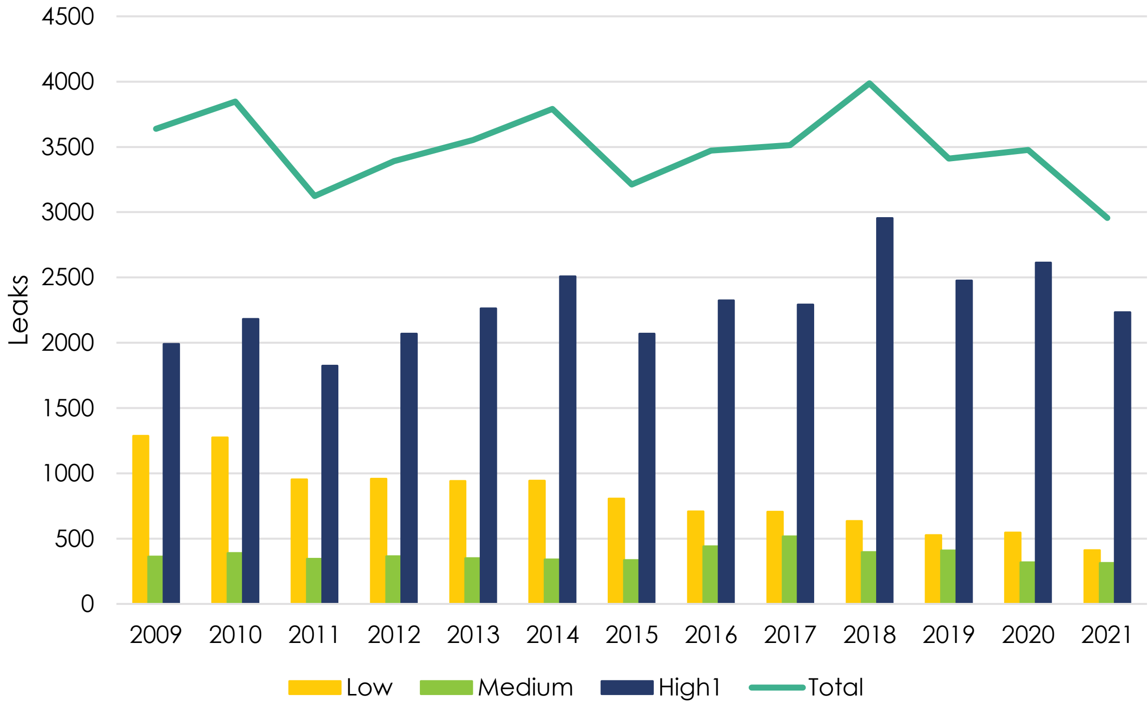


Figure 8: Reduction in LP service leaks

4.4.3. Material Leakage Rates

Cast Iron continues to have the highest leakage rate among all material types. The unique characteristics of cast iron can lead to circumferential break (broken back) due to a combination of point loading, ground movement, and mains deterioration (graphitisation). Such failures can release gas volumes at close to full bore ruptures and are instantaneous in nature. Cast iron fracture fault levels are therefore used to prioritise mains replacement. Cast Iron mains only remains in the LP network and will be replaced as part of the last leg of the LP mains replacement program

The P4 material type only remains in the MP Network. The leakage rate for this is comparable to Cast Iron and the continued replacement of it via the MP replacement program will address the increasing trend. A shown in Figure 11 below, Cast Iron and P4 are the worst performing materials.

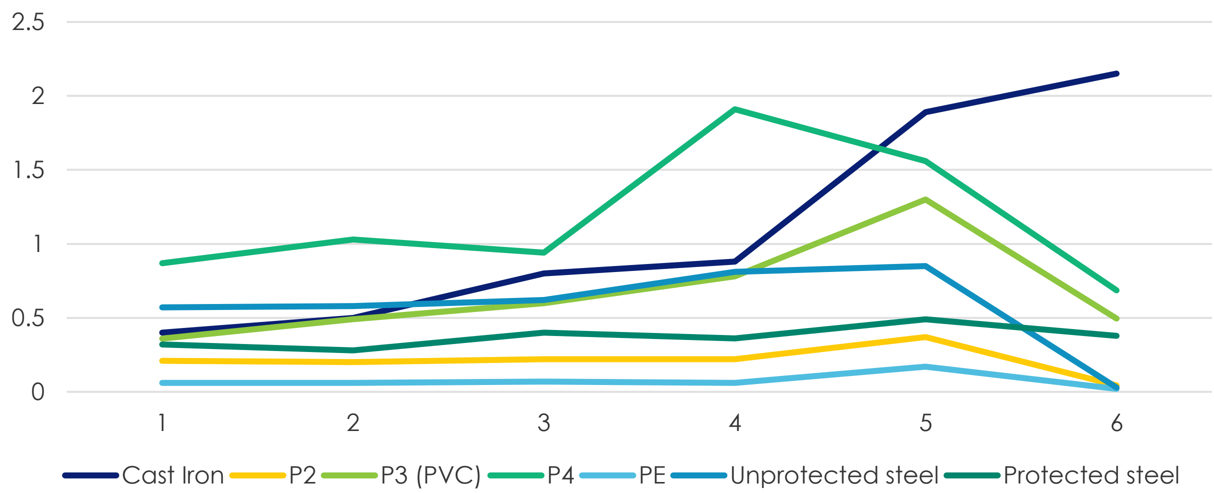


Figure 9: Mains Leakage Rate by Material Type

5. Risk

5.1. Safety

Gas Mains leaks caused by either third party damage or deteriorated Mains are considered the highest risk within this strategy. This is due to the potential consequences associated with the failure. Leaks from a Gas Main have the potential to cause death and injury to the public and to cause damage to property. The risk is also influenced by the likelihood of the gas escaping from the deteriorated Gas Mains and Services. The likelihood is dependent on the age, material type and location of the Gas Mains and Services. The responsible replacement of aging mains, on a safety risk prioritisation basis, is a key mitigation control set out in the Gas Safety Case (GSC) approved by Energy Safe Victoria.

Gas leaks from service pipes also have a potential to cause death and injury to the public. Whilst the volume of gas escaping from a Service is less than from a Mains, their location near a customer premises increases the likelihood of ignition.

In addition to mitigating safety risk, upgrading LP networks to HP reduces the number of district regulator stations and their respective maintenance and inspection costs. Reducing district regulators also lowers the overall system risk, as there will be fewer regulators in the network to possibly fail. In the proposed program to replace LP and MP pipes, thirty nine (39) District regulators will be eliminated with no new addition of any pressure regulator station. Refer to Appendix C for the list of district regulators to be removed as part of the proposed mains replacement program.

Where renewing the older mains with stronger and reliable pipe material of HP compatibility improves the reliability of supply, the older HP mains pose a greater risk of ignition due to leaks. The gas escape per leak is highest in comparison, therefore can lead to a higher degree of consequence. Renewing clusters of HP mains will achieve greater safety and continuity of supply.

An ongoing program of mains replacement is necessary to maintain safety at current levels due to the aged-based deterioration. This ongoing program also ensures continued compliance with the GSC. As described in AusNet Services' Formal Safety Assessment (FSA) required for the GSC, the mains replacement program is considered an effective control mechanism in regard to the identified risks on distribution mains.

5.2. Reliability

The LP network operates between 1-7kPa. The operating pressures of the LP network are limited by pressure restrictions due to the material types (cast iron and un-protected steel) in the network and operating the network at a higher pressure may affect the integrity of the assets. Due to the low operating pressure and leakage points in the network, the LP network suffers from blockages caused by water and scale. This is a common cause of outages for our customers on the LP network. Upgrading LP to HP has the benefit of increased capacity and reliability and removes the implications of water ingress. The increased reliability from the HP network provides the customer freedom of choice when installing gas appliances for residential or commercial purposes.

The removal of district regulators as part of LP mains replacement program will enhance reliability by eliminating the risk of the district regulators getting damaged and interrupting the supply or causing gas leaks.

5.3. Cost

With the ongoing deterioration rate of the LP and MP network, it is expected that operational costs will increase if replacement does not occur. Common repeated maintenance activities associated with the higher cost of the LP network include:

- emergency response;
- leakage survey;
- pin pointing and repair of leaks;
- clearing mains blockages;
- pump syphons;
- administration;
- supervision of Activities, IT systems, and Overheads (long term); and
- asset management of district regulators (Procedures, Spare Parts, Periodic Maintenance, Repair, Gas Emission).

5.3.1. Ongoing Opex Efficiencies by eliminating District Regulators

Operational efficiencies will be achieved in terms of reduction in asset management of district regulators. The proposed LP mains replacement program will enable decommissioning and consequently abandoning the remaining thirty-nine (39) district regulators.

District regulators are subject to various routine inspection and maintenance. They include:

- Monthly site maintenance
- Annual operation checks
- Monthly chart run for ensuring security of supply
- Full maintenance – 6 yearly, where components are replaced
- Follow-up works / maintenance

The flow-modelling of the gas network by the ‘Synergy modelling tool’, demonstrates that the proposed replacement program will not require the addition of any field regulator to replace the removed district regulators. Therefore, it will reduce the ongoing operational cost for maintaining the district regulators.

6. Mains Replacement Strategy

The mains replacement strategy is focused on reducing leakages, optimising operations, improving public safety, maintaining security of the supply and reducing emissions.

The LP mains replacement strategy involves the replacement of approximately 274km of LP mains with HP mains. This will result in the removal of the remainder of the LP network. The LP fleet is the worst performing and is also has the highest maintenance costs per km. This program of works will significantly improve safety and reliability performance and decrease operational costs. Much of AusNet Services' remaining LP network and likewise the majority of the worst performing LP mains are located in Rural Victoria.

The MP mains replacement strategy is to replace 94.5kms mains over 2024-28 access arrangement period. The strategy targets mains that have higher leakage rates and those where there is a noticeable increase in leakage incidents. The identified networks with high leakage rates are the un-protected steel network and the first generation polyethylene mains (P4 Polyethylene, Class 250). These networks will be prioritised for replacement in the next five years. The most deteriorated and poorest performing mains have been used to quantify the program, resulting in the replacement of 94.5kms of MP mains.

The HP mains replacement strategy targets the worst performing sections of the HP network for replacement. This will also improve safety and reliability. These mains will generally be the older first generation polyethylene mains (P2 Polyethylene, Class 575). By including these pipes as a planned replacement program we will achieve efficiencies as compared to ad hoc mains replacement. The program will focus on the Melton HP distribution network. It is not intended to be widescale program to replace the HP network, but rather a standalone program focusing on an area of highest concern.

6.1. Mains Replacement Historical Performance

The mains replacement program involves replacement of aged and leaking LP mains with polyethylene main. Since the introduction of the program in 2003, AusNet Services has demonstrated its commitment to completing the program by 2028 with the decommissioning of 1,455km[4] of LP mains to date. Due to the rate of deterioration, it was expected that leakage rates would increase. However, with targeted replacement at an increased rate, LIRs have steadily reduced. Similarly, MP LIRs have been maintained on the network in line with meeting the network objective on maintaining network safety. The level of replacement as demonstrated against the allowance set by the Australian Energy Regulator (AER) is detailed in Figure 10.

The MP mains replacement program was first introduced in 2013. By 2024 the program will have achieved its initial aim of targeting the highest risk mains and removing all cast iron mains from the MP network. However, the MP network still contains several other high risk assets including the first generation polyethylene (P4 Polyethylene, Class 250) and un-protected steel. These mains will be targeted in the 2024-28 access arrangement period. It is intended that all (~28.8kms) Class 250 PE will be removed from the MP network.

4 Data as at December 2020.

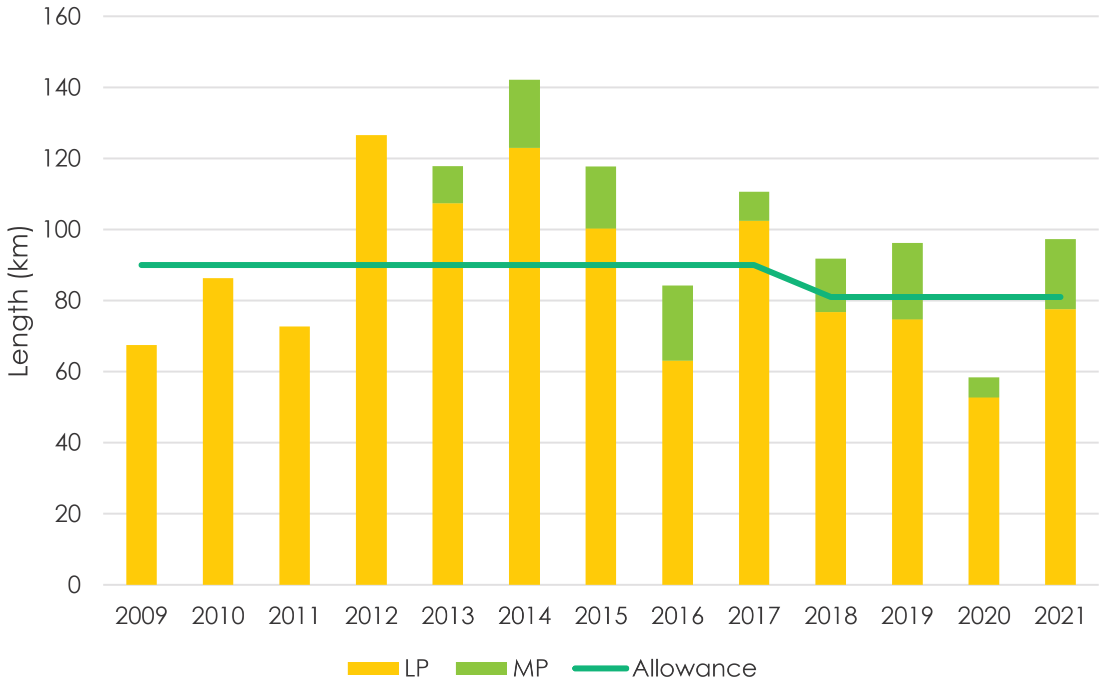


Figure 10: Mains Decommissioned by Year (2009-2021)

6.2. Low Pressure Network Analysis

Approximately 273.4 kms of the LP network will be remaining after the 2018-22 access arrangement period. This will equate to approximately 2.4% of the whole of the gas distribution network without considering the organic growth in the HP network. The average age of the LP network is 46 years which is highest of all pressure tiers (refer to

Table) .

Replacing the remaining LP network will achieve efficiencies through reduced operational procedures, training requirements, emergency equipment and other asset management overheads. The elimination of district regulators which do not have remote telemetry to monitor network performance will further reduce the risk of supply failure.

Most of the LP network replacements are required in smaller towns or regional centres with only 7.4 kms (~2.7%) of 273.4 required in the Melbourne metropolitan area. The LP replacement program in regional centres will assist in ensuring greater security of gas supply during the winter peak periods.

The comparison of leakage rates within the LP network has assisted in prioritising the replacement program. Figure 11 below illustrates different material types and their respective leakage rates over time.

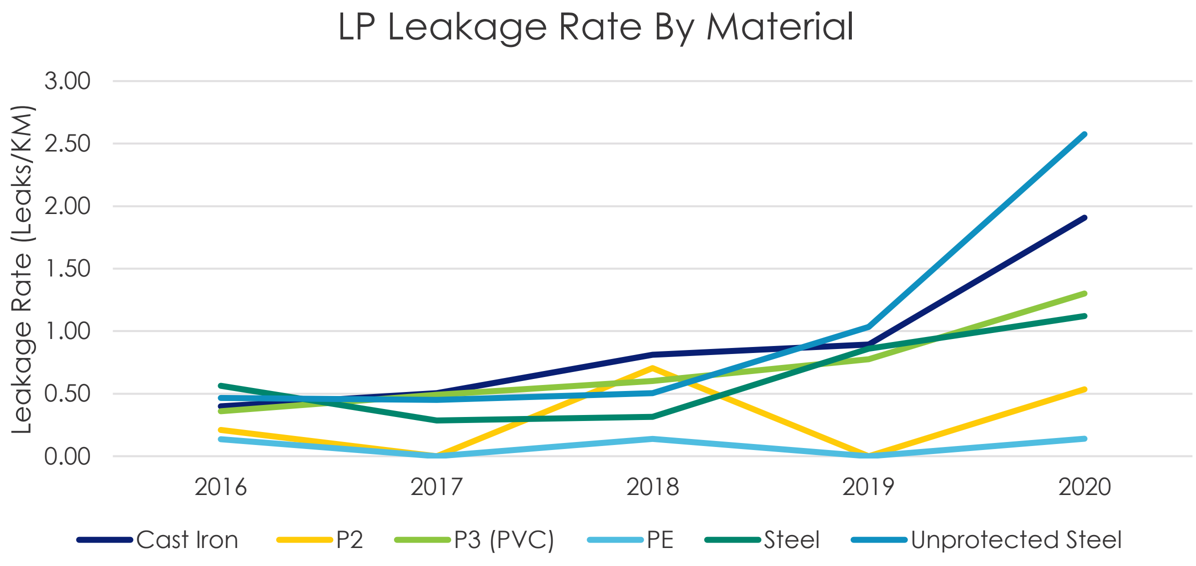


Figure 113: LP Network - Leakage Rate Breakdown By Material

6.3. Medium Pressure Network Analysis

Analysis of the LIR by Material type is shown in the Figure 12 below. Less than 1km of cast iron remains on the network, resulting in a near 0 LIR as there are very few leaks on this small section. The worst performing mains remaining in the MP Network are P4 Class 250 Polyethylene and Unprotected Steel which make up approximately 28.8km and 211.3km respectively of the entire MP network.

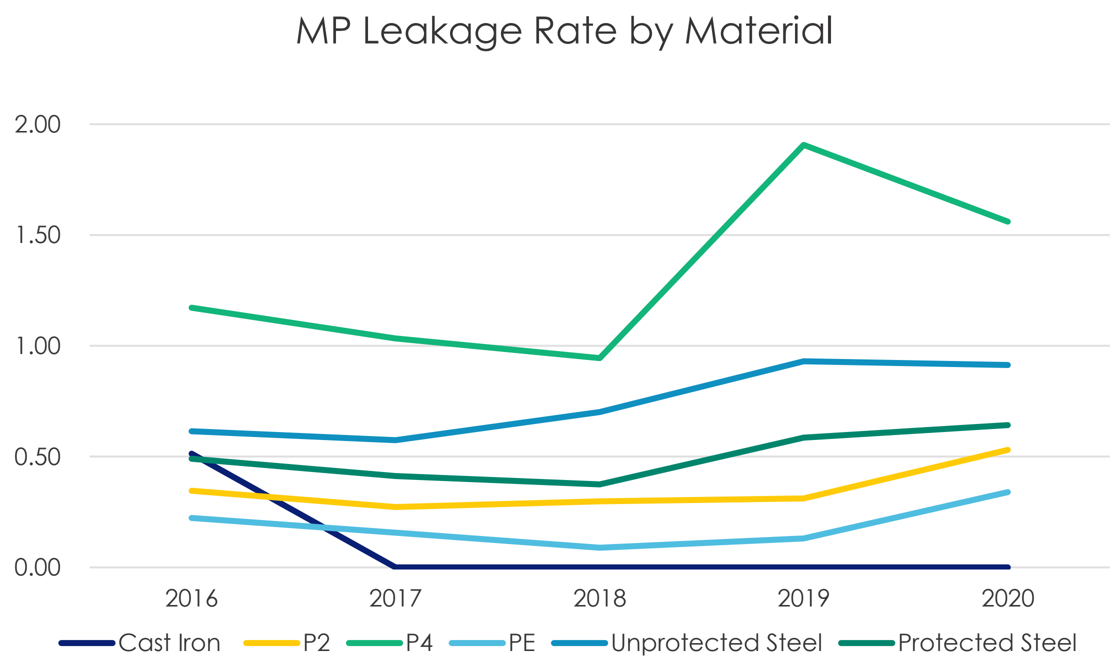


Figure 12: MP Network - Leakage Rate Breakdown by Material

Table 6 below contains a list of the post codes with the highest LIRs on the MP network in descending order. The MP network is fed by HP-MP field regulators and hence the replacement of the MP network requires consideration of the continuity of supply with the fringe point to be renewed first and progressively moving upstream towards the supplying field regulator.

Table 6: MP Network performance by location (as of December 2020)

Postcode	Suburbs	Kms	LIR (Leaks / KM)	No. of Leaks
3025	Altona East, Altona North, Brooklyn	35.35	6.03	213
3019	Braybrook, Braybrook North	28.83	4.20	121
3032	Ascot Vale, Highpoint City, Highpoint West, Maribyrnong, Travancore	2.05	3.41	7
3020	Braybrook, Sunshine, Sunshine North, Sunshine West	169.74	3.31	561
3023	Burnside, Caroline Springs, Deer Park, Deer Park North	62.71	2.76	173
3022	Ardeer, Deer Park East, Sunshine West	10.74	2.61	28
3011	Footscray, Footscray North, Middle Footscray, Seddon, Seddon West	14.15	2.54	36
3021	Kealba, Kings Park, St Albans, St Albans East, Sunshine	227.32	2.48	564
3012	Brooklyn, Footscray, Footscray West, Kingsville, Maidstone	60.95	2.23	136
3013	Yarraville, Yarraville West	1.84	2.17	4
3015	Kingsville South, Newport, Spotswood	7.63	1.31	10
3016	Williamstown, Williamstown North	11.36	1.06	12

Postcode 3025 has the highest LIR of 6.03. This area is densely populated and is undergoing subdivisions. Consequently, this further increases the population density and hence criticality of failure.

6.3.1. Average Age of MP mains by Material and Location

Figure 13 shows the average age of the MP network by material and location. The average age of Unprotected Steel is 63.5 years with oldest section more than 90 years old in post code 3013. The second oldest is cast iron pipe type. However, less than 1km of case iron is expected to remain after FY2022. P4 pipe type is reaching the end of its engineering life with an average life of 45 years and the oldest section in postcode 3011 reaching 50 years.

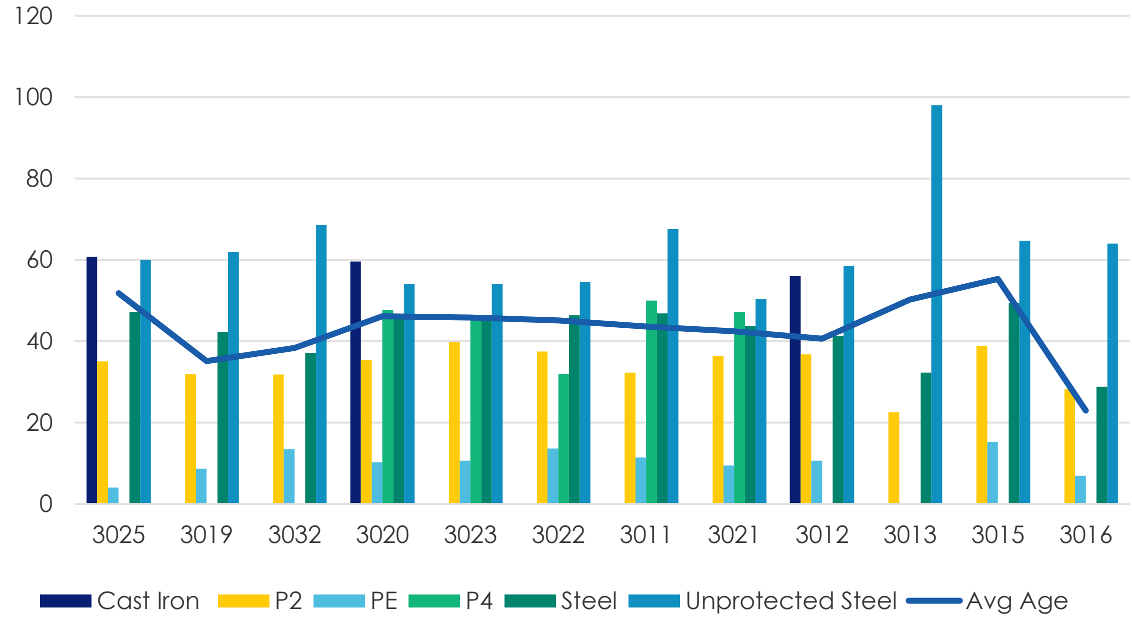


Figure 13: MP Average Age by Material & Postcodes (Dec 2020)

6.3.2. MP Network – P4 Material Type Analysis

28.8km of P4 material mains is left on the MP network, distributed over 5 postcodes as shown in Table below. The vast majority of P4 is located in postcode 3021 where the LIR is 7.23.

Table 7: P4 Material by Location

Postcode	Suburbs	Kms	LIR (Leaks / KM)
3020	Braybrook, Sunshine, Sunshine North, Sunshine West	0.404	4.95
3023	Burnside, Caroline Springs, Deer Park, Deer Park North	1.269	4.73
3022	Ardeer, Deer Park East, Sunshine West	0.011	90.91
3011	Footscray, Footscray North, Middle Footscray, Seddon, Seddon West	0.037	0.00
3021	Kealba, Kings Park, St Albans, St Albans East, Sunshine	27.125	7.23
Total		28.8km	

Error! Reference source not found. below shows that between 2016 and 2020, there was a correlation between P4 LIR and age.

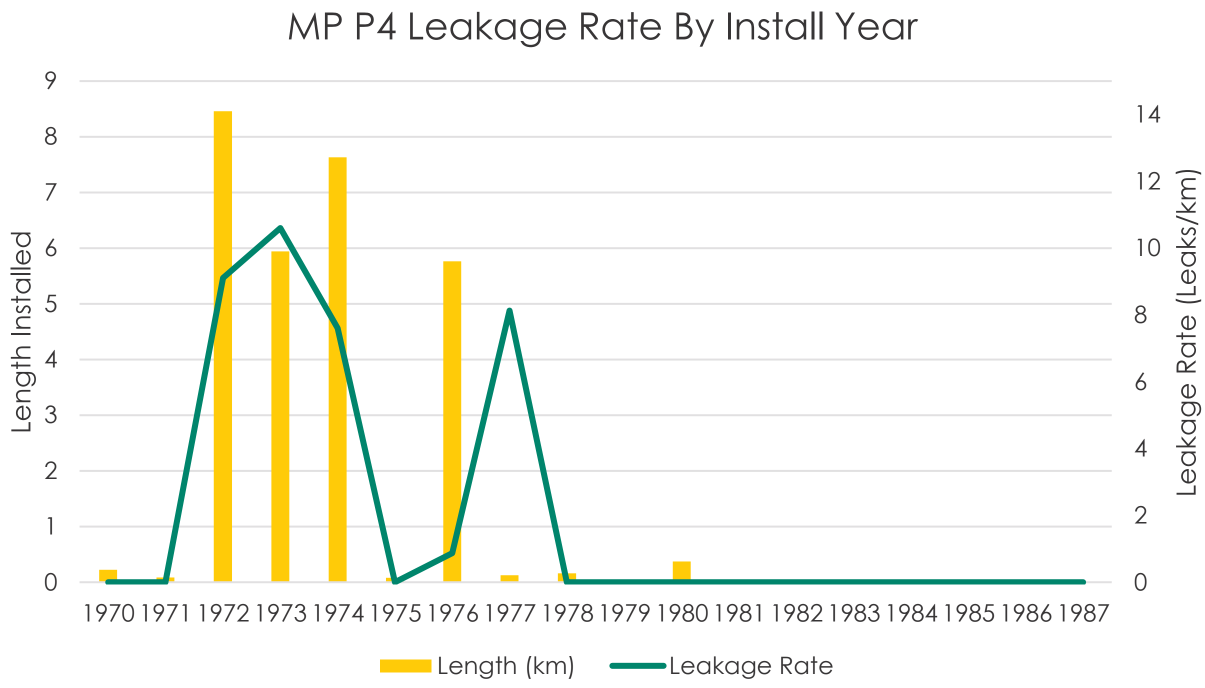


Figure 14: MP P4 Leakage Rates & Length by Installation Year

6.3.3. MP Network – Unprotected Steel Material Type Analysis

56.57kms of unprotected steel has been identified for replacement based on high LIR as shown in Table 8 below. This makes up 60% of the 94.5km MP replacement program,.

Table 8: Unprotected Steel by Location

Postcode	Suburbs	Kms	LIR (Leaks / KM)
3025	Altona East, Altona North, Brooklyn	14.70	8.17
3019	Braybrook, Braybrook North	3.05	11.98
3020	Braybrook, Sunshine, Sunshine North, Sunshine West	23.60	4.12
3011	Footscray, Footscray North, Middle Footscray, Seddon, Seddon West	3.76	4.79
3012	Brooklyn, Footscray, Footscray West, Kingsville, Maidstone	11.46	2.62
Total		56.57km	

6.3.4. MP Network – Protected Steel Material Type Analysis

Protected steel is experiencing an upward trend in LIR. For MP, it has risen from 0.49 in 2016 to 0.64 in 2020. 8.7kms of protected steel is identified in postcode 3019 (Braybrook and Braybrook North) which has a LIR of 5.87. This is the highest amongst all Protected steel MP networks.

6.4. High Pressure Network Analysis

AusNet Services has approximately 2,753 kms of Class 575 HDPE pipe type. The leakage rates of different networks, by location, are in between 0.18 to 0.46. Table below shows the different proportion of Class 250 HDPE pipe type in different networks.

Table 9: Class 575 HDPE in HP Network

Area	Length (kms)	Leaks in 2000	LIR
Geelong Coast	519.4	240	0.462
Greater Melbourne	1,378.1	545	0.395
Warrnambool, Portland, Hamilton	140.8	42	0.298
Bendigo, Castlemaine	327.0	94	0.287
Ballarat, Horsham, Stawell, Ararat	387.9	69	0.178
Total	2753.2	990	

Class 575 HDPE pipe type has been installed with primarily 50mm and 40mm diameter sizes; forming 99% of the whole pipe type within this category. Table 2 below shows the distribution of various pipes by their diameter size.

Table 2: Size Profile of Class 575 Pipe Type

DIAMETER	TOTAL LENGTH (KM)	PROPORTION
50mm	1,780,38	64.7%
40mm	936.47	34.1%
32mm	33.07	1.2%
Total	2,749.92	100%

HDPE mains were first installed in the Victorian Networks in the late 1970s. In Ausnet Services' network, most of Class 575 HDPE mains were installed in between the years 1980 and 2000. Figure 15 below exhibits the age of Class 575 HDPE pipe within Ausnet Services HP network.

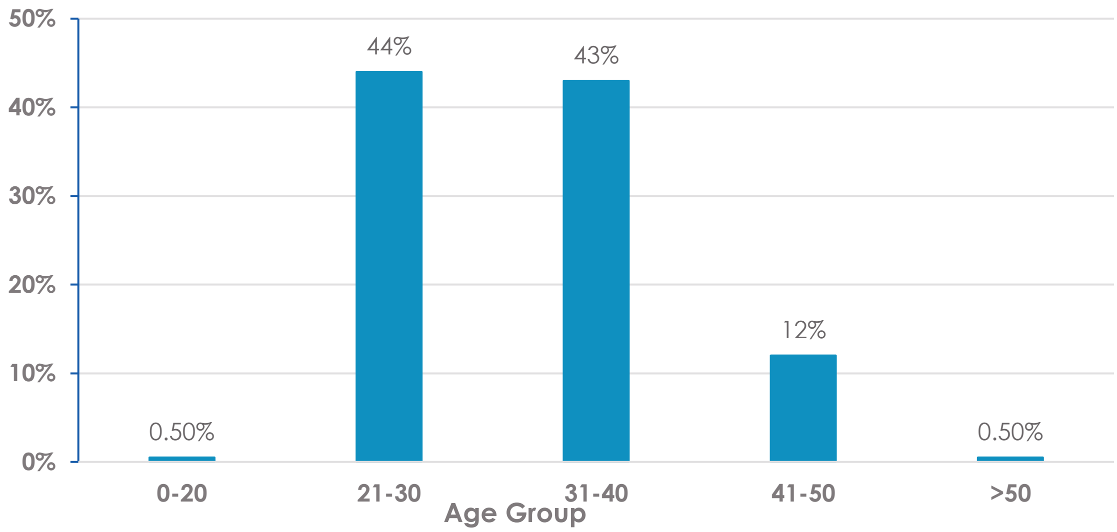


Figure 15: Age Profile of Class 575 HDPE (P2)

6.4.1. Melton Network, Class 575 HDPE Pipe Type

The Melton network has approximately 466km of distribution mains. Approximately 88kms (i.e. 19%) of the HP distribution mains in Melton were installed before 1981 and are more than 40 years old. Figure 16 below shows the age profile of mains in the Melton area by kilometres.

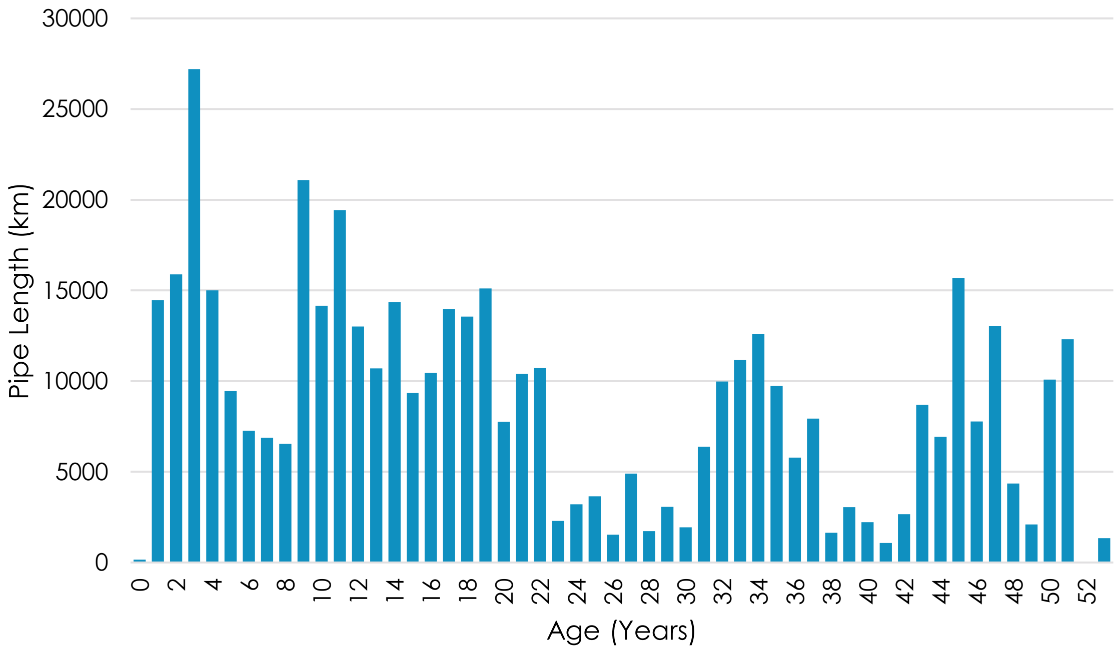


Figure 16: Melton HP1 age profile

The Melton HP gas network has evolved with time and has been made of different materials. The majority of the HP distribution mains (~84%) is built with High Density Polyethylene material including Class 575, PE 80 and PE 100. Figure 1917 below identifies the proportion of different distribution pipe types in the Melton HP distribution network.

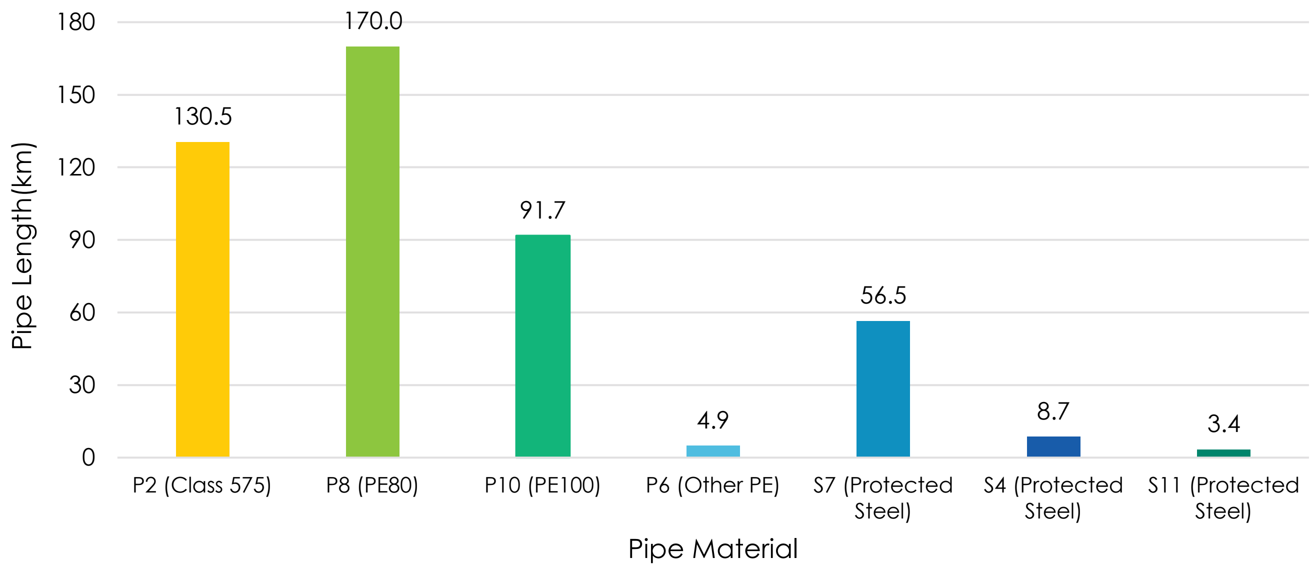


Figure 1917: Material distribution in Melton HP1

More than 28% of the Melton network is first generation HDPE Class 575. Class 575 HDPE pipe is named as P2 pipe type in AusNet Services. P2 pipe type is suitable for 575 kPa and was generally installed between 1975 and 2000. The current practice is to use the stronger and more reliable Polyethylene material PE100. The Melton network lies within the major population growth corridor and therefore the proportion of PE100 pipe type will increase with time.

Figure 18 below shows the age profile of P2 (Class 575) HDPE pipe type as a proportion of the entire Melton network. It shows that P2 has not been installed since the early 2000s. Approximately 28% of P2 pipe type is more than 40 years of age and nearing the end of its reliable life.

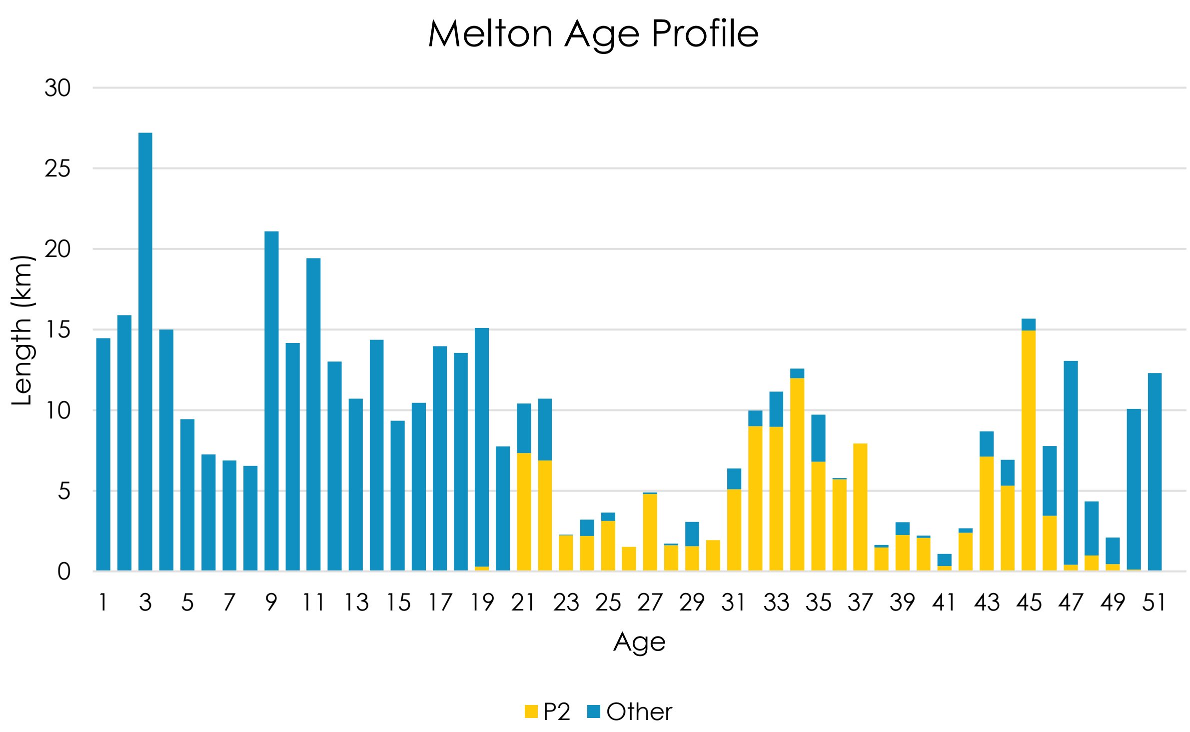


Figure 18: P2 Age Profile vs other materials on the Melton Network

AusNet

6.4.1.1. Melton UAFG Analysis

Figure 19 below shows the Unaccounted for Gas (UAFG) trend on the Melton network from 2013 to 2021. The 12-month rolling average has gradually increased since 2013 and has almost doubled from 3.45% to 6.63% in last 8 years.

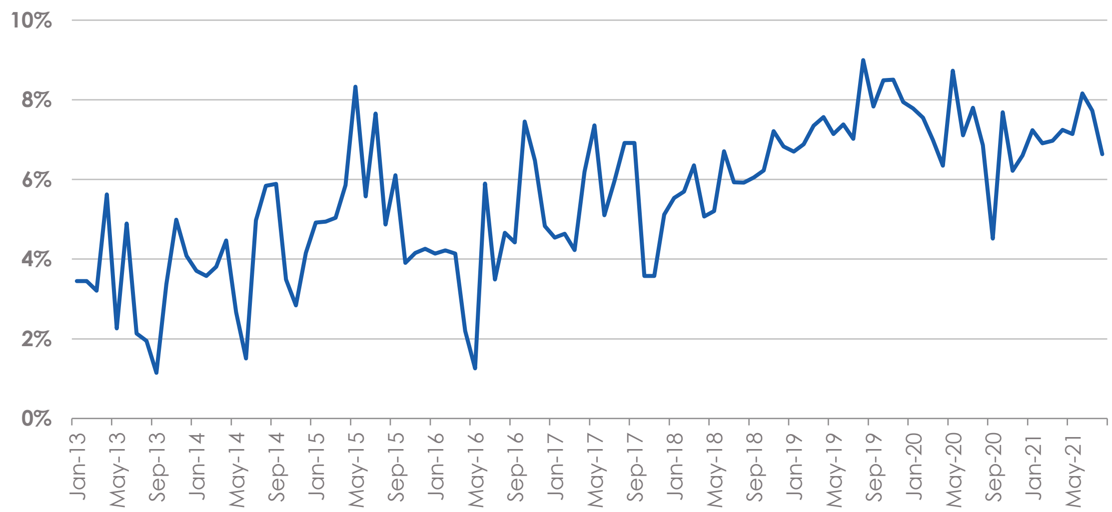


Figure 19: UAFG in Melton

Figure 20 below represents UAFG trend of the Melbourne metropolitan network from 2013 to 2021. It appears to be stable, remaining around the 3-4% range for much of the period. This is in stark contrast to the increasing UAFG in Melton.

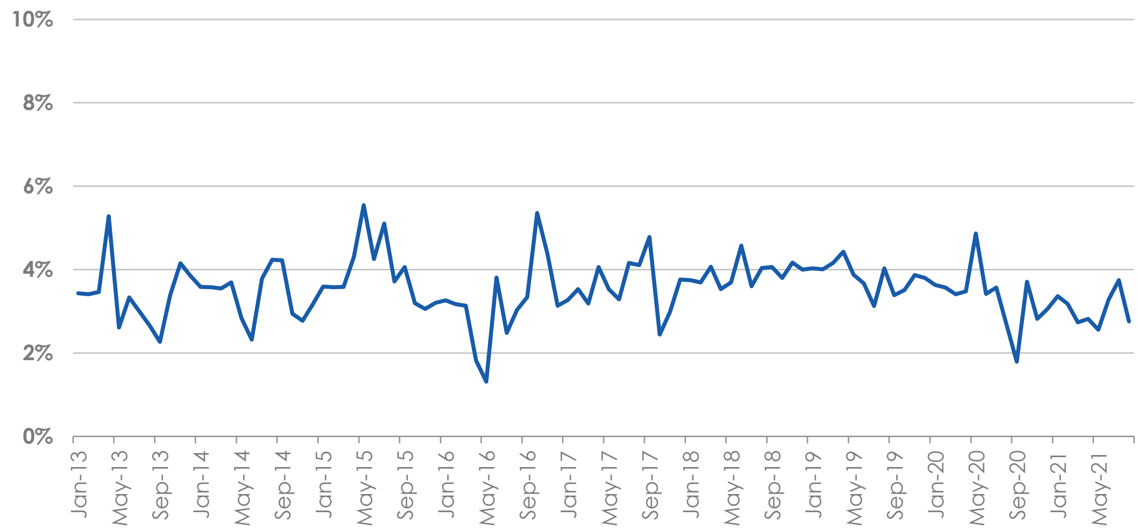
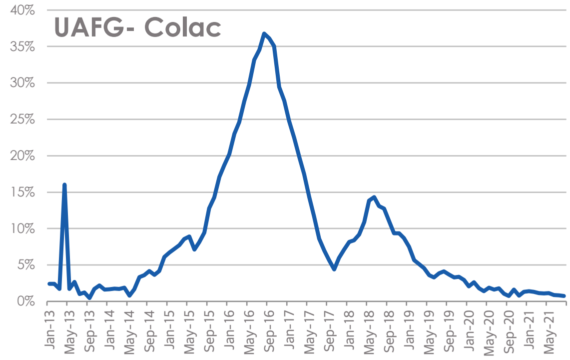


Figure 20: UAFG in Melbourne metropolitan area

The Melton UAFG trend does not reflect any pattern of major losses due to a metering issue of any large gas consumers. The gradual upward and downward changes can be related to mains and services leaks and



ongoing repairs.

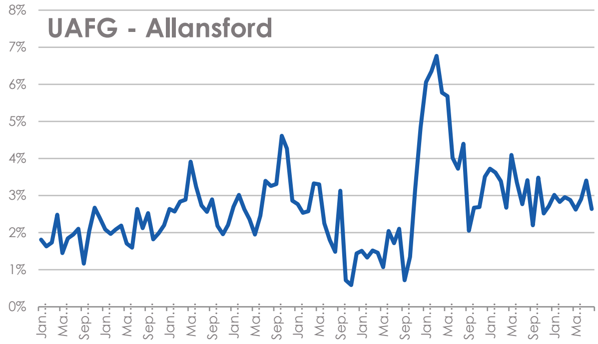


Figure 21 below shows typical UAFG trends and the pattern of metering issues at large consumers in Colac and Allansford.

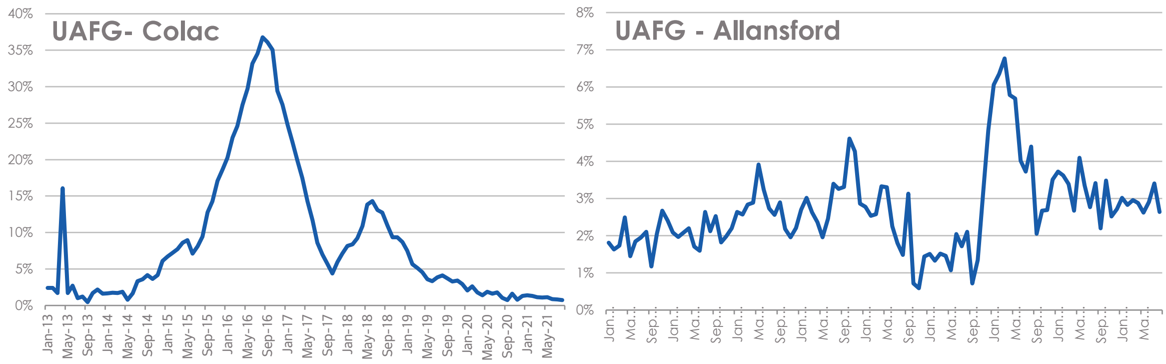


Figure 21: UAFG trends in Colac and Allansford

The above trends of Colac and Allansford represents the pattern where UAFG peaks significantly before returning to relatively low values.

6.4.1.2. Melton Network Leak Analysis

Analysis of 5 years of leakage data from 2016 to 2020 illustrates that the number of leaks are higher in the older pipes, as shown below in Figure 24. The data identifies that 58% of leaks have occurred on pipes aged 40 years or more.

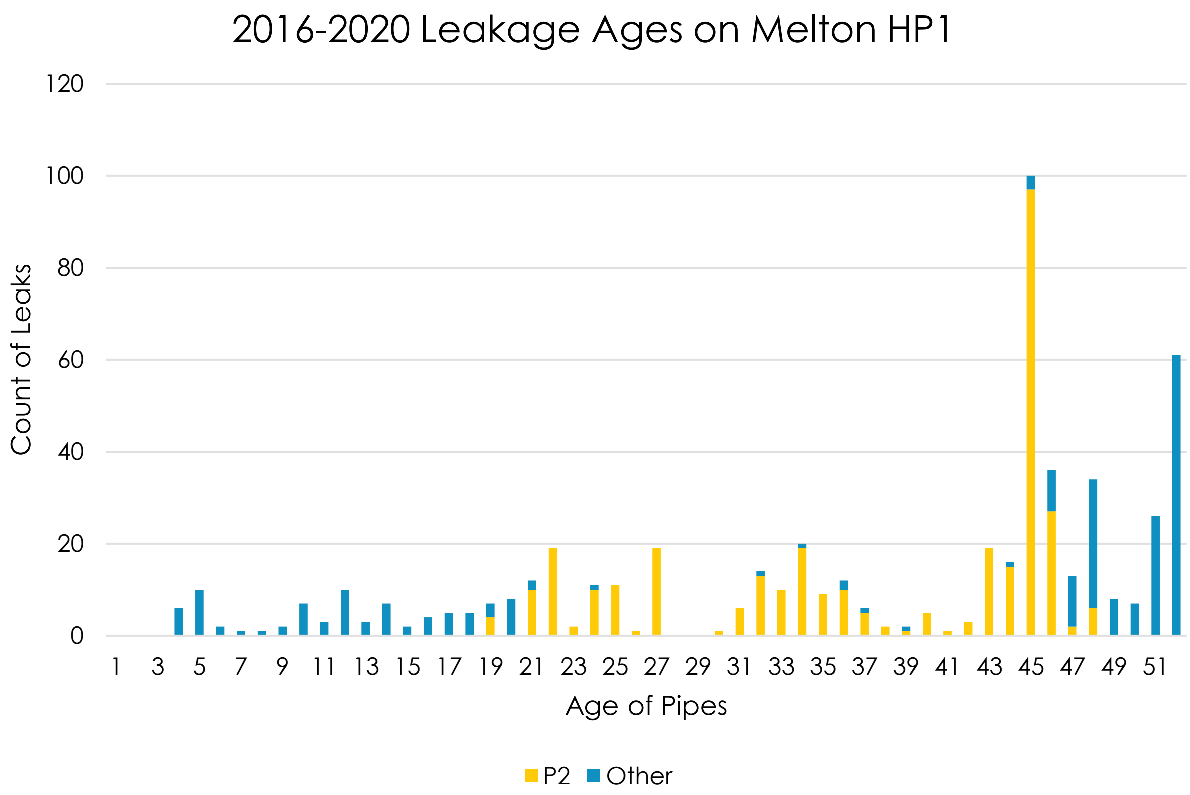


Figure 22: Leaks Versus Age of Melton HP1

Further analysis of just the P2 pipe type identified that 40% of leaks on this material have occurred in pipes of more than 45 years of age. This is shown in Figure 23 below.

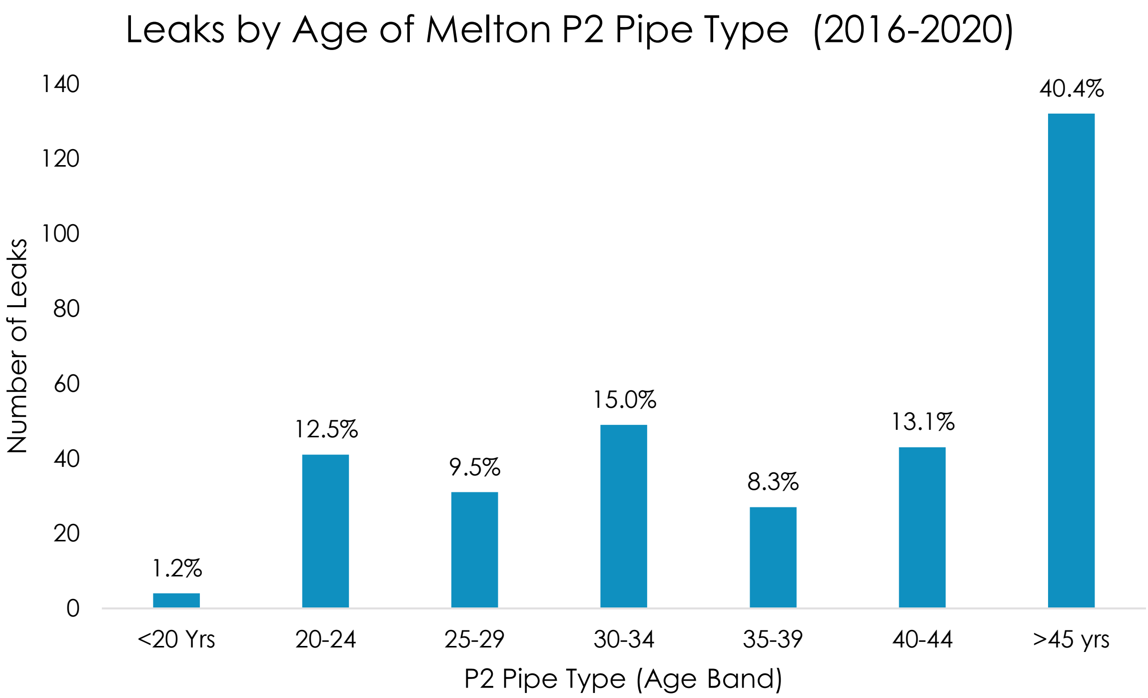


Figure 23: Leaks in Class 575 HDPE (P2) by Age (2016-2020)

The data in Figure 26 illustrates that leaks increase as pipes get older if not treated or replaced. The assessment of five years' of leakage data from 2016 to 2020 shows that the leaks on P2 pipe type have been increasing every year, with 85 leaks identified in 2020.

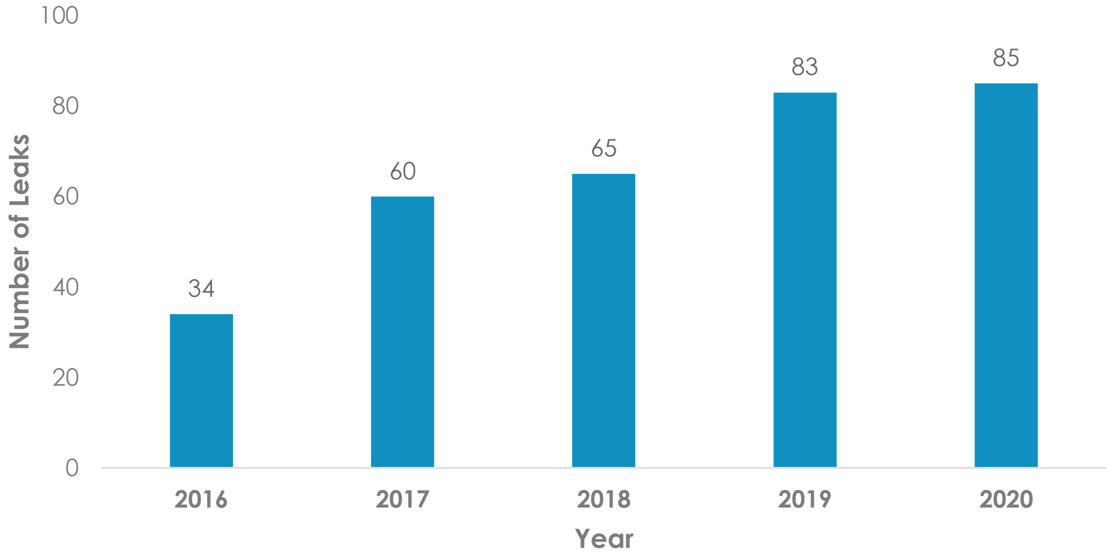


Figure 26: Annual leaks on the Melton P2 network

6.4.1.3. Large Consumers' Metering Efficacy in Melton Network

The total throughput from Melton City Gate was compared with the heavy users to identify whether any unaccounted gas is attributed to the major customers in the Melton network.

The Melton network has six (6) large Industrial Customers. They all use a minimum of 10TJ per annum gas and therefore are termed as 'Interval Sites'. In total, these 6 consumers make the 6% of total throughput from Melton City Gate.

Interval Sites are fitted with a 'data logger' provided by VIPAC to measure the hourly consumption. The big intervals meters in Melton area are installed at:

- [C.I.C]

Two years (2019 and 2020) of consumption data was assessed of these six sites. The Metering data of these sites was compared with the data obtained from VIPAC's data logger. The data did not show any discrepancy. This indicates that higher unaccountable gas in Melton Network is not attributed to Metering errors of the six biggest users in the Melton area.

7. Mains Replacement Program Prioritisation

The methodology for prioritisation of mains replacement is achieved via a three stage process; Identify, Quantify and Prioritise. This process is adopted in order to ensure that the highest risk mains, at the most sustainable cost are prioritised for each year. The performance of the network is reviewed on a yearly basis through a Post Implementation Review (PIR) to ensure the program has targeted the right areas for replacement and is achieving network objectives of maintaining safety across the network by maintaining or reducing leakage rates.

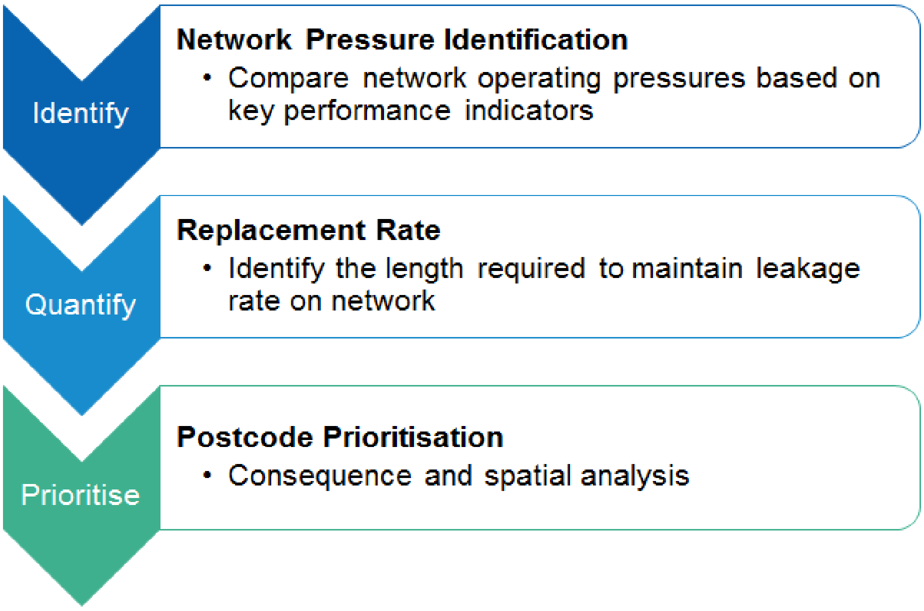


Figure 24: Stages of Prioritisation for the Mains Replacement Programs

7.1. Identification of Program

The first stage of the prioritisation process is the identification of the operating pressure of the three pressure tiers (HP, MP and LP) and identifies the highest risk network based on four key factors; risk, asset status, environmental and economic cost. Figure 25 below summarises the key factors and provides the outcomes:

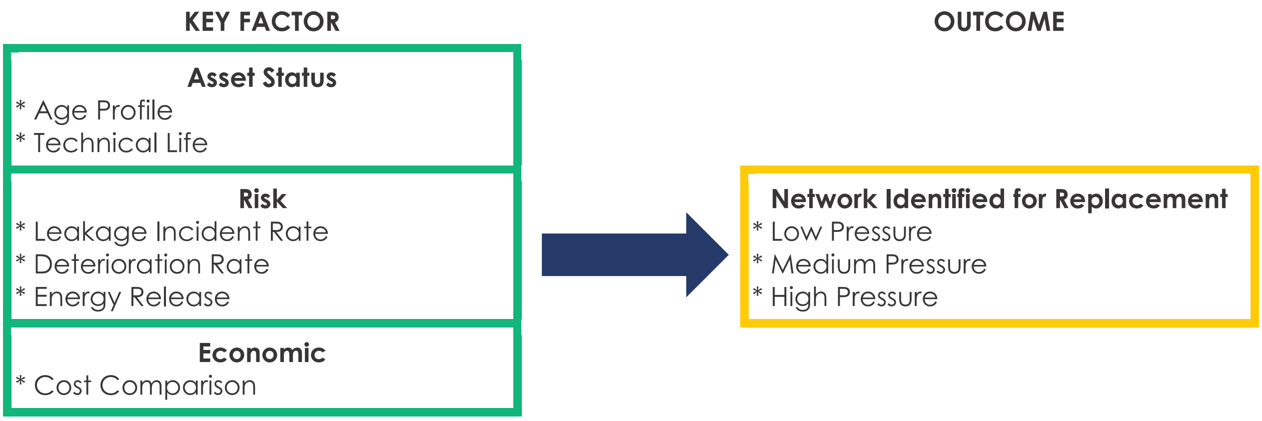


Figure 25: Identify Process for MRP

Risk is the critical factor and key priority for the mains replacement program. A risk weighting comparison was conducted to understand the relative levels of risk from leaks occurring in networks of different material types and operating at different pressure tiers. This highlighted the riskiest material types on each of the pressure tiers.

Table 3: Risk Weighting Results

Pressure Tier	Material	Length (km)	Average LIR	GAS FLOW RATIO	RISK WEIGHTING
High Pressure	PE	6,001	0.17	11.95	2.03
	Class 575 PE (P2)	2,753	0.36	11.95	4.30
Medium Pressure	Steel Protected	198	0.64	4.01	2.57
	Steel Unprotected	211	0.90	4.01	3.61
	PE	24	0.34	4.01	1.36
	Class 250 PE (P4)	29	1.56	4.01	6.26
Low Pressure	Steel Unprotected	16	2.57	1.00	2.57
	Cast Iron	179	1.91	1.00	1.91
	PVC	266	1.30	1.00	1.30
	PE	7	0.14	1.00	0.14

As identified in Table 3 above, the MP network has the highest risk mains; specifically, P4 Polyethylene Class 250. The second highest risk mains are identified in the HP network; first generation P2 Polyethylene Class 575 pipe type.

Due to the volume of gas released during an MP or HP leak, their criticality has been scaled up accordingly through the gas flow ratio. When combined with LIR to evaluate relative risk, it is clear that these mains should be targeted for replacement. For this reason, the MP mains replacement program is as relevant to maintaining network safety, as the low-pressure replacement program is.

7.2. Quantification of Program

The leading determinant of the length required for replacement is maintenance of the leakage rate. The secondary drivers are age profile, technical life, economical assessment and hydrogen compatibility. Figure 26 represents the process and outcome of length required for the mains replacement program.

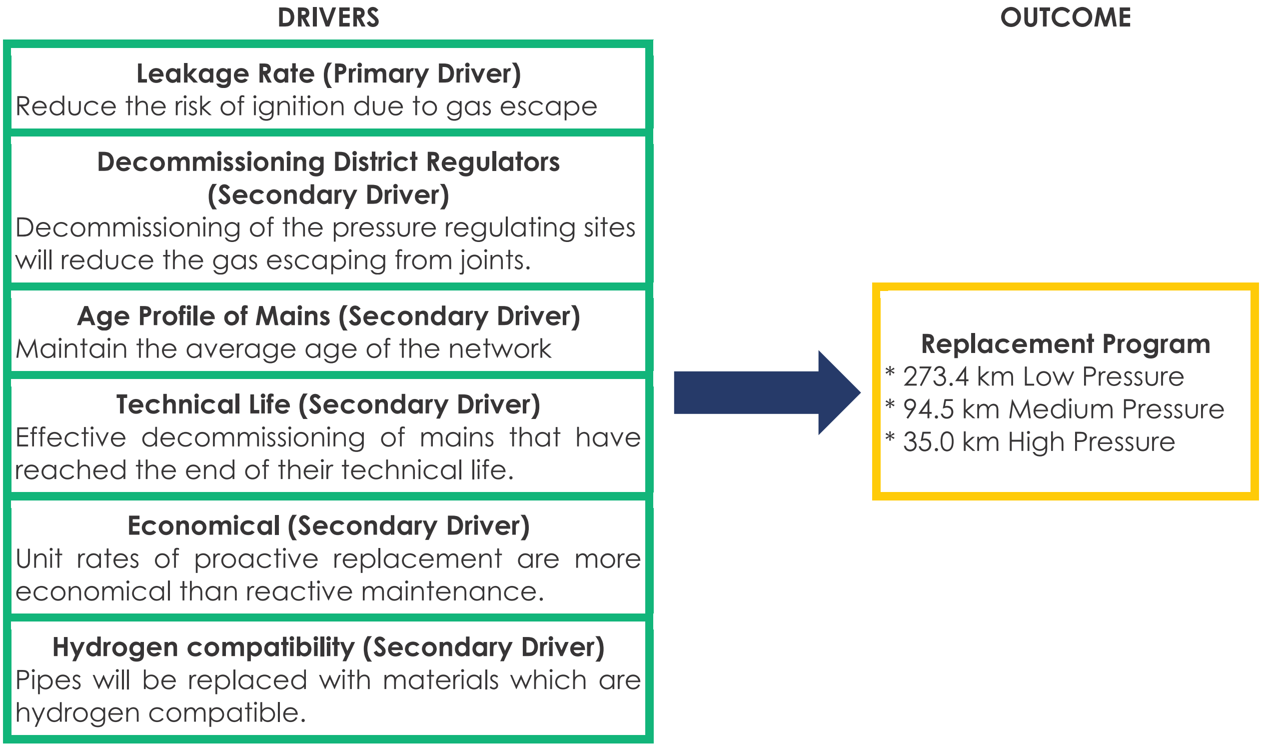


Figure 26: Quantification of MRP

7.2.1. Low Pressure

The LPMR program analysis demonstrates that an average replacement rate of 55 km p.a. of LP mains ensures that leakage rates are kept to the levels that reflects the average of the last 5 years. To maintain the safety of the community and continuity of work, the program as identified in Figure 270 is proposed.

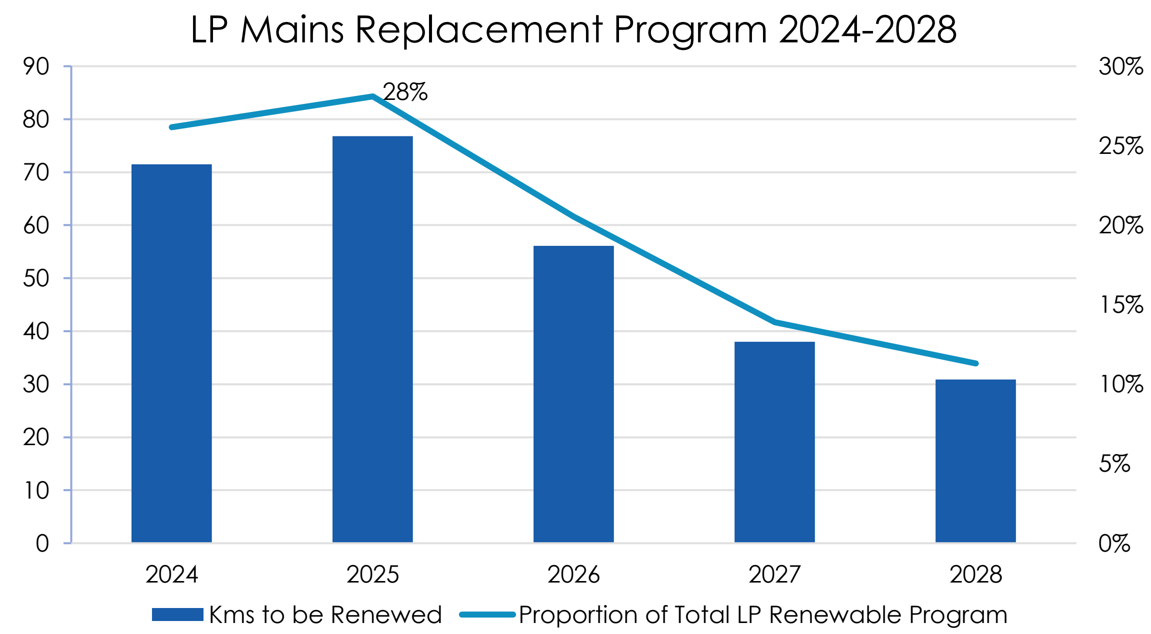


Figure 27: Proposed LP Replacement Profile

The remaining LP replacements are located in regional centres with the exception of 7kms of network in Ascot Vale. To maintain the continuity of the network and proper field resource allocation, more replacements are proposed in the earlier years of the program.

If the LP replacement rate was to decrease, the network may be at risk of increased LIR. AusNet Services is committed to completing the replacement of the LP network by 2028. A smooth replacement profile helps maintain consistency of work and maintain the skilled workforce working on our assets. This ensures that safe work practices are followed. The performance of the historical replacement profile is consistent with the proposed program. This allows for consistency for the workforce, is consistent with meeting the replacement of the LP network by 2028 and consistent with maintaining network safety.

From 2016 to 2020, the LIR of the LP network remained between 0.5 and 0.68; averaging 0.62. Considering the LIR, geographical constraints and operational requirements, Figure 28 below identifies the no. of leaks in the LP network for the upcoming access arrangement period, that is relevant to the proposed replacement program. The forecast of leaks in the LP network is reflected by the dotted line whereas the actual no. of leaks are shown by the solid line. It is clear that the reduction of mains will gradually lead to reduced leaks.

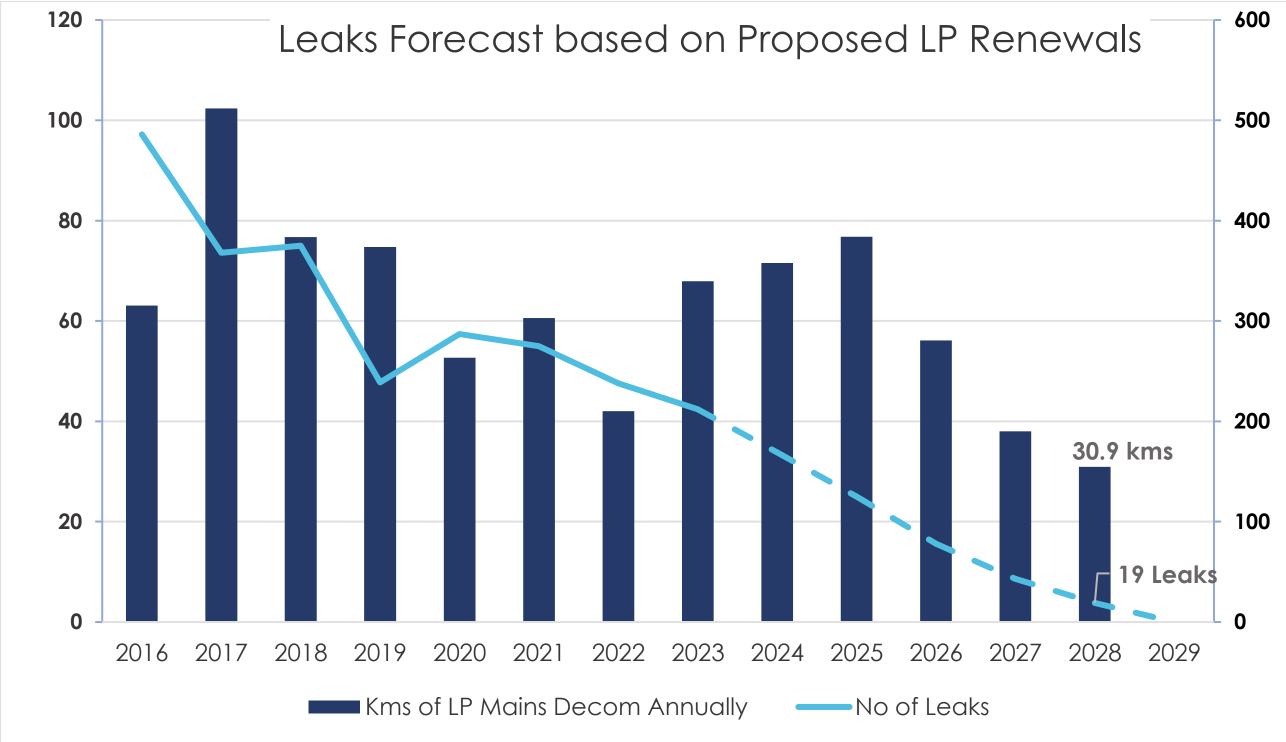


Figure 28: Proposed LP Replacement Profile

7.2.2. Medium Pressure

The worst performing materials on the MP network include the sections of first generation Class 250 PE and un-protected steel. From 2016 to 2020 the LIR on the MP network remained between 0.2 and 0.55; averaging 0.31. However, the first-generation Class 250 PE and Unprotected steel showed average LIRs of 1.56 and 0.9 respectively.

To manage the safety and reliability of supply, and to ensure the future leakage rates remain between 0.2 and 0.5, the remaining first-generation Polyethylene P4 (28.8kms) and 26% of unprotected steel (56.7kms) is proposed for replacement. Including a portion of protected steel, the program is forecast to replace a total of 94.5kms over the five-year period. A breakdown of the proposal can be seen in Figure 29 below.

Network Indicators	Poly Class 250	Steel Unprotected	Steel Protected	Cast Iron
Leakage Rate (5-Year Average)	1.32	0.75	0.5	0.1
Network Composition	4.5%	33.4%	31.2%	0.07%
Percentage of Material class identified as Highest risk for replacement	100% (28.8 kms)	27% (56.6 kms)	4.4 % (8.7 kms)	100% (0.46 kms)

Figure 29: MP Replacement Program

The majority of MP mains have reached their design life as shown in Figure 30 below. They will pose a significant risk of ignition due to gas escape due to organic deterioration.

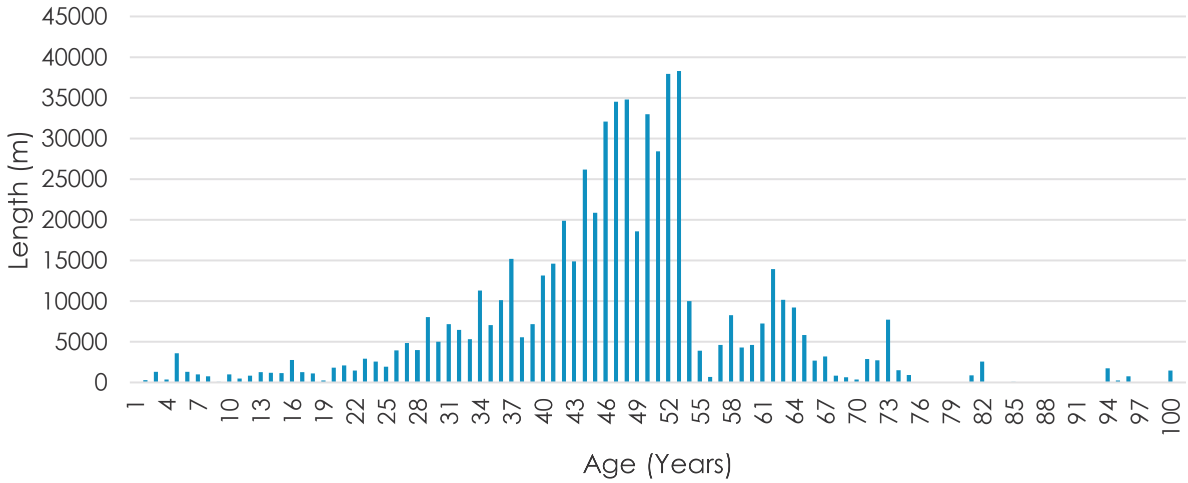


Figure 30: MP Age Profile

The MP network only remains in inner Melbourne metropolitan area as shown in Figure 31 and Table 12 below. Many sections of the MP network traverse within the vicinity of sensitive-use features such as shopping centres, schools, colleges and hospitals. Considering the location of the MP network, the consequence of failure is quite high and requires greater attention.

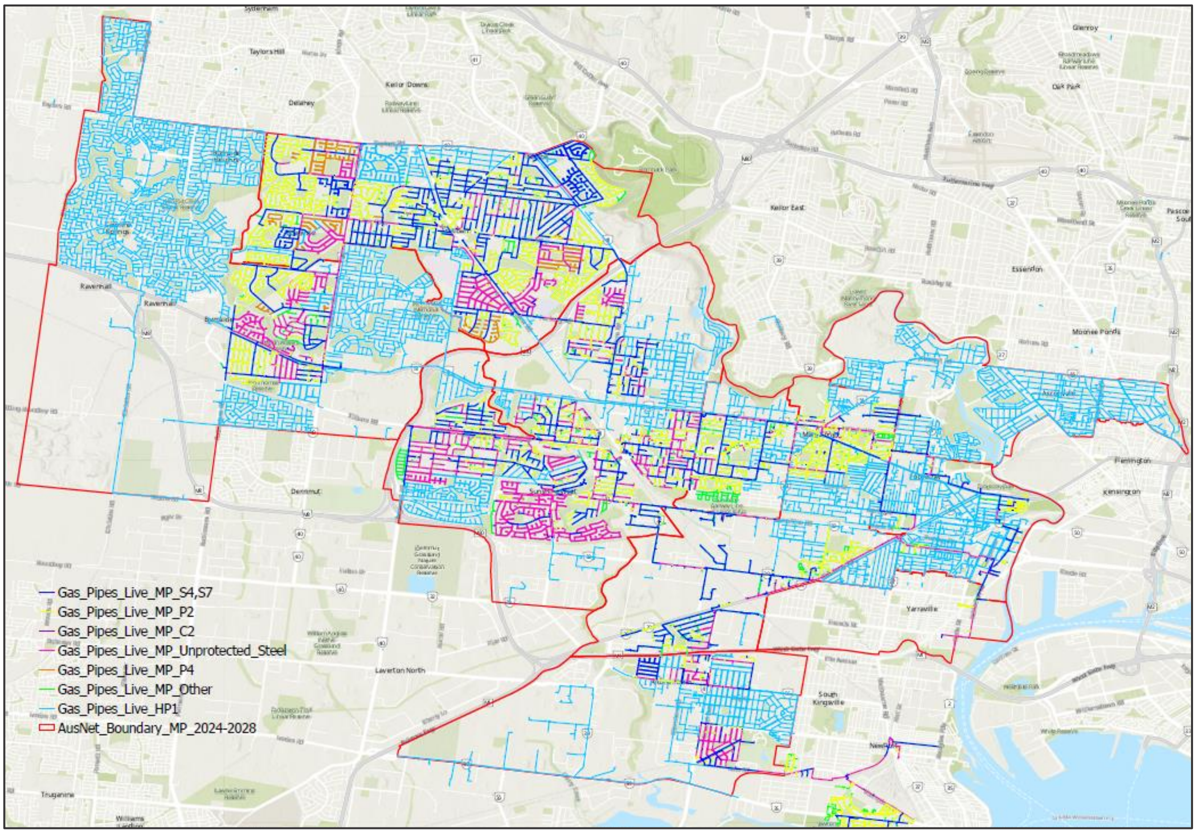


Figure 31: MP network within the Melbourne metropolitan region

Table 4: MP length by Location

POSTCODE	SUBURBS	LENGTH (KM)
3025	Altona East, Altona North, Brooklyn	35.351
3019	Braybrook, Braybrook North	28.833
3032	Ascot Vale, Highpoint City, Highpoint West, Maribyrnong, Travancore	2.051
3020	Braybrook, Sunshine, Sunshine North, Sunshine West	169.740
3023	Burnside, Caroline Springs, Deer Park, Deer Park North	62.705
3022	Ardeer, Deer Park East, Sunshine West	10.741
3011	Footscray, Footscray North, Middle Footscray, Seddon, Seddon West	14.152
3021	Kealba, Kings Park, St Albans, St Albans East, Sunshine	227.317
3012	Brooklyn, Footscray, Footscray West, Kingsville, Maidstone,	60.949
3013	Yarraville, Yarraville West	1.842
3015	Kingsville South, Newport, Spotswood	7.626
3016	Williamstown, Williamstown North	11.364

The program is focused the on highest leaking mains of the network; Poly Class 250 mains and unprotected steel mains . These materials make up 90% of the proposed program of 94.5kms. With delivery efficiencies it is evident that there are several benefits when performing block-replacement compared to like-for-like including unit rate efficiencies.

Block replacement of mains involves the replacement of sizeable area of mains where network characteristics allow the pressure upgrade. In like-for-like replacement the mains are replaced but the pressure upgrade may not occur and will rely on the future upgrades. Therefore, the like-for-like replacement is considered expensive for the life of the upgrade project. The aim of the block renewals is to replace a significant proportion of deteriorated, aged and high-risk mains through the open cut and/or insertion methods.

The proposed program has been designed ensuring the whole 94.5kms of MP mains replacement can adopt a block replacement approach instead of like-for-like approach. While prioritising and sequencing the annual works, the vicinity of the selected networks to the nearby HP network is also considered. Figure 32 below illustrates the example where MP mains will be renewed and connected to the nearby HP mains / network.

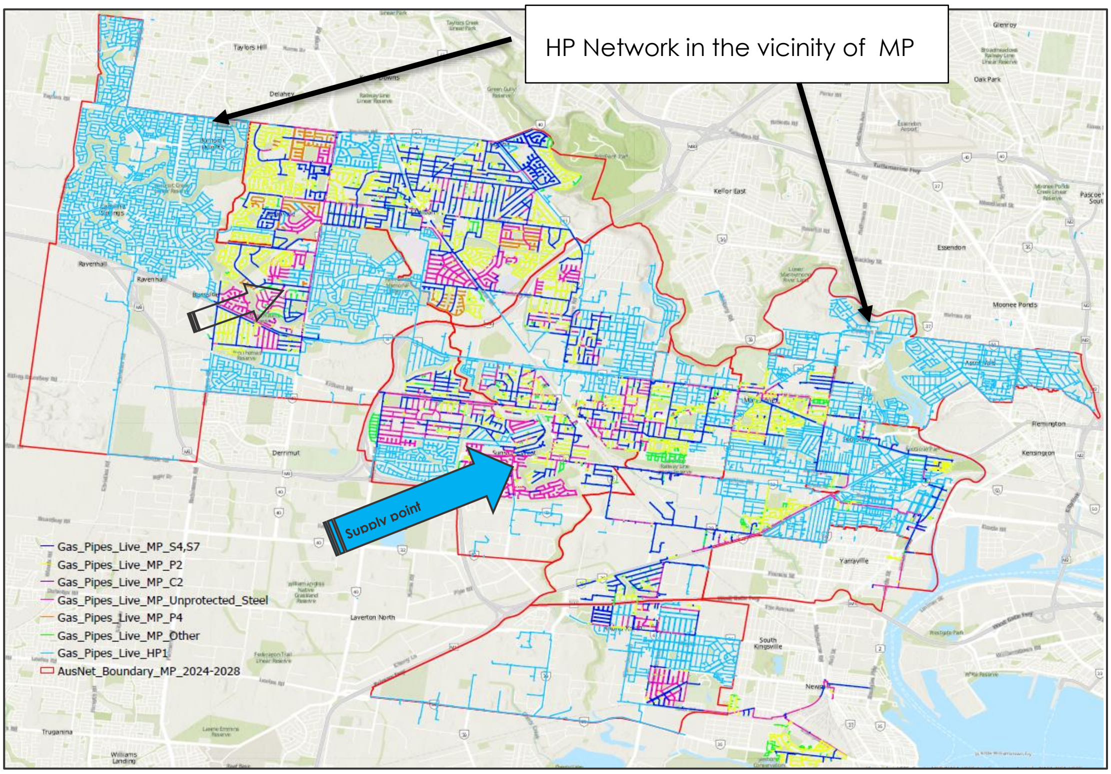


Figure 32: HP networks in the vicinity of MP (Block Replacement)

7.2.3. High Pressure

7.2.3.1. Melton

30% of the Melton network is constructed from the old generation P2 class poly mains. The usage of P2 mains was stopped since the late 1990s. Instead, the stronger and more reliable PE80 and PE100 were used.

The analysis has indicated that the LIR on P2 pipe type are increasing as the pipe is getting older. The average age of P2 pipe is 35 years with oldest is 51 years and the youngest of 21 years old.

The risk weighting of P2 pipe type in Melton is 4.3 (refer to Table 10). This risk rating is second highest after Class 350 P4 in the MP network. The P2 HP network constitutes 30% of HP Melton Network as show in the Figure 33 below.

Figure 33: P2 HP mains in Melton

The risk of gas escape in P2 poly mains is higher for the larger diameter mains. This is due to higher gas release from large diameter mains. Therefore, it becomes one of the criteria for designing the scopes for upgrade.

The assessment of 5 years' leakage data has identified the clusters of leaks in the P2 HP network. These clusters can be attributed to pipe age and quality.

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The scope of works will be designed to undertake the works in continuity of new mains as much as possible, instead of a piecemeal approach. This will enable the continuity of a new pipe-type, enhanced customer satisfaction, reduced safety threat and reduced traffic interruptions due to repairs.

7.2.3.2. Pipeline Sampling and Testing of class 575 HDPE High Pressure Mains

Old generation HDPE products have an oxidised inner surface that predisposes it to premature cracking when certain stresses are applied. The resulting shortened crack initiation time leads to dramatically reduced pipeline longevity through a predominant failure mechanism known as slow crack growth (SCG).[5]

Early squeeze off procedures, which were used to obstruct flow during repairs or for service connection, resulted in the "over-squeezing" of the first-generation HDPE mains. This, coupled with unrestricted release rates, resulted in significant damage to the structural integrity of the mains in which SCG occurs. Subsequent failures at squeeze off locations have and will continue to occur years later depending on the extent of the damage and the operating conditions. All HDPE mains have been squeezed off on average every 60 to 80 meters[6]. All of these points on the mains pose a risk of SCG.

The first-generation HDPE is aging and is now showing a gradual increase in leakages. Consequently, AusNet Services is collaborating with other Victorian distributors to review samples of the squeeze off points, by engaging Deakin University and the Future Fuels CRC (FFCRC). 100 samples will be taken from locations within AusNet Services' network. The locations will be selected addressing different soil type, temperature, precipitation, pipe age, etc.

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[5] Jacobs, "*Mains Replacement Program Review*", January 2016, pg. 24.
[6] Based on inspection results from South Australian inspection program.

The study by Deakin University and FFCRC will address the following objectives:

1) Determine the remaining life of class 575 HDPE mains based on key attributes / contributing factors. Currently this includes location, age and size. There will be a total of 300 samples (100 samples per distributer).
2) Determine remaining life of the class 575 HDPE mains squeeze off points and the best method for extending their life.
3) To investigate and test alternative pipe clamping options
4) Understanding the influence of hydrogen on clamp effectiveness

The outcome of this research will allow AusNet Services to make a decision for managing the class 575 HDPE assets in the future when leakage rates are expected to increase. The research will determine the effectiveness of proactive location and repairs of legacy squeeze off location. This repair option will then be evaluated against the asset replacement option to determine the best return in terms of asset management cost and safety.

A total cost of $738,430 is required to undertake the program. This expenditure will be incurred for the three following activities:

1) Purchase of Camera and Instrumentation
2) Sample Collection of the
3) Review by Deakin and FF CRC

Table 5 below shows the breakdown of the costs which will be incurred during the 2024-28 access arrangement period.

Table 5 Costs for Class 575 HDPE research

ITEM	DEAKIN & FFCRC REVIEW ($'000)	COST ($'000)
[C.I.C]		

7.2.4. MRP Prioritisation

The above mentioned process for LP, MP and HP form the basis to identify and prioritise the sections requiring replacement. This underpins development of the annual replacement program.

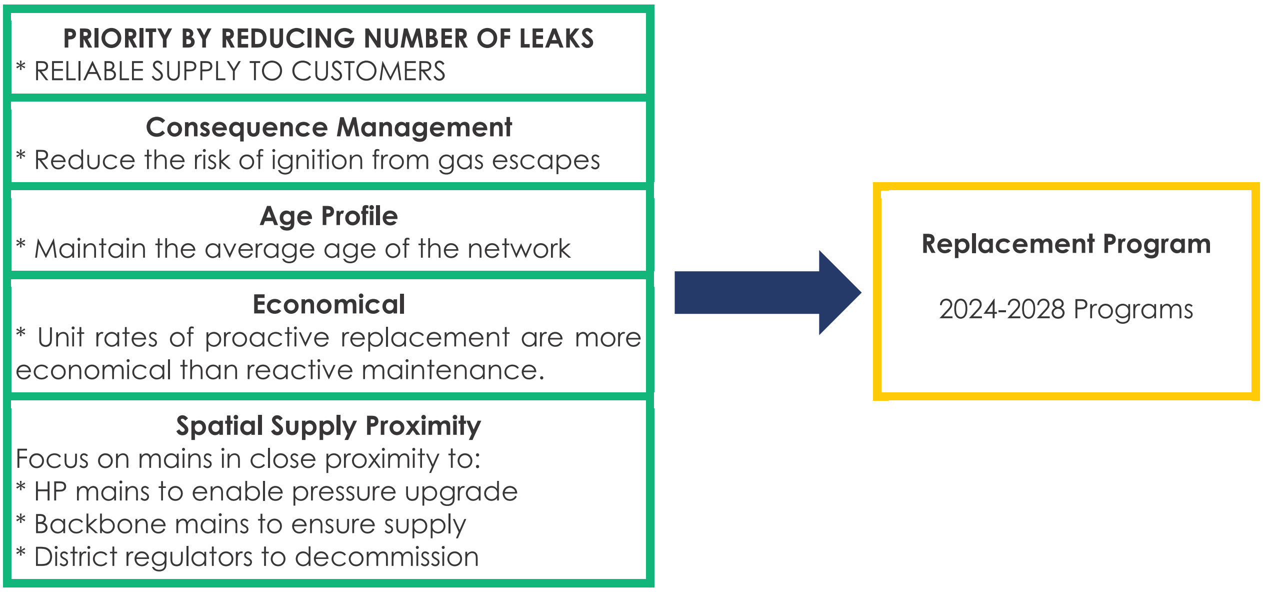

Figure 34: MRP Program Prioritisation

8. Reactive Mains and Services

The Reactive Mains and Service Replacement program is capitalised under the category of minor asset replacement. There are two types of works that are completed:

- Minor Mains and Services Replacement – This involves work necessary to enable the replacement of mains and services that have been identified to have failed and requires urgent replacement.
- Alter/lower Mains and Services – This involves work required where mains have been found to impact other buried utilities or have insufficient depth of cover.

Both are reactive in nature and occur when maintenance (i.e. fixing of a leak) is considered inefficient considering the condition of the asset. This excludes Mains and Services replacement associated with the Planned Mains Replacement Program, third party damages, and customer initiated works. Both of these categories apply for all three pressure tiers in the distribution network.

8.1. Reactive Mains and Services Replacement Program

The minor mains replacement program involves reactive replacement of mains less than 20 metres in length.[7] A historical analysis was extracted from the works management system, with the following work specifications shown in Table 14.

Table 6: Word Code Categories

WORK MANAGEMENT SPECIFICATION CODE	CATEGORIES WITHIN THE PRESSURE CATEGORY
3002 (Low Pressure Replacement ADHOC)	LP - Lower / Alter Mains & Services LP - Reactive Mains & Service Rep
3004 (Medium Pressure Replacement ADHOC)	MP - Lower / Alter Mains & Services MP - Reactive Mains & Service Rep
3006 (High Pressure Replacement ADHOC)	HP - Lower / Alter Mains & Services HP - Reactive Mains & Service Rep

Two counteracting factors which influence the reactive mains replacement requirements are:

- Mains deterioration with age, and reduction in ground cover increases the number of mains failing that require replacement; and
- Mains replacement as part of the LP mains replacement program will decrease the total aged cast iron mains remaining in the network that have a higher risk of failure.

The historical average for the last four year has been analysed to forecast reactive mains replacement required for the 2024-28 regulatory period as shown in Figure 38 below.

7 Larger projects requiring replacement of mains larger than 20 meters fall under the Project type 3001 – Mains Replacement Program.

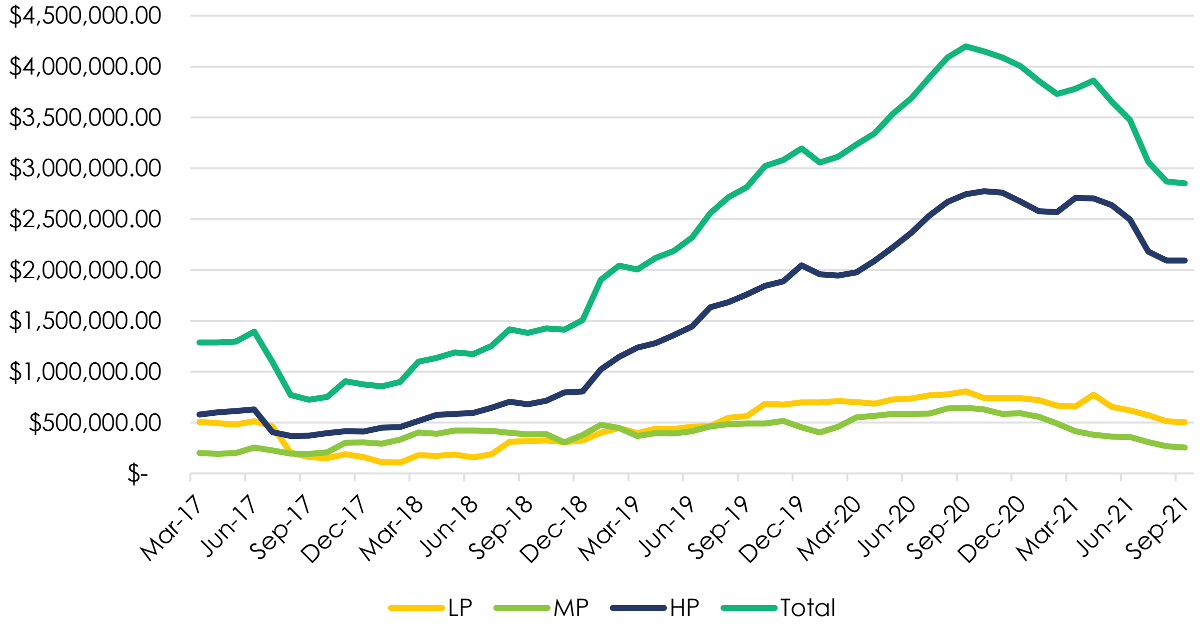

Figure 38: Rolling 12 month CAPEX on Reactive Mains and Service Replacement (Mar 2017 – Sep 2021)

The ongoing program to replace LP distribution mains will gradually offset the requirement for reactive LP expenditure. 273.4 kms of LP mains will be remaining from 1 July 2023. As this volume decreases over the 2024-28 access arrangement period, so will the ad hoc LP failures and repairs. Hence, the reactive LP works are forecasted to trend towards 0 across the period. Based on a four-year trend analysis and considering the ongoing efficiencies, [C.I.C] is forecasted for the 2024-28 regulatory period as shown in Figure 35.

[C.I.C]

Figure 35: Annual Reactive LP Mains / Service CAPEX

Ad hoc MP replacements are expected to continue over the 2024-28 access arrangement period. Whilst the fleet is deteriorating, 94.5km of proactive replacements are proposed to maintain network safety. Therefore, it is expected that ad hoc replacements will remain constant throughout the period. Based on a four-year trend analysis and considering the ongoing efficiencies, [C.I.C] is forecasted for the 2024-28 regulatory period as shown in Figure 36.

[C.I.C]

Figure 36: Annual Reactive MP Mains / Service CAPEX

The graph in Figure 37 below indicates that the ad hoc replacement of HP mains have been significant since January 2019. However the increasing trend was curtailed in 2020 in part due to a shift in preference to repair over replacement. It is expected that the recent downward trend will continue throughout the regulatory period. Additionally, the dedicated replacement program for renewing the first-generation poly type main in the Melton area will also result in reduced reactive mains and service replacements on the HP network. It is anticipated that a 10% year-on-year decline will be witnessed. Based on at four-year trend analysis and considering the initiatives, [C.I.C] is forecasted for the 2024-28 access arrangement period as shown in Figure 37.

[C.I.C]

Figure 37: Annual Reactive HP Mains / Service CAPEX

The total expenditure is dominated by the HP ad hoc expenditure and therefore also follows a downward projection. The initial year's forecast has been derived from a four year historical average for reactive mains & services replacement in each pressure tier with subsequent years following the nominated trend. The current reactive replacement methodology and rate are aligned with current practices and volumes. This results in the following program for reactive mains replacement shown in Figure 38 below.

[C.I.C]

Figure 38: Proposed Reactive Mains / Services Replacement Program

A total of $11.63 Million has been forecasted for the 2024-28 access arrangement period. The factors forming the basis for this forecast are:

1) Ongoing mains replacement program for poor performing LP and MP distributions mains
2) Renewing P2 pipe type HP mains in the Melton area.

By the end of 2024-28 regulatory period, LP Mains will no longer exist and hence will not require any budget for ad hoc replacements. Similarly 94.5kms of MP mains will be renewed which will improve performance and remove all cast iron mains from the network.

8.2. Reactive Service Replacement

When a broken service line is in a state where it is likely to fail again, replacement is preferred over repair. Analysis from the Asset Management data capture system (SAP) was used to analyse historical work performed. The following work codes were used:

- WS0041: RENEW DEFECTIVE SERVICE (NATURE STRIP AND ROADWAY); and
- WS0057: LOWER/ALTER SERVICE NON CHARGEABLE.

Two counteracting factors influence the reactive service replacement requirements:

- Services deterioration with age, and reduction in ground cover increases the number of services failing that require replacement; and
- Service upgrades associated with mains replacement program will decrease the number of reactive service replacement required.

In some cases, it is not possible to replace a service by inserting a smaller-diameter pipe. The installation of a new service is required by opening a trench within the customer property. This can result in significant extraordinary works.

8.3. Reactive Replacement Program

The current reactive replacement methodology and rate are aligned with current practices and volumes. The overall summary of the works program is shown in Table 7 below:

Table 7: Proposed Reactive Mains and Service Replacement in $'000

PROGRAM	2023-24	2024-25	2025-26	2026-27	2027-28	2024-28 TOTAL
			[C.I.C]			

9. Network Replacement CAPEX Proposal

This section describes the annual forecast of the replacement programs within this strategy. It is noted that the annual spend is based on the specific networks selected for replacement in each particular year.

9.1. Phasing and Financial Disclosure

All programs within the Mains and Services Strategy are defined in Australian Financial Year, consistent with the new reporting requirements of the AER.

All financial figures quoted within this document, including all historic and forecasted expenditure – unless otherwise specifically stated – have the following characteristics:

- Real Expenditure / Cost (reference year = 2022);
- Direct Expenditure only (i.e. excludes overheads and corporate finance costs); and
- In units of $1,000 (i.e. '000).

9.2. CAPEX SUMMARY

Figure 39 below shows a summary of the mains and services CAPEX for the 2024-28 access arrangement period.

[C.I.C]

Figure 39: Mains and Services CAPEX 2024-28, $'000

9.3. LP Annual Program

AusNet Services has carried out a detailed review of the LP mains replacement program. The networks for replacement were modelled and consequently the whole program has been split into 24 scopes of work. Location specific unit rates have been derived for each scope and finalised in the following three stages:

1) Desktop review and identification of unit costs, based on the recent historical costs for MRP.
2) Street-walks by experienced Project Manager to ascertain location specific features and unit cost refining.
3) Market Validation by issuing RFQs for three regional centres - Portland, Horsham and Stawell for FY23 works.

The 2024-28 replacement program includes postcodes located predominantly in Regional Victoria, as well as remaining segments of AusNet's LP Network in Geelong and the inner metropolitan region. The profile of kilometres to be replaced and CAPEX under the LP replacement program is detailed in Table 8 and 17 below.

Table 8: LP replacement lengths by location and year (km)

POSTCODE	SUBURB	2023-24	2024-25	2025-26	2026-27	2027-28	2024-28 TOTAL
			[C.I.C]				

Table 9: LP replacement CAPEX by location and year ($'000)

POSTCODE	SUBURB	UNIT RATE ($/M)	2023-24	2024-25	2025-26	2026-27	2027-28
			[C.I.C]				

9.4. MP Annual Program

AusNet Services has carried out a detailed review of MP mains replacement program. The networks for replacement were modelled and consequently the whole program has been split into 13 scopes of work. Location specific unit rates have been derived for each scope and finalised in the following three stages:

1) Desktop review and identification of unit costs, based on the recent historical costs for MRP.
2) Street-walks by experienced Project Manager to ascertain location specific features and unit cost refining.
3) Market Validation by issuing RFQs for two renewal projects in Altona network.

The 2024-2028 replacement program includes postcodes located in metropolitan Melbourne. The MP mains replacement unit rate is based on 'block replacement' methodology. A like for like unit rate is higher than that of block renewal due to the volume of mains replaced, and complexity around maintaining supply. The profile of kilometres to be replaced as part of the MP replacement program is detailed in **Error! Reference source not found.** below. **Error! Reference source not found.**9 below shows the annual CAPEX for the MP replacement program per scope and postcode.

Table 18: MP replacement lengths by location and year (km)

POSTCODE	SUBURB	2023-24	2024-25	2025-26	2026-27	2027-28	2024-28 TOTAL
			[C.I.C]				

Table 19: MP replacement CAPEX by location and year ($'000)

POSTCODE	SUBURB	UNIT RATE ($/M)	2023-24	2024-25	2025-26	2026-27	2027-28
			[C.I.C]				

9.5. HP Annual Program

The HP program will begin by focussing on replacement of the P2 pipes in Melton as this is one of the worst performing fleets on the network. It will also look into the life expectancy and extension of Class 575 HDPE mains. For the purpose of creating a 5-year forecast it was assumed that an average of [C.I.C].

Table 10: HP replacement CAPEX by year ($'000)

PROGRAM	2023-24	2024-25	2025-26	2026-27	2027-28	2024-28 TOTAL
HP Replacements		[C.I.C]				

9.6. Reactive Mains and Services Annual Program

The current reactive replacement methodology and rate are aligned with current practices and volumes. The overall summary of the works program is shown in the Table 21 below:

Table 11: Proposed Reactive Mains and Service Replacement in $'000

PROGRAM	2023-24	2024-25	2025-26	2026-27	2027-28	2024-28 TOTAL
			[C.I.C]			

Appendix A: Replacement Methodology

This section provides a brief overview of AusNet Services' mains and services construction methods and covers key topics including:

- Open Cut Construction Method;
- Insertion Construction Method;
- HP Standard Philosophy;
- Block vs. Like for Like Replacement Approach; and
- Upgradeable Mains Approach.

Open Cut

The open cut method is the typical method of laying pipe and is also used when replacement via insertion method cannot be achieved.

Insertion Construction Method

Insertion is a method of upgrading existing mains with polyethylene (PE) pipes up to DN 63 mm. This technique of inserting smaller PE pipes into larger pipes reduces excavation and reinstatement costs inherent with open cut methods. The advantages of the insertion method include:

- The existing pipe provides the new pipe additional physical protection from damage.
- Smaller diameter HP PE pipe can be utilised which involves lower material costs and lower labour costs as PE is easier to install.[8]
- Minimal ground works required reduces rectification costs, traffic management costs and environmental impacts.

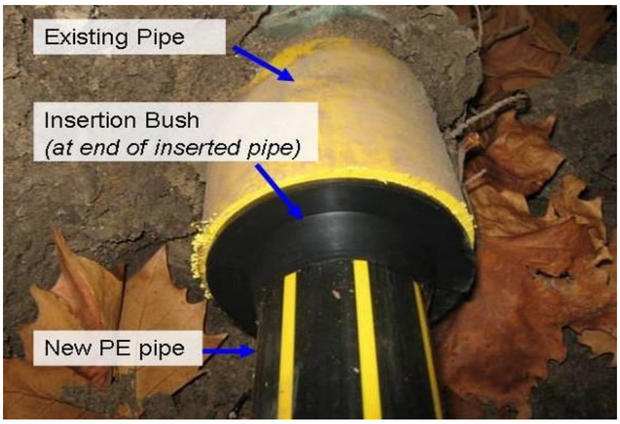

Figure 40: Insertion Bush

[8] Smaller diameter pipe can be used as there is more volumetric throughput when upgrading LP or MP pipe to HP operating pressures.

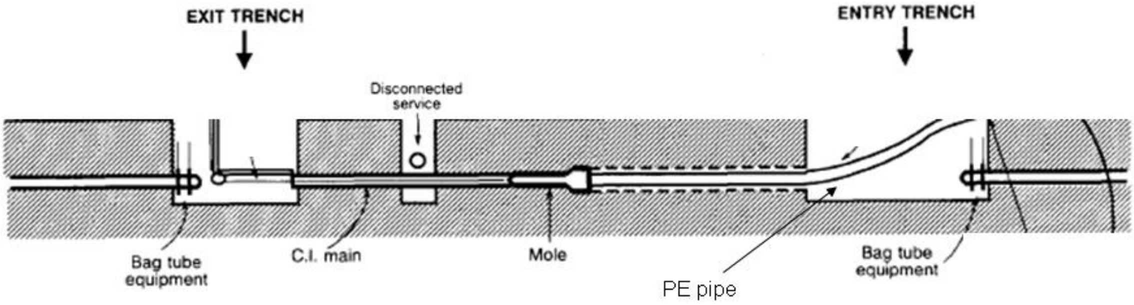

Figure 41: Insertion Method

The insertion method is used extensively within the LP mains replacement program. In contrast, due to the high volume of steel and relatively small volume of cast iron, the use of the insertion method becomes increasingly difficult in the MP network.

HP Standard Philosophy

It is AusNet Services' policy to lay all new mains to HP standard. In accordance with AusNet Services' Technical Standard TS4127: Distribution – Mains and Services, the policy is as follows:

- lay all new systems and all mains extensions to high pressure standard;
- replace/renew all distribution mains and services to high pressure standards; and
- utilise insertion techniques for renewals where feasible.

The installation of HP mains is operationally and technically preferred because it:

- meets most future capacity requirements by high pressure upgrade rather than by carrying out reinforcements and laying parallel high pressure mains to particular large customers;
- eliminates a substantial recurrent problem of outages due to water ingress;
- standardises infrastructure to gain operational efficiencies;
- reduces operational requirements over time;
- provides economy of scale savings in areas of replacement and associated overheads;
- provides reliability, quality of supply and environmental advantages sooner; and
- provides for the decommissioning of remaining district regulators.

Block vs. Like for Like Replacement

There are two approaches that can be adapted for the mains replacement programs identified.

Like for Like Replacement

Like for like replacement involves replacing existing mains with polyethylene or steel mains of similar capacity. Like for like replacement is employed where HP supply is not immediately available, and the mains has been identified as a high priority[9] for replacement. The replacement mains will be laid to HP standard (to enable

[9] Priority is based on high leakage rate, high OPEX cost, and high reliability and supply issues.

future upgrade of entire network pressure once high pressure is available) but operated at the existing network pressure.

Existing domestic regulators remain but services are pressure tested to HP standard. If a service fails a pressure test, it is decommissioned and re-laid to HP standard but sized for the existing network pressure to ensure continuity of supply.

Block Mains Replacement

Block mains replacement involves the replacement of sizeable area of mains where network characteristics allow, i.e. proximity to HP network and proximity to other mains identified for replacement. The aim of block renewals is to replace a significant proportion of deteriorated, aged and high risk mains through the open cut and/or insertion methods.

Upgradeable Mains

Upgradeable mains are mains installed in the LP or MP networks that can be simply upgraded to high pressure as the mains are capable (rated) to operate at HP standard. Upgradeable mains do not require substantial construction works as only minor works are involved to replace the customer's service regulator at the meter is required. Upgradeable mains therefore will have a lower unit rate compared with mains that require full replacement or renewal.

Appendix B: Energy Release Comparison Methodology

To quantify the relative risk contribution of each key material type to AusNet Services and the general public, a simple calculation has been derived that utilises the known leakage and energy release rates. The risk weighting highlights the networks AusNet Services' should focus its mains replacement programs to achieve its objective to maintain or increase network safety.

Orifice Discharge Calculations

Generally, the gas flows through an orifice obeys the law:

$$L = k \sqrt{P_U}$$

This formula is for subsonic or subcritical flow regime, where the area of the break is less than 4% of the cross sectional area of the main at the break. A simplification of the orifice equation provides a practical calculation approach to compare the pressure tiers.[10]

$$L = 0.13D^2\sqrt{(P_B(P_U-P_B))}$$

$$\text{Energy} = L \times \text{Energy Content NG}$$

Key Assumptions:

- D is equivalent diameter of break of 10 mm;
- Subsonic flow;
- P_b Pressure at break is at atmospheric pressure (101.3 kPa);
- P_U Upstream mains pressure at break;
- Energy content of Natural Gas 38.7 MJ/sm3; and
- Operating pressure based on the typical pressure of each network.

Table 12 below shows the calculation results for each pressure network:

Table 12: Gas Flow Calculation for Different Pressure Networks

PRESSURE	OPERATING PRESSURE	PU (KPA)	FLOW OF GAS (SM^3/HR)	ESTIMATED ENERGY (GH/HR)
Low Pressure	3.2	104.5	218.94	8.47
Medium Pressure	45	146.3	877.72	33.97
High Pressure	400	501.3	2616.85	101.27

10 Extract taken from old GFC library Document number 026/2001/001-16 "AG703 A guide for the control of UAFG."

Ratio Comparison

Ratio comparison of gas flow uses LP network flow as the baseline benchmark:

Table 13: Gas Flow Ratio Comparison with LP

LOW PRESSURE	MEDIUM PRESSURE	HIGH PRESSURE
1.00	4.01	11.95

Appendix C: List of Remaining District Regulators

Table 24 contains a list of thirty nine (39) district regulators which will be eliminated from AusNet Services' LP network as a result of the planned LP mains replacement program.

Table 14 List of District Regulators to be decommissioned GAAR 2024-28

SR NO.	REGULATOR NAME	SUBURB / TOWN	NETWORK NAME	MELWAY REFERENCE
1	P1-0269	ASCOT VALE	L01	28 F09
2	P1-0793	BALLARAT	L20	V566 D9
3	P1-0364	ARARAT	L39	V554 E9
4	P1-0365	ARARAT	L39	V554 C07
5	P1-5001	ARARAT	L39	V554 H07
6	P1-0351	HORSHAM	L42	V544 G4
7	P1-5002	HORSHAM	L42	V544 E06
8	P1-0844	STAWELL	L40	V550 E09
9	P1-0306	BALLARAT	L20	V566 A08
10	P1-0311	BALLARAT	L20	V566 C10
11	P1-0373	STAWELL	L40	V550 D08
12	P1-0823	HORSHAM	L42	V544 E03
13	P1-5003	STAWELL	L40	V550 F08
14	P1-0836	BENDIGO	L25A	V607 T06
15	P1-0842	BENDIGO	L25A	V607 P10
16	P1-0200	BENDIGO	L25A	V607 S4
17	P1-0201	BENDIGO	L25A	V607 Q08
18	P1-0861	BENDIGO	L25A	V607 T3
19	P1-0203	BENDIGO	L25A	V607 Q04
20	P1-0879	GEELONG	L49	451 E05
21	P1-0876	GEELONG	L49	452 A06
22	P1-0873	NEWTOWN	L49	451 F6

23	P1-0495	NEWTOWN	L49	451 K05
24	P1-0386	WHITTINGTON	L49	452 G12
25	P1-0419	COLAC	L38	V520 C04
26	P1-0520	WARRNAMBOOL	L22	V514 G03
27	P1-0370	COLAC	L38	V520 D06
28	P1-0465	PORTLAND	L43	V501 P12
29	P1-0877	PORTLAND	L43	V503 P04
30	P1-0784	WARRNAMBOOL	L22	V514 K07
31	P1-0412	WARRNAMBOOL	L22	V514 G05
32	P1-0883	HAMILTON	L21	V506 F09
33	P1-0825	WARRNAMBOOL	L22	V514 H08
34	P1-0413	WARRNAMBOOL	L22	V515 O5
35	P1-0411	WARRNAMBOOL	L22	V514 L06
36	P1-0354	WARRNAMBOOL	L22	V515 N9
37	P1-5004	COLAC	L38	V520 F04
38	P1-0447	WARRNAMBOOL	L22	V515 P9
39	P1-0343	HAMILTON	L21	V506 G06

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