AusNet Gas Services Pty Ltd

Gas Access Arrangement Review 2018–2022

Appendix 6E: Mains and Services Strategy – Public

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Mains & Services Strategy

Gas Network

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Executive Summary

This document outlines the strategy for the replacement of gas distribution mains and services relevant to AusNet Services for the period 2017 to 2022.

The majority (85%) of the distribution networks operate between 1kPa-515kPa and are comprised of high pressure (140-515kPa) polyethylene main. The average age of the network is 23.6 years with the total length of pipe being 10,951km servicing 660,000 customers. The distribution network spans inner Melbourne metro to western Victoria.

The replacement programs contained within this strategy include the low and medium 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.

The proposed Low Pressure Mains Replacement (LPMR) Program includes a total of 410km over the 5 year period 2018-22 of targeted and prioritised replacement. The program targets the worst performing and the most deteriorated mains. The Medium Pressure (MP) Mains Replacement Program (MPR) includes a total of 55km over the same 5 year period. Mains replaced within this program are targeted towards the replacement of unprotected steel networks and first generation polyethylene mains. The table below provides the following capital profile for the mains and services strategy.

Table 1: Calendar Year Capital Expenditure to 2022

Replacement Program		2017	2018	2019	2020	2021	2022	2018-2022
Low Pressure Mains Replacement	Volume (km)	83.5	85	84	83	79	78	410
	$ '000	$16,700	$23,425	$19,624	$18,999	$18,802	$18,280	$99,130
Medium Pressure Mains Replacement	Volume (km)	20	17	15	17	3	4	55
	$ '000	$5,000	$5,099	$4,157	$4,938	$1,216	$1,216	$16,626
Reactive Mains Replacement	$ '000	$1,059	$992	$992	$992	$992	$992	$4,960
Total Volume (km)		**104**	**102**	**99**	**100**	**83**	**82**	**465**
Total Spend ($'000)		**$22,759**	**$29,516**	**$24,773**	**$24,929**	**$21,010**	**$20,488**	**$120,716**

1 Document Overview

1.1 Purpose

The 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.

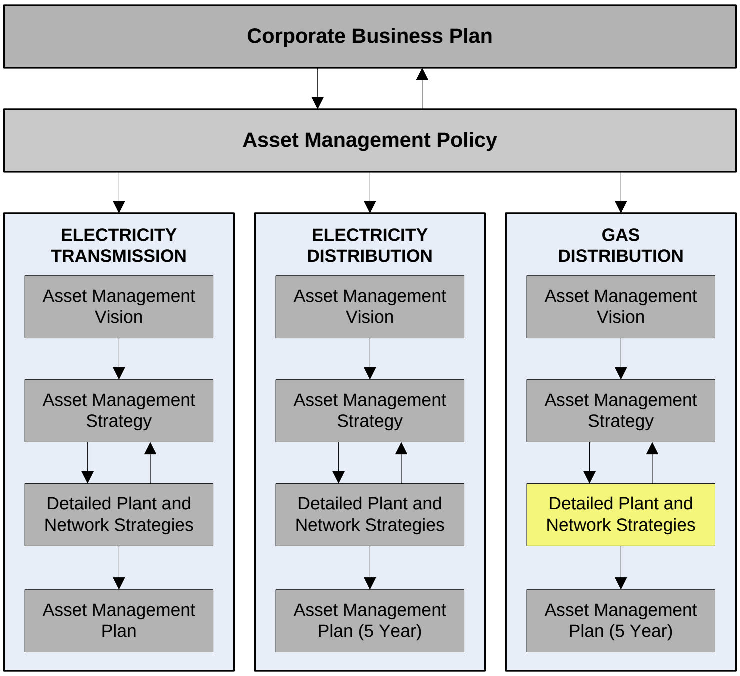
The Gas Distribution Mains and Service Strategy is one of several plant strategies developed and maintained for the management of AusNet Services' Gas Distribution Network. This strategy has the following objectives:

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

1.2 Relationship with other Management Documents

The mains and services strategy is one of a number of asset management related documents developed and published by AusNet Services in relation to its gas distribution network. As indicated in the figure below, detailed plant strategies, in which the Gas Distribution Mains & Services Strategy belongs, informs both the Asset Management Strategy (AMS) and Asset Management Plan (AMP) of the required capital programs needed to achieve the long-term objectives of the gas distribution network.

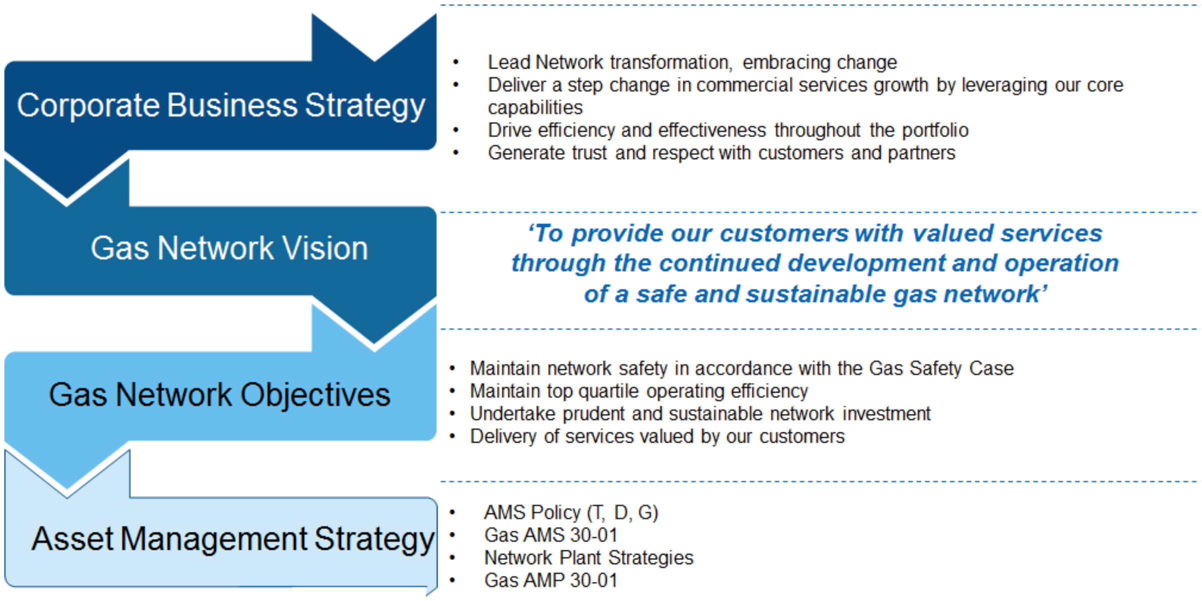
Figure 1: Asset Management System document interdependencies



2 Alignment of AusNet Services Business Drivers and Objectives

AusNet Services' purpose statement is to "Empower communities and their energy 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, and is a key theme throughout the Corporate Business Strategy. The following diagram provides the linkage between AusNet Services corporate strategy, and the gas network vision consistent with providing valued customer service and sustainable network investment. The gas network objectives which stems network vision then drives the development of the programs for each of the asset strategies

Figure 2: Alignment of Corporate, Business and Network objectives



The gas network objectives alignment with the business, regulators, and the delivery of plant strategies are detailed below:

Maintain network safety in accordance with the Gas Safety Case

Maintains the alignment to AusNet Services' commitment to 'Mission Zero'. The objective to maintain network safety is in recognition of AusNet Gas Services' current safety performance and design of the network.

Maintain top quartile operating efficiency

Aligns to the Corporate Business Plan with AusNet Services' aspiration to operate "all three core networks in the top quartile of efficiency benchmarks".

Undertake prudent and sustainable network investment

Alignment to AusNet Services' obligation to undertake prudent and sustainable network investment, as defined in the National Gas Rules and Gas Distribution System Code.

Delivery of valued services to our customers

Establishes the need to better understand our customers (their needs and behaviours) and deliver services they value.

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.

Table 2: Alignment of Mains and Services Strategies with Gas Network Objectives

Mains and Services Strategy	Gas Network Objective			
	Maintain network Safety	Maintain operating efficiency	Undertake prudent & sustainable investment	Deliver valued services to customers
Low Pressure Mains Replacement	•	•	•	•
Medium Pressure Mains Replacement	•	•	•	•
Reactive Mains Replacement	•	•	•	•

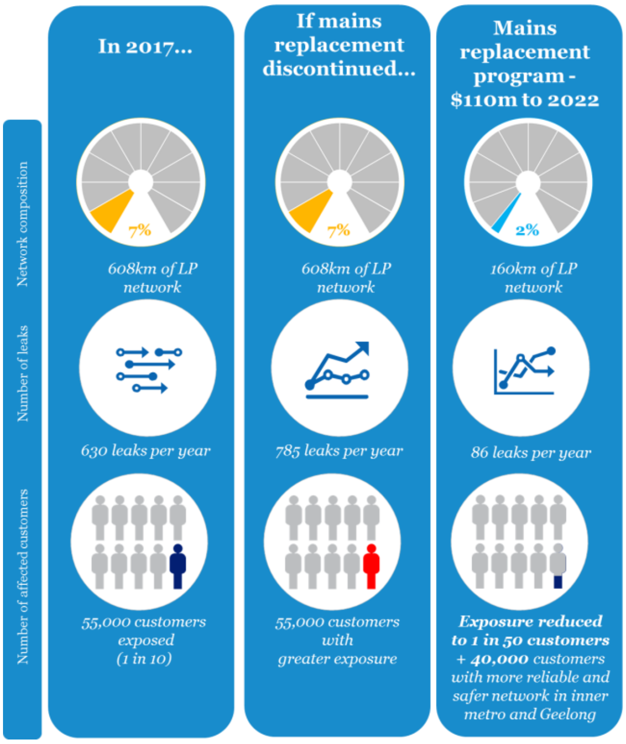
Gas Network Objectives

Maintain network safety in accordance with the Gas Safety Case;

The replacement of poor performing and compromised mains reduces leaks across the network, and decrease the risk of potential fire or explosion caused by a leak.

The replacement program will reduce leaks in the network, and there will be less exposure to risk for our customers. The following diagram describes the safety benefits of the program:

Figure 3: Safety Benefits of proposed LP Replacement Program



Maintain top quartile operating efficiency;
The replacement of poor performing and compromised mains, removes the deteriorated mains on the network, and the associated operational expenditure cost compared to other operating networks.

Undertake prudent and sustainable network investment;

This strategy represents 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 renewal program provides valued service to our customers as demonstrated by reliability, a decreased risk profile to the community with the reduction with leaking pipes, and provides the customer with freedom of choice with reference to diversification of appliances.

- **Safety – Reducing risk of gas leaks:** Gas pipes with the highest fracture and leak incident rate are targeted for replacement. Gas leaking from a pipe has the potential to cause death and injury to the public and property damage. The mains and service replacement program decreases the risk to the community associated with leaking pipes.
- **Enhanced Customer Service to consumers (increased system capacity):** High Pressure upgrade 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.

3.1 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 less than 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.

4 Asset Overview

The gas distribution network in accordance with AS/NZS 4645.1 encompasses all facilities between the outlets of all city gates, supply points, or equivalent and the outlet of the consumer's meter assemblies. The gas distribution network consists of approximately 10,951[1] km of distribution mains and services operating at high, medium and low pressures.

The majority of the distribution system operates at high pressure 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 (owned and operated by APA Group) to AusNet Services' distribution network.

The medium pressure distribution systems operate between 15kPa to 140kPa, with Field regulators regulating gas supply from AusNet Services' high pressure networks.

The low pressure distribution systems operate up to 7kPa with District Regulators regulating gas supply for AusNet Services high and medium pressure networks. A summary of the Distribution Mains is shown in the table below.

Table 3: AusNet Services' Distribution Mains Asset Summary

AusNet Services' Distribution Mains Asset Summary						
Network Average Age	23.93 Years					
Total Network Length	10,951km					
Length by Pressure	Low (LP) 776km	Medium (MP) 702km	High (HP) 9380km	High (HP2) 91km		
Length by Material	Cast Iron 263km	Polyethylene 7446km	PVC 410km	Other 29km	Un-Coated Steel 287km	Protected Steel 2514km

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 was predominantly used until the introduction of polyvinyl chloride (PVC) for low pressure like-for-like replacement and polyethylene for high pressure networks in the late 1970's. Today, PVC is no longer installed in the network leaving high density polyethylene as the dominate 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 managed, helping to offset some of the natural deterioration of the network.

4.1 Growth

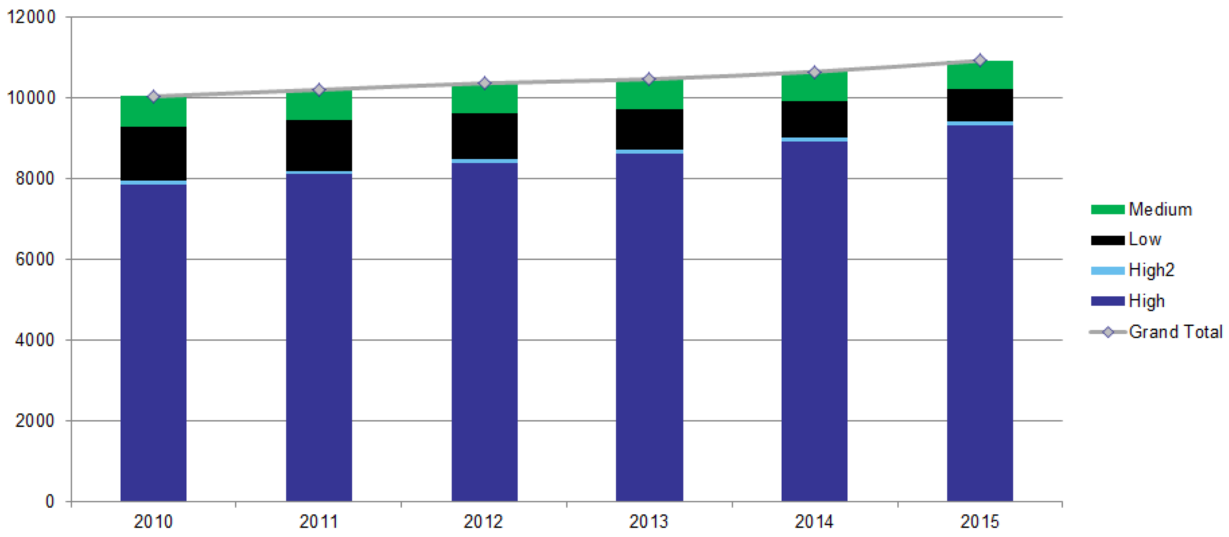
AusNet Services' distribution pipeline network length has grown at an average rate of 2.0% over the past 5 years as shown in the figure below. This is due to the development in growth corridors around Western Victoria.

The network area 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

[1] Mains asset data based on GRR (Gas Regulatory Report) extracted on July 2016.

such as Geelong, Ballarat and Bendigo. In addition, 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% per annum in the next five years. As growth in customer numbers continue, the length of main on the distribution network is expected to grow at a similar rate.

Figure 4: Total Network Length 2010-2015



4.2 Asset Classification

4.2.1 Network Pressure Classification

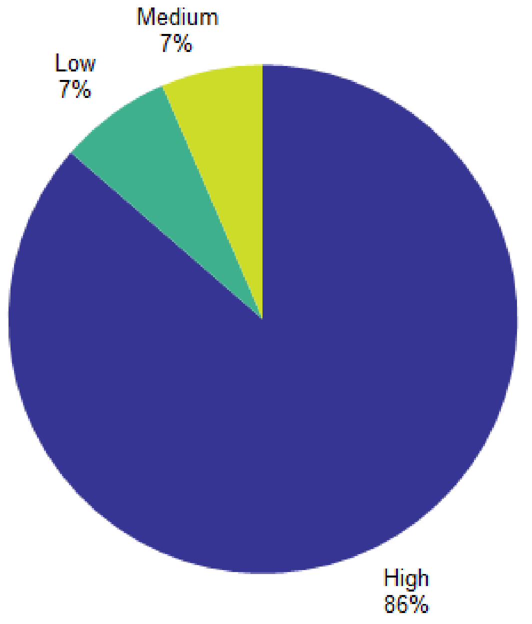
The distribution system transports gas from the transmission network (>1050 kPa) via three main pressure tiers to consumer service lines. The pressure tiers are referred to as low, medium, and high with a fourth minority pressure tier known as 'High Pressure 2'. High Pressure 2 accounts for less than <1% of the total distribution network.

Table 4: Length of Mains by Pressure Classification

Pressure Tier[2]	Operating Pressure (kPa)	Length (km)	Proportion
Low (LP)	Up to 3 kPa	776	7%
Medium (MP)	15 kPa – 140kPa	702	7%
High (HP)	140 kPa – 515 kPa	9381	86%
High 2 (HP2)	515 kPa – 1050 kPa	92	<1%
	Total	**10,951**	**100%**

[2] Data as at June 2016.

Figure 5: Proportion of Mains by Pressure, at June 2016



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 poly vinyl chloride.

4.2.2 Mains Material Classification

The dominant material types on the distribution network are protected (coated) steel (23%) and Polyethylene main (68%) which in total account for 91% of the network as shown in the figure below.

Figure 6: Network length by Material at June 2016

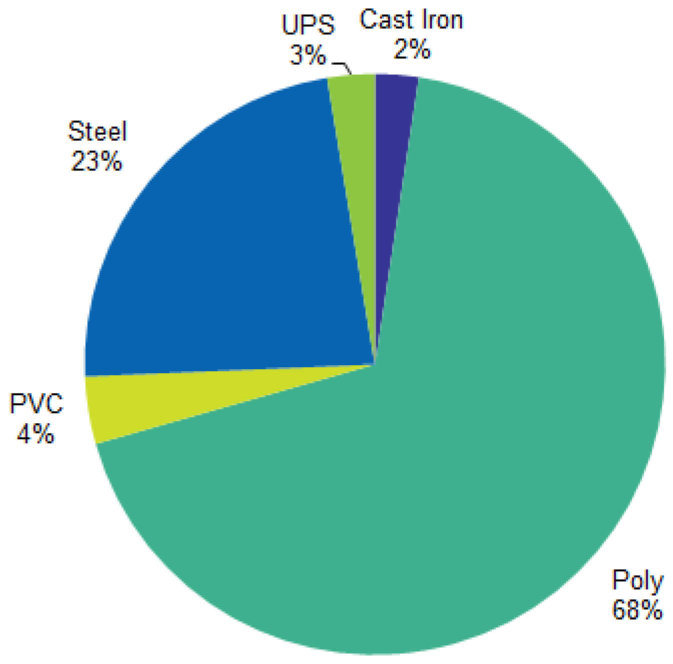


Table 5: Pipe Material Summary

Material Type	Description	Length
Cast Iron	Cast irons generally contain more than 2% carbon and are categorised into the two types for the purpose of engineering life analysis; lead jointed and mechanical jointed.	264km
Polyethylene (PE)	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.	7,446km
Un-coated 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.	287km
Coated Steel	Coated steel in both screwed and welded are dependent on the corrosion protection coating. The coatings are regarded as having an effectively indefinite life. The effective life of this piping system is determined by the faults in the corrosion protection coating.	2,515km
Poly Vinyl Chloride (PVC)	Poly Vinyl Chloride (PVC) was used extensively from 1970 to 1997 in the replacement of cast iron mains in "like" for "like" mains replacement program adopted by the Gas & Fuel at the time. PVC is only rated for operation at low pressure.	410km
Other	Other materials include ductile iron, wrought iron and asbestos cement pipe.	28km
Total		**10,951km**

4.3 Age Profile

The age profile of AusNet Services' distribution mains are displayed in Figure 7 below. The age profile of the network is up to 125 years with an average network age of 23.6 years.[3]

[3] Average age is calculated with 2016 as the base year.

Figure 7: Whole Network Age Profile

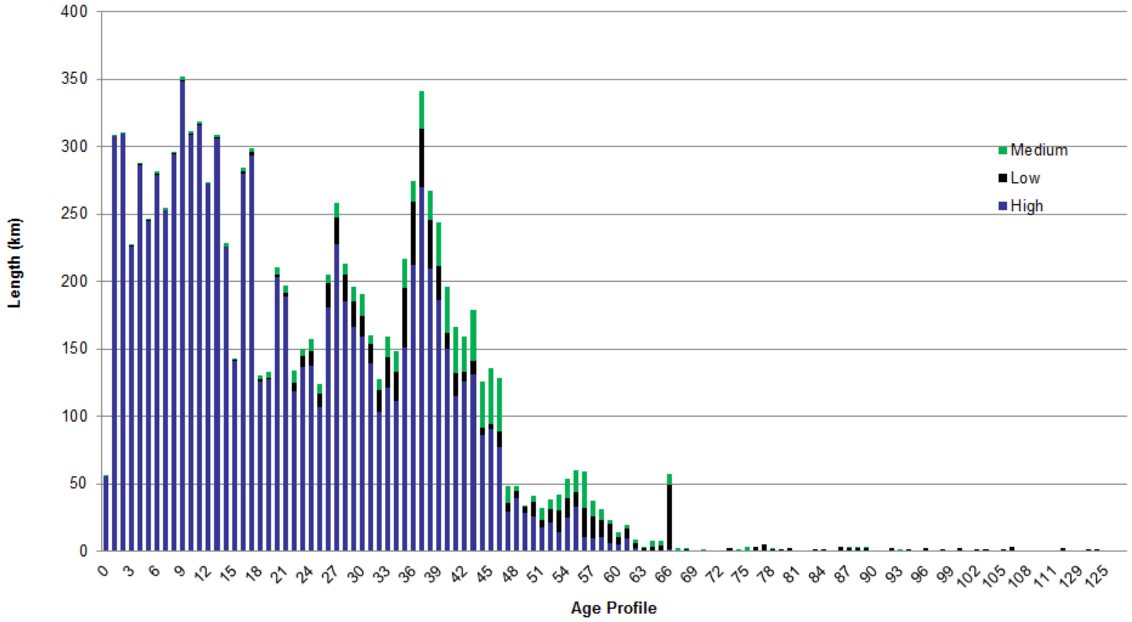


Table 6: Average network age by pressure

Pressure	Average Age
High	20.0
Medium	40.4
Low	43.8

As indicated in Table 6, the oldest operating network is low pressure, with an average age of 43.8 years. High pressure which accounts for 86% of the network only has an average age of 20 years.

4.4 Asset Performance

4.4.1 Network 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 a 'High Breakage Zones' and 'Trigger Survey'. Leakage management efforts are now targeted to those assets that pose the greatest risk, namely low pressure cast iron mains.

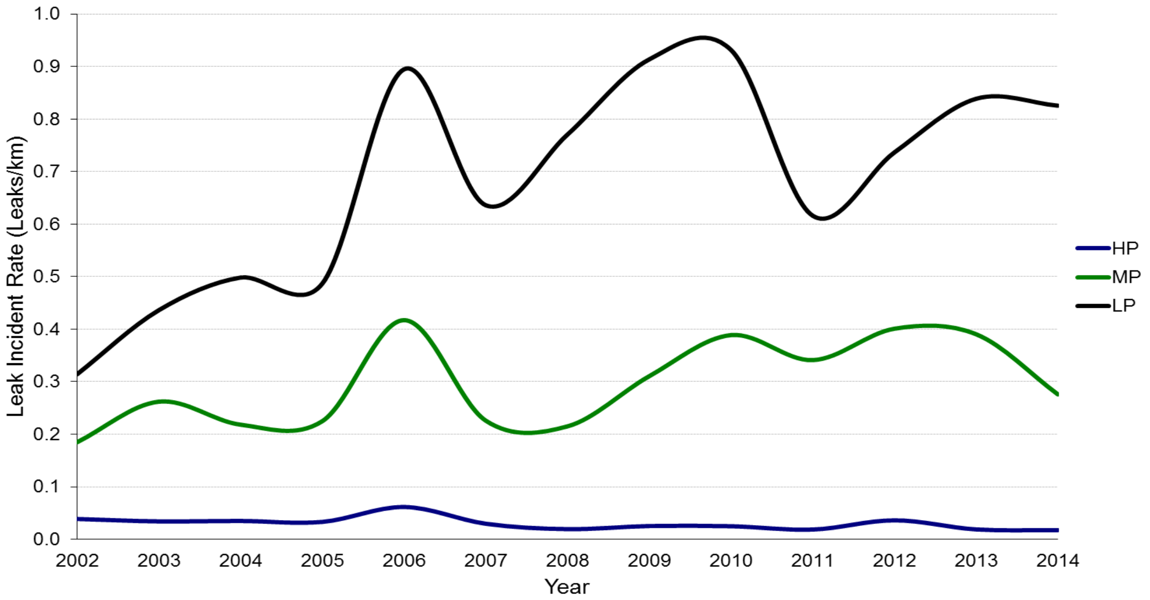
The work specifications (WS) that are currently used as an indicator of mains and services leaks include:

- 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 Leak Incident Rate (LIR) that is represented by the units of leaks/km.

The following figure shows the LIR (leaks per km of mains[4]) over the past 12 years by network pressure classification.

Figure 8: Mains LIR by Pressure Classification



The proactive replacement of LP mains has managed to maintain leakage rates on the network since 2006. The introduction of the Medium Pressure Mains Replacement (MPMR) program in 2013 has slightly reduced leakage rates within the network due to the targeted approach with removal of high risk cast iron mains. The leakage incident rate is the key indicator for network performance and indication of the risk profile.

The benefits of the MRP is realised through the reduction of total leaks on the network. Since 2010 there has been a 38% reduction in leaks on the low pressure network, and a 37% reduction on total leaks on the network.

4 Service leakage rates are also represented as leaks per km of mains length. This is because AusNet Services does not maintain an asset database of services with information such as service length, material and numbers. Therefore service leaks are only associated with the mains that the service is connected to.

Figure 9: Total Leaks per year by network pressure

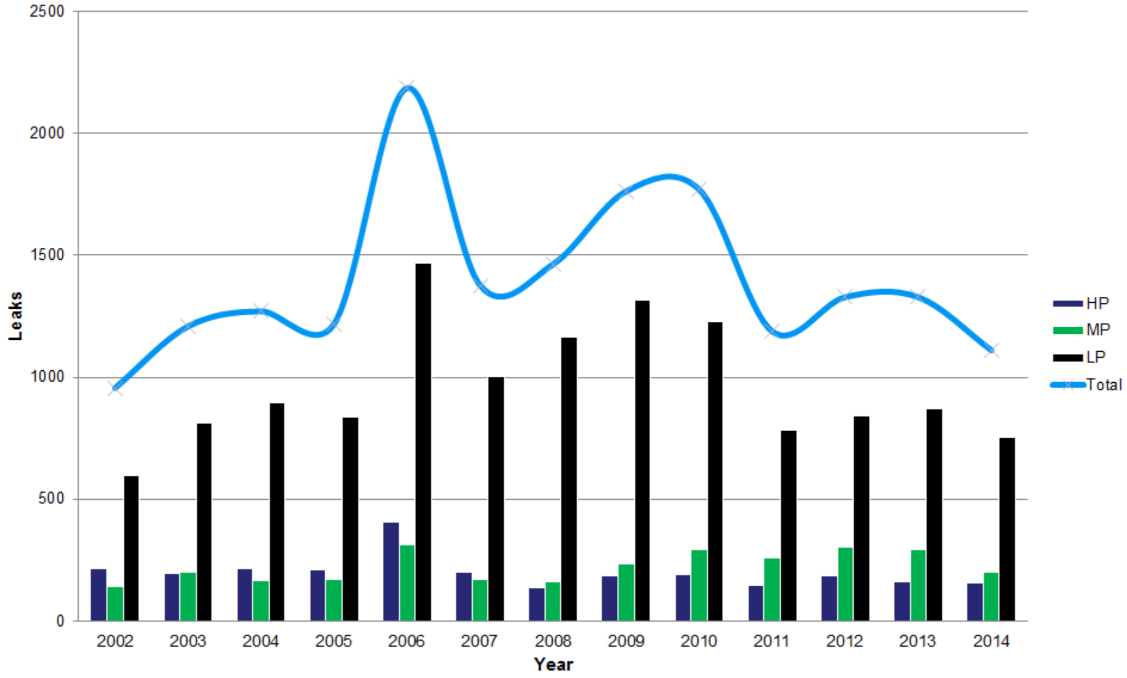
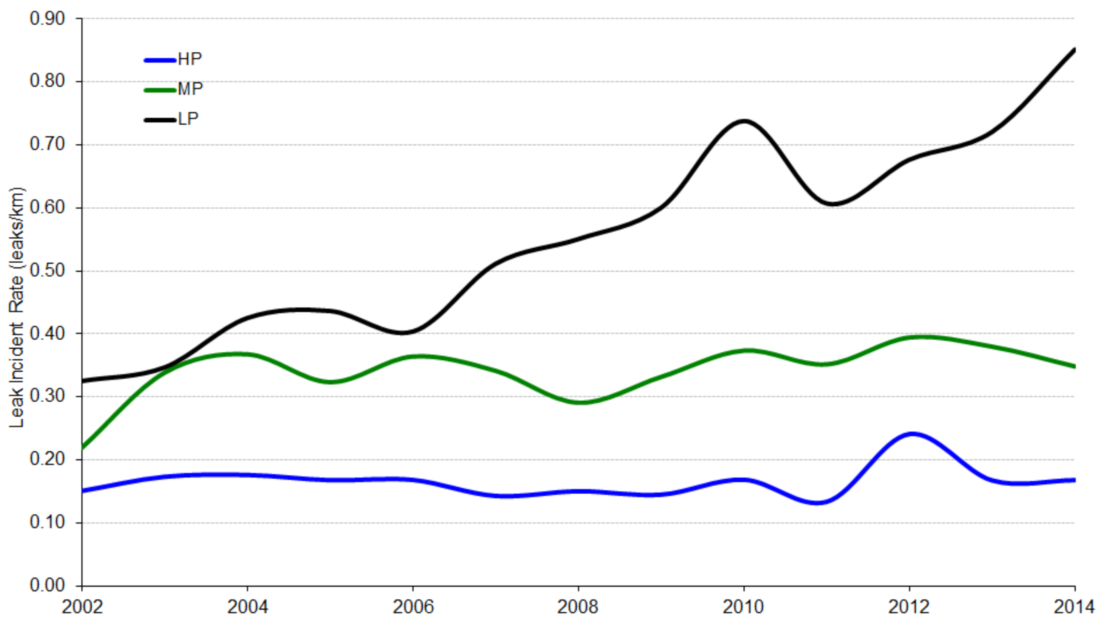


Figure 10: Service Leakage Rate by Pressure classification

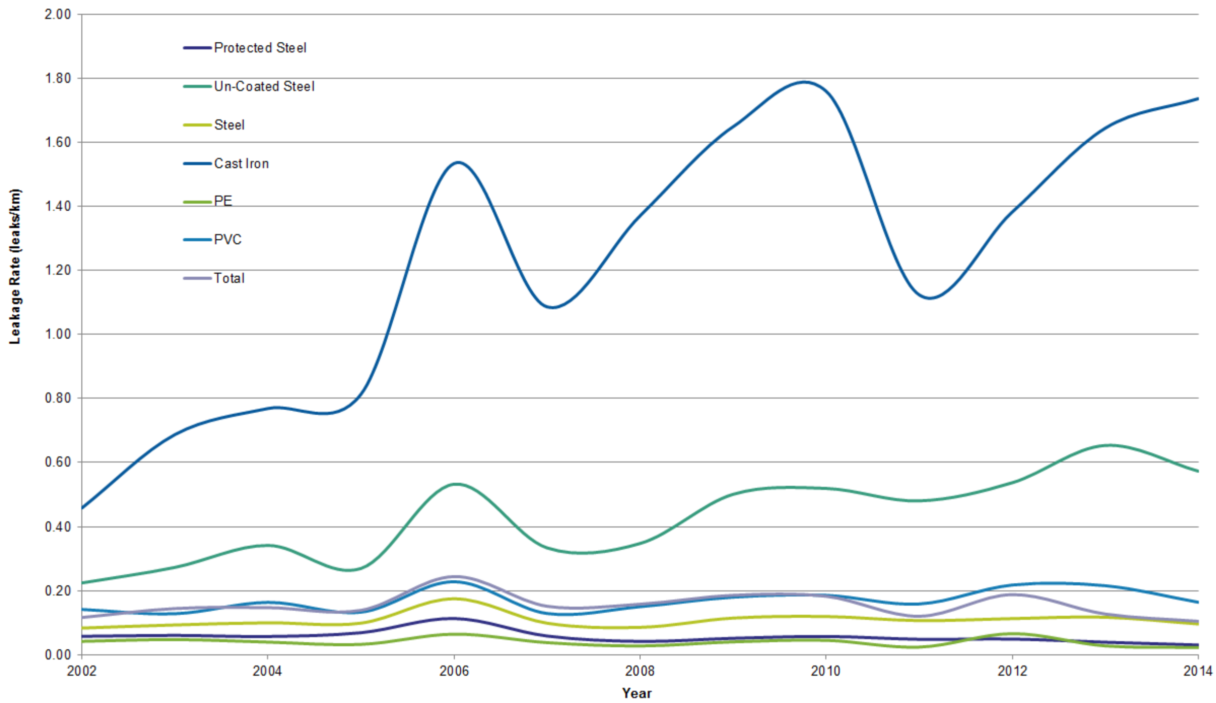


Leakage rates on services have increased on the low pressure network; however have remained relatively steady on the medium and high pressure network. The leading material failure associated with the service line includes cast iron (1.025 leaks/km) and PVC (0.80 leaks/km). There has been a marked increase (95%) in PVC service failure over the period since 2011. This is believed to be associated with the joint failure of the service line.

4.4.2 Material Leakage Rates

Cast Iron has the highest leakage rate compared to other 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.

Figure 11: Mains Leakage Rate by Material Type



As demonstrated in Figure 11 above, cast iron mains are the worst performing material type and therefore targeted for replacement on the low pressure network in order to manage leakage rates. Cast iron is followed by unprotected steel. The replacement programs have been successful in maintaining leakage rates on the poor performing material types.

5 Risk

5.1 Safety

Mains leak either caused by third party damage, or deteriorated main is the highest risk within this strategy, due to the potential consequences associated with the failure. A mains leak has the potential to cause death and injury to the public and to cause damage to property. Low pressure followed by medium pressure mains as described in Figure 8, have the highest leakage rate across the network. The responsible replacement of aging mains, on a safety risk prioritisation basis, is a key mitigation control set out in the Gas Safety Case.

Gas leak from a service pipe also has the potential to cause death and injury to the public, however is considered lower risk when compared to mains due to the smaller volume released from a service pipe compared to a mains pipe.

Additionally, upgrading LP and MP networks to HP reduces the physical number of District Regulator regulating 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.

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 Gas Safety Case (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 distributions mains.

5.2 Reliability

The low pressure 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 network) in the network and operating the network at a higher pressure may affect the integrity of the network. 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 to home, or commercial purposes.

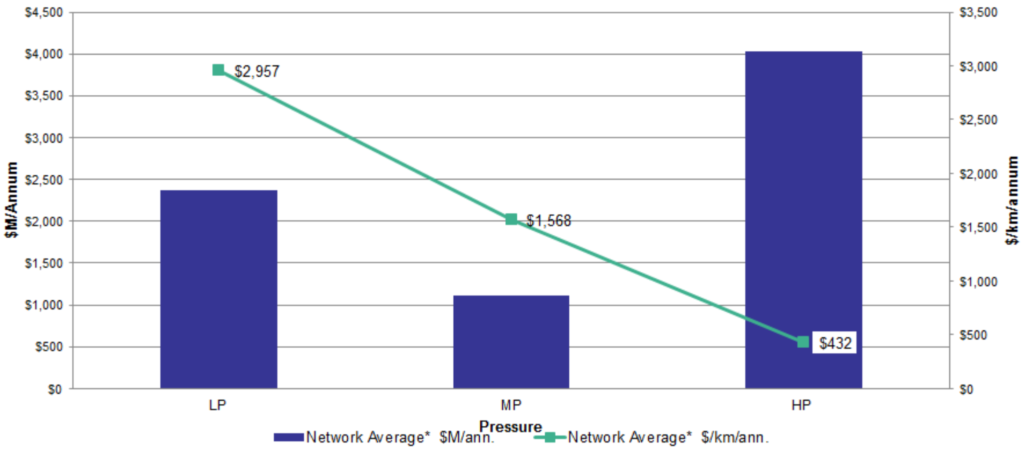
5.3 Cost

With the ongoing deterioration rate of the LP and MP network, it is expected that the operational cost is also set to 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;
- clear Mains Blockages;
- pump Syphons;
- administration; and
- supervision of Activities, IT systems, and Overheads (long term).

The figure below indicates that the ongoing operational cost for the LP network per kilometre is 7 times that of the HP network.

Figure 12: Operational cost by network pressure



The mains replacement program leads to a consistent operational expenditure per kilometre of network due to the removal of the worst performing mains.

6 Mains Replacement Strategy

The low pressure mains replacement strategy is the removal of 410km over the 2018-2022 period. The program aims to maintain leakage rates on the LP network through targeted replacement of the worst performing mains. Inner metro postcodes are currently high priority for replacement leading to higher unit rates in the first three years of the program, followed by an expected decrease in unit rates as the priority moves to country towns.

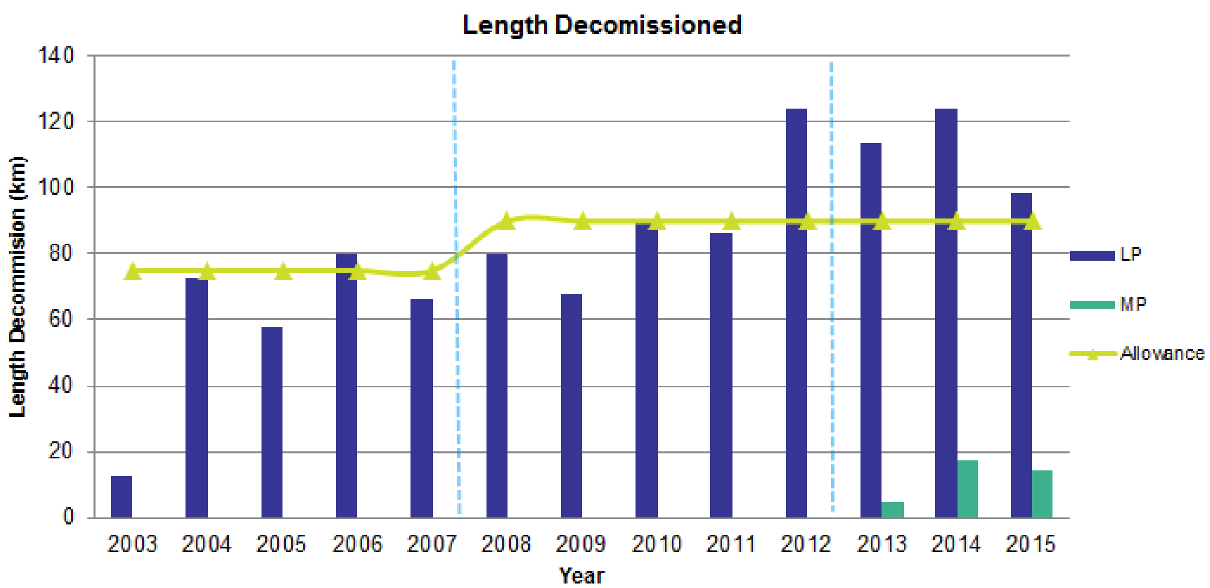
The medium pressure replacement strategy is to replace 55km of medium pressure over the 2018-2022 period. The medium pressure replacement strategy is to target mains that have had a leakage incident at a rate of that is consistent with that of the low pressure network. The identified networks with high leakage rates are the un-protected steel network and the first generation polyethylene mains (CL250). These networks will be prioritised for replacement in the next five years. The most deteriorated and poor performing mains have been used to quantify the program, resulting in the replacement of 24km of MP mains. An additional 30km of length is included in scope to replace high risk first generation polyethylene mains that are in close proximity to mains identified in the 24km for replacement.

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 2025 with the abandonment of 1,108km[5] of low pressure to date. In the current regulatory period, leakage rates were expected to increase due to the rate of deterioration. However with targeted, and an increased rate of replacement, leakage incident rates have been maintained on the network in line with meeting the network objective on maintaining network safety. The increased level of replacement is demonstrated against the allowance set by the Australian Energy Regulator (AER) is detailed in Figure 13.

The MPMR was first introduced within the current regulatory period. At the completion of financial year 2016/17, the program will have removed all cast iron main being the network's highest risk mains. However the MP network still contains high risk assets including un-protected steel and first generation polyethylene.

Figure 13: Mains decommissioned

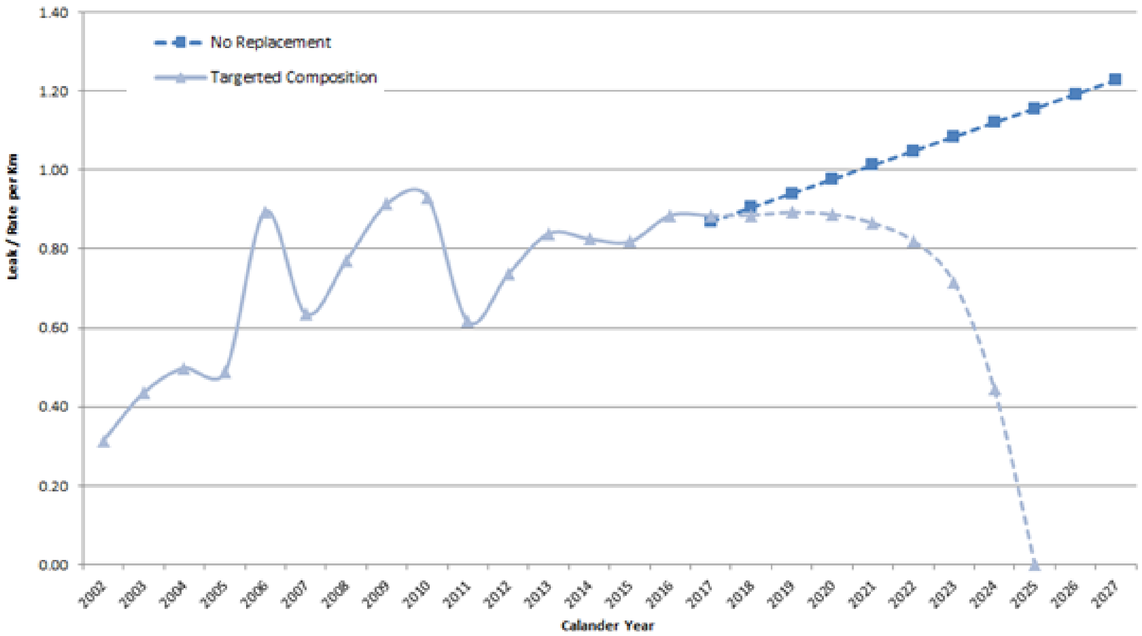


[5] Data as at June 2016.

6.2 Forecasted Leakage Rates

Analysis of leakage rates indicates that leakage rates will increase across the low pressure network due to network deterioration if the replacement does not continue. An increase in leakage rates does not maintain network safety. The figure below demonstrates that if replacement of the low pressure network was to stop, leakage rates will increase. Continuation of the LP program will maintain the leak rates over the period to 2022 and then begin to reduce leakage rates after 2022 as the LP network is decommissioned and replaced with HP mains.

Figure 14: Impact of renewal program on LP leak rate



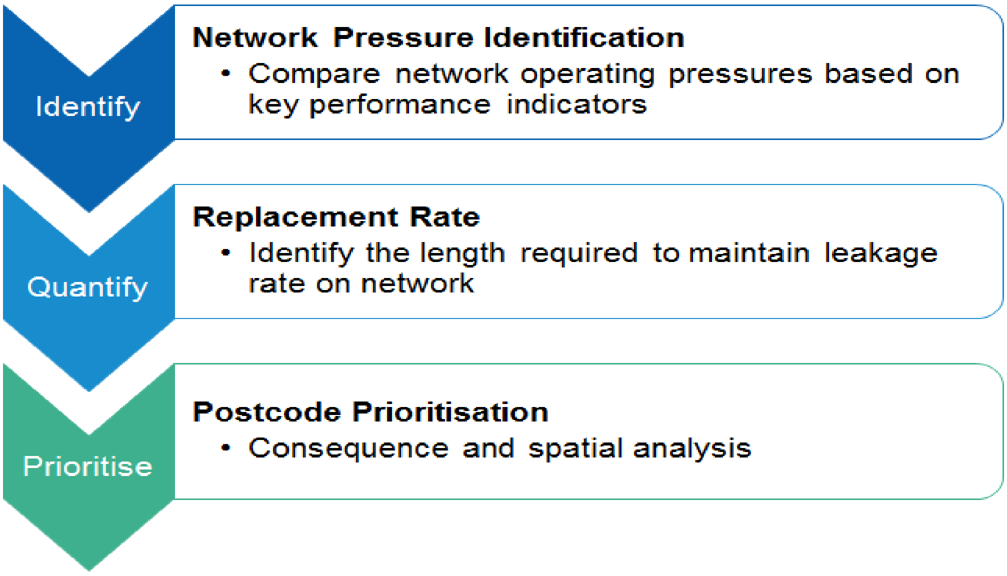
It is proposed to replace 410km of LP and 55km of MP over the 2018 to 2022 period in order to maintain network safety.

The following describes the prioritisation methodology to determine quantity and material type for replacement.

7 Mains Replacement Program Prioritisation

The methodology for prioritisation of mains replacement (both medium and low pressure programs) 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.

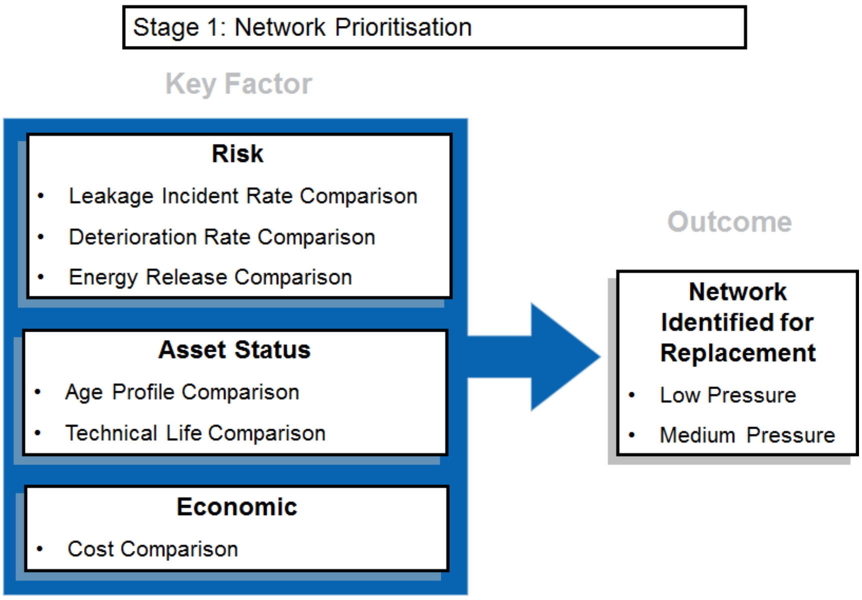
Figure 15: Stages of Prioritisation for MRPR



7.1.1 Identify 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. The figure below summarises the key factors and provides the outcomes:

Figure 16: Identify Process for MRP



Risk is the critical factor, and key priority for the mains replacement program. As seen above Figure 8, the low and medium pressure networks are the highest risk networks as inferred by high leakage rates.

Additionally, a risk weighting comparison was conducted to make a comparison of the risks of a leak occurring between the different material types operating at different pressure tiers. This highlights the worst performing material types on each of the network operating pressures, in order to perform a relative comparison. The applied risk weighting indicates that a leak on a Cast Iron, Un-Protected Steel or PE (Class 250) mains represents the greatest risk. These material types are specific to the MP and LP network.

Figure 17: Risk Weighting Results

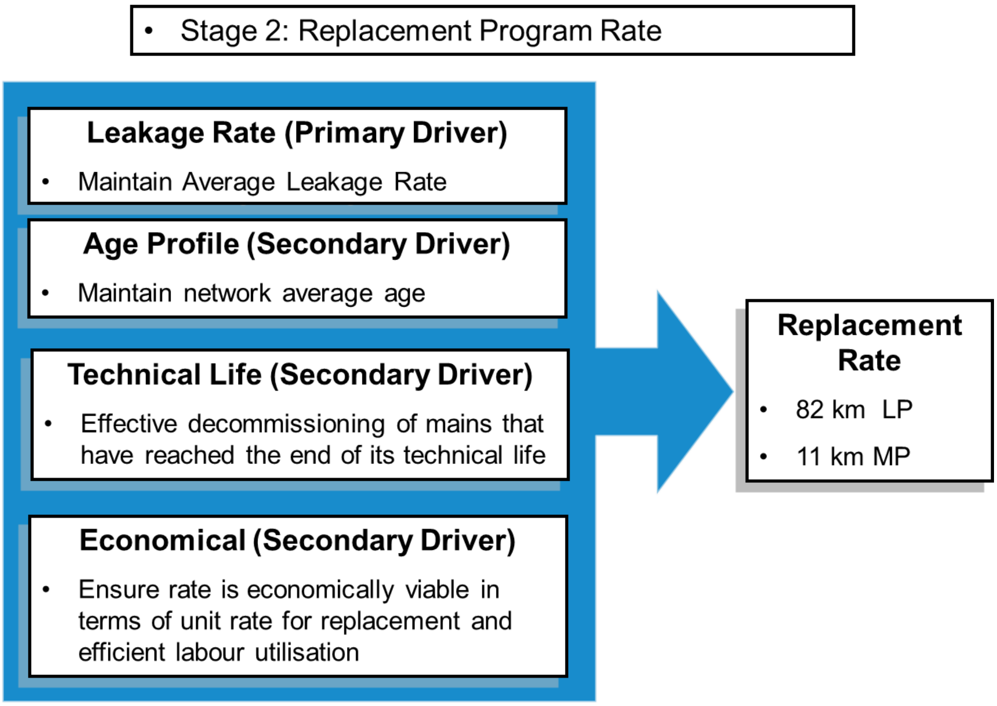
Pressure Tier	Material	Length (km)	Ave Annual LIR (leaks / km)	Gas Flow Ratio	Risk Weighting
High Pressure	Steel Protected	2289	0.02	11.95	0.24
	PE	7055	0.02	11.95	0.24
Medium Pressure	Steel Protected	305	0.09	4.01	0.36
	Steel Unprotected	147	0.76	4.01	3.05
	PE	204	0.05	4.01	0.20
	Class 250 PE (P4)	39	0.95	4.01	3.81
Low Pressure	Steel Unprotected	70	0.46	1.00	0.46
	Cast Iron	266	1.07	1.00	1.07
	PVC	420	0.14	1.00	0.14
	PE	18	0.07	1.00	0.07

As identified in Figure 17 above, the medium pressure network has the highest risk mains, including un-protected steel and Class 250 PE. Due to the volume release of gas on a medium pressure leak and the potential for failure it is critical that these mains are targeted for replacement. For these reasons the MP program is as relevant to maintaining network safety, as the low pressure replacement program is.

7.1.2 QUANTIFICATION OF PROGRAM

The leading determinant of the length required for abandonment is maintenance of the leakage rate. The secondary drivers are age profile, technical life, and economical assessment. Figure 19 represents the process and outcome of length required for the mains replacement program.

Figure 18: Quantification of MRP



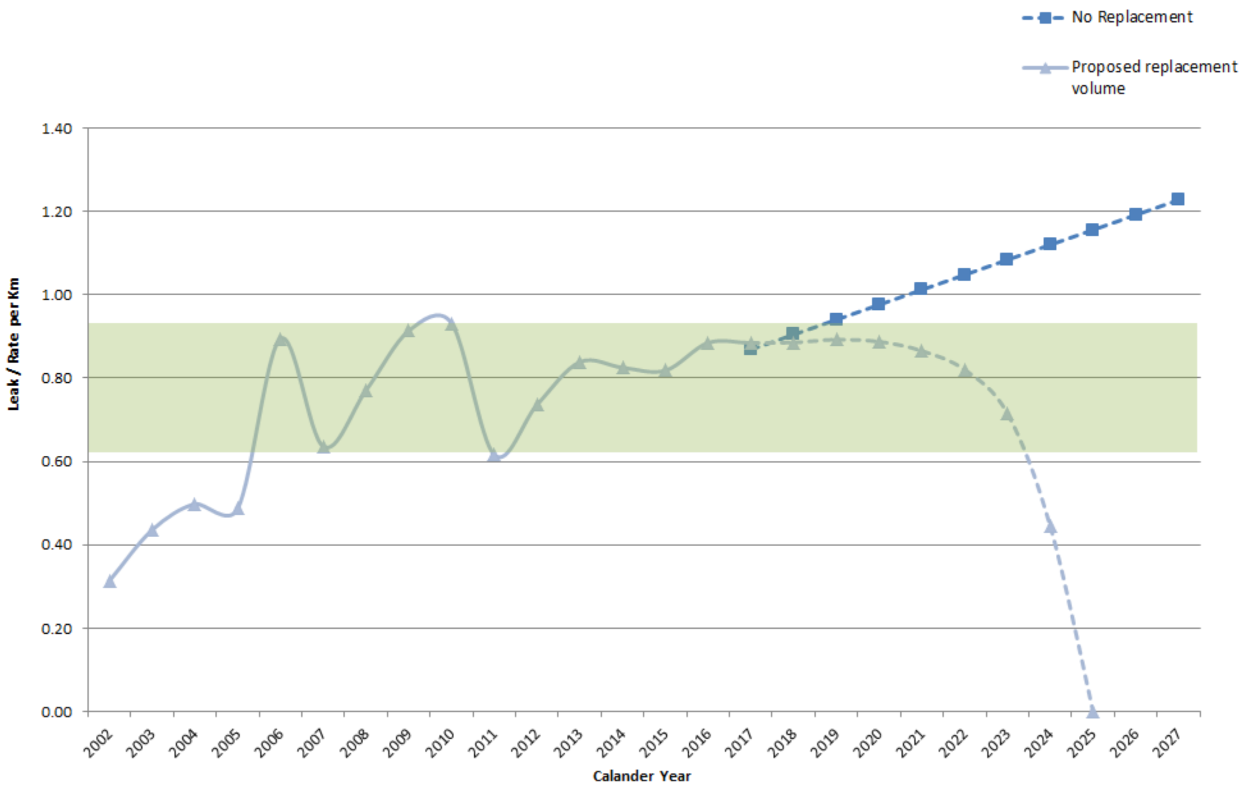
7.1.2.1. Proposed Mains Replacement Rate

Low Pressure

The LPMR program analysis demonstrates that an average replacement rate of 82km p.a. of LP mains ensures that leakage rates are kept within a band that reflects the minimum and maximum leakage rates over the recent years (a maximum of 0.92 in 2010 and minimum of 0.62 in 2011), which have been used to define a "maintain" safety case. This is reflected by the dotted line in the chart below, which projects flat leakage rates during the 2018-2022 period; followed by declining rates until program completion in 2025.

If the LP replacement rate was to decrease any further, the network may be at risk of increased leaks. Although the leakage rate may remain within the identified band, this has implications with the delivery of the replacement of the LP network by 2025. AusNet Services' is committed to completing the replacement of the low pressure network by 2025. 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, and is consistent with meeting the replacement of the LP network by 2025 and maintaining network safety.

Figure 19: Proposed Low Pressure Replacement Profile



Medium Pressure

With all cast iron replaced on the MP network by the end of 2017, the program is forecast to be reduced to 55km over the five year period. The majority (73%) of the medium pressure network demonstrates low and stable leakage rates and is minimal risk; however 27% of the network exhibits leakage rates that are similar to that of the low pressure network. With the additional risk of energy released on a medium pressure leak compared to that of low pressure as demonstrated in Figure 17, it is critical that the high risk assets are replaced in order to maintain safety on the network. The 27% of the network that is the worst performing includes the un-protected steel network, and class 250 PE, these identified areas form part of the medium pressure replacement program. The replacement strategy will be similar to current replacement programs including both like for like replacement and block renewal, targeting the high risk areas.

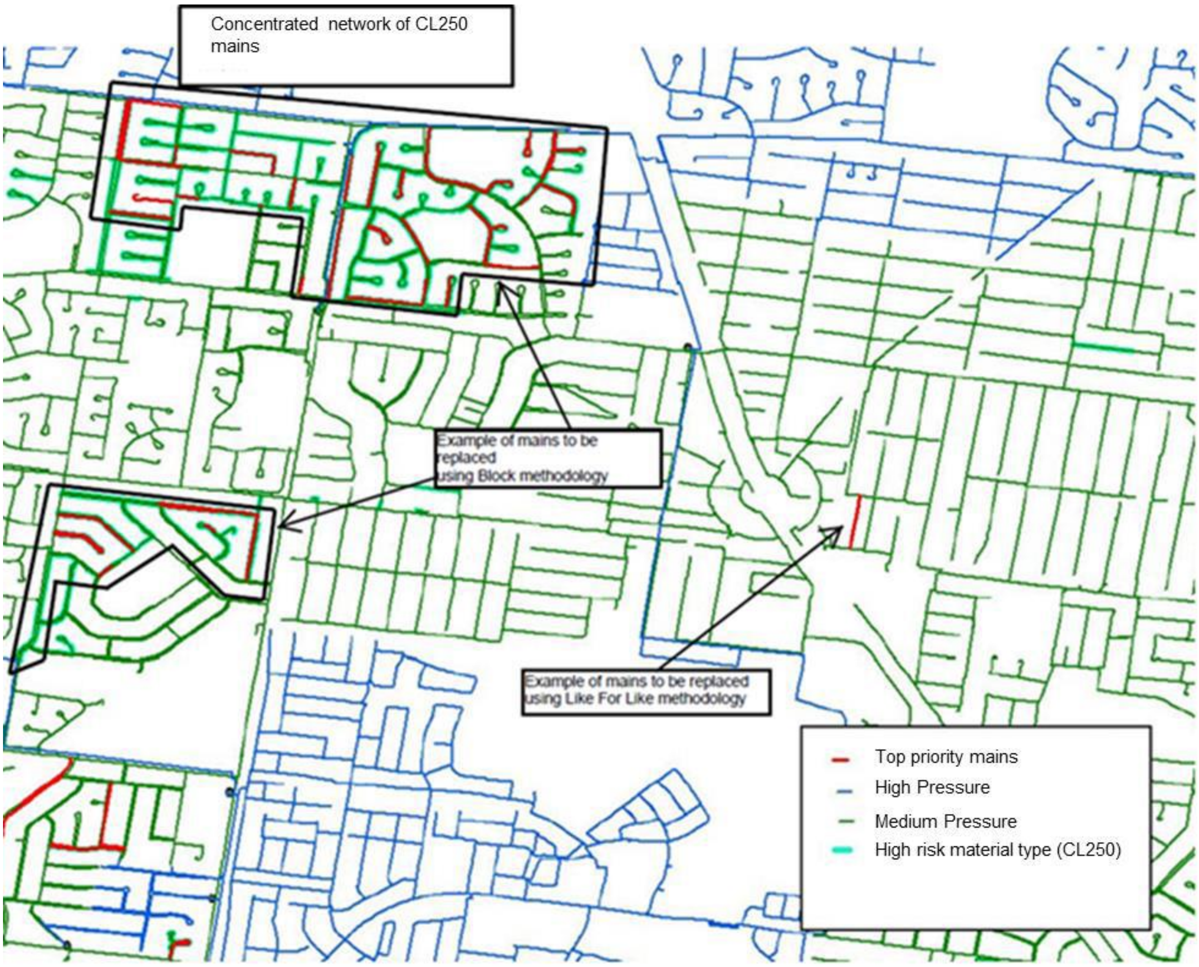
Figure 20: MP Replacement Program

Network Indicators	Steel Protected	Steel un-Protected	Poly Class 250	Polyethylene (PE)
Leakage Rate	0.09 Leaks/km	0.76 Leaks/km	0.95 Leaks/km	0.05 Leaks/km
Network composition	44%	21%	6%	29%
Percentage identified as Highest risk for replacement (2 leaks in 4 years)	2.4km (10%) 2km L for L 0.4km Block	13.1km (54%) 13.1km L for L	7.6km (31%) 0.8 km L for L 6.7km Block	1.6km (6%) 1.5km L for L 0.1km Block
Percentage identified for Block replacement	7.9km (23%) 5.6km of uncoated steel	1km (3%)	23km (70%)	0.2km (1%)

Of the 24km of highest leaking mains of the network, the program is focused on unprotected steel and Poly Class 250 main. 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 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. Under this approach, 37.5km of poor performing mains will be replaced.[6] Figure 20 represents some of the locations identified for block renewal replacement.

[6] For 7.2km of the mains meeting the replacement criteria, the close proximity of a HP feed and the concentration of poor performing MP mains means that block renewal is the most efficient approach for these mains.

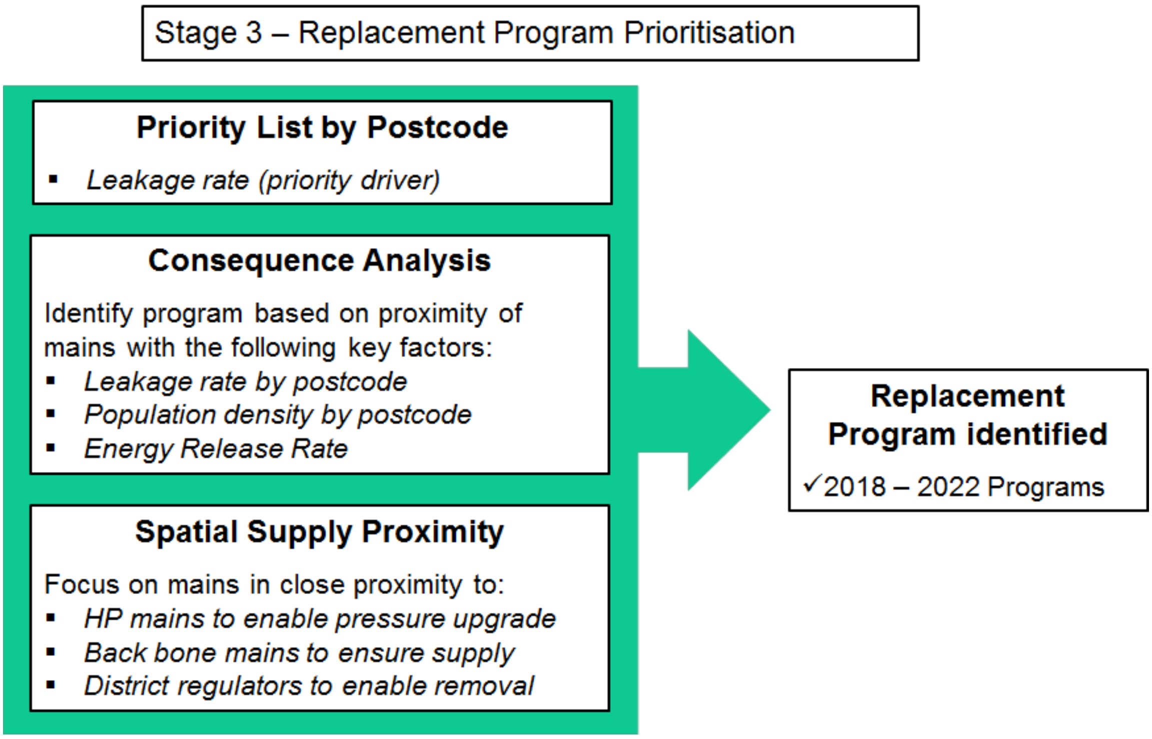
Figure 21: MP replacement, Block renewal Vs. Like for Like



7.1.3 Network Prioritisation of Program

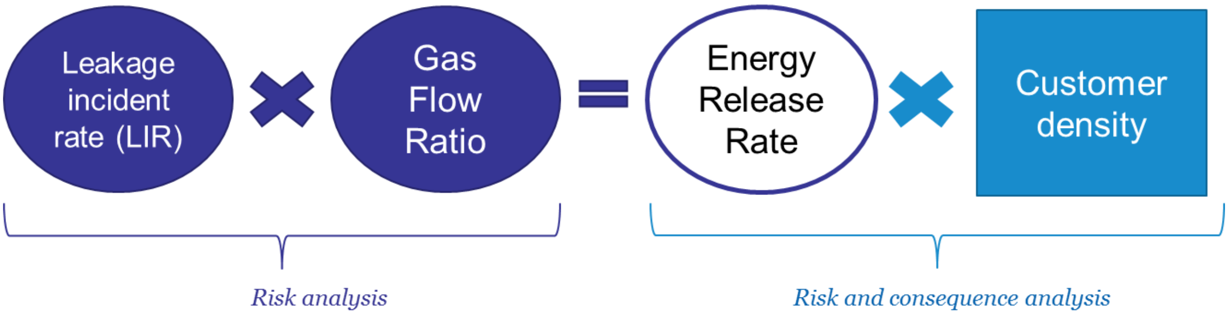
From the above process, the identified operating network pressures (LP & MP), and the programs length has been determined. The final stage is to prioritise the identified length, at the relevant operating pressures into location specific areas of the network in order to develop the replacement program for the year.

Figure 22: MRP Program Prioritisation



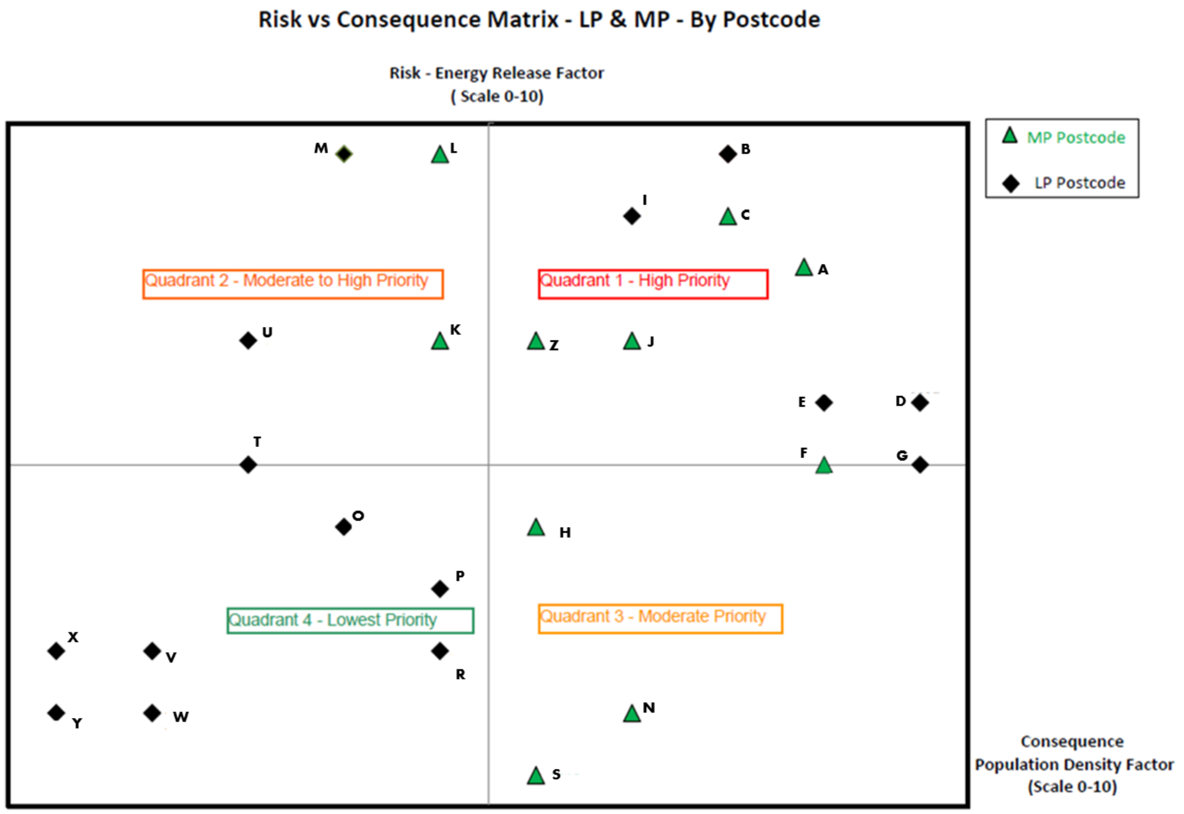
The location specific areas are identified by postcode with a prioritisation methodology that considers both risk and consequence. Risk is defined as the postcode leakage rate whilst consequence is influenced by the population density in that postcode; i.e. potential for harm to a greater number of people alongside the energy release rate which is derived from LIR and energy release ratio at the respective network operating pressure (LP,MP and HP).

Figure 23: Risk and Consequence Analysis



The following 2 by 2 matrix provides a visual representation of results from this prioritisation methodology for the LPMR and MPMR program, with postcodes within top right quadrant targeted first for the programs as reflected by the highest risk and highest consequence. Refer Appendix A, for further details of the consequence analysis.

Figure 24: Risk vs. Consequence Matrix for Postcode Priority



Once the postcodes have been identified the areas will be spatially reviewed to ensure that the network can adequately supply the upgrade, and that there is enough capacity left on the existing network to maintain supply.

8 Reactive Mains and Services Program

The reactive Mains and Service Replacement program is capitalised under the heading 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.

8.1.1 Reactive Mains Replacement Program

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

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

- WS0042: RENEW DEFECTIVE MAINS – MINOR; and
- WS0056: LOWER/ALTER MAIN NON CHARGEABLE

Two counteracting factors influence the reactive mains replacement requirements:

- 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 six year has been used to forecast reactive mains replacement required for the period 2018-22 as demonstrated below:

Figure 25: Proposed Reactive Mains Replacement

The forecast has been derived from five year historical average for reactive mains replacement. This results in the following program for reactive mains replacement in the table below.

Table 7: Reactive Mains Replacement (Units)

	2017	2018	2019	2020	2021	2022
Renew Defective MAIN – Minor	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C
Lower/Alter MAIN Non Chargeable	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C

8.1.2 Reactive Service Replacement Program

Reactive service replacement occurs when the service is at a state where it is infeasible to perform a repair, as it is like the service line will fail again.

Analysis from the Asset Management data capture system (SAP) was used to analyse historic work performed. The following work codes were used:

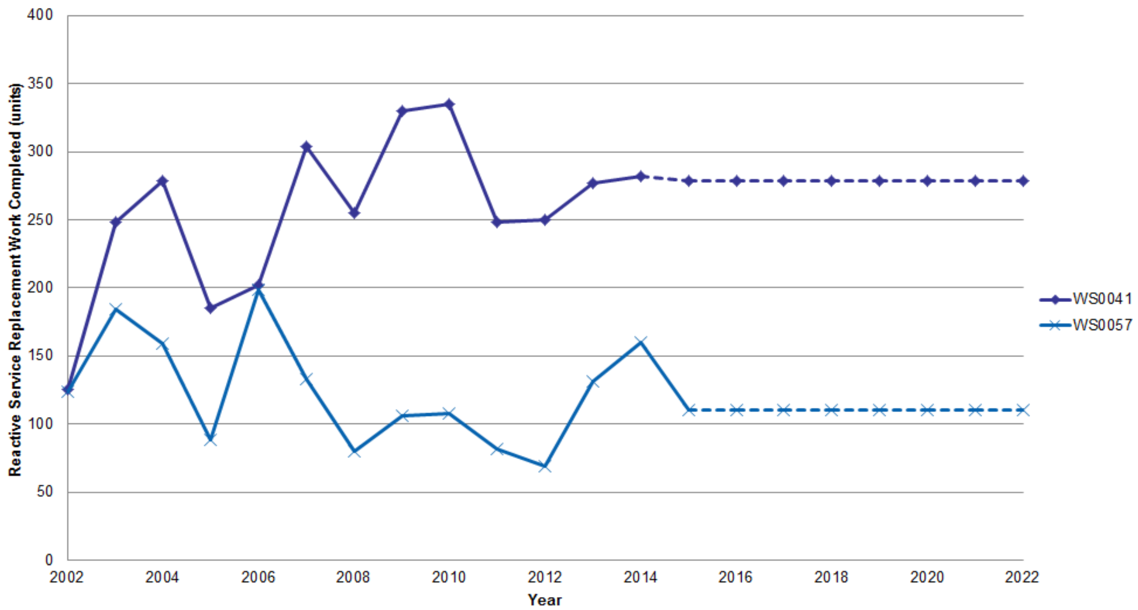
- WS0041: RENEW DEFECTIVE SERVICE (NATURE STRIP AND ROADWAY); and
- WS0057: LOWER/ALTER SERVICE NON CHARGEABLE.

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. This is because the mains replacement program targets aged cast iron mains that typically have aged services connected.

The reactive service replacement required for the period 2018-2022 is forecasted to continue along current trends as shown in Figure 26:

Figure 26: Proposed Reactive Service Replacement



The forecast for forecast service replacement has been derived from five year historical average. The program for reactive service replacement in the table below.

Table 8: Reactive Service Replacement (Units)

	2017	2018	2019	2020	2021	2022
Renew Defective SERVICE – Minor	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C
Lower/Alter SERVICE Non Chargeable	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C

8.1.3 Summary

Table 9: Summary of Proposed Reactive Mains and Service Replacement by unit of work

WS Description	2017	2018	2019	2020	2021	2022
RENEW DEFECTIVE SERVICE	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C
LOWER/ALTER SERVICE NON CHARGEABLE	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C
RENEW DEFECTIVE MAIN – MINOR	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C
LOWER/ALTER MAIN NON CHARGEABLE	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C

9 Capex Profile

9.1 Phasing and Financial Disclosure

All programs within the Mains and Services Strategy are defined in calendar years, consistent with the requirements of the Gas Distribution Safety Case, and the reporting requirements of the Australian Energy Regulator (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 = 2016);
- Direct Expenditure only (i.e. excludes overheads and corporate finance costs); and
- In units of $1,000 (i.e. '000).

10 Unit Rate Profile

The following describes the historic and forecast unit rates for the replacement programs within this strategy. It is noted that unit rates are based on length of mains decommissioned.

The unit rate profile for LP replacement is expected to increase in the first few years of the period, and then decrease. This is attributable to the completion of complex inner suburban postcodes including Kensington, Flemington, Footscray and Yarraville and the Geelong CBD. Once these complex postcodes are complete it is expected that the unit rate will decrease as the program moves into regional towns.

The first four years of the MP program is a combination of both bulk and like for like replacement projects. This results in a stable unit rate. In 2021-22 the program is focused on like for like replacement which has associated complexity resulting in a higher unit rate.

10.1 LP Unit Rate Determination

AusNet Services has performed a detailed review of LP mains replacement unit rates, at the individual postcode level. Unit rate analysis is carried out at the postcode level to ensure varying costs associated with location specific conditions are captured (e.g. traffic, ground conditions, vegetation).

The unit rate analysis is broken up into two parts:

A. Postcodes where MRP has been undertaken in recent years, and historical cost data exists.
B. Postcodes where no MRP has been undertaken, and no historical cost data exists.

The methodology to develop unit rates for each of these scenarios is described below.

Historical Unit Rates Exist

Historical project expenditure has been analysed for all postcodes where mains replacement will continue over the next five-year period.

From the analysis, a classification system was developed based on the characteristics and complexities of the streets with mains to be replaced. The complexity scaling system is based on a simple street given a score of one, and a complex street being assigned a score of five. Complex streets are characterised by heavy traffic, multiple shops, hard surfaces, and/or restrictions from local council and other authorities.

Figure 27: LP Complexity Scaling

Complexity		Definition
1	Very High	Most Complex - Has at least 75% of the following. Heavy Traffic, Tram/ buses, Shops, Units/Sub Divs. Hard Surface/Roadway. VicRoads or Reduced working hours
2	High	Complex - Has at least 50% of the following. Heavy Traffic, Tram/ buses, Shops, Units/Sub Divs. Hard Surface/Roadway. VicRoads or Reduced working hours
3	Moderate	Average has 25% of the following Heavy Traffic, Tram/ buses, Shops, Units/Sub Divs. Hard Surface/Roadway. VicRoads or Reduced working hours
4	Low	Clear - Low traffic, minimal units, shops, HARD SURFACE EXT or ROADWAY or OTHER ASSEST CONFLICTS
5	Very Low	Very Clear - Low traffic, minimal units, shops, soft surface, minimal interruptions

To derive a postcode unit rate, the streets from each postcode, together with the associated complexity scores, were assigned a unit rate based on the characteristics of historical projects with equivalent complexity. The unit rate basis is derived from market conditions since 2013 on projects completed as part of the LPMR program.

A. No Historical Cost Data Available – Estimated Unit Rates:

Within postcodes with no prior mains replacement, small mains replacement projects were developed for estimation. The estimation takes into account location specific complexities such as ground conditions, traffic management requirements, and reinstatement costs. Two projects were developed for each postcode; one within a commercially zoned area and the other in a residential area. This approach results in two unit rates per postcode. Based on the length of the residential and commercial split a weighted average was applied to derive the postcode specific unit rate.

The profile of kilometres replaced as part of the LPMR program is detailed below:

Figure 28: Low Pressure Length replaced by postcode and Year

Post Code	Suburb	2018	2019	2020	2021	2022	2023	2024	2025
3012	Footscray West	2.5							
3032	Ascot Vale	10.4	3.6						
3011	Footscray	14.1	7.0	7.3					
3215	Geelong North	2.1							
3013	Yarraville	10.8	7.0	7.1					
3058	Coburg	6.2							

Post Code	Suburb	2018	2019	2020	2021	2022	2023	2024	2025
3031	Flemington	6.2	5.0	11.0					
3040	Essendon	2.4	0.9						
3039	Moonee Ponds	3.2	2.3						
3218	Geelong West	0.3	10.0	8.0					
3220	Geelong	7.5	10.0	11.0	11.0	10.7			
3550	Bendigo	5.0	9.0	6.0	15.0	6.0			
3350	Ballarat	3.0	8.0	10.0	4.4				
3555	Golden Square		8.0	4.2					
3219	East Geelong		7.8	6.5	8.0	8.4			
3216	Belmont	11.5	0.8						
3250	Colac		5.0	12.0	8.0	10.0	9.8		
3400	Horsham				12.0	12.0	10.9		
3305	Portland				10.8	10.0		6.0	
3280	Warrnambool				10.0	15.0	30.0	20.0	10.0
3380	Stawell					6.0	20.0	10.1	10.0
3300	Hamilton						5.0	19.6	0.0
3377	Ararat							20.0	24.1
	Total	**85.2**	**84.4**	**83.2**	**79.2**	**78.0**	**75.7**	**75.7**	**44.2**

As a result from the prioritisation model, postcodes in inner metro Melbourne alongside with Geelong CBD, are the highest priority in the first three years of replacement. Table 10 details the percentage split of the representative locations of where mains will be replaced in each of the year of the program.

Table 10: LP location split for Replacement Program

	2018	2019	2020	2021	2022
Inner metro	65%	31%	31%	0%	0%
Geelong	12%	24%	23%	14%	14%
Regional	23%	46%	47%	86%	86%
Unit Rate ($/metre)	283	266	276	235	223

The below graphic represents the location of where works will be completed in inner metro locations as part of the 2018-2022 program. As the network areas become closer to Melbourne CBD, the networks become more densely populated, established, and have strict requirements of when works can be completed. Some of the recent projects that are being delivered have unit rates that are almost double than that of a project 3km further from the CBD.

Figure 29: Low Pressure Replacement Inner Metro Locations

C-I-C

Once inner metro works are complete, the unit rate is expected to decrease when the program will be Focussing on regional areas.

The capital expenditure profile derived from unit rate by length in postcode is detailed below. This shows the increase in spend in the first three year, due to inner metro postcodes.

Table 11: Capital expenditure profile LP replacement

C-I-C

10.2 MP Unit Rate Determination

The medium pressure unit rate is expected to increase steadily with the ratio of like for like replacement increasing compared to the block renewal approach. 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 2018-2022 program has identified 24.7km of MP main that are the worst performing mains on the network, focusing on un-protected steel and CL250 main. Of the 24.7km, 7.2km of main are identified to efficiently be replaced with a block renewal approach. Where a HP feed is in close proximity, and the poor performing MP mains within the network are close to each other, block renewal is an efficient renewal approach. Of the 37.4km included in the block renewal replacement, 27 kilometres is identified as poor performing CL250 main (70%). These identified mains are expected to continue to deteriorate, if not replaced.

The remainder 17.5km of main will be replaced in a like for like manner as they are not within an efficient distance of a HP feed.

Table 12: MP Unit rate breakdown

Summary	Block	LFL	Total
Length (km)	37.4km	17.5km	55km
Unit Rate ($/m)	$247	$454	$313
Total Cost ($'000)	$9,246	$7,958	$17,204

Block Unit Rate

The block unit rate for calculating estimated project spend is utilising historic projects of similar size and nature to determine an appropriate unit rate.

The average of three block replacement projects was used to provide the forecast for the five year period:

Table 13: Historic MP Projects

Projects Completed 2016	Forecast Unit Rate ($/m)
Hertford Rd, Sunshine	C-I-C
Perth Avenue	C-I-C
Glengala Rd, Sunshine	C-I-C
Average	**$247**

Like for Like Unit Rate

Each of the identified 17.5 kilometres of main was assessed and given a criteria of one to five (one being simple and five the most complex) on an individual lengths.

Figure 30: Unit rate street complexity rate

Complexity		Unit Rate	Definition
1	Very High	C-I-C	Large diameter >150, high traffic, and/or two or more of the following: high density dwelling, commercial installations, hard surface, road reserve, customer, or network supply impact.
2	High	C-I-C	Large diameter >150, moderate to high traffic and one of the following: high density dwelling, commercial installations, hard surface, customer, or network supply impact.
3	Moderate	C-I-C	Small Diameter < 150, high traffic // network supply impact // or two or more of the following: moderate to high traffic, high density dwelling, commercial installations, predominantly hard surface, customer supply impact.
4	Low	C-I-C	Small Diameter < 150, moderate traffic and one of the following: high density dwelling, commercial installations, mixture soft/hard surface, customer supply impact.
5	Very Low	C-I-C	Small diameter <150 and low traffic, minimal units, shops, soft surface, supply impacts.

Historic unit rates in line with the above criteria were used as a baseline to forecast unit rates. Projects recently completed in 2016 included Altona Nth LFL. The unit rate for the project was ranked criteria of 4 with a unit rate of C-I-C.

10.3 Reactive Mains and Services Unit Rate

AusNet Services aims to maintain the current reactive replacement methodology and rate in line with current practices. The reactive mains and services replacement unit rate is built up based on current average contractor unit rates over a 3 year period for the relevant work specifications.

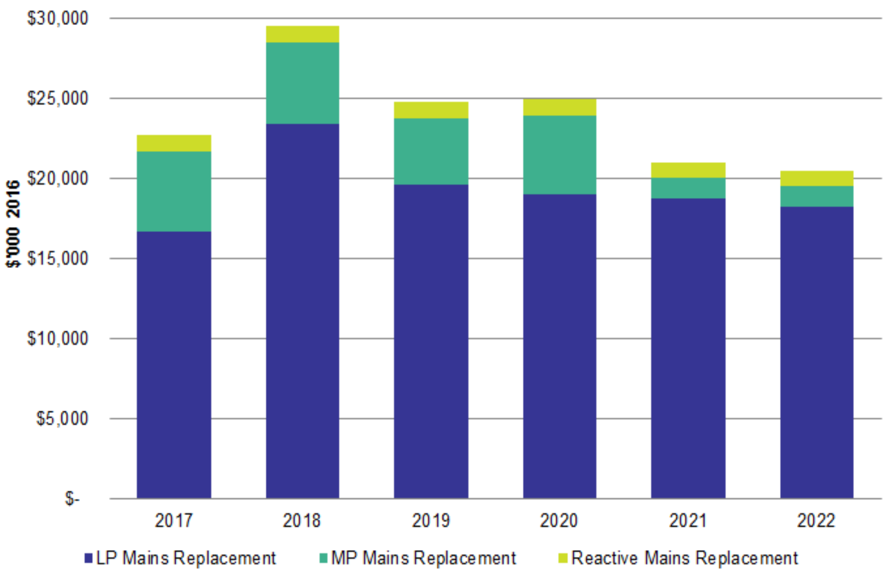
Table 14: Summary of Reactive Mains and Services Replacement Unit Rate

WS Description	Unit Rate
WS0041: Renew Defective SERVICE	C-I-C
WS0057: Lower/Alter SERVICE Non Chargeable	C-I-C
WS0042: Renew Defective MAIN – Minor	C-I-C
WS0056: Lower/Alter MAIN – Non Chargeable	C-I-C

11 Detailed CAPEX Requirements

Summary of CAPEX over the period 2012-2017 is shown in the figure below.

Figure 31: Mains and Services CAPEX 2017-2022



LP Mains Replacement Program

Annual replacement lengths by postcodes have been determined through prioritisation of leaking incident rate; combined with consequence of failure derived from postcode density. The annual expenditure by postcode is based on the LP MRP unit rate determined for each postcode area multiplied by the total postcode MRP length determined. This results in a variable annual replacement rate that is a more accurate representation of actual expected rates as it is project specific. The table below shows the proposed LP MRP for the 2018-2022 period.

Table 15: LPMR Proposed Works Program

	2017	2018	2019	2020	2021	2022
Length (m)	90,000	85,243	84,436	83,184	79,220	78,026
Unit Rate ($/m decommissioned)	$228	$284	$266	$276	$235	$223
TOTAL ('000)	**$20,493**	**$24,194**	**$22,502**	**$22,989**	**$18,647**	**$17,390**

MP Mains Replacement Program

Table 16: MPMR Works Proposed Program Summary

	2017	2018	2019	2020	2021	2022
Length (m)	20	17	15	17	3	4
Unit Rate ($/m decommissioned)	$250	$303	$283	$299	$361	$338
TOTAL ('000)	**$5,000**	**$5,099**	**$4,157**	**$4,938**	**$1,216**	**$1,216**

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 the table below:

Table 17: Reactive Replacement Works Program

WS Description		2017	2018	2019	2020	2021	2022	Total
WS0042: Renew Defective MAIN – Minor	Units	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C
	Cost ($'000)	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C
WS0056: Lower/Alter MAIN Non Chargeable	Units	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C
	Cost ($'000)	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C
WS0041: Renew Defective SERVICE	Units	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C
	Cost ($'000)	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C
WS0057: Lower/Alter SERVICE Non Chargeable	Units	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C
	Cost ($'000)	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C
Total Cost ($'000)		$993	$993	$993	$993	$993	$993	$5,957

12 Appendix A: Consequence Analysis – Methodology

A recent review has introduced a prioritisation methodology that considers both risk and consequence.

Risk is defined by the postcode leakage rate multiplied by gas flow ratio of the relevant pressure tiers. This yields an energy release rate associated with a leak in that postcode. Size and duration of leak also influences energy release, but for the purposes of this assessment they have been treated as a constant, not influencing the risk by pressure tier. The gas flow ratios of each pressure tier is summarised in the table below.

Table 18: Gas Flow Ratio

Pressure Network	Gas Flow Ratio
High	11.95
Medium	4.01
Low	1.00

Consequence is characterised by the potential to harm fewer or greater members of the public in the event of a gas leak incident. The population density of each postcode was used to quantify consequence. Population density data was obtained from Australian Bureau of Statistics 3218.0 Regional Population Growth, Australia.

Each postcode energy release rate and population density is then assigned a risk or consequence rating (0 - 10 scale). These points when plotted on a 2 x 2 matrix provide a visual representation of postcodes to be prioritised for mains replacement. Those with highest risk and consequence (see quadrant 1) would be targeted first, followed by quadrant 2 and 3, and finally quadrant 4.

Figure 32: Risk and Consequence Analysis

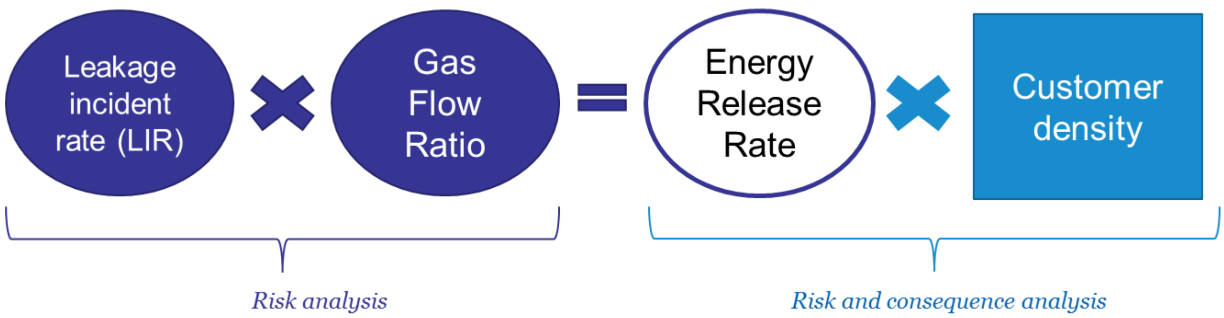
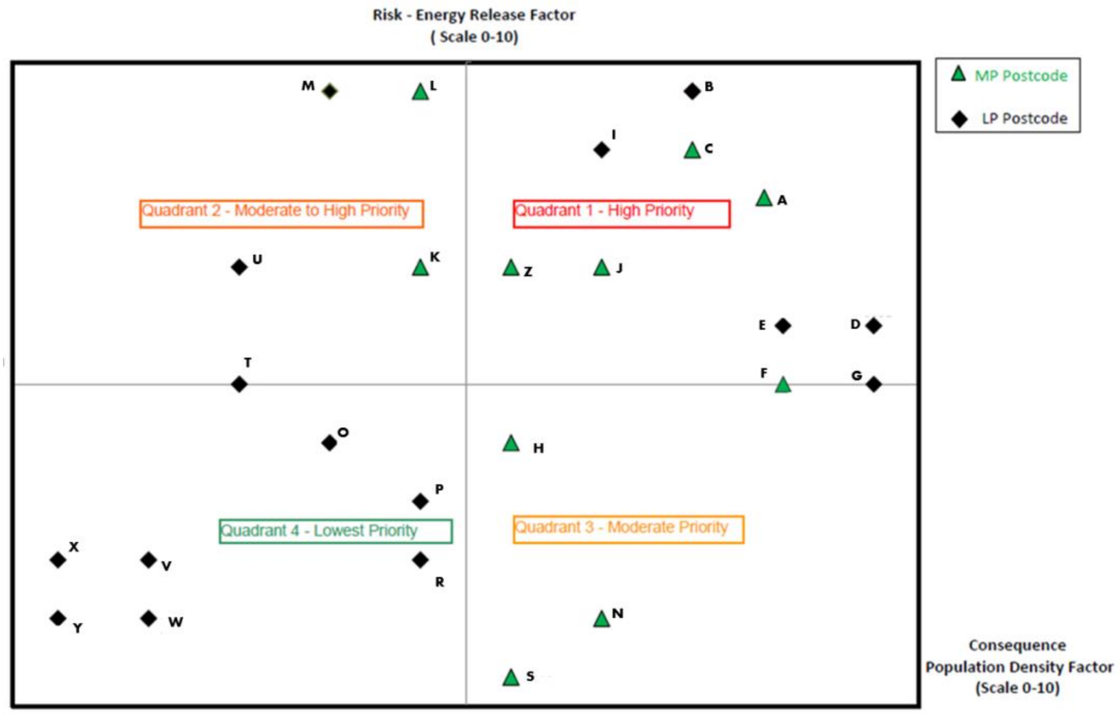


Figure 33: Postcode Risk Vs. Consequence Matrix by postcode



13 Appendix B: 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.

13.1 Open Cut

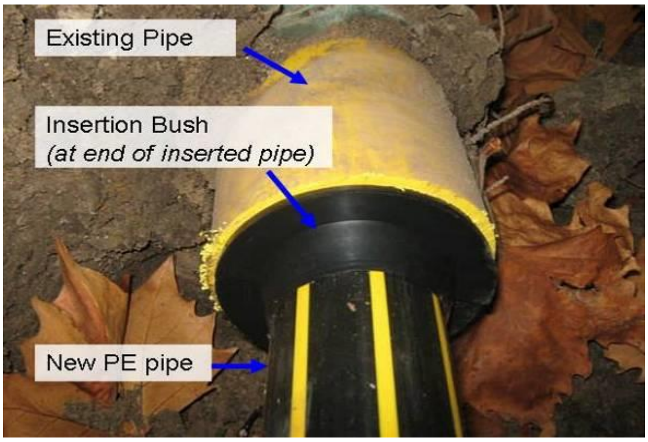
The open cut method is the typical method of laying pipe and is also used when replacement via insertion method cannot be achieved.

13.2 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 advantage of the insertion method includes:

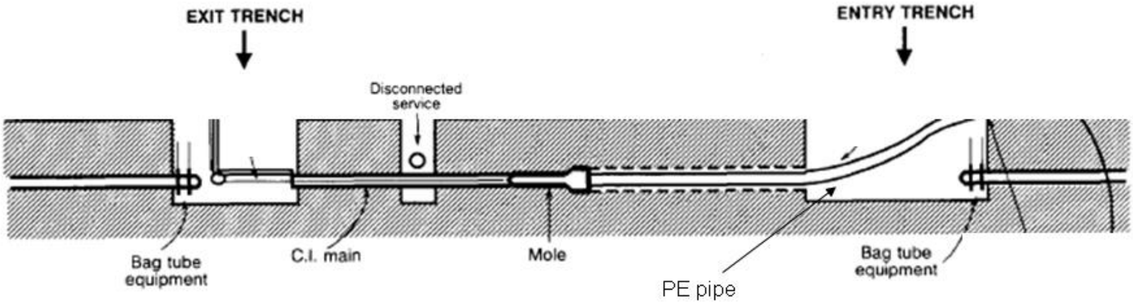
- Existing pipe provides the new pipe additional protection from damage.
- Smaller diameter HP PE pipe can be utilised which involves lower material costs and lower labour costs as PE is easier to install.[8]
- Minimal ground works required therefore reducing rectification costs, traffic management costs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

Figure 20: 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 35: Insertion Method



Insertion method is used extensively within the LP mains renewal 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.

13.3 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.

13.4 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 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.

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

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.

13.5 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.

14 Appendix C: 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.

14.1 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.

The figure below shows the calculation results for each pressure network:

Table 19: Gas Flow Calculation for Different Pressure Networks

Pressure	Mains Operating Pressure (kPag)	Pu (kPa)	Estimated flow of gas (sm^3/hr)	Estimated Energy (GJ/hr)
HP Network	400	501.3	2616.85	101.27
MP Network	45	146.3	877.72	33.97
LP Network	3.2	104.5	218.94	8.47

[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 low pressure network flow as the baseline benchmark:

Table 20: Gas Flow Ratio Comparison with LP

Gas Flow Ratio		
LP	**MP to LP**	**HP to LP**
1.00	4.01	11.95