Jemena Gas Networks (NSW) Ltd

Newcastle MP1 30kPa Rehabilitation

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1. Summary

This gas mains rehabilitation business case identifies various options to address the ongoing decline of network integrity and performance in the Newcastle MP1 network. The preferred option is to rehabilitate all cast iron mains with new PE at a cost of $26.4M, whilst maintaining the network pressure at 30kPa.

Gas mains in the Newcastle MP1 network were constructed in the 1950s by Hunter Gas. Jemena (AGL at the time) purchased the network in 1982. The network primarily consisted of ferrous materials such as cast iron and steel mains that supplied towns gas instead of natural gas. Typical of the older ferrous gas mains in the industry, cast iron and unprotected steel mains in the network do not have effective protection measures such as coatings or cathodic protection (CP). As a result, the unprotected ferrous mains have gradually corroded over the past 70+ years. The figures below indicate the inefficiency of repairing corroded cast iron mains, when compared to rehabiliate of the main. The repair clamps currently used only address the localised leak, however adjacent areas of the main are likely to be equally corroded and are likely to fail in due course causing additional leaks.

Figure 1-1&2: Examples of corroded cast iron mains and a repair clamp used throughout JGN

All Australian gas distribution businesses are systematically removing, or have fully removed, these types of older ferrous mains due to the increased safety, integrity and supply risks posed to the customers, general public and employees. Reduction in greenhouse gas emissions is a further driver for removing aged ferrous mains. There is a strong focus from customers and governments on emissions reduction, who expect energy providers to play their part in achieving greenhouse gas targets. The introduction of the Safeguard Mechanism[1], which requires industrial facilities (including gas networks) to reduce greenhouse gas emission by 4.9% per year, means it is essential the poorest condition mains are removed as soon as practicable.

Unaccounted for gas (UAG) is an indicator of network integrity and leaks, with JGN's overall network allowance being 2.9% of throughput. Based on the mains material type, previous leakage tests and publicly reported leaks, data indicates that the UAG from fugitive emissions in the Newcastle MP 30kPa network is likely to be significantly higher in comparison to the overall JGN network. These high leak rates, coupled with emissions reduction targets means the mains rehabilitation program should not be deferred further.

Standard historical practice when removing ferrous mains and replacing them with plastic pipe is to increase network operating pressure. However, in the Newcastle 30kPa network modelling indicates that the existing network is sufficient to meet demand for the medium term. This means we can defer conducting the pressure upgrade at this time, reducing the overall project cost.

As part of our ongoing mains rehabilitation program, we will insert the Newcastle networks' cast iron with plastic mains over three stages, with the first stage planned to start in 2025

1.1 Business need

The primary drivers for undertaking the Newcastle MP 30kPa rehabilitation project are to:

[1] See link.

- Ensure customers receive a reliable gas supply now and in the near-term future.
- Reduce greenhouse gas emissions in alignment with Jemena's Emission Reduction Strategy.

Supporting benefits that further justify the need for delivering this project are to:

- Reduce number and magnitude of gas leaks to improve personnel and public safety.
- Comply with Standards and Statutory Requirements.
- Reduce operational and UAG cost.
- Reduce emergency incidents and repairs.

1.2 Customer feedback

Customers have told us they value a safe and reliable gas supply, and expect JGN to ensure the gas network remains safe and that gas is available when customers need it. In recent engagements, customers have indicated a preference for targeted investment in safety and reliability, encouraging JGN to proactively manage integrity issues with the aim of reducing ongoing maintenance costs. A strong theme that emerged from our customer engagement program is that while customers expect JGN to keep costs as low as practicable and encourage non-critical investments to be deferred where prudent to do, safety must not be compromised.

Customers have suggested JGN should carefully consider the pace of investment, and take a considered approach to how the network may be used in the future. Customers want us to considered affordability over the short and long term when making decisions. Customers expect us to act now and plan for a net zero emissions future, rather than delaying investment. This includes looking at how new technology could be applied to improve asset management.

Reduction in greenhouse gas emissions is also valued by customers. Residential customers have expressed a preference for lower-emissions technology and support exploration of renewable gas technologies. Some larger customers have their own emissions reduction targets and expect their energy providers to play their part in facilitating a greenhouse gas decrease.

Customers continue to connect to the gas network. While growth in demand for natural gas services has slowed in recent years, new connections will continue during the next regulatory period, with growth expected in some pockets of the network. The distribution network is expected to continue to play a major role in NSW's energy future. Customers have told us that that they value choice and diversity in their energy supply. Though there is a current trend towards electrification of industries, 85% of Sydney customers agree that NSW needs a mix of energy sources – including solar, wind and gas – and that we should not 'put all energy eggs in one basket'. 78% of customers support having the choice of renewable gas options as part of the energy transition.[2]

Thousands of customers remain dependent on the gas network, with many not be willing or able to switch away from gas as an energy supply. As such, while investment in network growth may be more conservative than compared to historical levels, it is important JGN continues to invest to sustain the network and ensure compliant pressures and uninterrupted supply.

[2] Redbridge, Sydney energy attitudes and sentiments, December 2023.

1.3 Recommendation

In order to address the risks identified, five options have been considered.

Table 1: Summary of options

All dollar values are 2023 estimates. All opex values are the sum of cost accumulated from 2024 to 2050.

Option	Description	Total Opex	Total Capex	Risk
1	Reactive maintenance only	$58.1M	$0	Significant
2	Minor capital works on ferrous mains	$60.7M	$13.5M	Moderate
3	Rehabilitate only cast irons mains with plastic mains. Defer unprotected steel rehabilitation and network pressure upgrade.	$5.5M	$26.4M	Low
4	Rehabilitate all ferrous mains and increase network pressure to 210kPa	$5.5M	$45M	Low
5	Rehabilitate all mains and increase network pressure to 210kPa	$5.5M	$82.2M	Low

Option 3, which is to rehabilitate the cast iron mains and defer both the unprotected steel and network pressure upgrade, is considered the most prudent option. This project will eliminate the risks of gas leaks, mains repairs and operational costs associated with cast iron mains corrosion in the Newcastle MP1 network.

This option is consistent with customer feedback, in that it is a more targeted program than historical mains rehabilitation initiatives, and will focus solely on the cast iron mains.

1.4 Consistency with the National Gas Rules and National Gas Objective

When developing this business case, we have given regard to the requirements of the National Gas Rules (NGR) and the National Gas Objective (NGO).

NGR 79(1)

We submit that the proposed solution is prudent, efficient, consistent with good industry practice, and will achieve the lowest sustainable cost of providing services.

- **Prudent** – The expenditure is necessary in order to ensure the safety of the Newcastle MP1 network and the reliability of service to the thousands of customers whose gas supply is dependent on the network's ongoing operation. The work will reduce the current high rated risk to low.

- **Efficient** – Removing all the cast iron in the area as three targeted projects is the most cost effective option. Removal of the unprotected steel can be prudently deferred until such time that new technologies (such as Picarro) can inform future strategic rehabilitation programs. Work will be carried out by approved contractors based on competitively tendered rates to reflect the most favourable market rates possible.
- **Consistent with accepted and good industry practice** – The removal of cast iron main from distribution networks is consistent with accepted and good industry practice, with distribution companies across Australia on a pathway to removing, or already removed, all unprotected cast iron mains. The installation of PE that is capable of higher pressures, should it be required, is considered industry standard.
- **Achieve the lowest sustainable cost of delivering pipeline services** – A targeted cast iron rehabilitation project that enables deferral of unprotected steel mains rehabilitation and also deferral of pressure upgrade achieves the lowest sustainable cost of providing services, whilst being conscious of the changing landscape of gas and customer sentiment. It is prudent to invest now to remove of cast iron to help keep costs sustainable over the long term as leaving in situ results in escalating maintenance, emissions and UAG costs, as well as unacceptable safety concerns.

NGR 79(2)

The proposed capex is justifiable under NGR 79(2)(c)(i) as it is necessary to maintain the safety of personnel and the public living and working around the ageing cast iron network. The rehabilitation works can also be justified under NGR 79(2)(c)(v) as removing these leaking cost iron mains will contribute to meeting emissions reduction targets.

NGR 74

Demand forecasts are based on 2023 data, and the cost estimate has been developed using a top-down approach, utilising information from similar projects that went through a competitive tender process. We therefore consider that this estimate has been developed on a reasonable basis and reflects the best information available at this time.

NGO

Removing the aged cast iron mains from the network also contributes to achieving the NGO, specifically with regard to emissions reduction. Leakage rates in the Newcastle 30kPa network are 15 times higher than the overall network. Rehabilitating these leaking mains with fit-for-purpose plastic pipes will significantly reduce the volume of UAG and therefore the volume of methane potentially released into the atmosphere. This is likely to contribute towards achieving NSW emissions reduction targets and reducing Australia's greenhouse gas emissions.

SAFE GUARD MECHANISM

The Safeguard Mechanism is the Australian Government's policy for reducing emissions at Australia's largest industrial facilities which includes mining, oil and gas industries, manufacturing, transport and waste facilities. The Safeguard Mechanism applies to facilities emitting more than 100,000 tonnes of carbon dioxide equivalent (CO2-e) per year. There are legislated limits (also known as the "Baseline") on emissions which gradually decline (approximately by 4.9% yearly) over time to achieve emissions reduction targets. If emissions exceed the baseline target for the given year, the company would incur penalties and on the contrary if the emission remain under baseline, then they receive a credit. The greenhouse gas emission reduction target for NSW is 50% below 2005 levels by 2030 and approaching net zero by 2050. In 2022, JGN emission accounted to 292,825 tCO2e from which 98.75% was due to distribution (only accounts of medium pressure and low pressure networks) fugitive emissions.

1.5 Financial information

The rehabilitation will be efficiently planned over three stages as per the capital forecast shown in the table below.

Table 2: Newcastle MP1 Rehab Capital Cost estimate per stage.

All dollar values are 2023 estimates

Item	Stage 1 ($000)	Stage 2 ($000)	Stage 3 ($000)
Scheduled delivery Year	2025	2026	2027
Materials	225	225	225
Contractor costs	3,538	3,827	3,296
Labour	976	999	999
Total direct costs	**4,739**	**6,754**	**6,109**
Overheads	**2,433**	**2,775**	**2,510**
Risk allocation	1184	1,703	1,587
Total project cost	**8,268**	**9,529**	**8,619**
Total cost			**$26.4M**

2. Background

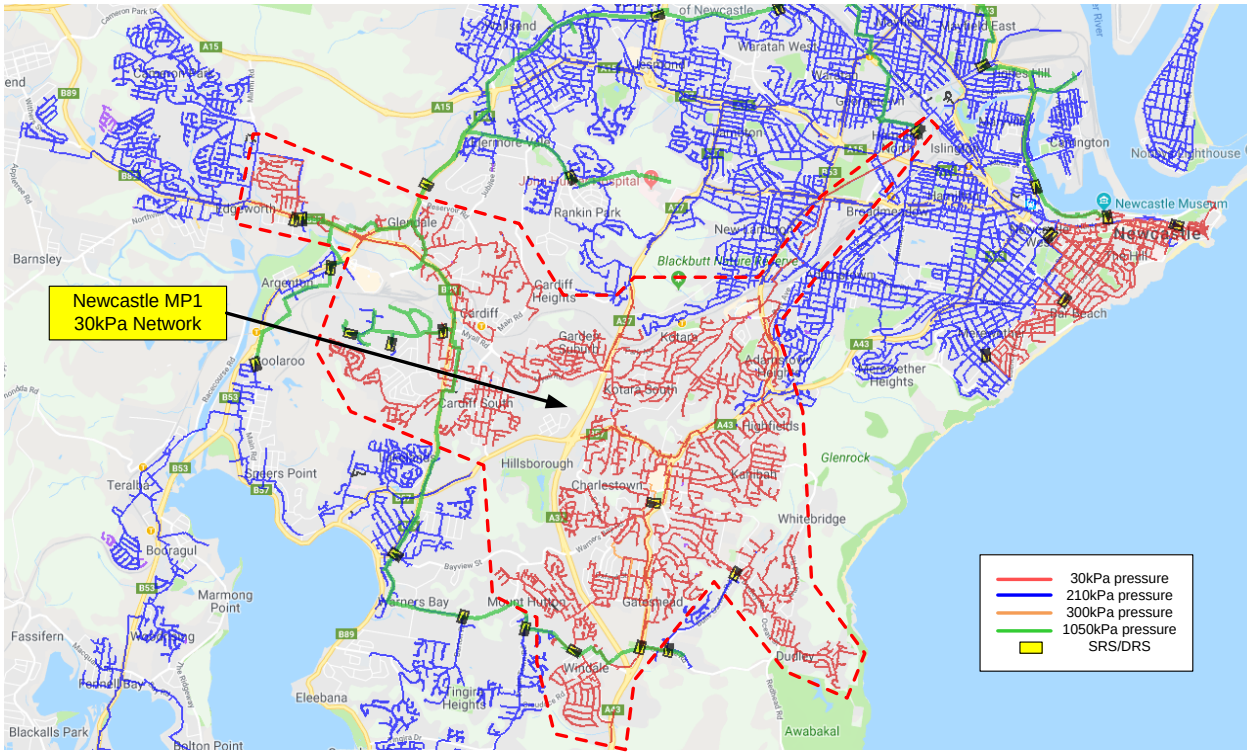
The Newcastle MP1 network is operating at 30kPa to provide gas supply to over 11,600 customers in 23 suburbs including Charlestown, Cardiff, Glendale, Kotara and Windale. The network is supplied by six secondary/district regulator sets (SRS). Four of the SRS are supplied off the secondary pressure mains, while the other DRS are supplied off the 210kPa and 300kPa mains. The total length of mains in the network is approximately 260 km. The mains in the Newcastle network are made up with a mix of ferrous (cast iron and steel) and plastic mains (PE and nylon). Cast iron and steel mains account for approximately 37km and 99km respectively. The remaining 124km are plastic mains.

The cast iron mains were mainly laid during the 1950s and 1960s. They make up ~12% by length of the total network. The mains are typically constructed of four and six inch pipe. From the 1980s, after the transition from town gas to natural gas, the network has progressively been laid with plastic mains such as nylon and polyethylene. This has resulted in a network consisting of various materials.

Over the past ten years, the integrity of the cast iron mains in the Newcastle MP1 network has deteriorated to a point where the performance of the network consistently fails Jemena Gas Networks' (JGN) performance indicators. There have been multiple instances where the mains have failed, causing gas leaks and risks to the public and community, also necessitating road closures and evacuations for repairs to occur. Leak rates in the area are higher than the network overall average, resulting in poor emissions performance. The Newcastle 30kPa network has been earmarked for rehabilitation for some time. We have been able to defer cast iron rehabilitation for several years, however the network has continued to deteriorate during this time. Current leak rates and the associated safety, supply, and emissions concerns, means it would not be prudent to defer these works further

A map showing the extent of the network is shown in the figure below.

Figure 2–1: Newcastle MP1 30kPa network map



2.1 Risk analysis

The current network performance gives rise to serious safety and operational risks, as well as a financial risk in paying penalties due to emissions exceeding baseline targets in relation to the Safeguard Mechanism. Unless action to mitigate risks is taken, there is increasing likelihood of gas release leading to serious harm, significant disruption to customer supply, or causing JGN to exceed its Safeguard Mechanism legislated limit. The risk level for this project is therefore assessed as significant. Under JGN's risk framework, any risks deemed significant (or higher) must be addressed to reduce the risk to low or as low as reasonably practicable (ALARP).

A risk assessment was conducted to determine the extent of the untreated risk. The risk assessment was undertaken in accordance with the Group Risk Management Manual JAA MA 0050 Revision 10.

Table 3: Risk rating

Contributing Factors/ Scenario	Strategic	Financial	Safety	Operational	Regulatory & Compliance	Reputation	Consequence (Highest Impact)	Likelihood	Risk level
Degradation of pipe and fittings causing gas release	Minor	Minor	Serious	Serious	Serious	Minor	Serious	Likely	Significant

Table 4: Untreated risk summary

Risk type	Consequence	Likelihood	Untreated Risk Summary	Risk Level
Strategic	Minor	Likely	• To not complete works would not be in alignment with JGN's Networks Asset Class Strategy. • Jemena emission reduction strategy would be impacted as this network has a high leakage (UAG from emissions 36%[3] vs 2.9% benchmark).	Moderate
Financial	Minor	Possible	• Jemena incurs higher operating costs to purchase gas to replace the gas lost through leakage. • If the ageing and corroding cast iron remains in situ, opex cost will continue escalating as unplanned and emergency repairs will increase • Jemena will also be liable to pay penalties for failing to reduce emissions below baseline targets as per the Safeguard Mechanism.	Moderate
Safety	Serious	Unlikely	• Leakage from corrosion of the pipe and fittings could cause fire and gas incidents that lead to injury to the public and Jemena employees • Environmental damage due to the higher leakage rates from emitted UAG.	Moderate
Operational	Serious	Likely	• Supply to customers would likely be affected in the event of emergency repairs. • Continuity of supply and level of customers cannot be assured when operating a network which requires continual maintenance and repair.	Significant
Regulatory	Serious	Possible	• High rates of leakage have the potential to cause adverse publicity. In larger incidents, reports may be requested by the technical regulator.	Moderate

[3] Note: this is an estimated figure based on leakage tests conducted on networks with similar materials composition

			• Jemena will also be liable to pay penalties for failing to reduce emissions below baseline targets as per the Safeguard Mechanism. •	
Reputation	Minor	Unlikely	• Responding to a high level of emergency incidents and repairs has required the use of the fire brigade and the police to ensure public safety. This is a drain on this resource to attend gas emergencies, and also affects their availability to the community • Constant customer complaints and being unsatisfied with the service may lead to higher disconnections and adverse media, which would negatively impact the reputation of Jemena.	Low

2.2 Consistency with asset class strategy and plans

As described in JGN's Networks Asset Class Strategy, our assets are necessary for the safe distribution of gas, while ensuring the correct pressures and volumes are available to all our customers at all times. In addition to keeping the network safe and reliable, understanding and minimising our fugitive emissions is critical to help achieve net zero greenhouse gas emissions and comply with JGN's legislative requirements.

Investment in the networks asset class is largely driven by the installation of new mains to service new areas, as well as the timely rehabilitation of existing mains and services. The rehabilitation of mains, services and pressure reducing facilities is optimised to achieve a balance of targeted risk reduction, whilst still maximising economies of scale where possible.

Once network assets are in service, as prudent asset managers our role is to ensure these assets continue to function safely, and remain fit for purpose, replacing or rehabilitating them in a timely manner. Our aim is to manage our network assets for the lowest practicably sustainable cost.

Our key considerations are:

- **Safety** – It is vital our network assets remain safe and compliant. We rehabilitate network assets when they pose an unacceptable safety risk. This may be due to deterioration in asset performance, or a change in the local environment that increases the risk associated with asset failure and/or unacceptable gas leaks. It is also important that our networks are constructed in compliance with AS/NZS 4645: Gas Distribution Management and its relevant Parts, and that our network activities and asset management align with ISO 55001. This enables us to demonstrate to ourselves, our customers, external stakeholders and business partners that we maintain industry good practice, whilst managing our risk to as low as reasonably practicable.
- **Reliable service** - It is vital our network assets continue to provide the required levels of service. Our networks and flow stopping activities are designed such that third party damage incidents as well as planned and reactive maintenance is such that it does not interrupt the supply to residential, commercial or industrial customers where possible. Hydraulic modelling and network design ensure that pressures and capacity are carefully balanced to remain above the minimum allowable, whilst also being mindful that higher pressures result in increased fugitive emissions.
- **Enable net zero** – We have a responsibility under the Safeguard Mechanism and the Government's Net Zero 2050 targets to reduce our greenhouse gas emissions, and to use our network assets to help customers reduce theirs. The largest source of greenhouse gas emissions from our network is fugitive gas. Therefore, where there is an opportunity to modify our network assets to reduce or better measure our greenhouse gas emissions we will consider investment. Similarly, where renewable or lower- emissions gasses are introduced into the gas distribution system, we must also invest in the appropriate network assets to ensure they remain safe and that gas volumes can be measured accurately.

Jemena's Emissions Reduction Plan is to reduce CO_2 emissions to Net Zero by 2050. The Federal Government is also mandating via the Safeguard Mechanism to reduce 4.9% of CO*2* emissions every year from mid-2024 to 2030. In Jemena Gas Networks (JGN) the biggest contributor to CO*2* emissions is in the form of methane from fugitive emissions on gas assets, namely mains, services and meters.

The key pillars of the Emissions Reduction Plan for JGN are:

- Pressure reduction (both permanent and Seasonal)
- Targeted network repair and rehabilitation, and
- System use gas reduction

The rehabilitation of the cast iron mains in the Newcastle MP1 network aligns to the strategies presented in the JGN Network Asset Class Strategy 2023 such as safety, reliability and reducing fugitive emissions.

3. Options

3.1 Option costs & benefits

The following options were considered to address the risks associated with the Newcastle MP1 30kPa network:

- **Option 1**: Reactive maintenance only.
- **Option 2**: Minor capital works on ferrous mains.
- **Option 3**: Rehabilitate cast irons mains only with plastic mains and maintain network pressure at 30kPa
- **Option 4**: Rehabilitate all ferrous mains (steel and cast iron mains) and increase network pressure to 210kPa.
- **Option 5**: Rehabilitate all mains and increase network pressure to 210kPa.

3.1.1 Option 1: Reactive maintenance only (Maintain Status Quo)

This option considers reactively responding to network maintenance as it continues to deteriorate over time, with no planned or proactive maintenance to be conducted. The risk profile will continue to escalate with more corrective maintenance occurring in an attempt to maintain an acceptable level of safety and reliability.

There would be increasing costs associated with responding to larger and more frequent leaks, as well as increasing operational costs for UAG. Opex would be approximately $1.5M p.a. ($2023), conservatively increasing to $1.7M p.a. over the next 25 years.

3.1.1.1 Benefits

There would be no immediate capital investment in the network, therefore this is a less capital-intensive option and would have a lower impact on network tariffs in the short term. However, reactive operational maintenance costs would escalate significantly over time given that no proactive maintenance will be completed.

3.1.1.2 Limitations

- If no proactive works are undertaken, our regression analysis demonstrates publicly reported leaks, and therefore all leaks, will increase further in the following years. The likelihood of an incident that may cause injury would therefore increase too. This option fails to improve safety to customers.
- Continuity of supply cannot be assured when operating a network that requires continual maintenance and repair. Hence the option fails to improve reliability of supply.
- This option also fails to improve efficiency and affordability to customers as operational costs will continue to increase due to recurring operating and maintenance activities, increased UAG, lost revenue from current customers and reputational damage to Jemena.
- This option does not provide JGN with a means to reduce emissions from gas leaks, nor enable a comparison of the emissions using the Picarro technology of pre and post repair. Hence this option does not support the transition to ‘Net Zero by 2050’ and Jemena emission reduction strategy.
- This option will also involve ongoing penalties for failing to reduce emissions below legislated limits in accordance with the safeguard mechanism.

3.1.2 Option 2: Minor capital works on ferrous mains

Under this option, we would deliver a program of minor capital works, with any other works undertaken on a reactive basis. These works would target small rehabilitation jobs on a risk basis – effectively maintaining the current level of operational expenditure through an ongoing reactive program of small capital rehabilitation

activities. The priority of mains to be rehabilitated is based on the risk level of individual sections of mains, relative to each other.

The capital cost for this option is approximately $360K per year ($ 2023) with opex cost starting at $1.5M in 2023 and increasing to $1.7M by 2050.

3.1.2.1 Benefits

- This option would allow JGN to address the most urgent risks first, with the remainder of issues managed on a reactive basis.
- According to the priority and level of deterioration of the mains within the network, individual sections will be rehabilitated to reduce the ongoing leaks and associated repairs this would ensure customers receive a reliable gas supply

3.1.2.2 Limitations

- This option would require capacity development projects to ensure supply pressure is maintained. Additionally, as the network deteriorates at an increasing rate, opex would likely never reduce hence the option fails to improve efficiency of the network and affordability to customer.
- The success of this option requires JGN's minor works program to keep pace with the deterioration of the ferrous mains network. There is a risk under this option that the volume of ongoing reactive works would increase as further integrity issues are discovered.
- This option limits our ability to reduce emissions from gas leaks and enable a comparison of the emissions using the Picarro technology of pre and post repair. Hence this option does not support the transition to 'Net Zero by 2050' and Jemena emission reduction strategy.
- This option is not consistent with the long-established industry good practice of proactively removing aged cast iron mains from gas distribution networks.
- This option will still involve ongoing penalties for failing to reduce emissions below legislated limits in accordance with the safeguard mechanism.

3.1.3 Option 3: Rehabilitate cast irons mains only with plastic mains - defer unprotected steel rehabilitation and network pressure upgrade.

This option is rehabilitation of all the remaining cast iron mains (37km) in the Newcastle MP1 network. The scope involves insertion of new PE mains into cast iron mains, with the project to be completed over three years from 2025 to 2027. The performance of the networks plastic mains is considered satisfactory.

It is historical practice that once a network area is rehabilitated, operating pressures are increased as part of the same project. As JGN would prefer not to continuously return to the areas to conduct works that can be disruptive to customers and high cost (traffic management costs, etc.). However, network modelling demonstrates that the existing Newcastle network will meet the capacity demands of customers for the short-to-medium term. Therefore, any pressure increase has been deferred until such time that capacity constraints determine it must be done.

Based on the bottom-up costing for this rehabilitation, the forecast capex is $26.4M ($2023). Ongoing O&M and UAG cost up until rehabilitation is approximately $1.3M per year, and penalties for non compliance with safeguard mechanism is approximately $200k p.a. Opex cost would significantly be reduced after the completed works and are estimated to be $29k per year, until 2050.

This project is expected to commence in 2025 and the deferral of cast iron mains rehabilitation poses an unacceptable risk, because of poor integrity, high leakage rates which in turn causes safety and supply issues. Customers have also expressed the high importance of emissions reduction. Our plan to target a network with estimated high UAG from leakage aligns with customer expectations. Customers have also expressed the high importance of emissions reduction. Our plan to target a network with high UAG aligns with customer expectations.

In addition to safety concerns, Jemena deems it prudent from a customer perspective to do this project in CY25. Deferral of the project does not address Jemena's emissions reduction strategy, which is a priority to customers, as deferral does not reduce emissions until the project is completed.

3.1.3.1 Benefits

- Cast iron mains account for the greatest number of leaks and repairs. The mains rehabilitation project will further improve safety to customers by reducing the number and frequency of publicly reported leaks, as well as undetected leaks. Consequently, it will reduce the risk and potential harm to our customers, the public and Jemena personnel.
- Less reactive maintenance would practically eliminate network supply interruptions derived from publicly reported leaks, ensuring customers receive a reliable gas supply.
- Rehabilitating the cast irons mains will significantly reduce emissions, as well as its associated cost such as penalties from non-compliance with safe-guard mechanism. It would also enable us to reach Jemena's Emission Reduction target of Net zero by 2050.
- A proactive cast iron mains rehabilitation is the most efficient manner to remove the risks with significantly lower costs than a mains repair or a piecemeal reactive mains rehabilitation. This is because the fixed costs associated with rehabilitating mains are spread over a greater volume and using the insertion technique is a cost-effective rehabilitation methodology. Also, the project can be designed such that minor network capacity upgrades can be achieved when rehabilitation are done.
- Operating costs will be reduced significantly after rehabilitation project, making the network more affordable to customers over the longer term.

3.1.3.2 Limitations

- The older plastic mains will still have levels of leakage. However, the repair of plastic mains is less complex than for ferrous mains and the magnitude of leakage is typically lower.

3.1.4 Option 4: Rehabilitate all ferrous mains and increase network pressure to 210kPa

Under this option, we would rehabilitate all 136km of remaining ferrous mains (cast iron and steel) in the network. The method of rehabilitation is by inserting new PE mains into the old ferrous mains, with the project taking three years to complete, 2025 to 2027.

Historical practice is to increase pressure to 210kPa where ferrous mains have been removed from the network. This increases the overall quality of supply to customers, mitigates potential capacity shortfalls, and allows for ongoing growth in customer connections. Network modelling demonstrates that upgrading the pressure to 210kPa will meet the capacity demands of the long term.

The capital cost for this option is $45M ($ 2023) with an annual operational cost reducing from $1.5M prior to the rehabilitation, to $29K post project completion.

3.1.4.1 Benefits

- Along with cast iron, unprotected steel mains also account for higher than average leakage rates. Rehabilitating both the unprotected steel and cast iron mains will improve safety to customers by reducing the probability, magnitude and frequency of leaks. It will therefore reduce the likelihood of harm to our customers, the public and our employees.
- Removing all ferrous mains would significantly reduce ongoing maintenance costs and minimises the likelihood of supply interruptions do to leaks. This ensures customers will receive a reliable gas supply.

- A proactive ferrous mains rehabilitation is the most efficient manner to remove the risks with lower costs than a mains repair or a piecemeal reactive mains rehabilitation. This is because the fixed costs associated with rehabilitating mains are spread over a greater volume and using the insertion technique is a cost-effective rehabilitation methodology. Also, the project can be designed such that minor network capacity upgrades can be achieved when rehabilitation are done, deferring pressure upgrades further into the future.
- Rehabilitating these gas mains will significantly reduce emissions in the form of UAG. It will significantly reduce leaks, and will contribute towards JGN meetings its targets under the Safeguard Mechanism, as well as contributing towards NSW emissions reduction targets.
- Operating costs are reduced significantly after rehabilitation project, making the network more affordable to customers.

3.1.4.2 Limitations

- The older plastic mains will still have levels of leakage, however the repair of plastic mains is less complex than for ferrous mains.
- Although all the cast iron must be removed, this option foregoes the opportunity to prudently defer steel mains rehabilitation while we deploy improved leak detection technology (Picarro), which will help us optimise our asset management strategies.
- While growth in demand for natural gas services has slowed in recent years, the number of connections continues to increase. However, it may not be necessary upgrade the network to 210kPa just yet, as maintaining pressures at 30kPa should meet demand in the short to medium term.

3.1.5 Option 5: Rehabilitate all mains and increase network pressure to 210kPa

This option rehabilitates the entire 260km network through either insertion or direct lay to remove cast iron, steel and older plastic mains over three years from 2025 to 2027. On completion, the network pressure will be upgraded to 210kPa. The capital cost for this option is $82.2M ($ 2023) with an ongoing annual operational cost decreasing from $1.5M to $5K in 2050.

3.1.5.1 Benefits

- The mains rehabilitation project will improve safety to customers by significantly reducing the probability and frequency of a publicly reported leak. Consequently, it will significantly reduce the likelihood of harm to our customers, the public and our employees
- It would ensure customers receive a reliable gas supply as opposed to continuing with the current repair process in the area which often requires isolation of sections gas mains. Repairing only provides a temporary and ad-hoc solution to a network that is progressively deteriorating.
- Rehabilitating these gas mains will significantly reduce emissions in the form of UAG. It will significantly reduce leaks, and will contribute towards JGN meetings its targets under the Safeguard Mechanism, as well as contributing towards NSW emissions reduction targets.

3.1.5.2 Limitations

- Not all mains in the network have integrity or supply issues and hence replacing all mains is not cost effective.
- While growth in demand for natural gas services has slowed in recent years, the number of connections continues to increase. However, it may not be necessary upgrade the network to 210kPa just yet, as maintaining pressures at 30kPa should meet demand in the short to medium term.
- There is a very high capital cost associated with this option.

3.2 Options analysis

Criteria	Option 1	Option 2	Option 3	Option 4	Option 5
Option description	Reactive maintenance only	Minor capital works on ferrous mains	Rehabilitate cast irons mains only with plastic mains. Defer unprotected steel rehabilitation and network pressure upgrade	Rehabilitate all ferrous mains and increase network pressure to 210kPa	Rehabilitate all mains and increase network pressure to 210kPa
Comparison of options	• No upfront capital.	• Minor impact on UAG from emissions • Addresses highest risk in minor capital works. •	• Lower upfront capital than options 4 and 5. • Provides a safer network for the public and employees. • Eliminates the risk of complex repairs on leaking cast iron mains for Jemena personnel. • Improve efficiency and affordability of the network through reducing operational costs. • Contributes to emission and UAG reduction targets. • Reduce ongoing opex cost	• Provides a safer network for public and employees. • Eliminates the risk of complex repairs on leaking cast iron mains for Jemena personnel. • Accounts for future growth and standardises the network to 210kPa. • Improve efficiency and affordability of the network through reducing operational costs. • Significantly reduces emissions and UAG. •	• Provides a safer network for public and employees. • Eliminates the risk of complex repairs on leaking cast iron mains for Jemena personnel. • Eliminates the HDPE, old nylon and non-standard joints. • Accounts for future growth and standardises the network to 210kPa. • Improve efficiency and affordability of the network through reducing operational costs. • Reduce ongoing opex cost
Treated risk ranking	Significant	Moderate	Low	Low	Low
Total Opex	$58.1M	$60.7M	$5.5M	$5.5M	$5.5M
Total Capex	$0	$13.5M	$26.4M	$45.0M	$82.2M
Relative NPV to ‘Option 1’ ($2023)	---	-$5.9M	$57.8M	$40.9M	$7.2M
Option Analysis	Does not address the issue	Fully addresses the issue	Fully addresses the issue	Fully addresses the issue	Fully addresses the issue
Recommendation	Not recommended	Not recommended	**Recommended**	Not recommended	Not recommended

All dollar values are 2023 estimates. All opex values are the sum of cost accumulated from 2024 to 2050.

4. Recommendation

Option 3 is recommended. Rehabilitate cast irons mains with plastic mains and maintain network pressure at 30kPa.

The proposed solution addresses safety of the public, customers and our employees, but also delivers a cost-effective solution in the medium term. In addition to primary drivers, this option will significantly reduce our fugitive emissions and UAG, whilst enabling JGN the time to utilise new technologies in development of future r strategies for other rehabilitation network materials.

This option addresses the project drivers and aligns with Jemena's business plan, customer expectations, the NGO, the NGR and NSW Regulatory Instruments, and industry good practice.

4.1 Economic analysis [PEM investment framework]

Please refer to Investment Framework file name 'JGN - RIN - 4.3 - Newcastle MP1 30kPa Rehabilitation - CBAM - 20240628 - Public'.

Please refer to the Price estimate model for Stage 1, 2 and 3.

JGN - RIN - 4.3 - 10022511 - Newcastle MP1 30kPa Rehabilitation Stage 1 - PEMO - 20240628 - Public
JGN - RIN - 4.3 - 10069080 - Newcastle MP1 30kPa Rehabilitation Stage 2 - PEMO - 20240628 - Public

JGN - RIN - 4.3 - 10069081 - Newcastle MP1 30kPa Rehabilitation Stage 3 - PEMO - 20240628 - Public

4.2 Risk outcomes for the preferred option showing how risks is mitigated / reduced.

The treated risk in implementing Option 3 to rehabilitate the cast iron mains is reduced from 'Significant' to 'Low'.

Table 5: Summary of preferred option

PREFERRED OPTION – Risk assessment summary				Treated risk summary		
Preferred option/Treated risk	**Cost**	**Benefit**	**Key mitigations**	**Consequence**	**Likelihood**	**Risk level**
Option 3 Rehabilitate cast iron mains only	$26.4M	• Eliminates all the corrosion issues and reduces opex cost associated with cast iron mains • Reduction in UAG from emissions • Provides a safer network for the public and employees. • Improve efficiency and affordability of the network through reducing operational costs.	• Provides a safer network for the residence and visitors • Complies with the Gas Supply Act 1996; No 38 (3), due for the ferrous mains being rehabilitated and condition of plastic mains being addressed on an as required basis • Reduces penalties incurred by safeguard mechanism as a result of reduced emissions.	Minor	Unlikely	Low