Jemena Gas Networks (NSW) Ltd

SPM - Lidcombe to Banksmeasdow Pigging Facilities

Options Analysis

GAS-1400-RP-CP-005

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Jemena

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1. EXECUTIVE SUMMARY

1.1 PROJECT AND KEY DRIVERS

The Sydney Primary Main (SPM) is a critical asset managed by Jemena Gas Networks (JGN) supplying gas to over 500,000 customers across Sydney Region. Recent inspections have revealed active corrosion and thinning of the pipe wall, posing significant safety risks. Traditional spot checks have become less efficient and costly due to the deteriorating condition of the SPM and rising inspection expenses. To address these challenges, Jemena has developed a strategy, outlined in the Jemena Asset Class Strategy[1], which involves reconfiguring sections of the SPM to enable in-line inspection (pigging). Our approach is to de-rate the main where possible, and if de-rating is not feasible, we will explore reconfiguring the pipeline to enable pigging. This options paper focuses on the Lidcombe to Banksmeadow section of the SPM.

The SPM segment from Lidcombe to Banksmeadow comprises of two sections installed at different times. The Lidcombe to Mortlake section, installed in 1968, is around 55 years old and originally served for transporting town gas before the introduction of natural gas. Conversely, the segment downstream from Mortlake to Banksmeadow, installed in 1976 with the arrival of natural gas in Sydney, is approximately 47 years old. Both sections are becoming progressively challenging to inspect using direct inspections (excavations) due to their placement beneath bitumen-paved roads in the urban environment of Sydney suburbs. An assessment of pipeline's condition is crucial for ensuring safety and reliability. Historical spot checks were cost-effective within the pipeline's design life but are no longer efficient due to escalating costs and the deteriorating condition of the SPM. The consequences of through-wall corrosion leading to gas escape or an explosion underscore the need to address the pipeline's integrity. This project is crucial for public safety, JGN's gas distribution system integrity, and Jemena's financial stability.

The primary driver behind the "Lidcombe to Banksmeadow – Pigging Facilities" project is the urgent need to proactively address critical integrity and safety concerns. These issues are primarily linked to the corrosion occurring beneath disbonded heat shrink sleeves (HSS) at field joints (i.e. girth welds) and under mainline HDPE coating installed along the pipe body. The identified threats and associated risk ratings emphasize the severity of the situation. The potential risk of through-wall corrosion leading to gas escape is rated as "High" according to both Jemena's risk assessment matrix and the AS2885.1 Risk Matrix. This risk not only poses a threat to public safety but also has the potential to cause massive sinkholes, disrupt traffic, and result in building destruction if ignition occurs.

Additionally, the project addresses critical obligations under the Gas Supply Act 1996, including ensuring the continuity of natural gas supply to customers and the development of efficient and safe gas distribution systems. The SPM's aging condition, situated in a high-consequence urban environment, combined with the presence of corrosion, requires immediate attention. The existing controls, such as cathodic protection (CP) and direct current voltage gradient (DCVG), are insufficient to guarantee pipeline integrity, making it imperative to take proactive measures to safeguard public safety and ensure the reliability of gas distribution system.

[1] GAS-999-PA-PL-002 Asset Class Strategy Jemena Gas Networks - Pipelines_2022: http://ecms/otcs/cs.exe/open/321938051

1.2 CREDIBLE OPTIONS

The following options were assessed for this project and are provided in Table 1 below. The table shows the capital, operational and risk costs of each option in present value terms.

Table 1: Options Summary

Option	Option Name	Description	Cost (A$ 000's) in present value terms		Treated Risk (Highest Risk)	
					Jemena	AS2885
1	Maintain Status Quo **(Not recommended)**	This involves existing inspection techniques including digging up the main and inspecting the pipeline for any metal loss.	Capex	Nil	High	High
			Opex	$ 1,200[2]		
2	Reconfigure the pipeline to enable in-line inspection (pigging facilities) **(Recommended option)**	In-Line Inspection (pigging) is capable of inspecting the entire pipeline condition and it doesn't impact customers supply. Using this technology is industry standard and recognised as an efficient means of managing a pipeline.	Capex	$ 11,171	Moderate	Low
			Opex	Nil		
3	De-rate Lidcombe to Banksmeadow section **(Not recommended)**	This option explores de-rating the pipeline section between Lidcombe to Banksmeadow to secondary pressure. This option would result in a network not able to serve customers that currently take gas at pressures higher than secondary.	Capex	$ 45,000[3]	Moderate	Low
			Opex	Nil		

Note: The other potential options, such as "hydrostatic testing" and "pipe replacement" were excluded because they do not align with the Jemena Asset Class Strategy requirements. Hydrostatic testing requires a network shutdown, which would impact the gas supply, while the pipe replacement is both cost inefficient and unfeasible due to space constraints

1.3 RECOMMENDATION

Option 2: Reconfigure the pipeline to enable in-line inspection by constructing pigging facilities is the recommended solution.

Based on the options analysis of the identified threats, associated risk ratings, and the business needs, it is recommended that the most viable, practical and cost effective solution for addressing the integrity issues associated with the SPM (Lidcombe to Banksmeadow) pipeline is to proceed with the reconfiguration of the pipeline to enable in-line inspection. This option aligns with the imperative of ensuring public safety, maintaining the integrity of JGN's gas distribution system, and safeguarding Jemena's financial stability.

[2] 3 digs per year at a total cost of $400k per dig.

[3] Although, this option is currently not viable, the cost is assumed based on SPM Integrity management Stage 1 and Stage 2 cost.

Reconfiguring the pipeline to enable in-line inspection not only represents the most prudent approach to addressing these critical issues but also stands as a fiscally responsible choice that aligns with long term sustainability objectives. It provides the necessary assurance of safety, reliability, and compliance while mitigating the financial risks associated with unexpected and costly repair works. This recommendation underscores the significant benefits and prudent risk mitigation offered by this option, making it the best choice for Jemena's strategic approach to the Lidcombe to Banksmeadow pipeline's project.

The cost estimate for the project has increased from $8.96M to $11.17M due to additional activities identified during the FEED stage, particularly concerning a complex 90-degree back-to-back bend adjacent to the railway track in Flemington. This bend poses a significant risk to the passage of the ILI tool, necessitating an integrity dig within the rail corridor to ascertain its configuration. This involves complex and deep excavation, field-based service locating, potholing, and survey works, along with obtaining permits and engaging specialist subcontractors. Additionally, Jemena's preferred pigging vendor, Rosen, will conduct a pump and pull through test in Germany to refine the tool design in light of identified challenges. The outcomes of this test are crucial for future ILI planning, ensuring secure tool passage through bends and other potential restrictions. Despite the increased cost, this option remains the most prudent in terms of both cost and strategic benefits, ensuring the safe and effective inspection of the pipeline

1.4 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 consider 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.

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.

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.

1.5 NATIONAL GAS RULES

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 ongoing integrity of the SPM is maintained and to reduce the risk of major gas escapes that could impact public safety and reliability of supply. ILI is proven to help address the risk associated with high pressure pipelines and therefore represents an investment that a prudent pipeline operator would incur.
- **Efficient** – The forecast expenditure is based on rates applied in previous ILI reconfiguration projects, and costs will be undertaken subject to a detailed engineering assessment and design.
- **Consistent with accepted and good industry practice** – ILI is accepted industry good practice and has become commonplace among Australian gas distribution pipeline operators. AS2885.3 mandates that pipeline integrity and condition be assessed to confirm the pipeline's ability to safely operate at the nominated MAOP. AS2885.3 requires ILI to be considered where practicable.
- **Achieve the lowest sustainable cost of delivering pipeline services** – The proposed expenditure is necessary to maintain the long term integrity of the SPM. Failure to do so would result in additional expenditure (reactive response to a major gas escape and bringing forward replacement) and increase the long term operating cost of the pipeline. The project is therefore consistent with the objective of achieving the lowest sustainable cost of delivering services. It may also enable us to extend the technical design life of the SPM and manage the future replacement/maintenance schedule more efficiently. Deferring replacement costs and being able to utilise fully depreciated assets for as long as is safe and practicable will eventuate in the lowest sustainable cost of providing pipeline services.

NGR 79(2)

The proposed capex is justifiable under NGR 79(2)(c)(i) and 79(2)(c)(ii), as it is necessary to maintain the safety and integrity of services. Corrosion is one of the primary failure modes associated with steel high pressure pipelines, and any pipeline failure has the potential to interrupt supply to thousands of customers at any one time. Early detection of corrosion is essential to maintain the safety and integrity of services, particularly with pipelines that are beyond their design life.

The current practice of DCVG surveys and dig ups alone is insufficient to manage the integrity risk to an acceptable level, as urban encroachment means there are too many sections of the SPM that cannot be dug up or inspected without inserting an inline inspection tool. It is therefore prudent to reconfigure the pipeline to allow pigging and extend the life of the asset, negating the need to incur the high costs of pipeline replacement.

NGR 74

The forecast costs have been arrived at on a reasonable basis by following realistic assumptions of costs, informed by previous ILI reconfiguration projects along the SPM. Rates are comparable with the market and the volume of pipeline that is to be reconfigured is being limited for the next access arrangement period, with a view to informing more accurate forecasts in future periods. We therefore consider the costs estimates represent the best forecast possible in the circumstances.

NGO

The SPM is vital to the gas distribution network in Sydney and will continue to provide gas distribution services to customers throughout the next regulatory period and for the foreseeable future. The SPM is likely to have a significant role throughout Australia's energy transition, therefore maintaining its efficient operation is in the long term interests of consumers.

2. PROJECT BACKGROUND AND KEY DRIVERS

2.1 PROJECT BACKGROUND

The Sydney Primary Main (SPM) is a vital asset for Jemena Gas Networks (JGN), supplying gas to more than 500,000 customers across Sydney. The maximum operating pressure of the Primary Main is 3.5 MPa, and it operates in compliance with the Gas Supply (Safety and Network Management) Regulation[4] (2022), and by extension, the Australian Standard AS2885.3[5].

The SPM segment from Lidcombe to Banksmeadow DN550 consists of two sections installed at different times. The Lidcombe to Mortlake section, dating back to 1968, served for transporting town gas before natural gas. In contrast, the Mortlake to Banksmeadow segment was installed in 1976 with the introduction of natural gas, and is approximately 47 years old. This DN550 pipeline lacks In-Line Inspection (ILI) provisions.

This section is part of the SPM Horsley Park to Banksmeadow segment. In the first phase of SPM integrity management in 2021, 23km in the Horsley Park to Lidcombe section underwent modification for ILI. The second phase, scheduled from 2024 to 2026, involves pipework modification from Lidcombe to Banksmeadow, enabling ILI inspection in 2026.

The Horsley Park to Banksmeadow section comprises of the following segments:

- Horsley Park to Lidcombe – DN550, approximately 23 km
- Lidcombe to Banksmeadow – DN550, approximately 22.5 km

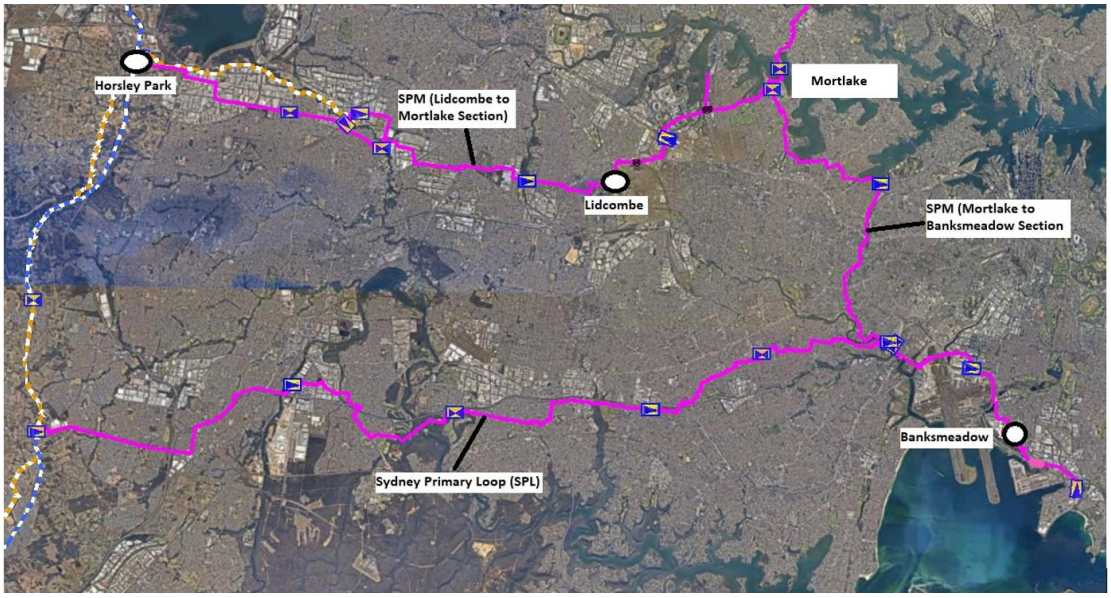

Figure 1: SPM (Lidcombe to Banksmeadow) Configuration

AS2885.3 mandates that pipeline integrity and condition be assessed to confirm the pipeline is able to continue safe operation at the nominated maximum allowable operating pressure (MAOP). The SPM has historically met

[4] Gas Supply (Safety and Network Management) Regulation 2022 Link

[5] AS2885.3 – 2022 – Pipeline – Gas and Liquid Petroleum Part 3: Operation and Maintenance, Section 6: Pipeline Structural Integrity, including but not limited to operational control, corrosion protection, pipe wall integrity and inspection

this regulatory obligation by performing integrity digs. This method has been acceptable in the past because we have relied on the design of the pipeline to provide the assurance that any corrosion that occurs is manageable.

However, the SPM is now an aging asset, with certain sections installed between 1968 to 1982. As the pipeline approaches 50 years of operation, it is imperative to fully understand the pipe wall's condition to confirm its ability to continue safe and reliable operations. This can be efficiently confirmed by measuring the pipe wall thickness, best provided by performing ILI.

Ensuring the pipeline's safe operation is of paramount importance, especially as the Lidcombe to Banksmeadow section of the SPM traverses high density urban as well as industrial environments, where the consequence of a loss of containment event would be catastrophic.

The project's goal is to enhance the safety and integrity of the SPM asset. The first phase, completed in 2021, involved the modification of pipework and reconfiguration for in-line inspection between Horsley Park and Lidcombe. The pipeline was then successfully inspected using an In-Line inspection tool which identified couple of locations with significant corrosion, necessitating permanent repairs.

The second stage is currently being undertaken, and is primarily focused on confirming the feasibility of pigging from Lidcombe to Banksmeadow (this project). This is a continuation of these efforts of managing the SPM integrity, with plans for reconfiguration and inspection of the DN500 section (Mortlake to Putney) in 2026, DN250 section (Putney to Stringybark) in 2028 and the de-rating of the Stringybark to Willoughby (DN150) section in CY25. The feasibility and FEED of Lidcombe to Banksmeadow pigging facilities is planned to be completed in CY24, start of construction in CY25 and completion in June 2026, aligning with Jemena's Asset Class Strategy aimed at maintaining the integrity of the Sydney Primary Main pipeline sections.

The Table 2 below provides the breakdown of the project stages with their respective years of when the reconfiguration and inspections are planned.

Table 2 – Reconfiguration Plan of SPM Segments

Project State	Segment Name	Pipeline Reconfiguration Year	ILI inspection Year
Phase 1	Horsley Park to Lidcombe	2020 – 2021 (completed)	2021
Phase 2 (this project)	Lidcombe to Banksmeadow	2023 – 2026 (ongoing)	2026
Phase 3	Mortlake to Putney	2024 - 2026	2027
Phase 4	Putney to Stringybark	2027 – 2028	2029

Note: Stringybark to Willoughby section will not be reconfigured to be piggable, instead is being de-rated to secondary pressure by augmenting the network and is planned to be completed by 2026.

2.2 IDENTIFIED NEED

The 2019 Five yearly Safety Management Study (SMS)[6] , asset operational reports[7][8] and recent pipeline's APIAR[9] have identified the threat of corrosion at the field applied disbonded HSS on the SPM. Modern high-pressure gas mains are designed to enable a pig tool to run through the pipe which inspects the thickness of the pipe wall from the inside that can identify all corrosion. This inspection method is an industry wide practice as it is the most cost effective and efficient way of inspection.

The SPM does not have this capability and we historically verify the condition by conducting spot checks by digging holes and inspecting the condition of the pipework. The spot checks we complete are expensive especially since these mains travel through high density areas such as the inner west Sydney.

There is also a safety risk in conducting these spot checks as we do not know the full condition of the pipeline. By reconfiguring the pipeline to inspect the pipeline more thoroughly, using a pigging tool provides a cost-effective method to show a complete picture of the condition of the pipeline allowing us to identify and correct material defects.

If integrity management works are not carried out on the 550mm diameter SPM (Lidcombe to Banksmeadow), potential outcomes may include a gas leak due to external corrosion caused by inadequate CP due to shielding. Such a leak could release flammable gas, leading to possible ignition and catastrophic consequences, including the risk of fatalities for workers and the public within the pipeline radiation contour, which can extend up to 195[10] metres. Additionally, property damage would likely be extensive and depending on the location of the gas release could also result in damage to the environment.

6 GTS-1299-RP-RM-007 Five Yearly Safety Management Study SPM LINK

7 GAS-1400-RP-IN-002 – Sydney Primary Main Coating Defect Operational Report (Revision 2) LINK

8 GAS 1400-RP-IN-005 – Sydney Primary Main - Direct Inspection Operational Report (Revision 1) LINK

9 GAS-999-RP-IN-003 JGN Pipelines Asset Performance and Integrity Review (APAIR) - July 2021 to June 2022": http://ecms/otcs/cs.exe/open/321230339

10 Radiation contour for 12.6 kW/m^2 will be 195m for a full bore rupture of hole size of 540mm for a DN550 pipe and 315m for radiation contour of 4.7 kW/m^2

Figure 2 Wednesday, Feb. 6, 2019. A 4-inch plastic gas pipe explosion in San Francisco.

The risk of gas escape resulting in either; a sinkhole substantially impacting road or rail infrastructure or leading to jet fire affecting public safety is rated as *HIGH* which is above the broadly accepted level defined in the Jemena Risk Manual[11] and AS 2885 and requires further risk reduction, if the risk cannot be shown as low as reasonably practicable (**ALARP**).

2.3 PROJECT DRIVERS AND OBLIGATIONS

Based on the identified risk, a solution is required to assess the integrity to ensure the assets are compliant with the obligations and requirements of the Gas Supply Act 1996 No. 38[12] and by extension the Gas Supply (Safety and Network Management) Regulation 2022[13] and Australian Standard AS 2885.3[14].

- *Jemena will not be able to meet its obligations under the Gas Supply Act 1996 No.38 - Facilitate the continuity of supply of natural gas to customers and Consider the development of efficient and safe gas distribution systems*

The current approved safety and operating plan accepted by the **NSW** regulator is Jemena's Safety Case (**SAOP**) of New South Wales (**NSW**) gas assets. The **SAOP** calls on the **JGN ACS** as the principal document which defines the approach and principal methods by which each asset class contributes to delivering Jemena's Asset Management and Health and Safety objectives as defined in the **JGN** Asset Business Strategy (**ABS**). These are to:

11 Refer to: JAA MA 0050 – Group Risk Management Manual – Figure 9: Risk Evaluation, Escalation and Reporting Table

12 Gas Supply Act 1996 No. 38 – Part 1 Section 3 clause (1) subclause (b1), clause (3), and clause (3A)

13 Gas Supply (Safety and Network Management) Regulation 2022 Link

14 AS2885.3 – 2022 – Pipeline – Gas and Liquid Petroleum Part 3: Operation and Maintenance, Section 6: Pipeline Structural Integrity, including but not limited to operational control, corrosion protection, pipe wall integrity and inspection

- *Non-compliance with Australian Standards AS 2885.1*[15] *and AS 2885.3*[16]
- Operate and maintain Jemena assets in a way that protects or enhances community safety; and
- Be the customers' first choice for world leading, reliable and sustainable energy solutions.

Jemena as a prudent gas operator, takes into account and complies with relevant standards (such as codes, Australian Standards, guidelines or other requirements) when operating a gas network.

The external corrosion threats which have been identified on the **SPM** cannot be mitigated with current measures and if not checked can affect the pipeline's integrity resulting in a risk of loss of containment, loss of supply or financial loss.

Summary of identified threats and associated risk ratings (as per Group risk management manual and AS2885.1 Risk Matrix) are provided below. The untreated risk levels as determined by the Jemena and AS2885 risk assessment matrices is shown in Table 3. Refer to Appendix A for the detailed risk assessment.

Table 3 – Untreated Risk Ratings

Threat Type	Threat Cause	Threat Consequence	Untreated Jemena Risk Rating	Untreated AS 2885 Risk Rating
People (safety)	Through wall corrosion leading to loss of containment resulting from corrosion under disbonded HSS due to CP shielding (Pin hole gas leak assuming 20 mm hole results in unacceptable heat contours at 12.6kW/m^2 = 10 m & 4.7 kW/m^2 = 15 m)	Corrosion failure will result in gas escape leading to a massive sinkhole which would potentially shutdown traffic, and would sink surrounding properties and infrastructure, affecting public safety. If the gas leak were to ignite, fatalities would occur within a radius of 15m and buildings would be destroyed.	High	High
Supply		Inability to provide gas to all customers during planned or emergency shutdown (minimum 5 to maximum 21 days) DUE TO necessary reduction of pipeline MOP or lack of pressure containment capabilities. This would impact more than 150,000 customers downstream of Tempe PRS.	Significant	Intermediate
Environmental		Crater formation close to source of leak. Damage to buildings and infrastructure Release of significant amounts of unburnt natural gas to atmosphere.	Moderate	Intermediate
Financial		Necessary permanent repair at location of pipe wall defect. Requiring unplanned or unbudgeted expenditure for repair works (> $1M < $10M)	Moderate	N/A

15 AS2885.1: 2018 Pipelines - Gas and Petroleum; Part 1- Design and Construction

16 AS2885.3: 2022 Pipelines - Gas and Petroleum; Part 3- Operation and Maintenance

2.4 CURRENT STATUS OF ASSET

Over the 2004 to 2023 period, more than 80 spot checks have been undertaken along different sections of the SPM pipeline of which, 54 spot checks have confirmed disbondment and poor adhesion of heat shrink sleeves (HSS). Thirty-five (35) sites found corrosion under the disbonded HSS which confirms the risk is real. None of these disbonded HSS were detected by our coating (DCVG) and corrosion CP surveys.

To date all anomalies were repaired either by installing composite wraps, welded sleeve or by replacing the damaged coating. Based on the existing integrity dig data, a wholistic assessment of the integrity of the entire **SPM** cannot be drawn with confidence based on the large remaining pipeline length which is unassessed.

Recent ILI in 2021 on Horsley Park to Lidcombe section found 54 external corrosion anomalies, with the maximum wall loss of 66% was identified at Wetherill Park along the 23kms section.

Below is the ILI features distribution for Horsley Park to Lidcombe section:

2021 ILI summary (SPM - HP-Lid)		
Anomaly / Features	**Qty**	**Deepest Feature (depth %)**
Total corrosion anomalies (metal loss)	**62**	66% wall loss (external)+ (ERF = 0.65, KP 2.62)
External corrosion anomalies (metal loss)	**54**	66% wall loss Corrosion Cluster of 15 anomalies within 2m @ Wetherill Park (ERF = 0.65, KP 2.62) 28 different locations (1.2 defect per km)
Internal corrosion anomalies (metal loss)	**8**	12% wall loss (ERF = 0.45, KP 11.56)
Pipe mill anomalies	**27**	16% depth (KP 17.5)
Girth Weld anomaly	**7**	Without any metal loss (possibly weld misalignments)
Dents	**2**	2.7% ID < 6% OD with no metal loss KP 1.7 @ 5 o'clock

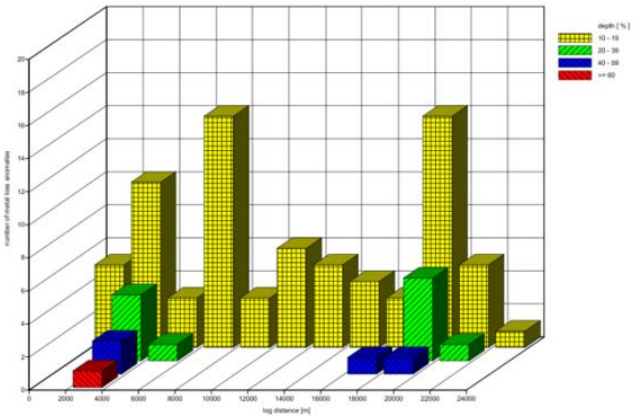

Figure 3: SPM (HP-Lid) ILI Anomalies Distribution

Figure 4: Corrosion Anomalies found on SPM (HP-Lid) - ILI

Figure 5: Coating Defect, Corrosion and Crack Like Features found on SPM

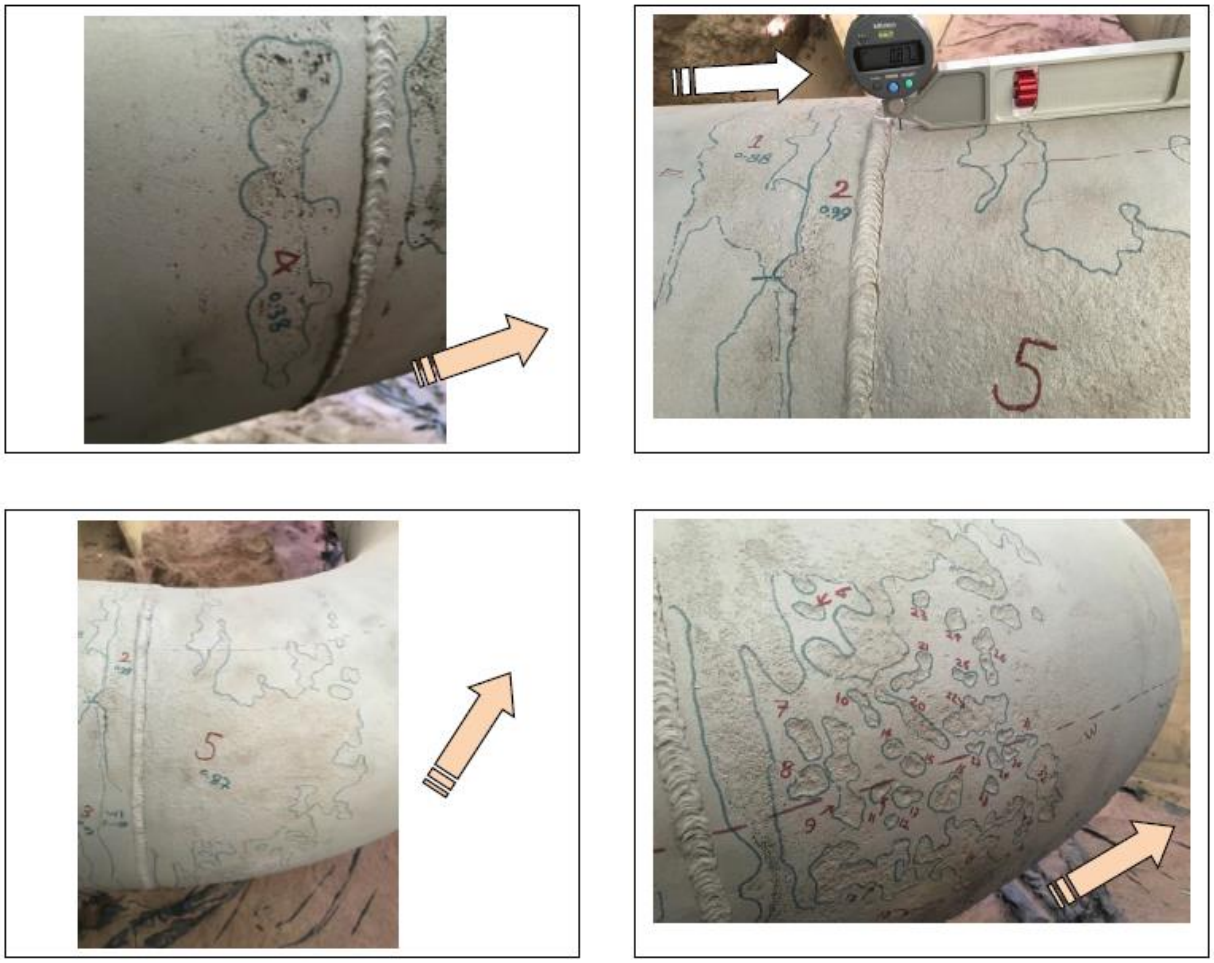

Figure 6 – Example of Corrosion found under disbonded HSS on SPM (arrows indicate gas flow)

2.5 ASSUMPTIONS

Table 4 lists the assumptions that are applicable to this Options Analysis.

Table 4: General assumptions and implications

S.No.	Assumptions	Implication
1.	All sections of SPM including Lidcombe to Banksmeadow is subject to corrosion under HSS similar to recent findings on similar vintage pipelines within JGN and SPM (HP-Lid).	Some sections may be worse or better than the assumed and may/ or may not require significant repairs.
2.	The pipeline construction details for Lidcombe to Banksmeadow section are reliable and selected sections of the pipeline can be inspected via pigging.	This assumption is based on SPM (HP-Lid) section, however, if the bend investigations and other feasibility assessment find un-piggable bends, costs will increase.

3.	Pipeline operation risk during pigging is tolerable.	The schedule of the pigging activity will need to be planned outside the winter period to avoid any capacity / supply risks.
4.	A small foot print will be required for pipe modification and installation of temporary receiver system, and no land will need to be acquired or leased.	If land for pig launcher and receiver facility needs to be acquired or leased costs will increase.
5.	Hydrostatic testing of the section is not a credible option	Hydrostatic testing would require a shutdown of the main for up to two weeks, resulting in loss of supply to more than 150,000 customers

2.6 STRATEGY

Jemena is required to demonstrate that pipeline integrity is monitored, assessed and maintained in accordance with AS2885.3 to ensure continuous safe operation. This project is a continuation of works to improve the safety and integrity of the SPM asset by making provision for in-line inspection and address the risks related to external corrosion under disbonded HSS.

As part of Jemena Asset Management System (AMS)[17], we conduct annual asset condition assessments for all our assets. These assessments provide critical insights into an asset's remaining life expectancy and when preventive actions are warranted[18]. Based on findings discovered on pipelines of similar vintage, the threat related to undetected corrosion under disbonded HSS on SPM have been identified through an asset condition assessment, notably the **JGN** Pipeline Asset Performance and Integrity Report (**APAIR**)[19]. These findings are incorporated into the **SPM** Integrity Risk Register[20], which both then feed in to the **JGN ACS**[21].

Historically, the integrity of the entire Sydney Primary Main (SPM) was managed through sporadic integrity digs to inspect the pipe wall condition. Data collected from these checks was used to infer the pipe's condition and operational safety in similar locations. This approach was suitable, given the pipeline's age and the reasonable cost of such spot checks.

However, our strategy underwent a transformation in 2018 for two main reasons:

1. The SPM's condition is deteriorating with age.
2. The cost of integrity digs has escalated, diminishing the efficiency of spot checks.

Consequently, our new strategy is focused around de-rating the main wherever possible. In instances where de-rating is not feasible, we are actively pursuing pipeline reconfiguration to enable in-line inspection (ILI), also known as pigging, as a more efficient and cost-effective approach.

17 JEM AM MA 0001 Jemena Asset Management System Manual http://ecms/otcs/livelink.exe/open/301179363

18 JEM AM MA 0001 Jemena Asset Management System Manual http://ecms/otcs/livelink.exe/open/301179363– Section 10.5 and 10.5.1

19 GAS-999-RP-IN-003 JGN Pipelines Asset Performance and Integrity Review (APAIR) - July 2021 to June 2022": http://ecms/otcs/cs.exe/open/321230339

20 GAS-1400-RG-RM-001 – JGN - Sydney Primary Main (SPM) – Integrity Risk Register

21 Refer to GAS-999-PA-PL-002 JGN – Pipelines Asset Class Strategy: http://ecms/otcs/cs.exe/open/322879221

Examples of recent findings of corrosion under disbonded coatings and major anomalies discovered on SPM pipeline sections and other JGN assets of similar vintage are listed below:

- In 2022, corrosion cluster with approximately 66% of metal loss was identified along the 2m of pipe on SPM (HP-Lid) after being inspected via ILI for the first time in 2021. The pipe coating had disbonded and had completely fallen off. Although the corrosion did not lead to a gas leak, the pipeline still required a permanent repair using a Type B welded full encirclement sleeve.

- In 2022, isolated wall defect was identified on the SPM (HP-Lid) pipeline after the first ILI in 2021. The maximum wall loss found was 71%, and approximately 40mm long and wide. The pipeline was repaired using a clock spring.

- In 2022, an ILI anomaly identified on Northern Trunk in 2018 ILI was inspected in 2022, which was found to have a corrosion cluster with a maximum wall loss of 90% at the girth weld under a disbonded HSS. Although, this did not result in a gas leak, it impacted the MAOP of the pipeline and was repaired using a Type B Sleeve.

- In 2020, a corrosion cluster was found under a disbonded HSS on Licence 8b pipeline when it was first inspected via ILI in 2018. A maximum wall loss of 97% was recorded in the field which resulted in a major repair using Type B sleeve.

- In 2020, multiple crack like features similar to SCC were identified on a pipe body on SPM (Putney to Stringybark) section as part of an encroachment dig up. One of this features had a maximum depth of 1.58mm (25% wall loss) with an approx. length of 710mm. Although, there was no correlation between the contributing factors and actually finding crack like anomalies similar to SCC on the pipeline, the risk of SCC on SPM, particularly Putney to Stringybark section cannot be completely ignored. Pipeline was repaired using Petro Sleeve (compression sleeve) and wrapped with STOPAQ.

Based on the above, it is evident that external corrosion threats have been identified on the SPM pipeline and have the potential to affect the pipeline integrity resulting in a risk of loss of containment, loss of supply or financial and reputation loss. Depending on the location of loss of containment event, it could have serious operational / customers / reputation and financial impacts to JGN. Since the Lidcombe to Banksmeadow pipeline is a dual feed supply from Lidcombe to Tempe and single feed supply downstream of Tempe, loss of containment at downstream of Tempe could lead to curtailment or failure of gas supply to Mascot and Banksmeadow PRS supplying more than 150,000 customers including residential homes, small businesses, and large industrial users.

3. CREDIBLE OPTIONS

The following options were identified to address the threat of external corrosion on SPM (Lidcombe to Banksmeadow):

• Option 1: Maintain Status Quo (continue with DCVG every 5 years and 3 integrity digs every year)

• Option 2: Reconfigure the pipeline section to enable in-line inspection

• Option 3: De-rate the entire SPM – Lidcombe to Banksmeadow section

All options are explained in detail below.

3.1 OPTION 1 – MAINTAIN STATUS QUO (INTEGRITY DIG PROGRAM)

This option is no longer considered to be an acceptable method of validating the ongoing safe and reliable operation of this pipeline. Knowledge of the pipelines condition and specific threat that cannot be mitigated, requires a more complete understanding of the condition of this asset.

Under this option, JGN would continue undertaking integrity digs in areas where corrosion is inferred to be more susceptible. This can include locations where the pipeline has historically had poor coating, issues with CP and where the pipe is subject to changing wet and dry conditions.

These locations would then be inspected by digging up the main and physically removing the HSS and inspecting the pipeline for any metal loss. The data gained can then be extrapolated across other areas of Lidcombe to Banksmeadow pipeline. However, this does not give the same level of confidence as undertaking direct inspection of the pipe wall along the full pipeline length. This option would require three integrity digs performed each year on this section of the pipeline and a DCVG survey performed every five years.

3.1.1 CONSTRAINTS

The following constraints provided in Table 5 are applicable to Option - 1

Table 5: Constraints for Options - 1

Description	Implication
Some sections of pipeline are inaccessible as they are under major road, or within a reserve.	The condition of the pipeline at these locations will remain unknown, and will be at risk of failure. If dig ups are performed it will require a significant capital cost, in the range of ($400k to $800k for one dig up).
Disbonded HSS cannot be detected through above ground inspection techniques such as DCVG.	Random locations will be selected for dig ups which reduces the probability of finding the actual defect. More length of pipeline would need to be exposed to search for girth welds with disbonded HSS which substantially increase the cost of dig ups.
There are approximately 2835 welds (based on 34 km pipe) on this section of SPM and it is not possible to confirm which of the welds would result in a failure.	Based on available records, 75% of HSS were found to have disbondment, thus approximately 2125 welds would need to be exposed and inspected. If 5m length of pipe is exposed during each dig up activity, it would result in a cost of approximately $637M based on an average cost of $300k per dig.

3.1.2 BENEFITS & DRAWBACKS:

The expected benefits and drawbacks of this option are provided in the Table 66 below:

Table 6 : Benefits and Drawbacks of Option 1

Benefits	Drawbacks	Risk Reduction	
		Jemena	AS2885
• Validate identified threats, pipeline condition and confirm MAOP of the pipeline localised to locations where integrity digs have been performed • Allows the repair of any identified defect immediately during dig up such as coating or metal loss anomalies as these can be repaired prior to the occurrence of through wall corrosion at the targeted location. • Avoid initial capital outlay by spreading the cost overtime • Allows finding other integrity issues which are currently unidentified and provides data for trending purposes	• Public safety and security of supply will be at “High” risk due to pipeline failure • No guarantee against high consequence events • Does not address the pipeline overall safety, supply and integrity concerns as the rate of anomaly deterioration / corrosion rate cannot be determined to adequately evaluate pipeline remaining life, thus the pipeline refurbishment activities cannot be efficiently planned. • Integrity dig at a specific location does not represent statistically the entire pipeline condition, thus the overall pipeline condition remains unknown. • The chances of finding a defect in the exact location where an integrity dig takes place is low, can give false indication of condition of the coating and pipeline. • JGN reputation and gas distribution business would be at stake. • The cost of dig ups will continue to rise due to the continuous growth of Sydney population and infrastructure, thus in long term the cost will be disproportionate to the benefit achieved. • Unbudgeted OPEX expenditure would be required to undertake ad-hoc repairs. • This option will cause more frequent disturbance to environment and community.	High	High

3.2 OPTION 2: RECONFIGURE THE PIPELINE TO ENABLE IN-LINE INSPECTION – CONSTRUCTING PIGGING FACILITIES (LIDCOMBE TO BANKSMEDOW)

In-Line Inspection (pigging) involves the use of devices known as pigs which clean the pipeline and are capable of checking pipeline condition. It requires a pig trap to insert a pig into the pipeline and a receiver at the end of the pipeline to receive the pig once it has travelled the length of the pipeline.

The ILI of the Pipeline would be used to identify areas where pipe wall integrity has deteriorated, informing where repair works would take place[22]. Once the initial ILI has been performed, ongoing integrity of the pipeline will be maintained by operating in accordance with the **JGN ACS.**

ILI is the pipeline industry preferred integrity assessment technique to validate the structural integrity of high pressure pipelines. The method measures pipeline wall conditions throughout the length of the pipe and records the location and characteristics of any anomalies found. It is a cost effective method for detecting integrity anomalies such as corrosion (capable of detecting corrosion under HSS), manufacturing issues and mechanical damage.

This option includes all necessary pre-work for performing the **ILI**, which involves digging up and validating that existing bends / tees would allow passage of modern ILI pigs, modifying existing pipework, installing ILI launcher/receiver infrastructure, detailed selection of an inspection tool, and finally undertaking the ILI inspection. This project will only involve the construction of the pigging facilities, while the actual pigging will be carried out by a subsequent project.

3.2.1 CONSTRAINTS

The following constraints provided in Table 767 are applicable to Option - 2

Table 76: Constraints for Option 2

Description	Implication
Pipeline construction details are not adequately available to confirm that the pipeline is piggable	To determine the piggability of pipeline, feasibility assessment will be required to confirm the characteristics and geometry of the existing bends. The results of the investigation will determine if any pipeline modification are required for the pigging.
There are no pig launcher or receiver facility on existing SPM pipeline (Lidcombe to Banksmeadow) to allow ILI activity.	Pipeline modification will be required to install Pig receiver facility.
The connections to the existing stations may cause hindrance or obstruction to ILI tool	Pipeline may need to be inspected in multiple segments or modification of the pipework will be required at these stations.

3.2.2 BENEFITS & DRAWBACKS:

The expected benefits and drawbacks of this option are provided in the Table 78 below:

[22] The cost of any major pipeline cut out repairs has not been considered in this Options Analysis, only the cost of validation digs, sleeve or composite repairs and coating reinstatement are included post pigging based on experience with pigging of pipelines of similar vintage

Table 7: Benefits and Drawbacks of Option 2

Benefits	Drawbacks	Risk Reduction	
		Jemena	AS2885
• Provides quantitative data to accurately assess any anomalies found on the pipe wall and allows targeted repairs to be undertaken to ensure safety and security of supply, including minor repairs prior to worsening of any identified anomaly • Reduces number of random dig ups, frequent disturbance to environment and community, and long term cost o by minimising dig up footprints • The ILI will determine the presence of corrosion under disbonded HSS, thus the actual data of the entire pipeline and ability to target problematic areas minimises the likelihood of through wall corrosion occurring. • Ability to conduct ILI without removing the line from service thus maintaining supply. • Determine threats along the pipeline which may have been unidentified prior to ILI and assess the associated risk. • Confirm the ability to continue operating at MAOP as required for a ten-yearly AS2885.3 Remaining Life Review[23] • Ability to establish appropriate intervals to monitor for changes in existing anomalies or newly identified anomalies and determine an effective corrosion rate for all identified anomalies; and • Provides a reliable and comprehensive dataset for continued management of long term integrity of the Pipeline and ensure security of supply	• Modification to pipework will be required to implement pigging activity • Due to the configuration of the asset, minimum two launcher / receiver facilities system may be required. • Validation digs will be required to validate pigging results • Not all ILI tools from various vendors have the same detection and characterization capabilities	Moderate	Low

[23] Refer to **AS**2885.3 – Pipeline – Gas and liquid petroleum – Part 3: Operation and maintenance – Section 10.3

3.3 OPTION 3: DE-RATE LIDCOMBE TO BANKSMEADOW SECTION OF SPM

This option is to de-rate the Lidcombe to Banksmeadow section of the SPM to operate at secondary pressure. In order to de-rate this section, this would require excessive augmentation to the secondary network and would include the reconfiguration of primary receiving stations and the decommissioning of multiple primary reducing stations along the SPM. This option effectively requires a total re-design of the way the network is operated and is not considered to be feasible.

Whilst the pressure reduction will reduce the consequence of a leak failure with ignition, due to lower pressure in the pipeline (reducing the overall risk rating) reduction of pressure will result in loss of supply to existing customers. Currently, to successfully de-rate this section of SPM to secondary pressure (1,050 kPa), a 50% reduction in total gas load is required which is not expected to occur in the near future.

Note: This option is currently feasible only for Lane Cove to Willoughby section of SPM (DN150) without any reduction of load, however, network augmentation is required to maintain supply to existing customers. This project is SPM Integrity Management Stage 2.

3.3.1 CONSTRAINTS

The following constraints provided in Table 9 are applicable to Option - 3

Table 9: Constraints for Option 3

Description	Implication
Downgrading the primary main to secondary pressure will result in supply constraints	Significant secondary network augmentation will be required to offset supply requirements, increasing the capital expenditure.

3.3.2 BENEFITS & DRAWBACKS:

The expected benefits and drawbacks of this option are provided in the Table 80 below:

Table 80: Benefits and Drawbacks of Option 3

Benefits	Drawbacks	Risk Reduction	
		Jemena	AS2885
• Pressure reduction will make catastrophic failure (ignition resulting in fatality) to remote. • Reduces overall risk ranking from High to Low (AS2885) • No mandatory requirement to perform ILI as per AS4645. Corrosion threat can be controlled by BAU activities (CP surveys and gas leakage surveys)	• Result in network capacity constraints and loss of security of supply. • The capital expenditure required to augment the network to maintain supply is disproportionate to the benefit achieved as there will still be limited supply to the existing customers.	Moderate	Low

3.4 COMPARISON OF OPTIONS

A summary of the options analysis is provided in Table11 below:

Table 11: Options summary including risk, benefits and cost

Criteria		Option 1	Option 2	Option 3
Option description		Maintain Status Quo	Reconfigure for ILI – Install Pigging Facilities	De-rate the entire Lidcombe to Banksmeadow section
Safety		Fatality risk exists	Majority of defects will be detected prior to failure	Failure rate and consequence will be reduced
Integrity		Limited applicability	Majority of defects will be detected prior to failure	Failure rate and consequence will be reduced
Supply Reliability		Un-planned repairs due to pipe failure	No impact to supply	Result in supply constraint
Regulatory Compliance (AS2885)		Limited compliance	Meets compliance	Meets compliance
Strategic Benefit		Limitation in forecasting future asset integrity planning works	Allows long term capital & operational works planning & expenditure	No major benefit
Delivery Constraints		• Restrictions exist on the location of integrity dig (busy arterial road or railway corridor). • Require traffic management.	• Availability and approval for suitable land in road reserve • Investigation digs to confirm piggability. • Design of launching receiver system to perform pigging • Modification to existing pipeline will be required.	• Augmenting of network will be required. • Delays to construction due to other utilityies and council approvals. • Disturbance to community and environment during construction. • Require traffic management.
Treated Risk Ranking	Jemena	High	Moderate	Moderate
	AS2885	High	Low	Low

Criteria	Option 1	Option 2	Option 3
Cost Estimate (10 year period – excluding risk)	A$ 1,200 k	A$ 11,171 k	A$ 45,000 k
Options Analysis	○ Does not address the issue	● Fully addresses the issue	◑ Partially addresses the issue
Recommended order of preference for options	**3 (not recommended)**	**1 (recommended)**	**2 (not recommended)**

4. RECOMMENDATION

4.1 RECOMMENDED SOLUTION

Three options were analysed to mitigate the threat of loss of containment impacting safety of the workers and members of the public from corrosion failure on SPM (Lidcombe to Banksmeadow) section as a result of CP shielding at disbonded HSS and pipeline coating.

Option 2 (Reconfigure pipeline to enable In-Line Inspection – by constructing pigging facilities) is recommended as it makes the pipeline safe and is the lowest total cost option.

At present, the ILI method offers the only way to positively identify all external metal loss in the pipeline in a non-destructive manner. This option will provide a wholistic data set to assess the entire pipeline condition and confirm MAOP, and will allow JGN to ascertain critical pipeline asset integrity information that will assist in defining the prudent and efficient long term capital and operational works planning and expenditure.

Accurately validating the pipeline integrity using In-line inspection will mitigate the safety, supply, compliance and integrity risk to Low as per AS2885 risk matrix and Moderate in terms of Jemena Risk Management Manual. This option is also the most economical (long term) and efficient option as it meets the requirements of AS2885.3 and Jemena obligations under the Act.

The remaining 2 options are not recommended for the following reasons for this section of SPM:

Option 1 (Maintain Status Quo) is **not recommended** as integrity digs do not provide a comprehensive data set of pipeline condition when compared to the recommended option, as a result this option will not reduce the risks to acceptable levels. Furthermore, as the Sydney will continue to get more dense subsequently requiring more traffic management, the overall cost of spot check will continue to increase and thus it cannot be deemed as a sustainable solution.

Option 3 (De-rating pressure from Primary to Secondary) is **not recommended** as this option is currently not viable for this section of SPM due to capacity constraints and would mean that at the secondary pressure the SPM would be unable to meet the supply pressure required to maintain gas supply to existing customers (Refer to Technical Memo – Gas Load Requirements for downgrading the JGN Primary Mains dated 04th February 2019).

4.2 SCOPE

Based on the options analysis, Option 2 is recommended as the threat mitigation control against undetected external corrosion as a result of CP shielding at disbonded coatings leading to pipeline failure in High Consequence Areas.

The necessary activities for implementing the recommended option are outlined below:

1. Engage pigging vendor during FEED design:
   - Collaborate with pigging vendor during Front End Engineering Design (FEED) phase.
   - Conduct feasibility assessment using available alignment plans, valve drawings, past dig up data, and bend investigation results.
   - Evaluate the configuration of the back to back bed at Flemington by performing an integrity dig
   - The pigging vendor to fabricate a test loop replicating the actual features at Flemington

- This is to trial the ILI tools by pumping them through the test loop to ensure safe passage through the back to back bend.

2. Evaluate and finalize permanent pig receiver facility location at Banksmeadow:
   - Identify suitable location for permanent receiver facility at Banksmeadow.
3. Undertake DBYD, potholing and site survey:
   - Perform Dial Before You Dig (DBYD) checks, and conduct potholing to locate underground services.
   - Conduct site surveys to assess the environment.
   - Carry out geotechnical investigation to determine the water table, soil properties, and other relevant factors.
4. Modification of existing pipework at Lidcombe:
   - Dig a trench to expose the existing pipeline and hot tap fittings and pipe work for modification.
   - Proceed with modification at the Lidcombe site, isolating the section, cutting end caps on both ends, removing the existing reducer, S-bend riser, and reinstating the straight section of DN550 pipe.
   - Prior to commissioning, run a foam and gauge pig to confirm piggability of the section.
5. Design, fabricate, and pressure test the permanent receiver system for Banksmeadow:
   - Develop detailed designs for the permanent receiver system.
   - Fabricate the necessary components.
   - Perform pressure tests to ensure the system's integrity.
6. Civil Construction:
   - Prepare the construction site at Banksmeadow, including site clearing, excavation and leveling, construction of access roads, foundation and base preparation for receiver barrel, and installation of site fencing and security measures.
   - Dig a trench to expose the pipeline at Banksmeadow for hot tap installation and pipe work modification.
   - Modify existing pipework to accommodate the permanent receiver barrel and supporting equipment
   - Install DN250 (CL300#) ball valves for double block and bleed isolation
   - Construct the permanent receiver facility within Jemena Banksmeadow PRS compound.
7. Perform pre-commissioning activities:
   - Conduct all mandatory testing as per AS2885 standards.
   - Ensure that the system meets safety and performance requirements.

8. Commission the Banksmeadow Pig Receiver Facility:

   – Commission the newly constructed pig receiver facility at Bankmeadow to allow for In-Line inspection from the permanent Horsley Park Launcher facility to the permanent receiver facility at Banksmeadow.

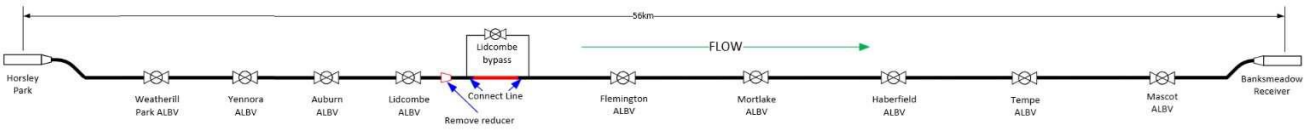

Figure 7: Schematic for Horsley Park to Banksmeadow Pigging

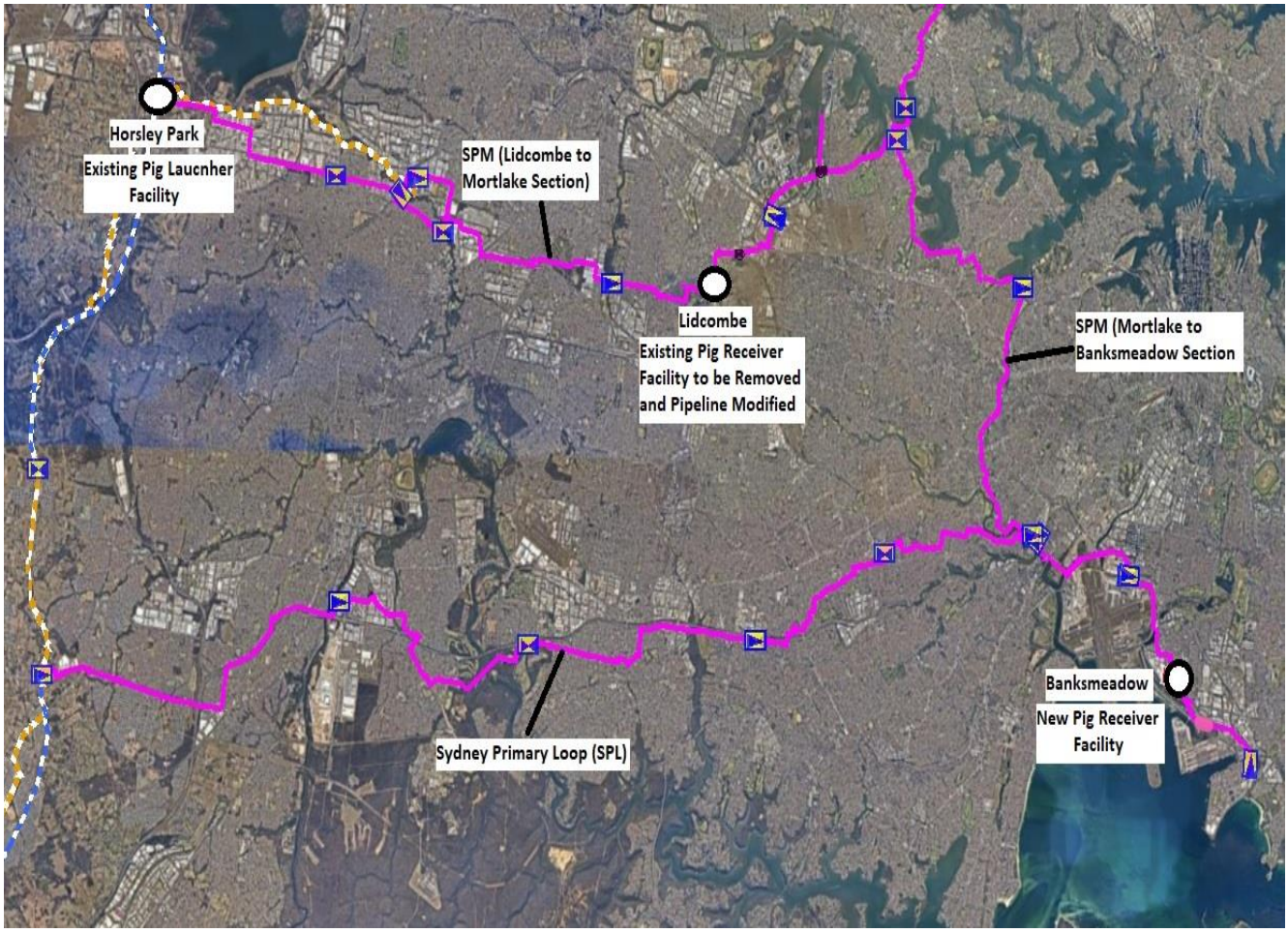

Figure 8: Proposed Pig Launcher and Pig Receiver Locations

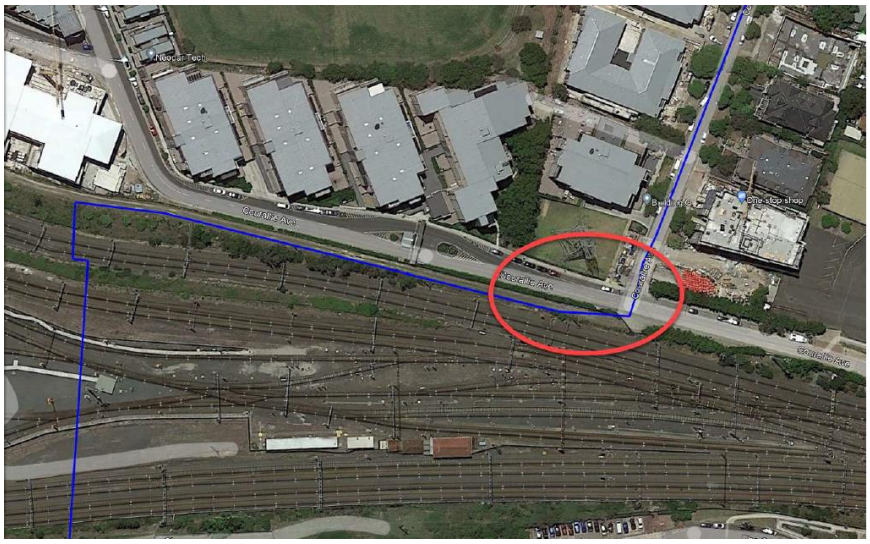

Figure 9: Dig Location for Investigating Back to Back Bend Configuration

Figure 10: Banksmeadow Pig Receiver Site

4.3 COST DETAILS

4.3.1 COST METHODOLOGY

The cost estimate is based on the received quotations from the approved Jemena pigging vendor and actual costs of similar projects that underwent a competitive tendering process, which is all incorporated into Jemena's Project Estimation Model (PEM) developed by the FEED Project Manager.

4.3.2 SUMMARY OF COSTS

The summary of the cost estimate is provided in Table **129**12:

Table 129: Project Estimation

Activities	Item	Project Estimate ($000,2023)
Lidcombe to Banksmeadow		
Pigging Facilities	Materials	$ 646 k
	Contractor Costs	$ 4,772 k
	Jemena / Zinfra Labour	$ 1,121 k
	Risk (excl overhead)	$ 1,389 k
	Total Direct Costs	**$ 7,928 k**
	Indirect & Overheads	**$ 3,243 k**
	Total Direct costs + Overheads	$11,171 k

At the previous submission, the cost estimate to complete the project was $8.96M. However, in the revised submission, the cost estimate to complete has increased to $11.17M.

The variance in cost is due to additional activities identified during the FEED stage, particularly concerning a complex 90-degree back-to-back bend adjacent to the railway track in Flemington. This bend poses a significant risk to the passage of the ILI tool, necessitating an integrity dig within the rail corridor to ascertain its configuration. The major increase is in the Contractor and Labour cost due to additional time and effort required for the works. Additionally, there are still a few unknowns in the project, which is why a contingency cost of $1.389M is being estimated at this stage.

The integrity dig involves complex and deep excavation, field-based service locating, potholing, and survey works, along with obtaining permits and engaging specialist subcontractors. Additionally, Jemena's preferred pigging vendor, Rosen, will conduct a pump and pull-through test in Germany to refine the tool design in light of identified challenges. The outcomes of this test are crucial for future ILI planning, ensuring secure tool passage through bends and other potential restrictions. Despite the increased cost, this option remains the most prudent in terms of both cost and strategic benefits, ensuring the safe and effective inspection of the pipeline.

4.3.3 ECONOMIC ANALYSIS

Refer to Costs and Benefits Analysis Model – JGN - RIN - 4.3 - 10033694 - SPM - Lidcombe to Banksmeadow Pigging Facilities - CBAM - 20240628 - Public

Based on the Costs and Benefits Analysis Model, the preferred option is Option 2. It is recommended as it delivers the highest net customer benefit and a positive net financial benefit to investors. This recommendation is solely based on financial metrics.

4.3.4 PREFERRED OPTION COST ESTIMATE

The cost estimate for Option 2 is provided in the Project Estimating Model (PEM)

Refer to JGN - RIN - 4.3 - 10033694 - SPM - Lidcombe to Banksmeadow Pigging Facilities - PEMO - 20240628 - Public

5. TERMS AND DEFINITIONS

Term	Definition
AA	Access Arrangement
ACS	Asset Class Strategy
ALARP	As Low As Reasonably Practicable
ALBV	Automatic Line Break Valve
APAIR	Asset Performance and Integrity Report
AS	Australian Standards
CP	Cathodic Protection
DBYD	Dial Before You Dig
DCVG	Direct Current Voltage Gradient
DN	Diameter Nominal
HCA	High Consequence Area
ILI	In Line Inspection
JCARS	Jemena Compliance and Risk System
JGN	Jemena Gas Network
km	Kilometre
m	Metre
M	Million
M-W	Mortlake to Willoughby
M-LC	Mortlake to Lane Cove
MAOP	Maximum Allowable Operating Pressure
MFL	Magnetic Flux Leakage
MLV	Main Line Valve
NSW	New South Wales
PEM	Project Estimating Model
PIMP	Pipeline Integrity Management Plan
PRS	Pressure Regulating Station
RFE	Request For Estimate
SMS	Safety Management Study

SMYS	Simplified Minimum Yield Strength
SPM	Sydney Primary Main
SPL	Sydney Primary Loop
T1	Residential
T2	High Density
TRS	Trunk Receiving Station
WT	Wall Thickness

6. REFERENCES

6.1 INTERNAL

1. GTS-1299-RP-RM-007 Five Yearly Safety Management Study SPM http://ecms/otcs/cs.exe/open/316790472
2. GAS-1400-RG-RM-001 – JGN Sydney Primary Main Risk Register http://ecms/otcs/cs.exe/open/307521857
3. Refer to GAS-999-PA-PL-002 JGN – Pipelines Asset Class Strategy: http://ecms/otcs/cs.exe/open/322879221
4. GAS-999-RP-IN-003 JGN Pipelines Asset Performance and Integrity Review (APAIR) - July 2021 to June 2022": http://ecms/otcs/cs.exe/open/321230339
5. Technical Memo – Gas Liquid Requirement for downgrading the JGN Primary Mains dated 04th February 2019

6.2 EXTERNAL

1. Australian Standard AS2885.3-2022, Pipelines – Gas and Liquid Petroleum Part 3 Operation and Maintenance
2. Gas Supply (Safety and Network Management) Regulation 2022 Link

Appendix A Network Risk Assessment Summary

A risk assessment was conducted to determine the level of risk severity of the untreated risk. The table below shows the summary of results and then the treated risk summary for each option. The risk assessment was undertaken in accordance with the Jemena Risk Manual JAA MA 0050 Revision 7 (7/6/2022).

UNTREATED IMPACT/CONSEQUENCES								UNTREATED RISK SUMMARY		
Contributing Factors/ Scenario	**Strategic**	**Financial**	**Safety**	**Operational**	**Regulatory & Compliance**	**Reputation**	**Comments**	**Consequence (Highest Impact)**	**Likelihood**	**Risk Level**
(People – Safety) Pipeline integrity issue i.e. metal loss corrosion failure due to CP shielding or metal loss combined with third party damage resulting in Loss of containment with ignition causing jet fire	N/A	Major (Jemena)	Catastrophic (Jemena) Catastrophic (AS2885)	Major (Jemena) Severe (AS2885)	Major (Jemena)	Major (Jemena)	○ SAFETY: CATASTROPHIC – Potential fatality (1 to 5) associated with Loss of Containment anywhere on line ○ REGULATORY: MAJOR – Government/regulator review results in fines and/or litigation/ or loss of license ○ REPUTATIONAL: MAJOR - Reputation impacted in pipeline industry, government and community stakeholders. Significant stakeholders criticism / negativity ○ OPERATIONAL: MAJOR – Loss of Supply to 50,000 to 160,000 customers	Catastrophic (Jemena)	Unlikely (Jemena)	High (Jemena)
								Catastrophic (AS2885)	Unlikely (AS2885)	High (AS2885)
(Supply) Inability to maintain supply to all customers during emergency or planned repairs as a result of pipeline failure causing loss of supply to customers downstream of Putney ALBV or Tempe PRS	N/A	Severe (Jemena)	N/A	Major (Jemena) Severe (AS2885)	Major (Jemena)	Severe (Jemena)	○ FINANCIAL: SEVERE – Loss of supply during repair works of SPM (minimum 3 days to maximum 21 days). Financial consequence includes lost transmission and distribution profits, claims for lost profits by customers, breach of supply contracts, etc ○ OPERATIONAL: MAJOR – Loss of supply (minimum 3 days to maximum 21 days), Loss of Supply to 50,000 to 160,000 customers. ○ REGULATORY & COMPLIANCE: MAJOR – Violation of Gas Supply Act requirement to ensure the continuity supply of natural gas to customers requiring formal explanation by senior management and regulatory review ○ REPUTATION: SEVERE – Persistent public scrutiny for loss supply for large scale loss of supply to large customers including airport and major customers.	Major (Jemena)	Unlikely (Jemena)	Significant (Jemena)
								Severe (AS2885)	Unlikely (AS2885)	Intermediate (AS2885)

(Environmental) Through wall corrosion resulting from CP shielding under disbonded HSS result in a gas leak leading to either a crater formation, damage to nearby buildings and/or release of CO_2 to atmosphere	N/A	Serious (Jemena)	Severe (Jemena) Severe (AS2885)	N/A	Severe (Jemena)	Severe (Jemena)	○ FINANCIAL: SERIOUS – ($1M - $10M) impact absorbed under normal operating condition. ○ ENVIRONMENT: SEVERE – Harm to natural environment that can be remediated (<1 year management). ○ REGULATORY & COMPLIANCE: SEVERE –Regulator requires formal explanation and remedial plans, fines or penalties. ○ REPUTATION: SEVERE – Reputational impacted with some stakeholders.	Severe (Jemena) Severe (AS2885)	Unlikely (Jemena) Unlikely (AS2885)	**Moderate** **(Jemena)** Intermediate (AS2885)
(Financial) Necessary permanent repair of pipe wall defect DUE TO metal loss / external corrosion (<200mm in length, pin hole 50mm) resulting from CP shielding or CP under protection at coating defects or metal loss combined with third damage	N/A	Serious (Jemena)	N/A	Severe (Jemena)	N/A	N/A	○ Financial: SERIOUS - unplanned or unbudgeted expenditure for dig up, hot-tap, repair, and remediation of site (cost between $1M to $10M) ○ OPERATIONAL: SEVERE – Potential restriction of supply for < 3000 customers. Business interruption 1 to 7 days.	Severe (Jemena) N/A	Unlikely (Jemena) N/A	**Moderate** **(Jemena)** **N/A**

PREFERRED OPTION – Risk assessment summary				TREATED RISK SUMMARY		
Preferred Option/Treated risk	Cost	Benefit	Key Mitigations	Consequence	Likelihood	Risk Level
Option 1 – Maintain Status Quo (Integrity Dig Program)	A$ 1,200 k	- Validate pipeline condition only at the areas targeted; - Determine threats, rate of change of pipeline condition and confirm continued MAOP at the locations targeted only; provides data for future trending purposes. - Avoid initial capital expenditure by spreading cost overtime. - Overall pipeline condition remains unknown and can also give false indication of coating and pipeline.	People (Safety) ○ Targeted confirmation of the Pipeline's ability to continue operating at MAOP, localised to locations where integrity digs have been performed and confirmation of control effectiveness through trending of integrity data. ○ Defects can be easily identified and immediately repaired and recoated. ○ No guarantee against all unknown anomalies causing pipe failure or loss of supply which do not fit trend	Catastrophic (Jemena)	Unlikely (Jemena)	High (Jemena)
				Catastrophic (AS2885)	Unlikely (AS2885)	High (AS2885)
			(Supply) ○ Targeted confirmation of the Pipeline's ability to continue operating at MAOP, localised to locations where integrity digs have been performed and confirmation of control effectiveness through trending of integrity data. ○ Defects can be easily identified and immediately repaired and recoated. ○ No guarantee against all unknown anomalies causing pipe failure or loss of supply which do not fit trend.	Major (Jemena)	Unlikely (Jemena)	Significant (Jemena)
				Severe (AS2885)	Unlikely (AS2885)	Intermediate (AS2885)
			(Environmental) ○ Defects can be easily identified and immediately repaired and recoated. ○ No guarantee against all unknown anomalies causing pipe failure or loss of supply which do not fit trend.	Severe (Jemena)	Unlikely (Jemena)	**Moderate (Jemena)**
				Severe (AS2885)	Unlikely (AS2885)	Intermediate (AS2885)
			(Financial) ○ Reduction of likelihood by rectification of potential problem areas by targeted investigation and repair of HSS with known adhesion issues and at coating defects with CP under-protection. ○ No guarantee against all unknown anomalies causing pipe failure or loss of supply which do not fit trend.	Severe (Jemena)	Unlikely (Jemena)	Moderate (Jemena)
				N/A (AS2885)	N/A (AS2885)	N/A (AS2885)

Option 2 – Reconfigure pipeline to enable In-Line inspection Pigging Facilities	A$ 11,171 k	- Pigging the pipeline will provide data to accurately assess any anomalies found and if required undertake repairs to ensure safety and security of supply - Pigging can be conducted without removing the line from service thus maintaining supply. - This option will validate the pipeline condition along the pipe wall. - Assist in targeting locations and reduce ongoing cost for the validation dig program; - Once an ILI base line is established, it is feasible to rerun inspection tools at appropriate intervals to monitor for changes in anomalies or new anomalies. - Provide a reliable and comprehensive dataset for continuing management of long term integrity and ensure security of supply;	People (Safety) ○ Confirmation of the Pipeline's ability to continue operating at MAOP in its entirety. ○ Identify pipe wall defects in need of further investigation and possible repair to ensure continued operability of the Pipeline at MAOP in its entirety. ○ Identify areas on the pipe wall potentially subject to active corrosion and undertake further investigation, initiating digs and perform repairs where necessary to prevent loss of containment events. ○ Satisfy the requirements of AS2885.3 Section 6 "Pipeline Structural Integrity".	Major (Jemena)	Rare (Jemena)	Moderate (Jemena
				Major (AS2885)	Hypothetical (AS2885)	Low (AS2885)
			(Supply) ○ Identify areas on the pipe wall potentially subject to active corrosion and undertake further investigation, initiating digs and perform repairs where necessary to prevent loss of containment or loss of supply events.	Major (Jemena)	Rare (Jemena)	Moderate (Jemena)
				Severe (AS2885)	Remote (AS2885)	Low (AS2885)
			(Environmental) ○ Identify anomalies on the pipe wall prior to pipe failure resulting in gas escape.	Severe (Jemena)	Rare (Jemena)	Moderate (Jemena)
				Severe (AS2885)	Remote (AS2885)	Low (AS2885)
			(Financial) ○ Identify anomalies on the pipe wall which may be subject to active corrosion and perform preventative integrity digs to remove CP shielding or coating defect before permanent repair is required.	Serious (Jemena)	Rare (Jemena)	Low (Jemena)
				N/A (AS2885)	N/A (AS2885)	N/A (AS2885)
Option 3 – De-rate pressure from primary to secondary	A$ 35,000 k	- Pressure reduction will make catastrophic failure (ignition resulting in fatality) to remote. - Reduces overall risk ranking from High to Low (AS2885)	People (Safety) ○ Lowering the pressure will provide more safety margin before pipeline failure occurs due to corrosion.	Severe (Jemena)	Unlikely (Jemena)	Moderate (Jemena)
			○ Pressure reduction will reduce the consequence of leak failure with ignition due to less pressure in the pipeline	Severe (AS2885)	Remote (AS2885)	Low (AS2885)
			(Supply)	Severe (Jemena)	Unlikely (Jemena)	Moderate (Jemena)

			○ Lowering the pressure will provide more safety margin before pipeline failure occurs due to corrosion. ○ Network reinforcement / augmentation will be required to meet supply	Severe (AS2885)	Remote (AS2885)	Low (AS2885)
			(Environmental) ○ Lowering the pressure will provide more safety margin before pipeline failure occurs due to corrosion. ○ Lower cost to repair secondary pipeline	Serious (Jemena)	Unlikely (Jemena)	Low (Jemena)
				Minor (AS2885)	Remote (AS2885)	Negligible (AS2885)
			(Financial) ○ Lowering the pressure will provide more safety margin before pipeline failure occurs due to corrosion.	Serious (Jemena)	Unlikely (Jemena)	Low (Jemena)
				N/A (AS2885)	N/A (AS2885)	N/A (AS2885)