Jemena Gas Networks (NSW) Ltd

Lic 2B and WPM Integrity Management

Options Analysis

WBS: BAB-RAK-000063

Document Number: GAS-1499-RP-IN-001

28 March 2024

Jemena

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1. EXECUTIVE SUMMARY

1.1 PROJECT AND KEY DRIVERS

Licence 2 and Wollongong Primary Main (**WPM**) pipelines were previously the sole source of natural gas supply to the entire Wollongong region, transporting natural gas from Wilton (received from the Moomba to Sydney Pipeline). Since the construction of Eastern Gas Pipeline (**EGP**) in 2000, gas is now being supplied by EGP via the Port Kembla lateral to the Wollongong region.

Licence 2 pipeline has two sections, Lic 2a[1] and Lic 2b[2]. Licence 2b and WPM[3] pipelines are unpiggable. Refer to Figure 1.1 for the arrangement of the pipelines.

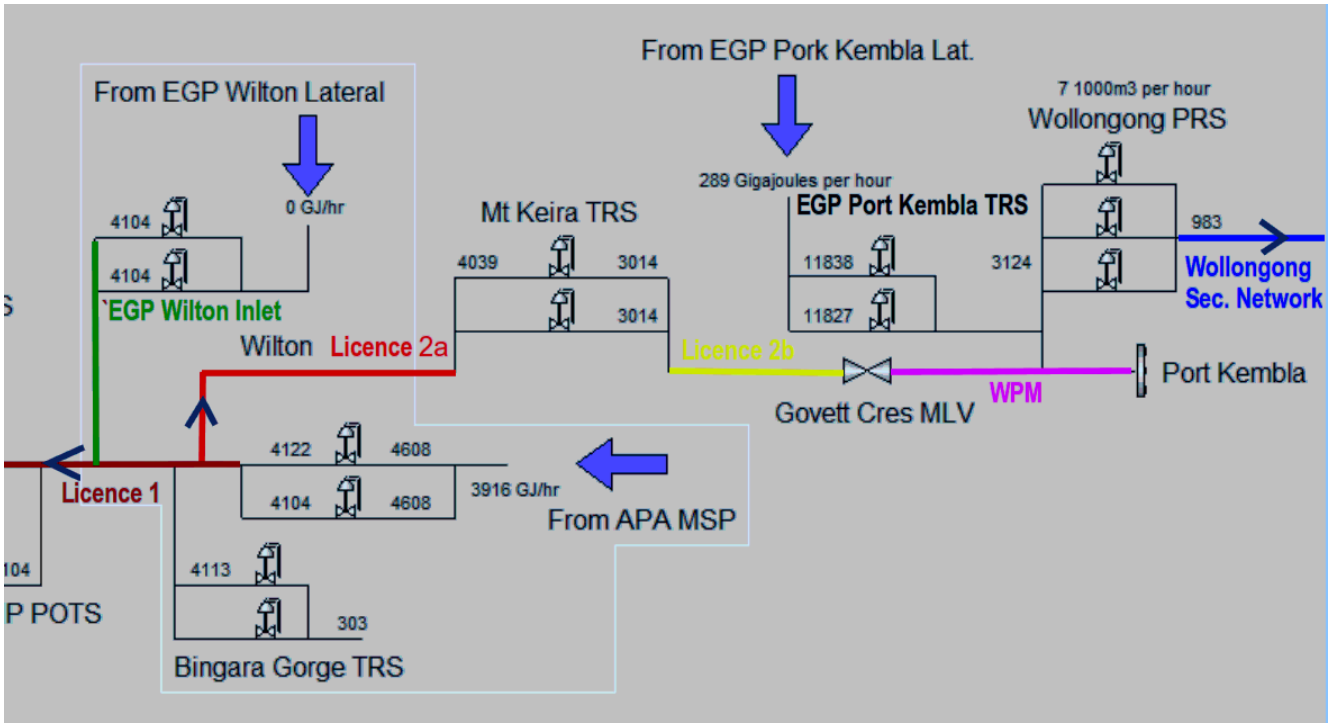


Figure 1: Schematic arrangement of the pipelines

Note: The pressures shown in the figure are typical inlet and outlet pressures of the facilities

A credible threat faced by JGN assets is active corrosion due to disbondment of field applied coatings (known as heat shrink sleeves (**HSS**)). Disbonded HSS prevents cathodic protection (**CP**) from being effective in protecting the steel pipe from corrosion (**CP shielding**).

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

[1] DN500, 21km long section from Wilton TRS to Mt Kiera TRS

[2] DN500,10km long section from Mt Kiera to Govett Crescent

[3] DN250 section from Govet Cresent to Wollongong PRS and DN150 section from Wollongong PRS to Port Kembla

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 cracks 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 these 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 findings, an adequate solution is required to assess the integrity of the pipeline to ensure:

1. The assets are fit to continue operating at the Maximum Allowable Operating Pressure (**MAOP**) thereby confirming the asset and public safety.

2. The assets are compliant with the obligations and requirements of the Gas Supply Act 1996 No. 38[4] and by extension the Gas Supply (Safety and Network Management) Regulation 2022[5] and Australian Standard AS 2885.3[6].

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

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

[6] 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

1.2 CREDIBLE OPTIONS

The following options were evaluated for this project:

Table 1.1 - Credible Options Summary

Criteria	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
Option	Maintain Status Quo	Install Pigging Facilities and Perform Inline Inspection	Derate the pipeline to secondary pressure (1050kPa)	Perform hydrostatic test	Decommission Licence 2 and Wollongong Primary Main	Suspending Licence 2 and Wollongong Primary Main
Description	Continue with indirect integrity management program.	Install pigging facilities for both Lic2b and WPM to enable ILI and perform ILI (MFL & EMAT) and conduct dig ups based on ILI.	The asset will be operated at secondary pressure and managed via AS4645	Hydrostatic pressure testing will provide some assurance of the Pipeline's ability to continue operating under its design conditions and MAOP	Decommission both pipelines in place by filling it with a slurry and disconnect from the stations.	Pipelines will be suspended by isolating them from JGN and to be filled by inert gas such as nitrogen at low pressure.
Safety	🔴	🔴🟢	🟢	🔴🟢	🟢	🟢
Reliability	🔴	🔴🟢	🟢	🔴🟢	🟢	🟢
Compliance	🔴	🔴🟢	🟢	🔴🟢	🟢	🟢
Treated Risk Ranking	High	Significant	Moderate	Significant	Risk is eliminated	
Treated Risk Ranking (AS 2885 risk matrix)	High	Intermediate	Low	Intermediate	Risk is eliminated	
Cost (CAPEX)	Nil	A$ 22.0 M (pigging facilities)	A$ 2.012 M	A$ 17.0 M	Nil	Nil

Criteria	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
Cost (OPEX)	Digs – A$ 11M (over 10Y)	ILI – A$ 8.0 M (every 10Y) Validation Digs - A$4 M (every 10Y)	A$ 1.2 M[7] (one-off) for decommissioning Wollongong PRS	Hydro – A$4.6 M (every 10Y)	A$ 11.0 M (de-com works) ~A$ 8.0 M (write off)	A$ 2.5 M
Total Cost	A$ 11.0 M	A$ 34.0 M	A$ 3.212 M	A$ 21.6 M	A$ 19.0 M	A$ 2.5 M
Recommended order of preference for options	Not Acceptable	2 Not recommended	**1** **Recommended**	4 Not recommended	5 Not recommended	3 Not recommended

[7] Refer to Wollongong PRS decommissioning OB which will be managed as a separate OPEX project Link

1.3 RECOMMENDATION

Option 3: Derate the pipeline to secondary pressure is the recommended solution , costing AUD $2.012 M (capex). Implementing this option will reduce the impact of pipeline failure and thus reduce the health and safety risk rating from High to Moderate (Jemena) / Low (AS2885). No further integrity management is necessary to comply with the standard requirements. This option prioritises customer benefits by maintaining the supply without imposing additional burdens. However, Option 2 is also under consideration if both pipelines are to be utilized for hydrogen storage to facilitate the transition to a low-carbon future.

Note: The decommissioning of the Wollongong PRS will be managed under a separate OPEX project in the future.

1.4 CONSUMER ENGAGEMENT

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

The completion of this risk reduction work complies with the New Capital Expenditure Criteria in Rule 79 of the National Gas Rules because:

1. *The project has been developed as would be incurred by a prudent service provider acting efficiently, in accordance with accepted good industry practice, to achieve the lowest sustainable cost of providing services (Rule79 (1)(a))*

2. *The project is necessary to maintain and improve the safety and integrity of services, and comply with regulatory obligation and requirement (Rule 79(2)I(i)(ii) and (iii))*

The Lic 2 and WPM pipelines are ageing, and the likelihood of failure increases with ageing if there is insufficient integrity data about the pipe wall condition. As corrosion is a precursor of pipeline failure it is necessary that they be identified and resolved. Pipeline failure Is potentially fatal to anyone in the area of impact in addition to the health risks associated with a loss of containment of the natural gas. Therefore, the expenditure is necessary to maintain the safety and integrity of pipeline services.

The proposed solution is also consistent with rule 79(1)(a) of the National Gas Rules:

- Prudent – The expenditure is required to maintain gas reliability and to comply with regulatory obligations. These are the requirements of a prudent operator.
- Efficient – The option selected is the most cost-effective long-term option that meets the necessary operational requirements in order to remain compliant with legal obligations and Australian standards.
- Consistent with accepted and good industry practice – Addressing the risks associated with the corrosion is accepted as good industry practice. Complying with the obligations set out by the NGR is considered consistent with good industry practice.
- Necessary to achieve the lowest sustainable cost of delivering pipeline services –The proposed project balances the risk of reliability, disruption to community and cost to customers to provide the lowest sustainable cost.

The project is also consistent with rule 79 (2)(c), because it is necessary to:

- Maintain and improve the safety of services (79(2)(c)(i)) – if loss of containment occurs as a result of pipeline failure due to corrosion, then there would be a high risk to public safety and will also expose Jemena to significant financial and reputational risks.

Comply with a regulatory obligation (79(2)(c)(iii))- Jemena is required by the Code to ensure the pipeline is operated in a safe manner and a continuous supply of gas to customers is maintained at all times.

To achieve the lowest sustainable cost of delivering pipeline services – The sustainable delivery of services includes reducing risks to as low as reasonably practicable and maintaining reliability of supply.

2. PROJECT BACKGROUND

2.1 GENERAL BACKGROUND

The Lic 2b and WPM pipeline sections are over 40 years old, , have been found to be susceptible to corrosion at field-applied joint coatings due to disbondment . Lic 2b and WPM have sections that traverse through densely populated areas, including sensitive locations such as childcare centres, aged care facilities, and hospitals.

The integrity management of Lic 2b and WPM is managed through pipeline integrity dig program which is based on the indirect inspection methods including coating defect survey[8] and CP surveys[9]. However, these inspections are not capable of detecting disbonded HSS or any corrosion occurring at the HSS . Consequently, the full condition of the assets remain unknown, and if the pipelines are left unchecked, corrosion may lead to gas leaks with the potential to ignite and endanger public safety.

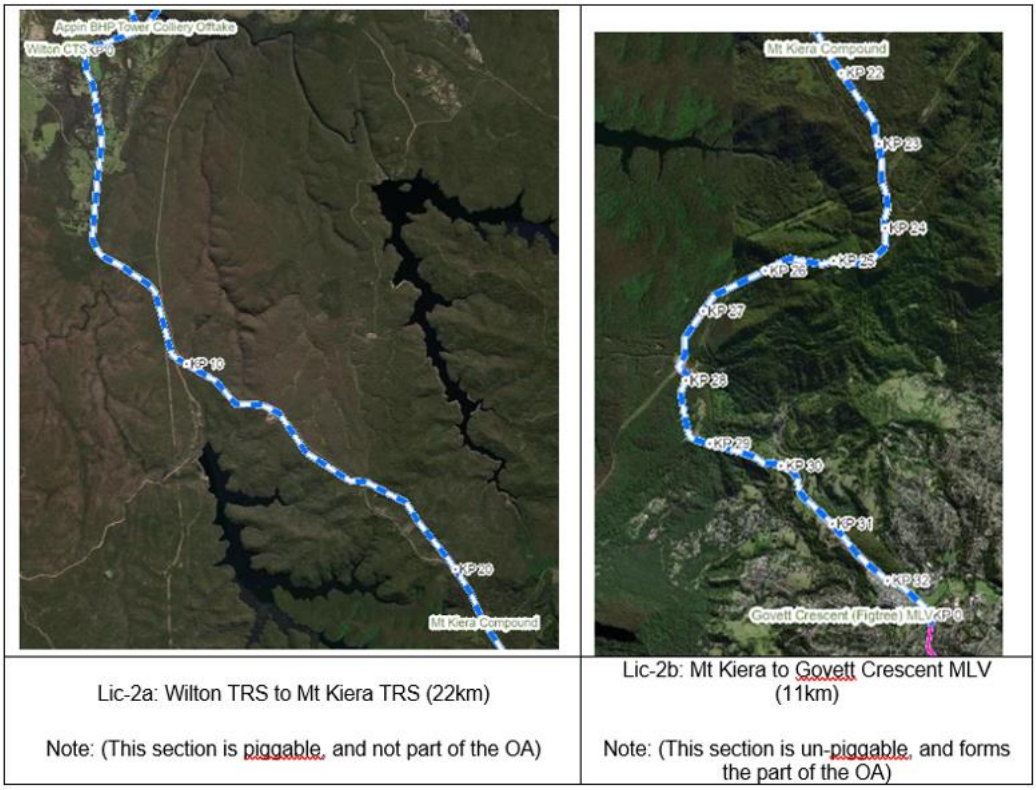


Figure 2: Southern Trunk (Licence 2)

[8] Direct Current Voltage Gradient (DCVG) survey to size and locate pipe coating defects, it is based on measuring the voltage gradients in the soil above a cathodically protected pipeline.

[9] Pipe to soil “On” potential surveys using a data logger.

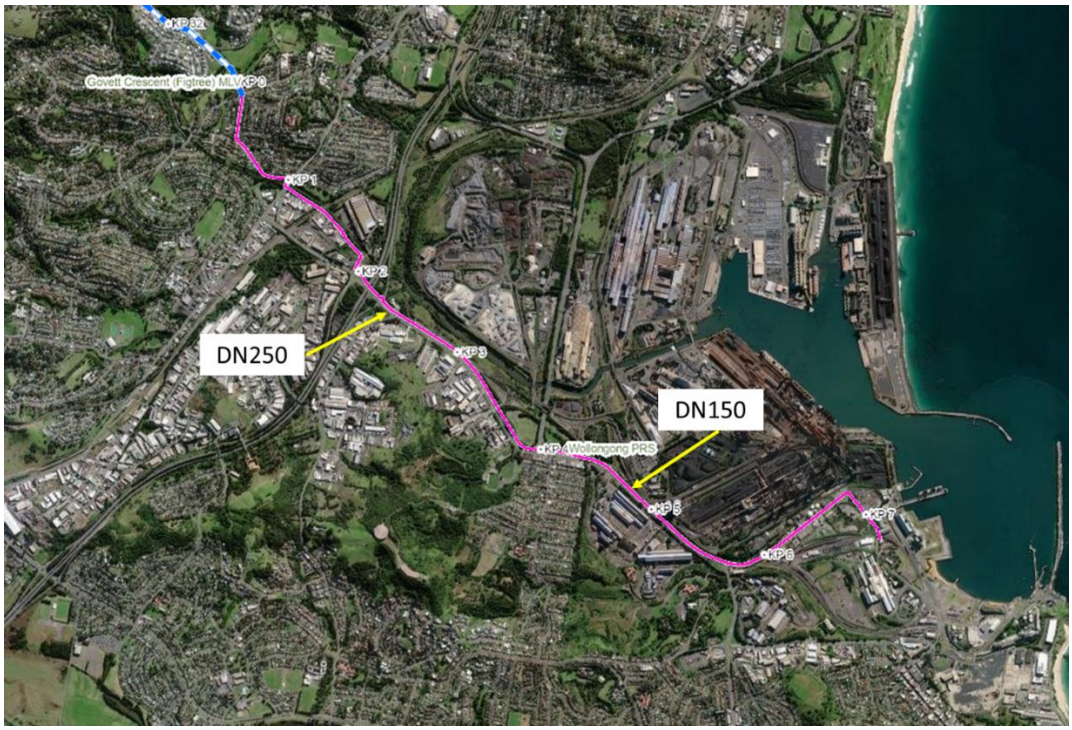


Figure 3: Wollongong Primary Main (7.3 km)

2.2 IDENTIFIED NEED

The 2019 5 yearly SMS, recent asset operational reports[10,11] and asset risk registers[12,13] have identified the threat of corrosion at the field applied disbonded HSS.

The risk of gas escape resulting in jet fire affecting public safety is rated as ***HIGH*** which is above the broadly accepted level defined in the Jemena Risk Manual[14] and AS 2885 and requires further risk reduction if the risk cannot be shown as low as reasonably practicable (**ALARP**).

Scenario	Description	Survival Time (min)
Maximum demand	Full winter load	6
Average demand	60% of full load	27
Minimum demand	20% of full load	52

10 Refer to GAS-1190-RP-IN-001 – Southern Trunk Coating Defect Operational Report

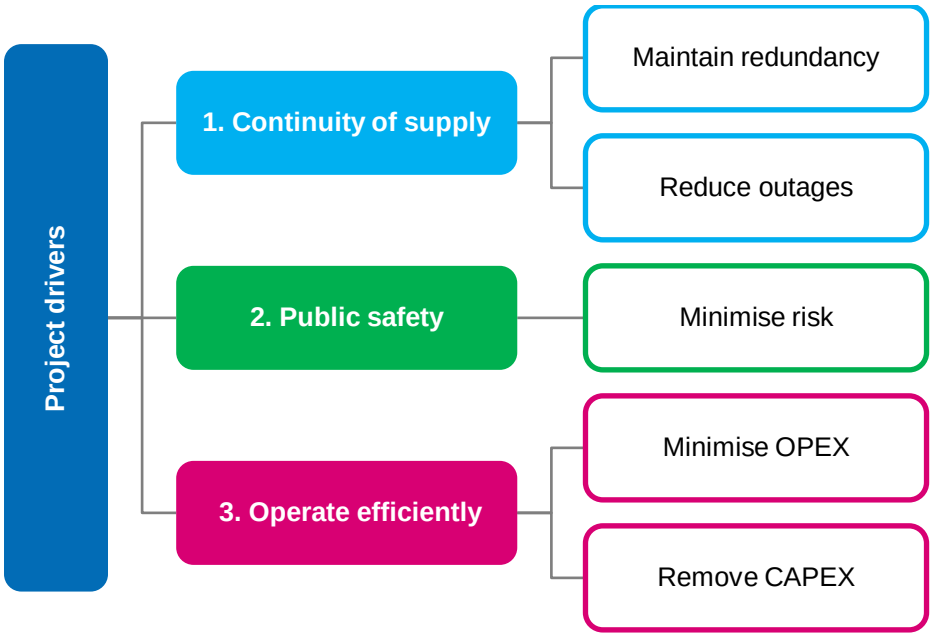
11 Refer to GAS 1415-RP-IN-001 – Wollongong Primary Main Coating Defect Operational Report

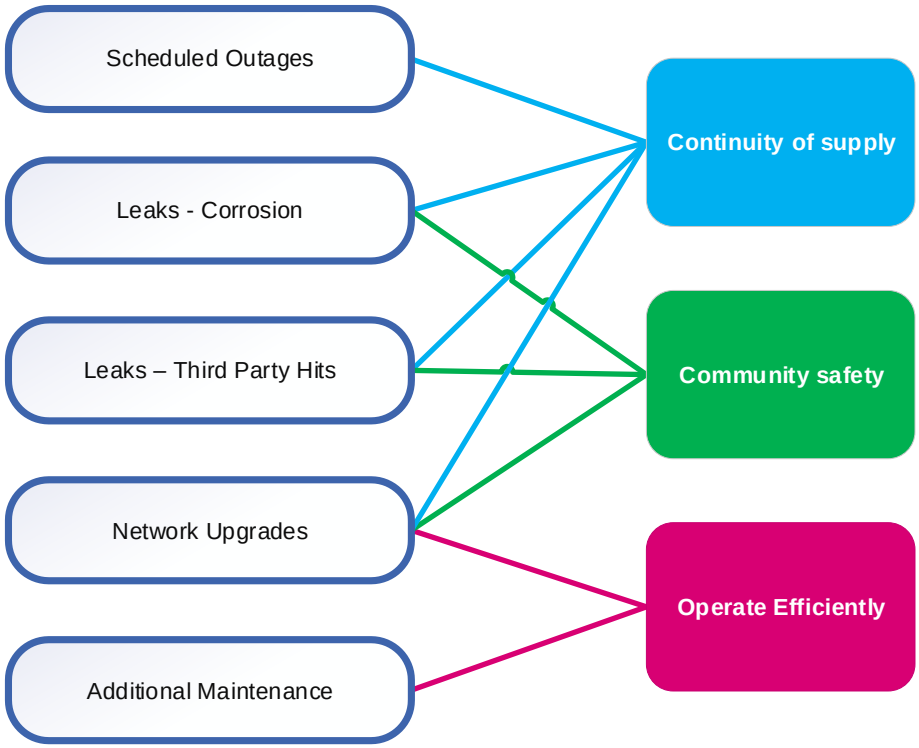
12 GAS-1190-RG-RM-001 Pipelines Southern Trunk - Risk Register Risk ID 1190-002.001

13 GAS-1415-RG-RM-001 Pipelines Wollongong Primary Main - Risk Register Risk ID 1415.003.001

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

2.3 PROJECT DRIVERS AND OBLIGATIONS





ID	Mitigation description	Benefits and considerations	Drivers impacted
1	Business as usual	**Benefits:** ◦ Minimal CAPEX and stable OPEX ◦ Retain redundant supply **Considerations:** ◦ Compliance upgrades - Wollongong PRS	1 3
2	Integrity inspection: Inline Inspection	**Benefits:** ◦ Confirm and maintain integrity – Lic 2b, WPM ◦ Retain redundant supply ◦ Can be inspected for hydrogen utilisation **Considerations:** ◦ Compliance upgrades - Wollongong PRS ◦ Vastly increased maintenance ↑OPEX ◦ Network upgrade ↑CAPEX	1 2
3	Derate the pipeline to secondary pressure (1050kPa)	**Benefits:** ◦ Reduce risk from gas escape ◦ Remove maintenance requirements ↓OPEX **Considerations:** ◦ Compliance upgrades - Wollongong PRS ◦ Lose redundant supply	1 2
4	Integrity inspection: Hydrostatic pressure testing	**Benefits:** ◦ Confirm integrity – Lic 2b, WPM ◦ Retain redundant supply **Considerations:** ◦ Compliance upgrades - Wollongong PRS ◦ Vastly increased maintenance ↑OPEX	1 2
5	Decommission: Lic 2 and WPM	**Benefits:** ◦ Remove risk from gas escape ◦ Remove maintenance requirements ↓OPEX **Considerations:** ◦ Compliance upgrades - Wollongong PRS ◦ Lose redundant supply	2 3
6	Suspend operation: Lic 2 and WPM	**Benefits:** ◦ Remove risk from gas escape ◦ Reduce maintenance requirements ↓OPEX **Considerations:** ◦ Compliance upgrades - Wollongong PRS ◦ Lose redundant supply	2 3

Based on the risk identified in the sections 2.1 and 2.2, 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[15] and by extension the Gas Supply (Safety and Network Management) Regulation 2022[16] and Australian Standard AS 2885.3[17].

- *Jemena will not be able to meet its obligations under the Gas Supply Act 1996 No.–8 - 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**)[18] of New South Wales (**NSW**) gas assets. The SAOP calls on the JGN ACS[19] as the principal document which defines the approach and 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**)[20]. These are to:

  - 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

- *Non-compliance with Australian Standards AS 2885.1*[21] *and AS 2885.3*[22]

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

The untreated risk levels as determined by the Jemena and AS 2885 risk assessment matrices is shown in Table 2.1. Refer to Appendix A for the detailed risk assessment.

Table 2–1 - Untreated Risk Ratings

Threat Type	Threat Cause	Threat Consequence	Untreated AS 2885 Risk Rating	Untreated Jemena Risk Rating
People	Through wall corrosion under disbonded HSS causing CP shielding	Corrosion will lead to gas escape resulting in jet fire affecting public safety.	High	High
Supply	Through wall corrosion under disbonded HSS causing CP shielding	Supply will not be affected as the supply can be maintained through EGP Port Kembla lateral	Low	Low

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

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

17 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.

18 Refer to GAS-999-PA-HSE-002 – Safety Case (**SAOP**) of Jemena Gas Assets (**NSW**) – [Not available on ECMS]

19 Refer to Jemena Gas Networks – Pipelines Asset Class Strategy

20 Refer to GAS-999-PA-IN-003 – Jemena Gas Network (**NSW**) Ltd – Asset Business Strategy 2024-2030

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

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

Threat Type	Threat Cause	Threat Consequence	Untreated AS 2885 Risk Rating	Untreated Jemena Risk Rating
Regulatory	Through wall corrosion under disbonded HSS causing CP shielding	Safety risk to public and environment with possibility of fatalities will lead to Regulatory investigations or government review. Major fines or penalties and prosecution possible.	N/A	Significant
Reputational	Through wall corrosion under disbonded HSS causing CP shielding	Safety risk to public and environment with possibility of fatalities will lead to significant adverse media /public attention on a state level. Reputation impacted with significant number of stakeholders. Significant stakeholder criticism lasting weeks.	N/A	Significant
Financial	Through wall corrosion under disbonded HSS causing CP shielding	Necessary permanent repair at location of pipe wall defect. Requiring unplanned or unbudgeted expenditure for repair works	N/A	Low
Environmental	Through wall corrosion under disbonded HSS causing CP shielding	Release of CO_2 or CH_4 to atmosphere.	Low	Low

2.4 CURRENT STATUS OF ASSET

2.4.1 LICENCE 2

The Lic 2 was constructed in 1976, and it is more than 40 years old. This section was designed without the provision for pigging, and the pipeline integrity assessment has been based on CP surveys (performed 3 times a year as per ACS), DCVG surveys (performed every 5 years- as per ACS) and investigation digs (as required). It has to be noted that DCVG has not been effective in finding HSS disbondment.

There is a significant threat to pipeline integrity caused by corrosion resulting from CP shielding at disbonded HSS. To date, seven HSS joints have been inspected on Licence 2a and Licence 2b. All but two sites were found to have significant corrosion. At two sites on Licence 2a, where corrosion was detected, it was assessed to impact the pipeline's MAOP, leading to the implementation of permanent repairs.

2.4.2 WOLLONGONG PRIMARY MAIN

Wollongong Primary Main was constructed in 1982, and it is more than 40 years old. These sections were designed without the provision for pigging, and the pipeline integrity assessment has been based on CP surveys (performed 3 times a year as per ACS), DCVG surveys (performed every 5 years as per ACS) and investigation digs (as required). It has to be noted that DCVG has not been effective in finding HSS disbondment.

A significant threat to pipeline integrity is corrosion due to CP shielding at disbonded HSS as there are no effective methods to identify the condition of HSS. To date 5 HSS joints have been inspected. All 5 HSS inspected had corrosion resulting in metal loss. At all locations the pipeline was fit for service for the pipeline MAOP.

2.5 ASSUMPTIONS

The following are the list of assumptions taken into consideration while undertaking this options analysis.

1) There is no expected future additional customer demand for Licence 2 and WPM.
2) There is an increase interest in renewable gas such as hydrogen and the repurposing of these pipelines have the potential to provide hydrogen projects in Port Kembla with a distinct storage advantage, enabling variable hydrogen production to decouple from variable demand as well as enabling high value demand like heavy vehicle transport to scale up over time.
3) The Central Trunk (Licence 1) ROP will not increase above 5.5MPa in the near future.
4) Mt Kiera and Port Kembla TRS can regulate the pressure to secondary without additional modification (confirmed by facilities team based on high level investigation).
5) Lic 2a can be pigged with secondary downstream pressure (confirmed by Capacity Planning based on high level investigation).
6) Wollongong PRS becomes redundant; however, the facility will be maintained.
7) Minor modification of pipe work and E&I changes will be required at Wollongong PRS to bypass the flow to secondary network.
8) WPM is a telescopic pipeline; it is assumed that multiple pig launcher configuration will be used to undertake ILI of WPM DN250/150 telescopic sections.
9) The pipeline construction details are reliable, and this section of the pipeline can be inspected via pigging.
10) There will be no requirement for replacement or removing of pipeline bends.
11) Relevant stakeholder approvals and environmental issues can be adequately managed.
12) A small footprint will be required for pipe modification and installation of permanent or temporary pig launch and receiver system, and land will need to be acquired or leased.
13) It has been assumed that where Lic 2b and/or WPM pipelines are suspended or reduced to below AS 2885 pressure for a prolonged period of time, extensive engineering and condition assessment work will be required to upgrade the pipelines back to AS 2885 pressure.
14) It has been assumed that operating the assets at secondary pressure will require lesser frequency for maintenance activities as the consequence of any identified threats will be lower compared to higher operating pressure. This will need to be confirmed by a Safety Management Study and reflected in the Pipeline Integrity Management Plan as required by AS 2885.3.
15) Any option not involving decommissioning of the assets will retain the existing pipeline license and easement.

2.6 STRATEGY

Operating a pipeline, Jemena is required to demonstrate that the pipeline integrity is monitored, assessed and maintained in accordance with AS2885.3 to ensure continuous safe operation. This project was identified to fulfil the regulatory requirement to operate the Licence 2b and WPM in compliance with the JGN Distribution Network (Primary Mains) and JGN Asset Class Strategy (ACS). .

As part of Jemena Asset Management System (AMS), the structural integrity of the Licence 2b and WPM is reviewed on an annual basis using the operational data. The threat related to undetected corrosion under disbonded HSS was captured within the Licence 2 (GAS-1190-RG-RM-001) and WPM (GAS-1415-RG-RM-001) Risk Registers and identified in the JGN Pipeline Asset Performance Report (APAIR) (GAS-999-RP-IN-003) and assessed using the Jemena Risk Management Framework detailed within JAA MA 0050 and AS 2885 risk matrix. The identified threat was assessed as High which requires a further reduction if practicable otherwise the risk needs to be assessed to be As Low as Reasonably Practicable (ALARP).

3. CREDIBLE OPTIONS

The following options have been identified for analysis:

- Option 1: Maintain Status Quo
- Option 2: Install Pigging Facilities and Perform Inline Inspection
- Option 3: Derate the pipeline to secondary pressure
- Option 4: Perform hydrostatic test
- Option 5: Decommission Licence 2 and Wollongong Primary Main
- Option 6: Suspending Licence 2 and Wollongong Primary Main

3.1 OPTIONS ANALYSIS

The following feasible options could be used to address the business need.

3.1.1 OPTION 1: MAINTAIN STATUS QUO

Integrity digs can be conducted in areas where corrosion is considered to be more likely. 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. The data gained can then be extrapolated across other areas of the pipeline.

As pipelines age there is an expectation that risk will slowly increase. There is a known issue of CP shielding with disbondment of the HSS type joint coating used on Lic 2b and WPM. DCVG is not effective in identifying disbonded HSS joint coating.

3.1.1.1 Benefits

Benefits of this option are:

- Avoid initial capital outlay (i.e., the costs can be spread out over time)
- Validate identified threats, pipeline condition, and confirm MAOP only at the targeted locations.
- Allows repair of any identified defect to be undertaken

3.1.1.2 Drawbacks

Expected drawbacks of this option are:

- This option will 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 pipe wall corrosion defect in the exact location where an integrity dig takes place is low.
- Pipeline will require several excavations on an annual basis at significant capital expenditure to determine overall pipeline integrity.
- This option will cause more frequent disturbance to environment and community.
- The reduction in pipeline integrity would lead to an increase in the indirect costs and risks of responding to

failures, including:

- More expensive and intrusive repairs e.g., cut out of failed pipeline section rather than recoating or strengthening in situ.
- Likely regulatory penalties, civil damages, reputational and customer losses, gas losses and risk of injury and death for the public and employees.

3.1.2 OPTION 2: INSTALL PIGGING FACILITIES AND PERFORM INLINE INSPECTION

Inline inspection (pigging) is the industry preferred inspection technique to validate the structural integrity of high-pressure pipelines as it inspects wall condition of the entire length of the pipeline. Both Lic 2b and WPM pipeline sections were constructed without pig trap facilities. Permanent/temporary pig trap facilities are required to be constructed for each of the pipelines to enable ILI to be undertaken.

3.1.2.1 Benefits

Benefits of this option are:

- Enable pigging of the Lic 2b and WPM pipelines and hence will have full condition assessment of pipeline. This will enable a more confident Asset Management plan and risk assessment in future.
- Provide a reliable and comprehensive dataset for long term integrity management of the pipeline.
- Satisfy the requirements of AS2885.3 Section 6 “Pipeline Structural Integrity” thereby maintaining safety and security of supply to the public.
- Allows to investigate the opportunity to repurpose the existing Wilton to Wollongong pipelines (Lic. 2a & 2b and WPM) to a dedicated hydrogen pipeline by assessing the pipelines compatibility and readiness to carryout NG-H2 blended mixtures and/or 100% Hydrogen in future.

3.1.2.2 Drawbacks

Expected drawbacks of this option are:

- Large capital and operational expenditure compared to some of the other feasible options. If pigging finds significant issues, additional spend will be required to repair defects found.

3.1.3 OPTION 3: DERATE THE PIPELINE TO SECONDARY PRESSURE

This option is to reduce both Lic 2b and WPM pipeline pressure (currently 3500 kPa) to secondary pressure (1050 kPa). The pressure reduction is possible with the current set up at Mt Kiera TRS and Port Kembla TRS. The pressure regulation of Mt Kiera TRS is only possible if the inlet pressure at Mt Kiera TRS is <5.5 MPa. This is due to lack of heating capacity at Mt Kiera TRS. Therefore, the Wilton PLS/EGP Wilton Lateral station outlet pressure shall be restricted to ROP of 5.5 MPa. Note that this is less than the MAOP (6.895) of Licenced JGN Pipelines.

3.1.3.1 Benefits

Benefits of this option are:

- Reduce consequence of pipeline failure scenarios.
- Pipeline can still be used for future supply (i.e., redundancy etc.)
- The pressure reduction will make the likelihood of catastrophic failure of pipeline along this section

negligible and also reduces the consequence of a leak failure with ignition due to lower pressure in the pipeline, thus reducing the overall risk rating.

- The implementation of this scenario would not require ILI or any additional integrity management to establish the condition of the pipeline and therefore all sections will comply to the standard requirements.
- Pressure reduction reduces the risk of failure by:
    - Reducing hoop stress on the pipe wall
    - Increasing the tolerable metal loss depth before failure
    - Increasing the critical defect length to failure
    - Limiting the gas discharge rate in the event of loss of containment

3.1.3.2 Drawbacks

- Cannot go back to higher pressure without significant work (e.g., ILI, hydro test).

3.1.4 OPTION 4: PERFORM HYDROSTATIC TEST

A successful hydrostatic pressure test will prove that pipeline has adequate wall thickness to contain the pipeline MAOP. Undertaking the hydrostatic pressure testing to the required test pressure will provide some assurance of the Pipeline's ability to continue operating under its design conditions and MAOP for the ten years succeeding the hydrostatic pressure testing. The test is required at certain intervals (10 yearly) to continuously prove the integrity of the pipeline.

3.1.4.1 *Benefits*

Benefits of this option are:

- The risk of pipeline failure will be reduced from High to either Significant or Intermediate.
- Validate the pipeline's ability to continue operating at MAOP.
- Demonstrates compliance to AS2885.3 structural integrity.
- No supply interruption.

3.1.4.2 *Drawbacks*

Expected drawbacks of this option are:

- Large capital expenditure compared to some of the other feasible options.
- As hydrostatic testing does not assess pipe wall anomalies directly, there would be no way possible to determine the corrosion rate for any anomalies identified. This would inhibit any possible decision making to perform proactive minor repairs to the Pipeline or justification for reduction in integrity assessment frequency.
- Individual anomalies would not be able to be identified and assessed to determine their exact nature.
- By performing hydrostatic pressure testing, any pipe wall anomaly which is not able to operate at the test pressure will result in failure of the pipe wall. In order to ensure the Pipeline can continue to operate safely and reliably, any point of failure on the Pipeline will need to be identified and repaired prior to returning to service. This process may need to be repeated several times in order to achieve the

necessary test pressure, potentially requiring multiple dig ups that could be extensive depending on the nature of the failure.

3.1.5 OPTION 5: DECOMMISSION LICENCE 2 AND WOLLONGONG PRIMARY MAIN

Decommission both pipelines in place by filling them with slurry and disconnecting them from the stations. This includes decommissioning (by removal) of Mt Kiera TRS and ALBV as this would no longer be required. Wollongong PRS will be used for capacity support and maintained. Pumping foam or grout into the pipeline as part of decommissioning cannot be done in a single section, hence, excavation at multiple locations is required to inject foam.

The entire Licence 2 pipeline will be decommissioned as there is no benefit identified to retain Licence 2a section without Licence 2b and WPM.

3.1.5.1 *Benefits*

Benefits of this option are:

- Removes the risk of pipeline failure.
- No further cost associated with maintaining the assets.

3.1.5.2 *Drawbacks*

Expected drawbacks of this option are:

- Expensive to decommission the pipelines.
- Loss of redundant supply to Wollongong.
- Unable to use these pipelines for any future development in Wollongong area.

3.1.6 OPTION 6: SUSPENDING LICENCE 2 AND WOLLONGONG PRIMARY MAIN

Lic 2 and WPM pipelines will be suspended in accordance with AS2885 requirements. This will include filling the pipelines with low-pressure nitrogen. The pipeline sections will continue to be protected with CP. CP and DCVG surveys, as well as exposed asset and ROW inspection frequencies, will be determined based on a risk assessment for suspending the pipelines.

The entire Licence 2 pipeline will be suspended, as there is no benefit identified in retaining the Licence 2a section without Licence 2b and WPM.

3.1.6.1 Benefit.

Benefits of this option are:

- Removes the risk of pipeline failure.
- Relatively low cost to implement the option.
- Pipeline and easement is available and maintained.

3.1.6.2 *Drawbacks*

Expected drawbacks of this option are:

- Cannot operate the pipeline without significant work to bring it back to operation (e.g. ILI, hydro test).
- Loss of redundant supply to Wollongong

While costs are low, they will continue for perpetuity.

3.2 COMPARISON OF OPTIONS

A full risk assessment for each option is provided in Appendix A: Risk Assessment Summary

Table 3–1 - Options Comparison

Criteria	Option 1	Option 2	Option 3	Option 4	Option 5	Option6
	Maintain Status Quo	**Install Pigging Facilities and Perform Inline Inspection**	**Derate the pipeline to secondary pressure**	**Perform Hydrostatic Testing**	**Decommission Licence 2 and Wollongong Primary Main**	**Suspending Licence 2 and Wollongong Primary Main**
Safety - Public Lack of data to validate and confirm pipeline condition at HSS. Undetected corrosion will lead to gas escape and jet fire affecting public safety.	DCVG is incapable of detecting disbonded HSS joint coating, therefore the direct inspections via integrity digs (based on CP and DCVG results) will have limited applicability. Direct inspection can validate identified threat and confirm MAOP only at the targeted location.	Small, large or developing defects can be detected that could lead to an in-service incident. Pigging will determine threats along the pipeline, rate of change of pipeline condition and confirm ability of pipelines to maintain MAOP.	Reduces the consequence as well as likelihood of pipeline failure resulting in an acceptable risk level.	Hydrostatic pressure test will prove that pipeline has adequate wall thickness to contain the pipeline MAOP. However small or developing defects cannot be detected and may fail during the subsequent test which will result in repair of the pipeline	Eliminates the risk	Eliminate the risk
Complies with NGR	No	Yes Consistent with accepted and good industry practice (79(1)) and also	Yes Consistent with accepted and good industry practice (79(1)) and also complies to NGR (79(2)(c) (i) (ii) &(iii))	Yes Consistent with accepted and good industry practice (79(1)) and also complies to NGR (79(2)(c)(i)(ii)&(iii))	Yes Consistent with accepted and good industry practice (79(1)) and also complies to NGR (79(2)(c)(i)(ii)&(iii))	Yes Consistent with accepted and good industry practice (79(1)) and also complies to NGR (79(2)(c)(i)(ii)&(iii))

Criteria	Option 1	Option 2	Option 3	Option 4	Option 5	Option6
		complies to NGR (79(2) (c) (i) (ii) &(iii))				
Delivery constraints	None	- Modification to existing pipeline to install permanent or temporary pigging facilities. - Integrity digs for bends verification	- A detail assessment to be undertaken. - Modification of pipework at Wollongong PRS	- Logistical issues such as sourcing and disposal of water. - Adequate exclusion zones to manage public safety in the event of a failure in highly populated areas.	None	None
Treated Risk Ranking (Jemena)	High	Significant	Moderate	Significant	Risk is eliminated	Risk is eliminated
Treated Risk Ranking (AS 2885 risk matrix)	High	Intermediate	Low	Intermediate	Risk is eliminated	Risk is eliminated
Cost (CAPEX)	Nil	A$ 22.0 M (pigging facilities)	A$ 2.012 M	A$ 17.0 M	Nil	Nil
Cost (OPEX)	Digs – A$ 11M (over 10Y)	ILI – A$ 8.0 M (every 10Y) Validation Digs - A$4 M (every 10Y)	A$ 1.2 M[23] (one-off) for decommissioning Wollongong PRS	Hydro – A$4.6 M (every 10Y)	A$ 11.0 M (de-com works) ~A$ 8.0 M (write off)	A$ 2.5 M
Total Cost	A$ 11.0 M	A$ 34.0 M	A$ 3.212 M	A$ 21.6 M	A$ 19.0 M	A$ 2.5 M

[23] Refer to Wollongong PRS decommissioning OB which will be managed as a separate OPEX project Link

OPTIONS ANALYSIS – LICENCE 2B AND WPM – INTEGRITY MANAGEMENT

Criteria	Option 1	Option 2	Option 3	Option 4	Option 5	Option6
Recommended order of preference for options	Not Acceptable	2 Not recommended	**1** **Recommended**	4 Not recommended	5 Not recommended	3 Not recommended

4. RECOMMENDATION

4.1 RECOMMENDED SOLUTION

Six 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 Lic 2b and WPM pipelines as a result of CP shielding at disbonded HSS and pipeline mainline coating.

Option 3 is preferred and recommended as it reduces the safety, supply and integrity risks from High to Moderate (Jemena)/Low (AS 2885). The pipeline will remain operational as a supply source to Wollongong which increases the security of supply. This option is the most economical and efficient option.

The remaining 5 options are not recommended for the following reasons.

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 areas 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 2 is **recommended but not preferred** due to the extensive capital investment required to undertake the integrity assessment of pipelines.

Option 4 is **not recommended** as this option presents significant practical difficulties for implementation. Although this option will meet AS2885.3 compliance by confirming the pipeline MAOP (at that moment in time), it does not provide a comprehensive data set of pipeline condition when compared to the recommended option, thus cannot be used for future asset integrity capital and operational planning works and implementation.

Option 5 is **not recommended** because decommissioning the pipeline assets is expensive. Additionally, this option would eliminate the currently available redundant supply to Wollongong

Option 6 is **not recommended** as this option will require an extensive capital investment to bring the pipelines back to operational status after being suspended.

4.2 SCOPE

A detailed engineering assessment (including HAZOP and SMS) has to be carried out for the proposed changes. It was identified that minor piping and E&I modifications will be required at Wollongong PRS as this facility become redundant by implementing this option. Mt Kiera TRS and Port Kembla PRS existing equipment are capable to regulate the pressure to secondary pressure.

High Level scope is as follows:

Mt Kiera TRS and Port Kembla PRS will have their outlet pressure reduced to 1050 kPA without modification.

Wollongong PRS will be decommissioned with (in reference to drawing A0-TP-0681)

- Removal of buried isolation valve V001
- Removal of buried isolation valve V401
- Removal of all three runs between valve V001 and V401 including filters, meters, slam shut valves and pressure control valves.
- Removal of all instrumentation lines and associated SCADA connections.
- Removal of facility enclosure including any pits, walls and flooring.
- Installation of a DN250 CL150 interconnection upstream of V001 and downstream of V401
- Weld end caps at points where valves V001 and V401 were removed and
- Use of appropriate hot-tap and bypass configuration to achieve uninterrupted supply downstream during decommissioning.

Potholing will also be required upstream of Wollongong PRS to confirm pipe interconnection between Wollongong PRS, WPM, EGP, and Port Kembla Meter Station prior to scope being confirmed.

4.3 COST DETAILS

4.3.1 COST METHODOLOGY

The cost estimate is based on the received quotations from contractors and actual costs of similar projects that underwent 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 below.

Table 4.1: Project Estimation

Item	Project Estimate (AUD 000s)
Materials	27.5 k
Jemena Internal Labour	604.12 k
Contractor Costs	562.2 k
Risk (excl overhead)	232.26 k
Total Direct Costs	**1,426.08 k**
Indirect & Overheads	585.98 k
Total Project Estimate	**2,012.06 k**

Refer to JGN - RIN - 4.3 - 10038241 - Lic 2B and WPM Integrity Management - PEMO - 20240628 - Public

Note: The decommissioning of the Wollongong PRS A$1.2M will be managed under a separate OPEX project in the future.

5. TERMS AND DEFINITIONS

Table 5–1 - Terms and Definitions

Term	Definition
ACS	Asset Class Strategy
ALARP	As Low as Reasonably Practicable
ALBV	Automatic Line Break Valve
AS	Australian Standards
CP	Cathodic Protection
DCVG	Direct Current Voltage Gradient
DN	Diameter Nominal
EGP	Eastern Gas Pipeline
E&I	Electrical and Instrumentation
HSS	Heat Shrink Sleeves
ILI	In Line Inspection
JGN	Jemena Gas Network
km	Kilometre
m	Metre
MAOP	Maximum Allowable Operating Pressure
MOP	Maximum Operating Pressure
MLV	Main Line Valve
NSW	New South Wales
PRS	Pressure Regulating Station
PLS	Pressure Limiting Station
RY	Regulatory Year
SMS	Safety Management Study
SMYS	Simplified Minimum Yield Strength
T1	Residential
T2	High Density
TRS	Trunk Receiving Station
WPM	Wollongong Primary Main

6. REFERENCES

6.1 INTERNAL

1. GAS-1190-RP-RM-003 Licence 2 Five Yearly Safety Management Study
   http://ecms/otcs/cs.exe/open/318695432
2. GAS-1190-RG-RM-001 JGN Pipelines Southern Trunk - Risk Register
   http://ecms/otcs/cs.exe/link/310010508
3. GAS-1415-RP-RM-001 WPM Five Yearly Safety Management Study
   http://ecms/otcs/cs.exe/open/316796671
4. GAS-1415-RG-RM-001 - JGN - Wollongong Primary Main - Integrity Risk Register
   http://ecms/otcs/cs.exe/link/306765005
5. GAS-1190-RP-IN-002 – Southern Trunk Coating Defect Operational Report
   http://ecms/otcs/cs.exe/open/308238552
6. W24303 – Jemena Gas pipeline DCVG Coating Defect Survey Report – 2023
   http://ecms/otcs/cs.exe/open/322855263
7. GAS 1415-RP-IN-002 – Wollongong Primary Main Coating Defect Operational Report
   http://ecms/otcs/cs.exe/open/307942803
8. JGN - RIN - 4.3 - 10038241 - Lic 2B and WPM Integrity Management - CBAM - 20240628 - Public

6.2 EXTERNAL

9. Australian Standard AS2885.3-2022, Pipelines – Gas and Liquid Petroleum Part 3 Operation and Maintenance
10. Australian Standard AS2885.1-2018 Pipelines – Gas and Liquid Petroleum Part 1 Design and Construction
11. ASME B31.8S Managing System Integrity of Gas Pipelines
12. 2022 Gas Supply (Safety and Network Management) Regulations
13. National Gas Rules Version 38
14. Gas Supply Act 1996

Appendix A 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 using both the Jemena Risk Manual JAA MA 0050 Revision 10 (22/5/2023) and also the AS 2885.1 risk matrix.

UNTREATED IMPACT/CONSEQUENCES									UNTREATED RISK SUMMARY		
Contributing Factors/ Scenario	**Risk Assessment Method**	**Environmental**	**Financial**	**Safety/People**	**Operational/Supply**	**Regulatory & Compliance**	**Reputation**	**Comments**	**Consequence (Highest Impact)**	**Likelihood**	**Risk Level**
Unable to confirm the pipeline integrity i.e., metal loss, corrosion failure due to CP shielding resulting in Loss of containment with ignition causing jet fire	**Jemena**	Minor	Serious	Catastrophic	Minor	Major	Major	○ ENVIRONMENTAL: MINOR - Minor on site effects rectified with negligible residual effect. ○ FINANCIAL: SERIOUS - Unplanned or unbudgeted expenditure for dig up repair, and remediation of site. ○ SAFETY: CATASTROPHIC –Potential fatality associated with Loss of Containment anywhere online ○ OPERATIONAL: MINOR - Supply shortfall met from other sources ○ REGULATORY: MAJOR – Government/regulator review results in fines and/or litigation ○ REPUTATIONAL: MAJOR - Reputation impacted in pipeline industry, government and community stakeholders.	Catastrophic	Unlikely	**HIGH**
	AS 2885	Minor	N/A	Major	Minor	N/A	N/A	○ ENVIRONMENTAL: MINOR - Effect very localised, very short term and minimal rectification ○ SAFETY: MAJOR –Few fatalities, multiple injuries at T1 location class ○ OPERATIONAL: MINOR - Supply shortfall met from other sources	Major	Unlikely	**High**

PREFERRED OPTIONS – Risk assessment summary				TREATED RISK SUMMARY		
Preferred Option/Treated risk	Cost	Benefit	Key Mitigations	Consequence	Likelihood	Risk Level
Option 1 (Status Quo) – Indirect Inspections via integrity digs based on DCVG & CP data	$11 M	○ 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. ○ Does not address safety concerns; pipe integrity verified to confirm pipeline MAOP only at areas inspected. Integrity of remainder of pipeline remains unknown.	○ Targeted confirmation of the Pipeline's ability to continue operating at MAOP only at localised locations where integrity digs have been performed and confirmation of control effectiveness through trending of integrity data. This is not effective in mitigating the risk.	Catastrophic (Health and Safety)	Unlikely	HIGH (Jemena)
				Major (People)	Unlikely	High (AS2885)

Option 2 – Install Pigging Facilities and Perform Inline Inspection	$34 M	○ Pigging the pipeline will provide data to accurately assess any anomalies found and if required undertake repairs to ensure safety and security of supply. ○ This option will validate the pipeline condition along the length of the pipelines. ○ Assist in targeting locations and reduce ongoing cost for the validation dig program. ○ Once an ILI base line is established, it is feasible to re-run inspection tools at appropriate intervals to monitor for changes in anomalies or new anomalies. ○ Provide a reliable and comprehensive dataset for continuing management of long-term integrity and ensure security of supply;	○ Confirmation of the Pipeline's ability to continue operating at MAOP in its entirety. ○ Identify pipe wall defects in need of further investigation and possible repair to ensure continued operability of the Pipeline at MAOP in its entirety. ○ Satisfy the requirements of AS2885.3 Section 6 "Pipeline Structural Integrity".	Major (Health and Safety)	Unlikely	Significant (Jemena)
				Major (People)	Remote	Intermediate ALARP (AS2885)
Option 3 – Derate the pipeline to secondary pressure	A$ 2.012 M (CAPEX only) A$1.2M (Opex)	○ Reduces consequence of pipeline failure. ○ Pipeline can still be used for future supply (i.e., redundancy etc.)	- The pressure reduction will make catastrophic rupture along this section completely negligible and also reduces the consequence of a leak failure with ignition due to lower pressure in the pipeline, thus reducing the overall risk rating.	Severe (Health and Safety)	Unlikely	Moderate (Jemena)`
				Minor (People)	Unlikely	Low (AS2885)
Option 4 – Perform hydrostatic test	$21.6 M	○ Performing the hydrostatic pressure testing provides confirmation that adequate wall thickness remains along all sections of the Pipeline such that the Pipeline is able to maintain containment at the testing pressure. By testing at pressure specified in ASME B31.8S, there will be some assurance that there is sufficient wall thickness remaining so that general corrosion will not result in through wall corrosion before the next integrity assessment after 10 years. ○	○ Validate the pipeline's ability to continue operating at MAOP. ○ Demonstrates compliance to AS2885.3 structural integrity ○ No supply interruption.	Catastrophic (Health and Safety)	Rare	Significant (Jemena)
				Major (People)	Remote	Intermediate (AS2885)
Option 5 – Decommission Licence 2 and Wollongong Primary Main	$19.0 M	○ Eliminates the risk of pipeline failure. ○ Health and safety risk is eliminated ○ Health and safety risk is eliminated	○ Eliminates the risk of pipeline failure. ○ Health and safety risk is eliminated ○ Health and safety risk is eliminated	Risk is eliminated		
Option 6 – Suspending Licence 2 and Wollongong Primary Main	$2.5 M	○ Eliminates the risk of pipeline failure. ○ Health and safety risk is eliminated.	○ Eliminates the risk of pipeline failure. ○ Health and safety risk is eliminated	Risk is eliminated		