Evoenergy

Integrity Assessment of the Canberra Primary Main

Options Analysis

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Authorisation

Name	Job Title	Date	Signature
Prepared by:			
	Engineer – Pipelines, Planning & Assessment Distribution		
Reviewed by:			
	Planning & Assessment Manager – Gas Distribution		
Endorsed by:			
	Principal Engineer – Pipelines		
Approved by:			
	GM Asset Management – Gas Distribution		

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1. EXECUTIVE SUMMARY

1.1 PROJECT AND KEY DRIVERS

The Canberra Primary Main (**CPM**) is the major pipeline for the supply of natural gas to industrial, commercial and residential customers in the Canberra region via the secondary pressure distribution network. The CPM is approximately 42.8km long and receives gas from two supply sources : the Fyshwick Trunk Receiving Station (**TRS**) and the Watson Custody Transfer Station (**CTS**).

The Canberra Primary Main is susceptible to the threat of external corrosion that has the potential to cause through wall pipe defects leading to a risk of loss of containment affecting public health and safety and/or a loss of gas supply to customers. External corrosion is expected to grow linearly over time provided all contributing factors remain constant, this results in an increased risk of loss of containment and loss of supply events occurring as the Pipeline ages. This project has been identified to continue conducting In-Line Inspection (**ILI**) of the pipeline on a ten-yearly schedule and ensure that the threat of through wall corrosion by either cathodic protection (**CP**) shielding or CP under-protection at pipeline coating defects remains non-credible in a ten-year timeframe between successive ILI's and to mitigate the threat.

The principal drivers for performing an integrity assessment on the CPM are:

a. Compliance - remain compliant with the obligations and requirements of Australian Standard (**AS**) 2885; and

b. Safety - eliminate the risks associated with a of loss of containment or loss of supply event.

There are also numerous secondary benefits in performing the integrity assessment, including:

a. Affordability - ensure that pipe wall anomalies are remediated before costly permanent repair of the pipe wall is required.

b. Reliability - ensure the reliable supply of gas to the Canberra Domestic Market.

If the Pipeline is operated in accordance with the current status quo there are untreated risks which are considered intolerable as assessed against AS2885.1[1] and the Group Risk Management Manual[2]. The identified risks are above the acceptable limits given in both AS2885.1 and the Group Risk Management Manual and require further risk reduction if they cannot be justified to be As Low As Reasonably Practicable (**ALARP**)[3].

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1 Refer to AS2885.1-2008 2018 – Pipelines – Gas and liquid petroleum – Part 1: Design and Construction

2 Refer to JAA MA 0050 – Group Risk Management Manual [http://ecms/otcs/cs.exe/link/295482907]

3 Refer to AS2885.1-2018 – Pipelines – Gas and liquid petroleum – Part 6: Pipeline Safety Management and JAA MA 0050 – Group Risk Management Manual [http://ecms/otcs/cs.exe/link/295482907] – Figure 10

1.2 CREDIBLE OPTIONS

Table 1-1 : Summary of Credible Options

Option	Option Name	Description	Cost ($000's, Real 2020)
1	Maintain Status Quo – Perform 10-yearly ILI, along with validation digs post ILI. **(Recommended Option)**	Perform ILI in compliance with the ten-yearly frequency nominated in the Evoenergy Pipeline Integrity Management Plan (**PIMP**)[4]. Validation digs are required post ILI operation to confirm the accuracy of the ILI data and assess / repair any severe anomalies.	[redacted]
2	Do nothing	No integrity assessment would be completed on the Canberra Primary Main for the remaining life of the asset.	OPEX : $0
3	Perform hydrostatic pressure test	Perform hydrostatic testing of the Canberra Primary Main with appropriate contingency to repair any controlled failure of the pipe wall. Hydrostatic pressure testing would continue on a ten-yearly cycle for the Pipeline.	OPEX : $3,850[6]
4	Undertake targeted integrity dig program	Undertake three integrity digs of the Canberra Primary Main per year and perform coating defect assessments via direct current voltage gradient (**DCVG**) surveys every five years. Dig locations would be chosen from assessment of the previous ILI results, DCVG survey results and CP data.	OPEX : $1,321 p.a OPEX : $6,605 over 5 years

1.3 RECOMMENDATION

The recommended option to address the drivers of the project is **Option 1: Maintain Status quo** – 10 yearly ILI (with validation digs). The implementation of this option would see the loss of containment, loss of supply and loss of licence to operate risks eliminated and also ensure that the greatest strategic and integrity benefits are achieved out of all assessed options. Option 1 also ensures that operation of the CPM remains in compliance with the requirements of AS2885.

1.4 NATIONAL GAS RULES

The OPEX for this project is consistent with rule 79(2) of the National Gas Rules (**NGR**)[7] as it is necessary in order to maintain the safety of services (Rule 79(2)(c)(i)), it is necessary in order to maintain the integrity of services (Rule 79(2)(c)(ii)) and it is necessary to comply with a regulatory obligation or requirement (Rule 79(2)(c)(iii)).

4 Refer to Evoenergy Pipeline Integrity Management Plan (PIMP) [http://ecms/otcs/cs.exe/link/310602806]

5 Refer Cost Estimates from the Project Estimation Models (PEM). *Note : $1.28M of these project costs are post RY26.*

6 Estimate based on previous Jemena quotes of similar scope for Hydrostatic tests and disposal of water.

7 Refer to National Gas Rules Version 38

The recommended solution is consistent with:

- Rule 79(2)(c)(i) as a loss of containment event has a potentially catastrophic consequence on public safety. By implementing the recommended option, all loss of containment risks would be eliminated and deemed non-credible.
- Rule 79(2)(c)(ii) as implementing the recommended option allows for identification of areas in need of remediation in order to ensure that integrity, safety and supply are maintained.
- Rule 79(2)(c)(iii) as it is a requirement of the Gas Supply (Safety and Network Management) Regulation to:
  - ensure that the operation the Pipeline are in accordance with AS2885. AS2885 requires that Jemena create and implement a PIMP on behalf of Evoenergy, which is the Evoenergy PIMP; and
  - lodge and implement a pipeline management plan.

The Evoenergy PIMP calls for all pipelines with pigging capabilities to have ILI conducted with a ten-yearly inspection frequency

By performing Option 1: Maintain Status quo of perform ten-yearly ILI (with validation digs), Evoenergy would be fulfilling the regulatory requirements listed above. The proposed solution ensures consistency with rule 79(1)(a) of the National Gas Rules, as the solution can be considered:

- prudent – The expenditure is required to ensure adherence to the ten-yearly ILI frequency stated in the Evoenergy PIMP required by the PIMP and AS2885.3. Meeting this obligation is taken to be in line with the actions of a prudent network operator;
- efficient – The cost estimates for this project were developed from the actual costs of performing similar ILI and validation digs of other pipelines[8] , and comparison to expenditure for projects on similar pipelines with adjustment for inflation and changing vendor costs; and
- consistent with accepted and good industry practice – The nominated inspection frequency aligns with recommendations made within the American Society of Mechanical Engineers (**ASME**) B31.8S[9] and with the ILI frequency nominated by other pipeline operators within Australia[10].

[8] Cost estimates for ILI and validation digs are based on recent Jemena ILI and validation digs projects.

[9] Refer to ASME B31.8S-2004 – Managing System Integrity of Gas Pipelines – Table 3 Integrity Assessment Intervals – Pipeline with hoop stress >50% SMYS and > 1.39xMAOP

[10] Refer to 330-POL-AM-0022 – (APA Group) Technical Policy – In-line Inspection – Transmission Pressure Pipelines – Section 4.1

2. PROJECT BACKGROUND AND KEY DRIVERS

2.1 PROJECT BACKGROUND

The Canberra Primary Main, currently operating with a maximum operating pressure (**MOP**) of 6,200kPa, is an integral part of the Evoenergy gas distribution network, receiving natural gas from the upstream pipelines (Dalton – Watson Lateral & Hoskinstown to Fyshwick Pipeline) and delivering it to the downstream secondary (1050kPa) network. Figure 1 shows the CPM in relation to the upstream pipelines and high pressure facilities that, in turn feed into the secondary network. The CPM is approximately 45km long with a nominal diameter (**DN**) of 250mm and was constructed between 1996 – 1998.

The CPM was pigged for the first time in 2015 via ILI, using geometry and metal loss detection tools. Two anomalies were identified from the ILI report[11] and a direct inspection and repair was carry carried out (validation digs) to validate and repair the pipeline structural integrity at those locations.

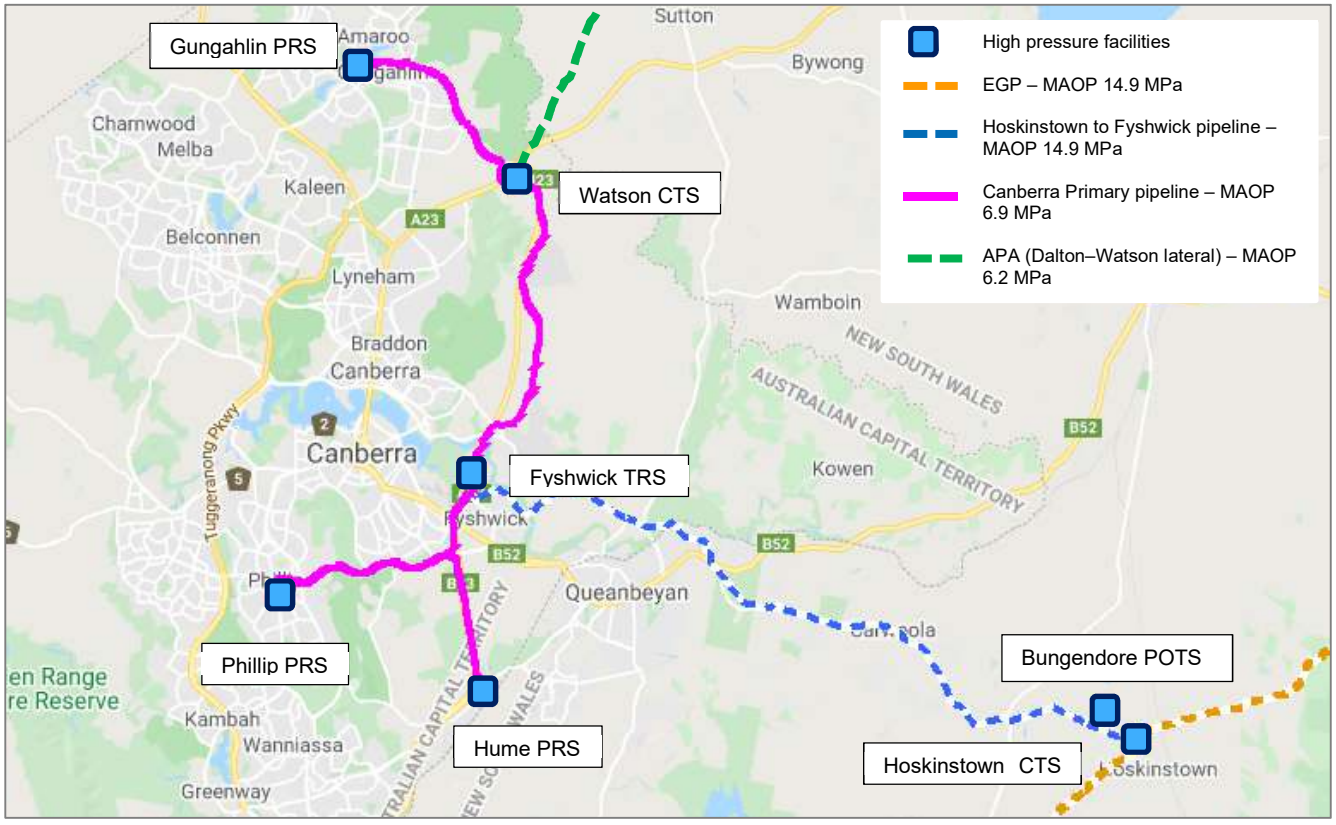

Figure 1 : Canberra Primary Main

[11] Refer ILI Operational Report GAS-4100-RP-IN-004 [http://ecms/otcs/cs.exe/open/310602920]

2.2 IDENTIFIED NEED

Scheduled integrity assessments of the Canberra Primary Main are required, in order to provide confirmation that the Pipeline is able to provide continued gas supply to the Canberra Domestic Market and to ensure the continued operation of the Pipeline does not pose unacceptable health and safety risks to Jemena employees or the general public, as per the Jemena Health and Safety Policy[12] as required by AS2885.3 via the PIMP[13].

The CPM is subject to external corrosion at coating defects caused by CP under-protection[14] which are time-dependant and have the potential to affect the Pipeline's integrity and result in loss of containment, loss of supply or financial loss events.

The risk of loss of containment due to external corrosion caused by CP under-protection is considered non-credible with the current maintain status quo approach.

2.3 PROJECT DRIVERS AND OBLIGATIONS

The integrity threats which have been identified on the Canberra Primary Main have the potential to affect the Pipeline's ability to operate safely and reliably. These threats have the potential to result in fatalities of the public from a loss of containment, or lead to loss of supply and financial loss events. The risk ratings of these events based on maintaining the status quo are given in Table2-1.

Table 2-1 : Current risk on the Canberra Primary Main for maintaining status quo

Risk Type	Threat	Risk	Risk Rating (Group risk management manual)[15]	Risk Rating (AS2885)
Loss of supply	Through-wall external corrosion resulting from CP under-protection at coating defects.	Inability to provide gas to all customers during emergency shutdown due to the current Canberra Primary MOP or lack of pressure containment capabilities.	Non-credible	Non-credible
Loss of containment	Through wall corrosion resulting from CP under protection at coating defects.	Loss of containment (gas leak) with ignition causing a jet fire resulting in deaths.	Non-credible	Non-credible

As the operator of high pressure gas transmission pipelines, Jemena (on behalf of Evoenergy) ensures safe and reliable transport of gas by complying with the requirements of AS2885, which requires that Jemena create and implement a PIMP[16] as the instrument to "ensure continued pipeline integrity during the life of the pipeline".

12 Refer to JEM PO 0396 – Jemena Health and Safety Policy [http://ecms/otcs/cs.exe/link/244756610]

13 Refer to Evoenergy Pipeline Integrity Management Plan (PIMP) [http://ecms/otcs/cs.exe/link/310602806]

14 Under-protection is taken as non-compliance with the protection criteria given in section 2 of AS2832.1 – Cathodic protection of metals – Part 1: Pipes and cables

15 Refer to JAA MA 0050 – Group Risk Management Manual [http://ecms/otcs/cs.exe/link/295482907]

16 Refer to AS2885.3 – Pipelines – Gas and liquid petroleum – Part 3: Operation and maintenance – section 5.1

The Evoenergy Safety Case[17] outlines Jemena's Asset Management and Health and Safety objectives. These are to:

- manage our assets without compromising employees, contractors and public safety as per the Jemena Health and Safety Policy and Compliance with the Law Policy; and
- facilitate continual improvement in the safety, reliability and performance of our assets, through the establishment, maintenance and governance of effective asset and safety management systems.

Jemena ensures the safe and reliable operation of the Canberra Primary Main by operating in compliance with the Evoenergy Safety Case[17] and by extension with the Evoenergy PIMP. Operating in non-compliance with the Safety Case would result in a written order by the Director-General "to take such action as is specified in order to comply with" the Evoenergy PIMP[18]. This would compel Jemena to perform an integrity inspection of the Pipeline at the frequency nominated in the Evoenergy PIMP. This risk is eliminated in the current maintaining status quo operation of the Pipeline.

2.4 CURRENT STATUS OF ASSET

The most recent integrity assessment of the Canberra Primary Main was performed in 2015 via ILI[19]. Metal loss anomalies identified by the ILI were assessed in compliance with AS2885.3[20] and found that two anomalies required closer inspection. Validation digs post ILI were carried at these two locations to confirm the accuracy of the ILI data and repairs of these anomalies were completed. It was then determined that the Pipeline is able to continue operating at its MAOP and that loss of containment or loss of supply event is non-credible.

The nominated inspection frequency of 10 years broadly aligns with recommendations made within the American Society of Mechanical Engineers (**ASME**) B31.8S[21] and with the ILI frequency nominated by other pipeline operators within Australia[22].

2.5 ASSUMPTIONS

The options assessed within this document are done so under the assumption that :

1. The ILI tool measurements are accurate;
2. The Classification of pipe wall anomalies from the 2015 ILI are accurate and as stated by the ILI vendor;
3. No external interference has occurred on the Canberra Primary Main that would prevent pigging operations from taking place;
4. The Pipeline is traversable by an ILI tool;
5. The pig launchers and receivers are suitable to accommodate an ILI tool.

17 Refer Evoenergy ACT Gas Distribution Safety Case – Section 1.6 [http://ecms/otcs/cs.exe/link/310605390]

18 Refer to Evoenergy Pipeline Integrity Management Plan (PIMP) [http://ecms/otcs/cs.exe/link/310602806]

19 Refer ILI Operational Report GAS-4100-RP-IN-004 [http://ecms/otcs/cs.exe/open/310602920]

20 Refer to AS2885.3 – Pipelines – Gas and liquid petroleum – Part 3: Operation and maintenance – Table 9.2

21 Refer to ASME B31.8S-2004 – Managing System Integrity of Gas Pipelines – Table 3 Integrity Assessment Intervals – Pipeline >30% SMYS and at 4.2xMAOP

22 Refer to 330-POL-AM-0022 – (APA Group) Technical Policy – In-line Inspection – Transmission Pressure Pipelines – Section 4.1

3. CREDIBLE OPTIONS

The following options were identified for assessment:

- Option 1: Maintain Status quo - Perform ten-yearly in-line inspection (with validation digs post ILI)
- Option 2: Do nothing
- Option 3: Perform hydrostatic pressure testing
- Option 4: Undertake targeted integrity dig program

All options are explained in detail below.

3.1 OPTIONS ANALYSIS

3.1.1 OPTION 1: MAINTAIN STATUS QUO – PERFORM TEN-YEARLY IN-LINE INSPECTION (WITH VALIDATION DIGS POST ILI)

This option would perform an in-line inspection of the full length of the pipeline in its three sections (Watson-Gungahlin, Watson-Phillip & Narrabundah-Hume) in compliance with the ten-yearly frequency nominated in the Evoenergy PIMP. Validation digs are required post ILI operation to confirm the accuracy of the ILI data and assess / repair any severe anomalies.

3.1.1.1 Risk reduction

All risks associated with this option are either mitigated to an acceptable level or deemed non-credible. Refer to Table 3–1 and Table 3–2 for the risk ratings associated with this option. Also Refer to Appendix A and Appendix B for an in-depth risk assessment of Option 1: Maintain Status quo - Perform ten-yearly ILI (with validation digs post ILI).

3.1.1.2 Benefits

Compliance:

- In compliance with the nominated interval for successive ILI inspections specified in the Evoenergy PIMP**;**
- Aligns with the recommended integrity assessment frequency given in ASME B31.8S[23]; and
- Aligns with the current best practice within the Australian pipeline industry[24].

Integrity:

- Allow for a more precise calculation of the corrosion rate experienced by the Pipeline by comparison of congruent pipe wall anomalies, in a more timely fashion;
- Ability to identify pipe wall anomalies likely to lead to through wall corrosion and to perform proactive repairs, in a more timely fashion.

Strategic:

- Provides an accurate corrosion rate for all anomalies in a timely fashion; allowing the justification for decisions to decrease inspection frequency via ILI potentially saving future OPEX;
- Simplify the assessment of remaining life required by AS2885.3-2012;

[23] Refer to ASME B31.8S – Table 3

[24] Refer to 330-POL-AM-0022 – (APA Group) Technical Policy – In-line Inspection – Transmission Pressure Pipelines – Section 4.1

- Allows for the validation of credible threats to the Pipeline including:
  - damage to the pipe wall due to third party interference;
  - external corrosion on pipe length during times of CP under protection; and
  - external corrosion occurring under disbonded pipe coatings.
- Allows for the identification of metal loss and pipe deformation events which do not conform to observed trends.

AS2885.1 asks that consideration be given to what has not been done to mitigate the risk, and for detailed evaluation of the resulting risk[25]. Without this assessment, the risk rating would remain unvalidated and would be steeped in assumptions resulting in unacceptable risk level.

3.1.1.3 Drawbacks

There are no integrity or compliance drawbacks associated with Option 1.

3.1.1.4 Cost

This option would have an OPEX cost of [redacted] for both the ILI inspection of the pipeline and validation digs required post ILI.

3.1.2 OPTION 2: DO NOTHING

This option of doing nothing would see that no integrity assessment is conducted on the Canberra Primary Main going forward. This option would mean operating the Pipeline in non-compliance with the ten-yearly ILI frequency nominated in the Evoenergy PIMP.

3.1.2.1 Associated Risk

Refer to Appendix A and Appendix B for an in-depth risk assessment of Option 2: Do nothing. Refer to Table 3-1 and Table 3-2 for the risk ratings associated with this option.

This option has associated risks which are considered intolerable when assessed against both AS2885 and the Group Risk Management Manual. This is due to the threat of external corrosion being uncontrolled by this option.

3.1.2.2 Benefits

There are no compliance or integrity benefits associated with Option 2: Do nothing.

Strategic:

- Reduction in OPEX by Evoenergy, ultimately leading to a reduction in the gas distribution services charge passed on to customers.

3.1.2.3 Drawbacks

Compliance:

- In non-compliance with the nominated interval for successive ILI inspections specified in the Evoenergy PIMP.

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[25] Refer to AS2885.1 – Pipelines – Gas and liquid petroleum – Part 1: Design and construction – Appendix G section G3

[26] Refer Cost Estimates from the Project Estimation Models (PEM). *Note : $1.28M of these project costs are post RY26.*

Integrity:
- Inspection interval outside of the maximum recommended inspection frequency of 10 years given in ASME B31.8S[27]; and
- Inspection frequency outside of industry best practice for similar pipelines.

Strategic:
- The threat of external corrosion would remain unmonitored for 20 years following identification, which is against the recommendation in AS2885.1 to demonstrate that the risk associated with the threat is ALARP as soon as possible.

3.1.2.4 Cost

This option incurs no additional OPEX costs for Evoenergy.

The operational and maintenance strategy for maintaining the Pipeline will remain unchanged for all options assessed unless otherwise stated. Any change in the maintenance strategy of the Canberra Primary Main as a result of this Options Analysis will only increase the number of maintenance tasks performed. Hence the Option 2: Do nothing will be taken as the baseline cost and zeroed out with all other options incurring additional costs from this baseline.

3.1.3 OPTION 3: PERFORM HYDROSTATIC PRESSURE TESTING

This option would see hydrostatic pressure testing of the entire Canberra Primary Main conducted at 9.58MPa[28] (or as otherwise determined in accordance with AS2885 to give confidence that corrosion anomalies will not fail within a ten year period) instead of performing an ILI. Hydrostatic testing would then be used as the ongoing integrity assessment every ten years in lieu of ILI.

Once the testing is completed, the Pipeline will require complete dewatering and drying, and reinstatement of all affected stations. This option assumes repairs will be undertaken for any ruptures or tears which occur in the pipe wall as a result of the testing, although the cost of these repairs is not taken into consideration in this analysis.

3.1.3.1 Risk reduction

Refer to Appendix A**Error! Reference source not found.** and Appendix B for an in-depth risk assessment of Option 3: Perform hydrostatic pressure testing. Refer to Table 3–-1 and Table 3-2 for the risk ratings associated with this option.

This option has associated risks which are considered intolerable when assessed against both AS2885 and the Group Risk Management Manual.

3.1.3.2 Benefits

Compliance:
- Integrity assessment frequency in compliance with the recommended timing given in ASME B31.8S for successive hydrostatic pressure tests.

Integrity:
- Provides confirmation that adequate wall thickness remains to maintain containment at the testing pressure; and;

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[27] Refer to ASME B31.8S-2004 – Managing System Integrity of Gas Pipelines – Table 3 for a pipeline operating at hoop stress greater than 50% SMYS.

[28] 9.58MPa was chosen as the test pressure for the hydrostatic pressure testing by using the nominated test pressure of 1.39 times MAOP for a 10 yearly inspection interval as nominated in ASME B31.8S – Table 3 for a pipeline operating with hoop stress above 50% SMYS.

- Provides 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.
  - ***Note:*** this option will not allow identification of where corrosion is occurring if failure of the pipe wall does not occur.

Strategic:

- Simplify the ten-yearly assessment of remaining life required by AS2885.3-2012;

3.1.3.3 Drawbacks

Compliance:
- Be in non-compliance with the requirements of AS2885.3-2012[29] as the decision is:
  - not able to be justified from a risk reduction, compliance or cost reduction perspective; and
  - in non-compliance with the inspection method nominated in the Evoenergy PIMP, namely ILI[30].

Integrity:
- No confirmation of the Pipes continued ability to maintain pressure for a ten-year period between successive tests;
- Introduces an additional risk of internal corrosion from incomplete dewatering and drying post-testing of the Pipeline
  - ***Note:*** Based on risk levels and water testing, biocides or oxygen scavengers would be used to minimise this risk.

Strategic:
- Any point of failure on the Pipeline would need to be identified and repaired prior to returning to service;
  - ***Note:*** 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 or difficult to locate resulting in significant delays before returning to service.
- There is no way possible to determine the corrosion rate for all anomalies which did not result in failure of the pipe wall meaning:
  - no visibility of where to perform proactive repairs to prevent future through wall corrosion; and
  - no ability to justify decisions to decrease inspection frequency;
- No ability to validate the credibility of identified threats unless they result in pipe wall failure during testing.. This would inhibit any possible strategies to perform proactive repairs to the Pipeline prior to failure occurring.

3.1.3.4 Cost

This option would have an OPEX cost of $3.850M (Real, $2020)[31] to perform hydrostatic testing of the Canberra Primary Main.

[29] Refer to AS2885.3 – Pipelines – Gas and liquid petroleum – Part 3: Operation and maintenance – Section 6.6.1

[30] Refer Evoenergy Pipeline Integrity Management Plan (PIMP) [http://ecms/otcs/cs.exe/link/310602806]

[31] Estimate based on previous Jemena quotes of similar scope for Hydrostatic tests and disposal of water.

3.1.4 OPTION 4: UNDERTAKE TARGETED DIRECT INSPECTION PROGRAM

This option would see three integrity digs performed each year at selected locations on the Pipeline and a DCVG survey performed every five years for the entire length of the Canberra Primary Main. The integrity digs would target areas with known issues, including the highest risk anomalies, and any coating defects which have experienced periods of CP under-protection and locations where a high level of third-party activity has occurred.

This program would start from RY25 and be performed for the remainder of the assets life.

3.1.4.1 Risk reduction

Refer to Appendix A and Appendix B for an in-depth risk assessment of Option 4: Undertake targeted integrity dig program. Refer to Table 3–1 and Table 3–2 for the risk ratings associated with this option.

This option has associated risks which are considered intolerable when assessed against both AS2885 and the Group Risk Management Manual. This is due to the threat of external corrosion being uncontrolled by this option.

3.1.4.2 Benefits

There are no compliance benefits associated with this option.

Integrity:

- Any coating or metal loss anomalies found during the integrity dig would be repaired, if deemed necessary, as part of the scope of the dig;
  - ***Note:*** Performing the repairs before wall corrosion occurs would eliminate the loss of containment risk for those anomalies, however, due to the small number of integrity digs that would be performed, the expected reduction in likelihood for the risk of loss of containment would be insignificant;
- Confirm the ability of the pipeline to continue operating at MAOP at the areas subjected to an integrity dig, though this is not applicable to the entire length of the Canberra Primary Main.

Strategic:

- Directly inspect any of the highest remaining anomalies identified in the 2015 ILI and perform repairs if necessary;
- Ability to determine a corrosion rate for the Pipeline by comparison of found anomaly dimensions to the measurements from the 2015 ILI;
  - ***Note:*** This would allow for a maximum of 30 corrosion rates to be calculated which may provide a justification for the reduction in inspection frequency, leading to potential reduction in OPEX.
- Provide sufficient data to allow for validation of the accuracy of the ILI tool used in the 2015 ILI; and
- Potential to identify systematic issues with existing controls, including:
  - localised damage from unauthorised third-party works;
  - disbonded pipe coating; and
  - external corrosion due to CP under-protection.

3.1.4.3 Drawbacks

Compliance:

- Be in non-compliance with the requirements of AS2885.3-2012[32] as the decision is:
  - not able to be justified from a risk reduction, compliance or cost reduction perspective; and
  - in non-compliance with the inspection method nominated in the Evoenergy PIMP, namely ILI[33].

Integrity:

- The interval between successive integrity assessments would be:
  - outside of the maximum recommended inspection frequency given in ASME B31.8S[34]; and
  - outside of industry best practice for similar pipelines.

Strategic:

- Highly unlikely to identify any high consequence events which do not conform to the observed trends; and
- May lead to unnecessarily dire conclusions of the Pipeline's integrity due to confirmation bias resulting from targeting integrity dig locations using equivalent selection criteria.

3.1.4.4 Cost

This option would have an opex cost of $1.321M per annum to undertake three integrity digs of the Canberra Primary Main and perform coating defect assessments via DCVG surveys every five years. The opex cost over five years would equate to approximately $6.6M.

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32 Refer to AS2885.3 – Pipelines – Gas and liquid petroleum – Part 3: Operation and maintenance – Section 6.6.1

33 Refer Evoenergy Pipeline Integrity Management Plan (PIMP) [http://ecms/otcs/cs.exe/link/310602806]

34 Refer to ASME B31.8S-2004 – Managing System Integrity of Gas Pipelines – Table 3

3.1.5 RISK REDUCTION - AS PER THE JEMENA GROUP RISK MANAGEMENT MANUAL

Refer Appendix A for detailed risk assessment, a summary of risks is provided in Table 3–1: Risk rating for each option under consideration (Group Risk Management Manual)

Table 3–1: Risk rating for each option under consideration (Group Risk Management Manual)

Identified risk	Option 1: Maintain Status quo - Perform ILI (with validation digs post ILI)	Option 2: Do nothing	Option 3: Hydrostatic pressure testing	Option 4: Integrity dig program
Loss of containment (gas leak) with ignition causing a jet fire resulting in deaths due to through wall corrosion resulting from CP under-protection at coating defects.	Non-credible	Significant	Non-credible	Significant
Inability to provide gas to customers supplied off the Canberra Primary Main due to lack of pressure containment capabilities caused by external corrosion at coating defects with CP under-protection.	Non-credible	Significant	Non-credible	Significant
Not operating the Pipeline in compliance with the Evoenergy PIMP and AS2885.	Non-credible	High	Moderate	High

3.1.6 RISK REDUCTION - AS PER AS2885

Refer Appendix B for detailed risk assessment, a summary of risks is provided in Table 3–1: Risk rating for each option under consideration (Group Risk Management Manual)

Table 3–2: Risk rating for each option under consideration (AS2885)

Identified risk	Option 1: Maintain Status quo - Perform ILI (with validation digs post ILI)	Option 2: Do nothing	Option 3: Hydrostatic pressure testing	Option 4: Integrity dig program
Loss of containment (gas leak) with ignition causing a jet fire resulting in deaths due to through wall corrosion resulting from CP under-protection at coating defects.	Non-credible	Intermediate	Non-credible	Intermediate
Inability to provide gas to customers supplied off the Canberra Primary Main due to lack of pressure containment capabilities (from gas leak or immanent failure of the pipe wall) caused by external corrosion at coating defects with CP under-protection.	Non-credible	Negligible	Non-credible	Negligible

3.2 COMPARISON OF OPTIONS

A full risk assessment for each option is provided in Appendix A: Group Risk Mgmt Manual & Appendix B: AS2885 Risk Assessment Summaries.

Table 3-3 : Options Comparison including risk, benefits and expected cost

Criteria	Option 1	Option 2	Option 3	Option 4
Option description	Maintain Status quo: Ten-yearly ILI (with validation digs)	Do nothing	Hydrostatic pressure testing	Targeted direct inspection program
Integrity benefit	●	○	◑	◔
Compliance benefit	●	○	◔	○
Strategic benefit	●	○	○	◔
Complies with NGR	Yes	No	Yes	No
Treated Risk Ranking (Highest) (Group Risk Mgmt Manual)	Non-credible	High	Moderate	High
Treated Risk Ranking (Highest) (AS2885)	Non-credible	Intermediate	Non-credible	Intermediate
Cost Estimate (Opex, $000's, Real 2020)	[redacted]	0	3,850	1,321 per annum 6,605 over 5 years
Net Present Value (**NPV**)[36] (Opex, $000's, Real 2020)	-3,302	0	-6,253	-11,496
Options Analysis	● Fully addresses the issue	○ Does not address the issue	◔ Partially addresses the issue	○ Does not address the issue
Recommended order of preference for options	1	4	2	3

[35] Refer Canberra Validation Digs and Canberra Integrity Assessment Project Estimation Models (PEMs)

[36] Refer Appendix C for NPV model extract

4. RECOMMENDATION

4.1 RECOMMENDED SOLUTION

The recommended option for performing an integrity assessment of the Canberra Primary Main is Option 1: Maintain status quo and undertake ten-yearly ILI (with validation digs). This option has proved to offer the greatest strategic and integrity benefits, with the risks which had intolerable risk ratings for other options being mitigated to non-credible.

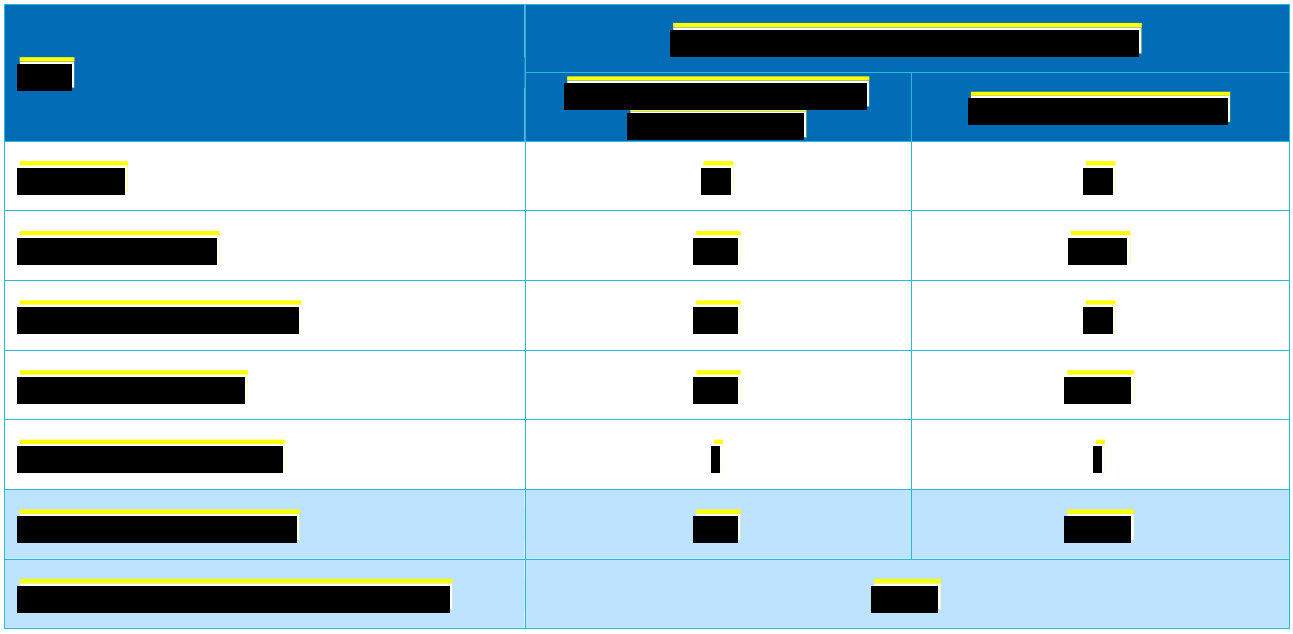
The key drivers for choosing this option is :

- remain compliant with the obligations and requirements of Australian Standard (**AS**) 2885;
- that it aligns with current best practice within the Australian pipeline industry;
- to eliminate the risks associated with a of loss of containment or loss of supply event;
- to ensure that pipe wall anomalies are remediated before costly permanent repair of the pipe wall is required; and
- to ensure the reliable supply of gas to the Canberra Domestic Market.

4.2 COST DETAILS

The cost methodology for the recommended option was obtained using the Project Estimation Models (**PEM**) for both the Integrity Assessment of Canberra Primary Main (ILI) and Canberra Primary Main Validation Digs.

Table 4-1: Project Cost Estimation



5. TERMS AND DEFINITIONS

Term	Definition
Anomaly	A discontinuity or imperfection of the pipe wall
As low as is reasonably practicable	The cost of further risk reduction measures is grossly disproportionate to the benefit gained from the reduced risk that would result
Cathodic Protection	The prevention or reduction of corrosion of metal by making the metal the cathode in a galvanic or electrolytic cell
Defect	An anomaly deemed unacceptable after engineering assessment
Direct Current Voltage Gradient survey	A method of locating coating holidays on a buried, coated structure without excavation of the buried structure
Hoop Stress	Circumferential stress in a pipe or cylindrical pressure-containing component, arising from internal pressure
Hydrostatic Pressure Testing	Test involving filling the vessel or pipe system with a liquid and pressurization of the vessel to the specified test pressure to test for strength and leaks
In-line Inspection	Inspection of a pipeline using an in-line inspection tool, also known as intelligent or smart pigging.
Integrity Dig	Direct inspection activities performed to confirm and validate information derived from indirect inspection activities (i.e. CP survey data, DCVG survey)
Integrity Assessment	Any assessment which direct assesses the condition of the pipe wall, ideally in a holistic manner.
Maximum Allowable Operating Pressure	The maximum pressure at which a pipeline or section of a pipeline may be operated, following hydrostatic testing or after an MAOP review performed in accordance with AS2885.
Maximum Operating Pressure	The operating pressure limit (lower than the MAOP) imposed by the Licensee from time to time for pipeline safety or process reasons.
Permanent Repair	A repair of the pipe wall which is intended to remain permanently to ensure pressure containment.
the Pipeline	Refers to the Canberra Primary Main Pipeline.

Term	Definition
ALARP	As Low As Reasonably Practicable
AS	Australian Standard
ASME	American Society of Mechanical Engineers
CP	Cathodic Protection
CPM	Canberra Primary Main
CTS	Custody Transfer Station
DCVG	Direct Current Voltage Gradient
DN	Diameter Nominal
EGP	Eastern Gas Pipeline
ILI	In-line inspection
MAOP	Maximum Allowable Operating Pressure
MOP	Maximum Operating Pressure
MPa	Megapascals
NA	Not Applicable
NGR	National Gas Rules
NPV	Net Present Value
OPEX	Operating Expenditure
PEM	Project Estimating Model
PIMP	Pipeline Integrity Management Plan
POTS	Packaged Offtake Station
PRS	Primary Receiving Station
SMYS	Specified Minimum Yield Strength
RY	Regulatory Year
TRS	Trunk Receiving Station

6. REFERENCES

6.1 INTERNAL

- JAA MA 0050 Group Risk Management Manual Revision 8
  http://ecms/otcs/cs.exe/link/295482907
- JEM PO 0396 – Jemena Health and Safety Policy
  http://ecms/otcs/cs.exe/link/244756610
- Evoenergy ACT Gas Distribution Safety Case
  http://ecms/otcs/cs.exe/link/310605390
- Evoenergy Pipeline Integrity Management Plan (PIMP)
  http://ecms/otcs/cs.exe/link/310602806
- ILI Operational Report (GAS-4100-RP-IN-004)
  http://ecms/otcs/cs.exe/link/310602920

6.2 EXTERNAL

- National Gas Rules Version 38 15th May 2018
  https://www.aemc.gov.au/sites/default/files/2018-04/NGR%20-%20v38.PDF
- AS 2885.0 : 2018 Pipelines – Gas and liquid petroleum – General requirements
- AS 2885.1 : 2018 Pipelines – Gas and Liquid Petroleum Part 1: Design and Construction
- AS 2885.3 : 2012 Pipelines – Gas and Liquid Petroleum Part 3: Operation and Maintenance
- AS2832.1 : 2015 Cathodic Protection of Metals – Part 1 : Pipes and Cables
- AS CB 28 : 1972 Gas Transmission and Distribution Systems
- ASME B31.8S : 2004 Managing System Integrity of Gas Pipelines
- 330-POL-AM-0022 (APA Group) Technical Policy – In-line Inspection : Transmission Pressure Pipelines

APPENDIX A : RISK ASSESSMENT – GROUP RISK MANAGEMENT MANUAL

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 Risk Management Manual JAA MA 0050 Revision 8.

UNTREATED IMPACT/CONSEQUENCES								UNTREATED RISK SUMMARY		
Contributing Factors/ Scenario	Strategic	Financial	Safety	Operational	Regulatory & Compliance	Reputation	Comments	Consequence (Highest Impact)	Likelihood	Risk Level
Inability to provide gas to customers supplied off the Canberra Primary Main (3 days maximum) due to lack of pressure containment capabilities (from gas leak or immanent failure of the pipe wall) caused by external corrosion at coating defects with CP under-protection.	NA	Serious	NA	Catastro-phic	NA	Severe	**Financial** – For a three day loss of supply whilst repair works of the Canberra Primary Main are undertaken. Financial consequence includes lost transmission and distribution revenue, claims for lost profits by customers, breach of supply contracts, etc. **Operational** – For a three day loss of supply to the PRS and TRS facilities. **Reputation** – Persistent public scrutiny for large scale loss of supply to large and small customers.	Catastrophic	NA	Non-credible
Loss of containment (gas leak) with ignition causing a jet fire resulting in death(s) due to through wall corrosion resulting from CP under-protection at coating defects.	N/A	Severe	Catastro-phic	Serious	Major	Major	**Financial** – Cost associated with the dig up, conducting a permanent repair and the remediation of the dig up. All costs to be incurred by Evoenergy. Also includes revenue loss due to supply loss, damage to property, legal costs, negligent loss of life claims, etc. **Safety** – Loss of life (at least 1) as the Pipeline is located in a T1 area. **Operational** – Loss of supply to a small number of customers. **Regulatory & Compliance** - Violation in ensuring safe supply of natural gas to customers requiring formal explanation by senior management and regulatory review. **Reputation** – Persistent loss of faith in company due to causing death(s) in a densely populated residential area.	Catastrophic	NA	Non-credible
Not operating the Pipeline in compliance with the Evoenergy PIMP and AS2885.	NA	NA	NA	NA	Catastro-phic	NA	**Regulatory & Compliance** - Violation in ensuring safe supply of natural gas to customers requiring formal explanation by senior management and regulatory review.	Catastrophic	NA	Non-credible

PREFERRED OPTION – Risk assessment summary				TREATED RISK SUMMARY		
Preferred Option/Treated risk	Cost (Opex $000's, Real 2020)	Benefit	Key Mitigations	Consequence	Likelihood	Risk Level
Option 1 – Maintain Status quo - Perform ten-yearly ILI (with validation digs post ILI) (**Recommended Option**)	[redacted]	Performing ILI of the Pipeline allows for accurate identification and measurement of anomalies on the pipe wall. This data allows quantification of the severity of the identified anomalies and pinpoint areas in need of further investigation or immediate repair. Comparison of new ILI data with previously obtained ILI data allows for estimation of a corrosion rate for each identified anomaly. Assessment against B31G allows for an informed estimation of when an anomaly is likely to fail Level 1 assessment, allowing for a more robust method of determining the frequency of integrity assessment via ILI. ILI results can be used to validate the credibility of threats such as: o mechanical damage due to unauthorised third party interference; o external corrosion due to coating defects/CP under-protection; and o identify locations on the Pipeline with increased likelihood of pipe wall failure or pin-hole leak. Minimised impact to customers caused by disruption of supply during pigging operations. Provide validation of the condition and continued operability of the Pipeline at MAOP as required for 10-yearly Remaining Life Review, including the calculation of a maximum corrosion rate experienced by the Pipeline.	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.	Catastrophic	NA	Non-credible
			Identify areas on the pipe wall subjected to active corrosion and undertake further investigation. This would include initiating integrity digs and perform repairs where necessary to prevent loss of containment events.	Catastrophic	NA	Non-credible
			Operate in compliance with the Evoenergy PIMP	Catastrophic	NA	Non-credible
Option 2 – Do nothing	0	Reduced OPEX spend	No mitigation	Catastrophic	Rare	Significant
			No mitigation	Catastrophic	Rare	Significant
			No mitigation	Catastrophic	Unlikely	High

PREFERRED OPTION – Risk assessment summary				TREATED RISK SUMMARY		
Preferred Option/Treated risk	Cost (Opex $000's, Real 2020)	Benefit	Key Mitigations	Consequence	Likelihood	Risk Level
Option 3 – Perform hydrostatic pressure testing	3,850	Provide validation of the condition of the Pipeline at MAOP as required for 10-yearly Remaining Life Review.	Confirmation of the Pipeline's ability to continue operating at MAOP in its entirety. Pressure testing at 1.7 x MAOP will confirm that sufficient wall thickness remains on all sections of the Pipeline for continued pressure containment for next ten-year period, based of recommendation from B31.8S.	Catastrophic	NA	Non-credible
			Confirmation of the Pipeline's ability to continue operating at MAOP in its entirety. Pressure testing at 1.7 x MAOP will confirm that sufficient wall thickness remains on all sections of the Pipeline for continued pressure containment for next ten-year period, based of recommendation from B31.8S.	Catastrophic	NA	Non-credible
			Some form of integrity assessment undertaken to confirm the Pipeline's continued operation at MAOP. Formal explanation required by senior management, justifying why ILI is not to be performed, in non-compliance with the Evoenergy PIMP.	Severe	Unlikely	Moderate
Option 4 – Undertake targeted direct inspection program	1,321 pa 6,605 over 5 years	Directly inspect the pipeline and validate its condition and the ILI results can be used to select the locations of IDs and validate the credibility of threats such as: o external corrosion due to CP under-protection; o identify locations on the Pipeline with increased likelihood of pipe wall failure or pin-hole leak; and o determine an average corrosion rate experienced by the Pipeline and confirm continued MAOP at the locations targeted. Conducting DCVG survey can help in obtaining additional information related to the coating condition of the Pipeline viand allow for further investigation.	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. No guarantee against anomalies causing restriction or loss of supply which do not fit trend.	Catastrophic	Rare	Significant
			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. Some reduction in risk through continual repair. No guarantee against anomalies causing restriction or loss of supply which do not fit trend.	Catastrophic	Rare	Significant
			No holistic confirmation of the Pipeline's ability to continue operating at MAOP.	Catastrophic	Unlikely	High

APPENDIX B : RISK ASSESSMENT – AS2885

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 AS2885.6.

UNTREATED IMPACT/CONSEQUENCES					UNTREATED RISK SUMMARY		
Contributing Factors/ Scenario	People	Supply	Environment	Comments	Consequence (Highest Impact)	Likelihood	Risk Level
Inability to provide gas to customers supplied off the Canberra Primary Main (3 days maximum) due to lack of pressure containment capabilities (from gas leak or immanent failure of the pipe wall) caused by external corrosion at coating defects with CP under-protection.	NA	Severe	NA	**Supply** – For a three day loss of supply to several TRS and PRS facilities supplies all downstream customers.	Severe	NA	Non-credible
Loss of containment (gas leak) with ignition causing a jet fire resulting in death(s) due to through wall corrosion resulting from CP under-protection at coating defects.	Catastrophic	Severe	NA	**Safety** – Loss of life (at least 1) as the Pipeline is located in a T1 area. **Supply** - Loss of supply to a small number of customers.	Catastrophic	NA	Non-credible

PREFERRED OPTION – Risk assessment summary				TREATED RISK SUMMARY		
Preferred Option/Treated risk	Cost (Opex $000's, Real 2020)	Benefit	Key Mitigations	Consequence	Likelihood	Risk Level
Option 1 – Maintain Status quo - Perform ten-yearly ILI (with validation digs post ILI) (**Recommended Option**)	[redacted]	Performing ILI of the Pipeline allows for accurate identification and measurement of anomalies on the pipe wall. This data allows quantification of the severity of the identified anomalies and pinpoint areas in need of further investigation or immediate repair. Comparison of new ILI data with previously obtained ILI data allows for estimation of a corrosion rate for each identified anomaly.	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.	Severe	NA	Non-credible

PREFERRED OPTION – Risk assessment summary				TREATED RISK SUMMARY		
Preferred Option/Treated risk	Cost (Opex $000's, Real 2020)	Benefit	Key Mitigations	Consequence	Likelihood	Risk Level
		Assessment against B31G allows for an informed estimation of when an anomaly is likely to fail Level 1 assessment, allowing for a more robust method of determining the frequency of integrity assessment via ILI. ILI results can be used to validate the credibility of threats such as: ○ mechanical damage due to unauthorised third party interference; ○ external corrosion due to CP under-protection; and ○ identify locations on the Pipeline with increased likelihood of pipe wall failure or pin-hole leak. Provide validation of the condition and continued operability of the Pipeline at MAOP as required for 10-yearly Remaining Life Review, including the calculation of a maximum corrosion rate experienced by the Pipeline.	Identify areas on the pipe wall subjected to active corrosion and undertake further investigation. This would include initiating integrity digs and perform repairs where necessary to prevent loss of containment events.	Catastrophic	NA	Non-credible
Option 2 – Do nothing	0	Reduced OPEX spend	No mitigation	Severe	Hypothetical	Negligible
			No mitigation	Catastrophic	Hypothetical	Intermediate
Option 3 – Perform hydrostatic pressure testing	3,850	Provide validation of the condition of the Pipeline at MAOP as required for 10-yearly Remaining Life Review.	Confirmation of the Pipeline's ability to continue operating at MAOP in its entirety. Pressure testing at 1.7 x MAOP will confirm that sufficient wall thickness remains on all sections of the Pipeline for continued pressure containment for next ten-year period, based of recommendation from B31.8S.	Severe	NA	Non-credible
			Confirmation of the Pipeline's ability to continue operating at MAOP in its entirety. Pressure testing at 1.7 x MAOP will confirm that sufficient wall thickness remains on all sections of the Pipeline for continued pressure containment for next ten-year period, based of recommendation from B31.8S.	Catastrophic	NA	Non-credible

PREFERRED OPTION – Risk assessment summary				TREATED RISK SUMMARY		
Preferred Option/Treated risk	Cost (Opex $000's, Real 2020)	Benefit	Key Mitigations	Consequence	Likelihood	Risk Level
Option 4 – Undertake targeted direct inspection program	1,321 pa 6,605 over 5 years	Directly inspect the pipeline and validate its condition and the ILI results can be used to select the locations of IDs and validate the credibility of threats such as: o external corrosion due to CP under-protection; o identify locations on the Pipeline with increased likelihood of pipe wall failure or pin-hole leak; and o Determine an average corrosion rate experienced by the Pipeline and confirm continued MAOP at the locations targeted. Conducting DCVG survey can help in obtaining additional information related to the coating condition of the Pipeline viand allow for further investigation.	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. No guarantee against anomalies causing restriction or loss of supply which do not fit trend.	Severe	Hypothetical	Negligible
			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. Some reduction in risk through continual repair. No guarantee against anomalies causing restriction or loss of supply which do not fit trend.	Catastrophic	Hypothetical	Intermediate

APPENDIX C : NPV MODEL

Below is the screenshot of the 'Options Comparison' tab of the NPV model : ***Evoenergy – NPV Model – Integrity Assessment of Canberra Primary Main.xlsx***