Jemena Gas Networks (NSW) Ltd

Revised 2025-30 Access Arrangement Proposal

Attachment 5.3

Picarro

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Overview

Consistent with changes to the NGO and NGR, we have considered how we can implement measures to support the achievement of Australian and NSW emissions reduction targets and help address the threat of climate change.

Our emissions are not immaterial. In providing our reference services we emit 0.34 $MtCO_2e$, 98.9% of which is due to fugitive emissions (gas lost to the atmosphere through leaks).[1] This makes us the 103rd largest emitter in Australia.[2]

To play our role in delivering Australia's lower emissions energy future, we identified that we need greater visibility of leaks across our network and over the 2020-25 period began the implementation of innovative Picarro technology to provide granular and accurate data on the location and size of leaks across our network. This in turn allows us to identify, prioritise and repair leaks.

In preparing our Initial 2025 Plan we considered enhanced use of Picarro technology to improve the safety of our network, reduce emissions and lower Safeguard Mechanism costs (and network bills) by facilitating the move to direct emissions measurement.

There is no other feasible approach to identify, quantify and prioritise and repair leaks on our network and to achieve these goals.

The AER did not accept our proposal due to an absence of Government decisions related to emissions reporting: if (and when) we will be able to report on measured emissions as well as what level of data quality will be required. The AER considered that undertaking 3- to 5-yearly surveys combined with interim estimates based on engineering calculations and modelling would be sufficient to move to direct emissions measurement.

We do not consider that the draft decision gives adequate consideration to the safety benefits or reduction in actual emissions achieved from enhanced surveys. We note that reducing *actual* not reported emissions is what is required to address the threat of climate change and is the focus of the NGO.

We also consider that only approving expenditure which reduces *reported* emissions rules out all technologies not yet enabled by the NGER Scheme and creates an unnecessary regulatory barrier to innovation. We do not consider that this is consistent with the vision recently outlined by the AER Chair.[3]

Helpfully, since lodging our proposal the Government's position on emissions reporting has been made clear. The Government has agreed in-principle to implement higher order reporting methods (which will allow us to report emissions using Picarro data) and flagged that the NGER Scheme will remain consistent with international frameworks which emphasise the importance of accurate, credible and actionable emissions data.

In particular, contrary to the AER's draft decision, it is improbable that we will be able to move to direct emissions measurement based on 3- or 5-yearly survey data and interim estimates. The proposed Measurement, Reporting and Verification (MMRV) framework, which Australia has joined, indicates this data would receive a letter grade score of 'D' or 'F'. This is not consistent with the Government's commitment to ensuring that the NGER Scheme remains world class and consistent with international reporting frameworks.

We have also received new information on our network safety (recent events indicate that the public is reporting less leaks than we had anticipated, underlining the safety benefits of Picarro) as well as the nature of leaks on our network. Picarro data to date indicates that a small number of leaks drive a majority of emissions and that our network continually and randomly deteriorates both of which highlight the importance of frequent inspections to deliver a prudent and efficient leak detection and repair program.

Given the AER's feedback, we have undertaken further analysis of whether we could make greater use of engineering calculations and modelling. We found that given the diverse nature of our network a large number of

1 Fugitive emissions for 2023/24.

2 2022-23 Safeguard Mechanism data by facility. See here.

3 Q&A with AER Chair Clare Savage 13 August 2024. Available here.

representative samples to monitor network condition and degradation is required. We found that even with engineering calculations and modelling, the minimum number of vehicles to produce a reasonable estimate through spatial-temporal extrapolation is six vehicles.

Based on this finding and the new information available, we re-evaluated our approach. We considered multiple factors: safety, emissions reduction, data quality, and delivery constraints. We also examined how these factors would affect our ability to implement direct emissions measurement. Moving to direct measurement is critical because it will ensure accurate emissions reporting under the Safeguard Mechanism. If we continue to report emissions under the current reporting method, we risk overcharging consumers by reporting higher emissions than we actually produce.

Given the AER's feedback in the draft decision and the new information available, we have revised our proposal to implement a phased approach (option 4 in Table 4–1). This will require six vehicles – a step change of 3.75 additional vehicles (given 2.25 vehicles are in the base year). We will move to eight vehicles in our 2030 Plan.[4]

Under this approach we will bear the risk that we need to purchase additional vehicles to move to direct emissions reporting.

Table OV–1: Updated summary of options

Option	Safety benefits	Reduction in annual emissions (2025-30)	Expected data quality	Direct Emissions measurement	Step change ($2025)	NPV ($2025)
1. Status quo – 3 cars	Low	50,000 tCO2e	OGMP 2.0 Level 3 'D' or 'F' MMRV data quality	Improbable	$1.7 m	-
2. Spatial-temporal extrapolation – 6 cars	Medium	105,000 tCO2e	OGMP 2.0 level 4 'B' MMRV data quality	Possible	$15.3 m	$182.2 m
3. 100% annual survey – 8 cars	High	132,000 tCO2e	OGMP 2.0 Gold Standard: level 4 'A' MMRV data quality	Highly likely	$21.5 m	$249.9 m
4. Staged approach: Spatial-temporal extrapolation before moving to 100% survey – 6 then 8 cars **(Revised 2025 Plan)**	Medium/ high	105,000 tCO2e	OGMP 2.0 Gold Standard: Level 4 with pathway to level 5) 'C before moving to 'A' MMRV data quality	Likely	$15.3 m	$244.2 m

4 Or potentially earlier.

1. Initial 2025 Plan

Over the 2020-25 period we began the implementation of Picarro technology (a form of Advanced Mobile Leakage Detection) to identify leaks. This was not included in our opex allowance.

Following an initial pilot and trial, we deployed two vehicles to replace our existing 5-yearly walking survey program in 2023.[5] Based on the success of the Picarro technology we ended 5-yearly walking surveys in July 2023 effectively eliminating the cost of these 5-yearly surveys from our 2023-24 base year.[6] We since purchased a third vehicle resulting in 2.25 vehicles included our base year.

In respect of our adoption of Picarro technology, the NSW Government Department of Climate Change, Energy, the Environment and Water (DCCEEW) noted:[7]

> *The Department supports and encourages any and all practices that contribution to the improvement of the safety, reliability and quality of Jemena's gas distribution network, this includes the introduction of new and innovative technologies such as PICARRO's Surveyor Leakage Detection technology. Through previous showcasing events and as summarised in your letter, the Department acknowledges the clear benefits that the PICARRO technology brings to this aspect of Jemena's operations, as well as assisting them to meet operational efficiency, energy reporting, environmental and broader business objectives.*

In developing our Initial 2025 Plan, we considered expanding the use of Picarro technology to make our network safer, reduce actual emissions as well as lower reported emissions and in turn Safeguard Mechanism costs. This technology can achieve these goals by:

- Identifying leaks faster and more accurately by providing an estimate of the leak size (emission flow rate).
- Providing data to enable optimised repair programs.
- Quantifying the benefits of other emission reduction initiatives (such as pressure reduction).
- Improve the accuracy of emissions measurement and thereby facilitating the move to a higher order reporting mechanism.

We explored three options:

1. Status quo – surveys conducted as part of our 5-yearly compliance program.
2. Moving to enhanced coverage – surveying 60% of the network annually.
3. Advanced measurement and reporting – surveying 100% of the network annually.

Given the direction of travel for emissions reporting, we considered that moving to annual network surveys would provide the government and the community sufficient confidence that the data collected could be relied on for emissions reporting. This would allow us to move to direct measurement approach (see box 1) and away from the use of benchmarks. We did not consider that moving to direct measurement would be possible with data obtained in Option 1 or 2.

5 The first two units were purchased in 2023 and the third in Q2 2024.

6 We also ended annual surveys in high-density community use areas in 2024. The cost of these surveys is incremental and relatively small given that they are undertaken in conjunction with other activities, such as high-risk area valve maintenance.

7 JGN DCCEEW – RP – Att 5.4 – Implementation of PICARRO Vehicle Mounted Leak Survey Methodology Response – 20241119 – Public.

The move to direct emissions measurement: actionable, credible and more accurate

We considered that moving to a higher-order reporting mechanism would require direct emissions measurement, requiring annual surveys across our entire network. We considered that less frequent surveys accompanied by an interim estimate would not be acceptable.

This view was based on the global shift in international best practice away from generic assumptions and towards measurement-based reporting. The goal of improved measurement is to produce credible and actionable emissions data.[8] Interim estimates are not actionable and do not improve the credibility of our reporting.

The OGMP 2.0 Reporting Framework was designed (in part) to strengthen the credibility of methane reporting to inform methane-reducing challenges and best practice through a more robust and consistent reporting framework.

OGMP 2.0 members are expected to work towards achieving 'gold standard' reporting, which means they can credibly demonstrate that they are contributing to climate mitigation and meeting methane reduction objectives and targets. Gold standard reporting requires that emissions be reported at a 'Level 4' standard with demonstrable efforts to move to 'Level 5' where:

- Level 4 – Specific Emissions Source Level – reporting is based on direct measurement or other methodologies
- Level 5 – Integrating bottom-up source level reporting (level 4) with independent site-level measurements, obtained using direct measurement technologies at a site / facility level on a representative sample of facilities.

We also considered the Climate Change Authority's (CCA) 2023 review of the NGER Scheme. The CCA found that the accuracy of estimated fugitive emissions may be impacted due to the use of simple emissions factors and identified a number of improvements to enhance the accuracy of emissions reporting. This included increasing the availability of higher order reporting methods.[9]

Moving to direct emissions measurement not only allows us to reduce actual emissions but ensures that these reductions are reflected in our reporting, lowering Safeguard Mechanism costs. This was one of the drivers which led to the benefits identified in Option 3 being significantly higher than the other options.

Given the material difference between Option 2 and Option 3, our analysis did not take into account the benefit annual surveys provide by allowing us to quickly detect and repair leaks (which arise continuously and randomly across our network) and in turn halt ongoing deterioration of our network.

We sought customer feedback on this plan at our March 2024 customer forum. Customers voted strongly in favour of our proposal as they supported concrete efforts to genuinely reduce emissions. Customers considered that we should be more proactive and considered that the incremental costs of purchasing additional vehicles acceptable given the impact on emissions reduction.

Accordingly, our Initial 2025 Plan included:

- A step change for 5.75 additional Picarro units to enable annual complete network surveys ($21M).
- No request for an increase in leak repair costs (which we estimated will cost $10M).[10]
- True-up of safeguard mechanism costs to ensure that customers receive 100% of the benefits of reduced Safeguard Mechanism costs.

8 Mineral Methane Initiative OGMP 2.0 Framework, pp 2-3. Available here

9 Climate Change Authority 2023, *2023 Review of the National Greenhouse and Energy Reporting Legislation,* pp5-6. Available here.

10 While not included in our proposed step change, these costs were included in our economic analysis.

2. Draft decision

While the AER considered it prudent for us to pursue improvements to better manage our network, it was not satisfied that eight Picarro vehicles is prudent and efficient for emissions reduction measurement and reporting purposes.[11]

The AER considered that the prudent level is three vehicles based on two considerations both of which relate to how emissions are reported.[12]

First, the AER reflected whether the Clean Energy Regulator (CER) will allow us to report emissions on a direct measurement basis and require us to continue to report emissions using generic assumptions: [13]

> *In terms of JGN's reporting concerns, we are not satisfied JGN has provided evidence, nor an indicative timeline, to demonstrate that the CER will adopt the new emission accounting methodology.*

Second, the AER concluded that the CER will allow direct emissions measurement to be based on survey data collected over a 3- or 5-year cycle rather than annually:[14]

> *However, we also consider that should a direct-measurement approach be adopted in the future, a lower inspection requirement, than the proposed annual frequency, is likely to be sufficient. For instance, the United Nations Environment Programme's Oil and Gas Methane Partnership 2.0 reporting framework is currently the only comprehensive, measurement-based international reporting framework for the oil and gas sector. As such, and in the absence of supplied information or discussion to detail an alternate direct- measurement approach, we therefore consider the CER may likely refer or adopt a similar measurement approach. In this regard, we note that both the framework's level 4 and level 5 reporting allow for 'detailed engineering calculations and modelling'. This means that rather than requiring annual direct measurements, this may be completed on a 3 or 5-year cycle. Modelling may be completed for the interim years, including measurements where notable changes occur (e.g. following rectification of leaks).*

The AER also noted that:[15]

> *We expect that realised cost savings associated with the reduced requirement to complete labour-intensive walking surveys, would adequately offset these incremental costs. JGN did not capture these savings in its analysis of costs and benefits.*

[11] AER 2024, *Draft decision Jemena Gas Networks (NSW) access arrangement 2025 to 2030, Attachment 6 – Operating expenditure,* p.30. Available here.

[12] AER 2024, *Draft decision Jemena Gas Networks (NSW) access arrangement 2025 to 2030, Attachment 6 – Operating expenditure,* p.30. Available here.

[13] AER 2024, *Draft decision Jemena Gas Networks (NSW) access arrangement 2025 to 2030, Attachment 6 – Operating expenditure,* p.30. Available here.

[14] AER 2024, *Draft decision Jemena Gas Networks (NSW) access arrangement 2025 to 2030, Attachment 6 – Operating expenditure,* p.30. Available here.

[15] AER 2024, *Draft decision Jemena Gas Networks (NSW) access arrangement 2025 to 2030, Attachment 6 – Operating expenditure,* p.30. Available here.

3. AER Chair's message to network businesses

After our proposal was lodged but prior to the AER's draft decision, the AER Chair gave a speech *Adapting regulation to Australia's energy future* challenging the notion that regulation is a barrier to innovation.

The AER Chair said that the AER recognises that it is not business-as-usual anymore, it may have to think differently and that it was "open-minded and open for businesses."

The AER Chair indicated that if businesses believe they have a better way to spend money, the pathway to change is to show the AER the consumer value or in the words of Jerry Maguire 'show me the money' and 'help me help you'.[16]

Given these comments, we had expected that our Picarro step change was the kind of innovation the AER was looking to encourage. Our proposal represented a departure from business as usual and was essential to delivering not only a lower emission energy system but a lower emissions economy as a whole.

We also noted that, despite lodging our proposal before the speech was given, we demonstrated the significant consumer value of our proposal (and more). In particular we:

- Demonstrated our seriousness and commitment to deploying this innovative technology by implementing the first stage (without an ex-ante allowance and in turn incurring EBSS penalties) in the current regulatory period – rather than waiting for AER approval.
- Genuinely engaged our customers and received resounding endorsement.
- Demonstrated material customer benefits, both in terms of emissions and network bill reductions.
- Only included a proportion of the costs required (our proposed step change did not include additional repair costs to repair the additional leaks we identify).
- Proposed that 100% of the reduced Safeguard Mechanism costs – the financial upside of Picarro – flows directly to consumers through lower bills, via the tariff variation mechanism.

[16] Q&A with AER Chair Clare Savage 13 August 2024. Available here.

4. Revised 2025 Plan

We are disappointed with the AER's draft decision. Picarro is essential to improving the safety of our network, reducing emissions and lowering Safeguard Mechanism costs (and network bills). There is no other feasible approach to achieve these goals.

The AER's draft decision is based on an absence of Government decisions related to emissions reporting: if (and when) we will be able to report on measured emissions as well as what level of data quality will be required.

The draft decision does not take into account the two of the three benefits: safety and emissions reduction. We note reducing *actual* rather than *reported* emissions is not only what addresses the threat of climate change but is the focus of the NGO.

We consider that only approving expenditure which reduces *reported* emissions rules out all technologies not yet enabled by the NGER Scheme and creates an unnecessary regulatory barrier to innovation. We do not consider that this is consistent with the vision set by the AER Chair.

Since lodging our proposal, the Government's positions on emission reporting have been made clear:[17]

- The Government has agreed in-principle to implement higher order reporting methods. It has commissioned a panel of experts, led by Australia's Chief Scientist, to examine approaches for estimating fugitive methane emissions using atmospheric measurement technologies and practices to make improvements to the NGER Scheme.
- The Government is committed to ensuring that the scheme remains world class and consistent with international reporting frameworks. Given global international good industry practice is to move towards more accurate, credible and actionable emissions data, it is improbable that the Government will accept less accurate, unverified and unactionable data for measurement-based reporting, as the AER suggests.

The AER's misunderstanding that 3 or 5 yearly surveys with interim estimates is sufficient appears to be based on a desktop review of OGMP 2.0. We encourage the AER to obtain technical advice from a suitably qualified expert in emissions reporting.

An approach of permanently relying on interim estimates is not consistent with OGMP 2.0 (which requires demonstrable efforts to move to 'Level 5'). Further, it would result in 'D' or 'F' grade data quality, as assessed against the proposed Measurement, Monitoring, Reporting and Verification (MMRV) framework – a framework Australia has joined.[18] The Australian Government has said it will consider the MMRW framework in establishing higher order estimation methods.[19]

We provide further detail and implications of the Government's announced decisions regarding the NGER Scheme in section 4.1.

The implications of the AER's draft decision are material and go beyond our modest request for a step change of $21M. It creates a regulatory environment where we will be financially penalised if we attempt to make our network safer and deliver an estimated ~$1 billion in economic benefits to the community and our customers (including through network bill reductions).

The draft decision creates a financial incentive for us to abandon attempts to identify and reduce emissions. This will make the NSW and Australian government emissions reduction targets harder to achieve (resulting in higher costs across the economy) and results in our customers paying higher network bills due to higher Safeguard Mechanism costs.

[17] See here. page 2 and 11

[18] See here.

[19] See here, page 11

New information now available

Since lodging our proposal, we have also received new information on:

- Safety – recent events indicate that the public is reporting less leaks than we had anticipated. This means the improved safety outcomes from more frequent inspections and in turn a more effective leak detection and repair program are greater than initially expected. See section 4.2.
- Leak data – key insights include:
  - It is more efficient to focus on leak detection rather than leak repairs as a small number of leaks drive the majority of emissions. Our latest Picarro data shows the top 10% of leaks are responsible for 52% of our fugitive emissions. Greater leak detection data enables us to focus on the largest and highest value leaks and improve the effectiveness of our repair program. See section 4.3.
  - Network deterioration is stochastic and continuous. Leaks have been identified across all network areas including in those in good condition). In areas we have surveyed twice we have found new large leaks within a year, highlighting the benefits of earlier and more frequent inspections. See section 4.4.
- International good industry practice
  - Large gas distribution network operators are deploying Picarro for their leak surveys, leak detection and repair programs and emissions reporting. There is a pattern of operators starting with initial surveying (like we have) and after receiving regulatory approval moving to annual or more frequent surveys.
  - Leak detection and repair programs, beyond existing leak survey requirements, are increasingly becoming mandated. Examples include the EU Methane Regulation and the proposed rule currently being considered by Pipeline and Hazardous Materials Safety Administration (PHMSA) in the United States.

Consideration of the AER's feedback

Given the AER's focus on engineering calculations and modelling we have undertaken additional engineering analysis and further discussed the potential of this option with Picarro, to assess the feasibility of this option.

Spatial-temporal extrapolation is possible if we obtained a sufficient number of representative samples each year. This is a challenge as our network is composed of a variety of materials, operates in different soils and conditions, and was built by different organisations using different operational practices. A large number of representative samples need to be obtained to undertake spatial-temporal extrapolation with a reasonable level of certainty.

While moving to direct emissions measurement with three cars is not realistic, it is possible to undertake spatial-temporal extrapolation with a reasonable level of accuracy with six vehicles. See section 4.6 for further details.

We have re-evaluated our approach by considering the status quo (three vehicles), spatial-temporal extrapolation (six vehicles) or maintaining our approach to survey 100% of the network (eight vehicles). In undertaking this analysis, we incorporated the latest data obtained from Picarro.

We find that surveying 100% of the network continues to provide the highest net-present value. However, we also find similar cost and emissions outcomes over the 2025-30 period with the spatial-temporal extrapolation and 100% annual surveys options. This is because delivery constraints limit the value we can extract in the short-term from the additional leak data. See section 4.7.

Revised 2025 Plan

Given the AER's feedback in the draft decision and the new information available we have revised our proposal to implement a phased approach. We will deploy to six vehicles for the 2025-30 period before moving to eight vehicles next period.[20]

[20] Or potentially earlier.

We ruled out the status quo (three cars) on the basis that it provides the lowest safety benefits, smallest reduction in emissions and will not provide sufficient quality to facilitate the move to direct emissions measurement.

While spatial-temporal extrapolation provided similar outcomes to 100% annual survey in the short-term, the approach has a lower NPV and is not consistent with OGMP 2.0 (due to no pathway to move to level 5 reporting). There was also increased risk, relative to 100% annual survey approach, that the data would not be of sufficient quality to enable the move to direct emissions measurement. This is important as without the move to direct emissions measurement our customers will pay higher than necessary costs through the Safeguard Mechanism.

While the 100% annual survey (option 3) had the highest NPV, we note that the cost outcomes are slightly higher in the short term and are conscious that the AER has already not accepted this approach.

Accordingly, we also considered a staged approach (option 4) of first adopting a spatial-temporal extrapolation approach before moving to 100% annual survey provides the best of both options. We will bear the risk that the data is not of sufficient quality to move to direct emissions and we need to purchase additional Picarro units in the 2025-30 period.

Table 4–1: Summary of options

Option	Safety benefits	Reduction in annual emissions (2025-30)	Expected data quality	Direct Emissions measurement	Step change ($2025)	NPV ($2025)
1. Status quo – 3 cars	Low	50,000 tCO2e	OGMP 2.0 Level 3 ‘D’ or ‘F’ MMRV data quality	Improbable.	$1.7 m	-
2. Spatial-temporal extrapolation – 6 cars	Medium	105,000 tCO2e	OGMP 2.0 level 4 ‘B’ MMRV data quality	Possible.	$15.3 m	$182.2 m
3. 100% annual survey – 8 cars	High	132,000 tCO2e	OGMP 2.0 Gold Standard: level 4 ‘A’ MMRV data quality	Highly likely.	$21.5 m	$249.9 m
4. Staged approach: Spatial-temporal extrapolation before moving to 100% survey – 6 then 8 cars	Medium/high	105,000 tCO2e	OGMP 2.0 Gold Standard: Level 4 with pathway to level 5) ‘C before moving to ‘A’ MMRV data quality	Likely.	$15.3 m	$244.2 m

Notes: Our economic analysis assumes direct emissions measurement is possible with three vehicles (even though this is improbable) understating the benefits of all other options. The analysis assumes we only repair leaks greater than 36 tCO2e understating future emissions reduction benefits – and is the primary reason this analysis indicates a lower value than our initial options analysis. The NPV of the Option 4 is lower than Option 3 as the optimal time to move to 100% annual surveys is in the 2025-30 period, rather than next period.

Step change costing

Lastly, we note that we do not capture cost savings from the reduced requirement to complete walking surveys as only immaterial costs were incurred in the base year (we only incurred an immaterial amount of costs in July 2023).

In preparing our costings we took into account all material costs. This includes the Picarro vehicle deployed part-way in the base year. As our step change was to implement a program requiring 6 vehicles and 2.25 vehicles are included in the base year, the step change included in this Revised 2025 Plan is for 3.75 vehicles.

4.1 NGER Scheme changes

NGER changes are a matter of when not if

Since we lodged our proposal, the Australian Government has agreed in principle to the Clean Energy Regulators' (CER) recommendation to resource the Department of Climate Change, Energy, the Environment and Water to establish higher order reporting methods for all fugitive emissions sources included in the Measurement Determination.[21]

Our current understanding is that Picarro technology will be considered by expert methane reporting panel led by Chief Scientist Cathy Foley – one of three prioritised workstreams for implementing the Government's response to the CER's recommendations. Minister Bowen has noted (emphasis added):[22]

> *By listening to the expert advice we are ensuring Australia remains a world leader in emission estimation, which is crucial to delivering emissions reductions.*

Given the CER's recommendation, the Australian Government's agreement in principle and the legislated emissions reduction targets (of which the purpose is to provide regulatory certainty),[23] we are confident that the change to a high order reporting mechanism will occur.

Timing implications of NGER changes

While the Government has not published an indicative timetable for the expert methane reporting panel or when the changes to the NGER scheme will occur,[24] we are optimistic that a change could occur for the 2025-26 reporting period.

Regardless, any delay does not materially affect the prudency or efficiency of moving to enhanced measurement now as:

- Deploying additional Picarro vehicles improves data quality, provides the government confidence in the technology and increases the likelihood that a change occurs sooner.
- Repairing leaks provides ongoing benefits over time. Even if the move to direct emissions measurement is delayed by one or two years, 80-90% of the benefits of reduced safeguard mechanism costs will still be realised over a 10-year horizon
- It provides time to reduce the number of large leaks prior to direct emissions reporting coming into effect. Delaying inspection and leak repairs will delay 'actual' emission reductions, especially once deliverability constraints are considered.

What is required to move to a higher order reporting mechanism

The Australian Government considers that the NGER Scheme is one of the most sophisticated and comprehensive schemes of its type in the world.[25] The NGER Scheme is continuously improved based on the latest available science, data, research and independent reviews. NGER scheme methods and data are subjected to annual technical review under the Paris Agreement Enhanced Transparency framework.

Accordingly, we expect that the Australian Government will only accept a move to a higher order reporting mechanism based on direct emissions measurement if it can have confidence in the data we collect. Higher quality

[21] See here. We also note that the introduction of a new emissions reporting methodology is implemented through a legislative instrument determined by the Minister for Climate Change and Energy. An act of parliament is not required.

[22] Minister Bowen Media Release, *Chief Scientist Cathy Foley to lead expert methane reporting panel.* 26 August 2024 Available here.

[23] Climate Change Bill 2022 Revised Explanatory Memorandum. See here.

[24] However, there is an annual process to update the Measurement Determination which means that once a decision has been made it can quickly be added without legislative change.

[25] See here, p.2.

measurement increases the likelihood and reduces the expected timeframe to move to a higher order reporting mechanism.

The Australian Government in making an agreement-in-principle to adopt higher order methods noted:[26]

> *In undertaking this work, the department will consider existing and emerging international frameworks for methane emission measurement, reporting and verification. This includes those being developed by the United Nations Environment Program and industry - the Oil and Gas Methane Partnership (OGMP) 2.0 and the Steel Methane Partnership (SMP); and the international working group on international gas supply chain emissions Measurement, Monitoring, Reporting and Verification (MMRV) framework which Australia has joined alongside 11 other countries and the European Commission.*

The proposed MMRV Data Quality Indicator Matrix was published in October this year, see extract in Table 4–2.[27] To achieve a data quality score of 1 (the highest) data must be less than 1 year old. Or in other words complete annual inspections (as we had proposed in our 2025 Plan) are required to achieve the highest quality data metric.

A 3 yearly to 5 yearly inspection cycle, considered by the AER in its draft decision as sufficient, would result in a score of 4, the second lowest. Accordingly, it is improbable, and in turn not consistent with Rule 74, that data collected over a 3-5 year inspection cycle could be sufficiently reliable to enable a move to direct emissions reporting.

Table 4–2: Extract of MMRV Data Quality Indicator Matrix (Proposed)

Indicator	1 ('A')	2 ('B')	3 ('C')	4 ('D')	5 ('F') Default
Data Reliability	Verified data based on measurement. Reported similarly to Level 2, but with addition to site-level measurements (includes characterization of site-level emissions distribution for a representative population). (e.g., ~ equivalent to OGMP Level 5)	Verified data based on a calculation or non-verified data based on measurements; emissions reported by detailed source type and using specific emission factors (EFs) and activity factors (AFs). (e.g., ~ equivalent to OGMP Level 4)	Non-verified data based on calculation; emissions reported by detailed source type and using generic emission factors (EFs). (e.g., ~ equivalent to OGMP Level 3)	Documented estimate; emissions reported in consolidated, simplified sources categories, using a variety of quantification methodologies, progressively up to the asset level, when available. (e.g., ~ equivalent to OGMP Level 2)	Undocumented estimate; emissions reported for a venture at asset or country level (i.e., one methane emissions figure for all operations in an asset or all assets within a region or country). (e.g., ~ equivalent to OGMP Level 1)
Data Representativeness: Temporal Correlation	Less than 1 year of difference from date of data collection.	> 1 year of difference but < 2 from date of data collection.	> 2 years of difference but < 3 from date of data collection.	> 3 years of difference but < 5 from date of data collection.	Age of data unknown or more than 5 years from date of data collection.

[26] See here, Recommendation 16.

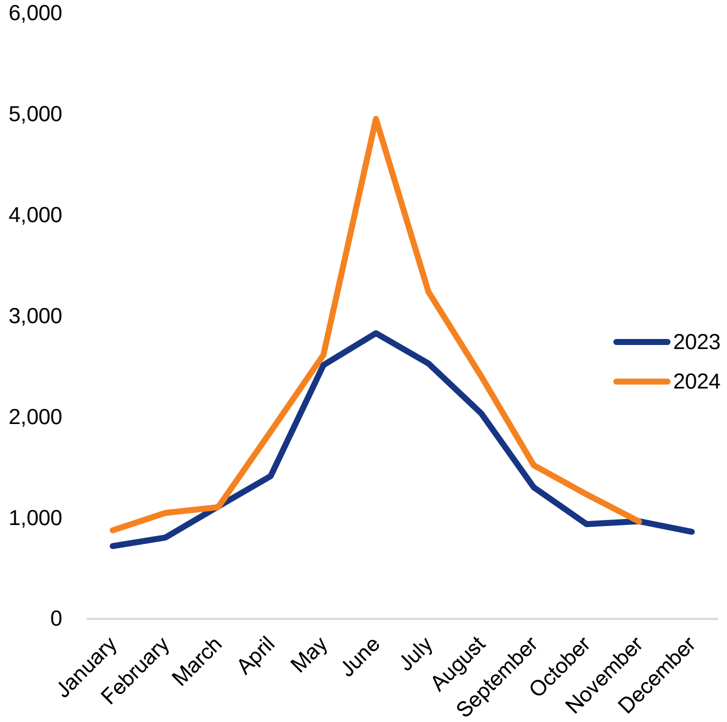
[27] US DOE Webinar, *Greenhouse Gas Supply Chain Emissions Measurement, Monitoring, Reporting and Verification Framework,* 11 October 2024, Slide 21. See here.

4.2 Safety value of more frequent inspections

Following the suspected gas incident in Whalan Sydney on 1 June 2024, we experienced a surge in publicly reported leaks. This is shown in Figure 4–1 which presents monthly publicly reported calls of gas leaks confirmed by our Gas Service Technicians.

The 2023 line (in blue) shows that confirmed publicly reported leaks typically increase in winter, when gas volumes are higher. However, in June 2024 following the Whalan incident confirmed gas leaks were 75% higher than the prior year. A higher level of leaks continued for the next three months until November.

Figure 4–1: Confirmed Publicly Reported Leaks



The media coverage of the incident led to the public reporting odours (and leaks) which had been previously overlooked. This implies that public reporting of leaks is a less effective control than we had anticipated, likely due to reduced vigilance over time. This is supported by the results of our emissions surveys which have found large leaks in similar areas.

More frequent surveys of our network via the Picarro technology will enable more of these leaks to be identified (sized and located) and rectified in a timely manner leading to improved safety outcomes.

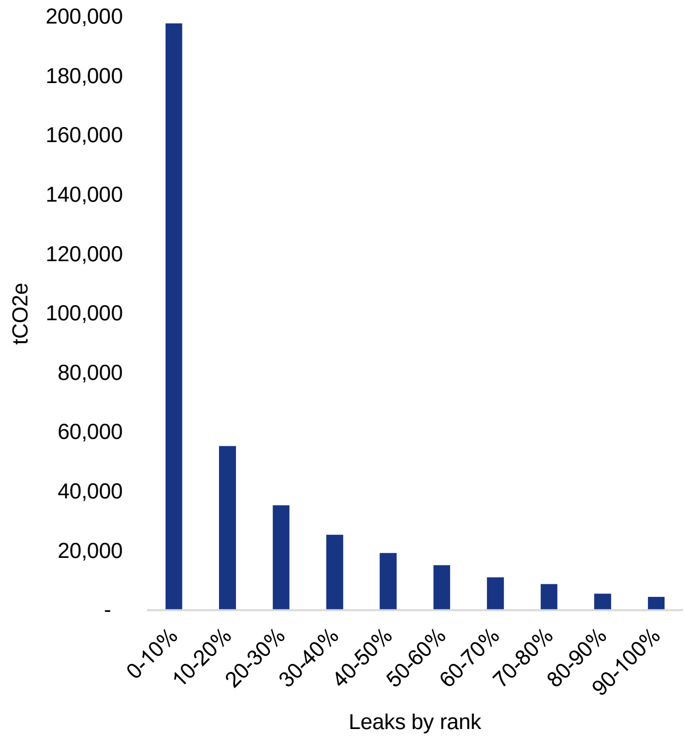
4.3 Small numbers of leaks drive most emissions

The NGR set out that opex must be as would be incurred by a prudent service provider, acting efficiently, in accordance with good industry practice to achieve the lowest sustainable cost consistent with the achievement of the NGO (which now includes an emissions reduction component).[28]

To determine efficiency and prudency, leak detection and leak repair needs to be considered together. While a lower level of leak detection reduces inspection costs this has the trade-off of reduced repair effectiveness – in terms of safety, emissions and Safeguard Mechanism costs.

The optimal balance of leak detection and repair depends on the nature of the leaks. Leak data collected to date, highlights that a small number of large leaks drive the majority of our emissions. Figure 4–2 below shows emissions stratified by leak ranking (top 10%, next 20% etc.). The top 10% of leaks are responsible for 52% of our fugitive emissions. This indicates that the more efficient approach is to focus on identifying leaks which will in turn optimise the efficacy of our repair program.

Figure 4–2: Emissions by leak ranking (tCO2e)



We have compared three leak detection and repair programs with the following levels of:

- 3 vehicles – 30% of the network.
- 6 vehicles – 60% of our network.[29]
- 8 vehicles – 100% of the network.

With each inspection approach we undertake a constant number of repairs (1,500). We have valued the benefits of repairs using:

- The Energy Ministers' Value of Emissions Reductions (VER) applied for 10 years starting in 2025. Using a later start year would increase the value as the VER increases over time.

[28] Rule 91.

[29] We have reduced the proportion of the network inspected to take into account the need to obtain a representative sample of our network each year to undertake spatial-temporal extrapolation.

- Safeguard Mechanism compliance costs over 10 years starting in 2025. We have used the ACCU price forecast used by Energy Ministers. For this analysis, we have assumed that we are able to report actual emissions using all three levels of inspection (consistent with the AER's premise in its draft decision).

The results, shown in Table 4–3, indicate that more frequent inspection provide dramatically different outcomes in terms of emissions and cost reductions. This is because with a complete picture of our network we are able to maximise the value of our repair program to target the worst leaks. The value of improving repair effectiveness is substantially larger than the additional inspection costs.

Table 4–3: Value of 1,500 repairs by inspection approach

Annual inspection approach	Emissions reduction	Present Value of VER	Present Value of Safeguard Mechanism cost reductions
100%	66,299	126.2	78.0
60%	50,110	95.4	59.0
30%	33,217	63.2	39.1

We note that the analysis above does not include a value of reducing safety risks. If safety was quantified it would be proportional to the size of the leak and show a similar outcome across inspection approach as the VER.

4.4 Our network is continually deteriorating

4.4.1 Factors which drive network deterioration

Leaks across our network arise due to multiple factors such as:

1. **Material vulnerabilities:** Our gas distribution network, comprised of legacy cast iron, unprotected and protected steel and historical and modern plastics (nylon and polyethylene) materials, has been in service for decades. Overtime corrosion, embrittlement, and joint weakening steadily increases the likelihood of cracks and leaks.

2. **Mechanical stress and ground movement:** Seasonal temperature fluctuations, soil settling, occasional seismic activity, civil construction and tree roots exert continuous mechanical stress on buried pipelines. Even slight ground shifts contribute to the slow formation of micro-cracks that can enlarge over time. As these small defects accumulate and worsen, they create a persistent risk of gas escaping.

3. **Vulnerabilities in joint adhesives and sealants:** Pipeline joints rely on adhesives, glues, or sealants, which degrade gradually under environmental conditions, civil construction activities, temperature extremes, and chemical exposure. As adhesives weaken, microchannels develop within joints, allowing gas to seep through. These channels grow over time.

4. **Operations and maintenance activities:** Operations and maintenance activities such as 'squeeze-off' of plastic pipes, new connections, etc. can lead to time-dependent and time-independent failures. Squeeze-offs, used to temporarily isolate supply, over stress the plastic and can lead to cracking and other damage to the plastic pipes that in time will degrade and subsequently leak.

5. **Historical higher pressure:** Portions of the network have previously been operated at higher pressures (e.g., 300kPa rather than the current standard of 200kPa). Over time, these elevated pressures accelerate stress on the pipe wall, seals and fittings, increasing the likelihood of leaks as the components age and settle into lower-pressure operation. Similar effects can be produced through poor construction testing regimes.

Degradation is not a one-off event. It is a continuous, stochastic process that occurs incrementally across the entire network. New leaks emerge while small leaks grow to release high volumes of gas.

4.4.2 Insights from recent Picarro surveys

Our recent surveys have provided further information on the ongoing degradation of our network and in particular where and when large leaks occur. We have found that large leaks:

- Continually develop. Repeated surveys of the same network area, generally within 12 months, have found several new large leaks or the growth of a smaller leak into a larger leak.[30]

- Arise across all network areas, even in areas which we have historically considered in good condition, such as areas with modern plastics and in recently rehabilitated areas.

- Occur in high density community use areas. This is surprising given that these networks are operated at low pressure (which reduces the flow rate of leaks) and the large numbers of members of the public who would be near enough the leak to smell it.

- Cannot always be located after the first survey. While Picarro technology provides very detailed granular data, the leak must subsequently be investigated, found and repaired by our field crews. This has not always been possible due to the leak being inside a rehabilitated conduit or due to changes in the ground conditions. Successive surveys increase the likelihood that these leaks are eventually found and repaired.

[30] Good industry practice is to prioritise repair of the largest leaks. However, this means that the smaller, unrepaired leaks will continue to deteriorate and grow over time. As we discuss in section 4.3, generally the most prudent and efficient approach is to invest more in leak detection rather than increasing the number of leak repairs by reducing the repair threshold.

This demonstrates that surveys need to be completed annually. A summary of the most recent data from successive surveys (collected in the last few months[31]) is shown in Table 4–4 below.

Table 4–4: Large leaks (top 2.6%) identified from repeated surveys by Leak Investigation Search Area

	1st Survey	2nd Survey	Network condition	Notes
Silverwater	6	5	Plastic mains, operating at low pressure (7kPa)	Mixture of new leaks and leaks not located by field crews from the initial survey.
Granville	9	1	Plastic main.	In this area smaller leaks were also repaired for network configuration reasons and accordingly no small leaks increased over time. However, one larger new leak was identified.
Castle Hill	5	1	Plastic mains.	New leak close to a previous leak. First leak might have masked second leak.
West Pennant Hills	2	3	Plastic mains.	Two new leaks, one existing from prior survey.
Parramatta	1	3	Plastic mains, operating at low pressure (7kPa) due to CBD area	Two new leaks. One the initial survey was not able to be located at the time.
Matraville	0	4	Recently rehabilitated with new plastic mains	Mixture of leaks not found in initial survey and leaks that increased in size since the first survey
West Ryde	1	2	Plastic mains.	Two leaks increased in size since first survey.
Concord West	0	2	Plastic mains.	Two new leaks identified.
Northmead	0	1	Plastic mains.	Previously identified leak increased in size.
North Sydney	2	0	Plastic mains, operating at low pressure (7kPa) due to CBD area	

Note: A large leak is defined as a leak with a flow greater than 10 scfm (0.28m^3/minute). These leaks make up the top 2.6% of leaks on our network.

[31] Specifically October, November and December 2024.

4.5 International good industry practice

Internationally, adopting innovative technologies for leakage surveys, emissions measurement and leak detection and repair programmes is not only accepted industry practice—it is rapidly becoming a regulatory requirement. This is already the case in Europe and is likely to soon be the case in the United States.

We have taken this international experience into account in developing our 2025 Plan. We have also had regard to these new / prospective regulatory requirements in considering the AER's proposal that we undertake partial surveys – noting that general movement towards businesses are moving to 100% annual surveys and the requirements to survey poorer conditions areas more frequently (see section 4.6).

While there is not currently a *technical* requirement to deploy innovative technology and leak detection and repair programs in Australia (yet) the Safeguard Mechanism creates an *economic* requirement to adopt similar practices.

International practice

Table 4–5 summaries large gas network operators who currently use Picarro and their current survey approach.[32] It is important to note that emissions reporting practices are different. For instance, the United States does not have a single national reporting scheme similar to NGERS.

The table shows that large users tend to start with partial surveys initially to undertake safety driven leak surveys. Users then tend to ramp up to 100% or 200% to collect data for emissions reporting and to undertake leak detection and repair programs. These programs initially focus on the largest leaks which drive the majority of emissions ("super emitters"). These networks then increase survey frequency and shift their focus to smaller leaks.

Our understanding is that this phased approach is generally due to the regulatory approval for funding from economic regulators or to demonstrate the capability of the technology for leak survey purposes. As Shawn Anderson, the Senior Vice President-Strategy & Chief Risk Office of NiSource, a gas and electricity utility across 6 states, outlines:[33]

> *Supportive policy and regulatory frameworks are necessary to reach our long term decarbonization goals. And NiSource is focused on key areas such as alternative fuels legislation, delivery of energy efficiency programs, advancement of accelerated leak detection, continued gas system modernization and renewable energy investments. NiSource is also taking an active role in supporting the development of technologies that will enable decarbonization through the natural gas system. Across our states, we are deploying Picarro advanced leak detection vehicles like the one out front today. And innovations like these have the potential to greatly influence utilities visibility into their emissions inventory and transform how the industry identifies, prioritizes and repairs leaks.*

Table 4–5: Survey approach and plans for large gas networks using Picarro

Picarro User	Survey Proportion	Roadmap 2025-2026	use case	Method for emissions reporting
[redacted]		[redacted]	[redacted]	[redacted]
[redacted]			[redacted]	[redacted]

32 Additional users include New Mexico Gas, Summit / Colorado Natural Gas, One Gas, Centrepoint, MDU, Southern Company, NiSource, Consumers Energy operating in New Maxico, Colardo, Texas, Oklahoma, Kansa, Minnesota, North Dakota, Washington, Illinois, Virginia, Georga, Indiana, Virginia, Pennsylvania and Michigan.

33 See here.

Picarro User	Survey Proportion	Roadmap 2025-2026	use case	Method for emissions reporting
[redacted]	[redacted]		[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]		[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

European Union

In the European Union gas distribution system operators are required to undertake leak detection and repair surveys using state-of-the-art industry practices and the best technologies commercially available.

Survey frequency depends on the material and design pressure. Ductile cast iron mains are required to be inspected every 6 months, unprotected steel 12 months, polyethylene 24 months.[34]

United States

The Pipeline and Hazardous Materials Safety Administration (PHMSA) a part of the US Department of Transportation, has proposed a Rule to reduce methane emissions from distribution pipelines. The proposed rule[35] strengthens leakage survey and patrolling requirements, introduces periodic methane leakage survey requirements see Table 4–6.

Table 4–6: Leakage survey requirements under PHMSA Proposed Rule

Area	Minimum leakage survey timeline requirements
Business districts	Once per calendar year, at intervals not exceeding 15 months
Non-business districts	At least once every 3 calendar years, at intervals not exceeding 39 months
Pipelines known to leak based on their material (cast iron, unprotected steel, wrought iron, and historic plastics with known issues), design or past operating and maintenance history	At least once every calendar year not exceeding 15 months

[34] Note the regulations set our two types of surveys. Type 1 (capable of inspecting 7000 parts per million in volume of methane or 17 grams per hour of methane) and type 2 (1,000 parts per million in volume of methane of 5 grams per hour of methane for underground components).

[35] See here.

The Proposed rule also mandates Advanced Leak Detection Programs. In developing these programs operators must analyse the effectiveness of handheld leak detection equipment, periodic surveys with equipment mounted on mobile, aerial or satellite-based platforms, continuous monitoring via stationary sensors and other commercially available technology. These surveys must be undertaken no less frequently than the requirements in Table 4–6.

We note the AER's draft decision proposed survey approach of 3 to 5 years is insufficient to meet the requirements of these proposed rules.

4.6 Engineering calculations and modelling

4.6.1 Our network is too heterogenous to make reasonable interim estimates with three vehicles

Given the AER's focus on detailed engineering calculations and modelling we have re-evaluated our approach and further considered partial surveys and interim estimation. We have also discussed the feasibility of this option with Picarro. In this assessment we have ignored the main drawback of interim calculations in that they do not provide actionable insights to identify or repair leaks.

Interim estimates can be produced using spatial-temporal extrapolation. To implement this approach, we would need to obtain a sufficient number of representative samples from across our network each year – based on material, age, pressure, geography (country, suburban CBD, coastal), and construction practices.[36] We would then be able to use this data to estimate leaks in areas which have not been surveyed.

The main challenge is that our network is not homogenous. It has been developed over decades using variety of materials, operates in different soils and conditions, and was built by different organisations using different operational practices. As a result, a large number of representative samples need to be obtained to undertake spatial-temporal extrapolation with a reasonable level of certainty.

Obtaining representative samples each year introduces a level of operational inefficiency, due to the additional planning, coordination and limitations it creates. A simple plan to simple rotate through all areas on an orderly 3 or 5 yearly cycle will not generate sufficient representative sample data on a year-to-year basis. The inefficiency from this requirement is one of the main reasons[37] this approach has not been widely adopted and is not good industry practice.

Given the composition of our network, our engineering review, supported by information supplied by Picarro, is that spatial-temporal extrapolation to a reasonable level of certainty with three vehicles is not feasible.

Engineering calculations and modelling

Engineering calculations and modelling are used to understand emissions in two ways:

- Type1: Emission Rate Calculations. The use of Picarro technology relies on complex (and proprietary) engineering calculations to determine the emissions flow rates. These are the type of engineering calculations that are anticipated in the direct emissions reporting mechanisms, such as OGMP 2.0.
- Type 2: Carbon Footprint Analysis Calculations. Calculations used to estimate the carbon emissions of activities by applying assumptions.

Managing uncertainty in these types of engineering calculations is crucial for ensuring accuracy and reliability. Uncertainty may arise from the use of multiple sources of assumptions/estimations/approximation used to generate the calculation (accuracy of data), reliability of the data; the lack of validation or verification; the inability to quantify the uncertainty through statistical means or the lack of regular reviews to capture changes in the data sets over time (or utilisation).

In the context of OGMP2.0 guidelines for level 4 and level 5, detailed energy calculations should be interpreted as the modeling required to convert a series of one-time measurements of the network occurring progressively over the course of a year into a yearly emissions inventory. In other words, the engineering calculations and modelling are the necessary steps to convert and interpret the raw data collected yearly though direct measurements into a measurement informed emissions inventory (MIEI).

[36] Which differ over time and based on historical ownership.

[37] In addition to not providing actionable insights.

4.6.2 A six-vehicle survey regime as an interim step is feasible

While we do not consider that three vehicles are sufficient, our preliminary analysis[38] indicates that six vehicles is the minimum number required, taking into account the condition of our network and the need to obtain a representative sample of our network to undertake spatial-temporal extrapolation.

This analysis is based on dividing up our network into two classes:

- Good – areas made up of modern materials newer polyamide (nylon), high density polyethylene 100 and protected steel.
- Poor / deteriorating – areas made up of older materials.

The split of our network is shown in Table 4–7.

Table 4–7: JGN network composition – good versus poor or deteriorating (km)

Material	Good	Poor / deteriorating	Total
Cast Iron	-	112	112
Polyamide – Prior 1990	-	9,043	9,043
Polyamide – Post 1991	11,053	-	11,053
HDPE (80)	-	669	669
HDPE (100) – Prior 1995	-	1,377	1,377
HDPE (100) – Post 1996	1,683	-	1,683
Other polyethylene	-	389	389
Protected steel	1,807	-	1,807
Other	-	2	2
Overall	**14,543**	**11,592**	**26,134**

While leaks occur in all areas as outlined in section 4.4, we expect that poor / deteriorating areas will contribute the largest number of leaks and have the higher level of variability with respect to condition and ongoing deteriorating between material types and age. To accurately estimate emissions in these areas, identify the highest safety risks and optimise our repair program, we will need to survey all of these areas each year.

For our more modern areas (56% of the network) we assume that will be able to inspect these areas on a three-year cycle. This is a conservative assumption as these areas as while the materials are similar the networks are not homogenous – given the differences in age and location.

As shown in Table 4–8, this approach would require six vehicles. This is equivalent to surveying ~60% of the network each year.

Table 4–8: Vehicles required for partial survey with spatial-temporal extrapolation

	Partial survey and spatial-temporal extrapolation	Notes
Poor / deteriorating areas survey	11,592	Inspect poor deteriorating areas (11,592 km) each year
Good areas surveyed	4,847	Inspect good areas (14,543 km) on a 3-year cycle

[38] Permitting in the time required to respond to the AER's draft decision.

	Partial survey and spatial-temporal extrapolation	Notes
Total	16,439	Good and poor areas combined
Km inspected per vehicle per year	2,750	Vehicle driving 200 nights for 5.5 hours at a speed of 15km/hr, doing 6 passes per length of main.
Vehicles required	**6**	**Total mains divided by km inspected per vehicle, rounded up to nearest whole number**[39]

4.7 Updated economic analysis

We have updated our economic analysis to consider the new option of spatial-temporal extrapolation (six vehicles) against our both the status quo (three vehicles) and surveying our whole network each year (eight vehicles).

We have also updated our economic analysis to take into account the latest leak data available. This includes:

- Our current estimate of network wide emissions (378,000tCO2e).
- That the top 10% of leaks drive 52% of emissions. On average these leaks emit 36tCO2e per year.
- Leaks randomly and continuously arise across our network.

This data allows us to provide a more accurate forecast of the emissions reduction possible (rather than assume percentage reductions based on international experience as we did in our initial business case). To derive our repair program, we assume that:

- We only on repair leaks larger than 36tCO2e per year.
- Our network continues to degrade, and the public does not report 500 large leaks per year.[40]
- We are able to find and repair 60% of the repairs we identify.
- A delivery constraint of 1,500 additional repairs per year (~$2.7M).

For the purposes of this analysis, we have assumed direct emissions measurement is possible under all options.

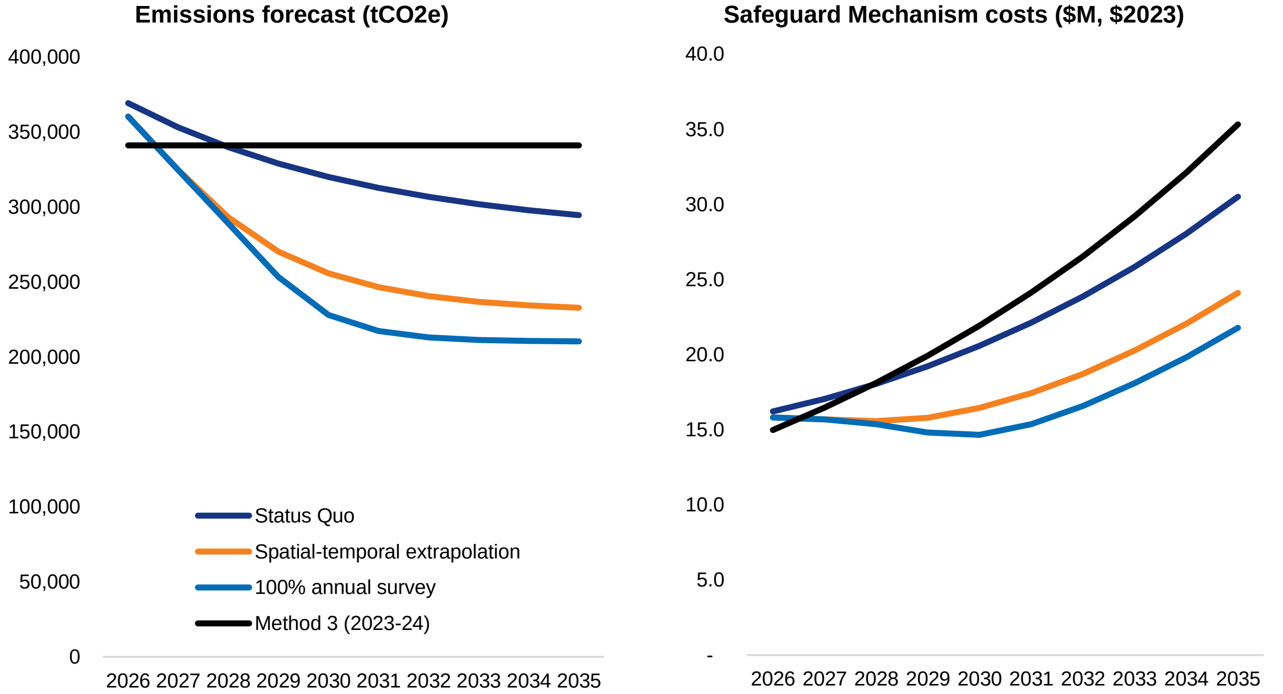
Figure 4–3 shows the emissions forecast, and in turn the Safeguard Mechanism costs[41] for the considered options as well as if no change to emissions measurement occurs (based on 2023-24 reported costs).

[39] We consider than an additional driver is required to increase vehicle utilisation and to cover sick leave, training etc.

[40] The insights from our analysis does not materially change with leaks +/50%. We also note that this is likely a conservative assumption given the volumes of publicly reported leaks (shown in Figure 4–1).

[41] Note that this is not a forecast of Safeguard Mechanism liabilities. We instead calculate the economic costs under the Safeguard Mechanism where every emission has the same value. If we are above the baseline the marginal emission represents a penalty (based on the prevailing price of ACCUs). If we are below the baseline the marginal emission represents a lost opportunity to generate a credit (valued at the prevailing price of ACCUs).

Figure 4–3: Emissions forecast based on the leak detection and repair program



Key findings include:

- Under the status quo approach we are able to deliver small annual emissions reductions. However, progress is slow and gradual as the number of large leaks repaired is largely offset by ongoing deterioration.
- Spatial-temporal extrapolation and 100% annual survey both deliver quicker emissions reductions.
  - Emissions reductions are very similar initially due to the repair delivery constraint.
  - Over time the 100% survey approach is able to deliver lower sustained emissions reductions due to a greater ability to keep on top of ongoing degradation.
- The end-steady state of emissions depends on the frequency of surveys to stay on-top of ongoing network degradation.
- Not being able to move to direct measurement (and continuing to report using generic assumptions) will lead to consumers paying more than necessary from either 2027 or 2028.[42]
- Emissions reductions plateau in this analysis as we only repair leaks greater than 36tCO2e. In reality, consistent with good industry practice adopted by other Picarro users, we would reduce this threshold and achieve further emission reductions.

We use the above information to forecast repair costs, Safeguard Mechanism costs, the value of emissions reductions (net of Safeguard Mechanism costs) and UAG reductions. The NPV of these costs (including the marginal costs of additional Picarro units) and benefits are shown in Table 4–9.

Table 4–9: NPV of each option ($2025M)

	Status Quo	Spatial-temporal extrapolation	100% annual survey
NPV	-	182.2	249.9

[42] 2027 where undertake spatial-temporal extrapolation or 100% annual survey. 2028 in the status quo option.

The key result here is, even if direct measurement is possible with three vehicles (which we do not think is a reasonable assumption) the most prudent and efficient approach is to survey 100% of our network each year. This is because the lag in actionable data together with ongoing network degradation leads to higher emissions and costs to the community.

Given the similarity in initial emissions reductions between the spatial-temporal extrapolation and 100% annual survey approach (shown in Figure 4–3), we further considered the timing of the costs (opex as well as the costs plus the value of emissions reductions).

As shown by Figure 4–4, annual costs are initially slightly higher in the 100% survey approach as the costs of the additional vehicles do not exceed the additional value of emissions reduction. This is due to the delivery constraint preventing us from extracting maximum value from the additional data obtained. This changes in 2029 as leaks reduce and the additional data provides benefits by reducing emissions to a lower steady state. As a result, a slower ramp-up to 100% annual surveys may be a practical approach – if the data can be used to move to direct emissions measurement – given repair delivery constraints.

Figure 4–4: Annual costs by option ($2023M)