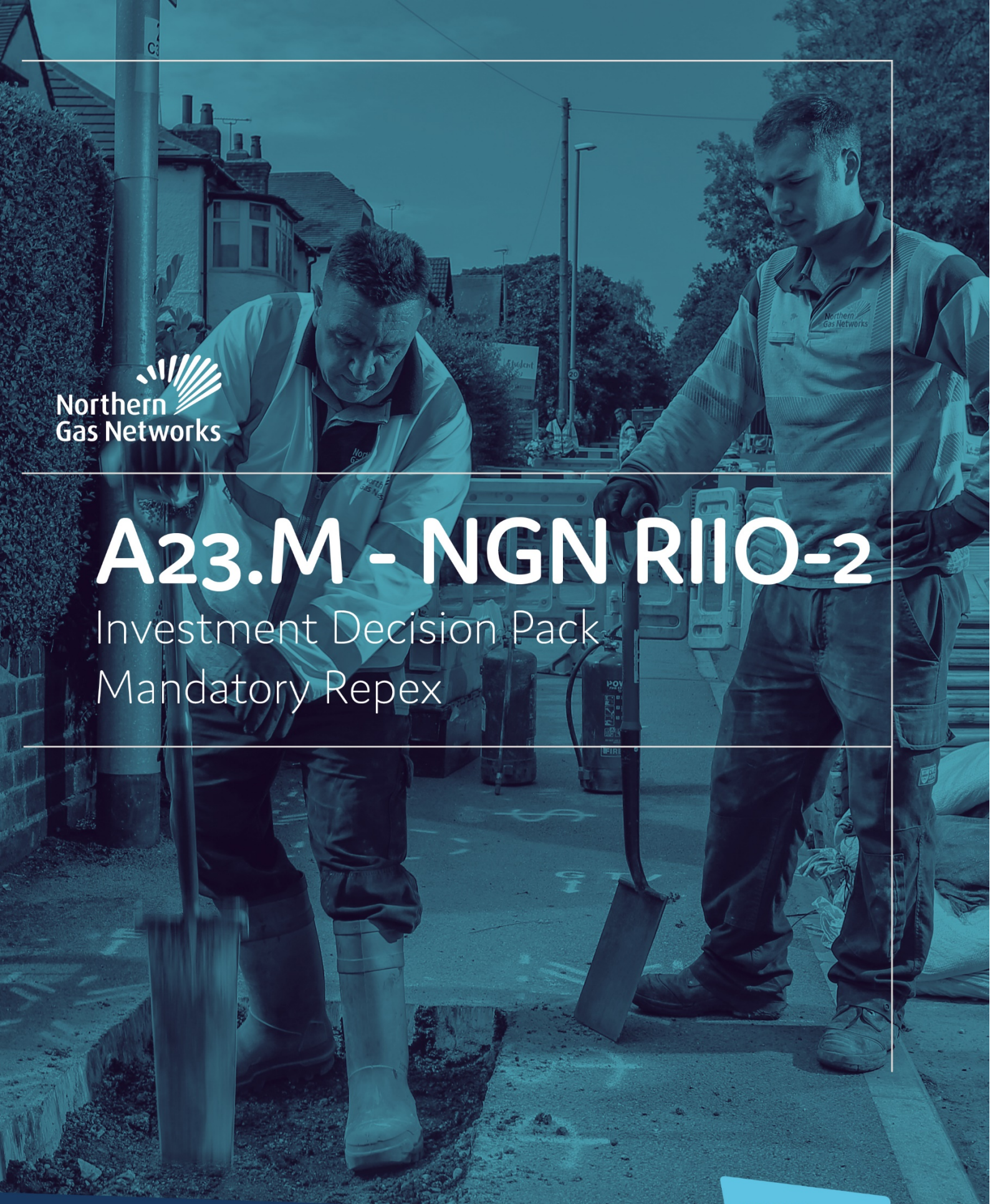


Northern Gas Networks

A23.M - NGN RIIO-2

Investment Decision Pack
Mandatory Repex

we are the network

1. Table of Contents

2. Introduction

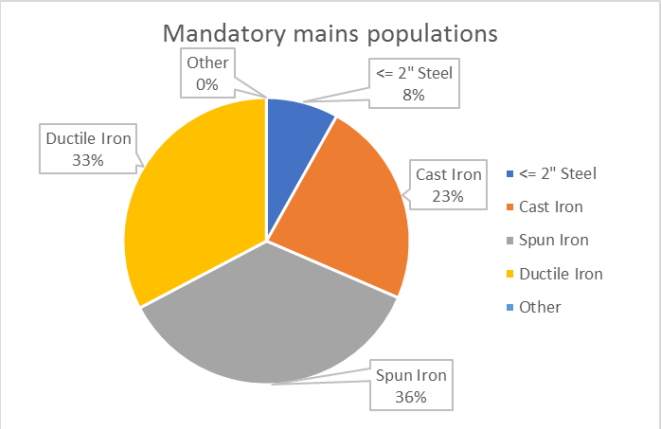
This Engineering Justification paper outlines the processes we have undertaken to determine the mandatory replacement investments we plan to complete on our distribution network through RIIO-2. This covers Tier 1 iron mains (those <= 8" diameter within 30m of property and captured by HSE's Iron Mains Risk Reduction Programme), Tier 2A iron mains (iron mains >8" and <18" diameter scoring above the agreed Risk Action Threshold), mains made from non-standard materials (principally asbestos), associated services and small diameter (<= 2") steel mains or services encountered during our activities whether these are planned works or following escapes.

3. Equipment Summary

NGN's pipe distribution network < 7 bar consists of approximately 35,000km of mains and over 2.5 million services providing gas to domestic, commercial and industrial consumers. This network, whose development began in the late 1800's and continues to this day, is constructed from a variety of materials, principally pit-cast iron; spun-cast iron; ductile iron; steel and polyethylene. There is also a small population of mains made from other non-standard materials, principally asbestos.

Of the total distribution mains in the network, approximately 29,000km are non-mandatory mains which are discussed elsewhere. For mandatory mains, the current material mix is:

	km	%
<= 2" Steel	500.3	8.1%
Cast Iron	1,434.1	23.3%
Spun Iron	2,202.1	35.8%
Ductile Iron	2,010.9	32.7%
Other	0.2	0.0%
TOTAL	6,147.6	100.00%



Within this population of mandatory mains assets, the Tier 1 population to be addressed by 2032 is forecast to be 4,718km at 31st March 2021.

4. Problem Statement

When the gas distribution network was established, the pipes transporting gas around towns and districts were made from iron. Iron was considered to be a sound material for gas distribution at the time. However, following several high-profile fatal incidents, national risk-based programmes to replace targeted iron mains came into operation and have been in place in various forms since the 1970s.

The Iron Mains Replacement Programme (IMRP) was introduced by the Health & Safety Executive (HSE) in 2002 specifically to address concern about the failure of iron mains, particularly cast-iron mains due to fracture. The Mains Risk Prioritisation System (MRPS) was also created at this time to provide an estimate of the risk of an incident presented by each individual section of main. This enabled NGN and other gas distribution networks to prioritise investment on iron main replacement, targeting investment towards replacing the riskiest pipes. The IMRP required the distribution companies to replace all 'at risk' iron mains (i.e. those within 30 metres of a property) within 30 years of 2002 and became known as the "30/30 programme".

Following a 10-year review commissioned by the HSE, IMRP was revised in 2013 to become the current Iron Mains Risk Reduction Programme (IMRRP), also known as 'The Three-Tier Approach'. The key advances to the methodology were:

- For most iron pipes (those ≤ 8" diameter within 30m of properties – Tier 1) the requirement remained unchanged – those pipes within 30m of property are still required to be decommissioned by 31st March 2032.
- For iron pipes >8" and <18" (Tier 2) a Risk Action Threshold was established with all pipes above this required to be decommissioned.
- Tier 2 pipes below the Risk Action Threshold and Tier 3 pipes (iron pipes ≥ 18") are subject to Condition Monitoring and management regimes (which may include decommissioning where the pipes have deteriorated beyond safe or effective repair) and may also be subject to decommissioning where this is justified by a Cost Benefit Analysis. Replacement of these pipes is covered in the Non-mandatory EJP.

Tier 1. These pipes must be replaced by 2032 and we are required by HSE to replace these pipes at a rate which will achieve full decommissioning by 2032 at the latest. HSE also requires that we select and prioritise pipes for replacement in a way that is informed by the safety risk that they present to the public – the methods for this are detailed in our replacement procedures which must be agreed with HSE and form part of NGN's Safety Case.

Tier 2A. These are Tier 2 pipes scoring above the Risk Action Threshold that we have agreed with HSE and are also required to be replaced under IMRRP.

Non-standard Materials. We are required by HSE to replace all mains made from non-standard materials, principally asbestos.

Small diameter (<= 2") steel mains. HSE requires us to replace these (subject to our agreed procedures) when they are encountered either during planned works (e.g. mains replacement activities) or following escapes.

Steel Services. As with small diameter steel mains, HSE requires us to replace these when they are encountered either during planned works or following escapes.

What are the outcomes that we are aiming to achieve? – The primary driver and outcome for the IMRRP remains an improvement in the safety of the gas distribution network and in particular the reduction in the risk of an incident arising from the failure of an iron main and gas entering a property leading to an explosion and potential injury and/or loss of life.

However, replacement of this category of asset also contributes significantly to the reduction of a number of additional risks including:

> ***Reliability*** - Replacement of these assets will improve the condition and operational performance, resulting in fewer leaks arising from joint failures, corrosion and fractures and the associated impacts these have upon the reliability of supply to customers, particularly unplanned interruptions but also interruptions from ongoing planned repair of asset failures.
>
> ***Environment*** – failures of these assets result in fugitive emissions of gas (leakage) with a significant environmental impact. Asset replacement results in the removal of these emissions and delivers a significant improvement in environmental performance.
>
> ***Financial*** – without full replacement, ongoing asset deterioration leads to asset failure that require permanent repair. These repairs add significantly to the operational costs of these assets on an enduring basis. Replacement forgoes the requirement for future repairs and these associated costs.

How will we understand if the investment has been successful? – The primary assessment of the overall outcome of the investment will be compliance with and achievement of HSE policy requirements for mandatory mains. We will also measure the risk position as reported under the NARMs methodology. We have set a relative risk target which will be reported annually.

Additionally, we are proposing within the RIIO2 Outputs framework that the Tier 1 Iron Replacement workloads will be a specific Price Control Deliverable (PCD) for both the overall volume of work but also the workload diameter band mix.

What are the spend boundaries associated with this Engineering Justification Paper? – This EJP covers only those mains assets which are required to be replaced under current HSE policies. It does not include the costs to manage these pipes prior to their replacement (e.g. escape response and repair). The proposed costs do, however, include the costs for service relays and transfers associated with the replacement of mandatory mains and also steel services encountered as part of other works (for example service escapes) as these costs are unavoidable under current HSE policy and our requirement to maintain customer supplies

5. Probability of Failure

The probability of failure of Tier 1 iron pipes is calculated within the MRPS model and also within NARMs. Within NARMs this is defined as:

PoF = Function (Install Decade, Diameter, Material, Pressure, Distribution Zone)

Within the NOMs methodology the following Failure Modes have been identified for Distribution Mains:

- Capacity failure – where the pipe network is under-sized to meet demand
- Corrosion failure
- Fracture failure
- Interference failure – for example 3rd party damage
- Joint failure
- General emissions – background leakage or shrinkage from the pipe network

Values are typically expressed in number of failures per kilometre of pipe.

For mandatory Tier 1 iron pipes the PoF is not a determining factor as to whether or not a pipe will be replaced – all pipes within scope must be addressed. However, this is a long term programme finishing in 2032 and so we use the Probability of Failure – along with other factors – to inform the prioritisation order for replacement.

5.1. Probability of Failure Data Assurance

The failure models are based on various industry standard guidelines (see GDN Asset Health Risk Reporting Methodology document) and the failure rates have been statistically derived using actual asset information such as age or material and historic failure data taking into consideration other influencing factors such as weather or temperature.

Our **Core Asset Data** for Distribution Mains includes location, Diameter, Length, Material, Pressure, Failures and Risk Scores. It is scored as amber within our Data Improvement Plan for NARMS. Mains location, Pressure, material and length data is robust however, assumptions have been applied for the age of metallic distribution mains

Asset Health and Failure Data is scored as green within our Data Improvement Plan for NARMS which means our data is robust and complete. This does include some assumptions for the age of metallic Distribution Mains, but can be infilled

Our **Financial Data** is scored as green within our Data Improvement Plan for NARMS which means our data is robust and complete.

6. Consequence of Failure

Under the IMRRP, the principal consequence of failure is the risk of explosion as calculated by the MRPS model. This is the primary output of the model and is used to inform the priority order for the replacement of Tier 1 pipes and also to determine if a Tier 2 pipe falls above the Risk Action Threshold and so is mandated to be replaced.

Within the NARMs methodology the following consequence measures have been identified for Distribution Mains.

- Gas escape
- Gas in building
- Supply interruption
- Loss of gas
- Water ingress
- Explosion

7. Options Considered

7.1. Options Summary

Three options were considered for the "Mandatory Replacement" category:-

1. Manage the existing mandatory replacement assets by only intervening following failure (i.e. "do nothing")

2. Carry out the proposed RIIO-2 Mandatory Replacement programme as detailed below:-

Tier 1 Proposal. We are planning to replace Tier 1 pipes on a flat-line basis through RIIO-2 (i.e. replacing an average of 1/11th of the remaining 2021 population per year) and have calculated that the rate to achieve this is 429km / year. We must replace the 20% highest scoring Tier 1 pipes from our risk model. These are known as seed pipes. The remaining 80% of the workload can be selected from anywhere in the remaining Tier 1 population. We group pipes together into efficient projects to ensure the full clear-out of T1 pipes and use optimisation techniques to schedule these through time in the most effective way, taking into account efficiency of delivery, impact of pipe failures (e.g. forecast leaks), and the impact on stakeholders. We also put a key focus on the overall deliverability of the programme of work up to 2032, considering geographic constraints around the maximum annual workload we can deliver in any given location and in particular ensuring that we complete a balanced programme of works rather than deferring all of the more complex works to the end of the programme.

Tier 1 Legacy Stubs Proposal. Prior to the 10-year review of the Replacement Programme (see section 4 above) all iron mains pipes within 30m of property were mandatory and required replacement by 2032. As a result, provided it was in compliance with our agreed policies and procedures we sometimes left a short 'stub' of mandatory Tier 1 iron main from a smaller diameter pipe to a larger pipe as it was overall a more economic and efficient solution to replace the 'stub' when the larger pipe was replaced later in the programme.

However, many of these larger parent pipes are no longer required to be replaced by 2032 as they are part of the non-mandatory Tier 2 and 3 workload which now only get replaced on a CBA basis. This has led to the stranding of short length stubs. We identified this unintended consequence in RIIO-1 and as a result modified our policies and work procedures to ensure that no additional Tier 1 stubs would be created in RIIO-1.

Legacy stubs of iron pipe <= 8" diameter and within 30m of property are mandatory under the HSE Enforcement Policy and so need to be replaced by 2032. We have used GIS (Graphical Information System) tools to identify the number of legacy stranded stubs and short lengths we have across our network and plan to replace them at a constant rate to achieve completion by 2032. As a result we expect to abandon an average of approximately 665 stubs per annum.

These short length projects adjoining larger pipes are relatively expensive. We have worked with an external organisation (Steve Vick International) to develop an innovative remote foam bagging system, which they now commercially market as E- SEAL. Where circumstances permit, this allows a Tier 1 stub to be remotely and permanently isolated and abandoned without having to cut out the parent main, resulting in smaller excavations, less disruption and reduced costs. Taking this into account we expect to spend an average of £7.8m per year through RIIO-2 replacing legacy stubs.

Resolving the issue of legacy stubs does not represent an additional cost to the customer. To replace all of the Tier 2 and Tier 3 positive scoring iron up to 2032 (as required under the previous "30/30" IMRP) would have cost approximately £53.2m per year. Addressing just the Tier 1 legacy stubs reduces this cost by 85%.

Tier 2A Proposal. By the end of RIIO-1 we will have replaced all of the pipes that currently score above this level as calculated by the MRPS tool. However, the MRPS risk score of a pipe changes through time based both on its performance and the performance of other pipes, and we currently estimate that approximately 2km / year of these pipes will migrate to above the threshold through RIIO-2 and so this has been included as part of our mandatory workload.

This is our current best estimate of the volume of Tier 2A pipes to be replaced through RIIO-2. However, the movement in risk score of an individual pipe over a period of time has many drivers including model coefficient updates and the performance of individual and groups of pipes (failures, Gas in Buildings, etc.) which are dependant on external factors outside the control of the Network, such as weather conditions. This means that the actual volume of Tier 2A pipes to be replaced through RIIO-2 is extremely difficult to predict. We are therefore proposing to have a Volume Driver for Tier 2A with funding being based on the amount of workload delivered and the associated mains diameter using the appropriate unit costs.

Non-standard Materials Proposal. This principally covers pipes made from asbestos. These have previously been mandated by HSE to be abandoned and all known pipes in this category have already been replaced (or are in progress). However, we occasionally encounter some of this type of material which had not been previously captured on our records system. This is a very small workload and we anticipate approximately 0.5km / year through RIIO-2.

Small Diameter (<= 2") Steel Proposal. We will continue to replace these (subject to our procedures agreed with HSE, which are part of both our Approved Programme and our Safety Case) when they are encountered either during planned works (e.g. mains replacement activities) or following escapes. The anticipated RIIO-2 workload associated with this is approximately 44km/year.

Associated Services Proposal. We are required by HSE to replace steel services when they are worked on. We anticipate encountering approximately 161,000 services through RIIO-2 as part of the mandatory mains replacement programme detailed above. 60% (approximately 96,500) of these are expected to be steel, which will be replaced with PE. The remaining 40% are already PE and, following testing, will be transferred to the replacement main.

Other Services Proposal. In addition to the above, there are services which are not replaced as part of the mains replacement programme. Instead they are replaced after an escape has been reported on the network, as part of a service alteration, or when carrying out other meter work. As mentioned above, we are required by HSE to replace steel services where they are worked on. We anticipate this to apply to 31,661 services through RIIO-2.

3. Provide additional funding to increase Tier 1, Small Diameter Steel and associated services plus Tier 1 legacy stubs by +5% and +10% compared with Option 2 above. This would accelerate the HSE programme to complete Tier 1 mandatory replacement before 2032.

Future Energy Pathways. We have used the default assumption of current assumed proportion of methane CO2 in natural gas projected forwards due to uncertainties in the potential energy pathways and because this is reflective of the current gas quality legislation. However, we acknowledge that significant changes to gas demand or the allowed methane content of gas, for example due to the blending with or conversion to hydrogen, would impact the benefits of investment in our assets. Arup conducted analysis on the potential benefits of our H21 Programme (see A13 - NGN RIIO-2 Consumer Value Proposition) that showed 45% of the gas in our network is expected to be Natural, 15% biomethane and the remaining 40% hydrogen by 2040; due to a combination of blending and sub-areas of our networks being fully converted. This is consistent with Net-zero by 2050 aligned with the ENA Navigant report.

We have not explicitly modelled changes in the methane content of gas in our CBAs as overall gas demand and the change in C02 content of the gas is not expected to be different enough to materially impact the NPV, Payback & Option Ranking of our preferred investment programme. This is because carbon risk benefit is one element of overall risk benefit and this will be reduced by up to 40% by 2040 across all scenarios if the ambitious but realistic ENA Navigant report pathway is chosen. Our chosen programme represents value for money regardless and is mainly driven by

customer benefits such as avoiding loss of supply, safety considerations & avoiding increasing disruption from repairs due to deteriorating assets. The investments also ensure that we are compliant with relevant legislation. Therefore, it represents a no regrets investment programme that is consistent with net zero and will deliver value to customers whether a hydrogen or electrification pathway is chosen.

7.2. Options Technical Summary and Cost Summary Table

Description	Asset Category	1st year of GD2 spend	Final year of GD2 spend	Annual Volume of Interventions	Investment design life	Total GD2 Repex cost (£m)	Total GD2 Repex cost (£m)
"Do Nothing"	All	N/A	N/A	0	N/A	0	0
Preferred Solution	Tier 1	21/22	25/26	428.9km	50+ years	£286.7	£393.6
	Tier 2A	21/22	25/26	2km	50+ years	£3.8	
	<= 2" Steel	21/22	25/26	43.8km	50+ years	£22.0	
	Non-standard Materials	21/22	25/26	0.5km	50+ years	£0.5	
	T1 Legacy Stubs	21/22	25/26	665	50+ years	£38.6	
	Other Services	21/22	25/26	6332	50+ years	£41.9	
Preferred Solution +5% for T1 / <= 2" ST / Legacy Stubs	Tier 1	21/22	25/26	450.2km	50+ years	£301.1	£411.0
	Tier 2A	21/22	25/26	2km	50+ years	£3.8	
	<= 2" Steel	21/22	25/26	46km	50+ years	£23.1	
	Non-standard Materials	21/22	25/26	0.5km	50+ years	£0.5	
	T1 Legacy Stubs	21/22	25/26	698	50+ years	£40.6	
	Other Services	21/22	25/26	6332	50+ years	£41.9	
Preferred Solution +10% for T1 / <= 2" ST / Legacy Stubs	Tier 1	21/22	25/26	471.7km	50+ years	£315.4	£428.4
	Tier 2A	21/22	25/26	2km	50+ years	£3.8	
	<= 2" Steel	21/22	25/26	48.2km	50+ years	£24.2	
	Non-standard Materials	21/22	25/26	0.5km	50+ years	£0.5	
	T1 Legacy Stubs	21/22	25/26	731	50+ years	£42.5	
	Other Services	21/22	25/26	6332	50+ years	£41.9	

8. Business Case Outline and Discussion

8.1. Key Business Case Drivers Description

Option 1 was rejected. HSE has required us to replace mandatory pipes, to produce plans and to demonstrate progress towards achieving this by their timescales. Failure to produce and then comply with a plan would be a breach of our Safety Case. In particular, if we were to fail to produce an acceptable plan for Tier 1 pipes, HSE would exercise its power under the Pipelines Safety Regulations to impose a programme of works on us (which would be in line with our preferred option) and require us to achieve this.

Option 2 is our preferred option. This will deliver replacement of Tier 1 mains and Tier 1 legacy stubs at a steady rate to achieve complete abandonment by 2032. We will also replace Tier 2 pipes if they migrate to above the Risk Action Threshold, replace mains made from non-standard materials if they are discovered and continue with our policy (agreed with HSE) to replace small diameter steel pipes – either <=2" mains or steel services – where they are worked on in line with our procedures.

Option 3 was considered but rejected. There are a number of both operational and financial issues to consider when examining the acceleration of the Tier 1 replacement programme ahead of the baseline volumes to achieve the mandated completion date. These include:

- *Operational*
    - The programme has been developed and planned over a long period to ensure that it is sustainable and deliverable. Significantly accelerating workload will be constrained heavily in a number of geographical areas due to the large impact this would have on the local area in terms of road and lane closures.
    - Significant acceleration of the programme would require additional skilled resource (both internal and contractor) to deliver.

- *Financial*
    - To pull forward additional workload from post-2026 into GD2 would not deliver unit-rate efficiencies and would increase total costs in GD2.

Stakeholders have shown strong support for the continuation and completion of the replacement of pipes that impact upon the safety and reliability of their gas supplies. Acceleration of the Tier 1 programme has to be considered in the broader assessment of how best to meet customers' requirements. Our analysis has shown that, in the shorter term, investment in other categories of the metallic mains population would provide an improved cost-benefit case when compared to the Tier 1 population of assets. We are proposing increased/accelerated workloads in a number of other categories of asset within our RIIO-GD2 mains replacement programme including >2" Diameter Steel Mains and Large Diameter Tier 3 Iron Mains.

8.2. Business Case Summary

The tables below detail the headline business case metrics to allow a high-level comparison of the options

Tier 1, Tier 2A, <= 2" Steel, Non-Standard Materials + Associated Services

Option No	Description	GD2 Forecast	Total NPVs compared with baseline (£m)					Preferred Option
			2030	2040	2050	2060	2070	
Baseline	Baseline		£0	£0	£0	£0	£0	N
1	Preferred Option	£313.04	-£49.62	-£2.41	£172.33	£445.57	£816.56	Y
2	Preferred +5%	£328.51	-£52.10	-£2.68	£180.55	£467.16	£856.34	N
3	Preferred +10%	£343.97	-£52.77	-£0.97	£190.88	£490.82	£897.93	N

Legacy Tier 1 Stubs

Option No	Description	GD2 Forecast	Total NPVs compared with baseline (£m)					Preferred Option
			2030	2040	2050	2060	2070	
Baseline	Baseline		£0	£0	£0	£0	£0	N
1	Preferred Option	£38.64	-£13.25	-£23.97	-£26.41	-£23.99	-£18.31	Y
2	Preferred +5%	£40.57	-£13.91	-£25.18	-£27.75	-£25.23	-£19.29	N
3	Preferred +10%	£42.51	-£14.57	-£26.37	-£29.06	-£26.40	-£20.15	N

Other Mandatory Services

Option No	Description	GD2 Forecast	Total NPVs compared with baseline (£m)					Preferred Option
			2030	2040	2050	2060	2070	
Baseline	Baseline	£0	£0	£0	£0	£0	£0	N
1	Preferred Option	£41.90	-£11.52	-£14.58	-£4.63	£13.56	£38.00	Y

9. Preferred Option Scope and Project Plan

9.1. Selected Option

The preferred option is Option 2 – replace Tier 1 mains and Tier 1 legacy stubs at a constant rate from 2021 to achieve complete abandonment by 2032; replace Tier 2 pipes if they migrate to above the Risk Action Threshold; replace previously unidentified mains made from non-standard materials where these are encountered and continue with our policy (agreed with HSE) to replace small diameter steel pipes – either <=2" mains or steel services – where they are worked on in line with our procedures.

9.2. Spend and Workload Profile

Throughout GD2 we anticipate being able to deliver an ongoing efficiency cost reduction of 0.5% year-on-year. We also anticipate that the "other services" workloads and associated costs will gradually decline through the period as steel services are replaced as part of our ongoing mains replacement activities.

The table overleaf details the preferred option's workload and expenditure profile through RIIO-2:

	21/22	22/23	23/24	24/25	25/26	GD2 Total
Tier 1 Mains & Associated Services						
Mains (km)	428.9	428.9	428.9	428.9	428.9	**2144**
Services (interventions)	29494	29494	29494	29494	29494	**147469**
Cost (£m)	57.9	57.6	57.3	57.1	56.8	**286.7**
Tier 1 Legacy Stubs						
Cost (£m)	7.8	7.8	7.7	7.7	7.7	**38.6**
Tier 2a Mains & Associated Services						
Mains (km)	2	2	2	2	2	**10**
Services (interventions)	41.2	41.2	41.2	41.2	41.2	**206**
Cost (£m)	0.8	0.8	0.8	0.8	0.8	**3.8**
Non Standard Materials						
Mains (km)	0.5	0.5	0.5	0.5	0.5	**3**
Services (interventions)	36	36	36	36	36	**179**
Cost (£m)	0.1	0.1	0.1	0.1	0.1	**0.5**
<2" Steel Mains & Associated Services						
Mains (km)	43.8	43.8	43.8	43.8	43.8	**219**
Services (interventions)	2587	2587	2587	2587	2587	**12936**
Cost (£m)	4.4	4.4	4.4	4.4	4.4	**22**
Other Services						
Services (interventions)	6495	6412	6330	6251	6173	**31661**
Cost (£m)	8.7	8.5	8.4	8.2	8.1	**41.9**
Overall Mandatory Mains & Associated Services						
Mains (km)	475.2	475.2	475.2	475.2	475.2	**2376**
Services (interventions)	38653	38570	38489	38409	38331	**192452**
Cost (£m)	79.7	79.2	78.7	78.3	77.9	**393.6**

9.3. Investment Risk Discussion

The most significant risks that we envisage are a failure to have adequate resources (numbers, skills, location) to complete the work and failure to have access to the required locations.

The average Tier 1 diameter is drifting up (as we have forecast previously over the medium to longer term) but there is a reduction in length from RIIO-1 to RIIO-2. Our DSP contracting strategy is robust and stable, working directly with and providing support to the individuals, teams and organisations actually involved with doing the projects which, combined with our flexible BOL / Totex approach means that we don't foresee issues with resource availability. Our regionally-based BOL model means that we have developed closer local relationships with Councils and roads authorities. On top of this, we have a strong track record through RIIO-1 of actually delivering on our plans in terms of both length and diameter mix. Because of these we are confident that our RIIO-2 plan for mandatory replacement is robust and deliverable as proposed.