Northern Gas Networks

A22.j – Local Transmission System

Engineering Justification Paper

Contents

1. Summary table

Name of Project	*Local Transmission System RIIO-GD3 Programme*		
Scheme Reference	*A22.j.NGN*		
Primary Investment Driver	*Asset Health*		
Project Initiation Year	*2026/27*		
Project Close Out Year	*2030/31*		
Total Installed Cost Estimate (£)	*£5.63m*		
Cost Estimate Accuracy (%)	*+/-5%*		
Project Spend to date (£)	*£0m*		
Current Project Stage Gate	*Specific deliverable identification*		
Reporting Table Ref	*CV 5.01*		
Outputs included in GD3 Business Plan	*As per BDPT above*		
Spend Apportionment (£m)	**RIIO-GD2**	**RIIO-GD3**	**RIIO-GD4***
	£2.60m	£5.63m	c. £3-5m

**Expecting all investments listed for RIIO-GD3 to complete in RIIO-GD3. RIIO-GD4 cost estimate based on indicative asset health spend in RIIO-GD3*

2. Executive summary

This Engineering Justification Paper (EJP) proposes critical investments in our Local Transmission System (LTS) pipelines and ancillary items during RIIO-GD3. The primary focus is to address the growing risks associated with the aging assets within our LTS infrastructure, which consists of high-pressure steel pipelines constructed between 1960 and 1980 and sub-assets such as Cathodic Protection, valves and PIG traps. The key issues addressed in this paper include asset health deterioration due to aging pipelines and equipment, high replacement costs associated with LTS pipelines, and the need to maintain compliance with industry legislation and standards.

Our proposed solution emphasises continued robust inspection, targeted repairs, and continued extensive investment in Cathodic Protection (CP) systems rather than large-scale pipeline replacement. We will continue a rigorous inspection regime to monitor asset health, conduct targeted repairs and upgrades based on inspection outcomes, invest in CP systems where needed to ensure they remain effective and appropriately sited, and maintain and upgrade LTS valves and the chambers they are housed in to ensure accessibility and functionality. The summary of the intervention numbers and the associated cost for our preferred option (section 8.4) is listed in the below table:

	RIIO-GD3 EJP Preferred Option		
Asset	Workload units	Repex (£m) 23/24 prices	Driver
Portable Pig Traps	2	£0.44m	Asset Heath / Compliance
River Crossings - remediate	5	£1.00m	Asset Heath / Compliance / Health and Safety
Block valve civils upgrades	15	£1.02m	Asset Heath / Compliance / Health and Safety
CP Replacements - Groundbeds	17	£1.19m	Asset Heath / Compliance
CP Replacements - TR	42	£1.68m	Asset Heath / Compliance / Health and Safety
Pig Trap Isolation Valves	10	£0.30m	Asset Health

Table 1 GD3 Workload and Cost for Preferred Option

The cost of the proposed programme of work is estimated at £5.63m and comes well below the RIIO-GD2 proposal due to the only known diversion to be carried out in RIIO-GD3 being River Allen, covered by a separate Major Project EJP – A22.N. Otherwise, the volumes of interventions are comparable, with only additional investment in RIIO-GD3 being that on PIG trap isolation valves, estimated at £0.44m. We are confident in our cost estimates for proposed interventions because we have carried out similar work before and have therefore been able to build up a thorough cost base. However, we remain aware of potential risks that could impact the estimate and are employing variety of mitigation strategies.

The anticipated outcomes of our proposed investment include extended lifespan and improved reliability of LTS pipelines, reduced risks associated with asset health deterioration and continued compliance with industry standards and regulations, whilst reducing capital expenditure levels compared with RIIO-GD2. This approach ensures that our LTS assets continue to operate safely and efficiently while delivering value to our customers and stakeholders.

3. Introduction

This Engineering Justification paper details our proposals for investment on our Local Transmission System (LTS) pipelines and ancillary items during RIIO-GD3. It includes justification for improvements to our LTS for asset health reasons and is to be used in conjunction with the accompanying Cost Benefit Analysis, which is explored further in section 9.2. This paper explicitly follows Ofgem's guidance and is set out in accordance with the headings therein.

Our LTS pipelines are vital for our gas transportation services, and due to their high replacement costs, we conduct regular inspections, maintenance, and repairs on the pipelines and other related equipment, such as Cathodic Protection. This is to manage growing risks associated with asset health of these aging assets and to ensure they last as long as possible. During RIIO-GD2 we invested £28m in a variety of Capex interventions, including the TransPennine Electrification related diversions, to extend the life of our LTS pipelines as well as to maintain compliance with industry legislation and standards. During RIIO-GD3 we plan to manage these assets in a similar way and for this reason we are not forecasting any large-scale pipeline replacement, which means that we are proposing a significantly lower overall Capex spend of £5.63m. Instead, we will continue to invest in the robust inspection regime, targeting repairs based on the inspection outcomes. We will also continue to invest in Cathodic Protection (CP) based on asset health captured in the most recent assessments. This will cover situations where CP is nearing the end of effective operation, or where the siting of the system has become inadequate. We will also target a variety of LTS valves to ensure that they are accessible and functional when needed. We are proposing a single LTS diversion, the justification for which is contained within a separate EJP – A22.N River Allen Diversion.

This engineering justification paper seeks to present the rationale for our proposed RIIO-GD3 LTS investment, explaining our asset management decision-making process where we evaluate risk, value, and balance various intervention options. We have used a combination of our Value Framework and our asset data and expertise to determine the appropriate interventions during RIIO-GD3. Subject matter experts helped to identify where investments could be used to improve our resilience (from both a climate and physical security point of view). Our strategy is set out in the table below detailing the driver for investment.

	RIIO-GD3 EJP Preferred Option		
Asset	**Workload units**	**Repex (£m) 23/24 prices**	**Driver**
Portable Pig Traps	2	£0.44m	Asset Heath / Compliance
River Crossings - remediate	5	£1.00m	Asset Heath / Compliance / Health and Safety
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CP Replacements - Groundbeds	17	£1.19m	Asset Heath / Compliance
CP Replacements - TR	42	£1.68m	Asset Heath / Compliance / Health and Safety
Pig Trap Isolation Valves	10	£0.30m	Asset Health
Total	**91**	**£5.63m**	

Table 2 RIIO-GD3 Workload, cost and drivers

4. Equipment summary

The majority of the Local Transmission System (LTS) was constructed between 1960 and 1980, making pipelines our oldest assets still in operation. The LTS consists of approximately 1,300km of high-pressure steel pipelines which are used to transport large volumes of gas over long distances around our network. The pipelines connect the National Transmission System (NTS) Offtakes, Pressure Reduction Stations and Governors and feed the intermediate, medium and low-pressure networks through cascading pressure cuts across our network footprint. The Local Transmission System provides us with the capability to store large volumes of gas as 'linepack' which is used to meet peak demands throughout the day and cycling of pressures within the pipelines ensures we operate the network efficiently to limit supply constraints on the NTS during peak demand.

The Local Transmission System can be broken down into several sub asset classes:

OLI1 Pipelines – Steel pipelines of varied diameter and wall thickness operating above 7bar but not exceeding 70bar. The OLI1 classification determines that these pipelines can be internally inspected using Pipeline Inspection Gauges (PIGs).

OLI4 Pipelines – Identical in construction and pressure to OLI1 pipelines, however they cannot be inspected internally due to limiting features such as tight bends, smaller pipe diameters, or operating parameters, such as velocity and flow.

PIG traps – Above ground installations used to facilitate in-line inspections (OLI1 pipelines only). Equipment consists of launch and receiver pressure vessels, bridle/bypass pipework and isolation valves that can alter the flow of gas to propel the inspection tool through the pipeline.

PIG trap isolation valves – Full-bore valves fitted to allow safe isolation of a PIG trap from an LTS pipeline.

Overcrossings – Above ground pipework typically installed to traverse man-made infrastructure (roads, railways) or natural obstacles (watercourses, ditches) where below ground installation is not feasible.

River Crossings – Sections of pipeline running under a watercourse.

Sleeves – Larger diameter steel pipework installed outside the pipeline when additional protection is required, such as under roads or railways. Post installation each end is sealed to the carrier pipe, the sleeve annulus can be filled with a variation of materials such as grout, epoxy resin, nitrogen or left vacant.

Block Valves – Full-bore line valves that allow safe shut down and isolation of pipeline sections for maintenance activities or in the event of an emergency.

Cathodic Protection – A technique used to reduce the corrosion of metal pipelines. An impressed current system utilises a ground bed and transformer rectifier unit to ensure the pipeline acts as a cathode of an electrochemical reaction, with the ground bed corroding as the anode. Sacrificial anode systems consist of an anode 'bag' bonded to the pipeline, this system is used if impressed current systems pose a risk of electrical interference to other infrastructure e.g. railways.

Overcrossings are part of the LTS asset portfolio, however, do not form part of this Engineering Justification paper (EJP) as the investments are covered within 'Other Capex' in accordance with Regulatory Reporting. Instead, investments on Overcrossings are covered by a separate Overcrossings Engineering Justification Paper A22.K. The remaining aforementioned asset groups are covered under this EJP.

The figures below provide asset information for some of the key components of the Local Transmission System:

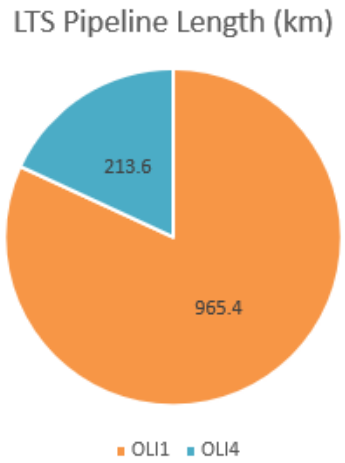

Figure 1 Total LTS pipeline length split by inspection type

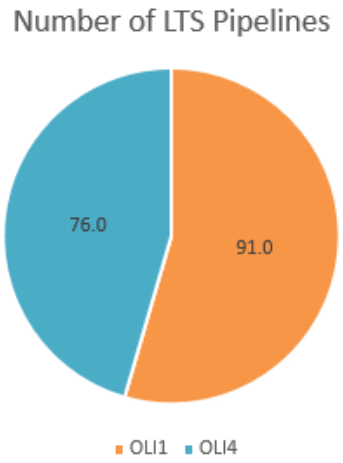

Figure 2 Total LTS pipeline number split by inspection type

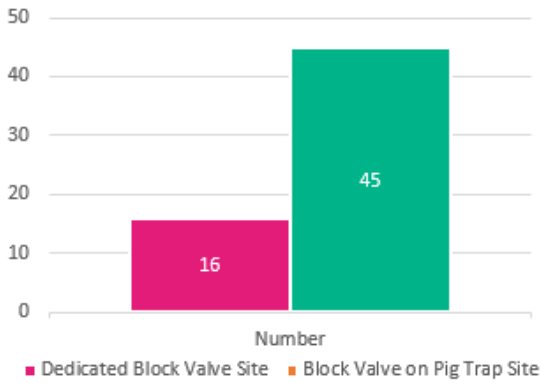

Figure 3 Number of Block Valve sites

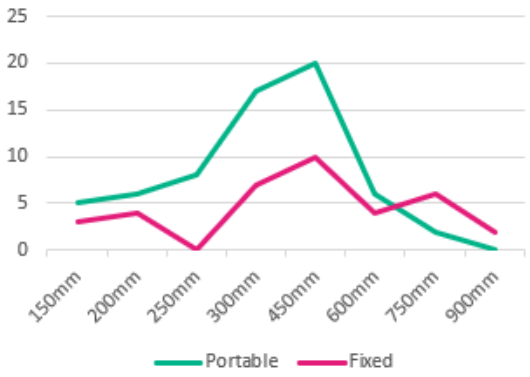

Figure 4 Number of PIG traps by diameter

5. Problem / opportunity statement

Why are we doing this work and what happens if we do nothing?

Our LTS pipelines and ancillary equipment are essential for our business operations. Overall, LTS contributes only 1% to the total network monetised risk. This low contribution is primarily due to the infrequent failure of LTS pipelines, which are relatively uncomplicated assets.

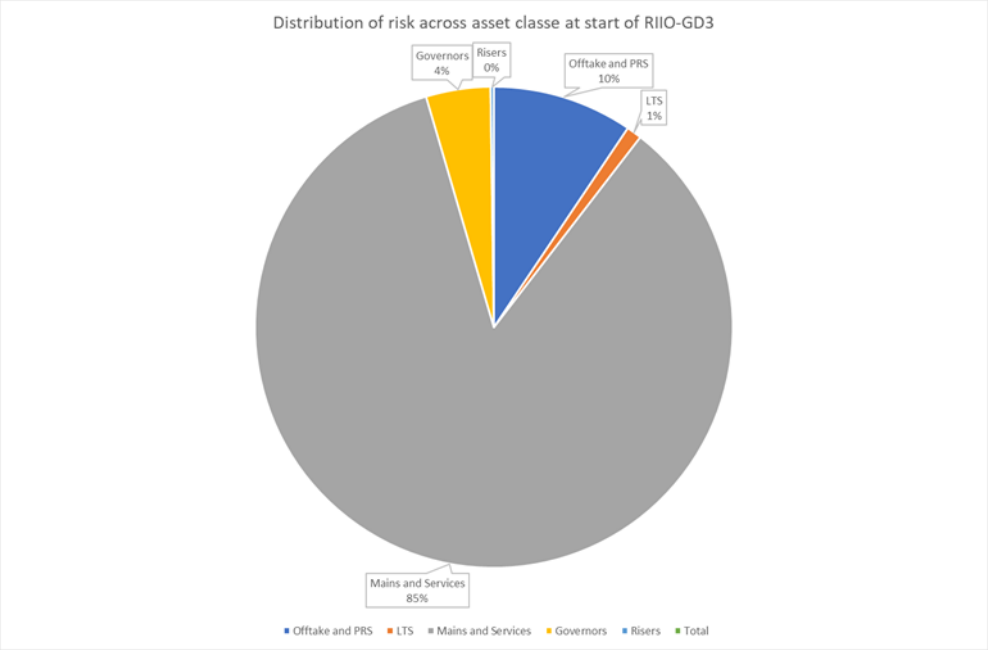

Figure 5 Asset risk distribution

When adequately protected from corrosion and interference and subjected to regular maintenance, these pipelines can operate safely for extended periods. In order to maintain this group of assets we already undertake a variety of maintenance, inspection and targeted repair activities, most of which are not covered by this paper due to them being considered Operational Expenditure (Opex) and therefore falling outside of the scope of this document. In addition to these Operational Expenditure activities, we must also ensure that the risk held within this asset class is mitigated through Capital Investment. Safety and reliability of these assets are paramount – they operate at high pressure, span the entire footprint of our network, both in rural and urban areas and are key in reliability of supply.

The reason for upfront capital investment is two-fold; lack of investment in this infrastructure is likely to lead to failure, which can have catastrophic consequences. The graph illustrating corrosion related failures in section 6 shows exponential increase from the late 2040s if no further intervention on the pipelines or protective devices, such as Cathodic Protection, is carried out. Also, the monetary cost of large-scale pipeline replacement is highly significant, therefore it is prudent to invest in preventative measures, such as CP, to extend the lifespan of an existing pipeline, thereby deferring the spread of the cost of its replacement further into the future.

To effectively direct our capital investments, we implement our Network Asset Management Strategy and rely on a blend of expertise from Subject Matter Experts (SMEs) and insights from our Decision Support Tool (DST). The tool, by utilising a variety of models and calculations based on industry wide practice, helps us identify the factors contributing to risks in this asset class, while the experts suggest the precise actions required to mitigate those risks.

Our DST utilises the Value Framework we developed to calculate the risk we hold on our assets as well as to understand how the risk changes over time as our assets deteriorate. LTS Pipelines account for 5% of our total network risk and include four **primary** asset classes: OLI1 Pipelines (Piggable), OLI4 Pipelines (Non-piggable), Sleeves and Valves. Within our Value Framework we report on risk in five categories: compliance, customer, environmental, financial and health & safety (further explained in Section 6 of this document).

The table below shows the risk profile of our LTS assets at 2027, split by both the primary LTS asset classes and the risk categories:

Risk Profile (£m)	Compliance Risk	Customer Risk	Environmental Risk	Financial Risk	Health and Safety Risk	Total Risk	Percentage
OLI1 Pipelines	£1.03	£2.41	£0.06	£1.16	£4.24	£8.89	80%
OLI4 Pipelines	£0.44	£0.12	£0.02	£0.21	£1.19	£1.97	18%
Sleeves	£0.03	£0.09	£0.00	£0.03	£0.16	£0.31	2%
Valves	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	0%
LTS Total	£1.49	£2.61	£0.08	£1.40	£5.59	£11.17	100%
Percentage	13%	23%	1%	13%	50%	100%	

Table 3 LTS risk profile

Of the four asset classes within LTS Pipelines, OLI1 pipelines hold most of the risk at 80%, which is predominantly made up of health and safety risk. This is to be expected as OLI1 pipelines constitute a large percentage of LTS assets and through internal inspections have detailed condition assessments undertaken. OLI4 pipelines hold the second highest risk with 18% and as with OLI1 pipelines this is also predominantly made up of health and safety risk. The discrepancy in risk values between OLI1 and OLI4 pipelines is due to the additional inspection data held for internally inspected pipelines. Through inspection of OLI1 pipelines any additional defects, though not considered severe or requiring intervention, would increase risk attributed to that asset. This is not the case with OLI4 pipelines, leading to a significant variance in risk held. Sleeves and Valves hold the lowest risk with only 2% combined.

Health and safety risk is by far the largest risk element within LTS, accounting for half of the total risk attributed to this asset class. As pipelines are the primary asset within the LTS asset class, it is understandable that most of the risk (98%) be held across OLI1 and OLI4 pipelines. The discrepancy in risk distribution between OLI1 and OLI4 pipelines is due to the variance in asset data available between the asset types. In the instance of OLI1 pipelines, inline inspection provides accurate asset data including any defects, corrosion points or coating disbondment. This additional data provides an accurate assessment of actual asset condition and leads to an increase in modelled risk. Outside of the NARM model we deem our OLI4 pipelines to be riskier than our OLI1 pipelines due to the fact we know less about them.

Customer risk accounts for the second highest total at 23% and is predominantly driven by OLI1 pipelines. Customer risk refers to the risk of a loss of supply incident and considers the number of properties affected, the costs associated with rectification, reconnection, GSOS payments and additional costs encountered during a loss of supply event.

The charts below summarise the age profile of all our pipeline assets. Although on its own age is not a reason to intervene, it can be viewed as a leading indicator to condition and faults. This analysis shows that of our pipeline population, over 90% of the length was installed prior to 1981. If age was the only consideration for intervention, a significant proportion of the asset class would require replacement. Targeted investment on protective assets (pipeline coating, cathodic protection etc.) allows us to extend the asset life of pipelines far beyond original design life, utilising existing assets in a means that provides superior value for the customers.

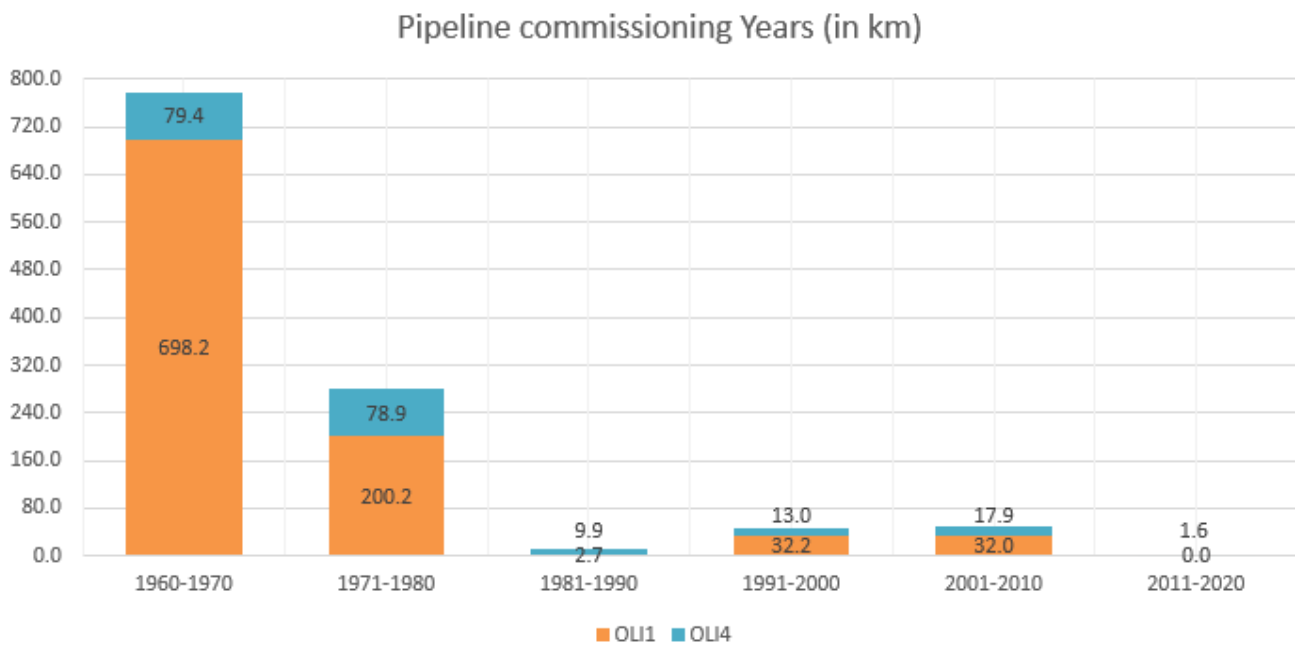

Figure 6 LTS length in km by year commissioned.

What is the outcome we want to achieve?

Our key aim is to ensure that we achieve our Strategic Asset Management Objectives as outlined and justified by our Network Asset Management Strategy. One of those objectives, consistently supported by our stakeholder research (for example, see Insight 1 and 9 from Appendix A3 below), is to ensure our assets are safe and resilient and cost efficient. From the risk analysis in Section 4 of this document, for this group of assets, health and safety risk is the main risk driver and so our objectives will focus on this area. Our most recent research also tells us that our customers expect value for money now more than ever, and that we make the right investment decisions for both our existing and future customers. Therefore, we have devised three objectives covering risk, cost and uncertainty.

What we heard	Appendix A3
Keeping bills as low as possible continues to be domestic and SME customers' top priority, however stakeholders are supportive of investment to respond to significant challenges of climate resilience and decarbonisation. Balancing the trade-off between investing now to future-proof and minimising expenditure to prioritise essentials poses a challenge.	Insight 1
Customers expect our top sustainability commitment to be keeping our infrastructure resilient. This means continuing to reliably supply customers in the short and long term, regardless of climatic conditions and impacts experienced by interconnected sectors (such as telecommunications, road networks etc). As customers are satisfied with the performance and availability of our services, they prefer us to maintain service levels at levels similar to today, and asked for us to reduce future risk with targeted investments to enhance removal, reduction, resistance and recovery strategies.	Insight 9

Table 4 Customer Insights

Risk objective: to maintain total risk to the same level as the starting position of RIIO-GD3 (plus or minus 10%)

We want to manage total risk

We know that our customers value safety and reliability as their number one priority. Management of risk for the LTS is achieved through proactive intervention on protective assets such as cathodic protection, extending the asset life of the pipelines. It is also achieved through investment in some of our LTS valve population to ensure that they are accessible and can be used when required. In addition to what our customers want, we want to provide a safe working environment for our operatives and so must reduce increasing risks associated with LTS pipelines. We will aim to maintain risk throughout RIIO-GD3. However, we need to balance this ambition with service and cost constraints.

We are on track to meet our NARM target in RIIO-GD2. RIIO-GD3 is considered to be a roll-over price control so we have decided not to take a step change approach to risk and have therefore adopted a risk objective that is consistent with that adopted in RIIO-GD2.

Efficiency objective = to minimise RIIO-GD3 spend over and above RIIO-GD2 levels

We know that our customers expect us to invest their money as wisely and as efficiently as possible. To do this we need to make sure we extract the maximum value from our existing assets before considering any drastic changes. We must understand the whole life cost of the decisions we make to ensure we are doing the right thing both now and in the future. To avoid escalating costs in the future we must consider the impact of investment on protective assets and interventions to ensure high value assets are fully utilised.

Service objective = to maintain supply interruptions to the same level as the starting position of RIIO-GD3 (plus or minus 10%)

We want to continue to provide exceptional service

The key service measure for our governor assets is the total expected number of supply interruptions. Table 1.06 of the 2023/24 Regulatory Reporting Pack (RRP) submission highlights that our current customer satisfaction scores for unplanned interruptions are exceeding the targets set by Ofgem (9.37 target against our actual performance of between 9.543 and 9.650 between 2022 and 2024). We therefore consider that current service levels are acceptable to our customers and provide a suitable benchmark.

As the regulatory landscape is likely to broadly remain the same in RIIO-GD3, adopting risk and service level objectives that are consistent with that adopted in RIIO-GD2 seems appropriate. Other Reliability metrics outlined in Table 1.06 of GD2 RRP demonstrate that we are currently operating a highly reliable network. Our aim therefore to maintain our RIIO-GD2 industry leading service levels in RIIO-GD3. Our RIIO-GD3 investments need to target this service measure and reduce it back down to a more acceptable level.

Certainty objective = to ensure our investments pay back within 16 years

To ensure the investments we make in RIIO-GD3 are right for both our existing and future customers, and to avoid the risk of asset stranding we must ensure that our investments offer a payback before either the asset life or a point in time where future uncertainty could reduce the forecasted benefits, whichever is the smallest time period. The RIIO-GD3 Business Plan Guidance states that a 16-year payback period is appropriate for the GD sector (page 45)[1], meaning that any new, refurbished or replaced equipment that pays back within this time

[1] Ofgem guidance on RIIO-3 Business Plan

frame will be deemed suitable for investment. In addition, we will consider extending the life of existing assets wherever possible, opting to invest in protective interventions to mitigate deterioration of high-cost assets.

Compliance objective = to ensure we are compliant with legislation relevant to each asset class

We want to ensure compliance with all relevant health and safety, or technical regulations.

During RIIO-GD3 we are required to undertake several interventions for compliance reasons. Failure to maintain our LTS assets risks non-compliance with the Pressure Systems Safety Regulations (PSSR) which is mandated by the Health and Safety Executive (HSE).

How will we understand if the spend has been successful?

The success of our investment proposals will be measured through achievement of our objectives listed in this document and, ultimately, the continued safety and reliability of our LTS pipelines.

To quantify this success, during RIIO-GD2 we utilised NARM and associated reporting. In RIIO-GD3 we decided to move away slightly from this approach and instead, whilst we will continue to report on our performance, we propose that LTS should no longer contribute to our NARM target. Instead, in addition to the use of guaranteed standards of service as a minimum, we will also utilise our monetised risk calculations through our Value Framework and conduct annual reviews in line with regulatory reporting. The reason for this shift is due to the immateriality of LTS investments when compared to other asset classes, which has become evident during RIIO-GD2 and is a view that is shared by all four Gas Distribution Networks.

We will regularly review and update our strategy based on any emerging trends or changes to the industry wide assumptions.

5.1. Narrative real-life example of problem

Local Transmission Pipelines (LTS) are key assets within the gas distribution system, often acting as a single point of failure. These pipelines are critical for the reliable and safe transmission of gas to both domestic and industrial customers. Despite their inherent robustness and longevity, maintaining an effective maintenance and upkeep regime is essential to ensure their continued performance and to mitigate the risks associated with potential failures.

In the following sections some of the individual asset subcategories covered by this paper will be discussed. Each subsection, through a case study of a project, will delve into the specific problems we face regularly, highlighting the challenges in ensuring our LTS assets operate safely and efficiently. We will provide detailed accounts of the issues encountered in maintaining these pipelines, supported by real-life examples, drawings, photos, and charts where applicable. Our aim is to convey the practical implications of these challenges and the strategies we employ to protect our customers and colleagues alike.

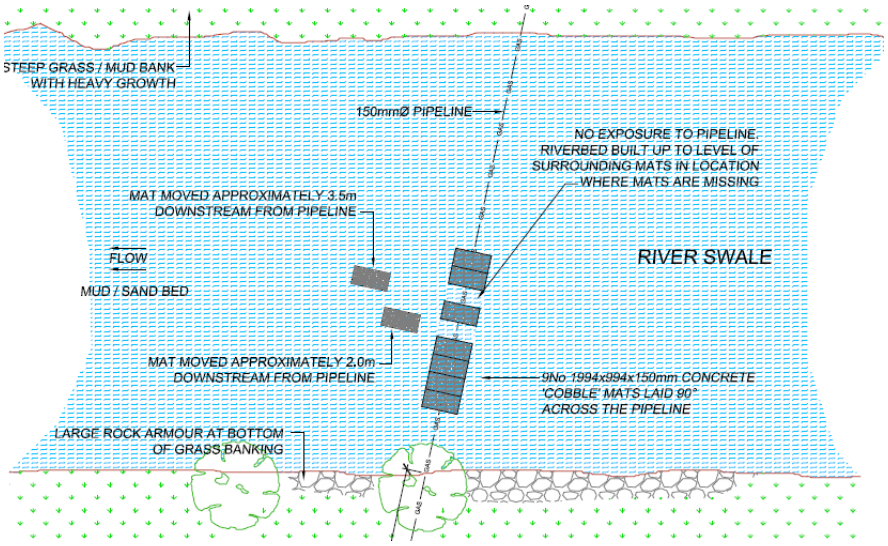

Figure 7 3 Thrintoft to Catterick pipeline in River Swale and concrete cobble mat displacement

RIVER SWALE RIVERBED EROSION CASE STUDY

During a routine inspection of our Local Transmission System (LTS) pipeline river crossings, we found that the section running from Thrintoft to Catterick had become exposed in the River Swale in North Yorkshire. This section was initially protected with specialised concrete cobble matting in 2015 after its first exposure, using nine mats designed to provide protection to the pipeline. Nevertheless, the survey indicated that two of these mats had slightly shifted downstream, exposing parts of the pipeline. The other mats stayed firmly anchored, fortified by natural riverbed materials that secured their placement.

Recognising the urgency of this issue, we promptly engaged one of our specialist contractors to mitigate the problem. Where feasible, the displaced mats were either repositioned back to their original locations or substituted and securely re-anchored into the riverbed. This detailed work was carried out in full cooperation with the landowner and the Environment Agency, ensuring all essential environmental considerations were observed. The project was executed swiftly and effectively, resulting in a durable solution that has proven reliable at this site over the years. This approach also provided excellent cost efficiency – the necessary work was completed for only around 3% of a cost of an LTS diversion. This successful intervention highlights our dedication to preserving the integrity of our infrastructure through proactive and measured responses.

Figure 8 [redacted] Block Valve chambers before improvements

Figure 9 [redacted] Block Valve chambers after improvements

[redacted] BLOCK VALVE CHAMBERS CASE STUDY

We operate a block valve site in Bradford which underwent significant improvement works during the RIIO-GD2 period. This site comprises two very large chambers, both of which were in poor condition for several reasons. The chambers frequently flooded, submerging the pipework in water and accelerating the deterioration of the chamber walls. Cracks began to appear, further compromising the structural integrity. Above ground, the brickwork was flaking away, and the old-style heavy concrete lids required substantial manual handling by engineers during maintenance visits. Corrosion and delamination of the support beams meant that some lids no longer fit properly, causing additional safety concerns with access to the chambers. Moreover, the access and egress ladders had become unsafe for use.

To address these issues, we conducted a thorough survey and proposed key improvements. Despite the challenges, the pipework, including the valves, were still in good condition. Therefore, in early 2024, we completed an upgrade to the block valve chambers. With these enhancements, the chambers are now safely accessible to our maintenance engineers who can monitor and maintain the assets without undue risk. The improvements have not only extended the lifespan of the chambers but also significantly improved safety and efficiency during maintenance operations.

5.2. Project boundaries

The boundaries of spend proposed by this justification paper include capital investment on the assets listed in Section 4 with some exceptions. It includes all necessary project costs such as design, procurement of materials, construction, commissioning and overheads. It **does not** include any costs associated with third parties such as NRSWA discounts or Network Rail lift and shift agreements and excludes any investment relating to other high-pressure equipment located on our Offtake or PRS sites. Also, it does not include investments on Overcrossings as these costs are included in A22.K and within the 'Other Capex' Business Plan Data Tables in accordance with regulatory reporting. Finally, it excludes the costs associated with the major project planned at River Allen, as this is covered by the dedicated River Allen major project Engineering Justification Paper A22.N.

6. Probability of failure

Likely Failure Modes

A failure in an asset is defined as the inability of an asset to fulfil one or more of its intended functions to a standard or performance that is acceptable and gives rise to a detrimental outcome. Failure in this asset class will lead to a gas escape which can be classed as either a leak or a full rupture of the pipeline. These failures have been categorised into the following Failure Modes within the NARM Methodology:

Defects – Faults or areas of weakness identified during inspections.

Corrosion – The gradual destruction of the pipeline by chemical reaction to the environment.

Mechanical Failures – Failings created during the manufacturing or construction process such as weld defects.

General Failures – Failings resulting from operation such as cyclic pressure fatigue or over pressurisation.

Interference – As a result of third-party actions.

Ground Movement – Can be either natural or human-made and may lead to stress on the pipeline.

Capacity – Where a pipeline becomes under sized to meet the demand.

The Probability of Failure (PoF) is the probability an asset will fail at a given point in time. NARM does not fully capture the risk of supply loss, necessitating a network methodology to provide a more accurate assessment of failure risks for our Cost Benefit Analysis to justify our RIIO-GD3 investments. The methodology incorporates several factors to provide monetised risk value, derived from likelihood of failure due to corrosion events (assessed to be the primary failure mode), likelihood of loss of supply due to failure, customer numbers fed by the pipeline, cost per day and duration to provide a total risk value:

$$\boldsymbol{P_f \times P_c \times N_c \times C \times N_s \times D = T_r}$$

Where:

P_f is Probability of Failure

P_c is Probability of Consequence

$N_c$is Number of Customers

$N_s$is Number of sites

C is Cost per Day

D is Duration of Loss of Supply (in days)

The above formula and terms are further discussed in Section 8 – Options Analysis.

Rate of Failure

The Failure Rate for an asset is the frequency of failures at a given point in time, typically measured as the number of failures over a year. In the NARM models pipelines are split into subtypes (pipe, sleeve and block valve) at which risk analysis is performed due to the different failure characteristics and paths through the risk models and pipe attributes (above ground, below ground and Cathodic Protection) are captured to act as a risk modifier to the pipeline section they are located on.

We have used our NGN Value Framework models to calculate the Failure Rates for each Failure Mode. The failure models are based on expert elicitation and industry recognised reports (UKOPA, IGEM, PIE and National Gas).

The graph below illustrates how the Failure Rates related to corrosion for LTS assets, change through time, without intervention, where the X axis represents years, and the Y axis represents number of failures per kilometre of LTS pipeline.

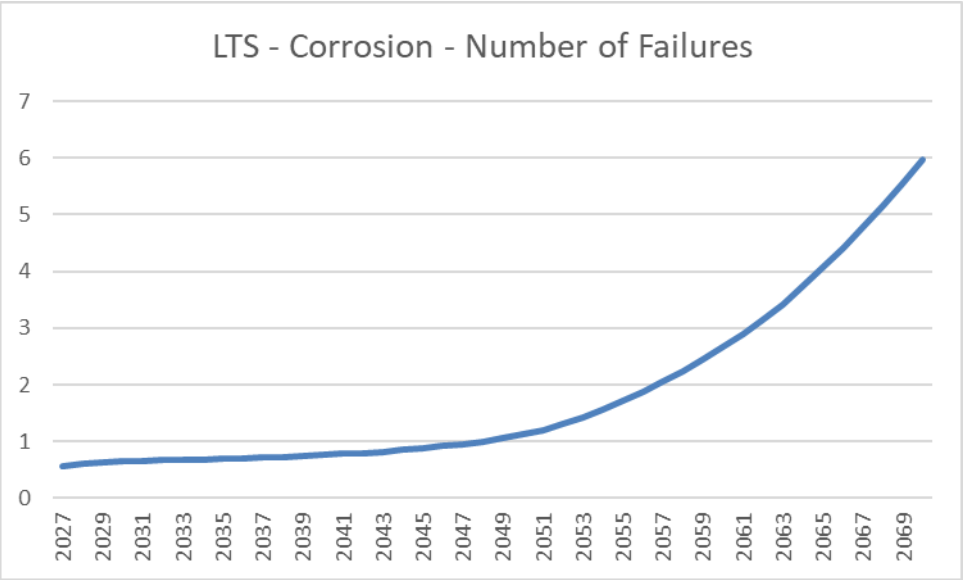

Figure 10 Change in number of corrosion related failures on LTS

This demonstrates the limited variance in failure rates over the RIIO-GD3 period for pipelines, sleeves and valves. However, when considering the effects of no intervention over a longer period, we see a significant increase in the expected numbers of failures. Failures do not always lead to a catastrophic event, and many can be remedied however they are a leading indicator to asset health. Without intervention, over the long term there may be a need to replace large sections of pipelines earlier than otherwise would have been required had we continued to protect and re-life the assets during RIIO-GD3. This demonstrates that the risk of corrosion failure is relatively low and consistent during RIIO-GD3 and RIIO-GD4. That can be attributed to our rigorous inspection and maintenance schedule and the historic upkeep of our Cathodic Protection Systems. If no interventions are carried out, the rate increase becomes more significant by RIIO-5 and then rises exponentially in the following years. This supports the need for continued investment in our Cathodic Protection systems.

6.1. Probability of failure data assurance

LTS pipeline probability of failure calculations are based on the NARM methodology. 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.

We have an annual process for gathering asset data from the business to support NARM RRP delivery, with majority of data coming ultimately from SAP. There is a documented process where the business leads supplying the data carryout reasonableness checks on the data supplied to the Asset Strategy team, who then carry out validation and consistency checks.

Our 2024 Data improvement plan assess key areas of data for robustness and completeness:

Our Core Asset Data for the LTS includes pipeline ID, diameter, length, material failures and property analysis. We recognise that there are some data gaps, but documented assumptions have been applied, which provides confidence that assets are managed in a consistent manner.

We utilise the data we collect as part of our inspections and maintenance regimes to assess probability of failure and failure rates based on real time asset data. Inspection methodology varies between assets within the LTS asset class, such as inline inspection for OLI1 pipelines, CIPS surveys for OLI4 pipelines, or regular health checks on our Impressed Current CP systems. All types of methodology provide good quality data on asset health that can be used to forecast deterioration and failure rates. The latest available data has driven our RIIO-GD3 proposals for LTS pipelines, and we will continue to review and update this data as time progresses.

It is recognised in the NARM methodology that the GDNs will have data gaps and will not hold the same level of asset data. To facilitate the population of the Monetised Risk modelling, a flexible but consistent methodology (with options) will be utilised to derive the Probability of Failure, Deterioration, Probability of Consequence and associated impacts of Intervention. This is set out in Table 6 of the NARM Methodology and ranges from Option A (GDN specific data from company systems) to Option B (Pooled/Shared data – where applicable) to Option C (Global/Assumed). Assumed data could be data that has been analysed to be representative of the population, arrived at by expert elicitation, or arrived at by researching relevant published studies/reports.

7. Consequence of failure

For each failure mode described in the previous section, there may be a Consequence of Failure (CoF) which can be valued in monetary terms. In the NARM methodology the CoF is calculated as the Probability of Consequence (PoC) multiplied by the quantity and Cost of Consequence (CoC) and are linked directly to Failure Modes which categorise the asset failure.

Types of Consequence

The NARM methodology sets out the Consequence Measures for each Failure Mode categorised into four risk groups: Customer Risk, Health & Safety Risk, Carbon Risk and Other Financial Risk. These are detailed below for the Local Transmission System:

Customer Risk

Supply interruptions – Loss of gas supply to our domestic, commercial or industrial customers. Supply interruptions on the LTS may lead to hundreds of thousands of customers affected for a considerable duration.

Health & Safety Risk

Rupture / Leak Ignition – Where the gas escape ignites, creating severe thermal radiation at up to a 1-mile radius.

Non-ignition impacts – Where a release of confined kinetic energy leads to blast damage or a pressure wave.

Carbon Risk

Leak – Where gas escapes through a stable hole whose size is less than the diameter of the pipe.

Rupture – Where gas escapes through an unstable defect which extends during failure to result in a full break of failure an equivalent size to the pipeline.

Loss of gas – Where gas escapes through either a hole or full rupture of the pipeline.

Financial Risk

The direct financial costs to the business for without-intervention work to the assets such as such as repair.

Customer Risk has been taken into account to analyse the impact on risk with respect to the start of RIIO-GD3 level for all of our options in Sections 8 & 9, and within our cost benefit analysis, as it has been determined to be the principal risk for LTS assets as discussed further below.

Where the principle of total monetised risk, applied across the asset base, is:

Total monetised risk = PoF x PoC x CoC

Different supply/demand scenarios have not been considered during our modelling as the current NARM Methodology does not include analysis for this. This is a future update to NARM in gas distribution that has been identified within the Methodology document and will be reviewed by the networks through NARM working groups. Overall, we are forecasting a slow recovery from impacts of the cost of living crisis and total domestic demand is forecast to return to 2021 levels between 2029 and 2031 for the NE (historically North East) and NO (historically North) distribution zones of our network. This is based on established econometric modelling and demand forecasting methodologies.

Although the NARM Methodology does not account explicitly for supply demand scenario analysis, the fault and failure data we currently base our modelling calculations includes data collected over a period of historic years, which goes back to before 2021. Consequence data from company systems also reflects the latest available view for our asset base at 2023/24 and is also based on data from historic events collected over a period of time. Therefore, we do not anticipate demand to have a material impact on our investment decisions or their benefits during RIIO-GD3.

NGN's Value Framework

We have developed an NGN Value Framework which we use to assess the value of intervention options consistently across asset classes. We use the NARM methodology as the basis of our Value Framework and are consistent with the Consequence Measures. However, we have re-categorised them into five risk groups, not four, so that there is clear distinction between NGN and societal costs and benefits and so that the present values being calculated are correct. This is further explained in our Network Asset Management Strategy. The five risk groups within our Value Framework are: Customer Risk, Health & Safety Risk, Environmental Risk, Compliance Risk and Financial Risk.

To derive a monetary value for the Cost of Consequence each Consequence Measure is allocated a monetary value which is multiplied by the quantity of the consequence. The monetary values used within our Value Framework are based on the agreed NARM assumptions and uses values common across GDN's such as the base price year, industry approved values such as the cost of carbon or the social cost of an injury and values specific to our business such as the cost of maintenance or the cost of loss of supply. The quantities we use are specific to our network such as the number of domestic properties at risk of a supply interruption and have been derived from system data, network analysis or assumptions based on demands, flow and redundancy.

When justifying our RIIO-GD3 capital programme the monetary value of each Consequence Measure is calculated to determine the benefit or avoided cost of an intervention. Examples include:

Health & Safety Risk – Societal benefits in avoided costs through reductions in the probability of fatality or non-fatality injury. These costs are in accordance with the NARM methodology.

Customer Risk – Avoided GDN costs through a reduction in costs of supply incidents (loss of supply). These costs have been calculated from historic incidents and the probability and scale of the incidents are based on NARM models. This risk is particularly key in the context of LTS pipelines thus it has featured in the Cost and Benefit Analysis.

Compliance Risk – Avoided GDN costs through a reduction in costs of fines and paying for explosion damage. These costs are in accordance with the NARM methodology. They have been separated from direct Financial Risk as we consider them highly uncertain and likely significantly underestimated by the values in NARM, which does not consider reputation, legal and handling costs.

Financial Risk – Avoided GDN costs through reductions in the costs to fix assets on failure and the direct financial cost of the gas leaked from and consumed by our assets. These costs are in accordance with the NARM methodology.

Environmental Risk – Societal benefits in avoided costs through reductions in the volume of carbon emitted when gas is leaked or consumed. These costs are in accordance with the NARM methodology and industry approved values.

Our Commitment to Resilience

Chapter 5 of our Business Plan demonstrates our longstanding commitment to ensuring that we are able to operate and maintain a resilient network. We have formalised our Resilience Framework and developed a number of individual resilience strategies which allow us to maintain our high standards. Our Resilience Framework ensures that we continually review the hazards facing our business and assess whether mitigations that we have in place remain sufficient or need to change. This is relevant to our asset management strategies as we need to take into account exogenous factors when considering both short- and long-term investment plans. Our Network Asset Management Strategy which is set out in **Appendix A18** brings this all together.

We have introduced a range of other resilience strategies, such as **Appendix A8 – Climate Resilience Strategy**. A climate risk assessment sets out the risks facing NGN currently, in 2050 and in 2100, as set out in section 1.5.2 of the strategy. The climate scenario risk analysis did not identify high risks for either the 2oC or worst-case 4oC warming scenarios assessed. As such, this recognises our resilience to material climate change risks in the long to very long term (2050+). This is due to our comprehensive asset integrity and management procedures that are in operation to ensure asset condition and performance. In addition, there is inherent resilience afforded by gas infrastructure assets being a sealed, pressurised system principally located underground. Resilience levels to climate change risks will be greater in lesser warming scenarios should they arise, due to lower climatic extremes. The likely current and future climate risk has been factored into our preferred strategies across our LTS assets from the outset by utilising our SME knowledge and risk assessments mentioned above.

We are taking a similar approach to RIIO-GD2 in putting together our investment plan, taking a balanced approach to asset management to ensure a safe, reliant and compliant network – ensuring we can continue to meet our licence obligations whilst at the same time minimising costs for customers.

8. Options considered

Types of Intervention

There are various ways in which we can intervene on our assets within this asset group. Each intervention has its own merits and drawbacks and the key to effective asset management is to understand how the assets behave and use data and information to ensure the right decisions are made, balancing risk and value to deliver a safe and reliable service for our customers. The interventions available for this asset group are:

Maintenance and repair – Pre-planned inspections and reactive repair works to ensure that performance is optimised, and the asset reaches its expected life. An example of this would be installation of a transmission shell around a defect following a planned Pipeline Safety Regulation (PSR) in-line inspection (ILI). This is a well-established, rigorous inspection and remedial programme which we propose to continue with in RIIO-GD3.

Refurbishment – A proactive planned intervention which includes inspection and replacement or servicing of major components and soft parts with the intention of extending the expected life of the asset. Examples of this include blasting and re-coating an overcrossing to ensure continued protection from the elements, or undertaking a localised diversion around a known issue along the pipeline such as drilling under a river where the pipeline has become exposed from riverbed erosion and other remediation is not suitable. There is a mix of a variety of refurbishment interventions proposed within our RIIO-GD3 plan, but mainly associated with the sub-assets such as PIG traps, Valves or Cathodic Protection. We are also proposing two localised diversions based on our experience during RIIO-GD2.

Replacement – Installation of a new asset to replace an existing asset, often because of poor condition, the new asset will of the same capacity but likely be a newer design. When considering the LTS this intervention is typically a last resort due to the large expense involved. We are not proposing to replace any high-pressure pipelines in RIIO-GD3.

Addition – Installation of a new asset on our network to provide extra capacity or increased service levels, usually in response to increased growth, customer requests or a Cost Benefit Analysis assessment. We are not planning to introduce any new high-pressure pipelines during RIIO-GD3.

Removal – Where we no longer require an asset, or we can manage our network in a more efficient manner we decommission and dispose of the asset from our network. We are not considering the removal of any high-pressure pipelines within RIIO-GD3.

Solely acting on failure, whether replacing or refurbishing, is a high-risk strategy for these assets and not acting at all is completely unacceptable due to health and safety, compliance and long-term financial and environmental cost. We are therefore not proposing these options to be available for this asset class.

Future Energy Pathways

Assumed proportion of methane is important within the risk calculations and CBA as within the NARM methodology the carbon equivalent of the methane content of the gas lost from our assets is quantified, resulting in a monetised Carbon Risk. Gas can be lost from our mechanical assets through leakage or failure.

We have gone with 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 our investments.

We have not explicitly modelled changes in the methane content of gas in our CBAs, as overall gas demand and the change in CO2 content of the gas is not expected to be different enough to materially impact the NPV, Payback & Option Ranking of our preferred investment programme. Our chosen programme represents value for money over a 20-year period regardless and is mainly driven by customer benefits such as avoiding loss of supply. The investments also ensure that we are compliant with relevant legislation. Our strategy therefore 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.

How we make asset decisions

We aspire to make conscious decisions that are balanced across our asset portfolio to ensure we can leverage the most value out of our assets. In making conscious decisions we can evaluate the risk we hold as a business and the impact it has on our strategic objectives. Asset management relies on accurate data. During RIIO-GD2 we have been working to improve our data and the way we capture and store this information, so it can be used to benefit our decision-making process. We use a wide range of asset data, global values such as the cost of carbon and specific values such as the loss of supply, costs from our updated unit cost analysis (see **section 8.6**) and the NARM methodology to calculate risk and value. Technical experts analyse options and set constraints (such as a constraint with the objective of maintaining risk) within our Decision Support Tool which maximises the value of our investments for the given constraints. We use the value measures from our Decision Support Tool in Ofgem's Cost Benefit Analysis template to compare the Net Present Value (NPV) of each option against the baseline option to determine the most suitable capital programme in RIIO-GD3. The diagram above is a simplified representation of this process.

Figure 11 How we make decisions

Options analysis

Our investment in LTS pipelines is distributed among the various sub-assets within this asset class. This section builds upon the case studies discussed in section 5, providing a deeper examination of these specific areas to illustrate the complexities of the work involved and how it informed the development of the optioneering proposals.

Cathodic Protection

We monitor our CP systems rigorously to ensure they are operating correctly and therefore providing sufficient corrosion protection. As described in section 4, there are two types of CP systems: Impressed current (Transformer Rectifier and a Groundbed) and Sacrificial Anode (Anode 'bag' bonded to a pipeline). Impressed Current systems are durable, but like any electrical equipment, the TR can become outdated, and the groundbed will eventually deplete and need replacement. We maintain a good record of our Impressed Current systems, regularly monitoring the TR units and collecting output information which allows us to build up an indication of the remaining life of a groundbed. Each groundbed is assigned a % life remaining and can therefore be prioritised for intervention on this basis. The TR units are robust, and only need replacing when they become obsolete or start malfunctioning. However, environmental and socio-economic changes, and evolving standards means that the location of some of our TR units has become unsuitable due to access restrictions or health and safety considerations. Sacrificial anode systems are often used to protect smaller lengths of pipeline or in instances where Impressed Current systems pose a risk of electrical interference. These systems are less complicated and must be maintained through ensuring that test posts are available and accessible and anode bags replaced when they become depleted. Regular monitoring allows us to continuously re-appraise the asset health and ensure that our investment proposals are aligned with the latest data.

Valves

There are various valves around the LTS network used to regulate pressure within the pipeline, isolate it completely or control the gas flow into some of the ancillary equipment, such as PIG traps. Valves are reliable when properly maintained, so we rarely encounter problems with them. During RIIO-GD3, potential problems

may include the aging and wear of PIG trap valves, as well as the ongoing issue with the worsening condition of our underground chambers that house block and line valves. We began addressing this issue with a small-scale improvement programme in RIIO-GD1 and continued during RIIO-GD2.

PIG Traps

We own and maintain a large number of PIG traps in the network, although we sometimes hire them from a few specialised suppliers for scheduled inspections. As with any pressure vessel, these assets follow strict safety procedures and undergo regular monitoring, which results in few problems with these assets. Besides routine maintenance, we anticipate needing additional portable PIG traps for the pipelines selected for inspection during RIIO-GD3. Since many of these pipelines are of similar diameter, we expect to require more PIG traps of that specific size to meet the programme's needs.

River Crossings

We perform regular inspections of the river crossings within our network to promptly identify and address any exposures and related safety concerns. Due to the nature of this issue, predicting the exact number of occurrences over a specific time frame is difficult. Natural evolution causes rivers to change and adapt; environmental changes result in more flooding events that can worsen alterations in watercourses, causing increased riverbed scour or riverbank erosion and potentially exposing pipelines. Throughout RIIO-GD2, we have already managed ten instances of exposure that necessitated different levels of remediation.

Sleeves

In past RIIO periods, we have resolved issues related to the most problematic vacant sleeves. As a result, we only expect routine maintenance tasks, like nitrogen re-fills, to be necessary.

In optioneering, we aimed to combine the aspects described above and focused on the risk associated with the loss of supply primarily, as this is one of the key areas for risk within the LTS asset class. We used the outputs in our Cost Benefit Analysis to compare the net present value of each option against the baseline scenario to determine the most suitable capital programme in RIIO-GD3.

NARM does not fully capture the risk of supply loss, necessitating a network methodology to provide a more accurate assessment of failure risks. The methodology incorporates several factors to provide monetised risk value, derived from likelihood of failure, likelihood of loss of supply due to failure, customer numbers fed by the pipeline, cost per day and duration to provide a total risk value:

$$\boldsymbol{P_f \times P_c \times N_c \times C \times N_s \times D = T_r}$$

In the instance of LTS pipelines these values have been determined through network analysis, known project lead times and loss of supply metrics:

$\boldsymbol{P_f}$ **Probability of Failure:** Probability of asset failing set based on expected number of failures due to corrosion across the LTS pipeline portfolio at the beginning of RIIO-GD3 and then varied based on intervention extent.

$\boldsymbol{P_c}$ **Probability of Consequence:** Probability of loss of supply event following asset failure, fixed at 100%.

$\boldsymbol{N_c}$**Number of Customers:** Value of customers impacted through loss of supply event, fixed at 52,235 customers based on network analysis.

$\boldsymbol{N_s}$**Number of sites:** There are 165 LTS pipelines – but for the purposes of the calculation and the probability of failure described above, LTS pipelines are treated as a single cohort.

C **Cost per Day:** Cost of per day per customer of loss of supply, set at £300 based on network loss of supply metrics

D **Duration of Loss of Supply**: duration between loss and reconnection of supply, base value of 60 days.

Ofgem CBA Template Assumptions

For all CBAs in our RIIO-GD3 submission, we used an assumed weighted average cost of capital (WACC) of 3.92% based on Ofgem guidance (a real average basis). We have assumed a depreciation Acceleration Factor of 100% across all CBAs and scenarios, i.e. no additional acceleration of depreciation. For Capex CBAs we have assumed a capitalisation rate of 33.7% based on our Totex forecasts in BPDTs and 100% for Repex CBAs. First year of expenditure outflow is set to 2027 in all scenarios for consistent relative NPV calculations. This is in line with Ofgem guidance for RIIO-GD3 and the approach taken in RIIO-GD2. We consider that the plausible ranges of these parameters would not materially affect CBA outcomes and have provided only one version of templates with these consistently applied (as they can be adjusted by Ofgem in any case).

We have not provided direct Opex associated with each CBA scenario as it would require us to artificially and subjectively divide up our maintenance and repair expenditure into each sub-asset class (CBA) and make a judgement on how this would be affected by each scenario. We do not record or report data at this level and we have no robust basis on which to provide it. In reality, maintenance and repair teams attend to multiple asset classes in single visits as part of an efficient function. Instead, we have provided the objectively calculated VF Financial risk, which is based on agreed industry NARM based calculations for estimating impacts on Opex under each CBA scenario. For those asset groupings not covered by NARM we have only included benefits and impacts of key benefits e.g. leakage. We consider this to be a more robust and objective approach to our CBAs. We have completed the NARM monetised risk memo lines from values in the NARM BPDT for baseline and preferred where they are available and relevant.

8.1. Baseline – Do minimum/nothing

This option is used as the baseline for which all other options are measured against. It does not include any capital investment but instead relies on the ongoing maintenance activities and repairs on failure. The cost of this is estimated at £7.23m. There are no direct benefits accrued under this option however it does include financial and societal impacts associated with loss of supply. This is equivalent to the deferral option.

8.2. First option summary - Limit investment

This option aims to target the key issues in each of the sub-assets, so can be phrased as a ‘do minimum’ option.

For Cathodic Protection, it is essential to address the systems that will become non-operational during RIIO-GD3 due to depleted groundbeds. A malfunction of Cathodic Protection can result in the pipeline experiencing increased corrosion, which could necessitate costly repairs or even replacement to maintain safety and reliability. If left unchecked, corrosion could lead to leaks and disrupt supply security. Our data suggests that 17 systems will fall into this category. Although this approach aims to minimise intervention and only target the key deliverables in terms of supply disruption, it overlooks other issues within this sub-asset that present risks, especially those related to the health and safety of our employees.

When it comes to valves, it is crucial to ensure their operational status through regular maintenance plans. Therefore, for this option, we have opted to simply continue with the existing maintenance strategy without further investment. This approach, however, does not take into account scenarios where the valve chamber is

inaccessible or unsafe, thereby preventing inspection and maintenance of the valve. These issues cannot be resolved without adequate investment.

For PIG traps within this option, we have decided against additional investment beyond the regular maintenance and repair. Whilst this option saves on the initial Capex, it ignores the potential risk we may face in RIIO-GD3 due to not having the adequate number of PIG traps of the necessary size, which could jeopardise our in-line inspection and revalidation programme.

In addressing river crossings, this option includes a provision to maintain similar levels of investment as during RIIO-GD2 to ensure that any emerging issues can be addressed promptly. This equates to five in-channel remedials and two LTS diversions, ensuring the integrity and safety of our river crossings.

Lastly, for sleeves, as explained earlier in Section 8, we are proposing ongoing maintenance only. This approach aims to manage the existing issues without additional capital investment, focusing on sustaining the current operational standards.

Overall, limiting investment in the way described above is very likely to have a negative impact on the ongoing maintenance cost. The range of impact is vast – from additional costs associated with, for example, aborted maintenance visits due to teams being unable to access a block valve chamber or a Transformer Rectifier, to potential costlier consequences of prolonged inability to properly maintain these assets, such as inability to access or operate a valve in an emergency or pipeline failure due to increased corrosion resulting from malfunctioning Cathodic Protection system.

8.3. Second option summary - Expand investment

This approach seeks to broaden the scope of investments and minimise risk.

For Cathodic Protection, we suggest increasing the number of systems addressed from those that would become non-operational during RIIO-GD3 due to depleted groundbeds, to include those that might become non-operational during both, RIIO-GD3 and RIIO-GD4. If Cathodic Protection fails, the pipeline may suffer higher corrosion levels, leading to expensive repairs or even replacement to ensure safety and reliability. Unchecked corrosion could result in leaks and compromise supply security. Our data indicates 35 systems will be affected. Beyond focusing on avoiding supply issues, we also propose addressing health and safety concerns associated with some of our TR units. Some units have deteriorated, and others have become unsuitable due to access restrictions or safety considerations. According to our data, 42 TR units need remediation.

Regarding valves, apart from continuing existing maintenance, this option aims to target all underground valve chambers not yet addressed during RIIO-GD1 and RIIO-GD2 and undertake a major refurbishment programme in RIIO-GD3. We also plan to address aging PIG trap isolation valves as wear and age-related issues arise.

For PIG traps, we will acquire five new portable PIG traps to enable the nine smaller diameter inline inspections (6- and 8-inch diameter) across the five-year period.

Concerning river crossings, this option includes diverting all river crossings found to be exposed in RIIO-GD3. The estimated seven exposures described in section 8.2 would mean that seven LTS diversions would be needed. If this was the case, delivery of such proposals would almost certainly extend into RIIO-GD4 due to the complexity of such works, therefore a challenging, but somewhat more realistic estimate of one diversion per year (five) are part of the proposal.

Lastly, for sleeves, as outlined earlier in Section 8, we propose to continue with the ‘do minimum’ approach.

While this strategy addresses the most amount of risk, it would also be the costliest due to advancing investments into RIIO-GD3. Furthermore, the maintenance cost overall is likely to remain broadly at current levels despite the additional Capex investment. This is due to the LTS pipeline inspection requirements and regular survey and maintenance of related sub-assets.

8.4. Third option summary - Balanced approach (preferred option)

Option four aims to find a balance between options two and three in order to maintain an acceptable level of risk associated with the LTS assets while focusing on the cost levels necessary to achieve the expenditure objectives outlined in section five. This is our preferred option.

For Cathodic Protection, we are proposing to address both – the supply interruption and health and safety risk, but steer away from bringing forward any RIIO-GD4 investment due to the cost implication. This would result in 59 Cathodic Protection interventions in total across the RIIO-GD3 period.

Concerning valves, a balanced approach between options 2 and 3 would be to address the civil and structural issues raised about our valve chambers while implementing a manageable programme similar to what we are successfully executing during RIIO-GD2. This approach would also meet cost constraints. Additionally, refurbishing the PIG trap isolation valves will ensure these essential valves gain an extended lifespan at a reasonable cost.

To effectively manage the in-line inspection programme during RIIO-GD3, particularly for smaller diameter pipelines, it is essential to have the appropriate resources available. For this option, we will use a combination of purchasing and hiring, and we plan to acquire 2 additional portable PIG traps.

For river crossings, we propose that the option described in section 8.2 is the most conservative whilst still being realistic, based on our RIIO-GD2 experience. We therefore expect to have to carry out five in-channel remedial interventions and complete two LTS diversions.

Finally, no change is proposed to our approach to sleeves – we are going to continue with maintenance activities of monitoring and nitrogen fill where required.

The mix of work described in this option has been selected using the latest asset data to address the issues arising from our aging infrastructure. From addressing river crossings to managing Cathodic Protection and valve chambers, we are able to prioritise key asset sub-categories to effectively balance the priorities of risk mitigation and cost management. By carefully selecting interventions that address the most critical issues while deferring less urgent investments, we can ensure that we are correctly managing both our resources and our infrastructure.

8.5. Options technical summary table

The below table summarises the options explored. It shows:

- The types of interventions that are being proposed,
- The volume of those interventions attributed to each option,
- The associated costs that have been allocated using the unit costs derived from similar works during RIIO-GD3,
- Design Life estimated by our Subject Matter Experts, and
- Period of spend – RIIO-GD3.

Option	Intervention type	Period of spend	Total CAPEX volume	Total CAPEX cost £m	Design Life
8.1 Reactive	Cathodic Protection	2026-2031	*0*	*£0.00*	n/a
	Valves		*0*		
	PIG traps		*0*		
	River Crossings - remediate		*0*		
	River Crossings - divert		*0*		
8.2 Limit Investment	Cathodic Protection	2026-2031	*17*	*£2.19*	20 years
	Valves		*0*		40 years
	PIG traps		*0*		40 years
	River Crossings - remediate		*5*		0-50+ years
	River Crossings - divert		*0*		50+ years
8.3 Expand Investment	Cathodic Protection	2026-2031	*77*	*£27.08*	20 years
	Valves		*56*		40 years
	PIG traps		*5*		40 years
	River Crossings - remediate		*0*		0-50+ years
	River Crossings - divert		*5*		50+ years
8.4 Balanced Approach (Preferred)	Cathodic Protection	2026-2031	*59*	*£5.63*	20 years
	Valves		*25*		40 years
	PIG traps		*2*		40 years
	River Crossings - remediate		*5*		0-50+ years
	River Crossings - divert		*0*		50+ years

Table 5 Options technical summary table

9. Business case outline and discussion

9.1. Key business case drivers description

This section intends to illustrate the outcomes of the optioneering process within this asset class. We have assessed the present value of each investment option between 2027 and 2070. By comparing the capital and operational expenditures for each scenario, as well as the impact it would have on the Loss of Supply risk, we derived all present value figures and evaluated them against the monetised risk associated with the “Do nothing” option described in section 8.1.

The below graph shows how each option impacts the Customer Risk. Limiting investment reduces the risk, however the reduction is only around 5%. Expanding investment reduces the risk by over 26% during RIIO-GD3, however it also comes at a cost of over £27m. Finally, the balanced programme offers an 18% risk reduction during RIIO-GD3 for £5.63m – under 21% of the cost.

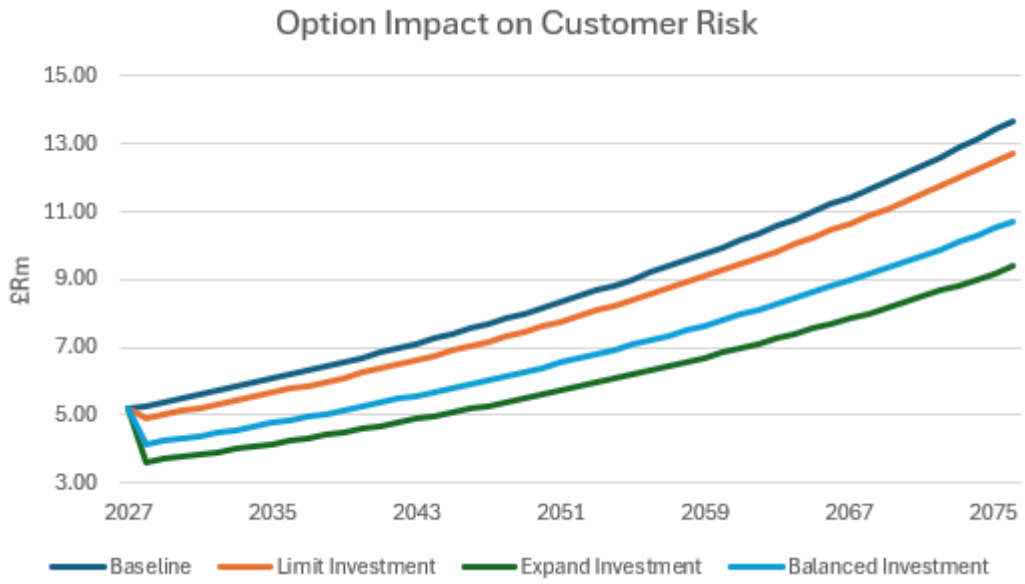

Figure 11 Change in Customer Risk (£m) attributed to different options

Our analysis of the business case drivers for each option reveals distinct attributes and potential benefits. Here, we outline the key value drivers for each of the four options:

Option 1: Reactive

Value Drivers:

- No upfront capital expenditure

Justification:

This option involves taking no action beyond routine maintenance. While this approach minimises short-term costs, it poses a significant risk of increased long-term expenditures due to potential pipeline failures and increased operational risks.

Option 2: Limit investment

Value Drivers:

- Lower capital investment compared to more comprehensive options (£2.19m – 13% of the RIIO-GD2 cost)
- Targeted risk reduction to address key issues driving biggest risk before intervention

Justification:

This option proposes limited interventions aimed at mitigating the most critical risks associated with security of supply. It places more focus on cost management, limiting capital expenditure.

Option 3: Expand investment

Value Drivers:

- Highest level of risk mitigation
- Enhanced operational safety and reliability
- Proactive asset management

Justification:

This option involves major interventions and a significant capital investment to upgrade key infrastructure, aiming to maximise risk reduction and ensure top operational safety and reliability. It provides the most thorough solution for long-term asset management, but costs over 64% more than the RIIO-GD2 LTS proposal.

Option 4: Balanced Approach (preferred option)

Value Drivers:

- Moderate capital expenditure - 34% of the proposal in RIIO-GD2. This is due to fewer diversions being included in the RIIO-GD3 proposal than that in RIIO-GD2.
- 18% risk reduction
- Improved asset reliability
- Objectives in section 5 satisfied or exceeded

Justification:

This option involves a more comprehensive set of interventions than options 1 and 2, including significant upgrades and purchase of new equipment. It aims to address a wider range of issues and vulnerabilities, thus ensuring better long-term asset performance and reliability while still managing costs effectively and providing a compromise between doing little to nothing and full-scale interventions.

Each of these options offers a different approach to balancing risk, cost, and asset performance, providing a spectrum of solutions from minimal intervention to extensive upgrades.

9.2. Business case summary

The table below details the headline business case metrics to allow a high-level comparison of the options:

Option	Desciption	RIIO-GD3 Intervention Volume	Total NPV compared to Baseline at 2070 (£m)						Payback (years)	Total Risk Change from 2026
			2035	2040	2045	2050	2060	2070		
-	Baseline/Reactive		-£50.8	-£72.9	-£93.4	-£112.4	-£146.7	-£177.5		10.4%
1	Limit investment	22	£0.9	£2.2	£3.5	£4.8	£7.2	£9.3	6	2.8%
2	Expand investment	143	-£9.7	-£5.0	£0.3	£6.0	£16.7	£26.4	19	-24.2%
3	Balanced Approach **(preferred)**	91	£3.8	£8.1	£12.3	£16.3	£23.7	£30.4	4	-13.4%

Table 6 Cost and Benefit Analysis summary

All proposed options achieve payback by 2045, this is due the value of Capex investment on LTS pipelines being relatively low when compared to some other asset classes. Expanding Investment comes at a cost higher than that in RIIO-GD2 and only returns a positive Net Present Value (NPV) in 19 years.

Limiting investment is the least capital cost option, at £2.2m, and pays back within 6 years. It does not, however, address some key intervention requirements, such as the purchasing of additional portable PIG traps or ensuring that below ground valve chambers are safely accessible for maintenance and operation purposes.

Finally, the Balanced Investment option manages cost (£5.6m – 34% of that proposed in RIIO-GD2) and provides positive NPV in 4 years. Furthermore, this option has the highest NPV in 2070, which represents the best long-term investment.

10. Preferred option scope and project plan

10.1. Preferred option

The preferred option is the Balanced Investment option described in section 8.4.

The table below provides details of the preferred option Capex spend (all A3) alongside Single Year Risk benefit and Long-Term Risk benefit output as shown in our NARM BPDT (Business Plan Data Template). Long-Term Risk calculations allow for accrual of benefit over the life of the intervention. These intervention lives are detailed in full in our NARM BPDT submission. In section 8.4 we detail the investments within our Preferred option.

	CAPEX Spend (£m)	NARM BPDT	
	All Investments	Single Year Risk Benefit (R£m)	RIIO-GD3 Long Term Benefit Output (R£m)
LTS	5.63	*0.006*	*0.207*

Table 7 A3 LTS Investment NARM benefit

10.2. Asset health spend profile

The table below details the preferred option's workload and expenditure during RIIO-GD3:

	GD3 Workload					
Intervention	**2026/27**	**2027/28**	**2028/29**	**2029/30**	**2030/31**	**Total**
Portable Pig Traps	1	1	0	0	0	**2**
River Crossings - remediate	1	1	1	1	1	**5**
Block valve civil upgrades	3	3	3	3	3	**15**
CP Replacements - Groundbeds	3	4	3	4	3	**17**
CP Replacements - TR	8	9	8	9	8	**42**
Pig Trap Isolation valves	2	2	2	2	2	**10**
TOTAL						**91**

Table 8 Proposed LTS workload distribution

	GD3 Cost (£m)					
Intervention	**2026/27**	**2027/28**	**2028/29**	**2029/30**	**2030/31**	**Total**
Portable Pig Traps	£0.22	£0.22	£0.00	£0.00	£0.00	**£0.44**
River Crossings - remediate	£0.20	£0.20	£0.20	£0.20	£0.20	**£1.00**
Block valve civil upgrades	£0.20	£0.20	£0.20	£0.20	£0.20	**£1.02**
CP Replacements - Groundbeds	£0.21	£0.28	£0.21	£0.28	£0.21	**£1.19**
CP Replacements - TR	£0.32	£0.36	£0.32	£0.36	£0.32	**£1.68**
Pig Trap Isolation valves	£0.06	£0.06	£0.06	£0.06	£0.06	**£0.30**
TOTAL						**£5.63**

Table 9 Proposed LTS cost distribution

NGN's expenditure forecasts are built on a tried and tested, robust and efficient process. This is founded in asset management principles that has seen NGN consistently benchmarked as the most efficient gas distribution

company by Ofgem since 2005. It should be noted that "robust and efficient costs" should not be interpreted as lowest cost. We have and are currently experiencing external and internal cost drivers that are increasing the cost to deliver some workloads and maintain service and compliance objectives. At NGN robust and efficient costs are defined as those which address the network, customer service and environmental risk in an effective and enduring way, to avoid future additional costs or service interruptions. Notably, Health and Safety and Security of Supply are priority drivers in determining the appropriate balance of risk and cost which enables investment decision making. As such, our costs are efficient over the life of the intervention and not just at a point in time, which would reduce cost but risk service failures or increased costs in future periods.

NGN's efficient and robust process to determine expenditure is as follows:

- Historic analysis of previous investment programmes to understand how expenditure has been effective in managing risk and the service levels that have been delivered. This provides the actual delivered cost of reducing risk and delivering services levels.
- Forward looking analysis of risk profile, cost drivers and pressures to understand what the forecast programme of work is and the cost associated with maintaining or enhancing performance. This allows a clear articulation of how actual delivered efficiency translates into future cost, accounting for any cost variance.
- A comparison of historic cost base versus forward projection to ensure costs are targeted at addressing compliance requirements (HSE), supply demand and account for additional costs drivers or challenging areas of work.
- Compare asset specific costs against third party industry database to understand where deviations from average costs might be and the reason for these changes. Third party data base is provided by Aqua Consultants who maintain database for regulated sectors.
- Compare costs against year 3 Industry RRP to assess how NGN costs compare to current delivered costs across GDNs.
- Compare future investment programme to current actuals using Ofgem RIIO-GD2 benchmarking to understand where NGN may be benchmarked on a like for like for like basis.
- Undertake robust Internal challenge with Independently appointed experts to weigh pros and cons of business case and relevance of costs to meet service levels and manage network risk.

The costs are then deemed to be robust and efficient from an NGN perspective and will be subject to a final technical scrutiny by an external consultant to ensure costs, benefits and risk removal are justified.

As demonstrated above, the unit costs used in both our Cost Benefit Analysis and capital expenditure forecasts have been derived using historical project cost knowledge, SME input on current cost trends and current cost quotations, to provide confidence in their accuracy, consistency and credibility. Since the introduction of SAP HANA S4 in Oct 2019 we have captured project costs at a more granular level to support regulatory reporting and to aid future investment decisions. During RIIO-GD1 the Unit Cost Database (UCD) was developed, this used extensive volumes of project cost data to derive cost curve models and provide a cost trend allowing for an accurate cost estimate, the allowances for RIIO-GD2 were driven by the UCD. External Project management, untimely delivery by contractors and third-party delays could all impact on costs, but uncertainty risk relating to unit cost was built in during the development of the UCD in RIIO-GD1 and has carried through into the RIIO-GD3 business plan development. The RIIO-GD3 unit rates incorporate analysis of efficient historical projects. No explicit efficiency over and above this is included within this EJP appendix as our efficiency target is covered within the main business plan - a 0.5% Ongoing Efficiency (OE) target. This means that in reality, NGN will be subject to a further 0.5% cost reduction target throughout RIIO-GD3 in order to meet the OE objectives that will be set by Ofgem (refer to Chapter 6 of NGN's Business Plan).

As a reliable starting point, our RIIO-GD2 unit cost allowances were converted to 23/24 prices. RIIO-GD3 project costs and forecasts were then compared against the 23/24 allowances. Where there were significant variances, time was spent with delivery and commercial SMEs to review and understand these differences. Technology improvements (new functionality), resource scarcity and project management are examples of where we have seen deviations in the RIIO-GD2 allowance, these have been reflected in the base RIIO-GD3 unit costs.

We have Framework partners in place for Capex delivery projects which improve certainty and ensure efficiency of costs.

The table below provides a summary of the assumed unit costs applied in modelling and CBA analysis for LTS Pipelines related work. For the avoidance of doubt, costs are shown in 2023/24 prices.

	GD3 Unit Cost 23/24
Replace Portable Pig Traps	£222,048.53
River bed / bank erosion - remediate	£200,000.00
River bed erosion - divert (Inc River Allen)	£3,682,973.09
Block valve civil upgrades	£67,891.93
CP Replacements - Groundbeds	£70,000.00
CP Replacements - TR	£40,000.00
Pig Trap Isolation valves	£30,000.00

Table 10 LTS unit costs

10.3. Investment risk discussion

The LTS asset class is comparatively small when considered against other asset classes, and the preferred scenario within the RIIO-GD3 investment strategy targets protective interventions only, limiting the risk of variability of failure rate and unit cost. Controls and processes have been put in place throughout the development of our RIIO-GD3 Capital Expenditure programme to ensure we mitigate both our customer's and our own exposure to risk, both in terms of the options considered and our approach to management of our high value assets. In undertaking a minimal cost approach, protective asset intervention as opposed to pipeline replacement, the scenario is a low-risk approach due to the strategy of investment proposed. Any variability in unit cost or rate of failure within the types on intervention would not have a significant impact on total investment.

Workload and unit cost risks are inherent when forecasting failure rates and intervention solutions for large populations of assets. The bullet points below outline the steps we have undertaken to ensure we limit these risks to provide an accurate capital programme.

Workload risk mitigations

- We have used a network methodology to calculate individual asset's Probability of Failure which uses asset attributes to determine specific failure rates (see Section 8).
- We regularly monitor our pipelines and ancillary equipment. The latest information from our in-line inspection schedule and Cathodic Protection performance has been used within our modelling.

- We have considered various options including workload volumes and chosen the solution which provides our customers with the most appropriate balance between cost, risk and service.
- We developed our optioneering with our businesses industry experts to ensure realistic volumes and costs
- Our RIIO-GD3 strategy is comparable with our RIIO-GD2 strategy and so we have a proven record we can manage our assets in this way.

Unit cost risk mitigations

- We have used our updated unit cost analysis (see section 10.2) to determine our unit costs.
- We are not planning to undertake new work activities. We have undertaken all interventions previously and therefore have recent cost examples.
- We have experienced Project Managers who have a proven track record of delivering this type of work in the past and we have a commercial team of quantity surveyors who are focussed on delivering value for money.
- Section 4.1 of **Appendix A7 – Workforce and Supply Chain Resilience Strategy** sets out some of the supply chain challenges that we have faced throughout RIIO-GD2. It acknowledges how NGN is a comparatively smaller GDN, which reduces our buyer power (section 4.1.2) and also discusses the significant inflationary pressures that have been placed on GDNs (section 4.1.4). For example, it discusses how the prices charged for coiled pipes have increased by 82% in the period from January 2020 to August 2023. In spite of these challenges, we are confident that our input unit costs remain efficient. This Appendix also touches on a number of external shocks which have impacted on things such as lead times. Examples include the Covid-19 pandemic, the Suez Canal blockage, Russia's invasion of Ukraine and rising geopolitical tensions. We outline in the strategy how we expect volatility to continue across our supply chain, and that we will utilise storage facilities in order to mitigate against supply input shortages. We plan to resource our supply chain and procurement team appropriately to help us overcome these challenges.

Appendix A21 – Cost Assessment and Benchmarking Approach demonstrates how, despite challenges facing us, NGN leads the industry in terms of cost efficiency, having been ranked the most efficient operator by Ofgem in both RIIO-GD1 and RIIO-GD2. This Appendix further outlines the value of NGN in Ofgem's cost assessment modelling at RIIO-GD2 by showing how NGN's frontier setting performance enabled Ofgem to set cost allowances that were £211 million lower than they would otherwise have been. In other words, our efforts to lead the sector on cost efficiency have resulted in significantly lower bills for consumers across the whole country.

We have achieved this position by being innovative in our thinking and directly and aggressively challenging industry norms and practices by bringing forward market-led, commercially focussed business solutions across almost every area of our business. For example:

- NGN introduced modern labour terms and conditions (T&Cs) for the majority of its operational workforce, leading to a significant reduction in legacy staff costs.
- NGN introduced a Direct Service Provider (DSP) model, leveraging small local engineering firms to deliver its replacement program instead of relying on the traditional 'tier 1' companies that have typically dominated the industry.
- Given that NGN has made strong productivity improvements over time, we have re-invested our outperformance payments in areas that (among other things) improve our productivity further. For example, we have used outperformance to invest heavily in IT systems through the SAP4 Hana investment and 'Future Ways of Working' programme. These projects are expected to significantly improve the customer experience and enable NGN to become a data-focused business.

We also outline in this Appendix our suggestion to target a 0.5% Ongoing Efficiency (OE) target, alongside the reasons why this is an appropriate level (see section 6 of the Appendix). This means that in reality, NGN will be subject to a further 0.5% cost reduction target throughout RIIO-GD3 in order to meet the OE objectives that will be set by Ofgem.

We outlined above how we have faced price increases significantly above inflation during RIIO-GD2. The Real Price Effects (RPE) methodology attempts to adjust for the difference between input price inflation and consumer price inflation. We outline in the Appendix our broad support for RPEs, however we note that during RIIO-GD2, all networks have seen relatively large swings in real term allowances year to year due to RPE and inflation volatility from the geopolitical energy shocks in 2022 and 2023. RIIO-GD3 therefore presents an opportunity to refine the basket of reference indices to better capture GDNs actual input price movements and better mitigate this risk. The impact of RPEs have not been factored into our unit cost pricing.

10.4. Project plan

With the exception of river crossing related issues, our LTS interventions will continue as part of the rolling programme established during RIIO-GD2, identifying individual deliverables (where not already identified) in the second half of 2025 and progressing through the relevant project stages thereafter, as described by the below high-level plan. The plan also shows that the work will be identified and go through the project process in batches, to ensure that the latest asset data can be used to identify specific interventions.

Batch 1 Batch 2 Batch 3	GD2 Year 5 (1st half)	GD2 Year 5 (2nd half)	Year 1 (1st half)	Year 1 (2nd half)	Year 2 (1st half)	Year 2 (2nd half)	Year 3 (1st half)	Year 3 (2nd half)	Year 4 (1st half)	Year 4 (2nd half)	Year 5 (1st half)	Year 5 (2nd half)
Identify deliverables												
Design contract award												
Design												
Stakeholder engagement												
Delivery contract												
Procurement & Delivery												
Close out												

Figure 12 LTS project plan

For river crossings, due to the reactive nature of this work, the initial project stage of investment proposal and a business case will commence as soon as an issue is discovered with the remaining project stages following as necessary.

10.5. Key business risks and opportunities

Risks:

- Availability of specialist contractors may become limited, potentially causing delays and increasing costs. This could be exacerbated by high demand for such expertise across the industry.
- Delays in planning and delivery due to the need to ensure alignment with key stakeholders. These delays could hinder the timely progression of the project and lead to additional costs.
- Increased costs associated with the most complex works due to unforeseen technical challenges and market conditions. Such complexities may require more resources and more sophisticated solutions than initially anticipated.
- Severe weather is likely to create additional challenges, such as increased deterioration on below ground valve chambers due to flooding and ground frost and increased risk of riverbed or bank erosion. We are continuing to monitor our assets and are focusing on our experience during RIIO-GD2 to ensure that we

have sufficient funding to address these issues as they emerge, whilst protecting our customers from undue increase in their energy bill.

- Cost variability - External Project management, untimely delivery by contractors and 3rd party delays could all impact on costs. However, framework partners who deliver the Capex workload are rigorously challenged to deliver value for money and alternative partners are continually being used were cost or delivery is a challenge. Uncertainty risk associated with unit costs has also been built into the analysis for unit costs used in the RIIO-GD3 planning process (see Section 10.2 for further details).

Opportunities:

- Leveraging advanced technology to achieve exceptional survey outputs and enhance project accuracy. Utilising state-of-the-art equipment and methods can significantly improve the quality and reliability of our data.
- Maintaining close working relationships with our existing contractors, facilitating smoother project execution. Strong partnerships can enhance collaboration, innovation, and efficiency in delivering project outcomes.

We discuss in Chapter 5 of our Business Plan how we are mitigating against the immediate risks facing our business in the RIIO-GD3 period. In terms of network asset management, we have identified asset condition deterioration, obsolescence and compliance – some of which are relevant to the LTS interventions set out in our preferred strategy. There are also wider considerations which indirectly impact on our investment decisions. Our Workforce and Supply Chain Resilience Strategy (Appendix A7) sets out our plans to tackle potential future skills shortages. Whilst we are not envisaging specific skills shortages in the RIIO-GD3 period thanks to our long-standing commitment to ensuring we have a 24/7, highly skilled workforce, we do need to ensure that our longer-term investment proposals are deliverable given the future challenges we may face as an industry. This strategy also discusses how we ensure that we have a resilient supply chain that can withstand shocks and unforeseen circumstances. This is also an important consideration given the limited supplier and resource pool facing increased demand as we move towards Net Zero.

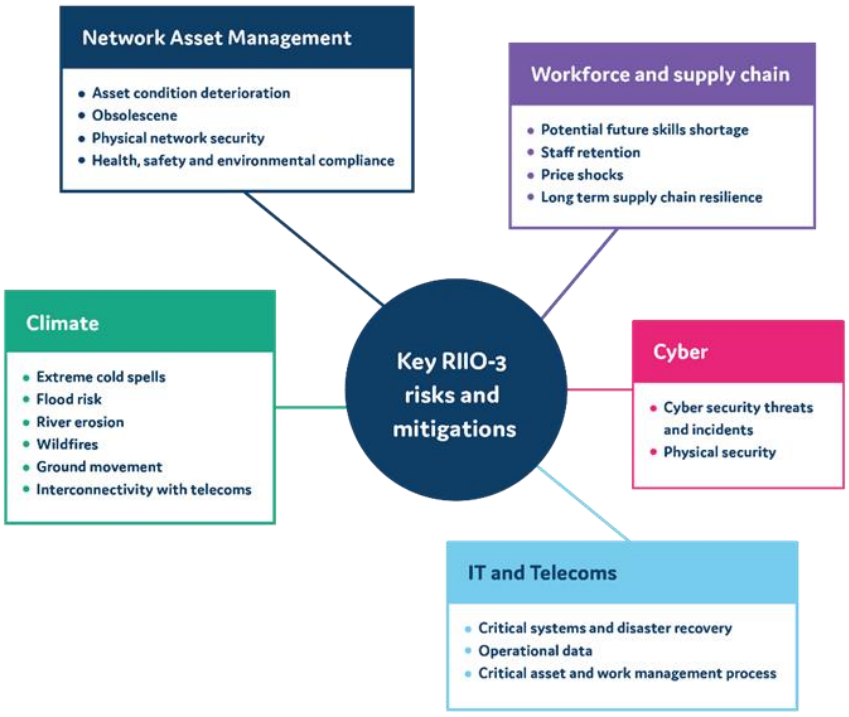

Figure 13 6RIIO-GD3 Key Risks and Mitigations

Based on the current Future Energy Scenarios (FES) assumptions and other related policies, we do not anticipate any changes to our preferred strategy during RIIO-GD3. This alignment ensures that our approach remains robust and adaptable to evolving industry standards and regulatory frameworks.

10.6. Outputs included in RIIO-GD2 plans

We anticipate finishing the RIIO-GD2 intervention programme on time and continuing with the aforementioned proposal in RIIO-GD3.