Northern Gas Networks

A22.k – Overcrossings

Engineering Justification Paper

Contents

1. Summary table

Name of Project	*Overcrossings – RIIO-GD3*		
Scheme Reference	*A22.k.NGN*		
Primary Investment Driver	*Asset Health*		
Project Initiation Year	*2026/27*		
Project Close Out Year	*2030/31*		
Total Installed Cost Estimate (£)	*£7.03m*		
Cost Estimate Accuracy (%)	*+/-5%*		
Project Spend to date (£)	*£0m*		
Current Project Stage Gate	*Planning*		
Reporting Table Ref	*5.06/5.01*		
Outputs included in GD3 Business Plan	*Yes – see section 10.2*		
Spend Apportionment (£m) (2023/24 prices)	**RIIO-GD2**	**RIIO-GD3**	**RIIO-GD4***
	£5.47m	£7.03m	c. £7-10m

**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 outlines our strategic proposal for investment in Overcrossings during the RIIO-GD3 period. The primary drivers for this investment proposal are the need to address asset health concerns, ensure the security of these exposed sections of pipeline and increase the resilience of these assets against climate change risks such as flooding.

Key points addressed include the identification of Overcrossings as vulnerable pipeline sections prone to accelerated deterioration and third-party damage. Our proposed solution involves an intervention programme like those initiated in RIIO-GD1 and RIIO-GD2, aimed at mitigating risks associated with these assets, which include loss of supply, health and safety and environmental risks. We propose to continue targeting the worst-condition assets for upgrades (those of condition rating 4 & 5), whilst applying a deterioration rate witnessed during RIIO-GD2. This proactive strategy seeks to reduce the risks related to Overcrossings, maintaining the integrity and reliability of our pipeline network, while also reaffirming our dedication to following the HSE guidelines.

Our recommended approach also involves an Opex investment to remove decommissioned overcrossings that are in poor condition, aiming to boost efficiency and eliminate the inherent risks associated with these assets, such as the risk of collapse and ensuing physical or environmental damage, from the network.

Through a comprehensive Cost Benefit Analysis, we have evaluated various intervention options and determined the most effective solutions to maximise value and minimise risk. The paper elaborates on our asset management decision-making process, highlighting the evaluation of risks, value, and intervention trade-offs. The options evaluated, their respective intervention volumes and costs are contained in table 1 on the next page:

	RIIO-GD3 EJP Preferred Option		
Asset	Workload units	Repex (£m) 23/24 prices	Driver
Security - vandalism	10	£0.09m	Health and Safety / Asset Health
Security - deterioration	50	£0.42m	Health and Safety / Asset Health
Flood defence	5	£0.08m	Health and Safety
Condition - rail	7	£2.11m	Asset Health
Condition - stream/ditch	11	£0.84m	Asset Health
Condition - canal/river	13	£2.09m	Asset Health
Condition - deterioration	10	£1.41m	Asset Health

Table 1 GD3 Workload and Cost for Preferred Option

Expected outcomes and benefits from this investment include:

- Enhanced pipeline integrity and operational reliability.
- Reduced risk of service interruptions and associated costs.
- Improved safety for surrounding communities and environments.
- Assurance of network resilience, ultimately benefiting our customers and stakeholders.

The comprehensive sections of this document outline the need for these investments, backed by technical evaluations, risk analyses, and justifications consistent with regulatory standards. By focusing on the upkeep and improvement of Overcrossings, we strive to provide a safe and dependable pipeline infrastructure that fulfils the expectations of our stakeholders and adheres to regulatory mandates.

3. Introduction

This Engineering Justification paper details our proposals for investment in our Overcrossings during RIIO-GD3. It includes a narrative for security and condition-based upgrades for asset health reasons and is to be used in conjunction with the accompanying Cost Benefit Analysis. This paper explicitly follows Ofgem's guidance and is set out by the headings therein.

Our Overcrossings represent vulnerable sections of above-ground pipelines, subjected to increased deterioration and risk of third-party damage through accidental or negligent impact. During RIIO-GD1 & GD2 we have undertaken a programme of works to intervene on the condition 4 and 5 assets as further defined in section 6, and we plan to continue this programme in RIIO-GD3.

This engineering paper aims to outline the justification for our proposed RIIO-GD3 Overcrossings investment, detailing our asset management decision-making process during which we analyse risk and value, as well as trade-offs between different intervention options. It explains the drivers for investment, the inputs and assumptions used in our Cost Benefit Analysis, and how our proposed investment benefits our customers and stakeholders.

	RIIO-GD3 EJP Preferred Option		
Asset	Workload units	Repex (£m) 23/24 prices	Driver
Security - vandalism	10	£0.09m	Health and Safety / Compliance
Security - deterioration	50	£0.42m	Health and Safety / Compliance
Flood defence	5	£0.08m	Health and Safety
Condition - rail	7	£2.11m	Asset Health
Condition - stream/ditch	11	£0.84m	Asset Health
Condition - canal/river	13	£2.09m	Asset Health
Condition - deterioration	10	£1.41m	Asset Health
Total	**106**	**£7.03m**	

Table 2 RIIO-GD3 Workload, cost and drivers

4. Equipment summary

Overcrossings operate as pipelines or distribution mains and further detail on equipment summary for these is provided in the relevant EJPs (A.22.l and A22.m). However, further narrative on these sub-set of mains is provided below.

Overcrossings were unable to be installed below ground due to environmental or architectural obstructions. The assets defined as above-ground pipework are typically installed to bypass impediments that prevent the installation of below-ground mains such as natural obstacles, rivers and streams, or man-made infrastructure such as roadways and rail lines. Installation and maintenance of overcrossings can be quite complex due to aspects such as their location or size, which indicates that these assets are critical to the surrounding network, and as such many of them provide single feeds.

We maintain a population of 370 above-ground exposed overcrossings in our network that are wide-ranging in construction methodology. As the design of each crossing is dependent on its function and environment of installation, the population varies significantly in pressure tier, diameter, length, and construction methods. 80%

of our exposed overcrossings population crosses a watercourse, and 18% of those are at an increased flood risk due to being one meter or less above the water level.

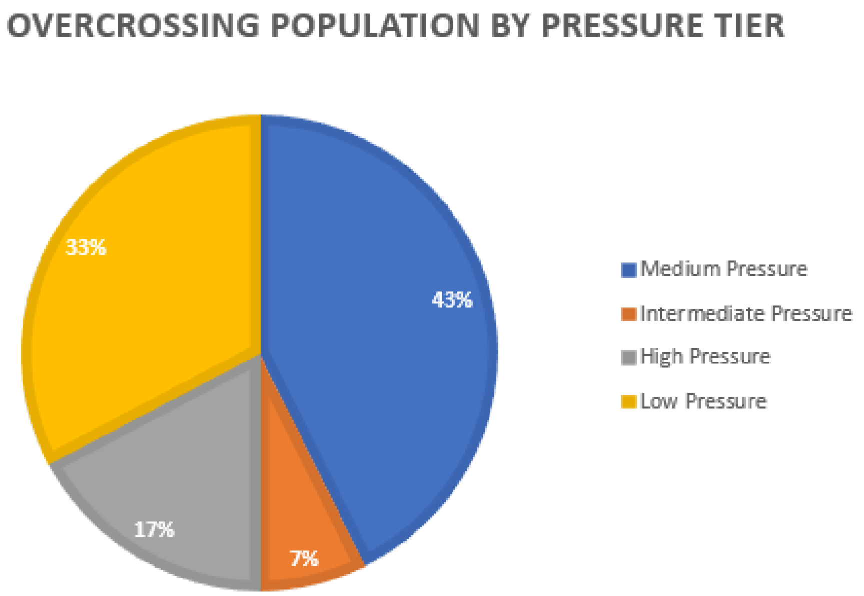

Figure 1 Overcrossings population by pressure tier

Due to progression in construction methodology and enhanced understanding of risk, overcrossings are no longer installed unless as a final resort. Directional drilling or bore tunnelling is the preferred approach to construction.

We also operate a population of 1815 non-exposed crossings in our network however these assets are not considered as part of this engineering justification document. The asset health of non-exposed overcrossings is generally managed through the usual pipeline validation and maintenance, or replacement programmes, depending on pressure tiers. There is no specific capital investment planned for RIIO-GD3 for non-exposed crossings, except for River Crossings and only in cases where the pipeline becomes exposed in the riverbed or riverbank. This investment is captured in the LTS Engineering Justification Paper.

5. Problem / opportunity statement

Due to ongoing exposure to the elements, overcrossings have a significantly shortened life expectancy than that of below-ground pipework. Cathodic protection cannot be applied above ground due to no electrodes being present (as is the case with below-ground pipework). The only means of protection is the pipeline coating which will deteriorate over time in service. Exposure above ground leads to an increased risk of corrosion to the carrier pipe and/or support structure, coating delamination, vandalism, and mechanical failure.

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

Failure to identify and track the asset lifecycle adequately will ultimately lead to failure. The consequences and means of failure for these assets are wide-ranging due to their construction, pressure tier, diameter, and length. For example, failure of a high-pressure overcrossings leading to a breach of containment will likely have far-reaching supply issues, as well as a high risk of injury or loss of life at the point of incident and nearby vicinity. The impact of failure is reduced in correlation to the pressure tier. Failure of a low-pressure crossing will lead to fewer supply issues, or no supply issues at all, and is less likely to lead to injury. Additionally, the failure of any overcrossings is likely to cause physical damage to its surroundings, may cause injury depending on its location and will have an environmental impact in the immediate vicinity due to leakage.

Investment in the overcrossings population is targeted to ensure the integrity of the overcrossings does not become compromised, whether it is through the condition of the pipework itself or the structures supporting the pipework. As many overcrossings were installed as part of the initial emergence of the gas networks, many have already been in service longer than anticipated. Even though robust refurbishment programmes have become commonplace in RIIO-GD1 & GD2 to extend the life of these overcrossings, the assessment and intervention programme needs to continue into RIIO-GD3 and beyond. Additionally, while refurbishment programmes have extended the operational life of many overcrossings, it is crucial to acknowledge that asset life cannot be prolonged indefinitely. Each overcrossing has a finite lifecycle, and we must be vigilant in recognising the point at which replacement or removal becomes indispensable.

In addition to the condition of the overcrossings, several other factors need consideration. These include ensuring security measures to prevent unauthorised access to the pipework or support structure, assessing flood risks that might impact the pipework or supporting structures, and dealing with decommissioned overcrossings that still exist on the network even though they are no longer functional. Overcrossings inherently pose significant health and safety risks due to their exposed nature. Therefore, the preferred approach is to remove them if possible. The mandatory mains replacement programme that primarily targets iron mains, 8 inches or below and within 30 metres of a property means that several distribution overcrossings around the network are being decommissioned. We want to make sure that those overcrossings are considered for removal in the first instance because if they remain in situ, they must be maintained in a safe condition, equipped with strong security measures and clear signage to prevent unauthorised access, although they no longer serve a purpose.

Throughout RIIO-GD1 and RIIO-GD2, we have extensively invested in improving our overcrossings. Beyond upgrading their condition, we have also enhanced security measures to meet HSE expectations. While RIIO-GD1 primarily targeted high and intermediate-pressure overcrossings, RIIO-GD2 expanded the focus to include more numerous distribution crossings. As we move into RIIO-GD3, we aim to sustain this investment programme, ensuring all overcrossings, irrespective of pressure tiers, receive necessary interventions based on their condition and requirements.

There has been a rising demand for investments in overcrossings due to flooding. During the RIIO-GD2 period, there have been cases where immediate action was necessary to address issues brought about by flooding events. Some overcrossings required evaluations for enhanced safeguarding measures to prevent debris from swollen watercourses from damaging the pipelines. Additionally, an incident where a well-maintained support structure sustained significant damage due to flooding has reinforced the need for increased investment in this area.

What is the outcome that we want to achieve?

Our main goal is to meet our Strategic Asset Management Objectives (SAMO) as defined by our Network Asset Management Strategy (NAMS). A key objective, backed by stakeholder research, is to maintain safe and resilient assets. As mentioned earlier, failure of an overcrossings can lead to serious health and safety issues and supply losses. Therefore, we must continue our strong investment programme to mitigate these risks.

To implement a resolution to the problem at hand in a way which aligns with our customer priorities we have defined the following objectives:

We want to manage the risk we hold within this group of assets. We know that reliability and safety remain top of our customers' priorities and so our investments in RIIO-GD3 will be focussed on effectively managing these risks.

We want to ensure efficient costs. We plan to balance risk and value to deliver the optimal solution for our customers at the most efficient cost. We use our decision support tool and asset data to maximise the value of our investments and our financial database to accurately and consistently forecast expenditure.

We want to maintain our excellent service levels. We continually monitor failures and leaks to ensure our investments allow us to maintain levels of service measures, such as expected number of supply interruptions. We target mains that pose the greatest risk and have the most disruptive impact on customers and the environment.

We want to protect our customers from future uncertainty. 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. As set out in section 9, our non-mandatory programme pays back within 16 years, meaning that it represents value for money for our customers regardless of energy pathway to Net Zero.

From our stakeholder research (for example, see Insight 1, 9 and 10 from Appendix A3 below) we know that network reliability and cost remain our customers key priorities.

We have proposed five objectives covering risk, cost, service, uncertainty and compliance. These will be used to determine how successful each option considered is at delivering against our customer's expectations.

What we heard	Appendix A3
Keeping bills as low as possible continues to be domestic and SME (Small Medium Enterprise) 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. How can we ensure intergenerational fairness amidst these competing priorities?	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
The impact of climate change requires us to proactively reduce the vulnerability of networks to storms, particularly in rural areas, and a collaborative, cross-network approach. 'Preventing supply interruptions from extreme weather by providing back up power' was the most highly valued service improvement among billpayers in our Customer Value Perception study (on average, respondents were willing to pay £0.53pp at 75%).	Insight 10

Table 3 Customer insights

We know that our customers expect value for money and that we will make the right investment decisions for both our existing and future customers. We will use the five objectives covering risk, cost, service, uncertainty and compliance to determine how successful each option considered is at delivering against our customers' expectations. There are trade-offs to meeting these objectives; by way of example, if we want to maintain or reduce risk then we will need to invest, and this may impact upon our cost efficiency objective. We therefore have carefully balanced these competing objectives as part of our options analysis which follows later in this EJP.

By investing in our overcrossing population, we are ensuring the secure supply to the network and minimising customer interruptions through targeted intervention in the assets known to be at risk, whether this risk arises from deterioration in condition or flood risk.

The objective of condition upgrades and flood risk-related interventions is to minimise customer risk and supply interruption. The nature of overcrossings means many provide single feeds to otherwise inaccessible areas, therefore loss of supply scenario is a prominent risk compared with integrated networks. The outcome of this investment is to ensure security of supply, whilst only targeting the necessary assets to ensure optimum investments and value for money.

The focus on overcrossings security investment also stems from the strategic objective mentioned above, considering the risk posed to the public due to the exposed nature of above-ground pipework. There have been recorded cases in the UK where exposed pipework without appropriate security measures has been accessed by members of the public which led them to injure themselves due to a fall. The management of these assets must consider the protection of the public from the dangers associated with above-ground pipework through investment in removing them completely where possible or employing robust security measures.

We also know that our customers expect value for money and that we make the right investment decisions for both our existing and future customers. This is grounded in our SAMO to continue being efficient and effective in our operations. As explained in the previous section, the number of overcrossings decommissioned through the mandatory mains replacement activities continues requiring inspections and maintenance although they no longer serve the network. These assets have reached the end of their lifecycle and must now be disposed of to avoid the continuous cost of surveillance and general maintenance being incurred.

To effectively direct our capital investments, we implement our NAMS and rely on a blend of expertise from Subject Matter Experts (SMEs) and insights derived from our data repositories. Overcrossings cannot be modelled as a separate asset class within our Decision Support Tool (DST) currently, so the risk allocation is calculated manually, using consistent methodology as set out in the NAMS. In RIIO-GD3, we are planning to work on ensuring that the DST can be utilised in the management of our overcrossing assets.

How will we understand if the spending has been successful?

The success of our investment proposals will be measured through the achievement of our objectives listed in this section and ultimately the continued safety and reliability of our overcrossings.

We can measure success through overcrossings health. NGN overcrossings population is assessed in mechanical integrity and security to ensure the assets are fit for purpose. These condition ratings range from 1 – As new to 5 – Extreme deterioration as defined in our internal procedures and throughout RIIO-GD2, we have operated a robust programme of upgrades targeted at the condition category 4 and 5 crossings, regardless of pressure. During RIIO-GD3, we will continue targeting the worst condition overcrossings, ensuring that the condition of the pipework as well as that of the supporting structures identifies the individual crossings to be targeted. The spend will have been successful if by the end of RIIO-GD3, we have reduced the overall number of overcrossings we have to maintain through the Opex removals and there are no overcrossings on our network that are rated condition 5.

5.1. Narrative real-life example of problem

Figure 2 Team Street overcrossings showing ineffective pipe support and temporary supports during the construction phase (LEFT: facing West; RIGHT: facing East)

CASE STUDY 1

TEAM STREET EMERGENCY RESPONSE AND NETWORK RECONFIGURATION

In 2022, a flooding event caused significant damage to two overcrossings that were in otherwise reasonable condition, leading to urgent intervention being required. The support towers for the bridge had lifted from the riverbed, rendering them ineffective. Temporary supports were installed to prevent immediate collapse, but it became clear that complete removal of the affected mains was necessary to ensure the security of supply and mitigate risks associated with above-ground pipework. Failure to address these issues could result in environmental damage and potential fines from the Environment Agency.

The initial project to replace the mains using directional drilling was deemed unfeasible due to the depth required and the surrounding infrastructure. Consequently, alternative proposals were necessary. The revised plan involved open-cutting 650 meters of 250mm PE pipe. Additionally, a new district governor (DG) was necessary to maintain pressures and accommodate future growth.

We reacted quickly and effectively to the crisis, ensuring minimal disruption to the supply network. However, as expected, the emergency nature of this work meant that the overall expenditure for the overcrossing removal was higher than it would have been for a pre-planned intervention. The impact on the network included continued security of supply and the elimination of high-risk overcrossings. This investment also provided strategic benefits, such as maintaining consistent pressure zones and enabling future network modifications. The overall expenditure for these projects was substantial but justified by the critical need to address the infrastructure's vulnerabilities and ensure long-term reliability and safety.

Figure 3 [redacted] medium pressure overcrossing (top)

Figure 4 Drone imagery of one of the pipe supports

CASE STUDY 2

[redacted]

An overcrossing located at the [redacted] was flagged for improvement due to poor pipe coating, previous leakage, and moderate corrosion. This medium-pressure overcrossing is attached to a Network Rail bridge, carrying a busy main railway line. There is a water main also attached to the same bridge.

Various solutions were explored, ranging from doing nothing, isolating and removing the pipe, refurbishing, diverting, and replacing it. The chosen approach was to divert the pipeline while leaving the overcrossing in place, mitigating immediate risks, and deferring its expensive removal (estimated at £800,000) until such time when efficiencies can be sought through collaboration with other infrastructure owners – Network Rail and Yorkshire Water.

To accurately assess the condition of the overcrossing, a drone survey was conducted in November 2023. The drone provided precise images and data, confirming the supports were still robust despite the mild corrosion. This technological assessment helped to inform the decision to defer the investment safely.

> By concentrating on the critical issue of leakage rather than any initially perceived structural issues which were proven not to exist, and utilising drone technology for an accurate condition appraisal, NGN has successfully postponed the removal of this overcrossing. This strategy allows for future collaborations with other utilities which operate in the same area ensuring efficient and coordinated project delivery.
>
> This case study demonstrates how we manage immediate risks, utilise advanced technology for accurate assessments, and can therefore make effective asset management decisions while ensuring pipeline safety and operational integrity, as well as value to our customers.

5.2. Project boundaries

The spending boundaries for this justification paper are limited to investments directly related to exposed overcrossings and our preferred option is to intervene on approximately 11% of the total population. As each crossing is approached on a case-by-case basis, spending incorporated in this justification paper can relate to investment in the overcrossing asset to extend its life through refurbishment or replacement, installation, or remediation of flood risk mitigation measures, such as impact protection, or security measures, such as fencing or anti-climb measures. Spending associated with the overcrossing removal has been incorporated into our Opex proposals, although is justified through the content of this paper. Spend associated with the installation/remediation of additional assets to facilitate the removal of a crossing is incorporated into our non-mandatory mains replacement, reinforcement or LTS justification papers, depending on the pressure tier and type of asset affected.

6. Probability of failure

Likely Failure Modes

An asset failure occurs when the asset is unable to perform one or more of its intended functions to an acceptable performance standard, resulting in a negative consequence. 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. Although overcrossings are not an asset in the NARM methodology, they form part of the Local Transmission System as well as the Distribution system and therefore failure can be assessed similarly. The failures have been categorised into the following Failure Modes:

Defects – Faults or areas of weakness identified during inspections.

Corrosion – The gradual destruction of the pipeline or supporting structures by chemical reactions to the environment.

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

General Failures – Failings resulting from support structures such as the pipe support or bridge structure.

Interference – As a result of third-party actions

Ground Movement – This can be either natural or man-made and may lead to stress on the pipeline.

Capacity – Where a pipeline becomes undersized to meet the demand.

Flood Risk – where a pipeline is at risk of being damaged during a severe weather event.

Through condition assessment as part of our maintenance schedule for overcrossings, each crossing is assigned a condition rating for several factors that impact the operability, maintainability, and safety of the crossing:

- Mechanical defect checks to ensure that there is no evidence of any defects and/or that the pipeline has not been damaged by a third-party
- Condition of a pipeline, coating, and insulation
- Civil structures, such as concrete or steel supports to ensure that they are in sound mechanical condition. Attention must be paid to erosion, corrosion, mechanical defects, and degradation e.g. powdering, and cracking. Consideration should be given to providing a specialist engineer to carry out this work and provide guidance on any necessary remedial work.
- Condition and effectiveness of security and access prevention measures.
- Condition and effectiveness of pipeline damage prevention measures.

Each of these factors is considered in giving the overcrossings a 1- 5 assessment score:

1. Good condition
2. Minor deterioration
3. Moderate deterioration
4. Severe deterioration
5. Extreme deterioration

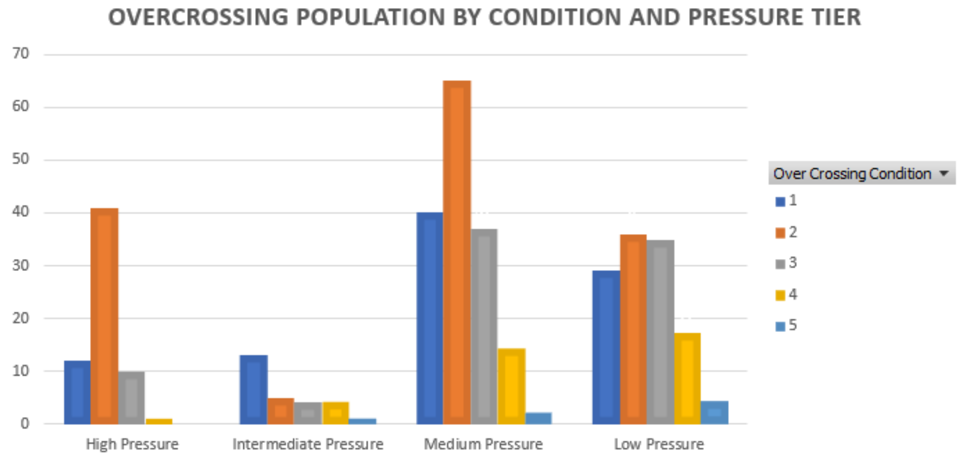

Figure 5 Overcrossings population by condition and pressure tier

In the example of condition 4 or 5, each factor could potentially have already failed as an aspect of the asset. Extreme deterioration of an overcrossings support structure would lead to failure of the asset in its entirety irrespective of whether the pipeline was in good condition. Using this classification methodology, investment can be targeted to those with the highest likelihood of failure or who have already failed in a certain aspect.

Our overcrossings evaluation also considers factors such as ground clearance, which is especially crucial when the structure spans a watercourse. Lower ground clearance in these cases increases the flood risk. Even with higher ground clearance, flooding can still pose a threat to overcrossings, particularly if pipe supports are situated within or near the watercourse; failure of these supports would compromise the entire structure. Whilst we currently do not collect a specific metric that would assist us in identifying overcrossings at flood risk, beyond the ground clearance information noted above, we recognise the importance of this data. To address this gap, we aim to review our current approach and are looking to re-introduce a dedicated flood risk index. This index will enhance our ability to measure and manage flood-related risks more effectively.

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 instance of overcrossings, an assumed rate of failure has been used. This is based on a condition assessment of each crossing and therefore varies across options depending on the condition of the overcrossings being targeted. The same applies to the deterioration rate – it differs depending on the condition rating but has been estimated using deterioration observed during RIIO-GD2. The below table sets out the pre- and post-investment Probability of Failure (PoF) and the annual deterioration rate:

Overcrossing condition rating	Pre-investment	Post-investment	Deterioration p/a
Condition 5	3.00%	1.00%	0.46%
Condition 4	1.30%	1.00%	0.16%
Condition 3	1.15%	1.00%	0.09%
Condition 2	1.05%	1.00%	0.05%
Condition 1	1.00%	1.00%	0.04%

Table 4 PoF and deterioration rates

Due to the integrated nature of Medium Pressure and Low-Pressure networks, failure does not necessarily cause a loss of supply incident, in this example, a 50% likelihood of supply loss has been used. Loss of supply impact has been taken as an average of all crossings highlighted within this strategy – estimated at 5,000 customers.

A secondary driver for investment is the health and safety risk associated with overcrossings security. This is represented through the likelihood of major injury or death and minor injury. Pre- and post-investment likelihood of failure remains static with condition-based failure as security measures are mechanical assets and are subject to similar deterioration and failure rates. The likelihood of major injury following asset failure is 1% and minor injury is 3%.

6.1. Probability of failure data assurance

Visual inspection surveys are undertaken at varied frequencies dependent on condition assessment as explained in the section at the time of the latest report. Sound overcrossings will be surveyed every five years under our MAINT10000 standard, as the condition deteriorates the survey frequency will be increased to a minimum of two years.

Compared to other assets the survey frequency for overcrossings is relatively short, this provides a dataset that is continually updated to reflect the condition of the assets. The worst condition crossings have an increased frequency of two years, the nature of these assets makes severe and rapid deterioration from exposure unlikely.

The operatives conducting the survey are VS/02 visual survey trained to provide an expert and competent assessment of whether the crossing is fit for purpose across all aspects. If a survey returns a score of 4 or 5 this will be based on clear evidence that is provided in correspondence the MAINT10000 report.

In addition to the standard visual surveys, NGN introduced drone-assisted imagery collection, which enables a thorough inspection of overcrossings where, mainly due to the length and height, such inspection cannot be conducted using conventional means. The imagery collected is of a very high resolution and can then provide a basis for the MAINT10000 report to maintain consistency.

7. Consequence of failure

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

Types of Consequence

Our Value Framework sets out the Consequence Measures for each Failure Mode categorised into five risk groups: Compliance Risk, Customer Risk, Health & Safety Risk, Environmental Risk and Financial Risk. The types of consequences relating to these risk categories for overcrossings are detailed below.

Customer Risk

Supply interruptions – Loss of gas supply to our domestic, commercial, or industrial customers. Overcrossings is critical to the gas transportation infrastructure, many of which were constructed to provide single feeds as underground pipework was not feasible. Failure of an overcrossings can lead to a loss of supply scenario impacting thousands of customers in which a complex scheme could be required to reconnect supply.

Health & Safety Risk

Rupture / Leak Ignition – Where the gas escape ignites and creates either a fireball or a fire. Many overcrossings span pathways, rail lines and roads, the failure of a crossing or support structure can cause an immediate risk to life both through the collapse of structures and thermal radiation from ignition.

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

Collapse – Where the structure collapses can lead to injury and/or property damage, independent of any gas leakage.

Fall from height – The very nature of overcrossings construction means these assets hold an inherent risk of injury to any member of the public that attempted to or succeeded in, accessing the structure.

Environmental 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.

Compliance Risk

Pollution incident - Failure of a support structure or overcrossings can impact the immediate environment, such as a crossing failing above a natural watercourse. In the event of an environmental pollution incident associated with contaminant release from a third-party asset, the third party would be potentially liable for the costs associated with remediating the damage, potential civil claims from impacted parties, and potential prosecution by the enforcing authority and a fine. Sentencing guidance in England identifies that fine selection for environmental incidents is informed by the turnover of the responsible party. In addition, the guidance states that where the defendant company's turnover very greatly exceeds the threshold for large companies, as is the case for us, it may be necessary to move outside of the suggested range of fines to achieve a proportionate sentence.

Third-Party incident – If an overcrossing was to fail over rail infrastructure, in addition to the risk to life mentioned previously, the emergency closure of a national rail line is estimated at c.£1m per day not accounting for the potential cost associated with damage to the failed structure would cause to rail infrastructure.

8. Options considered

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

Do nothing: Continue to monitor the condition, but only intervene (whether replace or repair) on failure. Not taking any action on failure would directly contradict our key purpose as a gas distribution network operator to maintain our network and therefore contravene our licence to operate.

The below is to be applied pre-emptively.

Removal: In the instance that the overcrossings feed into an integrated network and can be removed without supply constraints the preferred option is to simply remove the crossing.

Diversion to facilitate removal: If reinforcement options are available that eliminate the required for above-ground pipework, and are commercially viable, this will be undertaken to remove the crossing.

Condition upgrade: Typically blast and recoat of carrier pipework and/or renewal of the support structure to remove any corrosion points and extend the asset life.

Replacement: If no other option is viable then a replacement of the overcrossings and/or support structure.

Future Energy Pathways

The 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 mains and services assets through leakage or failure. Asset condition and failure are important because they influence the failure rate of assets and the duration of the loss of gas consequence respectively.

We have gone with the default assumption of current assumed proportion of methane CO_2 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 CO_2 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 safety risk mitigated, leakage reductions and 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 and 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, including 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 8.66 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 Software which maximises the value of our investments for the given constraints. We use the value measures from our Decision Support Software 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 below is a simplified representation of this process.

Figure 6 How we make asset decisions

Options Analysis

Over time our network assets deteriorate and to ensure we continue to deliver a safe and reliable service, something that our customers have told us they want, we need to invest in our network to reduce the risk of supply interruptions, health and safety and environmental incidents.

A consistent network methodology has been applied in our analysis which provides a more accurate representation of overcrossings failure, particularly the associated loss of supply risk. This incorporates several factors to provide monetised risk value, derived from the likelihood of failure, the likelihood of loss of supply due to failure, customer numbers fed from the crossing, cost per property and duration to provide a total risk value:

$$P_f \times P_c \times N_c \times C \times N_s \times D = T_r$$

This paper targets both LTS and distribution overcrossings. In the instance of distribution crossings, these values have been determined through network analysis, overcrossings condition assessment, known project lead times and loss of supply metrics. Due to the large volume of assets targeted within this strategy, average figures based on distribution overcrossing to ensure a conservative view have been applied on a programme basis:

$\boldsymbol{P_f}$: Variable based on condition rating and increasing at a rate assigned per condition rating as illustrated in Figure 3 above.

$\boldsymbol{P_c}$: Set average value across the population of 50% probability of loss of supply following asset failure.

$\boldsymbol{N_c}$: Set average value across the population of 5,000 customers loss of supply following asset failure.

$\boldsymbol{C}$: Set cost of £300 per day based on network loss of supply metrics.

$\boldsymbol{N_s}$: Variable based on the number of assets within a given condition rating.

$\boldsymbol{D}$: Set duration of 3 days loss of supply based on previous works undertaken.

We undertook a comprehensive review of various options to address different driver categories including condition, security, flood risk, and the removal of decommissioned overcrossings. By evaluating each category in detail, we were able to consolidate our findings into four distinct proposals. These proposals ranged from taking no action—using this as a baseline against which to measure all other options—to intervening on a significant portion of the overcrossing population through targeted efforts such as removal, refurbishment, or security or impact protection upgrades.

Our analysis ensured that we considered the broad spectrum of potential interventions and their associated risks and benefits. By doing so, we aimed to strike a balance between immediate needs and long-term sustainability, ensuring the mechanical integrity, security, and reliability of our network assets. This structured approach enabled us to present a well-rounded set of options, each tailored to mitigate specific risks and enhance overall system performance.

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

The option to do the minimum is used as the baseline for which all other options are measured against. It does not include any planned capital investment but instead considers the cost of ongoing maintenance activities and emergency intervention on failure on the entire overcrossing portfolio. There are no direct benefits accrued under this option however it does include societal impacts associated with leakage, injury and fatality. This is equivalent to deferral.

While the baseline option appears to present a cost-effective approach in the short term by focusing solely on ongoing maintenance activities and repairs upon failure, it is not acceptable given the far-reaching ramifications of such an approach. Reacting only when an overcrossing has failed exposes the network to significant risks and potential consequences. These include but are not limited to, the increasing level of failure risk, costly reactive interventions when a significant failure occurs, the issuance of Health and Safety Executive (HSE) improvement notices or prosecution in cases where security measures are found to be inadequate.

Moreover, when pipeline failures occur, the immediate consequences range from the leakage of gas into the atmosphere—a serious environmental concern—to more catastrophic outcomes such as structural collapse and damage to surrounding areas. This may also result in a loss of supply, affecting a significant number of customers and leading to substantial socio-economic impacts. In addition to these direct consequences, the lack of proactive planning means that repair works are often carried out under premium rates, driven by the urgency and unplanned nature of the required interventions. This reactive stance not only inflates costs but also compromises the reliability and integrity of the network.

Therefore, it is evident that a purely reactive approach, which intervenes only at the point of failure, is fundamentally flawed in this context. Not only does it lead to a loss of supply risk increasing to £9.72m during RIIO-GD3 (by over 5%), but it also fails to account for the broader implications of pipeline and overcrossings failures, including environmental, safety, and financial repercussions. A more proactive, strategic approach is essential to ensure the long-term sustainability and resilience of the network. For this reason, this option has been rejected.

8.2. First option summary - High-pressure focus

An option to focus on the smallest fraction of the overcrossing population has also been considered. This would involve remediating the poorest overcrossings in the high-pressure tier category only. Currently, there are no condition 5 overcrossings in the high-pressure tier category, however, there is one in the condition 4 categories which, if not remediated, will become condition 5 during RIIO-GD3. This option therefore considers this single overcrossing remediation only.

Condition 5, as defined in section 6, means that the overcrossings, although has not yet failed to the extent described in section 7, is of an increased likelihood of failure and therefore pose the highest health safety, and supply risk, when applied in the high-pressure category.

This alternative does not include any provision for overcrossings removals or impact protection necessary to address the heightened risk of flooding events affecting the overcrossings. Regarding security or anti-climb measures required to meet HSE standards, this option presumes that all overcrossings already have adequate security measures installed. These measures would only need replacement if they have deteriorated to a point where they are no longer effective or have been vandalised and rendered inadequate. To maintain consistency, the deterioration rates align with those in Figure 2. However, overcrossings security is rated on a scale of 1-3, unlike other components which use a scale of 1-5.

This approach could be viewed as short-sighted because the condition of the overcrossings will continue to deteriorate, necessitating work before they reach Condition 5. During the RIIO-GD2 period, we observed numerous instances where the planning required to ensure effective and safe intervention, in alignment with relevant stakeholders, took several years to complete. This signifies that proactive identification and intervention plans must be initiated well before the overcrossings reach such critical states of deterioration.

The complexities involved with stakeholder arrangements, such as those with Network Rail, further underscore the need for early action. These arrangements are sensitive due to the critical nature of the assets involved and the consequential impact on the wider public. Delaying intervention until conditions worsen not only heightens risks but also complicates the coordination efforts required to address these issues comprehensively and safely, which then, in turn, influences the unit cost.

Additionally, the "reactive" approach detailed in section 8.1 would be relevant to intermediate, medium, and low-pressure overcrossings, which represent much of the overall population. Failures related to these overcrossings, while sometimes less compelling in terms of supply loss, still present a significant risk to the environment and public safety. Failing to implement appropriate intervention strategies for these assets would amount to neglecting our asset management duties, a crucial condition for our operational licence.

Finally, this option disregards the impact of severe weather events on our overcrossing population. Failing to account for the increasing frequency and intensity of such events will likely exacerbate the rate of asset deterioration, leading to a higher likelihood of unexpected failures. Furthermore, the absence of proactive measures to mitigate these effects will not only compromise the structural integrity of the overcrossings but also escalate the associated risks and costs in the long term. This option also neglects the decommissioned overcrossings within the network that necessitate consistent inspections and maintenance of security protocols to comply with HSE standards.

8.3. Second option summary - Based on age

This option explores the possibility of increasing the rate of intervention from that seen in the RIIO-GD2 period. Unlike the previous option, this strategy would encompass overcrossings across all pressure categories, not limiting the focus to high-pressure tiers alone. By shifting the basis of intervention from condition score to age profile and the date of the last intervention, this option aims to proactively manage the asset lifecycle.

The rationale behind this methodology lies in the recognition that age and historical maintenance records offer a more comprehensive indication of potential failure risks. This approach seeks to pre-emptively address deterioration before it manifests in critical condition scores, thereby reducing the likelihood of unplanned disruptions and enhancing overall safety and reliability.

This forward-looking perspective could result in a more streamlined and effective investment regime, potentially lowering long-term costs by mitigating the need for emergency repairs.

Moreover, this option would necessitate a re-evaluation of existing stakeholder arrangements, ensuring that all parties are aligned with the revised intervention timelines. By fostering closer collaboration with entities such as Network Rail and other relevant stakeholders, the strategy aims to facilitate smoother coordination and implementation processes.

Implementing this strategy would involve a detailed analysis of the age profiles of overcrossings and the timing of their last major interventions. Whilst such data would enable a prioritisation framework that targets the assets with the highest probability of failure based on empirical evidence rather than solely on their current condition, it would come at a higher cost due to the volume of interventions being required.

To manage the condition of our existing population of 370 overcrossings in this way, based on the assumption that we would have to intervene on an overcrossings every 15 years and that our overcrossings population remains static, we would have to intervene, on average, on 25 overcrossings every year. A programme of this magnitude would be a major change to our RIIO-GD2 strategy and would nearly triple the intervention volumes and by extension the cost. Apart from the obvious impact, this would have on the funding requirements, it would also bring the challenge of deliverability.

In summary, implementing this proactive intervention strategy requires significant investment (estimated at over £22m) and a revamped asset management approach. Although the loss of supply risk would be reduced by approximately 6% during RIIO-GD3 and there would be additional benefits of improved safety, reliability, and a lesser likelihood for emergency interventions, the costs, and logistical hurdles to achieve this are substantial, making this option less acceptable.

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

The fourth option is our preferred option and represents a more balanced approach that lies between the two ends of the spectrum described by the options described above.

An optimal strategy would blend aspects from the thorough scope of the third option while moderating the frequency and intensity of interventions, ensuring both practicality and cost-efficiency. By choosing a more measured path, we can improve the safety and reliability of overcrossings without overstretching financial and logistical resources.

This option looks to expand on the second by extending the application to all pressure tiers. This ensures that the entire population of overcrossings is considered regardless of pressure tier, thus mitigating health and safety risks comprehensively.

In contrast to the third option which focuses on age and intervention history, the fourth option prioritises asset health. This method is backed by our comprehensive inspection programme, which routinely assesses asset conditions. Presently, fewer than 2% of our overcrossings are in condition 5; some are included in the RIIO-GD2 upgrade programme already, while others have worsened more rapidly than anticipated after recent inspections. We aim to address these overcrossings as soon as possible. In addition to condition 5 overcrossings, we must also target condition 4. By doing so, we can maintain risk at acceptable levels and prevent deterioration to the point where the improvement programme becomes unmanageable. This strategy allows us to address the more critical assets promptly while ensuring that those at the brink of severe deterioration are also attended to before reaching a condition that would overwhelm our resources and capabilities. Furthermore, as illustrated above, we plan to implement an accelerated deterioration rate % as represented by Figure 2 for RIIO-GD3 to represent actual conditions more accurately.

This option intends to resolve all the problems outlined in Section 5. Beyond improving the condition of deteriorating overcrossings, we can also propose several removals in our Opex plans based on existing data; specifically targeting tier 1 overcrossings and other decommissioned overcrossings that are either in a poor state or continue to face security issues.

Throughout RIIO-GD3, it remains crucial to address overcrossings security concerns in alignment with the HSE expectations. The goal of this option is to ensure that every overcrossing is equipped with appropriate security measures, prioritised according to consistent survey data instead of generic assumptions, therefore we propose to continue with RIIO-GD2 intervention volumes (60 interventions).

Finally, this option specifically addresses flood risk, which we know is growing. During RIIO-GD2, from 2021 to 2023, severe weather events impacted two overcrossings that were otherwise in good condition, requiring costly emergency repairs. By focusing on at-risk overcrossings proactively, we aim to reduce these occurrences.

8.5. Options technical summary table

The below table summarises the types of interventions proposed, and the volumes and costs associated with each of the options. It also confirms that the expenditure is planned for the RIIO-GD3 period and assumes a 15-year intervention life for a CAPEX overcrossings intervention before a follow-up intervention is likely to be required.

Option	Intervention type	Period of spend	Total CAPEX volume	Total CAPEX cost £m	Design Life
8.1 Reactive	OC condition	2026-2031	*0*	*0*	n/a
	OC security		*0*	*0*	n/a
	Flood risk		*0*	*0*	n/a
8.2 HP Focus	OC condition	2026-2031	*1*	*£0.17*	15 years
	OC security		*2*	*£0.01*	
	Flood risk		*0*	*£0*	
8.3 Based on age	OC condition	2026-2031	*125*	*£21.23*	15 years
	OC security		*125*	*£1.05*	
	Flood risk		*5*	*£0.08*	
8.4 Balanced (Preferred)	OC condition	2026-2031	*41*	*£6.45*	15 years
	OC security		*60*	*£0.51*	
	Flood risk		*5*	*£0.08*	

Table 5 Options technical summary table

9. Business case outline and discussion

When examining the four options described in section 8, it becomes evident that the first three represent the more extreme ends of the intervention spectrum. The first option, with its minimal approach, overlooks critical factors such as the impact of severe weather events and the need for ongoing maintenance of decommissioned overcrossings, thereby risking asset integrity and escalating long-term costs and risks. The second option, which focuses solely on high-pressure tiers based on condition scores, fails to consider a broader range of assets and their varied requirements. Conversely, the third option proposes a significant increase in the rate of intervention based on age and historical maintenance records, nearly tripling the intervention volumes seen in the RIIO-GD2 period and introducing substantial cost and logistical challenges.

To determine the optimum solution, we must consider the probability of failure, the consequences of failure, engineering options, and associated costs. The likelihood of overcrossings failures is influenced by various factors such as structural age, and maintenance history, however, the key metric is the latest condition assessment which we have used in our analysis. The consequences of these failures can be dire, ranging from minor disruptions to significant safety hazards and financial burdens due to emergency repairs and potential legal implications.

In our Cost and Benefit analysis, we observe that a balanced approach, as suggested in the fourth option, aligns well with these considerations. This method ensures that we proactively address the overcrossings most at risk of failure while maintaining ongoing surveillance and maintenance of others that are showing early signs of deterioration. This approach not only mitigates immediate risks but also distributes the intervention efforts more evenly over time, thereby preventing overwhelming our resources.

The graph below shows the impact each of the appraised options has on the Loss of Supply risk. It is clear that focusing on the High-Pressure overcrossings only would have minimal impact on the Loss of Supply risk when compared to the baseline, whilst both of the other options show a clear reduction.

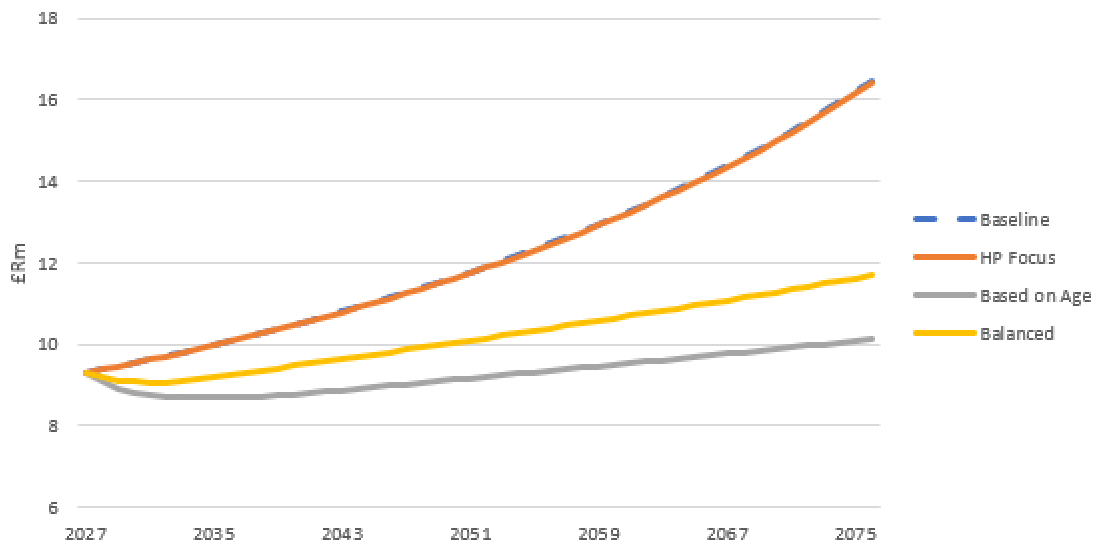

Figure 7 Loss of supply risk change associated with different options

From a cost perspective, the fourth option proposes a feasible increase in interventions that are financially sustainable within the RIIO-GD3 framework. While it requires a higher initial outlay compared to the minimal-intervention first option, it ultimately offers better value by reducing the likelihood of costly emergency repairs and extending the overall lifespan of the assets. This cost-benefit consideration underscores the importance of a strategic, data-driven approach to asset management.

By integrating these elements—the probability of failure, consequences of failure, engineering options, and costs—we can craft a robust and balanced intervention plan that ensures the longevity and safety of our overcrossings while maintaining financial prudence.

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 over a 16-year payback period. By comparing the capital and operational expenditures for each scenario, we derived all present value figures and evaluated them against the monetised risk associated with the “Reactive” option described in section 8.1.

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:

- Lowest initial capital expenditure
- Short-term operational savings

Justification:

Option 1 is designed to minimise immediate costs by limiting interventions to only the most critical cases. While this approach offers significant short-term savings, it fails to address the majority of overcrossings issues, potentially leading to higher long-term costs due to emergency repairs and asset failures.

Option 2: High-Pressure Focus

Value Drivers:

- Targeted risk reduction for high-pressure assets
- Improved safety for critical infrastructure
- Short-term operational savings

Justification:

Focusing on high-pressure tiers, this option aims to mitigate risks associated with the most critical assets. Although it enhances safety for these key elements, it does not comprehensively address the broader range of overcrossings, overlooking intermediate, medium and low-pressure assets that also require attention and account for the largest proportion of the overall population.

Option 3: Based on Age

Value Drivers:

- Increased asset reliability and lifespan
- Proactive maintenance approach

Justification:

By nearly tripling the intervention volumes, this option ensures thorough maintenance and renewal, or removal of overcrossings based on age and historical data. However, the substantial costs and logistical challenges associated with this aggressive approach would strain financial and operational resources.

Option 4: Balanced Programme

Value Drivers:

- Tried and tested capital and operational expenditure (compared with RIIO-GD2)
- Balanced risk mitigation across all asset tiers
- Enhanced asset longevity and reliability

Justification:

Option 4 represents the most pragmatic and sustainable solution, balancing immediate and long-term needs. By addressing the overcrossings most at risk of failure and maintaining ongoing surveillance, this option mitigates risks while optimising expenditures. The strategic distribution of interventions ensures resource manageability and aligns with the overall engineering scope for long-term asset health.

By providing a clear, justified outline of the value drivers for each option, stakeholders can make informed decisions that align with both financial prudence and engineering requirements.

9.2. Business case summary

The table below details the headline business case metrics to allow a high-level comparison of the options and shows that our preferred option results in a positive NPV within 12 years, and a comparable NPV in 2070 to that of a rolling programme, but only at 31% of the cost. Our most recent stakeholder engagement 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; our preferred option is therefore the Balanced Approached described in section 8.4 (option 3 in the below table).

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	-	-£76.7	-£112.3	-£144.0	-£172.0	-£219.4	-£259.2	-	5.0%
1	HP Focus	3	-£0.1	-£0.1	-£0.0	£0.0	£0.1	£0.2	24	4.5%
2	Based on age	255	-£11.5	-£7.7	-£2.7	£3.0	£15.1	£27.8	22	-6.5%
3	Balanced **(Preferred)**	106	-£1.1	£1.8	£5.2	£9.0	£17.2	£26.4	12	-2.7%

Table 6 Cost and Benefit Analysis summary

10. Preferred option scope and project plan

10.1. Preferred option

Our preferred option is **Option 4 – Balanced Approach**, as described in section 8.4. The selection of this option is based on a comprehensive evaluation of its alignment with our key business case drivers, including cost-effectiveness, loss of supply risk mitigation, and service delivery. Option 4 offers the most balanced approach by reducing the loss of supply risk by 3% during RIIO-GD3 whilst continuing with the level of expenditure similar to RIIO-GD2. As explained in section 9.2, this option also pays back within 12 years and maintains a positive NPV in line with the more expensive rolling programme option from 2060 onwards. It also addresses all the problems identified in Section 5.

Option 4 stands out due to its robust engineering scope that ensures the longevity and safety of our overcrossings. It presents a well-justified value proposition that is supported by detailed analyses and reflects a thorough understanding of the operational needs and financial prudence required for long-term sustainability.

10.2. Asset health spend profile

Cost:

	GD3 Cost (£m)					
Intervention	**2026/27**	**2027/28**	**2028/29**	**2029/30**	**2030/31**	**Total**
Security - vandalism	£0.02	£0.02	£0.02	£0.02	£0.02	**£0.09**
Security - deterioration	£0.08	£0.08	£0.08	£0.08	£0.08	**£0.42**
Flood defence	£0.02	£0.02	£0.02	£0.02	£0.02	**£0.08**
Condition - rail	£0.00	£0.00	£0.60	£0.90	£0.60	**£2.11**
Condition - stream / ditch	£0.00	£0.08	£0.31	£0.23	£0.23	**£0.84**
Condition - canal / river	£0.00	£0.16	£0.64	£0.64	£0.64	**£2.09**
Condition - detioration	£0.28	£0.28	£0.28	£0.28	£0.28	**£1.41**
TOTAL						**£7.03**

Table 7 Overcrossings cost distribution

Volume:

	GD3 Workload					
Intervention	**2026/27**	**2027/28**	**2028/29**	**2029/30**	**2030/31**	**Total**
Security - vandalism	2	2	2	2	2	**10**
Security - deterioration	10	10	10	10	10	**50**
Flood defence	1	1	1	1	1	**5**
Condition - rail	1	1	2	2	1	**7**
Condition - stream / ditch	0	2	3	3	3	**11**
Condition - canal / river	1	3	3	3	3	**13**
Condition - detioration	2	2	2	2	2	**10**
TOTAL						**106**

Table 8 Overcrossings workload 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 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.

10.3. Investment risk discussion

We have controls and processes in place throughout the development of our RIIO-GD2 Capital Expenditure programme to ensure we mitigate both our customers and our risk exposure. 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 used a network methodology based on known asset failure and deterioration rates.
- Over the past 6 years, we have surveyed all overcrossings, updating data to reflect ongoing deterioration in line with maintenance schedules.
- We have weighed various options considering workload volumes and selected the solution balancing cost, risk, and service for customers.
- We cross-checked our preferred option against asset data like age, condition surveys, pressure tiers, criticality, and crossing type.
- Subject matter experts contributed to the development of our strategy to ensure its validity and deliverability.
- Our RIIO-GD3 strategy builds on the successful RIIO-GD2 framework, proving our effective asset management.

Unit Cost Risk Mitigations

- Unit costs have been calculated based on expenditures reported during RIIO-GD1 and RIIO-GD2 periods (see section 10.2).

- We do not intend to initiate new work activities; all interventions have been previously conducted, with historic data available to support individual intervention cost estimates.
- We employ experienced Project Managers with a proven history of successfully delivering similar projects, supported by a commercial team of quantity surveyors dedicated to ensuring value for money.

10.4. Project plan

Given that this is an ongoing programme focused on targeting deterioration, our strategy involves dividing the workload into manageable batches. This approach ensures that each batch of overcrossings is addressed based on the most current condition data available. As the deterioration continues, the workload will inevitably evolve, requiring us to stay agile and ready to adapt our plans accordingly.

Furthermore, an opportunity presents itself to establish a risk provision if we can initiate the design process for the initial batch ahead of the RIIO-GD3 commencement. This proactive step could provide a buffer against uncertainties and enhance our ability to manage potential risks more effectively.

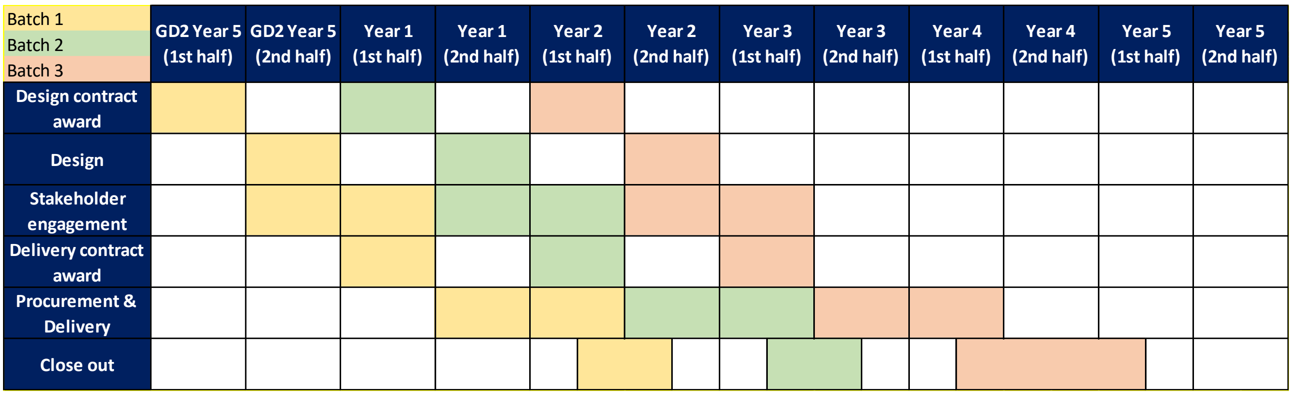

Figure 8 Overcrossings project plan

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 the high demand for such expertise across the industry.
- Delays in planning and delivery due to the need to ensure alignment with key stakeholders such as Network Rail. These delays could hinder the timely progression of the project and lead to additional costs.
- Increased costs associated with the most complex overcrossings due to unforeseen technical challenges and market conditions. Such complexities may require more resources and more sophisticated solutions than initially anticipated.

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.
- Utilising the comprehensive data we currently hold on to our overcrossings, allowing us to expand this resource to include crucial measures such as flood risk indicators. This enriched data set will enable more informed decision-making and risk management.

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.

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 – all of which are relevant to the odorant and metering 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.

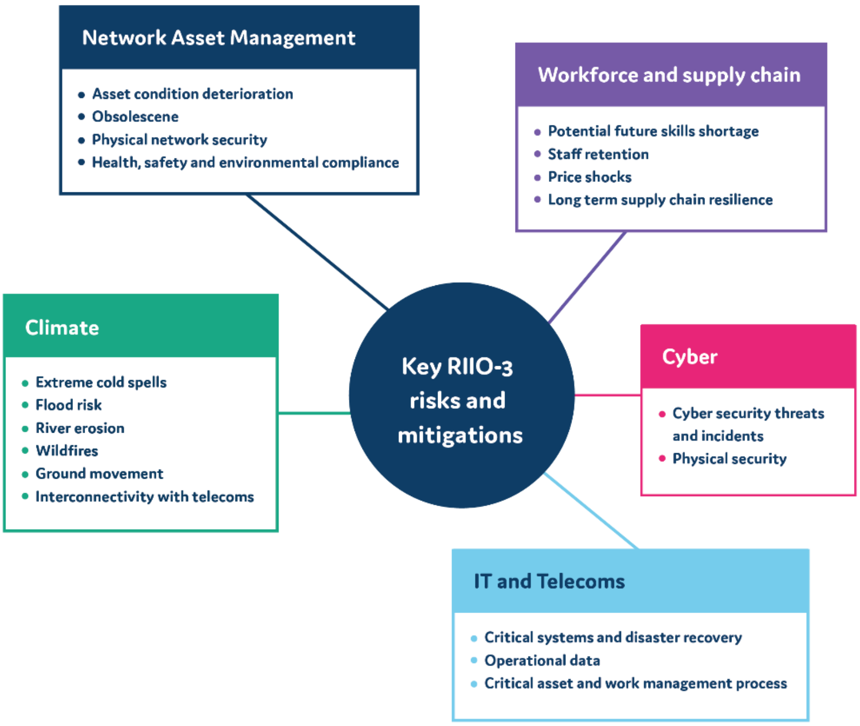

Figure 9 RIIO-GD3 Key Risks and Mitigations

10.6. Outputs included in RIIO-GD2 plans

We anticipate finishing the RIIO-GD2 intervention programme, potentially raising the overall numbers due to the previously mentioned higher rate of deterioration. While we do not foresee deferring any of the promised overcrossings from RIIO-GD2 to RIIO-GD3, we recognise that complications, particularly those affecting Network Rail assets, are likely and pose a risk that requires thorough management.