Northern Gas Networks

A23.G - NGN RIIO-2

Investment Decision Pack
Overcrossings

we are the network

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2. Introduction

This Engineering Justification paper details our proposals for investment on our Overcrossings during RIIO-2. It includes 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 in accordance with the headings therein.

Our Overcrossings represent vulnerable sections of pipelines, where being above ground, subjects them to increased deterioration. During RIIO-1 we have undertaken a programme of works to intervene on the worst condition asset and we plan to continue this programme in RIIO-2.

This engineering paper aims to outline the justification for our proposed RIIO-2 Overcrossings investment, detailing our asset management decision making process during which we analyse risk and value and trade-off 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.

3. Equipment Summary

Overcrossings operate as pipelines or distribution mains, however due to environment or architecture are unable to be installed below ground. The assets defined as above ground pipework are typically installed to bypass impediments that prevent the installation of below ground mains such as natural obstacle, rivers and streams, or man-made infrastructure such as roadways and rail lines. The complexity of installation for overcrossings indicates that the asset is critical to the surrounding network, and as such many of these assets provide single feeds.

We maintain a population of 352 above ground exposed overcrossings in our network that are wide ranging in construction methodology, often tailored depending on the environment of installation. As each crossing is independently designed dependent on function, the population varies significantly in pressure tier, diameter, length and construction.

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

We operate a population of 1830 non-exposed crossings in our network however these assets are not considered as part of this engineering justification document and no investment is forecast for them in RIIO-2.

4. Problem Statement

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

The assets are wide ranging in their construction and vary in pressure tier, diameter and length, therefore the consequence of failure is equally wide ranging, as is the means of failure. Failure of a high-pressure overcrossing 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. The impact of failure is

reduced in correlation to pressure tier, failure of a low-pressure crossing is unlikely to lead to supply issues or injury. However, there are additional considerations beyond that of a gas infrastructure supply scenario; the failure of any crossing is likely to have an environmental impact in the immediate vicinity due to leakage.

Due to on-going 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 electrolyte 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 increased risk of corrosion to the carrier pipe and / or support structure, coating delamination, vandalism and mechanical failure.

Investment in the overcrossing population is targeted to ensure mechanical integrity of the overcrossing does not become compromised. As many overcrossings were installed as part of the initial emergence of the gas networks, many have been in service longer than anticipated, and though robust programmes have become commonplace in RIIO-1 to remediate these crossings, not all have been addressed.

In RIIO-1 we have made a significant investment in our overcrossing's population. We have invested significantly in upgrading the condition of the crossings. Criticality was the primary means of determining investment, and as such the high and intermediate pressure overcrossings have been targeted so that, disregarding vandalism / unforeseeable circumstance, in RIIO-2 only medium and low-pressure crossings necessitate condition investment.

Additional consideration beyond the condition of the overcrossing is ensuring adequate security is in place to prevent unauthorised access to the pipework or support structure. Overcrossings present a considerable risk of injury access by members of the public and should therefore have robust security and signage in place.

Large scale investment programmes have been undertaken in RIIO-1 to ensure overcrossing security is up to standard and the assets are adequately protected. As protective measures are mechanical assets, many have been in place for several years and therefore deterioration must be accounted for in the existing population.

Due to the separate investment drivers of customer and health and safety necessitating divergent strategies, each subsequent section will be completed on an individual basis.

What is the outcome that we want to achieve?

From our stakeholder research we know that health and safety, reliability and cost remain our customers number one priority and we are seeing increasing importance placed on the environment. For this group of assets, Customer risk and Health & Safety risk are the main risk drivers however investment will also have an impact on reducing Environmental risk. 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.

By investing in our overcrossing's 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.

The objective of condition upgrades 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 scenarios 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 value for money.

Conversely, security upgrades are not linked to security of supply, rather to prevention of unauthorised access to these assets. Health and Safety risk, or risk to members of the public, is a key consideration for any above ground asset that is potentially accessible. The management of these assets must consider protection of the public from the dangers associated with above ground pipework through investment is robust security measures.

How will we understand if the spend has been successful?

NGNs overcrossing population is assessed in mechanical integrity and security to ensure the assets are fit for purpose. These condition rating range from 1 – As new, to 5 – Remediation required, and throughout GD1 we have operated a robust programme of upgrades targeted at the highest risk category 5 crossings, typically intermediate and high pressure. By the start of GD2 we are confident all IP and HP crossings will have been addressed, therefore in GD2 the remainder of condition 5 crossings will be targeted. The spend will have been successful if by the end of GD2 there are no overcrossings on NGNs network that are rated condition 5.

4.1. Narrative Real-Life Example of Problem

Case Study 1 – Condition Upgrade

Through maintenance surveys a high-pressure crossing was identified as requiring intervention due to severe corrosion to both carrier pipe and support structure, risking mechanical failure of the crossings. Following the VS/02 inspection a P11 survey was undertaken, this highlighted further corrosion points in which >40% wall thickness metal loss was recorded.

Though removal is the preferred course of action for an overcrossing, as part of our local transmission system it was not a viable option to remove this crossing without reinforcement or replacement.

Option appraisal was undertaken to determine best course of action that would provide greatest value against investment. Due to the rural location of the crossing, diversion was not a cost-effective solution option to remediate the defect, therefore a condition upgrade was undertaken.

To re-life the asset the pipework and support structure is blasted and re-coated to current specification, new pipe cradles installed, and additional security put in place.

Case Study 2 – Security Upgrade

Deterioration of existing crossing security was highlighted though visual survey, in this instance chevaux de frise with significant corrosion and inadequate signage notifying the public of risk. Works was undertaken to bring the crossing to current standard by installing new chevaux de frise, inverted V pipe toppers and signage. The relatively small investment to upgrade and improve the security of our asset has had a big health and safety impact, significantly reducing the risk of a member of the public gaining access to our asset and potentially injuring themselves from a fall from height.

4.2. Spend Boundaries

The spend boundaries for this justification paper are limited to investment directly related to exposed overcrossings. As each crossing is approached on a case by case basis, spend incorporated in this justification paper can relate to investment on the overcrossing asset, or installation / remediation of additional assets to facilitate removal of a crossing.

In the instance of investment to an existing crossing, spend will be separated between types of works / remediation necessary depending on the driver of the upgrade. This will be customer driven to mitigate loss of supply risk or health and safety driven to avoid health and safety risk.

5. Probability of Failure

Types of Failure

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 for 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. Although overcrossings are not an asset in the NARMS methodology, they form part of the Local Transmission System and therefore failure can be assessed in the same way. 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 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 support structures such as the pipe support or bridge structure

Interference – As a result of third-party actions

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

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

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

Through condition assessment as part on 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 made to erosion, corrosion, mechanical defects and degradation e.g. powdering, 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 given a 1- 5 assessment score:

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

In the example of classification 4 or 5 each individual factor could potentially have already failed as an aspect of the asset. Extreme deterioration of an overcrossing 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 have already failed in a certain aspect.

In addition to maintenance surveys NGN have recently commissioned a report into the impact of severe weather events on the crossing population. In this instance the report was targeted to determine:

- The most likely crossings to be impacted by severe flooding
- The most critical crossing at risk of severe flooding
- A combined risk ranking methodology to target future investment

The report identified key characteristics that would directly impact each of the above outputs (pressure, flood zones, LiDAR data), allowing a ranking to be completed.

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 dependant on the condition of the overcrossings being targeted:

Overcrossing Condition Rating	Pre-investment likelihood of failure (Baseline)	Post-investment likelihood of failure	Deterioration p/a
Condition 5	3.00%	1.00%	0.20%
Condition 4	1.30%	1.00%	0.20%

Due to the integrated nature of MP and LP networks, failure does not necessarily cause a loss of supply incident, in this example a 30% likelihood of supply loss has been used. Loss of supply impact has been taken as an average of all crossings highlighted within this strategy, 5000 customers.

A secondary driver for investment is the health and safety risk associated with overcrossing security. This is represented through 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 3%.

5.1. Probability of Failure Data Assurance

Visual inspection surveys are undertaken at varied frequency dependent on condition assessment at time of previous report. A sound overcrossing will be surveyed every five years under our MAINT10000 standard, as condition deteriorated the survey frequency will be reduced 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 a reduced frequency of two years, the nature of these assets makes severe and rapid deterioration from exposure unlikely.

In addition to the survey frequency, the operatives conducting the survey are VS/02 visual survey trained to provide an expert and competent assessment on whether the crossing is fit for purpose across all aspect. 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.

6. 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 are 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 on consequences relating to these risk categories for overcrossings is detailed below.

Customer Risk

Supply interruptions – Loss of gas supply to our domestic, commercial or industrial customers. Overcrossings are critical to the gas transportation infrastructure, many of which were constructed to provide single feeds as underground pipework was not feasible. Failure of an overcrossing 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 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.

Fall from height – The very nature of overcrossing 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 potentially prosecution by the enforcing authority and a fine. Sentencing guidance in England identifies that fine selection for environmental incidents are 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 suggest 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 potential cost associated with damage the failed structure would cause to rail infrastructure.

7. 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 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:

- **Removal:** In the instance that the overcrossing feeds 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 is commercially viable, this will be undertaken to remove the crossing.
- **Condition upgrade:** Typically blast and recoat of carrier pipework and support structure to remove any corrosion points and revalidate asset.
- **Replacement:** If no other option is viable then a replacement of the overcrossing and / or support structure.

Future Energy Pathways

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.

Arup conducted analysis on the potential benefits of our H21 Programme (see A13 - NGN RIIO-2 Consumer Value Proposition) that showed 45% of the gas in our network is expected to be Natural, 15% biomethane and the remaining 40% hydrogen by 2040; due to a combination of blending and sub-areas of our networks being fully converted. This is consistent with Net-zero by 2050 aligned with the ENA Navigant report.

We have not explicitly modelled changes in the methane content of gas in our CBAs, as overall gas demand and the change in C02 content of the gas is not expected to be different enough to materially impact the NPV, Payback & Option Ranking of our preferred investment programme. This is because we have not modelled Carbon savings as a benefit in our Cost Benefit Analysis and so the results would not be sensitive to the methane content of gas. Our chosen programme represents value for money over a 20-year period regardless and is mainly driven by health and safety and customer benefits such as avoiding explosions or loss of supply. Any change to gas demand would affect our Loss of Supply results however it would be the same across all scenarios. 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-1 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 value such as the cost of carbon and specific values such as the loss of supply, costs from our Unit Cost Database and the NARMs methodology to calculate risk and value. Technical experts analyse options and set constraints 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 scenario to determine the most suitable capital programme in RIIO-2. The diagram above is a simplified representation of this process.

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 a supply interruptions, health and safety and environmental incidents.

NARMs does attribute additional risk to above ground pipework, a limitation that is known to not be representative of the assets. Therefore, a network methodology has been applied to provides a more accurate representation of overcrossing failure. This incorporates several factors to provide monetised risk value, derived from likelihood of failure, likelihood of loss of supply due to failure, customer numbers fed from the crossing, cost per day and duration to provide a total risk value:

$$\boldsymbol{L_f \times L_c \times N_c \times C \times D = T_r}$$

In the instance of distribution crossings these values have been determined through network analysis, overcrossing condition assessment, known project lead times and loss of supply metrics. Due to the large volume of assets targeted within these strategy, average figures have been applied on a programme basis:

$\boldsymbol{L_f}$**:** Variable based on condition rating, 3% condition 5 / 2% condition 4 / 1% condition 1, increasing at a rate of $N(1.02)$ per year**.**

$\boldsymbol{L_c}$**:** Set average value across the population of 30% probability of loss of supply following asset failure

$\boldsymbol{N_c}$**:** Set average value across the population of 5000 customers loss of supply following asset failure

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

D: Set duration of 3 days loss of supply based on previous works undertaken

7.1. Option Summaries

We have considered three options for intervention due to condition and one option for intervention due to security which is included in each of the three options. The investment options considered for this asset group are listed below:

7.1.1. Baseline – Do 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 considers the cost of ongoing maintenance activities and repairs on failure. There are no direct benefits accrued under this option however it does include societal impacts associated with leakage, fatality and injury.

7.1.2. Option 1: Remediate condition 5 crossings

Condition 5 overcrossings have been determined through visual inspection to require intervention to ensure mechanical integrity and security of supply. Condition 5 crossings have not failed to the extent detailed in section 6 but are of increased likelihood and pose the highest risk of the overcrossing population. All overcrossing security is considerate adequate through RIIO-1 investment. Investment to target overcrossing security that has deteriorated to the point of failure or has been subject to vandalism will be target for investment.

Sensitivity analysis

Sensitivity analysis has been undertaken within the cost benefit analysis to demonstrate the impact each probability of failure, pre and post investment, and likelihood of consequence following asset failure.

Option	Scenario	Sensitivity	Probability of Failure (PoF) (Pre-investment)	Probability of Failure (PoF) (Post-investment)	Liklihood of a Loss of Supply Event (PoC)
Baseline (a)	Baseline	None	3.00%	0.10%	30.00%
1 (a)	Remediate Condition 5 Overcrossings	None	3.00%	0.10%	30.00%
2 (a)	Remediate Condition 5 Overcrossings	Post investment PoF	3.00%	0.50%	30.00%
3 (a)	Remediate Condition 4 & 5 Overcrossings	None	3.00%	0.10%	30.00%
4 (a)	Defer Investment	None	3.00%	0.10%	30.00%
Baseline (b)	Baseline	None	3.00%	0.10%	30.00%
1 (b)	Remediate Condition 5 Overcrossings	Pre investment PoF	2.00%	0.10%	30.00%
Baseline (c)	Baseline	None	3.00%	0.10%	30.00%
1 (c)	Remediate Condition 5 Overcrossings	PoC	3.00%	0.10%	15.00%
Baseline (d)	Baseline	None	3.00%	0.10%	30.00%
1 (d)	Remediate Condition 5 Overcrossings	Pre and Post investment PoF and PoC	2.00%	0.50%	15.00%

7.1.3. Option 2: Remediate condition 4 and 5 crossings

As above, however condition 4 crossings have also been determined through visual inspection to have deteriorated to the point of potential failure. This option would be to include a Programme of remediation prior to partial failure. All overcrossing security is considerate adequate through RIIO-1 investment. Investment to target overcrossing security that has deteriorated to the point of failure or has been subject to vandalism will be target for investment.

7.1.4. Option 3: Deferred investment

No investment in overcrossing condition throughout RIIO-2, targeted remediation of condition 5 crossings and security measures in RIIO-3.

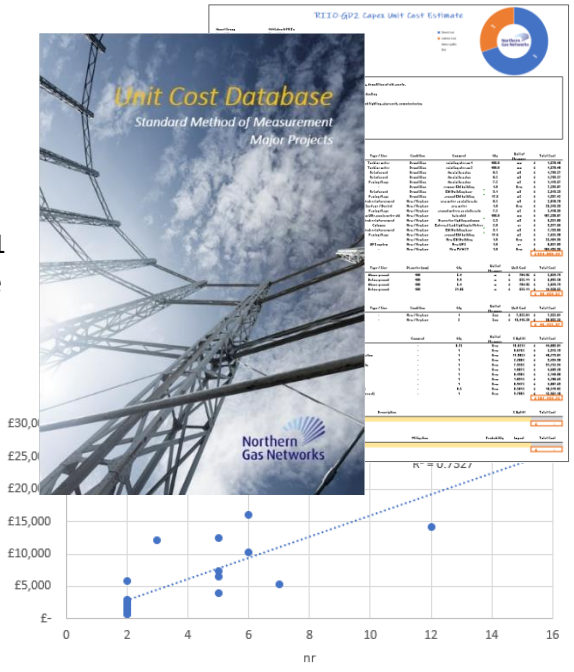
7.2. Options Technical Summary Table

Please see below the technical summary table for Offtake level options.

Option	Scenario	Sensitivity	First year Of Spend	Final year of Spend	Workload Volume	Design Life (Refurb / Replace)	Total Capex RIIO-2 Cost
Baseline (a)	Baseline	None	-	-	-	-	-
1 (a)	Remediate Condition 5 Overcrossings	None	2022	2026	50	20 / 40 years	£10.1
2 (a)	Remediate Condition 5 Overcrossings	Post investment PoF	2022	2026	50	20 / 40 years	£10.1
3 (a)	Remediate Condition 4 & 5 Overcrossings	None	2022	2026	76	20 / 40 years	£15.3
4 (a)	Defer Investment	None	2027	2032	0	20 / 40 years	£0.0
Baseline (b)	Baseline	None	-	-	-	-	-
1 (b)	Remediate Condition 5 Overcrossings	Pre investment PoF	2022	2026	50	20 / 40 years	£10.1
Baseline (c)	Baseline	None	-	-	-	-	-
1 (c)	Remediate Condition 5 Overcrossings	PoC	2022	2026	50	20 / 40 years	£10.1
Baseline (d)	Baseline	None	-	-	-	-	-
1 (d)	Remediate Condition 5 Overcrossings	Pre and Post investment PoF and PoC	2022	2026	50	20 / 40 years	£10.1

7.3. Options Cost Details

The unit costs used in both our Cost Benefit Analysis and capital expenditure forecasts have been derived using our Unit Cost Database (UCD) to provide confidence in their accuracy, consistency and credibility. We have developed our UCD during RIIO-1 and is a set of processes and systems used to allocate the costs of our capital projects to assets. We have developed a standard method of measurement which is a measurement rule book which details what costs should be included and excluded in a assets costs as well as detailing how the asset should be measured. These rules ensure that costs are allocated accurately and consistently to assets and the measures (e.g. m2) capture the asset quantity delivered. All our capital project



costs in RIIO-1 have been input into this database which has allowed for a significant number of data points for each asset providing greater cost confidence. The UCD uses these data points to derive cost curve models which provide a cost trend for a given yardstick and allows for an accurate cost estimate for a given asset based on actual historic costs. A cost estimating template is used to build up the individual elements of an asset intervention such as the indirect costs associated with construction projects such as mobilisation, site set up and welfare, and direct costs such as civil, mechanical and E&I costs associated with the intervention.

The table below shows our unit costs in 2018/19 prices which have been used in our CBA options analysis and the final proposed RIIO-2 capital expenditure forecasts. In addition, we have detailed what is included and what is excluded from the unit costs.

Overcrossing Unit Cost	Unit Cost (£m)	Inclusions / Exclusions
Condition Upgrade - Stream / Ditch	£0.08	**Unit costs include:** design, procurement, liaison with third parties, construction, commissioning and NGN overheads. Works can include scraping, grit blasting, grinding out cracks and repairing, painting, wrapping, welding, pipe or flange encapsulation, repair to pipe supports or pipe bridge, security fencing, removal of vegetation, installation of chevaux de fries, inverted V's, signage, scaffolding etc. **Unit costs exclude:** Any works undertaken on below ground pipework or ground stabilisation
Condition Upgrade - Canal / River	£0.15	
Condition Upgrade - Rail	£0.30	
Security Upgrades	£0.01	**Unit costs include:** design, procurement, construction, commissioning and NGN overheads. Works can include security fencing, removal of vegetation, installation of chevaux de fries, inverted V's, signage, scaffolding etc. **Unit costs exclude:** Condition upgrades to the overcrossing, supports or bridge structure.
Flood Risk Remedial Works	£0.37	**Unit costs include:** design, procurement, construction, commissioning and NGN overheads. Works can include block pipeline isolation such as block valve operation, hot tap and stopple or bagging off, installation of bypass pipework, pipeline repair or diversion, recommissioning. **Unit costs exclude:** Opex costs associated with a loss of supply event

8. Business Case Outline and Discussion

8.1. Key Business Case Drivers Description

The table below shows the results of each option and the following narrative then discusses the strengths and weaknesses of each.

Option	Description	Sensitivity	RIIO-2 Primary Interventions		RIIO-2 Total Capex Cost (£m)	Total NPV Compared to Baseline (£m)	Payback (years)
			Replace	Refurb			
Baseline (a)	Baseline	None	0	0	£0.0	£0.0	-
1 (a)	Remediate Condition 5 Overcrossings	None	0	50	£10.1	£71.5	5
2 (a)	Remediate Condition 5 Overcrossings	Post investment PoF	0	50	£10.1	£60.2	6
3 (a)	Remediate Condition 4 & 5 Overcrossings	None	0	76	£15.3	£83.3	6
4 (a)	Defer Investment	None	0	0	£0.0	£55.6	12
Baseline (b)	Baseline	None	0	0	£0.0	£0.0	-
1 (b)	Remediate Condition 5 Overcrossings	Pre investment PoF	0	50	£10.1	£43.6	7
Baseline (c)	Baseline	None	0	0	£0.0	£0.0	-
1 (c)	Remediate Condition 5 Overcrossings	PoC	0	50	£10.1	£39.1	7
Baseline (d)	Baseline	None	0	0	£0.0	£0.0	-
1 (d)	Remediate Condition 5 Overcrossings	Pre and Post investment PoF and PoC	0	50	£10.1	£14.7	17

Option 1 (a) - Remediate condition 5 crossings – Investment in the overcrossings known to be in poor condition throughout RIIO-2 provides the most cost-effective means of mitigating the risk to network security of supply. Through expert visual assessment the crossings identified within this strategy have been classed as condition 5, and in need of intervention prior to failure. A condition 5 assessment can be focused on several single elements within the makeup of the overcrossing, such as severe corrosion to support structures or deterioration of pipe coating, though this applies condition rating for a single element to the entire crossing, the failure of any single element will likely lead to complete failure of the asset. This option focuses investment on assets or components that have reached the end of asset life and present a significant customer and health and safety risk.

This option considers intervention on 50 overcrossings at a total capital cost in RIIO-2 of £10.1m. This option is of lower spend than Option 3 (a) which considers more interventions at a higher total cost, however it is obviously more than Option 4 (a) which chooses not to invest during RIIO-2. This option has a payback of only 5 years due to the high consequences of failure and the relatively little investment required to ensure the overcrossings integrity.

This option has the highest NPV of all options considered but only for the first eleven years after which Option 3 (a) becomes higher. The reason for this is because the benefits accrued for intervening on condition 5 assets is greater than the benefits accrued for intervening on condition 4 assets. This is because condition 4 assets have a lower probability of failure prior to investment leading to a smaller benefit being delivered for the same investment, leading to a lower NPV.

After around eleven years however, Option 3 (a) has a higher NPV. This is because in this option where we are only intervening on condition 5 overcrossings, the condition 4 overcrossings continue to deteriorate. After eleven years the risks associated with these condition 4 overcrossings begin to outweigh the added benefits delivered in the first eleven years for intervening on the condition 5 assets only.

Option 3 (a) - Remediate condition 4 and 5 crossings – This option considers intervention on the 50 condition 5 overcrossings and the 26 condition 4 overcrossings at a total cost of £15.3m. This is more than a 50% increase in spend per year than Option 1 (a). This option does provide a positive NPV, however this is not the only consideration for investment on these assets. Although condition 4 overcrossings have been determined to have deteriorated, it is not a classification that the asset is no longer fit for purpose and the risks associated with the asset do not yet warrant investment. Our view is that this option considers intervention on our assets too early and therefore we are not maximising the value we can get out of our existing assets.

Option 4 (a) - Deferred investment – This option considers no capital investment during RIIO-2 and so is the lowest cost option for this period. However, because of the lack of investment this option delivers no benefits to our customers during RIIO-2 and the risks associated with loss of supply increase. This option has the lowest total NPV of all options and the slowest payback of 12 years.

As previously stated, condition 5 overcrossings present a risk that requires intervention prior to asset failure. Deferring investment until RIIO-3 is not a viable option as the overcrossings highlighted within this strategy display signs of severe deterioration and corrosion that requires intervention to ensure security of supply.

Conclusion

Our preferred option is Option 1 (a) because it delivers the highest benefit for the cost within the RIIO-2 period. Investing in condition 4 assets does not constitute effective asset management as

much of the cost of the intervention is in erecting scaffolding to access it and we need to be sure there is enough necessary work required to the overcrossing to warrant the upfront investment. This CBA has determined that condition 4 overcrossings are not at immediate risk of failure and therefore do not require intervention within the RIIO-2 price control period.

Within this CBA we have only considered intervention within RIIO-2 where as in reality we would look to continue our overcrossing programme and would propose the condition 4 overcrossings to be upgraded during RIIO-3. In doing this our customers would benefit from the interventions which delivered the greatest benefit during RIIO-2 and only when the condition 4 assets have deteriorated further would we intervene on them to deliver similar benefit for the same cost.

Sensitivity Analysis

In calculating the Loss of Supply avoided costs that have been derived outside of the NARMs methodology, we have applied several assumptions. Sensitivity analysis has been completed on these assumptions, for the preferred option only, to demonstrate the impact of each variable if a lower tolerance is used. The outcome of each scenario sensitivity is detailed below.

Option 2 (a) – Sensitivity on the Post investment PoF

Total NPV reduces by 16% to £60.2m however payback only increases by a year to 6 years. This analysis proves that the investment is still beneficial, and our customers will get a quick return on their investment.

Option 1 (b) – Sensitivity on the Pre investment PoF

Total NPV reduces by 39% to £43.6m and payback increases to 7 years. This input to the CBA is therefore more sensitive than the post investment PoF however changing this parameter would not change the outcome of the Cost Benefit Analysis.

Option 1 (c) – Sensitivity on the PoC

Total NPV reduces by 46% to £39.1m and payback increases to 7 years. This input to the CBA is therefore most sensitive tested but again the investment still delivers a good total NPV and our customers would still get a quick return on their investment.

Option 1 (d) – Sensitivity on the Pre and Post investment PoF and the PoC

This option is an extreme worse case and as a result Total NPV is reduced by 80% to £14.7m. Even in this situation where every variable input is lowered the investment still offers a payback to our customers within 17 years.

Other Minor Investments

Security Upgrades – Throughout RIIO-1 we have undertaken a significant investment programme to ensure all overcrossings have adequate security prior to the commencement in RIIO-2. It is therefore only expected that deterioration of existing assets will be necessary through the next price control period, as a proactive upgrade programme is not necessary. We are forecasting to have to intervene on 62 overcrossings in RIIO-2 for a total capital cost of £0.5m

Flood Risk Overcrossings – We are forecasting to require a small capital investment to carry out work on overcrossings should a severe weather event occur. During RIIO-1, we had three such incidents; as a result, we commissioned a report to review the risk associated with flooding affecting our overcrossings. Without investing considerable amounts, we were unable to confidently identify

where we should invest to mitigate these risks. Due to this uncertainty, our RIIO-2 strategy is a reactive rather than proactive approach and will need £1.8m to cover these risks.

8.2. Business Case Summary

Option	Description	Sensitivity	No. of Assets Impacted	RIIO-2 Total Capex Cost (£m)	NPVs (relative to baseline, £m)						Preferred Option
					2030	2035	2040	2050	2060	2070	
Baseline (a)	Baseline	None	0	£0.0	-	-	-	-	-	-	-
1 (a)	Remediate Condition 5 Overcrossings	None	50	£10.1	£7.8	£16.7	£25.4	£41.8	£57.0	£71.5	✓
2 (a)	Remediate Condition 5 Overcrossings	Post investment PoF	50	£10.1	£5.8	£13.4	£20.8	£34.8	£47.8	£60.2	×
3 (a)	Remediate Condition 4 & 5 Overcrossings	None	76	£15.3	£7.2	£17.8	£28.1	£47.6	£65.9	£83.3	×
4 (a)	Defer Investment	None	0	£0.0	-£2.6	£4.3	£12.3	£27.4	£41.8	£55.6	×
Baseline (b)	Baseline	None	0	£0.0	-	-	-	-	-	-	-
1 (b)	Remediate Condition 5 Overcrossings	Pre investment PoF	50	£10.1	£2.7	£8.3	£13.8	£24.3	£34.1	£43.6	×
Baseline (c)	Baseline	None	0	£0.0	-	-	-	-	-	-	-
1 (c)	Remediate Condition 5 Overcrossings	PoC	50	£10.1	£2.0	£6.8	£11.6	£21.0	£30.2	£39.1	×
Baseline (d)	Baseline	None	0	£0.0	-	-	-	-	-	-	-
1 (d)	Remediate Condition 5 Overcrossings	Pre and Post investment PoF and PoC	50	£10.1	-£3.1	-£1.0	£1.1	£5.6	£10.2	£14.7	×

9. Preferred Option Scope and Project Plan

9.1. Preferred Option

Our preferred option is Option 1 (a) - to remediate overcrossings known to be in poor condition (rating 5) and to remediate overcrossing security in line with expected deterioration or vandalism from the onset of RIIO-2. The method of remediation will vary depending on network operability; however, the preference would always be to remove the crossings if without detriment to security of supply.

9.2. Asset Health Spend Profile

Intervention	Workload	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Condition upgrades - rail	10	£0.6	£0.6	£0.6	£0.6	£0.6	£3.0
Condition upgrades - stream / ditch	12	£0.2	£0.2	£0.2	£0.2	£0.2	£0.9
Condition upgrades - canal / river	8	£0.3	£0.3	£0.0	£0.3	£0.3	£1.2
Condition upgrades - deterioration	15	£0.0	£0.0	£0.9	£0.9	£0.9	£2.6
Security upgrades	63	£0.1	£0.1	£0.1	£0.1	£0.1	£0.5
Flood risk overcrossings	-	£0.4	£0.4	£0.4	£0.4	£0.4	£1.8
Total	108	£1.5	£1.6	£2.1	£2.5	£2.4	£10.1

The total forecast capital expenditure for Overcrossings has been included within this Cost Benefit Analysis and can be referenced back to the following documents:

- RIIO-2 Business Plan – Table 6.8
- RIIO-2 Business Plan Data Tables – Table 3.05
- A23.G - NGN RIIO-2 Investment Decision Pack – Overcrossings - CBA

9.3. Investment Risk Discussion

We have controls and processes in place throughout the development of our RIIO-2 Capital Expenditure programme to ensure we mitigate both our customer's and our own exposure to risk. 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 based on known impact of failure and deterioration rates of assets.
- We have undertaken surveys of the entire overcrossing population over the last 4 years, data is continuously updated to reflect deterioration as per the overcrossing maintenance and inspection frequency
- 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 have sense checked our preferred option against other asset data such as age, condition surveys, pressure tiers, criticality and crossing type.
- We have shared our preferred strategy with our businesses industry experts to sense check volumes and costs
- Our RIIO-2 strategy is comparable with our RIIO-1 strategy and so we have a proven record we can manage our assets in this way.

Unit Cost Risk Mitigations

- We have used our Unit Cost Database to determine our unit costs. This database holds c.17,000 datapoints which have been collated in a consistent way to ensure our historic costs accurately inform our RIIO-2 unit costs.
- We are not planning to undertake new work activities. We have undertaken all interventions previously and have historic costs allocated within our Unit Cost Database.
- We have benchmarked our unit costs against other GDN's to ensure our unit costs are efficient.
- 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.