Asset Health Engineering Justification Framework

Local Transmission System (LTS) Pipelines

Contents

1 Summary Table

Name of Project	Asset Health - Local Transmission System (LTS) Pipelines		
Scheme Reference	WWU.5		
Primary Investment Driver	Asset Health		
Project Initiation Year	2026		
Project Close Out Year	2031		
Total Installed Cost Estimate (£)	[redacted]		
Cost Estimate Accuracy (%)	+/-15% based on significant experience of delivering this work and detailed work and cost records.		
Project Spend to date (£)	£0m		
Current Project Stage Gate	Not started		
Reporting Table Ref	Table 5.01		
Outputs included in RIIO-GD3 Business Plan	Outputs will be in the BPDT, Table Ref. 5.01		
Spend apportionment 23/24 prices	G2	G3	G4
	-	[redacted]	-

The apportionment should detail the spend for the project over multiple price controls, if applicable. G3 would represent the request for this submission.

2 Executive Summary

Our LTS Pipeline assets move substantial volumes of gas at high pressure from the National Transmission System (NTS), reducing in pressure stages throughout the Local Transmission System (LTS), to the local distribution pipe network and our consumers. The assets represent a critical part of the network, as a single failure could impact on many thousands of customers. As the network is used to transport gas at very high pressures, any leaks could have very serious consequences.

WWU operate some of the oldest LTS pipelines in the UK, with Wales specifically operating pipelines constructed in 1967, or earlier, and thus they do not meet the quality required by the earliest subsequently published construction standards.

- the leak rate of our old (1967 or earlier) pipelines is 6.6 times higher than other UK equivalents

The purpose of this investment in our LTS Pipeline population is to ensure their continued integrity and compliance with WWU's Safety Case, as well as to meet stakeholders' requirements that we maintain risk and reliability in a financially efficient manner.

Our preferred option for these assets, our Balanced Plan, combines the flexibility of reactive maintenance with the reliability of planned replacement. This option offers the best of both worlds: the agility to address urgent issues promptly and the foresight to implement long-term improvements. It balances short-term operational necessities with strategic, long-term goals, ensuring the network's resilience and compliance with legislative standards.

The net-present value relative to baseline of our Balanced Plan option (in 2050) is -£1.5m.

Failure to undertake this work will result in an increased risk of not satisfying the requirements of the legislation, or non-compliance with the WWU Safety Case, and may result in a failure to deliver stakeholder outputs, or enforcement action by the Health & Safety Executive.

Table 1 - Cost & Volume Table, RIIO-GD2 to RIIO-GD3

	RIIO-GD2		RIIO-GD3	
	Cost (£m)	Volume (No.)	Cost (£m)	Volume (No.)
Above Ground Crossing Refurbishments	2.1	78	[redacted]	8
AC Monitoring and Mitigation Installation	0.6	23	[redacted]	68
AGI (Block Valve and Pig Trap Sites) Refurbishments	0.1	10	[redacted]	20
Condition-Driven Short Length Diversions	3.8	11	[redacted]	8
CP System – TR, Ground bed and Test Post Replacements	4.0	326	[redacted]	475
Inspections – Pre-Work, Surveys and Defect Investigations/Repairs	6.9	2,132	[redacted]	4,418
Marker Post Replacements	1.5	1,536	[redacted]	2,140
Nitrogen Sleeve Repairs	2.5	14	[redacted]	20
Riverbed and Bank Refurbishments	2.0	85	[redacted]	237
Shallow Depth of Cover Remediation	0.4	81	[redacted]	120
Third Party-Driven Short Length Diversions	0.3	0	[redacted]	2
Valve and Valve Chamber Refurbishments	1.8	137	[redacted]	130
Total	**25.8**	**4,431**	[redacted]	**7,646**

3 Introduction

This document aims to provide a comprehensive overview of Local Transmission System (LTS) pipelines. It will highlight key information related to this asset group and examine the probabilities and consequences of failures. Following this, it will explore various intervention strategies along with their associated costs, culminating in our recommended investment option for LTS Pipelines during RIIO-GD3.

Figure 1 – Cross country pipeline under construction (example photo, taken from: https://www.conservesolution.com/portfolio/cross-country-pipeline-a20-project/)

Gas enters the Wales & West Utilities' (WWU) Local Transmission System (LTS) from the National Transmission System (NTS) at 17 points of offtake across our network. Our LTS comprises a network of steel pipelines transporting gas in bulk at high pressure across our geography and the associated pressure regulating installations (PRIs). Maintaining the functionality of these pipelines, which deliver gas in large quantities to the downstream local distribution networks, is essential for providing a safe and reliable gas supply to our consumers.

We have established efficient procedures to manage the risks associated with this asset group; without these measures, we would fail to meet key stakeholder requirements and adhere to our legal obligations.

Each maintenance and inspection visit is an opportunity for our Operatives to raise any issues or observations through our fault reporting processes. These fault records, and results of other routine activities, feed into our risk models, ensuring that we are making decisions based on recent accurate records and data.

The proposed level of investment has been set to maintain the current risk outputs and compliance with the relevant legislation.

4 Equipment Summary

The diagram below, Figure 2, depicts the role and position of LTS pipelines (high pressure, >7 bar) within the gas distribution network, Figure 3 illustrates the geographic location of the LTS pipelines. Note, all mentioned gas pressures refer to gauge pressure unless otherwise specified.

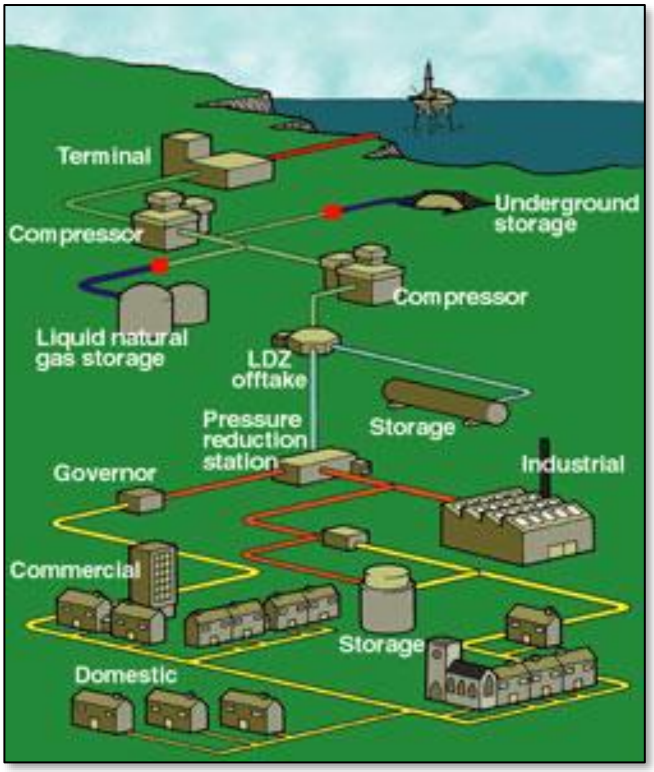


Figure 2 - Gas Distribution Network

Figure 3 - Network overview of LTS Pipelines

Offtakes form the physical interface between National Transmission System (NTS) owned by National Gas and the WWU gas distribution network system and assets. At these Offtakes, which are owned by the gas distribution network operator, gas is metered, and its calorific value is measured for custody transfer, before it enters the LTS pipelines system and on through the associated pressure reduction installations (PRIs). The purpose of these pipelines is the transportation and bulk storage of gas across our network to service customer demand.

There are 2,360km (RRP 2023/24) of carbon steel LTS pipelines across the WWU network, with a maximum operating pressure (MOP) ranging from 7 to 70 bar and diameters from 25mm to 1,200mm, see Figure 3 below showing network overview of these pipelines.

WWU also own and operate thousands of connected and related sub-assets that ensure we maintain the integrity of our LTS system. Some of these sub-assets are illustrated in Figure 4, their populations tabulated in Table 2 and brief description provided below.

Cathodic Protection (CP) Systems - A supplementary system to maintain buried steel pipelines and fittings, with its purpose being to protect the buried pipeline from corrosion where the coating alone may be inadequate to protect the steel from the environment in which it is laid. The first form of protection is an appropriate coating system which isolates the steel pipe from contact with the ground in which it is buried. When this coating fails, or contains minor defects, the CP system prevents corrosion by blocking the electrolytic reaction that causes it and allowing a sacrificial anode (ground bed) to corrode in preference to the pipeline. These two major components of a pipeline installation work hand in hand to reduce the key risks associated with failure of the integrity of a steel pipeline through corrosion, which would otherwise lead to a reduction in LTS pipeline asset life. The application of a cathodic protection system, partnered with an external pipeline coating, ensures the longevity of WWU's LTS pipeline population.

The CP systems deployed on our LTS pipeline population are impressed current systems, relying on an electricity supply to provide the voltage and current that protects the pipeline. The individual component names of the parts which make up an CP system (impressed current) are:

- **Transformer Rectifiers –** Provides the correct type of electricity to the system.
- **Ground Beds –** A buried sacrificial "bed" filled with coke material that deteriorates instead of the buried pipeline.
- **Test Posts –** An above ground post, used to collect data during inspections.

To ensure our CP systems continue to adequately protect our pipelines, we carry out a wide range of maintenance and inspection activities, in compliance with the Pipeline Safety Regulations (1996) and the Pressure Systems Safety Regulations (2000).

Block Valve Sites (AGIs) – a block valve site is an above ground valve assembly and is used to isolate individual pipelines or parts of a network.

PIG Trap Sites (AGIs) – pipeline inspection gauge (PIG) trap sites facilitate the in-line inspection (ILI) of a proportion of our LTS pipeline network. ILI is a mandatory requirement, set out in the Pressure Systems Safety Regulations (2000) and PIG trap sites are above ground installations that facilitate the entry and exit of an inspection tool from the pipeline.

In-Line Valves – valves situated in the line of the pipeline and can be operated to sectionalise the network when carrying out works, during emergency, etc.

Above Ground Crossings – an above ground section of pipeline that crosses a railway, road or watercourse. These sections are often self-supported but can also be contained within bridge structures or have purpose-built pipe bridges.

Below Ground Crossings – a below ground section of pipeline that crosses under a railway, road or watercourse. Several crossings have nitrogen sleeves installed for additional protection.

Nitrogen Sleeves – a larger diameter, outer sleeve to provide impact protection, filled with Nitrogen, as an inert gas preventing corrosion of the inner pipeline. Used for high consequence areas such as under major roads and railways. No longer allowed within IGEM/TD/1- thick wall pipe preferred.

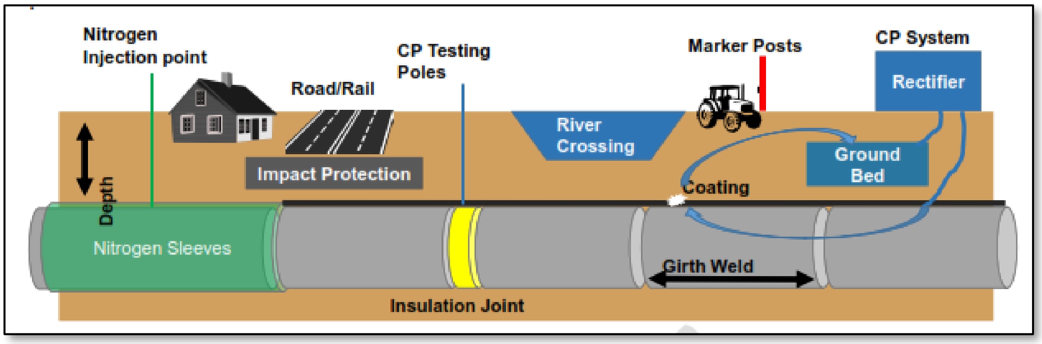


Figure 4 - LTS Pipelines, with associated equipment

Table 2 - Assets and sub-assets associated with LTS pipeline population (Forecast at 1st Year RIIO-GD3)

Asset	Count
LTS Pipelines	2,349km
Sub-Asset	**Count**
Cathodic Protection Systems	190
Block Valve and Pig Trap Sites (Above Ground Installations)	36
In-Line Valves	~1,600
Above Ground Crossings	125
Below Ground Crossings (River, Road, Rail)	3,082
Nitrogen Sleeves	98

Table 3 - Equipment Summary by Diameter & Maximum Operating Pressure (Forecast at 1st Year RIIO-GD3)

Nominal Diameter	Length (km)
≤200mm	972.832
>200mm & ≤300mm	595.863
>300mm & ≤450mm	343.191
>450mm & ≤600mm	262.082
>600mm & ≤800mm	0.000
>800mm	175.168
Total	**2,349.136**

Maximum Operating Pressure	Length (km)
≤30bar	1,020.613
>30bar & ≤50bar	1,126.871
>50bar & ≤70bar	201.647
>70bar	0.005
Total	**2,349.136**

5 Problem/ Opportunity Statement

The purpose of this investment in our LTS Pipeline population is to ensure their continued integrity and compliance with WWU's Safety Case, as well as to meet stakeholders' requirements that we maintain risk and reliability in a financially efficient manner.

This work will ensure that these assets remain fit for purpose and maintain compliance with the following Regulations:

- The Pipelines Safety Regulations 1996
- The Pressure Systems Safety Regulations 2000
- The Gas Safety (Management) Regulations 1996

Failure to undertake this work will result in an increased risk of not satisfying the requirements of the legislation, or non-compliance with the WWU Safety Case, and may result in a failure to deliver stakeholder outputs, or enforcement action by the Health & Safety Executive. In addition, the LTS Pipeline network may suffer an increasing fault rate due to advanced deterioration, incurring additional costs and in extreme cases an interruption of supplies.

The outcome we want to achieve is the continued safe transportation, distribution and storage of gas to deliver a safe and reliable supply of gas to the public, commercial establishments, and industry. In carrying out its undertaking, WWU protects the safety of its employees and the community, and safeguards the environment from the effects of accidents, incidents and pollution. As a minimum, WWU must always comply with all relevant legislative, regulatory and statutory obligations.

We will measure success through several performance indicators including:

- Customer interruption numbers
- Monetised risk levels (NARMs)
- Fault and failure rates

The following sections detail some of the specific challenges that we face when managing our LTS pipeline system.

Older Pipeline Network

Wales & West Utilities operate some of the oldest transmission pipelines in the UK still operating above 7bar, with the Wales LDZ specifically relying extensively on pipelines constructed between 1956 and 1967 by Wales Gas Board operatives. These, which do not meet many of the quality standards required by even the earliest published pipelines construction codes.

Some of these pipelines have socket and spigot joints, which have exhibited failures due to cracking of the socket and general corrosion due to poor and degraded coatings. Other pipelines in this group are constructed with conventional girth welds, but the welds are of such poor quality due to poor workmanship, and no valid quality control practices having been in place, that failures regularly occur.

Furthermore, these pipelines transported Towns Gas and as such have latent internal degradation, including internal stress corrosion cracking (SCC) and general corrosion. The pipe material itself is low-grade steel, with many inclusions and defects from original manufacture. The combined effect of these material and construction defects is resulting in regular loss of containment failures, leading to costly unplanned remedial work to keep them in service. In addition, it is becoming increasingly difficult to safely undertake hot works on these pipelines to facilitate short length diversions when these failures occur.

The majority of the old, pre-IGEM/TD/1 standard pipelines in other areas of the UK have either been:

- downrated to distribution pressures (below 7 bar)
- upgraded to meet TD/1 Edition 2 requirements
- have been replaced by reinforcement schemes required to meet growing demand

Due to the minimal load growth in the small, remotely located population groups in Wales, these old pipelines in Wales have remained an integral part of the transmission pipeline network with very little modification and no practical options to upgrade them.

The pipeline network developed in Wales to serve remote communities is located in difficult terrain, and consequently, this has resulted in:

- shallow trenches, resulting in shallow depth of cover over the pipelines,
- a large number of above ground sections,
- non-conventional construction ('socket/spigot' joints, as applied in low pressure systems),
- poor weld quality (pre-earliest published standards), highly unlikely to withstand adverse loading,
- pipelines constructed in sections of variable diameter and,
- small diameter pipelines, as the communities requiring supply were remote and fairly small.

The total length of live pipelines in the UK commissioned in 1967 or earlier, as of the end of 2021, is 4213 km, 484 km are operated by WWU, and of these pipelines (as of the end of 2021)

- 45% of the total leaks in the UKOPA database have occurred on WWU pipelines
- the leak rate of WWU pipelines commissioned in 1967 or earlier was 6.6 times higher than the leak rate of other UK pipelines commissioned in 1967 or earlier

The Local Transmission System (consisting of LTS pipelines) plays a pivotal role in supplying gas to our consumers, bulk-transporting gas across our entire network from the National Transmission System to feed our cities, towns and villages. This pipeline network is vital in feeding the consumers of today, and the consumers of tomorrow.

Reference should be made to EJP/HW009&HW010 and EJP/HS007 which detail the engineering justification for wholesale pipeline replacement of HW009/HW010 and HS007, respectively.

Watercourse Crossings

WWU manage c.1000 LTS pipeline watercourse crossings which are scheduled for inspection using a risk-based approach, depending on the type/movement of watercourse, depth of pipeline, etc. The locations of these crossings differ widely, from short ditch crossings and streams to extensive navigable and tidal river crossings. Inspections are performed in-house when possible; however, for larger and more complex rivers, specialist contractors are engaged due to the expertise and equipment required.

Rivers, by their nature, are subject to changes in the natural environment and weather patterns, resulting in erosion of both their beds and banks. The most frequent problem concerns the depth of cover over the pipeline, and as the depth reduces, the pipeline becomes more vulnerable to debris impact and accelerated corrosion, if exposed within the river.

This risk increases significantly with watercourse management activities such as ditch clearing and dredging carried out by landowners.

To ensure the integrity of these crossings, the typical solution involves installing concrete or gabion mats and/or reprofiling the river. This remedial approach helps to harden the riverbed, thereby significantly reducing the effects of erosion.

Mitigating riverbank erosion is a more intricate task and developing effective remediation strategies for the river requiring consultation with the Environment Agency (EA) or Natural Resources Wales (NRW) to confirm the sustainability of the solution.

River remediation work can be extremely complex work type as there are often land access issues, as well as the need for consents from the EA or NRW. In some cases, the consents to undertake work on these rivers can take months, even years, depending on the size and duration of the work required.

Early intervention is crucial when managing watercourse crossings, with the employment of a proactive identification and remediation approach avoiding future complex, significant-spend interventions.

Stray Current (AC & DC Interaction)

Given the length of the steel LTS pipeline system, spanning a huge geographical area, there are a number of locations where the pipelines run in parallel with overhead power lines in so-called utility corridors across agricultural land. When the two networks run in parallel with each other, the electromagnetic field generated by power lines can induce significant alternating current (AC) onto the pipeline. There are approximately 1,607km of WWU LTS pipelines within 3km of these high voltage overhead powerlines.

The issue of AC interaction with pipelines is considered a relatively new phenomenon, with previous focus being on the pipelines with deteriorating coating systems. However, the worst affected pipelines, from an AC interference perspective, are those with the best quality coatings due to the current leaving the pipeline at microscopic coating defects resulting in rapid localised corrosion. These corrosion defects are usually smooth deep defects occurring over a relatively short timeframe and if not identified soon enough can result in a through wall defect, see Figure 5 below:

Figure 5 - AC induced metal loss defect (~50% pipeline wall loss), subsequently shelled

Trees & Vegetation

The presence of trees and vegetation over gas pipelines poses several significant risks and challenges. These concerns are outlined in the UKOPA Good Practice Guide (UKOPA/GPG/041), which provides detailed guidelines on tree planting near high-pressure pipelines.

One of the primary issues with having trees and dense vegetation over a gas pipeline is that it hinders the ability to conduct over ground surveys. These surveys are critical for maintaining the integrity and safety of the pipeline, as they allow operators to inspect the pipeline route for any signs of damage, erosion, or other potential hazards, and also to undertake CP and coating checks along the pipeline length. Trees and dense vegetation create physical obstacles that make it difficult to access the pipeline, thereby impeding regular inspections and increasing the risk of undetected issues.

Another significant problem is the potential for tree roots to damage the coatings used to protect high-pressure pipelines. Tree roots can grow and spread extensively, penetrating and disrupting the protective coatings that safeguard the pipeline from corrosion and other forms of deterioration. Once the protective coating is compromised, the underlying pipeline becomes vulnerable to damage, which could lead to leaks or ruptures, posing significant safety and environmental risks.

Trees planted too close to gas pipelines also pose a threat due to the risk of falling in severe weather. A tree falling on a pipeline can cause direct physical damage, particularly if the tree is large and heavy. Additionally, the root systems of fallen trees can become entangled with the pipeline, exerting pressure and potentially damaging the pipeline's structural integrity. This risk is exacerbated in areas prone to storms, high winds, or other adverse weather conditions that could increase the likelihood of trees falling.

Cathodic Protection Remote Monitoring (2G and 3G)

The impending retirement of the 2G and 3G networks presents significant challenges for cathodic protection remote monitoring and Internet of Things (IoT) applications. These legacy cellular platforms have been a backbone for many remote monitoring systems, providing reliable and cost-effective communication channels for transmitting data from remote CP monitoring devices to central control systems.

As these networks are phased out, we have to transition to newer technologies, such as Long-Term Evolution (LTE) or 4G and 5G to maintain this essential telemetry feed back to monitoring systems. This transition isn't merely a matter of swapping out a SIM card; it often requires a complete overhaul of the existing hardware. Many CP monitoring devices currently in use were specifically designed to operate on 2G/3G networks, and the newer network protocols are often not compatible with the old hardware. As such existing suppliers of these products are not supporting the refurbishment and new hardware has to be installed.

Depth of Cover

Managing the depth of cover over natural gas pipelines is a critical issue. This challenge is compounded by natural erosion, farming, and other agricultural activities, leading to increased vulnerability to third-party damage. The guidance document, UKOPA/GPG/001 Managing Reduced Depth of Cover, outlines best practices and strategies for addressing these concerns.

The erosion of soil due to weather conditions significantly impacts the depth of cover over pipelines and various types of erosion, including water, wind, and gravity, contribute to this problem.

Agricultural practices also contribute to the reduction in soil cover over pipelines. Activities such as tillage, laser levelling, and livestock movement can compact or move the soil, reduce its volume, or increase erosion.

The reduction in soil cover over pipelines increases the risk of damage from third-party activities. Shallower pipelines are more susceptible to disturbances from farming equipment, construction activities, and other forms of third-party interference. Effective management of reduced depth of cover involves several strategies, including identification, risk assessment, and mitigation measures. Identifying sections of pipelines with reduced cover is essential and assessments will consider the pipeline's vulnerability to third-party damage, its susceptibility, and consequences of potential failures. Factors such as land use, pipeline depth, and design specifications are critical in this assessment.

Several mitigation measures can be implemented to manage the risks associated with reduced depth of cover, including enhanced liaison with Landowners; improved pipeline marking; installing physical protection; and increasing soil cover.

These specific challenges are continually managed as part of annual programmes of maintenance and intervention, and each visit is an opportunity for our Operatives to raise any issues or observations through our long-established fault reporting processes. These fault records, and results of other routine activities, feed into our decision-making processes, ensuring that we are basing our decisions on recent, accurate records and data.

The proposed level of investment has been set to maintain the current risk outputs and compliance with the relevant legislation.

5.1 Narrative Real-Life Example of Problem

The following examples show previous intervention works on pipelines:

PONTYATES to LAMPETER VELFREY – Riverbed & Bank Remedial, and Grouted Shell

Pipeline ID	WWU-WA-MN-PHW021
Project ID	14739
Completion Year	2024
Total Cost	[redacted]

During the river survey, it was found that the river had eroded part of the bank away, exposing the pipeline. Once work had started and a closer inspection of the pipeline occurred, it was found that there was damage to the pipeline, likely to be from debris moving down the river. This damage was repaired with the installation of a grout filled shell. The riverbank and bed were reconstructed, and a pipeline protection system was designed and installed to protect the pipeline from further erosion and damage.

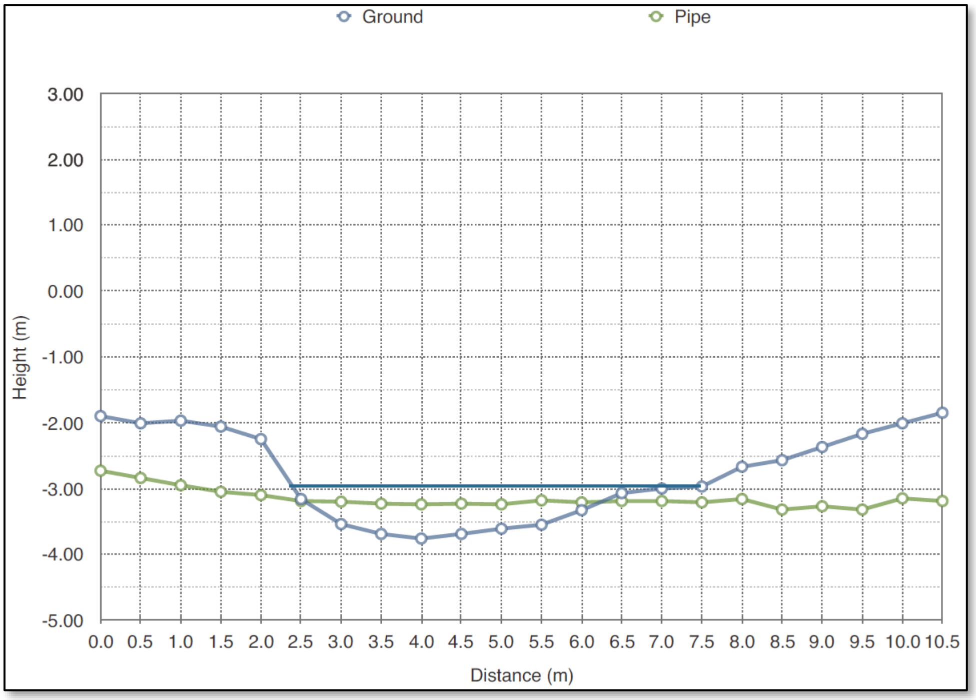


Figure 6 - Graph showing the river survey conducted on the pipeline in 2021

Figure 7 - River in full swell in October where the bank is starting to erode (rope indicates pipeline route)

Figure 8 - Pictures showing the exposed pipeline and vegetation growing around the eroded riverbank

Figure 9 - Pictures showing the newly installed shell (left) and the shell ready to be grout-filled (right)

Figure 10 - Completed project showing cleared vegetation and installed rock matting over the pipeline

LISKEARD to INDIAN QUEENS - Riverbed Remedial

Pipeline ID	WWU-SW-MN-PLQ000
Project ID	19094
Completion Year	2022
Total Cost	[redacted]

Following a river survey on the river Lerryn, it was found that both the riverbed and the riverbank and had been eroded away, reducing the cover over the pipeline. In the drier months cattle were able to walk over the pipeline and erode the ground. A concrete protection system was installed to protect the pipeline from damage.

Figure 11 - Pictures showing the vegetation growing around the pipeline and erosion of riverbank

Figure 12 - Picture showing completed project, with cleared vegetation and installed concrete padding over the pipeline

FISHGUARD - CARDIGAN – OLI4 Inspection & Defect Remedials

Pipeline ID	WWU-WA-MN-PHW030
Project ID	19884 & 19900
Completion Year	2023
Total Cost	[redacted]

During the 2021 PSSR inspection (AR: 15474), to which the close interval potential survey (CIPS) forms part of it, several defects were identified, with one being severe enough to require remediation to ensure on-going integrity. A further coating survey (DCVG) was undertaken, which identified a coating defect with associated metal loss. The defect was categorised as a “severe” thus requiring excavation and remediation in accordance with our internal procedures.

Following an investigation, a repair shell was required to ensure the integrity of the pipeline. Costs included materials, shell, grout, plant hire and installation/reinstatement.

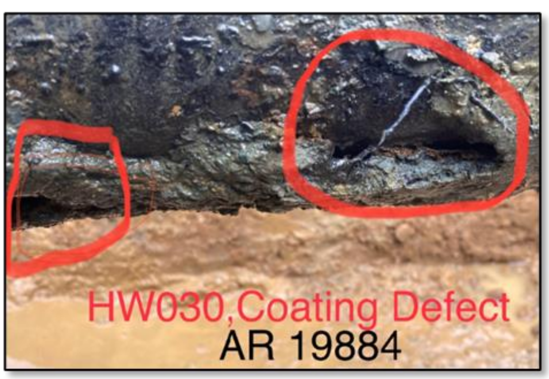


Figure 13 - Coating defect after excavation of the pipe section

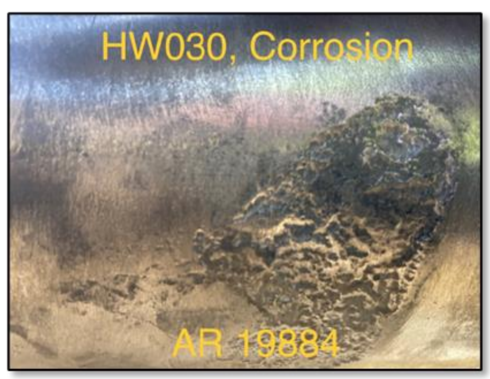


Figure 14 - Corrosion on the pipe after removal of the coating and cleaning of pipeline

Figure 15 - Completed shell with coating (left), reinstated track (middle) and newly installed fence / marker post (right)

JOHNSTOWN SPUR – Tree/Vegetation Management

Pipeline ID	WWU-WA-MN-PVN081
Project ID	18786
Completion Year	2023
Total Cost	[redacted]

Figure 16 – Before: several trees that are within 3 meters of the pipeline (pipe detector indicates route of the pipeline)

Figure 17 – After: trees that were within 3 meters of the pipeline have now been removed

During the five yearly route walks, approximately 30 trees were identified as being on or near the pipeline. An external contractor was used to clear along the pipeline route to ensure cathodic protection surveys, coating surveys, and general routes walks could be completed.

5.2 Project Boundaries

Examples of project spend boundaries can be seen below:

- **Wholesale Replacement** – replacement of main components of a pipeline system e.g. pipeline diversion, TR and ground bed replacement, valve replacement
- **Component Replacement -** replacement of test posts, crossing guards or marker posts
- **Refurbishment/Repair** – removal of old coating system and application of new one, repair of defects and other pipeline features, refurbishment of valves etc.
- **PSSR Inspections** – in-line inspection and above ground condition inspections, as well as visual and major inspections on PIG traps

This engineering justification paper does not include the spend associated with the ~49km pipeline replacements of HW009, HW010 & HS007. These projects have their own Engineering Justification Papers, reference: EJP/HW009&HW010 EJP and EJP/HS007.

6 Probability of Failure

Failure modes and probabilities of failure have been agreed, assessed and documented as part of the cross-GDN process to develop NARMs models. This was done through a number of cross-GDN workshops, with asset experts and through careful analysis of available data held by companies, to assess and quantify the rates of failures and future asset deterioration.

Figure 18 is an illustration of the process to monetise risk. It shows the relationship between the asset (left) and the total monetised risk value (right), taking into account the failure modes, the probabilities of failure, the consequences of failure and the costs of these consequences occurring.

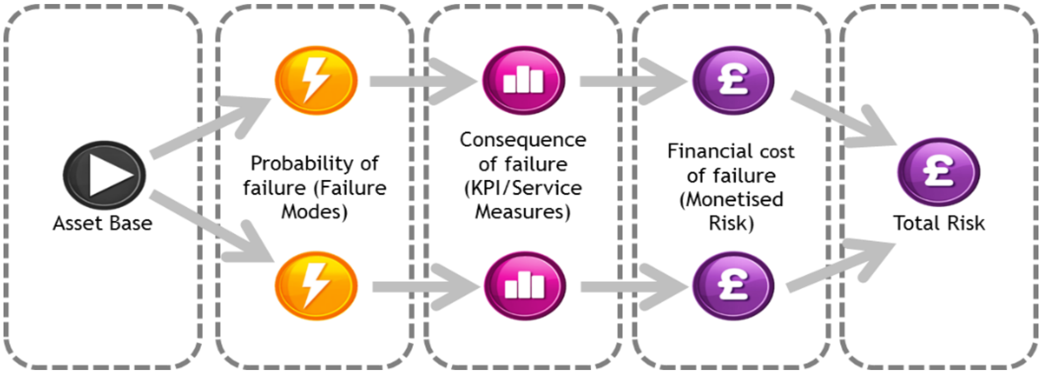


Figure 18 - From the asset to the total monetised risk, illustrative example

The failure modes for LTS Pipelines include:

- **Defects** – Corrosion defects identified on a pipe following a survey, of which some are scheduled for repair.
- **Corrosion –** Either internal or external corrosion of the pipe.
- **Mechanical Failures** – Including material and weld defects created when the pipe was manufactured or constructed.
- **General Failures –** General and other causes, e.g. due to over-pressurisation, fatigue or operation outside of the design limit.
- **Interference** – External interference caused by third parties.
- **Ground Movement** – Either natural (e.g. landslide) or man-made (e.g. excavation or mining).
- **Capacity –** Capacity issues identified on pipelines.

The predicted failure rates of the equipment are derived from WWU historical data and experience from the wider pipeline operator industry, in particular for high consequence, low probability events, where pooling data is necessary due to limited volume of these events.

6.1 Probability of Failure Data Assurance

Fault and failure data is collected when a defect is identified during routine or reactive inspection. This data is recorded through our robust fault reporting process into our core asset repository, SAP. This process allows us to attribute faults and failures against individual components and provides a full record of integrity issues identified over time across WWU's LTS pipeline asset base. All faults and condition reports are investigated, and plans put in place to address the issues found, to restore or maintain integrity.

7 Consequence of Failure

A leak is defined as a gas escape from a stable hole whose size is less than the diameter of the LTS pipeline (IGEM/TD/2). The model has the ability to model leaks of different sizes. A rupture is a gas escape through an unstable defect which extends during failure to result in a full break or failure of an equivalent size to the pipeline (IGEM/TD/2).

Figure 19 - A high pressure gas explosion, Belgium 2004

The number of leaks/ruptures per year is calculated based on the frequency of corrosion, mechanical failures, general failures, interference events, ground movement failures combined with the probability that each of the failure modes will lead to a leak/rupture respectively. These failures can then in turn result in a number of consequences, such as:

- Loss of gas
- Ignitions
- Non-ignition impacts
- Health and safety incidents
- Supply interruptions
- Reactive repair costs
- Prosecution costs

Consequence values (both probability of occurrence and financial effect) are dependent on the consequence events being assessed and are inter-related.

8 Options Considered

This section details the options considered for managing our LTS Pipeline population, following on from the Problem/Opportunity Statement set out in Section 5, and the probability of failure and consequences of failure, set out in Sections 6 & 7, respectively.

8.1 Baseline Option Summary: Reactive Only

This option focuses on ensuring compliance with existing legislative requirements through the implementation of basic repair and refurbishment activities, as necessary. The nature of the actions taken is generally reactive, responding to issues as they arise rather than through pre-planned interventions, implementing temporary and/or short-life fixes.

Unlike a proactive, long-term approach, this reactive option has minimal intervention, prioritising repairs based on legislative urgency and operational necessity. Generally, this option enables quick response times to critical issues while deferring less urgent repairs to align with budgetary constraints.

This is included to show the benefits of pro-active investment plans over reactive. In reality, for high pressure pipelines and other high-pressure assets, do nothing is not an option we could consider in reality. It does not deliver compliance with health and safety legislation and would never be accepted by HSE.

Table 4 - Benefits & Disbenefits of Baseline Option

Benefits	Description
Cost	Lowest cost option, maintaining and repairing only

Disbenefits	Description
Reliability	Lack of redundancy (multi-fed), lines that can't be repaired, supply interruptions
Safety	Require Operatives to work on increasingly dangerous assets
Safety	As areas develop around these lines, public safety will become unmanageable
Environment	Repeat short-fix interventions, creates more environmental disruption over time
Environment	Increased leakage occurrences, leading to increased gas emissions
Cost	Increased maintenance activities to manage deteriorating network
Cost	Cost of repairs will be increasingly expensive (mobilising multiple times, etc.)
Cost	Deferring significant works to future years, therefore more involved / expensive
Health / Risk	Health deteriorating, risk increasing, not what our stakeholders want from us
Reputation	Increasing reputational damage from incidents, increased public scrutiny
Regulator	Enhanced monitoring from HSE, leading to increasing scrutiny

Delivery Timescales: 2026 - 2031

8.2 1st Option Summary: Balanced Plan

This balanced plan option strategically integrates both reactive work and wholesale replacement activities, ensuring that it meets legislative requirements while optimising time, money, and resource allocation. By adopting a hybrid approach, the programme aims to provide a pragmatic solution that prioritises urgent repairs without neglecting the long-term sustainability of the network.

The balanced approach combines the flexibility of reactive maintenance with the reliability of planned replacement. This option offers the best of both worlds: the agility to address urgent issues promptly and the foresight to implement long-term improvements. It balances short-term operational necessities with strategic, long-term goals, ensuring the network's resilience and compliance with legislative standards.

Table 5 - Benefits & Disbenefits of Option 1

Benefits	Description
Reliability	Replacing assets with new (when applicable) will improve reliability / resilience
Safety	New, modern-standard assets will be safer to work on and for public in area
Safety	Balance of repair & replace with maintain high standards of safety
Environment	Replace end-of-life asset with new, long-life asset: less ongoing disruption
Environment	Reduced emissions from leaks & lower embedded carbon with effective spend
Cost	Similar levels of consumer contribution, in-line with stakeholder feedback
Cost	Replacing asset at end-of-life once exhausted repairs options = effective spend
Health / Risk	Health and risk of these assets maintained in-line with stakeholder feedback
Regulation	Maintain good relationship with regulators: compliant, with minimal findings

Disbenefits	Description

Delivery Timescales: 2026 - 2031

8.3 2nd Option Summary: Replacement Only

The Replacement Only option focuses on a proactive approach to asset management, ensuring that any component or system that fails or shows signs of potential failure is promptly replaced. This not only mitigates the risk of extensive downtime and costly reactive repairs, but also enhances overall system reliability and safety.

This option however means replacement of assets before their end-of-life, instead of applying life extending repairs, resulting in significant, ineffective cost.

Table 6 - Benefits & Disbenefits of Option 2

Benefits	Description
Reliability	Replacing broken assets with new will increase reliability / network resilience
Safety	New, modern-standard assets will be safer to work on and for public in area
Health / Risk	Improved health and risk metrics

Disbenefits	Description
Environment	Significant embedded carbon increase with construction of new/disposal of old
Disruption	Increased disruption to local communities as we carry out more involved works
Cost	Significant capital cost, unpalatable to our stakeholders based on feedback
Cost	Replacing asset before end-of-life (repair sufficient) results in ineffective spend
Safety	Large capital construction programme results in risk to workforce and public

Delivery Timescales: 2026 - 2031

8.4 Other Things Considered

As part of the option identification process, there were a number of things considered and discounted, and therefore not progressed through to a cost-benefit analysis assessment. These are documented below:

a) Do Nothing: we have legal obligations in primary and secondary legislation to manage our LTS Pipeline population, predominantly in accordance with the Pipeline Safety Regulations (1996) and the Pressure Systems Safety Regulations (2000), the option of doing nothing is not allowed. As a minimum, we need to continue our inspection and maintenance programmes, and fix what is identified as being defective.

8.5 Options Technical Summary Table

The below table details the technical summary of each option:

Table 7 - Options Technical Summary Table

	First Year of Spend	Final Year of Spend	Volume of Interventions	Equipment or Investment Design Life	Total Installed Cost
(Baseline) Reactive Only	Year 1 - 2026/27	Year 5 - 2030/31	7,450	~10 years	[redacted]
(1) Balanced Plan	Year 1 - 2026/27	Year 5 - 2030/31	7,646	~10 - 45 years	
(2) Replacement Only	Year 1 - 2026/27	Year 5 - 2030/31	7,646	~10 - 45 years	

8.6 Options Cost Summary Table

The below table details the range of costs for each LTS pipeline intervention option:

Table 8 - Range of unit costs for LTS Pipeline interventions, by option number

Intervention Type	(Baseline) Reactive Only	(1) Balanced Plan	(2) Replacement Only	Unit Cost Range £
Above Ground Crossing Refurbishments (including Guards)	✓	✓		[redacted]
AC Monitoring and Mitigation Installation		✓		[redacted]
AGI (Block Valve and Pig Trap Sites) Refurbishments	✓	✓		[redacted]
Condition-Driven Short Length Diversions		✓	✓	[redacted]
CP System – TR, Ground bed and Test Post Replacements	✓	✓	✓	[redacted]
Inspections – Pre-Work, Surveys and Defect Investigations/Repairs	✓	✓	✓	[redacted]
Marker Post Replacements	✓	✓	✓	[redacted]
Nitrogen Sleeve Repairs	✓	✓		[redacted]
Riverbed and Bank Refurbishments (including Surveys)	✓	✓		[redacted]
Shallow Depth of Cover Remediation		✓		[redacted]
Third Party-Driven Short Length Diversions	✓	✓	✓	[redacted]
Valve and Valve Chamber Refurbishments	✓	✓		[redacted]

9 Business Case Outline and Discussion

9.1 Key Business Case Drivers Description

The table below sets out the top three value drivers for each CBA, demonstrating where the majority of the monetised risk benefit is represented:

Table 9 - Key Value Drivers for Each CBA Model

	Financial Node	Description	CBA Model Percentage
Pipe	F_Death	Cost of death	~80%
	F_Legal_Penalty	Cost of legal enforcement and penalty payments following ignition/explosion	
	F_Displacement	Cost of displacement per person includes transportation, accommodation, meals, welfare arrangements, etc.	
Sleeve	F_Death	Cost of death	~88%
	F_Legal_Penalty	Cost of legal enforcement and penalty payments following ignition/explosion	
	F_Displacement	Cost of displacement per person includes transportation, accommodation, meals, welfare arrangements, etc.	
Valve	F_Displacement	Cost of displacement per person includes transportation, accommodation, meals, welfare arrangements, etc.	~90%
	F_Domestic	Cost of domestic customer supply interruption	
	F_Complaint_SI	Cost of complaint	

9.2 Business Case Summary

Our CBAs have been completed in line with Treasury Green Book Guidance and utilise the Ofgem issued model that is compliant with this guidance.

The table below is extracted from the Ofgem issued CBA model, populated for our assets and the programmes of work considered. For further detail, please see the corresponding CBA models as submitted to Ofgem with the RIIO-GD3 Business Plan.

Table 10 - NPV Relative to Baseline: LTS Pipelines

10 Preferred Option Scope and Project Plan

10.1 Preferred Option

The below table sets out the preferred option to manage our LTS pipeline population: **Option 1 – Balanced Plan**. Our plan is predominantly compliance-driven, in accordance with the Pipeline Safety Regulations (1996) and the Pressure Systems Safety Regulations (2000). However, by the very nature of operating a gas distribution network there will be unforeseen issues, and therefore this plan also accounts for some reactive interventions based on historical experience:

Table 11 - Intervention volumes, preferred option: Option 1, Balanced Plan

Intervention Type	Workload Volume
Above Ground Crossing Refurbishments	8
AC Monitoring and Mitigation Installation	68
AGI (Block Valve and Pig Trap Sites) Refurbishments	20
Condition-Driven Short Length Diversions	8
CP System – TR, Ground bed and Test Post Replacements	475
Inspections – Pre-Work, Surveys and Defect Investigations/Repairs	4,418
Marker Post Replacements	2,140
Nitrogen Sleeve Repairs	20
Riverbed and Bank Refurbishments	237
Shallow Depth of Cover Remediation	120
Third Party-Driven Short Length Diversions	2
Valve and Valve Chamber Refurbishments	130
Total	**7,646**

10.2 Asset Health Spend Profile

The table below details the spend profile, by year, for the LTS Pipeline interventions:

Table 12 - LTS Pipelines Spend Profile

	2026/27 (£m)	2027/28 (£m)	2028/29 (£m)	2029/30 (£m)	2030/31 (£m)	Total (£m)
Spend	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

10.3 Investment Risk Discussion

The future of energy in the UK is not certain over the long term, with the Future Energy Scenarios (FES) offer a number of pathways to 2050. We have considered these pathways when testing the robustness of our investment plan against future uncertainty, ensuring that it supports all credible pathways and avoids the risk of asset stranding.

The Offtakes & PRIs assets identified for proactive intervention have been tested using CBA. This gives a view on the time period over which an investment pays back i.e. at what point in time it becomes lower cost to invest than to not invest. Our test is whether this point in time at which the investment pays back is within the useful lifespan of the asset. If an asset was expected to be needed as part of the UK energy network until 2040 but not beyond, investment paid back by 2035 remains beneficial to bill payers. If the investment didn't pay back until 2042 then we would consider options to extend asset life within the expectations on us to keep the public safe.

The ongoing role of the gas network and the importance of maintaining resilience and security of supply is widely recognised beyond government, even taking longer term uncertainty into account. For example, all Future of Energy (FES) 2024 scenarios involve at least 20% of homes still on natural gas in 2045, even as many transition to electrification or hydrogen and NESO's Clean Power 2030 advice on the required gas generation capacity referenced above. As the gas system needs to meet peak demands, substantial infrastructure for safe, reliable supplies will be required even in scenarios where annual throughput may have significantly dropped.

All Future Energy Scenarios show a decrease in gas volumes albeit over different time periods and to different scales. If 50% of consumers in a street came off the gas network, the pipes feeding the street would still be required to service the other 50% of consumers, as would the district governors feeding the street, the higher-pressure pipes feeding the governor, the PRIs feeding the higher-pressure pipes and so on.

This challenge is exasperated by government policy and approach to electrifying heat, where the decision is left to consumers rather than a mandated approach targeting regions. With this approach, it is incredibly unlikely whole areas will leave the gas network in the short and medium term. If it does happen, it will be a much more sporadic move from gas, resulting in a requirement to operate our assets until the last consumer in a region decides to transfer.

Another challenge is FES gives UK wide pathways and does not provide a view and data on the individual GDN regions. This presents significant limitations in its usefulness with very broad assumptions required to influence regional plans.

The chart below shows how previous FES scenarios have not reflected the experienced reality.

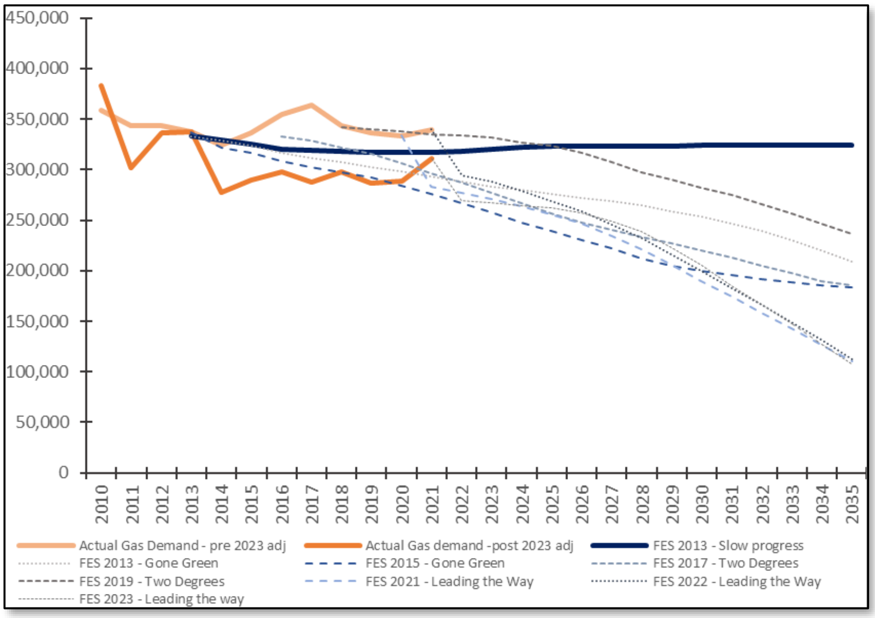


Figure 20 - Historical residential gas demand against most optimistic scenario in every 2nd year of publication, dating back to 2013

It should be noted that in the 2023 FES scenarios there was an adjustment to historical gas demand figures, and as such we have shown historical data both before and after the adjustment to maintain comparability with the original 2013 forecast. What is noticeably clear from these graphs is that, to date, the most accurate forecast appears to be the 2013 slow progress. As such it is difficult to have confidence that future forecasts will be any more reliable.

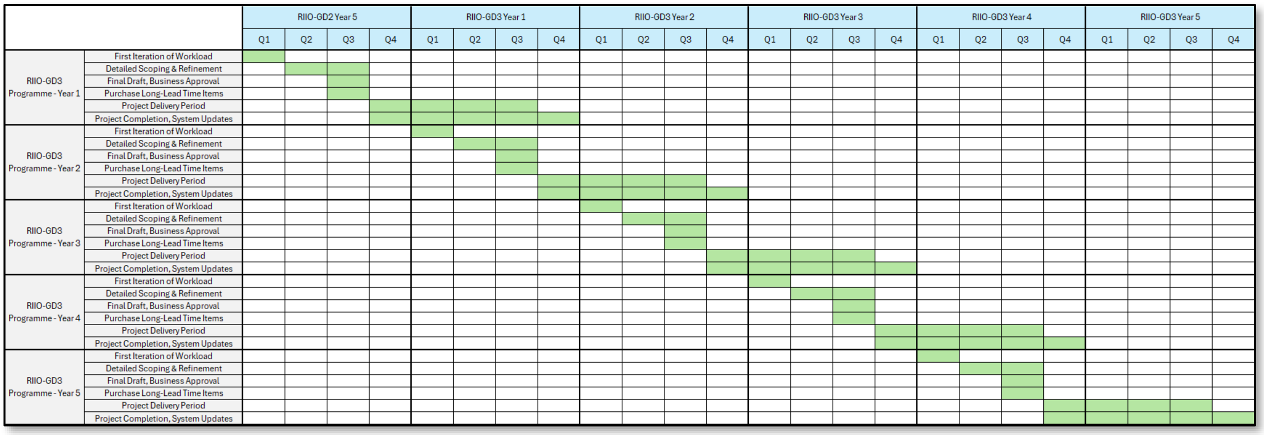
Due to slower and geographically dispersed take-up of heat pumps, and whilst we wait for the Heat Policy decision, moving to a short payback period cut-off for investments is not compatible with ensuring a safe, resilient, and efficient gas network while we transition to Net Zero. The gas sector collectively believes 25 years as a payback period is more realistic across all scenarios and prudent given the sector's legislative duties.

To manage sensitivities in delivery costs and benefits, we are using a prudent 20-year period to assess cost and benefits. This means investments paying back within this period can be justified with a high level of confidence.

10.4 Project Plan

The project plan in Table 13 below details the various stages of the project from the initial workload iteration stage through to record update and project completion. We don't envisage any long lead-time items that will put a RIIO-GD3 delivery in jeopardy, with all items able to be purchased and delivered within 3-6 months.

Table 13 - Project Plan of RIIO-GD3 Planned Investment



10.5 Key Business Risks and Opportunities

The table below summarises risks and mitigations related to delivery of our plan for this asset group:

Table 14 - Summary of Risks & Impacts of the Delivery Plan

Risk Description	Impact	Likelihood	Mitigation/Controls
Programme does not manage risk to required levels	WWU would not be meeting agreed targets for RIIO-GD3	<=20%	We have invested in data and analytics. Probability of failure and deterioration curves have been validated against reality. As long as the physical programme is delivered, this risk is minimal.
Risk to delivery timescales	Increased cost to recover programme if falling behind. Benefits to consumers not realised in a timely manner. Wouldn't comply with HSE mandated requirements	<=20%	We have established processes in place to deliver programmes such as this and have successfully delivered in RIIO-GD2. We have a robust workforce resilience strategy as documented in our RIIO-GD3 submission. Delivery of our investment plans are monitored at Exec / CEO level in our organisation.
Risk to planned costs	Consumers and WWU paying more than planned for work making it less cost beneficial. If cost is below planned cost, then consumers and WWU benefit from Total Expenditure (Totex) sharing incentive	<=20%	We hold excellent data on these assets, and we scope work well in advance. We have an excellent track record in delivering programmes like these. We operate an insourced delivery model for the bulk of our LTS Pipelines programme. Therefore, risk is minimal.

10.6 Outputs included in GD2 Plans

Although preparatory work for the RIIO-GD3 programme will be completed in RIIO-GD2, no physical and hence, outputs, will move between the two price controls.