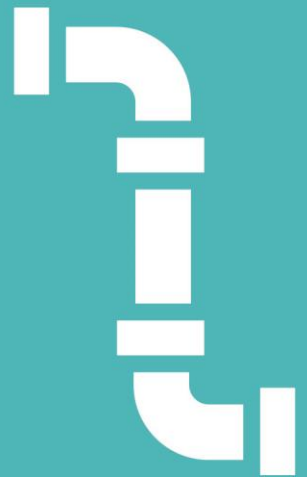




Appendix 15B1

General Pipelines



Version 0.1
September 2019

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Legal Notice

This paper forms part of Wales & West Utilities Limited Regulatory Business Plan. Your attention is specifically drawn to the legal notice relating to the whole of the Business Plan, set out on the inside cover of The WWU Business Plan. This is applicable in full to this paper, as though set out in full here.

This is a redacted copy.



2 Introduction

The purpose of this document is to give an overview of Local Transmission System (LTS) pipelines. It will outline some key facts associated with the asset group and the probabilities/consequences of failure. It will then go on to discuss the intervention options considered, with their associated costs, and finally our preferred option for investment in LTS pipelines during RIIO-GD2.

Gas from the National Transmission System (NTS) enters Wales & West Utilities' (WWU's) Local Transmission System, comprising high pressure steel pipelines, at one of seventeen points around our network.



Figure 1 - LTS pipeline under construction

The serviceability of these high pressure pipelines, which transport gas in bulk to the local distribution systems, is critical in ensuring a reliable and safe gas supply to our consumers. Efficient processes are in place to manage the risks associated with these pipelines, in order to ensure compliance with key safety and reliability legislation, as well as to meet stakeholders' needs and to operate the pipelines at minimum whole-life cost.



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 the results of other routine activities, feed into our health and 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 relevant legislation.

3 Equipment Summary

The following diagram illustrates the function and location of LTS pipelines, transporting gas at pressures above 7 bar gauge, within the gas distribution system.

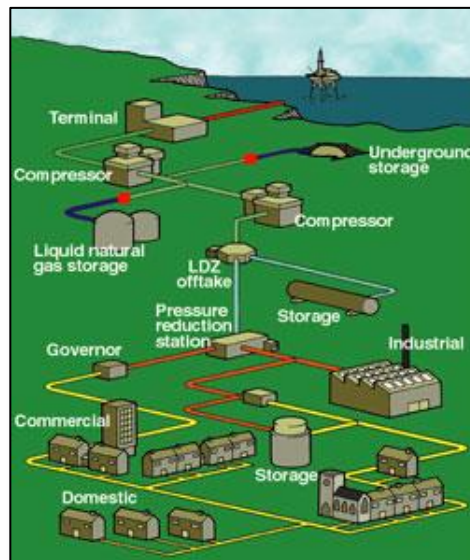


Figure 2 - Gas Distribution Network

Offtakes form the physical interface between the National Grid Transmission-owned National Transmission System (NTS) and WWU assets. Gas then enters the local transmission system (LTS) passing through LTS pipelines and pressure reduction stations before making its way to end users downstream. The purpose of these pipelines is the transportation and bulk storage of gas across our network.

There are 2,359km of carbon steel, LTS pipelines across the Wales & West Utilities network, with a maximum operating pressure (MOP) ranging from 7 to 70 bar and diameters from 25mm to 1,219mm. WWU also own and operate thousands of sub-assets that ensure we



maintain the integrity of our LTS system. Some of these sub-assets are illustrated in Figure 3, with their populations tabulated in Table 1 and descriptions provided thereafter.

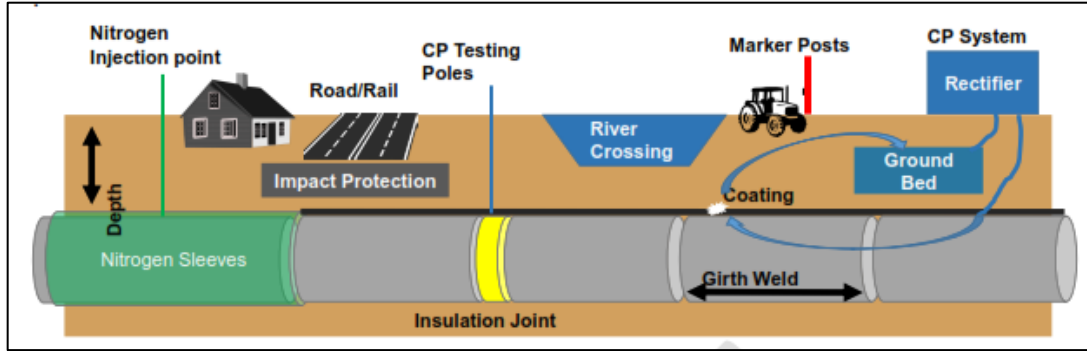


Figure 3 - LTS pipelines with associated equipment

Asset	Length
LTS Pipelines	2,359km
Sub-Asset	Count
Cathodic Protection Systems	190
Block Valve and Pig Trap Sites (AGIs ⁽¹⁾)	42
In-Line Valves	1600
Above Ground Crossings	93
Below Ground Crossings (River, Road, Rail)	2900
Nitrogen Sleeves	97

⁽¹⁾ Above Ground Installations

Table 1- Assets and sub-assets associated with LTS pipeline population

Cathodic Protection (CP) Systems – a second form of defense, after the coating system, when maintaining buried steel. The purpose is to protect the buried steel LTS pipeline from corrosion, which would result from the contact between the steel and the environment in which it is laid. The first form of defense, the coating system, insulates the pipe from contact with the ground in which it is buried. When this coating fails, the CP system prevents further corrosion by redirecting the corrosion process away from the pipeline and onto an anode within the ground bed. It does this by running a low voltage, direct current along the pipeline, creating a circuit from the rectifier, along the pipeline, to the ground bed. 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 lead to a reduction in the 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 system deployed on our LTS pipeline population is an impressed current system. This type of system requires an electricity supply to drive the voltage and current. The individual components which make up an impressed current CP system are:

- **Transformer Rectifier** – lowers the voltage and converts from AC to DC
- **Ground Beds** - a buried sacrificial “bed” that deteriorates instead of the buried pipeline
- **Test Posts** - an above-ground post used to collect data during inspections

The below diagram illustrates a typical impressed current system with a horizontal ground bed:

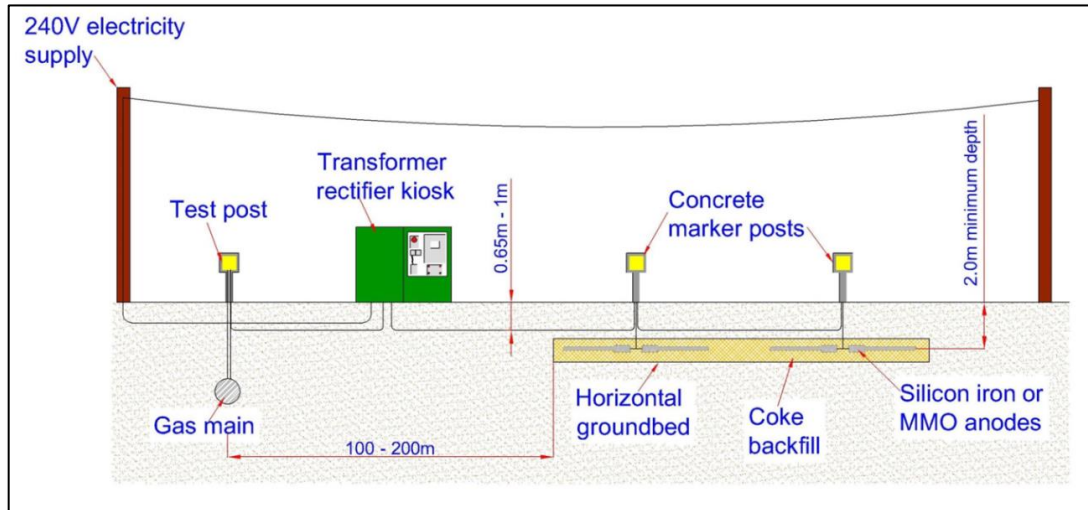


Figure 4 - Cathodic protection system

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). The following image illustrates one of these activities, an above ground close interval potential survey (CIPS).



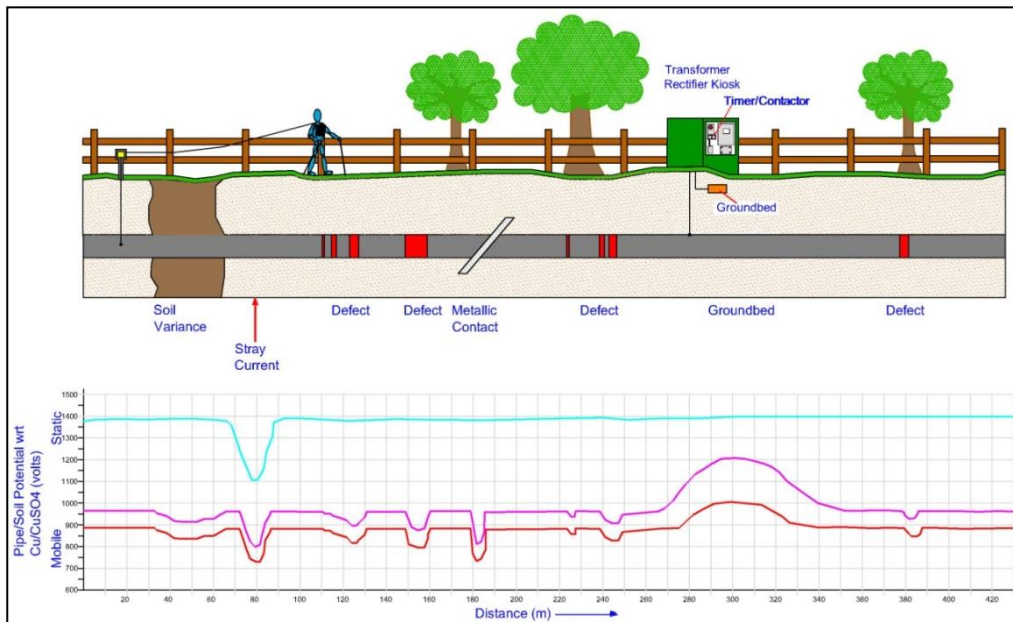


Figure 5 - Close interval potential survey (CIPS) illustration

The CIPS figure demonstrates that dips in pipe-soil potential readings indicate possible defects in the coating, where corrosion may then take place.

Block Valve Sites (AGIs) - a block valve site is an above ground valve assembly, 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 a PIG from the pipeline.

In-Line Valves - valves situated in-line with the pipeline – these can be operated to sectionalise the network when carrying out works, during emergencies 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 they may 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 - larger diameter, outer sleeve filled with nitrogen, with the 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 is now preferred.

4 Problem 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 compliant 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.

The outcome we want to achieve is for WWU to continue to ensure the safe transportation, distribution and storage of gas and to maintain a continuous supply to the public and industry.

We will measure success through several performance indicators including:

- Customer interruption numbers
- Monetised risk levels
- Fault and failure rates

As part of our investment process, we carry out sample audits on completed works and we also perform post-investment appraisals. Understanding the learning points following remedial work then informs future investment decisions.



4.1 Narrative Real-Life Example of Problem

The following examples show previous intervention works on pipelines.

Gilwern to Hafodyrnys Pipeline – 2015 OLI/4 Inspection & Defect Remedials

During the 2015 OLI/4 PSSR inspection, of which the close interval potential survey (CIPS) forms a part, several defects were identified. One was severe enough to require remediation to ensure compliance with the Pressure Systems Safety Regulations (2000). This defect can be seen on the right-hand side of the graph (the noticeable dip) in Figure 6 and was identified as being a coating defect with associated metal loss. The total project cost was £60,905.

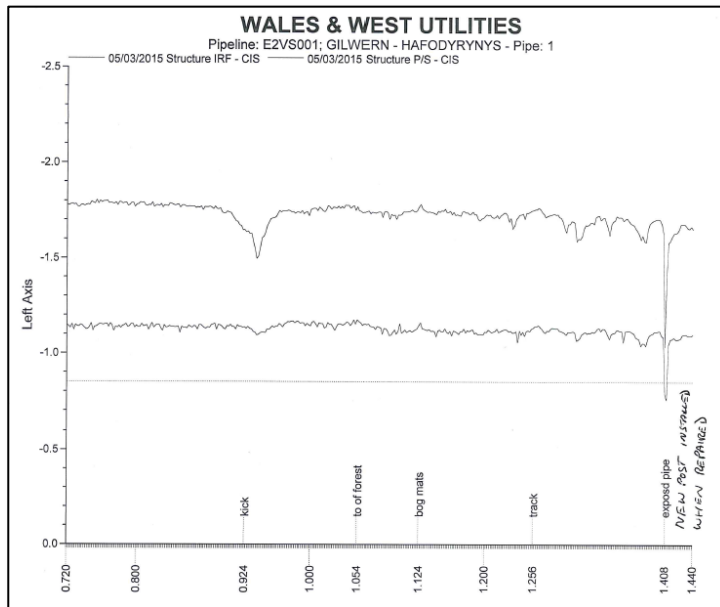


Figure 6 - Gilwern to Hafodyrnys Pipeline, OLI/4 inspection and defect identification



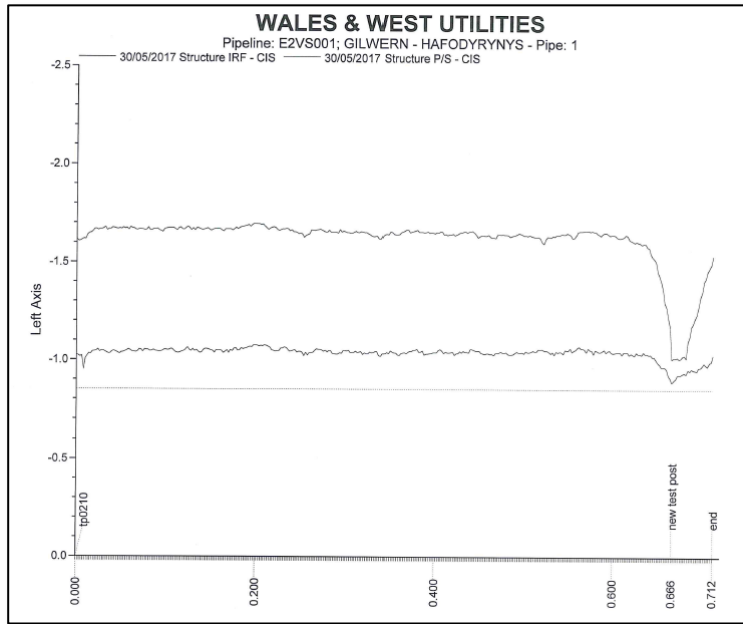


Figure 7 - Gilwern to Hafodyrynys Pipeline, re-inspection following remedial works



Hinton Charterhouse TR, Corston to Trowbridge Pipeline – Wholesale Replacement

This investment was to replace a transformer rectifier (TR) protecting the Corston to Trowbridge pipeline, at Hinton. This TR was in poor structural condition, consisted of obsolete componentry and performance data indicated it was approaching the end of its life. The existing installation was replaced with a new TR installation with new components that carried a manufacturer's guarantee.



Figure 8 – Hinton Charterhouse TR before wholesale replacement





Figure 9 - Hinton Charterhouse TR after wholesale replacement

The new TR consists of a new 5 amp, 24 volt unit manufactured by Solutech Electronics, with associated data monitoring by Abriox. The successful completion of this project means that this section of the Corston to Trowbridge pipeline is now fully compliant with legislation and will not need any further major intervention for 15+ years.



V290, Pontyates to Lampeter Velfrey – Valve & Chamber Refurbishment

During annual valve maintenance, it was identified that the below chamber was in a poor state of repair and required replacement, with the valves and pipework also requiring refurbishment. Total project cost = **REDACTED**



Figure 10 - Evidence of valve chamber degradation, replacement and valve/pipework refurbishment



Figure 11 - During valve chamber replacement works





Figure 12 - Valve chamber replacement and valve/pipework refurbishment complete



Gilwern to Hafodyrynys – Sleeve End Seal Replacements

Following several attempts to read the nitrogen pressure within the sleeve, it was decided that further investigation was needed to determine the condition of the sleeve end seals. Following investigatory works the sleeve was found to have been partially grouted with the end seals in poor condition. The remediation of the sleeve included cutting back the original sleeve end seals and removal of the redundant fill point, re-grouting of the sleeve and upgrading the CP connections. Total project cost = **REDACTED**



Figure 13 – Sleeve end seal replacement, before (1)





Figure 14 – Sleeve end seal replacement, before (2)



Figure 15 – Sleeve end seal replacement, after



4.2 Spend Boundaries

- **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** – OLI1 and OLI4 inspections, as well as visual and major inspections on PIG traps

This paper does not include the spend associated with AC mitigation, river crossing refurbishment, above ground crossing refurbishment or the full replacement of HN039.

5 Probability of Failure

Failure modes were identified 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. 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 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, in particular an inability to meet 1 in 20 peak winter demand

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.



5.2 Probability of Failure Data Assurance

Fault and failure data is collected when a problem occurs on site and is recorded through our robust fault reporting process in our core asset repository, SAP. This process allows us to attribute faults and failures against individual components and pipe sections and provides a picture of issues across WWU's LTS pipeline assets. All faults and condition reports are investigated and plans are put in place to address all issues.

6 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 ($IGEM/TD/2$). Our 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 diameter ($IGEM/TD/2$).



Figure 16 - 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, and 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
 - Death/major injury
 - Minor injury
 - Property and infrastructure damage
- 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.

7 Options Considered

The table below details the potential options which could be utilised when intervening on our LTS pipeline population:

Option	Strategy	Description	Total Volume	Total Cost
1	Baseline (Reactive Only)	This option would lead to an unacceptable level of increased gas escapes and increased associated costs	See Note 1	See Note 1
2	Replace / Refurbishment	This preferred option pays back within an acceptable time period which would be beneficial to the consumer	29.449km	REDACTED
3	Replace All	This option pays back within an acceptable time frame and provides cost benefits to consumers, but the increased expenditure over GD2 is not acceptable to stakeholders	29.449km	REDACTED

Note 1: the total volume is the total investment on LTS pipelines, excluding compliance-driven activities. The volume and cost associated with Option 1 is unknown due to the unpredictable nature of a reactive only strategy.

Table 2 - Options considered for our LTS pipeline population



7.1 Option Summaries

Baseline (Reactive Only):

In order to remain compliant with both PSR and PSSR the baseline maintenance would need to be done. Option 1 consists of undertaking this compulsory maintenance as well as reactive intervention work. The baseline maintenance is inclusive of all PSSR inspections such as OLI 4 CIP's surveys and OLI 1 pipeline internal inspections. All above ground crossings would receive biennial inspections, river inspections would be done on a risk based frequency with all CP maintenance being undertaken in accordance with ECP 2. As the intervention will be reactive only the costs associated with this work will inevitably increase due to the lack of planning time available. Areas such as river crossings will become exposed, drastically increasing the risk of damage and potential failure from debris strikes/third party damage. Failure to proactively refurbish areas of the pipeline such as above ground crossings will increase the risk of corrosion due to failing coatings.

Having a reactive only approach increases the risk of extended periods of supply interruption as a result of lead times and availability of emergency repair teams.

Due to the avoidable increase in risk, the inefficient delivery of work and the hugely unpredictable nature of reactive only intervention, the option of a baseline maintenance and reactive only intervention has been discounted.

Replacement/Refurbishment:

Baseline maintenance for Option 2 is identical to that of Option 1. Option 2 includes additional inspections in higher risk areas. Additional surveys such as DCVG surveys in high consequence areas such as sections of pipelines in close proximity to schools, hospitals, and or built up areas are also included in Option 2. The remediation of valves and valve chambers found to be in poor condition are included as proactive intervention. Undertaking these interventions proactively ensures that chambers do not collapse causing substantial damage to the pipeline and associated apparatus. Refurbishment of above ground crossings at the first signs of coating degradation reduces the risk of corrosion. See Above Ground Crossing EJP

River crossing surveys make up a large proportion of the annual maintenance on pipelines. It is inevitable that erosion to both bed and banks will occur over time. Targeted, well timed interventions to protect the pipelines at these crossing points can prolong the life of the pipeline, reduce risk of damage and avoid potential diversion costs. Option 2 includes targeted interventions on a number of these at risk crossings.

AC interaction is an emerging issue that can have catastrophic consequences to pipelines if left unaddressed. As this is a recently discovered issue there is no maintenance activity that can accurately identify the presence of AC interference. The monitoring and mitigation of



AC interaction has been included as part of Option 2. For more information refer to the AC EJP.

The installation of sleeves is no longer considered an adequate protective measure for high pressure pipelines however, there are numerous nitrogen filled sleeves in operation across the 2,359km of high pressure pipelines. These sleeves are checked annually to ensure that there is a positive pressure of nitrogen in the annulus between the pipeline and the sleeve. In some cases, the ends of these sleeves leak and require replacement. Failure to replace these seals can result in a corrosive atmosphere within the sleeve, the potential corrosion on the pipeline is very difficult to identify using traditional above ground survey methods. Option 2 includes the replacement of a number of these end seals to ensure adequate protection for the pipeline.

Undertaking a number of proactive interventions allows for a program of works to be developed and the work to be tendered. Understanding workload volumes allows for work to be planned in to effectively utilise resources. Failure to proactively intervene in a number of these cases could have a detrimental effect on the integrity of the HP network and result in large scale supply loss.

Option 2 is the preferred option as it incorporates the results of maintenance carried out across the network. The results of this maintenance work allows for the prioritisation of this intervention work based on the risk of failure and cost of refurbishment/replacement. The proactive intervention strategy allows for targeted risk reduction delivering the most cost-efficient program of work.

Replacement Only:

Option 3 is similar to Option 2 although this option has been discounted as this option focuses on the replacement of sections as opposed to the refurbishment suggested in Option 2. Undertaking a program of replacement would lead to decommissioning assets well before they reach end of life. The risk reduction associated with the replacement of sections rather than refurbishment is minimal when looked at on an asset population level.

Option 3 has been discounted due to the increased costs and minimal risk reduction associated with replacement over refurbishment.



7.2 Options Technical Summary Table

SECTION REDACTED

7.3 Options Cost Summary Table

SECTION REDACTED



8 Business Case Outline and Discussion

8.1 Key Business Case Drivers Description

The below table sets out the preferred option to deal with WWU's LTS pipeline population. Our plan is predominantly compliance-driven, in accordance with the Pipeline Safety Regulations (1996) and the Pressure Systems Safety Regulations (2000). The results of the CBA show that the lowest whole-life cost option is the preferred option.

8.2 Business Case Summary

SECTION REDACTED



9 Preferred Option Scope and Project Plan

9.1 Preferred Option

The below table sets out the preferred option to deal with WWU's LTS pipeline population. 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.

Intervention Type	Total Volume
PSSR Inspections – Pre-Work, ILI/OLI1 and Defect Investigations	47
PSSR Inspections – Pre-Work, OLI4 and Defect Investigations	584
PSSR Inspections – Pig Traps, Minor and Majors	71
Coating Surveys and Repairs	235
Pipeline Replacement ⁽¹⁾	1
Condition-Driven Short Length Diversions	12
Third Party-Driven Short Length Diversions	10
Pipeline Reinforcement	3
Above Ground Crossing Refurbishments (including Guards) ⁽²⁾	45
AGI (Block Valve and Pig Trap Sites) Refurbishments	15
Valve and Valve Chamber Refurbishments	61
AC Monitoring and Mitigation Installation ⁽³⁾	50
CP System – TR, Ground bed and Test Post Replacements	250
River Bed and Bank Refurbishments (including Surveys) ⁽⁴⁾	528
Nitrogen Sleeve Repairs	11
Shallow Depth of Cover Remediation	180
Marker Post Replacements	300
Total	2,403

⁽¹⁾ In separate Engineering Justification Paper: HN039 Pipeline Replacement

Figure 17 - Preferred option, with volumes



9.2 Asset Health Spend Profile

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

SECTION REDACTED

9.3 Investment Risk Discussion

- Future Energy Scenarios
 - The assets identified for proactive intervention have been tested to pay back within a timeframe compatible with all core Future Energy Scenarios, so as to minimise the likelihood of 'asset stranding', particularly where wholesale replacements have been identified

The future of energy in the UK is not certain although there are a limited number of credible pathways to decarbonisation. We have tested our investment plan against future uncertainty, ensuring that it supports all credible pathways and avoids the risk of asset stranding.

The cross-network common view of the future (single scenario), developed by all sectors at the request of Ofgem only looks to 2030 but we wanted to test our plan for our existing assets over a longer term. To achieve this, we used National Grid's Future Energy Scenarios (FES) as this looks out to 2050 and is widely regarded as a reputable source for examining the future UK energy mix based on the knowledge we have today.

The 76 assumptions underpinning each of the FES 2019 have been reviewed for their impact on the future use of the gas network and our gas assets. This has been done at a granular level – LTS pipelines (>7bar), Offtakes, PRIs, governors, Distribution pipes (<7bar) and services for time horizons 2030, 2040 and 2050. To evaluate investment plans, we used our assessment of their impact on our assets to inform suitable payback periods for conducting cost benefit analysis (CBAs).

The drivers with the most material impacts on our assets are:



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- Number of domestic gas users (as the current largest proportion of gas demand)
- Number of commercial gas users (as these typically represent larger loads per connection when compared with domestic)
- Number of industrial gas users (which currently represent around a third of total gas demand)
- Growth or proliferation of district heat networks (which can affect our existing assets depending on how these are fuelled)
- Changes to the generation mix (as decrease in coal combined with increasing amount of renewable generation means an increase in requirements for flexible gas generation)
- Extent of conversion to hydrogen networks (which would affect how we operate our network and our requirement for new assets to accommodate hydrogen such as strategic valves)



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The table below shows the impact of each scenario on the energy mix, the impact this has on LTS Pipelines and a view on a no regrets investment assessment period in each scenario.

For these assets, the shortest no regrets period is 30 years.

	2030	2040	2050	Conclusion
Community Renewables	11% decrease in residential heating installations connected to gas network from 2018. 238% increase in residential district heat installations from 2018. 85% of renewable capacity from wind and solar.	30.1% decrease in residential heating installations connected to the gas network from 2018. 575% increase in residential district heat installations from 2018.	44.2% decrease in residential heating installations connected to the gas network from 2018. 1023% increase in residential district heat installations from 2018. 91% of renewable capacity from wind and solar. 40% of heating installations connected to gas network.	A 30 year payback period is no regrets and will avoid asset stranding
Impact on LTS Pipelines	No impact as still required.	No impact as still required.	No impact as still required.	



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Two Degrees	5.4% decrease in residential heating installations connected to gas network from 2018. 188% increase in residential district heat installations from 2018. 86% of renewable capacity from wind and solar.	14.4% decrease in residential heating installations connected to gas network from 2018. 401% increase in residential district heat installations from 2018.	11% decrease in residential heating installations connected to gas network from 2018. 655% increase in residential district heat installations from 2018. 90% of renewable capacity from wind and solar. 63% of heating installations connected to natural gas or hydrogen network.	A 30 year payback period is no regrets and will avoid asset stranding
Impact on LTS Pipelines	No impact as still required.	No impact as still required.	No impact as still required.	
Steady Progression	4.5% increase in heating installations connected to the gas network from 2018. 46% increase in residential district heat installations from 2018. 85% of	5% increase in heating installations connected to the gas network from 2018. 112% increase in residential district heat installations from 2018.	4.4% increase in heating installations connected to the gas network from 2018. 204% increase in residential district heat installations from	A 30 year payback period is no regrets and will avoid asset stranding



	renewable capacity from wind and solar.		2018. 92% of renewable capacity from wind and solar.	
Impact on LTS Pipelines	No impact as still required.	No impact as still required.	No impact as still required.	
Consumer Evolution	2.8% increase in heating installations connected to the gas network from 2018. 126% increase in residential district heat installations from 2018. 85% of renewable capacity from wind and solar.	0.4% increase in heating installations connected to the gas network from 2018. 258% increase in residential district heat installations from 2018.	2.2% decrease in heating installations connected to the gas network from 2018. 414% increase in residential district heat installations from 2018. 91% of renewable capacity from wind and solar.	A 40 year payback period is no regrets and will avoid asset stranding
Impact on LTS Pipelines	No impact as still required.	No impact as still required.	No impact as still required.	

Table 8 – Summary of FES on gas asset in the long term

- Chosen Workload
 - The workload has been selected based on thorough analysis of fault and failure data, as well as the latest assessments of health and condition – any



changes to workload during GD2 would be expected to be primarily driven by the results of ongoing surveying and monitoring work.

- Our AIM risk modelling software, in addition to optimising on whole-life cost, allows for modelling uncertainty in base assumptions and provides confidence bands on key outputs e.g. Monetised Risk. This software has tested our planned intervention programme against input sensitivities and has confirmed that within a 90% level of confidence, our plan is robust and would not change due to any errors in input data

- Programme Risks
 - The delivery plan is currently being market tested for value and robustness and risks are summarised in the table below

Risk Description	Impact	Likelihood	Mitigation/Controls
Programme does not manage risk to required levels	WWU would not be meeting agreed targets for GD2	$\leq 20\%$	We have invested in data and analytics. We have validated deterioration curves. 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. Would not comply with HSE mandated requirements	$\leq 20\%$	We have established processes in place to deliver programmes such as this and have successfully delivered in GD1. We have a robust workforce resilience strategy as documented in our GD2 narrative. Delivery of our investment plans are monitored at Exec / CEO level in our organisation



<p>Risk to planned costs</p>	<p>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 totex sharing incentive</p>	<p>$\leq 20\%$</p>	<p>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, therefore risk is minimal</p>
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- Cost Assumptions
 - Unit costs have been derived at as granular a level as possible, and using historic spends, amongst other criteria such as component size/spec, pipeline diameter and location etc. when deriving associated costs. Due to this granular cost assessment, we have a high level of confidence in our forecasts

