Asset Health Engineering Justification Framework

Mandatory Distribution Mains Replacement Programme

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 page 3 of Document 1 of WWU Business Plan Submission. This is applicable in full to this paper, as though set out in full here

Contents

1. Summary Table

Name of Project	Mandatory Iron and steel mains replacement programme (including services, consequential steel, and non-compliant stubs)		
Scheme Reference	WWU. 18		
Primary Investment Driver	Safety and environmental emissions		
Project Initiation Year	2026		
Project Total Installed Cost Estimate (£) Close Out Year	2031		
Total Installed Cost Estimate (£)	[redacted]		
Cost Estimate Accuracy (%)	Based on very detailed costing model - +-5%		
Project Spend to date (£)	[redacted]		
Current Project Stage Gate	Not started		
Reporting Table Ref	BPDT CV6.01, CV6.02, CV6.07, CV6.08,CV6.11 and M8.04		
Outputs included in RIIO-GD3 Business Plan	PCD for Tier 1 delivery. NARMs metrics for all mains. Shrinkage forecasts will reflect the planned replacement types and volumes		
Spend apportionment 23/24 prices	GD2	GD3	GD4
		[redacted]	

2. Executive Summary

This paper sets out the investment case for 2,043km of main and service replacement related to the HSE mandated Iron Mains Risk Reduction Programme (IMRRP). This is a requirement under the Pipeline Safety Regulations (PSR) section 13a. This is made up of 1,675km of Tier 1 main, and 368km of consequential steel, there is currently no Tier 2 pipes passing the risk threshold to become mandatory Tier 2a iron in the programme. We anticipate the replacement of 77,856 and transfer of 77,856 services associated with the mandatory replacement of iron mains. We forecast to spend on average [redacted] per annum to deliver this programme of works.

The table below gives the comparison of GD2 to GD3 in 2023/24 prices

Price control	First Year Spend	Final Year Spend	Intervention Volume (km)	Investment Design Life	Total Installed Cost	Cost per m
GD2	[redacted]	[redacted]	1924.7	60+ years	[redacted]	[redacted]
GD3	[redacted]	[redacted]	2042.4	60+ years	[redacted]	[redacted]

Table 1 – GD2 vs. GD3 cost comparison

Note: for more accurate comparison the cost of stubs was not included in the comparison ([redacted] removed).

Cost has increased since the beginning of GD2 period particularly because the following factors (further details shown in Appendix 7):

- 22% increase in cost of materials
- 25% increase in enabling/back-office costs – additional support bringing workloads in house.
- 20% increase due to the volume and type of workload – increase in overall workload ensure delivery of IMRRP, more open cut, location of mains and material types.
- 8% increase in reinstatement costs

This investment will lower safety risk, reduce methane emissions and prevent gas escapes and associated disruption to the public. The impact of the Iron Mains Replacement programme across GD2 will have reduced emissions by over 50,000 tonnes of carbon dioxide equivalent (tCO_2e).

WWU have requested an uncertainty mechanism to manage the impact of additional Tier 2a mains becoming mandatory for the RIIO-GD3 period as a result of the ongoing review by HSE of their Enforcement Policy.

The non-mandatory programme is detailed in a separate Engineering Justification Paper (EJP) and Cost Benefit Analysis (CBA).

3. Introduction

Wales & West Utilities own and operate a population of circa 33,000km of buried main (as reported in RRP for 2023), transporting gas to our consumers at pressures ranging from 21mbar to 7bar. There are 3 distinct operating pressure tiers; Low Pressure (LP) 21-75mbar, Medium Pressure (MP) 75mbar–2bar and Intermediate Pressure (IP) 2-7bar.

The IP network is subject to the Pressure Systems Safety Regulations 2000 (PSSR) due to operating in excess of 2bar pressure. These assets total 1,550km and are constructed in either steel or polyethylene (PE). As mandated by PSSR, the steel is protected by Cathodic Protection (CP) systems and well maintained. These assets rarely fail, and investment is primarily in maintaining the CP systems in good health. This investment is described in the Steel Distribution Pipelines Engineering Justification Paper.

The MP and LP networks total 31,400km and are a mix of PE, steel and iron. PE is very reliable and rarely fails. The steel and iron however, are at the end of or beyond their expected life and we respond to circa 7,000 leaks per annum from these assets.

There are circa 2.5m customers connected to the WWU network individual gas services. They terminate at an Emergency Control Valve (ECV) which is generally situated at the inlet to a consumer’s gas meter. WWU’s network ends at the ECV and we do not own or manage the gas meter.

Services are predominantly constructed in either Polyethylene (PE) or steel. PE services are incredibly reliable, and a leak is extremely rare. We have laid services in PE since the 1970s. Steel services were generally installed prior to this so they are mostly over 50 years old with many much older. They are at end of their life and we experience circa 7,000 leaks per annum.

A large proportion of our MP and LP iron mains are subject to a replacement programme mandated by the Health & Safety Executive (HSE). This requires all iron mains up to and including 8” in diameter and within 30m of a building to be decommissioned by December 2032. This is a 30-year programme, and we have an excellent track record of delivering successfully since 2002.

Pipes that do not qualify as HSE mandated are considered for replacement based on a cost benefit assessment. This is classed as the ‘non-mandatory’ programme and is detailed in the ‘Non-Mandatory Distribution Mains Replacement Programme’ Engineering Justification Paper (EJP).

This paper sets out the work we plan to do and the associated costs. It expands on the drivers for us to invest and the benefits of investment.

4. Equipment Summary

The following asset categories have previously been defined by the GDNs, Ofgem, and the HSE, this paper will use these descriptions throughout.

Category	Population forecast at start of GD3	Description	Investment driver
Tier 1	2,194km (1,968 within 30m of properties)	Cast iron (CI), Spun iron (SI) and ductile iron (DI) mains with a diameter up to and including 8" / 225mm	All Tier 1 mains within 30m of a building are mandated by HSE to be replaced by December 31 2032. Mains may have properties built within a 30m proximity which then moves them into this category from non-mandatory.
Tier 2*	952km	CI, DI and SI mains with a diameter of between 9" – 17" / 225mm – 425mm	Any main passing a risk threshold agreed across GDNs and with HSE are mandated to be replaced in a reasonable time frame. These are classed as Tier 2a. The remaining population are replaced if CBA or stakeholder feedback makes a compelling case. These are classed as Tier 2b
Consequential steel	474km	Steel with a diameter less than or equal to 2"	The HSE require these to be replaced if the parent or feeder pipe is replaced. They also require us to replace these mains in a reasonable timeframe if they suffer a failure
Services (Steel, mixed PE/Steel, other)	225,086 (Associated with Mandatory mains only)	Metallic, part metallic or "other" services feeding domestic premises	ST services up to and including 2" diameter must be replaced entirely with PE whenever encountered either on a mains replacement project, connections work, or repair work. This includes "steel tailed" services.
Stubs (non-compliant)	2,585	Short Tier 1 pipe connected to Tier 2 or Tier 3 parent main that are greater than the minimum length allowed. These exist due to HSE changes to the enforcement policy in 2013 which removed the need to replace Tier2/3 leaving short stranded 'stubs'	All Tier 1 mains within 30m of a building are mandated by HSE to be replaced by December 31 2032

Table 2 – Asset details

The HSE are currently reviewing their enforcement policy for Iron Mains replacement. They have indicated that there will be “no change to the general approach” to Tier 2 mains (see ***Appendix 2***), however there is still work to be done to ensure a consistent approach across the GDNs. This will likely result in a change to the Tier 2a risk threshold calculation. Currently, WWU have no pipes qualifying for mandatory replacement due to passing the threshold. Ofgem have asked GDNs to review the Tier 2 a calculation and submit any resultant investment required by February 2025, for consideration in Draft Determinations. We have not attempted to estimate the outcome of this review in this paper.

Due to uncertainty as a result of the new HSE requirement to review thresholds, WWU request an uncertainty mechanism. This will mitigate against an unforeseeable future requirement for WWU to increase our mandatory mains workload. Should the HSE update their Enforcement Policy WWU will need to ensure that any additional length of mandatory main is replaced within an agreed timeframe.

Tier 2b/Tier 3 or Steel pipes are included in the non-mandatory programme EJP.

5. Problem/ Opportunity Statement

We are bound by legal obligations to manage and replace these mains. Our Tier 1 and Tier 2a replacement programme is mandated by HSE under the Pipeline Safety Regulations (PSR) section 13a. We have duties under the Pipelines Safety Regulations (PSR) to ensure that “a pipeline is designed, constructed and operating safely, provide a means of securing pipeline integrity, thereby reducing risks to the environment”.

Our population of buried iron and steel distribution mains and services are nearing the end or are beyond their expected asset life. There are regular failures and we respond to, and repair circa 14,000 leaks per annum (7000 mains and 7000 service).

Each leak requires our operatives to attend, make safe and then repair. Each leak results in emissions of methane to atmosphere which has a carbon equivalent impact 25x that of CO_2. Total emissions from the UK gas networks are circa 1% of the UK’s total emissions and mains failures are a significant contributor.

In addition, there is a significant safety risk, following a gas escape, of gas tracking underground and entering a building. The gas can collect and if volumes are significant enough and there is an ignition source, such as switching on a light, this can result in an explosion. There are many examples of this in the UK. Thankfully, these are now rare due to the success of the mains replacement programmes to date.

Our stakeholders have told us they want us to maintain the current levels of safety and reliability from our network and do not want to see this degrade. Stakeholders also want us to reduce methane emissions; this relies on older metallic mains being replaced with low emission Polyethylene. General consumers have told us they would like to see the mains replacement programme accelerated to improve safety and deliver environmental benefits. This is countered by feedback from local authorities who do not want an increase in replacement works due to the disruption the work causes. Our plan balances these stakeholder requirements.

One thing that the public and Local Authorities agree on is that when we replace mains in an area, we should do this in one visit and not return year after year. To achieve this, where possible we group mains into larger, more efficient projects and clear all metallic mains from an area.

However, in some instances clearing all metallic mains from certain areas can create large amount of disruption where mandatory pipe is connected a larger non-mandatory (Tier 2 or Tier 3) pipe. The larger mains are usually located within busy roads and abandoning the mandatory main including the connection from the non-mandatory often results in a short length of pipe or stub being left. A “stub” is a short length of Tier 1 pipe connected (via an iron tee) to a Tier 2 or 3 “parent” pipe which is deemed as non-mandatory. The key attribute of the stub is that it cannot be decommissioned without the tee in the parent main being cut out.

We have also received direction from HSE recently regarding mains in private land, HSE initially showed concerns about how the GDNs were managing the maintenance and risk of mains in private land ***(Appendix 3)***. A decision support tool has since been developed jointly by the GDNs with HSE engagement to provide guidance on when you should consider moving the main from private land into the highway or other agreed location. This is something that WWU will be using for the GD3 mains replacement programme. It should be noted that when a decision is made to move a main from private land as part of the replacement design, the cost of the project will be dramatically increased due to the increase in the volume of excavations for mains and services, and also the requirement to relocate downstream copper gas pipes to a new meter location.

Additionally, WWU may choose to replace services in bulk following a process of hotspot analysis.
HSE have Operational guidance for their Inspectors investigating gas incidents arising from the failure of steel service pipes (***Appendix 4***). HSE Inspectors will consider enforcement action if their investigation finds that the GDN has failed to *“Carry out the replacement and/or the condition assessment of the failed steel service pipe where there is evidence (obtained systematically by the GDN) of a heightened local risk of failure (i.e. a 'hot spot').”*

This involves checking leakage records to determine if there are areas of highly localised service leaks on metallic services – often limited to a single street or postcode. If the services are attached to a metallic main, a mains replacement project would be set up to replace both the main and the associated services. However, if the main is PE, only the services would be replaced with PE services and connected to the existing main.

In summary, we need to invest in our mains replacement programme to:

- Comply with our legal requirements under PSR,
- Meet our stakeholder’s requirements to reduce our carbon footprint, maintain our safety performance and reduce disruption from gas escapes, and
- reduce Opex costs associated with unplanned repairs.

Failure to deliver our planned programme would fail to meet the needs of our stakeholders, will see rising Opex costs and would not enable us to meet our emissions targets and deliver our contribution to the UK net zero target.

We will measure the success through various metrics:

- Length of metallic mains abandoned/number of metallic services replaced,
- Volumes of gas escapes, occurrences of gas entering a building, and
- Methane emission reductions calculated though our Leakage Reporting Monitoring Model (LRMM)
- Network Asset Risk Metrics (NARM).

We will continue to engage with our stakeholders, such as Local Authorities and HSE as we deliver the mains replacement programme. HSE will regularly inspect delivery of the plan and review and feedback on the key metrics that demonstrate the success of the investment.

5.1 Narrative Real Life Example of Problem

This section provides a summary of actual replacement projects, to demonstrate the challenges faced in managing these assets and the assessment process to arrive at a decision to invest.

Example 1: PETERSTON-SUPER-ELY, CARDIFF.

The first example is a scheme completed across 2022 and 2023 to replace all the remaining iron mains within the Peterston-Super-Ely low pressure network.

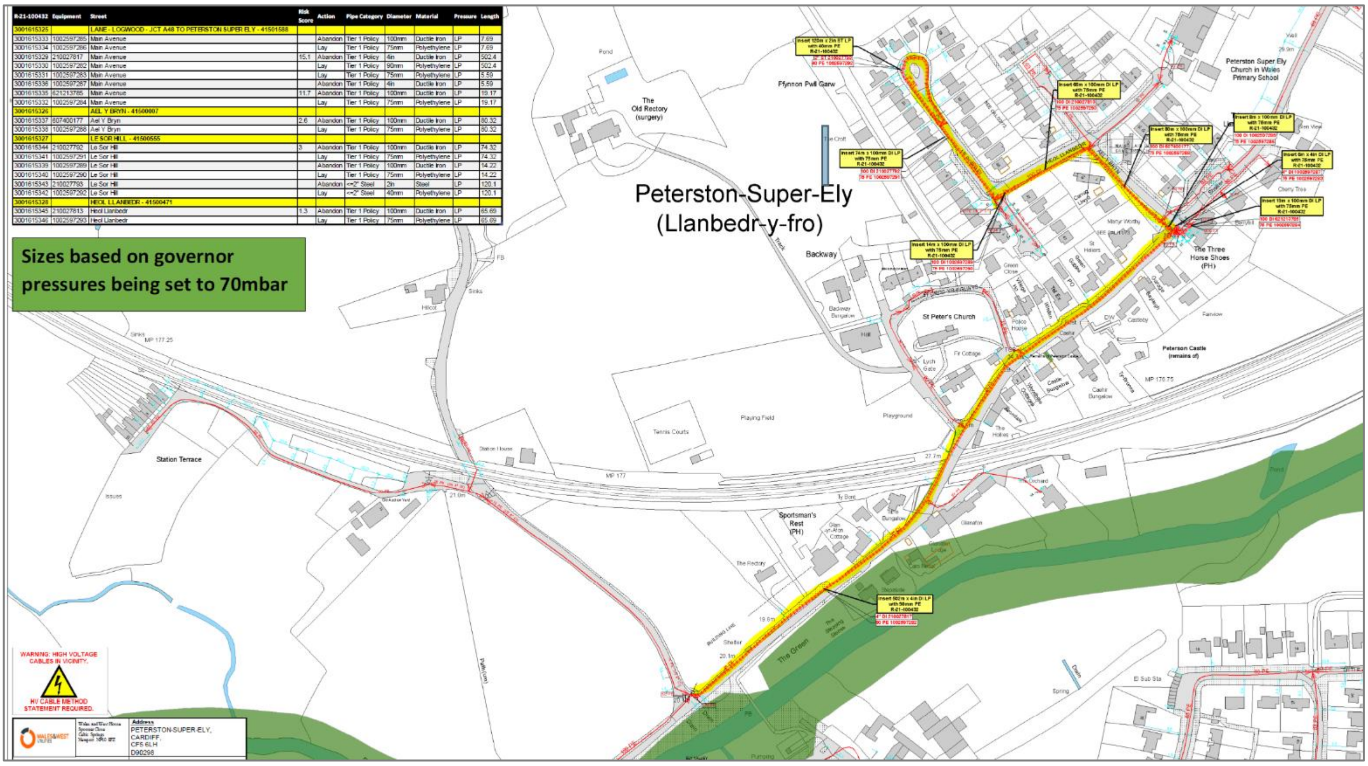

Figure 1: Shows the area of Peterston-Super-Ely, on the outskirts of Cardiff. The mains to be replaced are highlighted in yellow with pipes part of the project annotated with text boxes.

This is a village on the outskirts of Cardiff, with a rail bridge crossing the main East to West (London to Swansea) rail line. The project was to replace the remaining 769m of ductile iron and 120m of consequential steel main. The customers in the area are mainly domestic with some commercials (pub and post office/shop). The network is a single feed with the gas supply from the south side of the railway line.

Figure 2: Shows the wider area of Peterston-Super-Ely, showing both the two populated areas either side of the railway line.

The case to consider intervention

All remaining iron mains on the Peterston-Super-Ely network were Tier 1 mains part of the mandatory HSE Replacement programme. The work could be completed as one project, minimising the impact and disruption on the public, removing any need to return to repair leaks on iron mains and services.

The assessment process

We consider if networks can be made all PE as the operating cost of these networks is lower due to the reduced leakage and associated pressure management costs. This network was 83% PE prior to the replacement.

The iron mains being replaced were installed in the 1960s, with a total length of 769m. There was also 120m of consequential steel main being replaced.

Scoping and Costing the scheme

The scope of the project was to make the network all PE, replacing the remaining iron and some associated consequential steel.

To determine replacement sizes, we use network analysis modelling. Our models are an accurate reflection of the pipe network as it stands and are regularly updated with consumer demand data from Xoserve for every single gas meter in our region. This enables us to predict gas flows and pressures today and in the future.

We can then make changes to pipes in the model and assess the impact on flows and pressure to ensure any changes do not create a capacity issue and compromise security of supply.

Our preference is to abandon a main with no replacement as this is lowest cost to consumers. This is only possible if a main has no services attached and if its removal from the network does not result in capacity issues and poor pressures. For these reasons, this is not often a credible option.

If a replacement main is required, the most efficient technique is mains insertion. This is a replacement technique where the new PE pipe is inserted inside the metallic pipe to be replaced. This avoids digging a long trench as the operation can be achieved by pushing the new pipe into the old using an excavation at both ends. The replacement is quicker, lower cost, results in lower methane emissions during the operation. There are also shorter planned interruption times for consumers using this technique and reduced excavations is considerably less disruptive to the public.

The challenge is that the new main must be smaller to fit, so capacity in the network is reduced. By carrying out network analysis we can assess whether this will create a capacity issue. If it does, we re-analyse with other diameters to find the optimum size.

We design a network that's fit for today and for the future. To do this, we estimate future network demand by interrogating Local Authority Development plans and by looking at other intelligence on future gas use. This process ensures the new main is future proof and avoid reinforcement as demand on the network changes.

In this case, as this network no longer had any iron mains, we were able to raise the maximum operating pressure, this enabled all the mains to be inserted. Additional Network Analysis was required during the project as the engineering team on site identified that the main crossing the railway was not as shown on plans. There had been a special crossing installed laying multiple 2" steel mains not the single 4" iron main indicated. It is believed that this was due to the depth of cover on the bridge crossing the railway. Network Analysis confirmed that insertion of these mains was acceptable, and the project could be completed, making the network all PE.

The project was delivered for a cost of [redacted], saving approximately [redacted] if the project was delivered via open cut.

Future benefits

We forecast future leakage using current rate of failures of the pipe, the number of joints left to fail, and a view of future deterioration rates based on historic failures and their increase over time. Our Leakage Model was predicting likely emissions from these mains of approximately 19.5 MWh of gas (circa 50 tCO_2e) a year prior to their replacement.

Example 2: MAPLE CRESCENT, TREFECHAN, MERTHYR TYDFIL

The example below is a replacement project that took place in 2023. A street had experienced a number of failures on metallic services or service components. There were several 4” and 6” CI pipes supplying these services subject to the mandatory HSE replacement programme. The location affected is highlighted in the plan below:

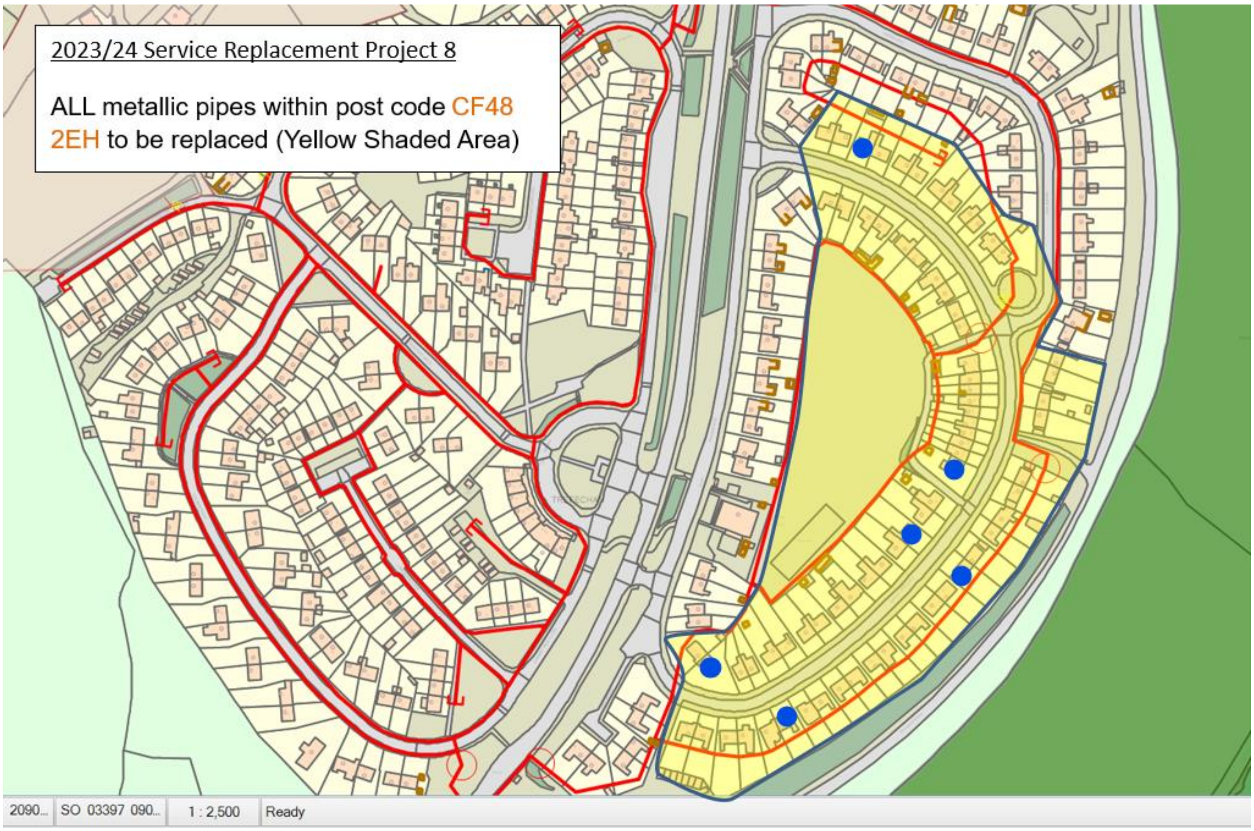

Figure 3: Service failures in Maple Crecent, Merthyr Tydfil

The blue dots represent a service failure - it can be seen that the failures affect the full length of the pipe. Each escape resulted in the public reporting a smell of gas and our engineers attending and repairing an escape by replacing the service.

The full leakage history of this street is as follows:

Work Order Number	Street 2	Equipment Number	City	Postal Cod	Pipe Stat	Pipe Diameter (Comp Forn	Pipe Material (Comp Forn	Pipe Pressure (Comp Forn	Repair Cau	Repair Component	Corrective Action	Year
3000865503	55	620252493	MERTHYR TYDFIL	CF48 2EH	LI	1IN	ST	LP	Corrosion	Pipe	Cut Off	2014/15
3000901691	40	620019253	MERTHYR TYDFIL	CF48 2EH	LI	1IN	ST	LP	Corrosion	Stand Pipe	new Compon	2014/15
3000932225	52	620252499	MERTHYR TYDFIL	CF48 2EH	PL	1IN	ST	LP	Corrosion	Pipe	Cut Off	2014/15
3001156508	3	211557851	MERTHYR TYDFIL	CF48 2EH	LI	1IN	ST	LP	Corrosion	Pipe	Cut Off	2016/17
3001607894	22	620019247	MERTHYR TYDFIL	CF48 2EH	LI	1IN	ST	LP	Corrosion	Pipe	Cut Off	2020/21
3001665663	33	620252471	MERTHYR TYDFIL	CF48 2EH	LI	1IN	ST	LP	Corrosion	Pipe	Cut Off	2021/22

Table 3: Leakage history in Maple Crecent, Merthyr Tydfil, CF48 2EH

As there are no appropriate remedial techniques for metallic services, each escape results in the replacement of the old service with a new PE service. As the services in this street were laid at the same time, there is potential for other failures to be experienced on the other metallic services in this street.

Rather than continuing to respond reactively to services failures which could lead to explosions and loss of life, the decision was made to replace all services in the postcode. This service failure ‘Hotspot’ approach is required by HSE and their inspectors frequently check we have a process in place and we are compliant with our process.

In this example, we extended the bulk service replacement into a full mains replacement scheme, to include the mandatory Tier 1 iron mains feeding these services (714m of 4” cast iron and 470m of 6” cast iron). In this instance we made the decision to install the replacement mains in the road and abandon any iron mains located in private land following a risk assessment.

This approach of extending the scheme gives the lowest whole life cost to deliver on our commitments and avoids us returning in later years to replace the iron main, disrupting the community twice. This approach is commonly applied, and it is incredibly rare that we replace services under a bulk program but leave metallic feeder pipes in situ.

5.2 Project Boundaries

The workload and associated expenditure proposed in this justification paper is for mains replacement in RIIO-GD3 for the following categories

- Tier 1 iron
- Tier 2 iron
- Consequential Steel
- Services

In addition to these categories we have PE mains; we are not proposing investment in replacing PE as there is no current justification due to low failure rates and emission levels.

The exception is “First Generation PE”, which is also known as “Imperial PE” because it generally has imperial diameters. There are challenges making connections to imperial PE so there may be short lengths requiring replacement in RIIO-GD3 if they are connected to iron and steel pipes in the programme.

Risers on MOBs are included in the Multiple Occupancy Buildings & Complex Distribution Systems EJP.

6. Probability of Failure

Predicting future performance of assets is critical to the assessment of operating costs, customer outcomes and safety risk to inform a meaningful CBA. To forecast future failures, we assess:

- Probability of failure for services/each individual main, and
- Rate of deterioration for services/mains.

There are four modes of failure for distribution mains; joint failure, fractures, corrosion defects, and interference damage. We feed our NARMs (Network Asset Risk Metric) assessment and CBAs using asset bespoke forecasts for each of these modes.

The rates of failure have been calculated using actual repair data going back to 2006. We record the cause, component and repair type for every leak we experience on the network. Some typical examples are illustrated in the table below:

Cause	Component	Repair type
Fracture	Pipe	Repair Clamp
Failure	Joint	Encapsulation
Corrosion	Pipe	Cut out

Table 4: Shows examples of failure, component and repair type.

This detail is recorded in our asset repository (SAP) against the individual asset with the exact co-ordinate of where that failure occurred. This enables us to calculate the annual rate of failure for every pipe in our network. We use trends over time to derive a deterioration rate to predict future performance.

The vast majority of pipes are repairable, with only a small number requiring the pipe to be immediately removed and replaced due to the magnitude of the failure. Appendix 1 shows the current failure rates as used in CBA and NARMs for service pipes and all combinations of material, diameter and pressure tier for mains:

6.1. Probability of Failure Data Assurance

We have many system validations built into our data repository system to ensure this data is accurate and we employ a data quality team to investigate exceptions. For example, if a leak was recorded by a field operative as corrosion on a PE main, this fails as an unacceptable combination as PE doesn't corrode. This flags an exception, and the data team will contact the operative to understand exactly what was done on site and correct the record. We are therefore highly confident in the accuracy of our pipe failure data and its use to calculate probability of failures.

This data is fed into our Asset Investment Manager (AIM) software. This is an industry leading tool that puts the data through statistical assessment to derive the appropriate deterioration rates and then forecast future performance at a pipe-by-pipe level.

The charts below show the forecast for gas escapes per km for the different mains categories. It can be clearly seen how network performance will deteriorate without investment to manage these ageing assets.

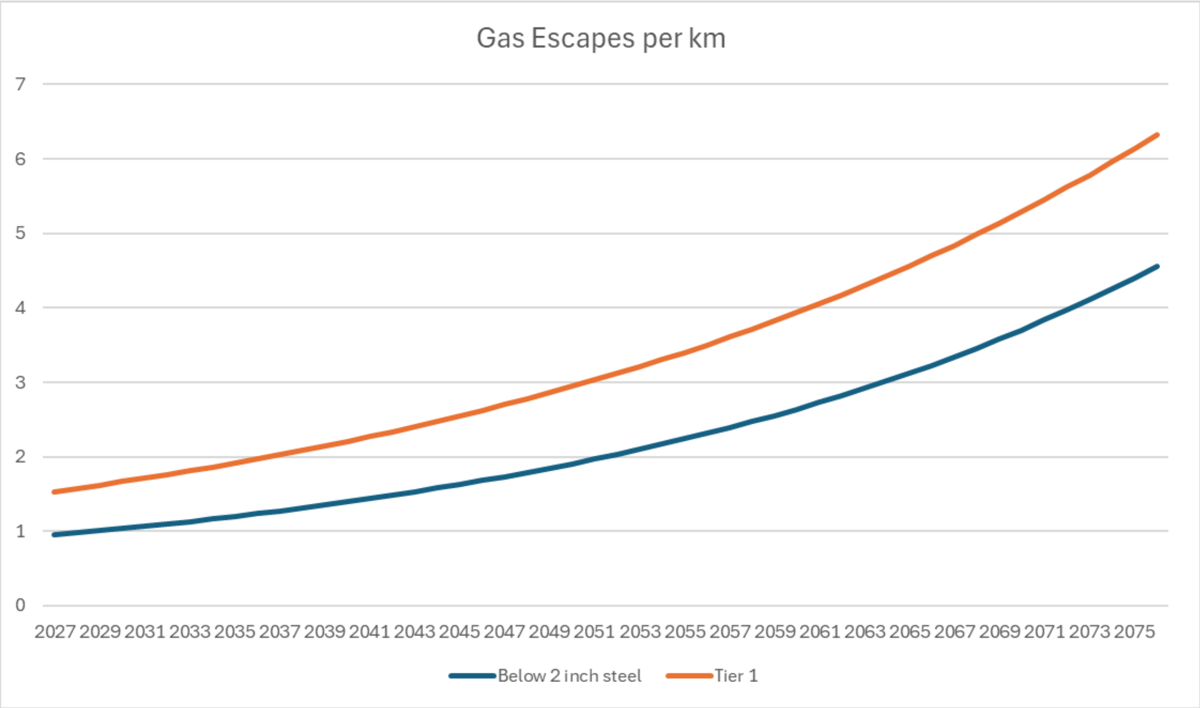

Figure 4: Gas escapes per Km without intervention

7. Consequence of Failure

For each failure mode, we assess the potential consequences. We record actual consequences in our asset repository for every single leak, so we can assess a probability of a consequence occurring on future leaks. This is critical to assessing the impact and associated costs.

As an example, we know how many leaks resulted in gas entering a building, how many occurrences of gas in building resulted in explosion and how many explosions resulted in fatalities or injuries. Using probability of asset failure combined with probabilities of resulting consequences, we have an accurate assessment of the risk of our assets.

The most significant consequence resulting from a failure on a gas distribution pipe is a gas escape leading to gas ingress in a building, which in turn leads to an explosion causing fatalities or major injuries. This is devastating to those impacted and is an event not tolerated by society. This could also lead to large legal penalties being issued, and huge reputational damage to the company.

An example of the consequences of a failure on a distribution main or service as modelled in our event tree analysis is illustrated below:

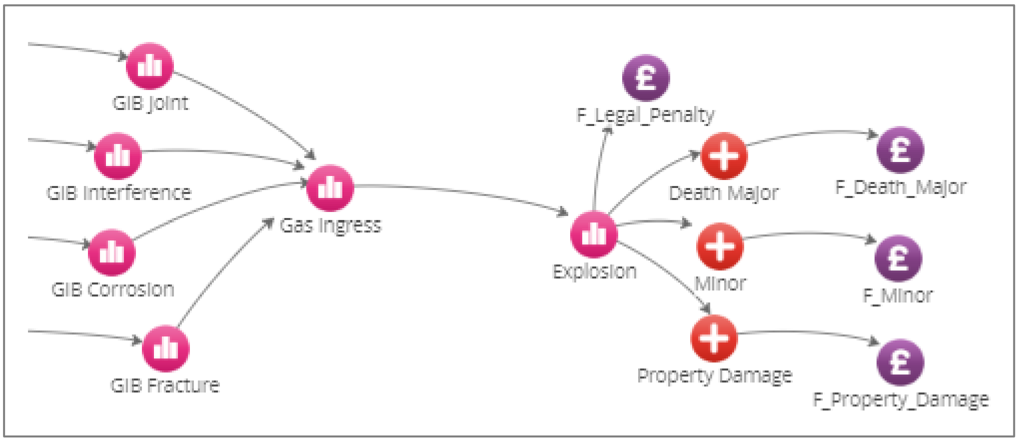

Figure 5: Risk map for Distribution Mains and Services showing the health and safety branch

The likelihood of a Gas In Building event (GIB) is calculated based on historical WWU data held in our asset data repository. For a GIB Joint, this is calculated as **0.0346 GIBs** for every joint failure (based on analysis of historical WWU data). For each GIB, there are calculated to be **0.00076 explosions** (based on analysis of national data sets). For each explosion, there are calculated to be **0.45 deaths** (based on analysis of national data sets). We value a fatality at [redacted] , an agreed figure for risk assessment of gas incidents. Multiplying the above probability of consequences (CoF) by probability of failures (PoF) give a likelihood of a death. Applying this likelihood to the [redacted] gives a monetised risk value of fatalities.

The illustration above is one branch of an event tree. For each asset group, there are many branches of failure, consequence and cost combinations assessing safety, reliability, environment and disruption. When all branches are summed together, we get a value of monetised risk for the asset. We can then assess the impact of our intervention plan on reducing PoF or CoF and produce a new monetised risk value for the asset. The delta in monetised risk before and after intervention gives a value to the intervention. Our AIM software provides a powerful optimisation tool that assesses hundreds of thousands of intervention combinations to produce the optimum investment plan to manage risk on our assets at minimum whole life cost.

Failures of gas distribution mains and services could also lead to gas supply interruptions, which seriously inconvenience consumers, our monetised risk assessment considers these impacts.

There are environmental consequences of mains failures, due to emissions of methane into the atmosphere. Methane is 28x more damaging to the atmosphere than carbon dioxide. We value this impact using DESNZ published cost of carbon. We use emission rates from a national leakage model, developed through collaborative testing across the GDNs and approved by Ofgem to inform our risk assessment.

Additionally, every failure results in an Opex cost to attend and risk assess the leak and make a repair. This is also factored into our risk assessment.

8. Options Considered

We have an obligation under PSR 1996 section 13a to decommission all iron mains up to 8" in diameter and within 30m of a building by 2032. The option to defer or reduce the volumes of decommissioning of these mains is not acceptable to the HSE and would leave us non-compliant with our legal obligations. This includes consequential steel (<2" in diameter) encountered through the abandonment of Tier 1 risk mains and the replacement or transfer of associated services.

The mandatory programme has two options available for the decommissioning of "at-risk" iron pipes up to 8", consequential steel, and services:

- Replacement with PE (via insertion or open-cut techniques)
- Abandon only

8.1 First Option Summary (Accelerated Tier 1 delivery)

Tier 1 mains

Our RIIO-GD3 plan for Tier 1 will ensure delivery of the IMRRP by the 2032 target. This is calculated by reviewing the total population of Tier 1 iron mains remaining at the start of RIIO-GD3 and considering a deliverable programme in terms of resource and stakeholder acceptance. We have also considered delivery risk in the last year of the IMRRP which is year 1 of RIIO-GD4. Balancing these considerations, we are proposing a RIIO-GD3 programme of 352km per annum. This is slightly more than a flat phased programme for the final 6 years but reduces work in 2031/32 to 208km, minimising cost and risk of retaining resource for delivering the final year of the 30 years.

Consequential Steel

When we deliver the 352km a year of Tier 1 mains it is anticipated that there will be approximately 77km a year of associated consequential steel that will need to be replaced. A total programme length of 386km.

Services

The forecast number of associated service replacements for the length of iron and steel mains above will be 81,818, there will also be a further 81,818 services transferred. Data collected from recent mains replacement projects shows there is almost and exact 50/50 split between relays and transfers – we have used this assumption.

Non-compliant Stubs

We have identified a population of 2,585 non-compliant stubs that will require a variety of intervention types, including open cut replacement, and risk reduction via remote foam bagging. The work will be flat phased across GD3, requiring 517 interventions a year at an annual cost of [redacted] a year. Total cost of the programme of [redacted]

8.2 Second Option Summary (Flat phased Tier 1 delivery)

Tier 1 mains

Our second option would see a reduction in the annual target verses the Accelerated Plan to deliver 335km per annum, 1675km across the programme ([redacted]less spend across GD3). This would allow for an easier transition from GD2 to GD3, however it would add more risk to delivery of the final year of IMRRP, increasing the final year workload to 293km.

Consequential Steel

There would be a reduction of approximately 19km of consequential steel workload as a result of the lower target Tier 1 target. Approximately 73km a year totalling 368km across the 5 years.

Services

There would be a reduction of approximately 8,000 services replaced or transferred across the 5 years as a result of the lower Tier 1 target, 155,712 in total across GD3.

Non-compliant Stubs

This workload will be the same as described above.

8.3 Options Technical Summary Table

This table summarises the investment options described above:

Investment Option		First Year Spend	Final Year Spend	Intervention volume	Investment Design life	Total installed cost
Accelerated Tier 1 delivery	Tier 1 mains	[redacted]	[redacted]	1,760 km	60	[redacted]
	Consequential Steel	[redacted]	[redacted]	386 km	60	[redacted]
	Services	[redacted]	[redacted]	163,637	60	[redacted]
	Non-compliant stubs	[redacted]	[redacted]	2585	60	[redacted]
	TOTAL COST					[redacted]
Flat phased Tier 1 delivery	Tier 1 mains	[redacted]	[redacted]	1,675 km	60	[redacted]
	Consequential Steel	[redacted]	[redacted]	368 km	60	[redacted]
	Services	[redacted]	[redacted]	155,712	60	[redacted]
	Non-compliant stubs	[redacted]	[redacted]	2585	60	[redacted]
	TOTAL COST					[redacted]

Table 5: Summary of investment Options (2023/24 prices)

Options Cost Summary

Cost

We have developed and validated a very detailed costing model that uses the concept of cost components to build up a programme cost. The model has been independently assured by Turner and Townsend. Our goal is to ensure we have the most robust cost driver information to inform our forecasts. Further details on how we build up the cost components are available in Appendix 6.

Workload Identification

Pipes are identified for the entire RIIO-GD3 programme and out to 2032 when the 30/30 programme completes

These pipes are grouped into projects and each pipe has detailed specific information to inform our cost model

- Existing diameter and material
- Replacement diameter and method
- Surface category
- Number and type of services attached to the pipe
- Region

The following table details the unit costs for each pipe size and how the programme is built up. Further details regarding the cost difference between replacement method (open cut / Insertion) are included in Appendix 5.

Replacement Diameter MM	Lay km	Cost Per Metre	Total Cost £m
32	16.36	[redacted]	[redacted]
40	313.30	[redacted]	[redacted]
55	16.91	[redacted]	[redacted]
63	40.89	[redacted]	[redacted]
75	644.32	[redacted]	[redacted]
90	39.68	[redacted]	[redacted]
110	1.16	[redacted]	[redacted]
125	560.64	[redacted]	[redacted]
140	17.29	[redacted]	[redacted]
180	281.11	[redacted]	[redacted]
225	0.30	[redacted]	[redacted]
250	101.83	[redacted]	[redacted]
315	3.63	[redacted]	[redacted]
355	2.58	[redacted]	[redacted]
400	2.39	[redacted]	[redacted]
450	-	[redacted]	[redacted]
500	-	[redacted]	[redacted]
630	0.01	[redacted]	[redacted]
Total	**2,042.40**	[redacted]	[redacted]

Table 6: Unit cost by replacement diameter

Additional Cost due to new HSE approach to mains in gardens

Mains Replacement includes the cost of adhering to recent Health & Safety Executive (HSE) review and revised expectations for infrastructure that is located within customer land (i.e. gardens). There is additional cost to re-locate the mains, which is more costly than using the existing in situ infrastructure as a conduit to the new main. A separate cost assessment for this defined programme should be undertaken given the significant cost increase to re-locate the mains and recognising that this is largely characteristic of Steel <=2" mains of which

WWU has substantially more than other networks as per RRP, hence the significant increase in this area.

The difference in activities compared to normal mains replacement in gardens will be:

- Moving the main from the garden to the highway or footpath using open cut techniques
- Open cutting new services to all properties
- If in the rear garden, moving the meter from the rear of the property to the front and installing new internal pipework in the property to take the gas from the new meter position to the gas appliances.

The cost of these activities is based on previous experience of doing this type of work, volumes are based upon the risk assessment tool developed by all GDNs to assess risk of leaving mains in gardens.

Additional Cost Non-Compliant Stubs

The cost is based upon the activities required to do this work, which include:

- Traffic Management – the location of stubs is often in busy highways as they are generally attached to Tier 2 and Tier 3 feeder mains in towns and cities.
- Excavations on the stub and parent main.
- Replacement of short lengths of iron with PE or appropriate techniques manage the risk of the main – e.g. Seal-back.

The [redacted] identified spend for non-compliant stubs and the [redacted]detailed in the table above make up the total proposed programme cost of [redacted]

9. Business Case Outline and Discussion

9.1 Key Business Case Drivers Description

The results of the CBA show that using Carbon price central base case (£/tCO_2e, 2023/2024 prices) from the Treasury's Green book, both investment options considered above will pay back by 2041.

The primary driver for the whole life cost savings compared with the baseline scenario is through reduced shrinkage and leakage costs. The integrity of PE mains is very high compared to metallic so there are significant reductions in emissions following replacement.

The second most significant factor is reduced repair expenditure. PE leaks are incredibly rare so replacing a metallic main with PE dramatically reduces the cost of operating the main

Other key factors impacting the CBA are likelihood of gas explosion and likelihood of customer interruptions following gas escapes.

9.2 Business Case Summary

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

The graph below compares the options considered by our proposed investment programme to an accelerated programme. It can be seen that both pay back by 2044, and that accelerating mains replacement increases the benefits. Our plan has had to balance this with stakeholder needs and resourcing constraints.

[redacted]

Figure 13: This graph shows a comparison between proposed options considered with Central cost of carbon.

The tables below are 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 GD3 business plan.

Proposed Mandatory Programme CBA results - Mains and services

[redacted]

Table 7: Shows combined Mandatory mains and services CBA results

The Proposed programme CBA for mandatory mains and services shows using the central CO_2 price estimate the “Flat phased Tier 1 delivery” scenario pays back before 2044, using the High CO_2 price estimate this moves forwards to before 2037. Using the Low CO_2 price estimate the payback moves out to 2052. The “Accelerated Tier 1 delivery” scenario also pays back in 2044 using the Central CO_2 cost.

10. Preferred Option Scope and Project Plan

10.1 Preferred Option

In summary, our preferred option would be the “Flat phased Tier 1 delivery” plan, delivering a mandatory replacement programme throughout RIIO-GD3 of circa 408km a year, with an average annual cost of approximately [redacted]. Continuing at this rate will enable us to remain compliant with the HSE Iron Mains Replacement Programme but would allow for an easier transition from GD2 to GD3. It would however add more risk to delivery of the final year of IMRRP, increasing the final year workload in 2032. The reduced Tier 1 workload also helps mitigate the potential risk of an increased mandatory Tier 2 workload that is currently unknown. WWU are requesting an uncertainty mechanism to cover any additional costs to deliver any further mandatory workload not defined in the paper.

10.2 Asset Health Spend Profile

The expected spend profile of the preferred option is as follows:

Year of Spend	Tier 1	Service Replacements	Consequential steel	Non-compliant stubs	Total Spend (£m)
2027	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2028	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2029	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2030	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2031	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Totals	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table 8: details the expected spend profile (2023/24 prices)

10.3 Investment Risk Discussion

Chosen Workload

- The workload has been selected using sophisticated predictive analytics, supported by our Asset Investment Manager (AIM) application. This has the latest assessments of health and condition and forecasts deterioration rates and future condition and failures. This enables forecast of future operating costs, safety risk and environmental impact. We then use AIM to optimise our programme, recommending groupings of pipes and an order of replacement to minimise delivery cost and achieve the maximum safety and environmental benefits as early as possible. Any changes to workload during RIIO-GD3 would be primarily driven by 3rd party activities e.g. new housing developments in the vicinity of pipes impacting the safety risk assessment
- 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:

[redacted]

Figure 14: Shows the confidence levels on our forecasts of cost and benefits over time

The chart above is an output of the sensitivity analysis provided by the AIM software. 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 table below highlights other risks and mitigations associated with our proposed mains replacement programme

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 workforce and supply chain strategy. 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 replacement costs. We have used a very detailed cost component model to forecast RIIO-GD3 costs. This has been validated against experience in RIIO-GD2. We have an excellent track record in delivering programmes of this nature. Therefore, risk is minimal

Table 9: Summary of the risks and impacts of the delivery plan.

- **Cost Assumptions**
  - Costs have been calculated at as granular a level as possible. For every single main we have assessed the replacement size, the replacement technique, the location (road, verge, pavement), the number of services and even the number of excavations required and the types of connection to be made in these excavations. Due to this granular cost assessment, we have a high level of confidence in our forecasts

10.4 Project Plan

This is a programme of works that is a continuation of RIIO-GD2. There are hundreds of projects each year that are managed by a Project Management Office (PMO) function and tracked at Executive level. Design of work happens circa 18 months prior to delivery so the early RIIO-GD3 programme will be fully designed in 2025.

The following tables illustrate the communication and associated activities that happen before, during and after a typical project.

Communications prior to work start

What	Who -> Whom	When
High level 2 to 5 year works programme	Programme Controller (PC) / Design Team -> Highway Authority (HA)	Yearly
Forward planning notice - 1 year work	Design Team -> HA	Yearly
Coordination schedules - 1 year work	Planner -> HA	Quarterly
Manage external stakeholder risk / expectations (in discussion with HA, if required)	PC -> HA	Programme level basis - considered by PC, then discussed / agreed with HA
Pre-works site engagement with HA Inspector	PC / Operations -> HA inspector	3.5 to 4 months before work starts
NRSWA Notices, Permits & Lane Rental (3 months / 10 days)	Planner -> HA	Minimum of 3 months before work start
Identification of High Profile Projects (HPPs)	Programme Surveyor / PC -> Performance Improvement Officer (PIO)	HPPs identified by the Programme Surveyor and reviewed with PC
Identify addresses impacted and identify customers on Priority Service Register (PSR) Send GSOP13 advance notification of interruption letter	Planner via Design Team -> Customer	3 weeks prior to start.
Planning Notification sent to Customer Support Officer (CSO) to plan into workload	Planner -> CSO	3 weeks prior to start (via confirmation of letters sent email)

Booklet with step-by-step guide goes out with GSOP13	Planner via Design Team -> Customer	Sent with GSOP13 letter
HPP Drop-in Centre	PMO / Corporate Affairs (CA) -> Customer	typically 3-4 weeks before start but arranged months in advance
HPP project specific newsletter	PMO / CA -> Customer	Same as GSOP letter timescale
Any high impact traffic management, including road closure application	Planner -> HA	Minimum of 6 weeks, but checks must be undertaken with the individual HA
Projects impacting adjacent HA, e.g. due to diversionary routes	Planner -> Adjacent HA	Suitable time before work starts
HPP - Press releases / local radio/ social media	PMO / CA -> Press	Approximately 2 weeks before work starts
Traffic light (TL) applications	Planner -> HA	HA Specific - expected minimum of 1 month before start
CSO will pre knock affected doors with priority on PSR domestic customers and businesses	CSO	1-2 weeks before start
CSO to use xoserve data to obtain contact details and call PSR customers who were not in on pre knock	CSO	Day or two after pre knock / one week before works
HPP - Update of works on WWU website	PMO -> CA	At different stages of project cycle via HPP meeting
Weekly HPP meeting	PMO & CA	Weekly
CSO provides secure list of PSR customer details and needs to the FLM / Team	CSO>FLM	1 week before start
Provide info to EMS on reruns and u40+ etc.	Operations / CSO -> Emergency and Meterwork Services team (EMS)	At any stage of finding out individual property specifics

Table 10: Communications prior to work start

External communications onsite during work execution

What	Who -> Whom	When
Advance warning signs near work location, including any diversionary routes	Planner -> Operations	2 weeks before work start
Streetworks Permit Info Board (England only)	Streetworks team / Planner -> Operations	Prior to works start onsite
Information boards onsite about the works	PMO / CA -> Operations	For duration of project
48 hours card notice delivered by Team onsite	Operations	48 hrs before gas off
Alternative heating and cooking offered and supplied to customers	CSO / Operations	Before gas off
CSO will knock doors and speak to customers during the project	CSO	After project is live
Updates to information boards onsite	CSO / Operations	If there are any updates or change in works that needs communicating
Project signage on barriers explaining reasons for not occupying site	Operations	If site is unoccupied
HPP update & midpoint review	PMO / CA -> Press	Determined / reviewed by the PC (generally agreed pre commencement)

Table 11: External communications onsite during work execution

Communications following work completion

What	Who -> Whom	When
Post works joint site meeting with HA inspector	Operations -> HA inspector	If required, will happen in the last week, prior to site clearance
Post works customer feedback	Operations -> customer	Soon after work completion
Post door knock conversation. Check customers are back on gas and private excavations completed	CSO	After gas interruption and area made good
Formal Customer Satisfaction Surveys (postal)	Explain Market Research	4 weeks after work completion
Works stop notice	Planner -> HA	Within 2 hours of site clearance
Registration notice	Streetworks Team / Planner -> HA	Within 10 days of site clearance
HA feedback	PC -> HA	Within 2 weeks following works completion
Press release / key stakeholder letter (KSL) / Newsletter / social media following works completion	PMO & CA	Within 1 week of Works Completion/ site clear

Table 12: Communications following work completion

10.5 Key Business Risks and Opportunities

Future Energy Scenarios

The future of energy in the UK is not certain over the long term. 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 mains 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 hydrogen4,5 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 disconnected from 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 exacerbated 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 makes a decision to transfer.

Another challenge is that FES gives UK wide pathways and does not provide a view or 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

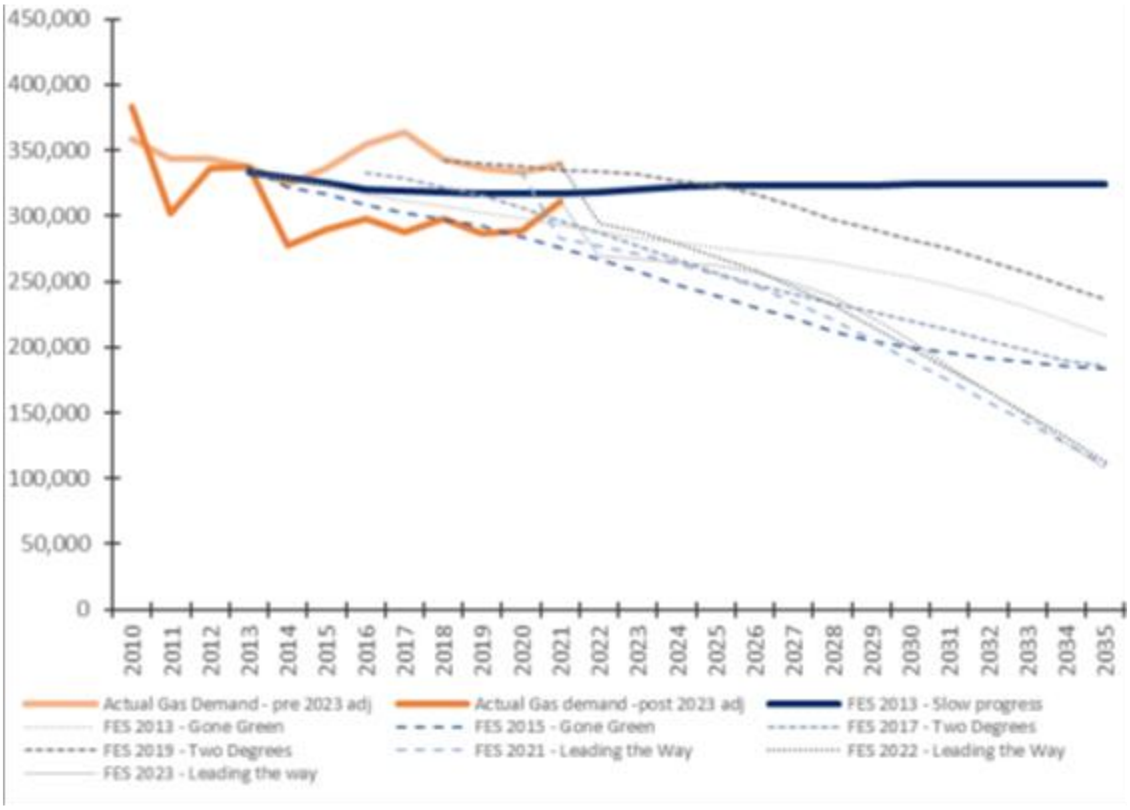

Figure 15 historical residential gas demand against the most optimistic scenario in every 2nd year of publication dating back to 2013

It should be noted that in the 2023 FES scenarios there was an adjustment to historical gas demand figures, 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.

Our mains replacement programme is built up of Tier 1 pipes required to be decommissioned by 2032 and pipes to be justified by CBA.

- Tier 2 and Tier 3 iron mains and services in our proposed programme pay back in 2047 and 2051 respectively. These assets are the feeder mains in towns and cities so in an electrification scenario would be the last pipes to be decommissioned. Most of the pipes selected are attached to Tier 1 projects and enable us to clear areas of metallic pipes. This prevents us from having to return to areas to fix leaks on single pipes after residents and the public have been already had disruptions from a large replacement project in their area.

- Steel pipes in our proposed programme all pay back <5 years due to significant environmental benefit.

These payback periods are well within the most pessimistic views on the future requirement of the gas network. As such, investment in replacement offers value for money and extremely low risk of stranded assets.

10.6 Outputs included in RII0-GD2 Plans

There are no outputs for delivery in RIIO-GD2 that will not be delivered in the period and that require deferral into RIIO-GD3. This is primarily mains replacement lengths, NARMs and environmental emissions for this paper.

We will come within the caps and collars for lengths by diameter bands and service numbers, as required by the Tier 1 mains and services PCDs.

APPENDICIES

Appendix 1 - Current failure rates as used in CBA and NARMs (Mains & Services)

MAINS	Joint Failure Rate per m	Fracture Failure Rate per m	Corrosion Failure Rate per m	Interference Rate per m
Tier 1 CI Low Pressure	0.134862325	0.004174568	0.012518322	0.000516446
Tier 1 CI Medium Pressure	0.255963723	0.007312902	0.035863534	0.001314908
Tier 2 CI Low Pressure	0.295622077	0.003135281	0.020826899	0.000461087
Tier 2 CI Medium Pressure	0.365746286	0.004506261	0.029647624	0.001006689
Tier 3 CI Low Pressure	0.001328935	0.00013039	0.000104131	1.13776E-05
Tier 3 CI Medium Pressure	0.001328935	0.00013039	0.000104131	1.13776E-05
Tier 1 DI Low Pressure	0.032729883	0.000971375	0.008236917	0.000404185
Tier 1 DI Medium Pressure	0.096012529	0.001828671	0.043860431	0.001447119
Tier 2 DI Low Pressure	0.042962416	0.000704646	0.007206294	0.000395442
Tier 2 DI Medium Pressure	0.11063933	0.001558695	0.020124065	0.000944905
Tier 3 DI Low Pressure	0.000334345	8.6926E-07	8.22595E-05	5.16981E-06
Tier 3 DI Medium Pressure	0.000334345	8.6926E-07	8.22595E-05	5.16981E-06
Tier 1 SI Low Pressure	0.074342451	0.00758972	0.007928432	0.000425634
Tier 1 SI Medium Pressure	0.36436859	0.020092792	0.033248595	0.00183949
Tier 2 SI Low Pressure	0.153376333	0.007551126	0.013958604	0.000594069
Tier 2 SI Medium Pressure	0.288270452	0.009865079	0.023822551	0.001285922
Tier 3 SI Low Pressure	0.000928509	0.000146945	6.09378E-05	7.37082E-06
Tier 3 SI Medium Pressure	0.000928509	0.000146945	6.09378E-05	7.37082E-06
Tier 1 ST Intermediate Pressure	0.000235689	1.85624E-07	0.000216756	6.49683E-06
Tier 1 ST Low Pressure	0.015564494	0.001577961	0.016132166	0.00035768
Tier 1 ST Medium Pressure	0.024713247	0.001620183	0.017788351	0.000607712
Tier 2 ST Intermediate Pressure	0.000235689	1.85624E-07	0.000216756	6.49683E-06
Tier 2 ST Low Pressure	0.056639844	0.001045132	0.019064239	0.000348663
Tier 2 ST Medium Pressure	0.059764967	0.001379982	0.022925188	0.000582574
Tier 3 ST Intermediate Pressure	0.000235689	1.85624E-07	0.000216756	6.49683E-06
Tier 3 ST Low Pressure	0.000235689	1.85624E-07	0.000216756	6.49683E-06
Tier 3 ST Medium Pressure	0.000235689	1.85624E-07	0.000216756	6.49683E-06

SERVICES	Joint failures per service per year	Fractures per service per year	Corrosion failures per service per year	Interference per service per year
Metallic	0.003273322	6.60521E-07	0.006990293	0.00026641
PE	0.000795968	0	3.01307E-06	0.00054014

Appendix 2 – "PROPOSED REVISIONS TO THE IRON MAINS ENFORCEMENT POLICY 2026 – 2032"

PROPOSED REVISIONS TO THE IRON MAINS ENFORCEMENT POLICY 2026 – 2032

Note:
Before implementation the proposed revisions to the Iron Mains Enforcement Policy, will be subject to HSE internal governance procedures and approval – this could result in further changes being made.

It is anticipated that the networks will be advised of the approved revised enforcement policy late January 2025.

Tier 1 – no change (other than to introduce additional flexibility, if required to accommodate potential net zero).

> *Whilst the Iron Mains review does indicate that there has been a slight increase in per/km failure rates, all "at risk" Tier 1 pipe should be addressed by 2032 (but see changes to Condition Monitoring below which will facilitate the identification of deteriorating Tier 1 pipes).*

Tier 2 – no change to general approach regarding decommissioning or other suitable measures above a defined risk threshold **but revision** to the risk assessment methodology to ensure its more appropriate to the assessment of absolute risk as applied to individual Tier 2 pipes.

> *See the section on "Concerns about methodology to prioritise Tier 2 pipes" in the previously circulated Iron Mains Review Presentation.*

Tier 3 – no change

Condition Monitoring - Extend the use of conditioning monitoring using Advanced Leakage Detection Technologies (ALD) **<u>for all iron pipes</u>** any distance.

Recognising that, resourcing constrains may require a programmed adoption:

- **Phase 1** (April 2026) "at risk" Tier 2 & 3 pipes as per the current enforcement policy
- **Phase 2** all remaining "at risk" Tier 1 pipes
- **Phase 3** – all remaining iron pipes (i.e. those iron pipes more than 30m from the building line

> *The objective is to ensure that by an agreed date within Approved Programmes all remaining iron mains are subject to condition monitoring regime using ALD.*
>
> *The current enforcement policy states "HSE expects the GDN operators to take advantage of innovative techniques that may allow them to pro-actively monitor the condition of pipes in*

Tier 2 scoring above the risk-action threshold and pipes in Tier 3 to predict the likelihood of failure and to improve asset integrity data."

Whilst to date the focus of the Iron Mains Enforcement Policy has been on managing the risk presented by the highest risk pipes, PSR Regulations 11 & 12 applies to all pipes.

Regulation 11

The operator shall ensure that—

> *(a) no fluid is conveyed in a pipeline unless the safe operating limits of the pipeline have been established; and*
>
> *(b)a pipeline is not operated beyond its safe operating limits, save for the purpose of testing it.*

and Regulation 13

> *The operator shall ensure that a pipeline is maintained in an efficient state, in efficient working order and in good repair.*

For example – if a pipe is leaking; then it is clearly operating outside its safe operating limits (or they have been incorrectly set); and if its leaking then it's not being maintained in an efficient state, in efficient working order and good repair.

The adoption of ALD techniques and it's use across the wider gas network, presents an opportunity for the networks to take measures to help ensure compliance with their Reg 11 and 13 duties in a way that has not been previously practicable.

WALES&WEST UTILITIES

Appendix 3 – HSE Request for Information - Mains on Private Land (25th April 2023)

HSE

Health and Safety Executive

Energy Division

ED Unit 3 Section 2
Ty Myrddin,
Old Station Road,
Carmarthen,
Carmarthenshire, SA31 1LP

Tel: +44(20) 3028-4737
Email:
mark.leadbetter@hse.gov.uk

http://www.hse.gov.uk/

Principal Inspector
Mark Leadbetter

Sarah Williams
Wales and West Utilities
Wales and West House
Spooner Close
Coedkernew
Newport
NP10 8FZ

Reference 2023/82803

Date: 25 April 2023

Dear Sarah,

COMPLIANCE WITH:

THE HEALTH & SAFETY AT WORK ETC. ACT 1974, SECTION 3(1)

Mains on Private land - Gas Mains Within Private Property

I am writing to operators of Gas Distribution Networks (GDNS) and Independent Gas Transporters (iGTs) following HSE's investigation of incidents and subsequent inspection into matters relating to the risk assessment, management and maintenance of mains located in private land.

As you are aware significant discussion has taken place over the last 12-18 months between HSE and a number of GDNs as well as at industry forums such as GTOSG regarding these assets and their associated risk.

HSE is concerned that the approach to the management of risk associated with mains in private property may not meet the requirements as documented in the legislation stated above in relation to risk assessment, design, management operation and maintenance, particularly when replaced either as part of the iron mains replacement program or due to leakage. At a high level the issue comes where the decision making, or risk assessment process for whether mains should be replaced in situ or relocated to the public highway is not formally documented or recorded and where suitable and sufficient systems are not employed to mitigate risk.

Action Required

In order to gain further understanding of the assets that would fall within the definition of mains within private property and the potential risks associated with these assets and to help inform future discussions, leading to an agreed industry approach. Please provide the following information in respect of your network to your lead inspector by the **23 May 2023**

1. Length, material and diameter of IP, MP and LP mains located within domestic private land (i.e., residential property) utilising available records
2. Length, material and diameter of IP, MP and LP mains located within domestic private land (i.e., residential property) identified via works undertaken on site e.g., replacement or leakage each year for the 5-year period 1st January 2016 – 31st December 2020
3. Number of 3rd party damages to IP, MP and LP resulting in a loss of containment for mains by material, diameter and pressure tier reported each year for the 5-year period 1st January 2016 – 31st December 2020 located within domestic private land (i.e., residential property)
4. Number of escapes not resulting from 3rd party damage to IP, MP and LP mains resulting in a loss of containment by material, diameter and pressure tier reported each year for the 5-year period 1st January 2016 – 31st December 2020 located within domestic private land (i.e., r)
5. Recording and management of these specific mains i.e., any additional considerations, communication with landowners etc. including any procedural documents already in place
6. General approach to replacing/maintaining these mains, i.e., relocate to road/footpath or leave in-situ and insert, with a brief overview of any risk assessment process, including any procedural documents already in place
7. The policy and procedural process that has been adopted by your network to manage the risk associated with mains located within domestic private land.

Information for employees

Section 28(8) of the Health and Safety at Work etc. Act 1974 requires me to give information to your employees about matters affecting their health and safety. To this end, please ensure that a copy of this letter is passed on to your employee representatives.

Meanwhile, should you require any further information or advice, or are unclear about what you are required to do then please do not hesitate to contact me.

Yours sincerely

Mark Leadbetter
HM Principal Inspector of Health and Safety

Appendix 4 – Enforcement considerations for inspectors investigating gas incidents arising from the failure of steel service pipes

Enforcement considerations for inspectors investigating gas incidents arising from the failure of steel service pipes (Enforcement considerations for inspectors investigating gas incidents arising from the failure of steel service pipes - operational guidance - HSE)

Formerly SPC ENF 186

Open Government Status

Fully Open

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Guidance owner

Hazardous Installations Directorate. Energy Division, ED5

Target Audience

HID Energy Division Unit 5 inspectors

Summary

This guidance sets out the key factors that inspectors should take into account when investigating gas incidents arising from the failure of steel service pipes and steel service 'tails' attached to polyethylene pipes. In particular, it describes the approaches typically adopted by the gas distribution network operators (GDNs) to manage the risk of steel service pipe failure. Steel risers in blocks of flats and steel gas mains are outside the scope of this guidance

Introduction

The failure of steel service pipes may lead to gas entering occupied buildings and the risk of fire or explosion should the gas ignite. The GDNs estimate that there are approximately 8 to 10 million steel service pipes taking gas from mains to consumers' premises. They fail typically through external corrosion which can be accelerated by acidic soil or the presence of decaying organic matter. Low pressure steel service pipes are not usually subject to cathodic protection (although those operating at higher pressures may be). Protective measures such as wrapping or coatings are sometimes used to prevent external corrosion but, due to damage or deterioration, they may not be fully effective.

The management of risk from steel service pipes is currently a significant issue for the GDNs.

Action

Inspectors investigating incidents caused by gas escapes from steel service pipes must consider whether it was reasonable to expect the duty holder to have identified and replaced the pipe prior to its failure.

Inspectors should consider taking enforcement action, in line with the Enforcement Management Model (EMM), if their investigation finds that the GDN has failed to:

i. Undertake steel service pipe replacement where iron mains replacement has previously taken place upstream of the failed service pipe (mains replacement provides an ideal opportunity for the GDN to replace steel services with minimal disruption to customers and is accepted practice across GDNs),

ii. Replace the failed steel service pipe when it had been the subject of previous leakage report(s),

iii. Carry out the replacement and/or the condition assessment of the failed steel service pipe where there is evidence (obtained systematically by the GDN) of a heightened local risk of failure (i.e. a 'hot spot').

The GDNs may adopt other, equally effective, means of prioritising steel service pipe replacement and/or other suitable means of managing risk across their steel service pipe population. The decision to take enforcement action following an incident should therefore be considered carefully on a case-by-case basis.

Background

Regulation 13 of the Pipelines Safety Regulations 1996 (PSR) - this Regulation requires the operator of a pipeline to ensure that it is maintained in an efficient state, in efficient working order and in good repair. This duty is absolute, and in the case of steel service pipes, maintenance generally means removal and replacement.

HSE accepts that it is not practicable for the GDNs to proactively establish and monitor the condition of all of the steel service pipes within their networks. Nor is it feasible for the entire population of these pipes to be replaced immediately. However, it may be practicable for operators of smaller networks to proactively assess the condition of their steel service pipes.

Regulation 13A of PSR - this offers the GDNs a statutory defence to Regulation 13 in the event of the failure of an iron pipe included within an approved mains replacement programme. However, Regulation 13A does not apply to steel service pipes and a GDN will be in breach of Regulation 13 in the event that these fail.

In 2011, an independent review into the effectiveness of the 30-year Iron Mains Replacement Programme (IMRP) concluded that the risks associated with the failure of steel service pipes does not justify their inclusion within the IMRP. As such steel service pipes continue to be excluded from the IMRP.

Further information

For further information please contact the Gas and Pipelines National Inspection and Operational Support Team (ED 5.4).

Appendix 5 – Breakdown of cost per meter (Preferred Option)

Total mandatory programme – Open cut and Insertion (not including additional cost of Stubs)

Replacement Diameter MM	Lay km	Cost Per Metre	Total Cost £m
32	16.36	[redacted]	[redacted]
40	313.30	[redacted]	[redacted]
55	16.91	[redacted]	[redacted]
63	40.89	[redacted]	[redacted]
75	644.32	[redacted]	[redacted]
90	39.68	[redacted]	[redacted]
110	1.16	[redacted]	[redacted]
125	560.64	[redacted]	[redacted]
140	17.29	[redacted]	[redacted]
180	281.11	[redacted]	[redacted]
225	0.30	[redacted]	[redacted]
250	101.83	[redacted]	[redacted]
315	3.63	[redacted]	[redacted]
355	2.58	[redacted]	[redacted]
400	2.39	[redacted]	[redacted]
450	-	[redacted]	[redacted]
500	-	[redacted]	[redacted]
630	0.01	[redacted]	[redacted]
Total	**2,042.40**	[redacted]	[redacted]

Mandatory programme – Insertion

Replacement Diameter MM	Technique	Lay km	Cost Per Metre	Total Cost £m
32	Insertion	15.13	[redacted]	[redacted]
40	Insertion	286.20	[redacted]	[redacted]
55	Insertion	12.89	[redacted]	[redacted]
63	Insertion	10.24	[redacted]	[redacted]
75	Insertion	635.40	[redacted]	[redacted]
90	Insertion	38.07	[redacted]	[redacted]
110	Insertion	1.16	[redacted]	[redacted]
125	Insertion	448.22	[redacted]	[redacted]
140	Insertion	17.29	[redacted]	[redacted]
180	Insertion	183.23	[redacted]	[redacted]
225	Insertion	-	[redacted]	[redacted]
Total		**1,647.82**	[redacted]	[redacted]

Mandatory programme – open cut

Replacement Diameter MM	Technique	Lay km	Cost Per Metre	Total Cost £m
32	Open Cut	1.23	[redacted]	[redacted]
40	Open Cut	27.10	[redacted]	[redacted]
55	Open Cut	4.02	[redacted]	[redacted]
63	Open Cut	30.65	[redacted]	[redacted]
75	Open Cut	8.92	[redacted]	[redacted]
90	Open Cut	1.61	[redacted]	[redacted]
110	Open Cut	-	[redacted]	[redacted]
125	Open Cut	112.42	[redacted]	[redacted]
140	Open Cut	-	[redacted]	[redacted]
180	Open Cut	97.89	[redacted]	[redacted]
225	Open Cut	0.30	[redacted]	[redacted]
250	Open Cut	101.83	[redacted]	[redacted]
315	Open Cut	3.63	[redacted]	[redacted]
355	Open Cut	2.58	[redacted]	[redacted]
400	Open Cut	2.39	[redacted]	[redacted]
450	Open Cut	-	[redacted]	[redacted]
500	Open Cut	-	[redacted]	[redacted]
630	Open Cut	0.01	[redacted]	[redacted]
Total		**394.57**	[redacted]	[redacted]

Appendix 6 – Cost Modelling Process.

Cost

We have developed and validated a very detailed costing model that uses the concept of cost components to build up a programme cost. Our goal is to ensure we have the most robust cost driver information to inform our forecasts.

Workload Identification

Pipes are identified for the entire RIIO-GD3 programme and out to 2032 when the 30/30 programme completes

These pipes are grouped into projects and each pipe has detailed specific information to inform our cost model

- Existing diameter and material
- Replacement diameter and method
- Surface category
- Number and type of services attached to the pipe
- Region

Additional Parameters

We run the workload through our purpose-built ‘Python Programme’ which produces the following;

- Connection points of each pipe based on a pre-set criteria, this produces a connection type which is a key cost driver.
- Grid Ref of each activity (Connection, Service, Main Laying) which is then used in a spatial query to identify the surface categories and road classification.

Below is an example of the Python Programme Connection output for a live mains insertion scheme;

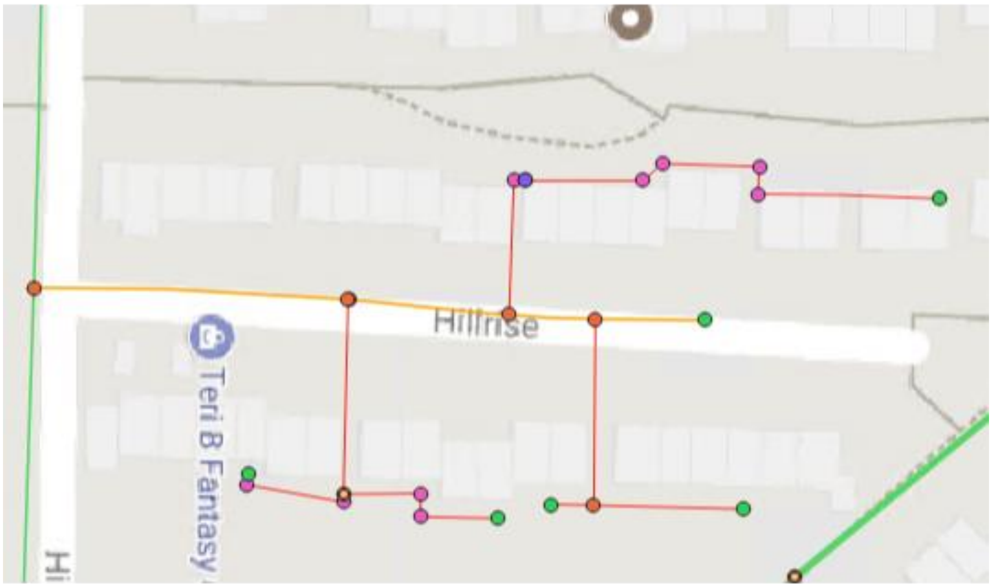

Figure 6: Example of the Python Programme Connection Output

Each dot indicates that a connection is required and the colours represent the connection type. These are produced in a list format based on the existing and replacement mains diameters for each pipe. Using the above scheme as an example, the pink dots represent a bend radius greater than what is possible to insert through therefore requiring us to Retrieve the live head and insert after the obstruction. See schematic below and a list of options available based on the existing diameter.

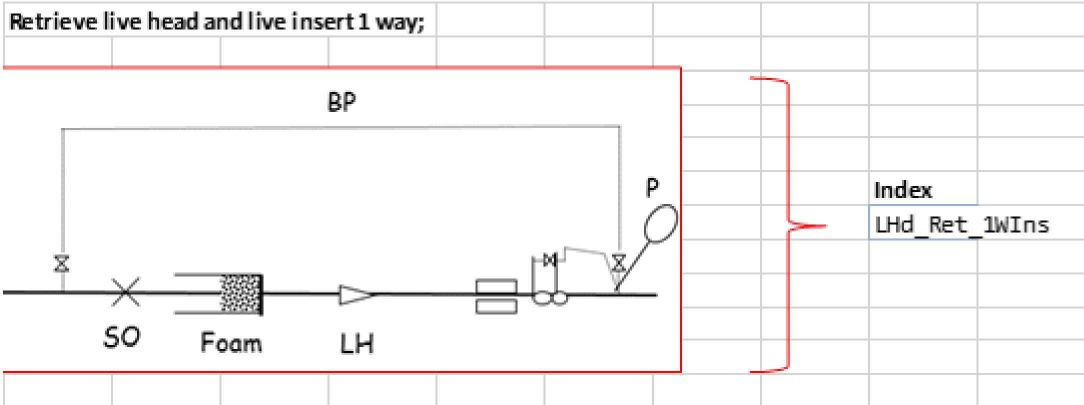

Figure 7: Schematic of live head retrieval

Index	Existing Dia
LHd_Ret_1WIns_LP_3_	3
LHd_Ret_1WIns_LP_4_	4
LHd_Ret_1WIns_LP_5_	5
LHd_Ret_1WIns_LP_6_	6
LHd_Ret_1WIns_LP_7_	7
LHd_Ret_1WIns_LP_8_	8
LHd_Ret_1WIns_LP_9_	9
LHd_Ret_1WIns_LP_10_	10
LHd_Ret_1WIns_LP_12_	12
LHd_Ret_1WIns_LP_14_	14
LHd_Ret_1WIns_LP_16_	16
LHd_Ret_1WIns_LP_18_	18
LHd_Ret_1WIns_LP_24_	24

Figure 8: Index codes for connection types

The Index codes above are for a specific connection type, in this example we are showing the connection set for an activity of Retrieving a Live head during a mains insertion operation and re-setting for another insertion push. This normally occurs at an obstruction such as a bend in the pipe or a syphon.

Other connection types, service types and main laying techniques follow the same process as above to produce the most accurate and robust information to forecast using our cost components.

Cost Components

The cost components are reflective of the application of industry and WWU's policies and procedures, providing us with vital safety factors such as minimum excavation size for a given Engineering Operation:-

- WW/PR/ML/1 (Work Procedure for Pipe System Construction)
- WW/PR/GR/1 (Work Procedure for Main Laying - General Requirements)
- WW/PR/SL/1 (Work Procedure for Service Laying)

There are 3 main Cost Components in Mains Replacement;

- Mains Connections – Connection types for all mains arrangements and sizes
- Main Laying – Open Cut and insertion across all diameters
- Services – a suite of service types rolled up into relays of steel services and transfers of PE services

As the components are built from very specific cost drivers which include;

- Excavation size
- Pipe & Fittings
- Aggregate Quantities

Cost component	Method of calculating workload	Method of calculating cost
Pipe and fittings	Based on workload and connection/service type	Rate per metre/component from current procured contracts
Excavation size	Based on industry policies and procedures - standards	Cost is linked to aggregate quantities
Aggregate quantities	Based on excavation size	Rate per tonne from current procured contracts – including regional rate differences
Connection types	Current working practices for each connection type established	Each connection type has a different cost based on Pipe and fittings, excavation sizes, aggregates and labour time required.

Number services	Based on workload – see design section	Rate per service type based on current working practices
Replacement technique	Based on workload – see design section	Time to excavate for different techniques, aggregate requirements and plant necessary to support technique

Outputs

Through multiplying the workload and additional parameters against the specific cost component we can estimate the costs at a very granular level by region, this is especially important to take account of the differing rates for activities such as 3rd party services for Reinstatement, Quarry costs etc. across our geography.

Outputs process map

This demonstrates a simplified process flow of our Mains Replacement costing model, The top (1st) section is the Services flow, 2nd is the Mains Connections, 3rd is the Dynamic Growth Connections and 4th is the Main Laying flow.

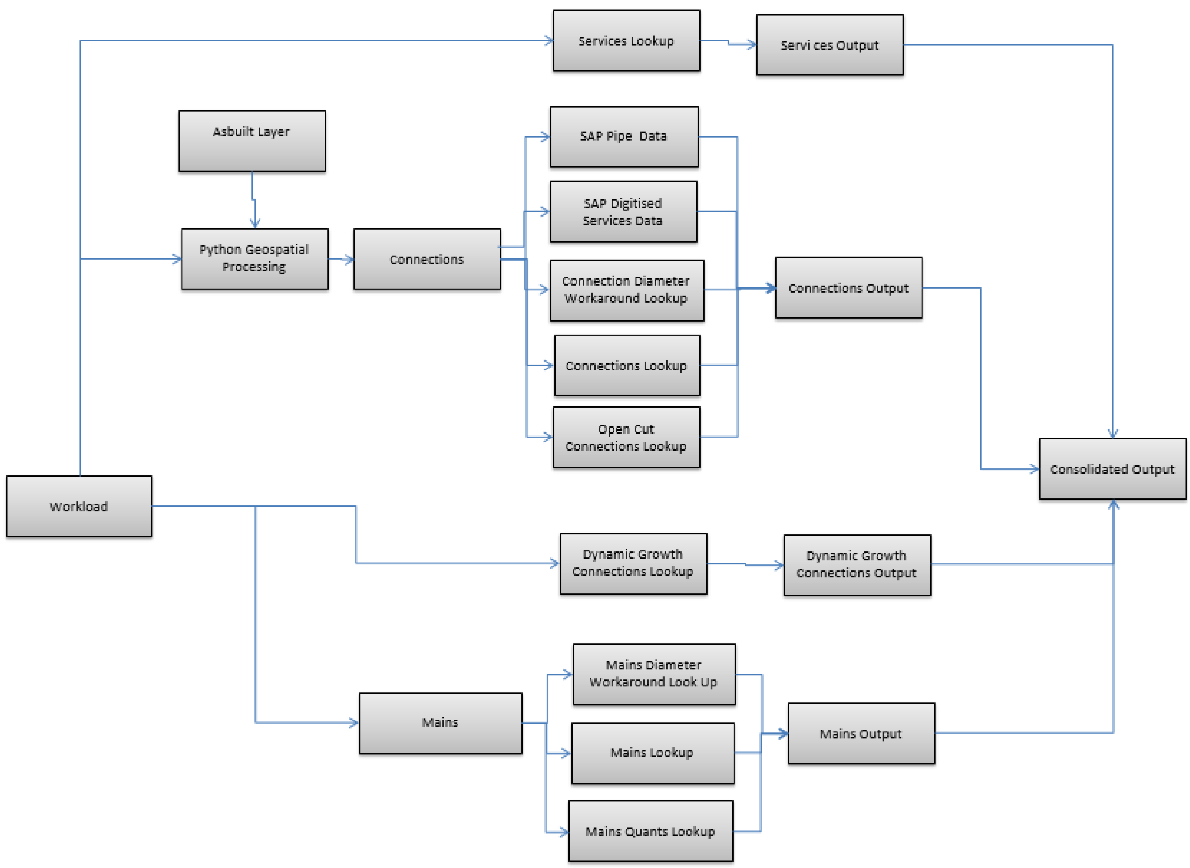

Figure 9: Process Flow for Mains Replacement Costing

Appendix 7 – Tier 1 Totex Waterfall for GD2 vs GD3.

[redacted]