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London Medium Pressure Supply Strategy



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Executive Summary

At the RIIO visit held on the 24th November 2015 Ofgem asked National Grid Gas Distribution (NGGD) about progress and plans in relation to the London Medium Pressure Strategy project. Concerns were raised in respect of the reduced delivery of main being taken off risk in the RIIO-GD1 period vs what has been funded in the Final Proposals. Ofgem requested a written submission clarifying the current position and how any shortfalls are being addressed.

This report addresses Ofgem's queries by:

- Confirming the background to the Regulatory Negotiations and iterations of the Business Plan submissions
- Outlining what was allowed in the Final Proposals and NGGD's position on this
- Describing how a number of different strategy options were developed and how the engineering constraints shaped these options
- Giving the detail of the option taken forward into delivery, namely the City Centre Schemes and how this needs to be delivered over two price control periods
- Summarising the views on achieving output delivery across the North London network.

Ofgem Final Proposals (December 2012) provided £93m funding for 69km of the London Medium Pressure Strategy project compared to the £165m and 98km NGGD had put forward. As a result of the difference, the overall London strategy had to be reconsidered however NGGD believed it could accept Ofgem's proposals because it allowed replacement of a significant length of large diameter MP mains during the regulatory period that would contribute towards:

- (i) our commitment to reduce city centre process safety risk and
- (ii) the outputs for the overall North London network over the RIIO-GD1 period.

The strategy and options were then reviewed by the business to decide the best solution to deliver the requirements over the RIIO period, consistent with the allowances and given that the RIIO-GD1 framework allowed us to trade-off across assets and asset classes.

The preferred solution was to retain the 'core' part of the original 98km strategy, which enabled the replacement of the large diameter mains in the city centre. These mains pose the highest process safety risk due to their proximity to large highly populated buildings many of which have national importance.

The solution requires the construction of a new 'standalone' 2 barg. network in the city centre. NGGD's proposals to Ofgem had always envisioned a build period of over two price control periods to remove the risk posed by pipes in the city centre. The long build period in the area is required because there are significant engineering challenges to be overcome, and to minimise cost and disruption to the public, insertion techniques will be used wherever possible. This requires a phased approach making use of low demand summer periods to ensure that adequate capacity is maintained at all times. In addition pressure elevation is required to compensate for the replacement mains being smaller than those, which they replace. This is a dominating factor in determining the order in which the pipes must be worked on.

This core city centre scheme, which has a positive Net Present Value of £80m and a Total Benefit of £166m equates to circa 28km of iron mains abandonment in RIIO-GD1 and 20km in RIIO-GD2. Opportunities may exist to flex workload between the regulatory periods however this is subject to obtaining the necessary statutory permissions and overcoming the engineering challenges central London gives rise to.

Whilst there is a gap between the 69km agreed at Final Proposals and the 48km being delivered over two price control periods, NGGD is actively reviewing opportunities to address the shortfall which will be optimised in conjunction with the remainder of Tier 2 & Tier 3 mains across the North London network whilst also recognising the mechanisms included within the Final Proposals, namely the End of Period Review.

It is NGGD's aim to deliver an asset management plan that delivers output commitments, including those related to Network Output Measures utilising trade-offs between or within asset classes. NGGD is committed to delivering the primary iron mains risk output and our Network Output Measures, our forecasts, as submitted in the 2014/15 RRP, include the full delivery of Tier 2 and Tier 3 km across the distribution mains asset class.

Given this position, NGGD consider that exploring the options is in customer interest, and that it may be necessary for output deferral, which would be assessed with any potential over or under delivery across all asset classes. As such, it does not merit inclusion in any Mid Period Review.

At the meeting Ofgem also asked about CBA justified Tier 3 MP work in East of England, North West and West Midlands Networks. NGGD had requested funding for 0.5km of specific CBA justified Tier 3 MP iron mains abandonment in East of England and 2.3km in North West. NGGD made no request for funding such replacement in West Midlands. NGGD expects to deliver the East of England and North West CBA justified work during the RIIO-GD1 period.

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1. Introduction

This paper has been prepared following a meeting between National Grid Gas Distribution (NGGD) and Ofgem on 24th November 2015 during which Ofgem enquired about the progress and plans to deliver London Medium Pressure Strategy Project.

1.1.1. What has Ofgem asked NGGD to clarify?

Ofgem has requested a written submission clarifying NGGD's current strategy. Their official question on 3rd December 2015 stated:

London Medium pressure:

- a) Provided detailed submission in respect of London's revised forecast of 24km across the 8 year period;*
- b) Consider if there's MP workload for NW and EoE*
- c) Quantify the financial impact*
- d) Respond accordingly to Ofgem's MPR consultation including workload and financial impact*

1.1.2. What is the scope of this document?

This document seeks to respond to Ofgem's queries by setting out the key milestones in the process for the London Medium Pressure Strategy project, discusses the options considered and highlights the challenges which resulted in the strategy which is currently being delivered.

2. Regulatory Negotiations

This section sets out the background between April 2011 and December 2012 during which the negotiations with Ofgem took place to secure funding for the RIIO-GD1 regulatory period, of which the London Medium Pressure Strategy forms part of.

2.1.1. Three Tier Programme

The joint HSE / Ofgem review of irons mains replacement was published in April 2011. The review replaced the 30/30 programme with a new programme referred to as the Three Tier programme.

In respect of all pipes greater than 18" in diameter the Three Tier replacement programme requires that individual projects be justified on a project by project basis. This meant that significant lengths of relatively high risk iron pipes came within the scope of cost / benefit analysis without there being any established process to carry it out. However, to obtain funding all GDNs were required to submit their business plans to Ofgem by the 30th November 2011. This meant that all pipes that might be cost justified to replace had to be analysed and plans for their replacement developed in just seven months. The work involved:

- Developing a cost / benefit analysis process that aligned with UK Treasury guideline and at the same time could be applied given already available information,
- Discussing the cost benefit analysis process with stakeholders,
- Analysing over 500km of MP pipes that potentially could be cost justified for replacement,
- Designing possible replacement projects from the population of potentially viable pipes using outline costs,
- Doing the optioneering to look at alternative potential solutions that might provide better / cost benefit,
- Checking to ensure that such projects, which might be viable, could be delivered from the perspective of gas flow / capacity requirements and that they would be buildable assuming adequate road access
- Costing the projects in more detail,

- Phasing them (over a 15 year period to enable maximum use of insertion)¹ and
- Generation and sign off of the RIIO business plan including accounting for the impact of the proposed programme on other RIIO business plan outputs, for example governor work.

Significant progress was made in tight timescales, something acknowledged by Ofgem and their consultants at the time.

Between November 2011 and December 2012 the focus of work was on the assumptions used within the cost / benefit analysis model, to assure overall customer benefit and that the work would be appropriately funded. During this period contact was made with stakeholders such as Highway Authorities, however because funding was not certain progress was limited because when discussing the acceptability of working in carriageways the highway authority requires specific proposals, including dates, to help them to judge whether the application is acceptable.

2.1.2. Original Business Plan (Nov-2011)

In order to justify the work, a detailed cost benefit analysis was developed. The model offset replacement cost against:

- Safety benefits (cost of life, cost of damage to buildings)
- Environmental benefits (leakage reduction)
- OPEX benefits (reduced repairs).

The process identified that mains in central London were cost beneficial to replace. This is because the process safety risks posed by continuing to operate such mains are significant. This is due to the non-typical nature of the properties adjacent to the mains, which tend to be large and heavily populated. Many of the buildings are valuable or have valuable contents or significant potential for consequential loss due to the amount of economic activity taking place in the building. It was also proven that the MP pipes in London are relatively high risk because they are situated in areas of limited open ground and neighbouring buildings have cellars in which gas can accumulate.

¹ Referenced in Appendix A8.4, Nov 2011 Submission, Para 3.115.

Having carried out a cost benefit analysis, the quantifying work was built into a number of schemes and assessed for a phased delivery over RIIO-GD1 and RIIO-GD2. The strategy allowed the replacement of the highest risk areas in central London without compromising the integrity of the network. The strategy focused on bringing a 2 barg. gas into central London to enable the insertion of pipes in the most congested inner London streets. It also included sections of pipe north of the city centre. The schemes were integrated and needed to be delivered in a phased and controlled way to ensure that London's MP network remained secure throughout the build period and included an element of CAPEX (reinforcement and upgrading of PRS). The November 2011 plan submission comprised the following:

Length*	97.1Km
Cost*	£171.1m

** Figures taken from Appendix A8.4 Business Plan, Nov-11*

2.1.3. Revised Business Plan (Apr-2012)

Following the November 2011 plan submission, Ofgem queried costs, and sought information on elements within the CBA model. Having carried out a detailed cost assessment for the strategy, the April 2012 plan was revised:

Length*	98.7km
Cost*	£165m

** Figures taken from Revised Business Plan, Apr-12*

2.1.4. Initial Proposals (Aug-2012)

Ofgem examined the strategy on scheme by scheme basis. Having not allowed the complete strategy, this impacted on overall deliverability. If system integration cannot be maintained, it is not possible to raise pressure to 2 barg. and carry out large elements of cost effective insertion.

Length*	54Km
Cost*	£39m

** Figures taken from OFGEM Initial Proposals Jul-2012*

Ofgem did not agree with our approach or assessment of the benefits of the London Medium Pressure Strategy. Ofgem's main concern was that the assessment of consequence of an incident in terms of cost of life and cost of property over inflated the benefits.

NGGD responded to Ofgem's Initial Proposals in September 2012 reiterating need for an appropriate risk mitigation programme and that the CBA / costing methodology was robust. It was also noted that Ofgem's unit rate of £700 per m, was not reflective of the complexity of the work required.

2.1.5. Final Proposals (Dec-2012)

After further supporting evidence was submitted and discussions held with Ofgem, the Final Proposals shifted significantly to allow 70% of the original business plan.

Length	69Km
Cost	£93m

** Figures taken from OFGEM Final Proposals Dec-2012*

The commentary from Ofgem on the London Medium Pressure Strategy is as follows:

NGGD's London Medium Pressure (MP) strategy

6.22. We have considered NGGD's London medium pressure (MP) strategy and we have assessed the plan consistent with our approach to assessing all other discretionary mains replacement.

6.23. We acknowledge that NGGD has undertaken a detailed assessment to inform its MP strategy. However we believe some of the assumptions NGGD has used to justify the project are unreasonable. In particular, our analysis indicates that NGGD has assumed the avoidance of a fatal incident around 40 times the nationally accepted average. We also have concerns that assumptions for property rebuild costs are high.

6.24. In appraising NGGD's MP strategy, we have used a risk value ten times the assumed national average fatality occurring as a result of mains failure (consistent with HSE's concept of disproportionate cost), and based on this, NGGD's MP strategy does not demonstrate a positive net present value within the required period (by 2037).

6.25. However, we accept that NGGD will need to replace some mains within this timescale, and we have allowed 70 per cent of their proposed workload based on our CBA approach (where we count benefits within a 24 year period). We set out our approach in detail in Chapter 8 and Appendix 3 of the Cost Efficiency supporting document (pg105).

2.1.6. Summary

As a result of the difference between Final Proposals and NGGD's Business Plan, the overall London strategy had to be reconsidered however NGGD accepted the Final Proposals in the round recognising the mechanisms included, namely the End of Period Review as this allowed removal of a substantial length of large diameter high risk process safety mains across the regulatory period.

Table 1 – Summary of Regulatory Negotiations

	Original BP	Revised BP	Interim Proposals	Final Proposals
Date	Nov-2011	Apr-2012	Aug-2012	Dec-2012
Length	97.1Km	98.7km	54Km	69Km
Cost	£171.1m	£165m	£39m	£93m
Unit Rate (£m/km)	£1.76m/km	£1.67m/km	£0.72m/km	£1.34m/km

This was then taken forward to design a revised strategy that contributed towards our commitment to reduce city centre process safety risk and the outputs for the overall North London network over the RIIO-GD1 and RIIO-GD2 periods.

3. Practicality, engineering design and stakeholder process

Any revised strategy was constrained by a number of factors which ultimately shaped the approach taken to develop the main three options considered. These factors are now discussed in more detail including pertinent engineering constraints, stakeholder engagement and process safety considerations.

3.1.1. Engineering Constraints

In addition to the significant challenges which would be expected undertaking complex works in a major city centre, there are some specific engineering challenges that are also unique to London and this project which need to be considered including the volume of other 3rd party work in London, medium pressure network capacity, operating windows and existing bridge crossings.

- There is a significant amount of major infrastructure, utilities and general construction work in central London therefore any work in the highway is highly sensitive and negotiations are often protracted with the required stakeholders.
- The existing capacity of the MP network is not sufficient to allow the sustained use of insertion techniques and will require pressures to be elevated in order to enable the use of reduced pipe sizes which dictates that mains must be replaced in a certain sequence to retain security of supply and network integrity.
- Much of the network can only be replaced during the summer in order to maintain network resilience which reduces the operating windows to between circa April-October and ultimately dictates the rate that mains can be safely inserted.
- The North London network also provides gas to approximately 18,000 customers south of the river, between Battersea and Lambeth. The existing MP bridge crossings at Vauxhall and Battersea cannot be pressure elevated and will need to be replaced and abandoned. Options were explored with Southern Gas Networks (SGN) to provide a supply of gas for this area however they were discounted owing to the significant reinforcement that would be required within SGN's network.

The above, together with other engineering constraints found during the detailed option assessment identified significant challenges with delivering within RIIO-GD1. Further detail on several other significant engineering constraints is contained within Appendix B.

3.1.2. Stakeholder

Whilst developing the different options during the Ofgem negotiations, it was not possible to undertake the level of stakeholder engagement to allow detailed project design. Initial discussions with key stakeholders took place outlining the high level strategy however assumptions had to be made in lieu of any detailed proposals that would have been required to have meaningful dialogue with key stakeholders such as Transport for London. During the pre-RIIO price control period assumptions had to be made based upon NGGD's knowledge of working in central London.

The level and extent of stakeholder engagement which has been undertaken since the start of RIIO-GD1 is discussed in further detail in Section 4.1.5.

3.1.3. Process safety risk

The figure below shows examples of some of the nationally important buildings situated within 30m of a medium pressure main in London.

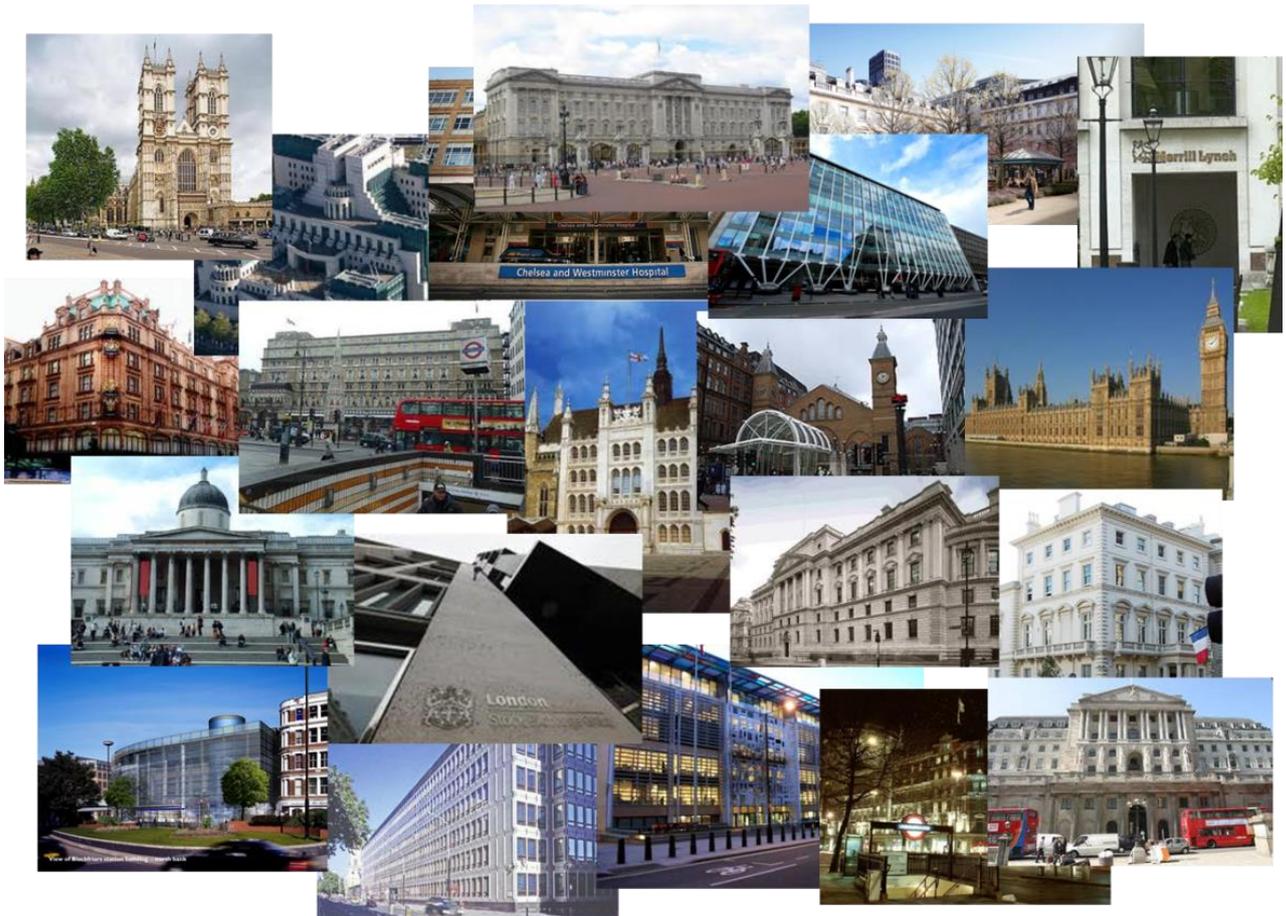


Figure 1 – Buildings in close proximity to T3 cast iron medium pressure mains

London MP mains have the potential to cause significant incidents due to nearby buildings having hundreds or even thousands of occupants. Additionally, there is the potential for

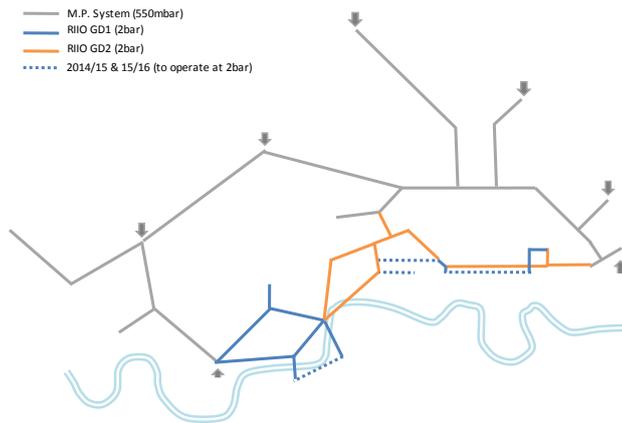
significant financial losses due the expense of replacing national important buildings and their contents and the potential impact on economic activity taking place within a building. The effect on public confidence also has to be considered (although this was not part of cost benefit analysis).

The mains were laid in the period 1860s to the 1880s. They are situated in streets with little open ground and the neighbouring properties have cellars in which gas can accumulate. For this reason they are predicted to be relatively high risk of giving rise to an incident in spite of their relatively low fracture frequency. This is borne out by recent high profile Gas In Buildings events, e.g. New Scotland Yard, Legal and General corporate headquarters.

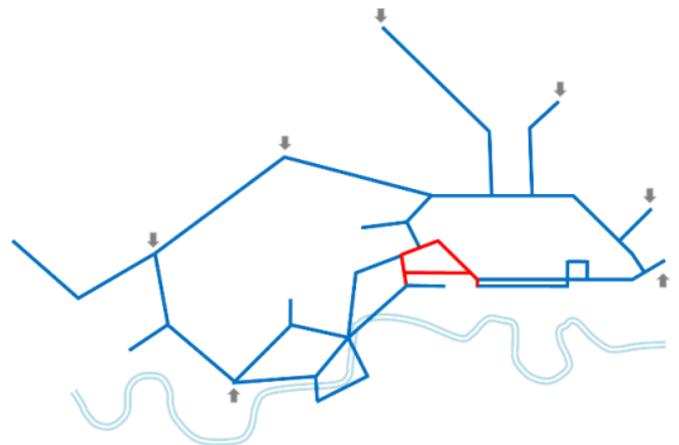
3.1.4. Strategy Options Considered

The above three factors lead us to consider alternative designs, approaches and delivery timescales. These are schematically shown in the Figures below.

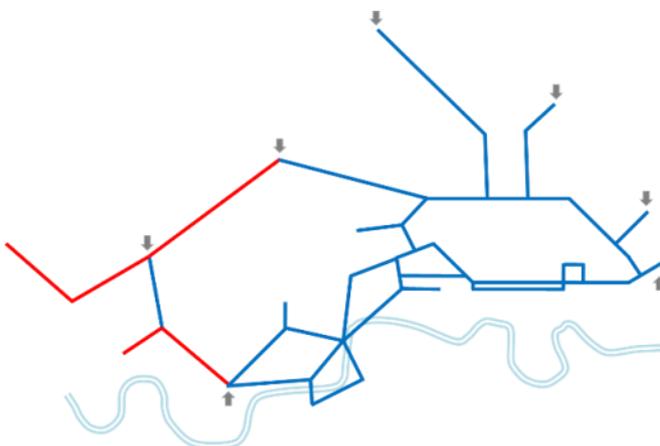
**Figure 2 – Option 1
City Centre Schemes**



**Figure 3 – Option 2
‘Square Mile’ Schemes**



**Figure 4 – Option 3
Outside City Centre**



The table below summarises the options and indicates their ability to contribute towards the primary driver of removing process safety risk in the city and other drivers.

Table 2 – Strategy Options Scoring Matrix

Driver / Consideration	Option 1 City Centre Schemes	Option 2 'Square Mile' Schemes	Option 3 Outside City Centre	Option 4 Defer	Option 5 Do Nothing
City Centre Process Safety Risk	Yes	Small contribution	No	No	No
Contributes towards RIIO Outputs Commitments (Risk Points, '000)	c.17k	c.4k	c.16k	Reactive approach	No
Deliverability	Challenging	Extremely difficult	Yes	Yes	Yes
Cost*	£109m	£40m	£44m	n/a	n/a
Length*	48km (over 2 x Price Controls)	13km	38km	n/a	n/a
Benefit*	£245m	£159m	£91m	n/a	n/a
Net Present Value*	£137m	£120m	£47m	n/a	n/a
Recommendation	Approve	Reject	Reject	Reject	Reject

* Figures based on 09/10 Alliance costs and 45 year NPV calculation. This was the information available at the time of selecting the most appropriate option.

Option 1, the City Centre Schemes, is the preferred option which has been taken into delivery. This is discussed in more detail in Section 4.

The rationale in selecting Option 1 is due to the fact that out of all the options considered, it contributes most towards the primary driver of decommissioning the highest risk process safety mains in city centre. These mains are in close proximity to nationally important buildings, high profile and densely populated areas. An additional benefit with Option 1 is it mainly utilises insertion techniques to replace mains which minimises disruption to customers and provides delivery at a cheaper unit cost.

Whilst Option 2, the Square Mile Schemes, goes some way to contribute towards the city centre process safety risk, it's a significantly smaller scheme and system pressures cannot be raised which constrains any future works in the central London medium pressure network.

To overcome this constraint results in a requirement size for size open cut replacement which is hugely disruptive to customers in highly sensitive areas. Note that some of the mains identified within Option 2 also form part of Option 1 although are delivered during RIIO-GD2.

Although Option 3, Outside the City schemes, also contributes towards risk removed, these mains are located in the suburbs in less densely populated areas and are not as high a process safety risk. This option therefore do not satisfy the primary driver of decommissioning the highest risk process safety mains in city centre and as a result, this option was not taken any further forward.

Option 4 Defer Replacement and Option 5 Do Nothing were both discounted. Further detail on Option 2 through to Option 5 is contained within in Appendix A.

3.1.5. Summary

NGGD recognises the shortfall between the 69km agreed at Final Proposals and the 48km being delivered over two price control periods and the need to ensure iron mains risk removed is delivered for the London network. Delivery of this shortfall will be reviewed and optimised in conjunction with plans for the remainder of the Tier 2 & Tier 3 mains across the North London network. Furthermore, as new technologies come online we will reassess the cost benefit case for replacing the mains which are out of scope of the original 98km London strategy proposals. Where beneficial to our customers we will build this into our replacement programme moving forward. Our current strategy, cognisant of the engineering constraints and stakeholder requirements is to address the 48km of mains over two price controls to remove the highest process safety risk mains which benefits our customers and unlocks opportunities to fulfil our regulatory commitments.

4. The Proposed Option – City Centre Schemes

The following section outlines the City Centre Schemes, the scope of projects included over RIIO-GD1 and RIIO-GD2 and a comparison of the outputs delivered against the Final Proposals. Justification on why these projects are being delivered over two price control periods is given. Finally a summary of the detailed stakeholder engagement to facilitate project delivery is given.

4.1.1. City Centre Schemes

The scheme currently being delivered focuses on decommissioning the pipes at the centre of the city over two regulatory periods. By doing so, this decommissions the mains that pose a highest process safety risk to the public and buildings in close proximity. The table summarises the projects within the overall City Centre Schemes and the figure depicts the schematic medium pressure network layout.

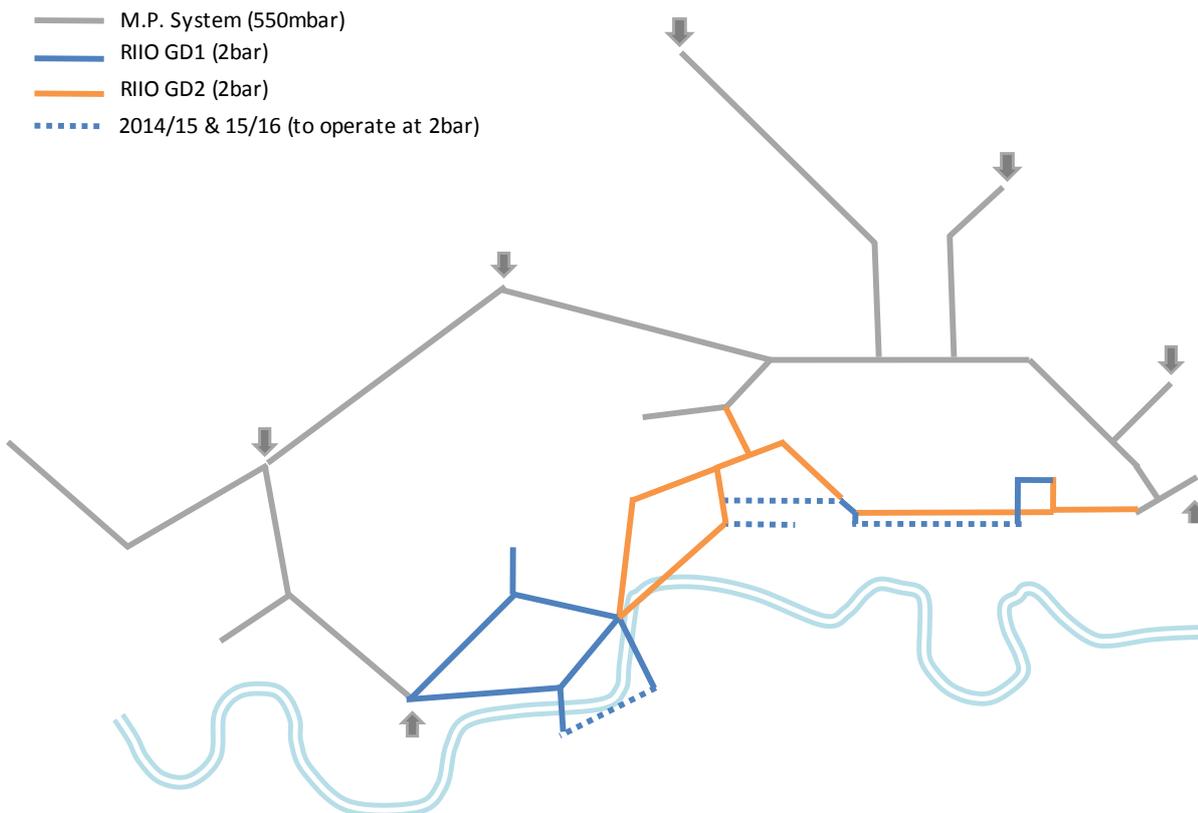


Figure 5 – Option 1 City Centre Schemes GD-1 & GD-2 Scope

Table 3 – Projects within City Centre Schemes

GD1	Length (km)	GD2	Length (km)
Aldgate / City of London	3.1	Embankment	2.7
Commercial Road	2.2	Bow Common to Aldgate	3.8
Queen Victoria Street	1.6	City 1	2.8
Battersea	2.8	City 2	2.6
Fulham / Hyde Park / Westminster	18.3	Leamouth to Bow Common	4.2
-	-	Westminster Abbey to Farringdon	3.9
Total	c.28km	Total	c.20km

4.1.2. Outputs

The RIIO-GD1 output commitments related to replacement of distribution mains and services primarily focused on safety related outputs. The relevant primary safety output commitments are:

- A set level of risk reduction for each network associated with mains that qualify under the 3 Tier iron mains replacement programme (i.e. mains within 30 metres of a property)
- A set length of mains replaced by material and criticality as defined by the Network Output Measure methodology at the beginning of RIIO-GD1 (April 2013).

Secondary safety outputs are:

- Length of iron mains off risk that qualify under the 3 Tier iron mains replacement programme
- Number of non-PE services replaced (examples of services connected to the T3 MP network in London include

NGGD has been given a TOTEX allowance to deliver the outputs, except for Tier 2 mains that are above threshold, which attract additional revenues on a per metre rate basis. Our reported km figures of Tier 2 mains above risk threshold will be used to determine the level of revenue for each distribution network.

For the LMPSS project specifically, the outputs across RIIO-GD1 and RIIO-GD2 are summarised as follows:

Table 4 – London Medium Pressure Strategy City Centre Schemes - Outputs

Output or Incentive	London MP Strategy Total	London MP Strategy GD1	London MP Strategy GD2
Risk Reduced Incidents / annum $\times 10^{-6}$	16,912	10,021	6,891
Length Decommissioned	48km	28km	20km
Cost*	£86m	£50m	£36m
Total Benefit*	£166m	£96m	£70m
NPV**	£80m	£47m	£33m
Unit Rate	£1.8m / km		

* Figures based on 13/14 tRIIO Prices which were made available early 2014, following selection of the preferred option

** NPV based on 24 year calculation

The CBA model offsets the project cost against the benefits of reduced repair costs, reduced leakage costs and the cost avoidance of an incident resulting in damage to property or the fatality of a member of the public. The CBA methodology used to assess this project is consistent with Ofgem's guidance and meets the requirements of T/PM/REP/2 Management Procedure for Distribution Pipe Replacement.

4.1.3. Why over two periods?

To deliver the entire city centre strategy requires a longer time than the RIIO-GD1 period due to a number of significant factors:

- a) The city centre environment and congested road space gives no reasonable opportunity for the cost effective use of open cut techniques to replace large diameter mains. A consequence being insertion is the preferred solution for any replacement to reduce the number of instances excavation is required.
- b) With the significant amount of major infrastructure, utilities and general construction work in the city centre, any work in the highway is highly sensitive and often contentious therefore negotiation with Transport for London, the local boroughs and stakeholders is a protracted process with some road closures taking in excess of 12 months to negotiate.

- c) As mains are replaced with inserted pipes the operating pressures has to increase which requires that the work proceed in a carefully phased fashion because legacy Victorian pipes cannot be safely operated at increased pressures and new pipes have inadequate capacity at legacy pressure.

These detailed engineering, planning and along with stakeholder requirements leave us to a position where we cannot deliver all of the proposals within RIIO-GD1.

4.1.4. Flexibility between GD-1 and GD-2?

NGGD will be considering the phasing of projects to bring forwards work, from RIIO-GD2 into RIIO-GD1, if it is in the interests of stakeholders and to contribute towards the overall North London network outputs however it must be recognised this is not a straightforward exercise given the reasons given above and the Engineering Constraints described in Section 3.1.1 and Appendix B.

4.1.5. Detailed Stakeholder Engagement

From the start of RIIO-GD1 NGGD has been communicating with stakeholders to work with them to develop the City Centre Schemes. Briefings, meetings and coordination between various project stakeholders commenced in 2013 and have covered the need for the work and how it will be undertaken. Stakeholders have been advised of measures that are being taken to complete the work as quickly and efficiently as possible and with the minimum of inconvenience to customers.

As well as consulting with Transport for London and the local borough highway authorities, the works also need to be discussed with Emergency Services, Royal Parks, MP's, Councillors, Bus Companies, Resident's Associations and many local businesses. Building relationships with these stakeholders takes time and significant effort is required to ensure these relationships are maintained. NGGD has developed a stakeholder plan to capture the key stakeholders and updates this on a regular basis as the project moves through the delivery phases.

Coordination with other major projects in central London has also been undertaken including significant developments at Aldgate, Nine Elms / Battersea as well as major infrastructure projects Crossrail and Thames Tideway Tunnel to ensure there are no conflicts with proposed work. In several instances, NGGD's work has been rescheduled to accommodate these third parties. Examples include deferring mains replacement at London Wall by 14 months in the City of London due to Crossrail and bringing forward works on Chelsea Embankment almost 3 years to facilitate Thames Tideway.

Further detail on NGGD's detailed stakeholder approach is included in associated document *London Gas Mains Replacement Dec-15* by Copper Consultancy.

4.1.6. Is this still beneficial?

NGGD is firmly of the opinion that our programme delivers real and tangible benefits for customers. The primary driver is the city centre process safety risk which has already been discussed in Section 3.1.3. Our programme replaces most of the highest process safety risk Victorian metallic mains in London. It is being delivered over two price controls, however this was always the plan given the constraints of working in that area.

Furthermore, in having a robust 2 bar medium pressure network, leakage is reduced which results in positive carbon and environmental impacts as well as a reduction in OPEX costs which ultimately benefits customers in the long term.

The other factor in having a robust city centre 2 bar medium pressure network is it provides maximum flexibility for future growth in London.

The positive cost benefit ratio for the RIIO-GD1 schemes also indicates the project provides value for money despite the mains being located in some of the most congested and high profile areas of central London.

Areas slightly further out from the city centre, which were cost justified in the CBA analysis we undertook, will not be worked on as part of the integrated strategy described here, however this does not mean that they do not form part of our wider asset management plans, which seek a balance between the various risks posed by different asset classes. Section 6 provides further explanation.

5. RIIO-GD1 Delivery

Works within the centre of London have been ongoing now for over 18 months. Significant progress has been made and the following section outlines the delivery programme and work that has been completed.

5.1.1. Delivery Programme and Completed Works

Replacement works commenced in 2014 in the City of London, initially around the Coleman Street and Aldgate areas which is now largely complete. Work has also been completed in the Blackfriars, Battersea and Vauxhall areas. Figure 6 indicates the areas of completed and future mains replacement work over the remainder of the RIIO-GD1 period. The table summarises the progress to date (Nov-15) and the forecast for the remainder of RIIO-GD1.

Table 5 - Delivery Programme over RIIO-GD1

Activity	Progress (km)	Total (km)	Remaining (km)	Forecast (km)					
				15/16	16/17	17/18	18/19	19/20	20/21
Aldgate / City of London	1.9	3.1	1.2	0.4	0.4	0.4	-	-	-
Commercial Road	0	2.2	2.2	-	1.2	1.0	-	-	-
Queen Victoria Street	1.6	1.6	0	-	-	-	-	-	-
Battersea	1.9	2.8	0.9	-	0.5	-	-	0.4	-
Fulham / Hyde Park / Westminster	0	18.3	18.3	-	2.6	3.7	4.0	4.0	4.0
Total	5.4	28	22.6	0.4	4.7	5.1	4.0	4.4	4.0

Significant works will be commencing in February 2016, to replace strategic gas mains in Chelsea and Fulham on the King's Road between Stanley Bridge and Gunter Grove. This is a busy area, close to Stamford Bridge, the ground of Chelsea Football Club. The management of traffic in this area is extremely sensitive as the main roads are not just through routes but also are major shopping hot-spots, and are close to residential areas where noise and disruption e.g. blocking parking bays must be minimised. The scope of work lies within the Royal Borough of Kensington and Chelsea and London Borough of Hammersmith and Fulham.

Following this, the intention is to work towards Hyde Park during 2017 and 2018. This is subject to agreement with the highway authorities therefore dialogue has already commenced. In 2018 and through to the end of RII0-GD1 will see the works pass through Knightsbridge towards Westminster, back down towards the River Thames and also along the Embankment from Fulham towards Battersea.

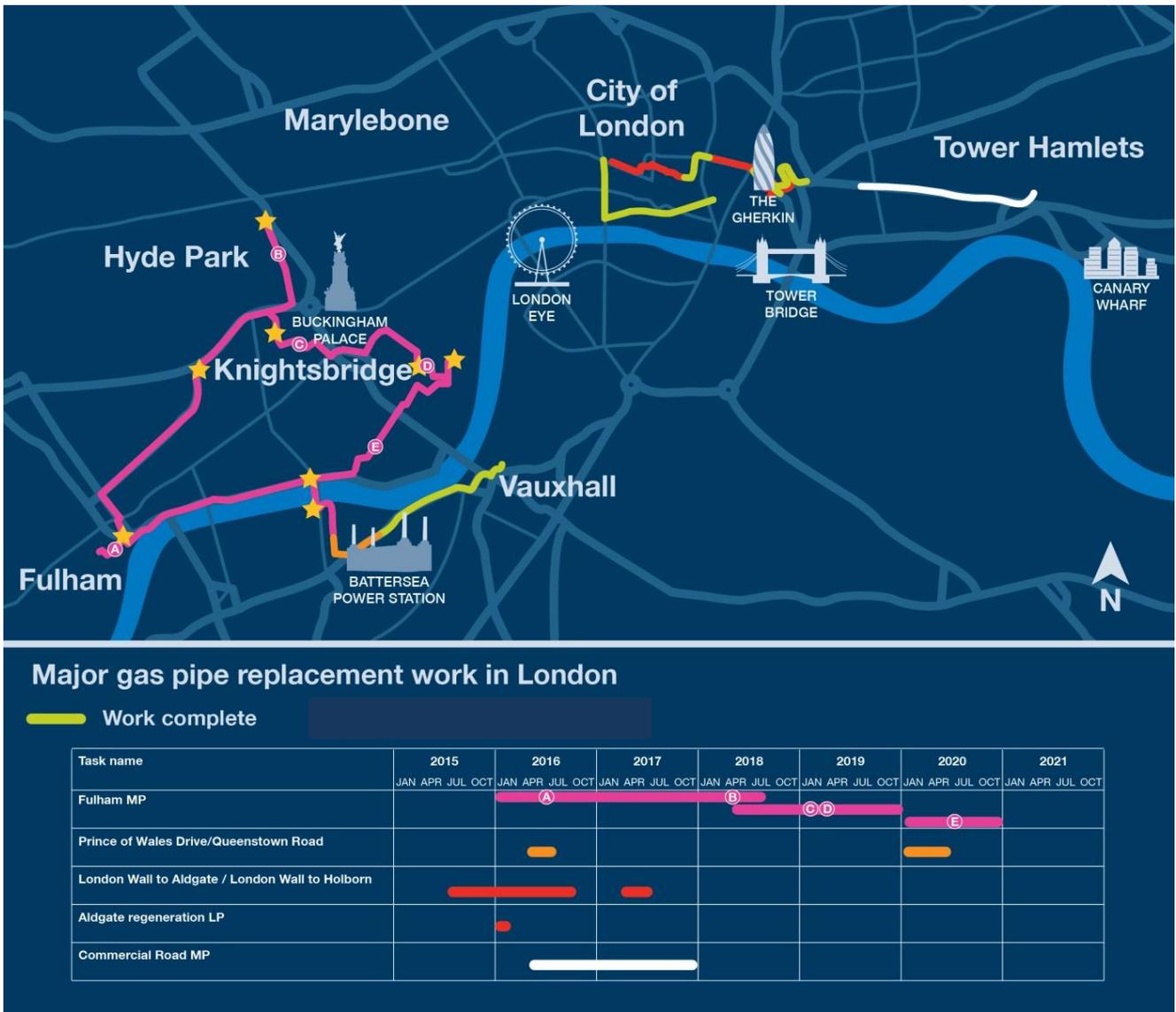


Figure 6 - LMPSS GD1 Scope and Remaining Programme of Work

The project remains on track despite a number of stakeholder and engineering obstacles to overcome. Agreeing road space and interfacing with third parties, including customers continue to challenge the delivery team and project schedule.

6. Look at Output Delivery and Options

Our aim is to deliver all our RIIO-GD1 output commitments across the 8 years including those that relate to Network Output Measures, such as the medium pressure mains in London.

Following Final Proposals we have looked at how we can deliver the best outcome for customers across both RIIO-GD1 and for RIIO-GD2.

In reaching our decision for the London medium pressure strategy city centre schemes, we had taken account of the mechanisms that had been included within Final Proposals, namely the End of Period Review, which would take into account trade-offs in NOMs between or within asset classes, which would lead to an equivalent level of risk removal.

A key element of assessing trade-offs is the analysis derived from the NOM Methodology to determine the comparable monetised risk across asset families, i.e. how we would demonstrate an equivalent level of risk removal. Our plan has assumed a trade-off with other CBA justified mains and a key element will be the assessment of monetised risk, which will either enable us to confirm that either;

- alternative CBA mains will deliver an equivalent level of risk removal;
- a need to explore alternative trade-offs; or
- Use the end of period review mechanism to carry-over an output.

Once our data gathering is completed during Q1 2016, we will then be in a position to develop our plan to deliver our equivalent NOM outputs for the 4 remaining years of RIIO-GD1, which may result in a change in approach once we have more information on equivalent risk removal calculations. This may include a justified under delivery given the needs case to complete the remainder of the medium pressure scheme in London during RIIO-GD2, or the delivery plans for additional km of medium pressure mains for the city centre schemes in RIIO-GD1.

Given our commitment to deliver the primary iron mains risk output and our Network Output Measures, our forecasts, as submitted in the 14/15 RRP in July 2015, include the full delivery of T2/T3 km across the distribution mains asset class.

Given this position, NGGD considers that exploring the available options is in the interest of customers. Within this process any output deferral would be assessed with any potential over or under delivery across all asset classes. As such, it does not merit inclusion in any Mid Period Review.

7. Other MP Workload in NW & EoE

Finally, in response to OFGEM's question (b), NGGD had proposed specific lengths for Tier 3 Medium Pressure investments in the North West (2.3km) and the East of England (0.5km) in the original plan however in the RIIO-GD1 Final Proposals there was no split between MP and LP for Tier 2 and Tier 3 mains.

In this case all iron mains replacement has been treated the same regardless of pressure. As a result in the North West and the East of England the normal business processes for Tier 2 and Tier 3 investments have been applied and these mains will be delivered during RIIO-GD1.

Appendices

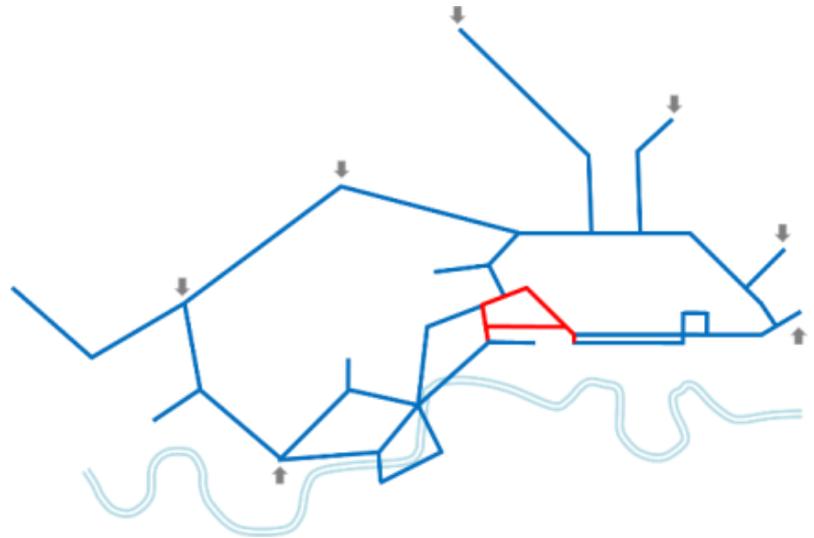
Appendix A – Further Detail on Options 2 to 5

Appendix B – Engineering Constraints

Appendix A - Options

Option 2

With a smaller strategy scope, this open cut option for replacement focuses on mains at the very core of the city centre, around the City of London area. Option 2 is intended to decommission the pipes presenting the highest process safety risk due to their proximity to nationally important buildings. In doing so, this option is intended to partially meet the primary risk driver whilst allowing for a greater amount on non-mandatory work to be carried out elsewhere across the London network. Whilst the scope of works is relatively small, system pressure cannot be raised, resulting in a size for size replacement that would be highly expensive (in terms of unit rates), hugely disruptive and complex to construct.



Abandonment	Risk removed points	Cost	Benefit	NPV	Cost / Benefit Ratio
13.3km	4,229	£39.8m	£159.3m	£119.5m	3.9

* Figures based on 45 years NPV and Alliance 09/10 costs

Key Points

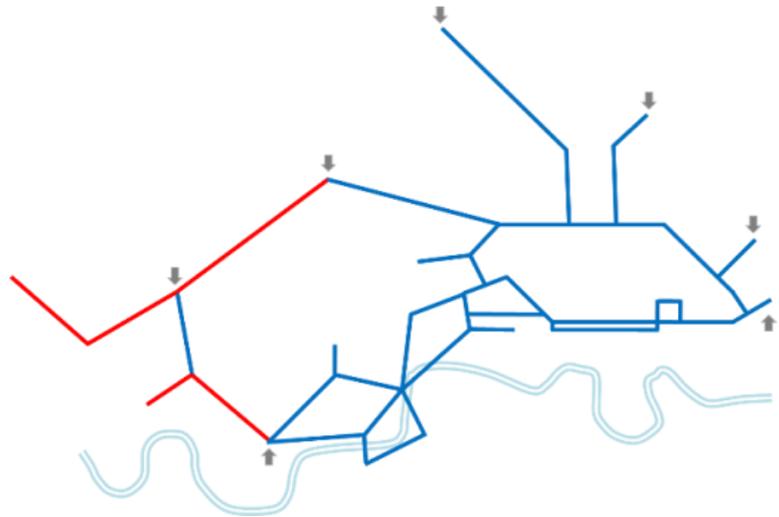
- Only two projects – minimal insertion
- Highest NPV benefit ratio but lowest risk removed
- Maintains ‘current’ network connectivity and operational flexibility
- Future GD2 city centre projects increasingly uneconomic
- High delivery risk
- Difficult to sell to stakeholders

Option 3 Outside City Centre

The proposed option would replace mains that did not pose as high a process safety risk as those in the centre of the city (Option 1).

If this option were selected, a reactive, open cut strategy to remediation and replacement would have to be adopted for the mains in the city centre. This approach would prove to be complex

and have an adverse effect on the cost of any future remediation. This would also have a significantly higher impact on those affected by any works. Whilst simpler and cheaper to construct than option 1, this scheme has been discounted since it avoids the pipes in the centre of the city posing a higher process safety risk. This approach is not consistent with the expectations that have been set with OFGEM and HSE. Selecting this option would likely undermine any future request for funding for a city centre replacement strategy.



Abandonment	Risk removed points	Cost	Benefit	NPV	Cost / Benefit Ratio
37.7km	16,268	£44.3m	£91.1m	£46.8m	3.9

* Figures based on 45 years NPV and Alliance 09/10 costs

Key Points

- Only four projects – mostly insertion
- Maintains current network connectivity and operational flexibility
- Lower delivery risk
- Most cost effective at removing risk
- Use of standard pipe
- Unlikely to deliver city centre projects in GD2
- Future outside city centre GD2 projects increasingly uneconomic

Option 4 Defer

This option involves a reactive strategy to the remediation and replacement of mains assets whilst awaiting an innovative solution to the risk management and remediation of the high risk assets.

Possible options could include;

Increasing leakage surveys or monitoring for those areas which are at a high risk but not currently required to do so under NGUK/PR/EM/72 - National Grid Gas Operational procedures for dealing with gas escapes and emergencies.

Replacing existing internal mechanical seals similar to Weko seals, however the life expectancy is significantly less than for a PE replacement pipe and consequently it is expected that further seal or mains replacement will be required sometime in the future.

The use of new technology to internally monitor performance of mains to detect failure could reduce risk. However the technology does not prevent failure and only mitigates risk by providing an early warning. Furthermore the equipment is not yet fully developed and has not yet been tested in London. This is a short-term piecemeal solution which does not lend itself to collaborative working and ultimately will not deliver schemes in an efficient and effective way.

Key Points

- Systematic repair programme expensive when compared with insertion options
- Enhanced maintenance or monitoring is a reactive strategy, which mitigates the effects of leakage, but does not remove the prime risk associated with fractures of MP mains
- Risks future funding?
- Difficult to sell to stakeholders

Option 5 Do Nothing

Doing nothing was discounted.

Appendix B – Engineering Constraints

In addition to the significant challenges which would be expected undertaking complex works in a major city centre, there are some specific engineering challenges that are also unique to London and this project which need to be considered including:

- Capacity:** The existing capacity of the MP network is not sufficient to allow the sustained use of insertion techniques and will require pressures to be elevated in order to reduce pipe sizes.
- Operating Windows** Although there is some capacity in the network to flex schemes the high demand during the winter significantly restricts the operating windows needed for insertion techniques and therefore much of the network can only be replaced during the summer in order to maintain network resilience. The speed at which mains can be replaced is also governed by the available windows and how much main can safely be physically inserted during this window.
- Reinforcement** To enable the successful replacement of all the MP mains in the ‘Square Mile’ and the replacement of the Grosvenor Railway Bridge & Vauxhall Bridge MP crossings (see below) it is necessary to provide a new crossing of the River Thames and the construction of a new network source at Battersea.
- Pressure Reduction Installations** Many of the installations (RMG Donkin 678 series regulators) which supply gas to the downstream Low Pressure network are only capable of operating at a maximum inlet pressure of approx. 1 bar and will need to be replaced prior to any pressure elevation.
- Materials** To maintain capacity and to reduce costs and disruption new materials had to be sort and approved, together with the processes, tools and training, specifically 800mm MDPE and 630mm HDPE.
- Existing bridge crossings** The North London network also provides gas to approximately 18,000 customers south of the river, between Battersea and Lambeth, the following MP bridge crossings which supplies to these customers cannot be pressure elevated and will need to be replaced and abandoned.

Grovesnor Railway Bridge - Is located adjacent to Battersea Park and the former power station. Originally constructed in 1859 the whole bridge was replaced piecemeal between 1963 & 67. The bridge currently supports a 36" LP and a 36" MP main which currently run alongside the railway tracks. Due to access restrictions by Network Rail the use of this crossing is not considered a practical and enduring solution and any replacement will require a new below ground river crossing

Vauxhall Bridge – Located downstream from Grosvenor Railway Bridge this bridge carries the A202 across the Thames, between the M16 building and Milbank. Originally built between 1809 and 1816, the bridge currently supports two 18" MP mains.

**Southern Gas
Networks**

We have spoken with SGN to examine the possibility to obtain capacity from them to supply customers south of the river, and also whether they wished to take capacity from us, and make a contribution to our building capacity on their behalf.

Neither option was considered cost effective or practical, and an extract from the correspondence is shown below. However a meeting with SGN was subsequently arrange to share ideas and to discuss a number of other planning matters including the Nine Elms, Battersea development and associated Northern Line extension (both of which straddle the two networks).

"The nearest IP connection point is 3km away off the 24" ST IP main at Kennington. The existing IP network in this area has no spare capacity."

"Based on 200,000scmh with 3.5bar min inlet pressure at NG's new PRS, an IP supply would need to be either 30" ST at 6bar or 36" ST at 4bar to maintain velocities <20m/s. Any route would suffer the usual complications, pinch points and difficulties of working in central London. Even if the 36" IP feeder could be laid there would be significant reinforcement required upstream, both in terms of mains lay and PRS rebuilds. We have not yet established the full extent of this reinforcement."

Subways

In total National Grid have approximately 5.2km MP mains, within the London Pipe Subways. Constructed in The City of London and Westminster between 1865 and 1880 at the same time as the underground railway and sewage network, they were built to house gas and water pipes, and telegraph cables. Although these mains are in good condition and are not subject to the same stresses as those outside the pipe subways they are not capable of operating at pressures above the current MOP and will therefore need to be replaced prior to any future pressure elevation.

Getting access to these mains particularly challenging because access is through small manholes, and the vaulted brick roof cannot be penetrated without significant civils work. In addition our mains are at the bottom of the subways with more recently installed power cables and fibreoptic telecoms cables, We are working to create new technology / new materials that we can use to replace these mains.