Your Gas Network

Appendix 09.15

Holford Salt Cavity E&I

RIIO-2 Spend: XXXX

Cadent
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Investment Decision Pack Overview

This Major Project Engineering Justification Framework outlines the scope, costs, and benefits of our proposals for Holford Salt Cavity storage system. As this project will cost in excess of XXXX, it is highlighted as a separate scheme in BPDT 3.01 and we have prepared a Cost Benefit Analysis.

Overview

Holford Salt Cavity is located in Cheshire. It is leased from Inovyn and operated as part of Cadent's North West (NW) Network. The cavity has a total capacity of 2.5 mscm and, due to the quantity of natural gas that is held, the facility is an upper tier site under the Control of Major Accident Hazard (COMAH) Regulations.

NW Network has relatively low storage capacity; therefore, Holford makes a considerable contribution to the network's resilience. It is used for diurnal smoothing, and plays a key role in meeting peak day demands and within-day peaks on NW Network.

We have performed network modelling to examine scenarios such as local demand increases or a high short-term peak demand, both with and without Holford being available. This showed that, if Holford were not available, widespread loss of supply is a credible threat. This demonstrated the need to have storage available to maintain a safe and reliable supply in NW Network.

The Holford facility has been operational since 1985. A 2019 study showed that, due to wear or obsolescence of certain parts, the control system requires investment is required to continue operation.

The following options to provide the necessary resilience were considered:

Baseline: Retain Holford indefinitely and make reactive repairs as necessary.

Option 1: Retain Holford indefinitely, making proactive equipment replacements in RIIO-2.

Option 2: Retain Holford only to the end of the current agreement with Inovyn in 2023 and then decommission, replacing with greater use of NTS flex.

Option 3: Replace Holford with new storage and pipeline links elsewhere in NW Network.

Option 4: Replace Holford by making greater use of linepack.

The baseline option is not tenable because many E&I parts are no longer available. Thus, the baseline would, in effect, mean giving up Holford storage without replacement. Since we have established that Holford will continue to be needed to provide resilience, this option was dismissed.

We dismissed Option 2 having found that its RIIO-2 Totex and ongoing Opex would both be higher than for Option 1 whilst reducing resilience

Option 3 was dismissed on the grounds of capital cost, safety issues and lead-time to identify and obtain permissions for a new high-pressure storage facility.

Option 4 was dismissed as not being a practical solution for NW Network, where the overall maximum operating pressure is limited to 32 barg.

We have therefore selected proactive maintenance of Holford to enable its long-term retention (Option 1) as the preferred option.

Summary of preferred option	£m
RIIO-2 Total Expenditure	XXXX
Project NPV (switching analysis)	XXXX

Material Changes Since October Submission

The document cost base has been uplifted to 18/19 post efficiency.

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2. Summary Table

All costs in this table and elsewhere in this Appendix are to a 2018/19 price base and include RIIO-2 efficiency savings for Capex.

Name of Project	**Holford Salt Cavity E&I**		
Scheme Reference	Cadent reference Line 155, Holford Salt Cavity E&I		
Primary Investment Driver	Process safety in support of security of supply		
Project Initiation Year	2019		
Project Close Out Year	2022		
Total Installed Cost Estimate (£m)	[redacted] Redacted due to commercial sensitivity		
Cost Estimate Accuracy (%)			
Project Spend to date (£)			
Current Project Stage Gate	Not applicable		
Reporting Table Ref	3.01 LTS, Storage and Entry/Storage (non-LTS)		
Outputs included in RIIO-1 Business Plan	No		
Spend apportionment	**RIIO-1**	**RIIO-2**	**RIIO-3**
	XXXX	XXXX	

Table 1: Summary table for Holford Salt Cavity E&I

(2018/19 price base with RIIO-2 Capex efficiency)

3. Project Status and Request Summary

A feasibility study to consider options for work required at the Holford Salt Cavity (SC) storage facility and the associated Warburton II Above Ground Installation (AGI) was completed in March 2019.

Conceptual design work began in October 2019. It is expected that all design preparations will be completed during RIIO-1.

This proposal is for RIIO-2 funding of the main works required to prepare Holford for continued use in the North West network.

Because of the breadth of equipment types involved in the proposed work, not all of which are covered by Network Asset Risk Metrics (NARMs), the work will be funded as a Price Control Deliverable (PCD) rather than through NARMs.

4. Problem Statement

Holford SC storage is located near Northwich, Cheshire (Figure 1) and operated as part of Cadent's North West (NW) Network. The facility is operated from the Distribution Network Control Centre (DNCC) and linked to Cadent's network by a 17 km high-pressure pipeline from/to the Warburton II AGI.

Holford has a total capacity of 2.5 mscm, of which approximately 1.7 mscm per day is deliverable. Due to the quantity of natural gas that is held, the facility is an upper tier site under the Control of Major Accident Hazard (COMAH) Regulations. Cadent is responsible for all operator's duties under COMAH Regulations (2015).

The cavity itself is owned and maintained by Inovyn, and leased by Cadent. The current 5-year contract with Inovyn commenced in 2018.

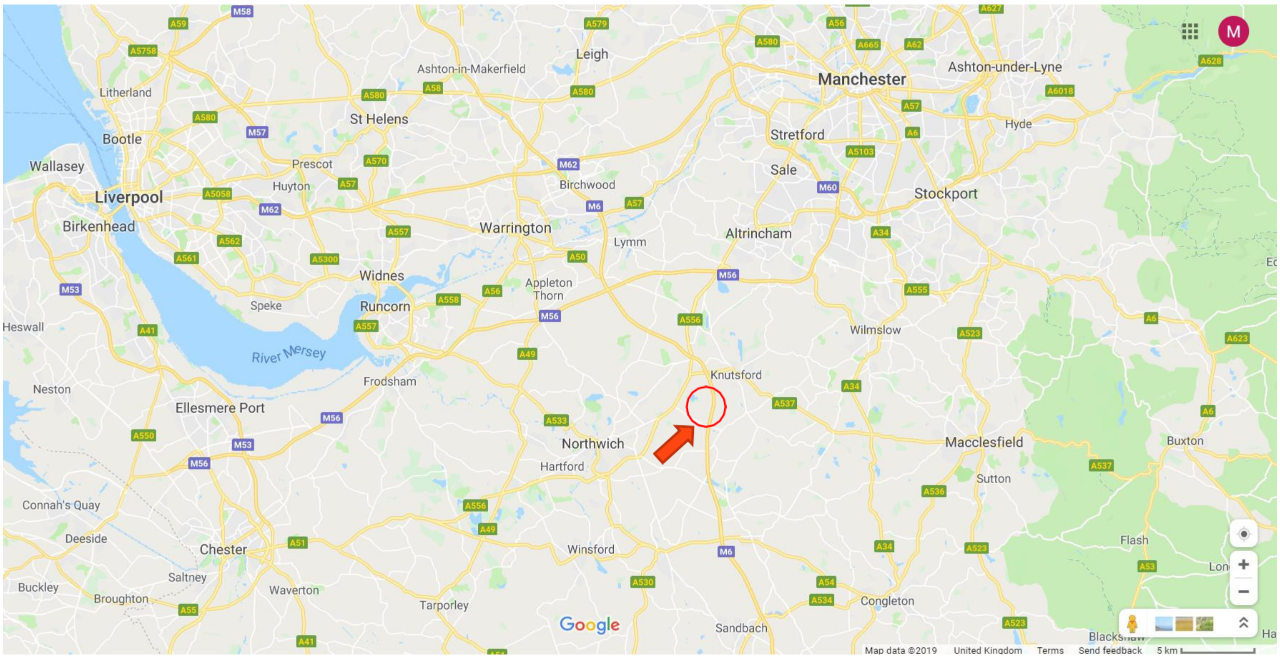


Figure 1: Approximate location of Holford Salt Cavity

In addition to being used for diurnal smoothing, Holford plays a key role in meeting peak demands — both for peak day demands and within-day peaks — on NW Network.

Table 2 gives our forecast of peak day demands[1] for NW Network (see also Figure 2 in Section 5.1). This shows that, regardless of general trends towards lower overall gas consumption, the peak day demand is expected to have a flat to slightly-increasing trend over RIIO-2 and beyond.

	2019	2020	2021	2022	2023	2024	2025
Peak Demand (mscm/d)	43.19	43.63	43.76	43.68	43.85	43.96	43.89
	2026	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Peak Demand (mscm/d)	43.91	43.72	43.83	43.88	43.82	43.73	43.88

Table 2: Forecast peak day demands for NW Network

[1] For comparison, NW Network's total demand on 1 March 2018 (maximum demand during the 'Beast from the East') was 43.13 mscm.

In addition, we forecast a 2.4% annual growth in peak 6-minute demand for NW Network over the next 10 years, based on expected new demand from housing and power generation. This will increase the peak 6-minute demand from 2.98 mscm to 3.72 mscm.

Table 3 shows that NW Network has relatively low storage capacity, compared with other Cadent networks. With Holford operating, the network has 7.7% of peak day demand available from stock and storage. This falls below 4% without Holford, which is less than half the peak day coverage available to any other Cadent network.

	Peak Daily Demand (mscm)	Stock and Storage (mscm)	Stock and Storage (% peak demand)
East Anglia	30.0	2.5	8.2
East Midlands	38.0	4.2	11.1
North London	36.9	3.7	10.0
North West (without Holford)	43.2	1.6	3.7
North West (with Holford)	43.2	3.3	7.7
West Midlands	33.3	3.2	9.6

Table 3: Cadent networks' storage capacities and peak day demands for 2019

Considering within-day peaks, we have performed network modelling to look at the impacts of scenarios such as a change in local weather and hence demand, or an unusually-high peak demand on a higher-demand day, both with and without Holford being available. The modelling took account of NTS offtake rules and showed that:

- If Holford (or equivalent storage) is not available there is potential for widespread inability to maintain minimum governor inlet pressures, leading to downstream loss of supply. Thus, without Holford, widespread loss of supply is a credible threat in certain circumstances — in other words, relatively low likelihood, high consequence events would be plausible.
- If Holford is available, then these consequences can be avoided.

Without Holford or other equivalent storage, NW Network would have to make greater use of National Transmission System (NTS) flexibility through the Offtake Profile Notice (OPN) process. Cadent trialled this approach during the winter of 2017/18 and found the following consequences:

- **Delays to balancing:** Compliance with the Uniform Network Code (UNC) implies a delay of 1 to 2 hours before gas can be taken in these circumstances.
    - This leads to the network being out of balance more, for longer, with potential impact on available linepack at peak times and increased likelihood of reliability failures.
- **Operational challenges and workload for DNCC:** The locations of NW Network's NTS offtakes mean that much of the extra balancing flow must be taken from offtakes in the northerly parts of the network (Samlesbury and Blackrod) — which already have high flows at peak times — and transferred to southern parts that can currently be balanced by Holford. These transfer flows give additional operational challenges for the DNCC because of network 'pinch points' that operate close to maximum flows even when Holford is online.

Investment drivers

We want to maintain a safe and reliable supply to our NW Network, where Holford SC currently provides a considerable element of the network's resilience.

This facility has been operational since 1985. Initial studies carried out for Cadent in 2019 showed that, due to wear and/or obsolescence of certain parts, the control system is no longer fit for purpose; investment will be required if Holford and its associated installations at Warburton II are to continue in operation for Cadent.

Given that the need for storage to cover diurnal and peak smoothing has been established, investment is therefore now necessary to ensure the continued safe and efficient operability of NW Network, either by Capex at Holford SC or by other investment to provide equivalent alternative storage.

Project challenges and complexities

At this stage of project development, there are no exceptional challenges foreseen in delivering the proposed work.

Key milestone dates

This project is at an early stage of development.

A feasibility study for works at Holford and Warburton was prepared in 2019. Within RIIO-1, conceptual design for this option is expected to be complete by the end of 2019 and the detailed design no later than the first quarter of 2021.

Understanding project success

Successful completion of this project will ensure a safe and reliable supply to the NW network — giving confidence that demand can be met when our customers need it most.

Assuming Holford is maintained, success will be a safe and reliable control system with all mechanical and E&I equipment associated with Holford SC operations (at both Holford and Warburton II) being in a fully functional and maintainable state to the satisfaction of HSE.

The alternative would be to make the cavity and its associated assets safe, and achieve reliability of supply by another means.

4.1. Related Projects

There are no current or projected related projects.

4.2. Project Boundaries

Project boundaries for the preferred option are:

- At Warburton II:
    - Volumetric control systems.
    - Fill and Empty systems instrumentation and telemetry.
    - Interlocks associated with the above two areas.
    - Non-fiscal metering system (marked in Appendix 1).
- At Holford:
    - Volumetric control systems.
    - Fill and Empty systems instrumentation and telemetry.
    - Interlocks associated with the above two areas.

5. Project Definition

5.1. Supply and Demand Scenario Discussion and Selection

The implicit base case scenario for this project is that the peak demand and diurnal variation will remain broadly the same over RIIO-2 as that observed in RIIO-1.

	ND Plan Year	Period	EA 1:20 Peak Day Forecast (mcm/d)	EM 1:20 Peak Day Forecast (mcm/d)	NL 1:20 Peak Day Forecast (mcm/d)	NW 1:20 Peak Day Forecast (mcm/d)	WM 1:20Peak Day Forecast (mcm/d)
RIIO GD1	2014 Plan	2013/2014	31.764	39.521	41.369	46.936	34.639
	2015 Plan	2014/2015	33.202	38.968	42.808	46.674	34.189
	2016 Plan	2015/2016	29.393	35.309	37.388	43.036	31.156
	2017 Plan	2016/2017	29.028	36.399	37.100	42.835	31.791
	2018 Plan	2017/2018	29.358	36.955	37.157	44.088	32.349
	2019 Plan	2018/2019	29.960	37.970	37.157	44.088	33.330
	2020 Plan	2019/2020	29.960	37.970	36.910	43.190	33.330
	2021 Plan	2020/2021	30.190	38.330	37.330	43.630	33.640
RIIO GD2	2022 Plan	2021/2022	30.240	38.680	37.480	43.760	33.740
	2023 Plan	2022/2023	30.390	38.640	37.460	43.680	33.710
	2024 Plan	2023/2024	30.420	38.660	37.520	43.850	33.810
	2025 Plan	2024/2025	30.490	38.700	37.740	43.960	33.860
	2026 Plan	2025/2026	30.450	38.560	37.680	43.890	33.790

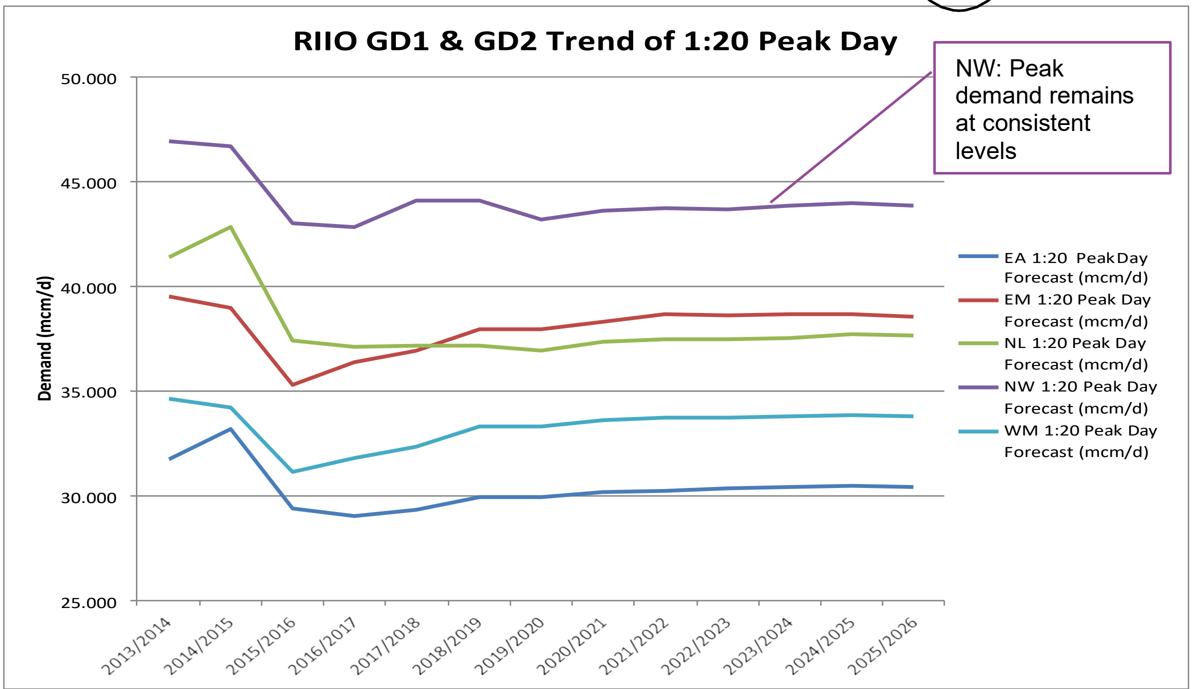


Figure 2: Plot showing peak demand forecasts over RIIO-1 & 2

However, once the case is made for retaining Holford in the NW Network (see Section 6.1), supply and demand scenarios do not affect the need for the requested work — this is driven by the obligation to maintain demonstrable process safety at this upper-tier COMAH site.

5.2. Project Scope Summary

Final detailed plans are expected to have the following scope. (See Appendix 1 for a Piping and Instrumentation Diagram (P&ID) of the Warburton II/Holford system.)

At Warburton II and Holford

- Regulator stream actuation and control:
  - Valves and actuators
  - Valve controls
- Interlocks
- Control, telemetry, and communications hardware and software

At Warburton II (only)

- Non-fiscal inlet metering (used solely to track movement of gas in Cadent's network)
- Slam shut actuation and control
- Field instrumentation and telemetry (pressure transmitters and switches)

At Holford (only)

- Wellhead Emergency Shut Down Valves (ESDVs) and actuators

Electrical systems

The capacity of electrical systems will be considered during final design.

Modifications may be required at Warburton II if electric or air valve actuation is selected.

Upgrading the electrical supply capacity may be required at Holford, especially if electric or air valve actuation is selected.

6. Options Considered

The following options have been considered:

- **Baseline**: Retain Holford storage without the proposed investment, making reactive repairs and replacements as necessary.
- **Option 1**: Retain Holford and proactively replace equipment identified in Section 5.2 to maintain asset health.
- **Option 2**: Retain Holford to the end of Cadent's current contract with Inovyn in October 2023 and then decommission the site, making minimal modifications to maintain process safety (PS) in the meantime.
- **Option 3**: Decommission Holford and replace with new storage facilities.
- **Option 4**: Decommission Holford and replace its storage capacity by making greater use of linepack.

6.1 Baseline: reactive repairs

Under this option, there would be no Capex at this point. Repairs would be made reactively as necessary to keep Holford SC in service.

This option is not tenable because Cadent is aware that there are obsolete and end-of-life components at Holford and Warburton II. Therefore, Cadent regards the reactive repair option as being incompatible with the general duty under Regulation 5 (1) of the COMAH Regulations (2015) for operators to *'take all measures necessary to prevent major accidents and to limit their consequences for human health and the environment'*. Thus, the baseline would, in effect, mean giving up Holford SC storage with the associated consequences for network resilience that are discussed in Section 4.

6.2 Option 1: proactive replacements

This option would make the necessary investment in RIIO-2 to maintain asset health and keep the facility available to Cadent for at least another 30 years.

6.3 Option 2: decommission in 2023

Under this option, Cadent would give up use of Holford in October 2023. Minimal Opex works would be done to maintain process safety.

This option is very unattractive because, as noted in Section 4, modelling has shown that operating without Holford or equivalent storage would expose the network to a credible threat of losing supply in plausible circumstances of high peak demands. As also discussed in Section 4, from an operations point of view not having this storage available to NW Network would leave the network with an overall level of storage that is abnormally low and not conducive to efficient operations.

Option 2 has been discounted because of the major detrimental impact on network resilience and overall network operability and flow-balancing — a reduction in customer service.

However, total Opex of the option over RIIO-2 was estimated for comparison with total cost (Capex + Opex) of the proactive replacements option (Section 6.6).

6.4 Option 3: replace with new storage facilities

The option of replacing Holford by building one or more new facilities, such as above-ground high-pressure storage (storage bullets) and associated high-pressure pipeline(s) was dismissed on the grounds of capital cost.

It would be significantly more expensive to develop a brand-new storage facility in a new location, than to maintain an existing site. The lead-time for such a facility, including identifying a site and obtaining permissions, also count against this option given NW Network's requirement for the resilience currently provided by Holford.

Decommissioning costs would also be incurred.

6.5 Option 4: replace Holford by increased use of linepack

We have considered whether the usable storage capacity provided by Holford could be replaced by making greater use of linepack in the high-pressure (HP) network.

Available linepack in the NW HP network is greatly restricted by the maximum operating pressure anywhere on the system being 32 barg. This limit is driven by sections of the HP network that are already at their maximum allowed design factor[2] of 0.3 at declared maximum operating pressure (MOP). These sections include:

- Blackrod to Shevington
- Blackrod to Warburton Tunnel
- Kingsway to Denton
- Stretford to Hawthorn Road
- Warburton Tunnel South to Partington or Warburton
- Windle to Kirkby

Replacing these sections with heavier-wall pipe to keep design factor below 0.3 at higher MOPs would be prohibitively expensive. (As a rule of thumb, an HP pipeline costs a minimum of around XXXX per metre to design, build and commission in greenfield conditions. Decommissioning costs would also be incurred.)

A programme of uprating without replacement, such as was used in the 1990s and early 2000s to allow parts of the NTS to operate at design factors above 0.72, would also be substantially more expensive than retaining Holford[3].

Therefore, the option to increase use of linepack was ruled out prior to CBA.

[2] Design factor = ratio of pipe hoop stress at MOP to specified minimum yield stress (SMYS) of the pipe steel
[3] Uprating is a well-established formal approach that is allowed under the IGEM/TD/1 standard. However, it is not clear that it could necessarily be used for pipelines that are limited to a design factor of 0.3 by their location in populated areas.

6.6. Options Cost Estimate Details

The options of retaining Holford without Capex investment before decommissioning in 2023, or retaining with proactive investment in asset health have both been costed and are included in the summary of Section 6.7.

Option 1: proactive replacements

Table 4 shows estimated Capex for equipment replacements necessary to maintain asset health for Holford beyond 2023.

Item	Cost (£m)	% of Total Installed Cost
Total Installed Cost		
Engineering Design		
Project Management		
Materials		
Main Works Contractor	Redacted due to commercial sensitivity	
Specialist Services		
Vendor Package Costs		
Direct Company Costs		
Indirect Company Costs		
Contingency		

Table 4: Capex cost estimate details for Option 1 — retain Holford with proactive replacements (2018/19 price base with RIIO-2 Capex efficiency)

In addition, total Opex over RIIO-2 for this option would be XXXX, made up of:

- Lease payments to Inovyn (set at XXXX per year at contract renewal in 2018/19) XXXX
- Annual Run-the-Business (RTB) costs[4] of XXXX (estimated in 2018/19 prices)

There would also be ongoing post-RIIO-2 Opex of XXXX per year for these items.

This proactive approach keeps the benefits noted in Section 4 and avoids the consequences of expanding the use of NTS flex for system balancing, while complying with Cadent's obligations under COMAH Regulations (2015) to prevent major accidents, and Pressure Systems Regulations (1996) to maintain a safe and secure system.

Option 2: decommission in 2023

There would be no Capex for this option but Opex would be necessary to assure process safety up to 2023 and to provide additional NTS exit capacity following decommissioning of Holford. Estimated Opex over RIIO-2 under this option would be XXXX (2018/19 price base), made up as follows:

[4] Planned inspection (including HSE re-charges) and maintenance, and general day-to-day engineering.

- Lease payments to Inovyn (set at XXXX per year at contract renewal in 2018/19) XXXX
- PS-related modifications XXXX (estimated in 2018/19 prices)
- Decommissioning XXXX (estimated in 2018/19 prices)
- RTB costs for the period 2021 – 23 XXXX (estimated in 2018/19 prices)
- Additional NTS exit capacity to replace the peak-smoothing supply currently provided from Holford: XXXX per year over 2024 – 2026, giving a total of XXXX in RIIO-2 (estimated in 2018/19 prices)

There would be ongoing post-RIIO-2 Opex of XXXX per year (estimated in 2018/19 prices) for additional exit capacity.

This option has been discounted due to the major detrimental impact on network resilience and overall network operability and flow-balancing — a reduction in customer service.

6.7. Options Summary

We have considered the following options for maintaining Holford Salt Cavity in RIIO-2.

Option Title	Baseline: Reactive Repairs	Option 1: Proactive Replacements	Option 2: Decommission in 2023	Option 3: replace with new storage facilities	Option 4: replace Holford by increased use of linepack
Start Date	Option discounted. Cadent is aware of deficiencies with assets. A reactive repair is therefore considered incompatible with the general duty under Regulation 5 (1) of the COMAH Regulations (2015) for operators to *'take all measures necessary to prevent major accidents and to limit their consequences for human health and the environment'*.	2019	N/A	This option has been discounted because of the high Capex required to develop a new site.	This option has been discounted. Option would require pipelines to be replaced to handle higher pipeline pressures while maintaining the required design factor. This has been dismissed because of the high Capex required.
Commissioning Date		2022	N/A		
Design Life (yrs)		30 10 (E&I)	N/A		
Total Installed Cost (£m)					
Cost Estimate Accuracy		Redacted due to commercial sensitivity			
RIIO-2 Opex (£m)					
RIIO-2 Totex (£m)					
Estimated post-RIIO-2 annual Opex (£m)					
Valid option for RIIO-2 and why		The only technically-viable option for RIIO-2.	This option has been discounted due to the major detrimental impact on network resilience and overall network operability and flow-balancing — a reduction in customer service		

Table 5: Summary of option costs (2018/19 price base with RIIO-2 Capex efficiency)

7. Business Case Outline and Discussion

Many of the options considered for Holford have been discounted because of their excessive required Capex or their impacts on levels of network resilience.

The baseline option to reactively repair assets upon failure is not tenable because Cadent is aware that there are obsolete and end-of-life components at Holford and Warburton II. Therefore, Cadent regards the reactive repair option as being incompatible with the general duty under Regulation 5 (1) of the COMAH Regulations (2015) for operators to *'take all measures necessary to prevent major accidents and to limit their consequences for human health and the environment'*. Thus, the baseline would effectively mean giving up Holford SC storage with the associated consequences for network resilience that are discussed in Section 4.

However, we have carried out CBA for illustrative purposes, to show that even without this legal mandate the proactive replacement option is the optimum solution.

Appendix 2 sets out the CBA approach, basis of calculations and detailed results for this investment case. We have used a 'Switching Analysis' approach for this project. Where it is not possible or proportionate to undertake a full CBA, this approach enables us to use CBA to identify whether an option would be cost-beneficial under reasonable risk scenarios of the likelihood and consequences of failure.

Modelling of baseline option

In this investment case we have approached the modelling of this baseline option differently.

Our approach is to define the baseline as the option where we do not invest proactively in our assets but we do inspect and maintain assets in line with our obligations, and repair under a fix-on-fail strategy. This is the absolute minimum investment we can make in our assets. Other options are then considered which represent increments of investment above the baseline.

However, for areas of investment such as this one, the forecast baseline cannot be assessed because of its highly uncertain nature. In these circumstances, the baseline cost is set at zero and in the options the changes in costs are considered — that is, we include the costs of reacting to a failure as avoided costs in each option, rather than as absolute levels of anticipated costs in the baseline. This enables us to test the results for their sensitivity to the level of avoided costs. In this specific investment case, we have looked at the probability of a fatality, supply interruptions and a reactive failure occurring, to result in the proactive approach being the most cost-beneficial.

From a pure CBA point of view the two approaches are equivalent — as CBA is all about comparing differences between options.

7.1. Key Business Case Drivers Description

As discussed in Appendix 2 we have used a switching analysis to look at the level of risk that would need to be avoided to make the preferred intervention option (Option 1: Proactive Replacements) cost beneficial.

We have looked at the following specific drivers:

- Cost of a fatality (value of life).
- Willingness to pay to avoid supply interruptions.
- The higher costs of reactive repairs compared with a proactive approach.

7.2. Supply and Demand Scenario Sensitivities

As noted in Sections 4, 5, and 6, we have established the need for NW Network to have access to the storage capacity provided by Holford. We considered options to achieve this and showed that such capacity is best provided by the existing Holford installation. Given that, the work proposed here aims to maintain long-term process safety at Holford and, therefore, we have only considered the single base-case supply and demand scenario.

7.3. Business Case Summary

We have assessed the following options for Holford Salt Cavity.

Option Title	Baseline: Reactive Repairs	Option 1: Proactive Replacements	Option 2: Decommission in 2023	Option 3: replace with new storage facilities	Option 4: replace Holford by increased use of linepack
Start Date	Option discounted. Cadent is aware of deficiencies with assets. A reactive repair is therefore considered incompatible with the general duty under Regulation 5 (1) of the COMAH Regulations (2015) for operators to *'take all measures necessary to prevent major accidents and to limit their consequences for human health and the environment'*.	2019	N/A	This option has been discounted because of the high Capex required to develop a new site.	This option has been discounted. Option would require pipelines to be replaced to handle higher pipeline pressures while maintaining the required design factor. This has been dismissed because of the high Capex required.
Commissioning Date		2022	N/A		
Design Life (yrs)		30 10 (E&I)	N/A		
Total Installed Cost (£m)					
Cost Estimate Accuracy		Redacted due to commercial sensitivity			
RIIO-2 Opex (£m)					
RIIO-2 Totex (£m)					
Estimated post-RIIO-2 annual Opex (£m)					
Valid option for RIIO-2 and why		The only technically-viable option for RIIO-2.	This option has been discounted due to the major detrimental impact on network resilience and overall network operability and flow-balancing — a reduction in customer service		

Table 6: Business Case Summary (2018/19 price base with RIIO-2 Capex efficiency)

Options 2, 3 & 4 were discounted without CBA because of their excessive required Capex or detrimental impact on network resilience in the NW region.

The baseline option of reactive repair on failure is not tenable because Cadent is aware that there are obsolete and end-of-life components at Holford and Warburton II. Therefore, Cadent regards the reactive repair option as being incompatible with the general duty under Regulation 5 (1) of the COMAH Regulations (2015) for operators to *'take all measures necessary to prevent major accidents and to limit their consequences for human health and the environment'*. Thus, the baseline would, in effect, mean giving up Holford SC storage with the associated consequences for network resilience that are discussed in Section 4.

However, we have carried out CBA for illustrative purposes to show that, even without this legal mandate, a proactive option is optimum.

The results of the CBA switching analysis (Appendix 2) show that the proactive option is optimum if at least one of the following scenarios is reasonable:

- A reactive fix will be required in less than 19 years' time, **or**
- We will have a failure at the Holford Salt Cavity that leads to a >24-hour interruption of supply to 5,000 properties within the next 54 years, **or**
- An asset failure will lead to a fatality (for example, by electrocution, fire, etc.) within the next 200 years.

Our engineering judgement is that these frequencies form a reasonable minimum description of event frequencies associated with the Holford Salt Cavity. For example,

- We judge that a reactive fix[5] is likely to be required in less than 19 years because the E&I equipment is currently 34 years old and obsolete.
- If the facility was to be inoperable for any length of time, and if this coincided with a period of high demand, then interruptions to supply to a significantly large population could occur. In our judgement, given the age and obsolescence of the equipment, combined with number of customers served and the relatively low storage capacity in the region[6], 1 in 50 years is a reasonable minimum estimate of this likelihood.

On this basis Option 1 is cost beneficial, is the only option that ensures compliance with our obligations under COMAH Regulations (2015) and maintains the current level of network resilience for NW Network.

[5] Including in response to safety-critical equipment not meeting performance standards, as well as works to remediate inoperability.
[6] As set out in Table 3 Holford supplies 3.5% of peak day demand in the NW Network. Without Holford only 4% of peak day demand would be available from stock and storage, which is less than half of the availability in other Cadent networks.

8. Preferred Option Scope and Project Plan

8.1. Preferred Option for this Request

The preferred option is Option 1, to retain Holford as a storage facility in NW Network and make proactive investments to maintain process safety and operability, with a design life of 30 years (10 years for E&I).

8.2. Project Spend Profile

2021 / 2	2022 / 3	2023 / 4	2024 / 5	2025 / 6	2026 / 7	2027 / 8	2028 / 9	2029 / 30	2030 / 1
XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Table 7: Annual Capex for preferred option (£m) to project completion (2018/19 price base, post-efficiency)

8.3. Efficient Cost

Costs for the preferred option in RIIO-2 will be for supply and installation of replacement equipment, which will be subject to tender.

Our RIIO-2 forecasts, as well as adjusting for workload and work mix factors, include ongoing efficiencies flowing from our transformation activities including from updating and renewing our contracting strategies. Our initiatives are outlined in Appendix 09.20, Resolving our benchmark performance gap. For Capex activities this seeks a 2.9% efficiency improvement by 2025/26 on the end of RIIO-1 cost efficiency level. We have applied an average efficiency of 0.9% over 5 years to this investment area, commencing at 0.3% in first year and rising to 0.6% in the second year.

All costs in this document are post-efficiency.

Holford Salt Cavity has various estimates of confidence for different components of work. For internal activities we have a high confidence, with contracting activity being more uncertain. The weighted average cost confidence is ±13%.

8.4. Project Plan

This work is at the early design stage and it is too soon to propose a realistic monthly plan for the works. Cadent currently expects that design work will be completed in RIIO-1 so that contracts can be let for main works early in RIIO-2. The materials lead times are expected to be long, and work would need to be performed during a summer period, so we expect the work to be completed in mid-2022.

8.5. Key Business Risks and Opportunities

Reference	Risk Description	Impact	Likelihood	Mitigation /Control
09.15 - 001	Supply & Demand deliverability risk of Resource availability within the Gas industry	Potential cost increases in labour / commodity markets as demand is greater than supply	Low	Intelligent procurement and market testing. Apprenticeship and Training programmes to fill skills gaps

09.15 - 002	Stretching efficiency targets may not be deliverable (unit costs increase)	Outturn costs are not met increasing overall programme costs.	Low	Established marketplace - ability to manage the known commodity market
09.15 - 003	Unforeseen outages and failures restrict access for planned work	Programme and delivery slippage due to delay of planned outages and or site access	Low	Proactive asset management with ongoing condition surveys and response plans to prevent failures
09.15 - 004	Unseasonal weather in 'shoulder months', Autumn and Spring reduce site access/outage windows	Increased demands affecting access to sites and planned outages delay and cost increases	Low	Controlled forecasting and maintenance of flexibility to react to unforeseen events. Detailed design solutions to minimise outages and reduce exposure.
09.15 - 005	Unexpected / uncommunicated obsolescence during RIIO-2 period of equipment components	Inability to maintain equipment at full capacity with risk of impact upon supply	Low	Maintain a close relationship with equipment supply chain and manage a proactive early warning system where spares / replacements become at risk.
09.15 - 006	Legislative change - There is a risk that legislative change will impact the delivery of our work.	Potential increase in the amount of consultation and information exchange required and require us to align our plans with the safety management processes operated by 3rd Party landowner / asset owners. The potential impact is more engagement and slower delivery	Med	We have established management teams to address these issues. We have also identified UMs for key areas.
09.15 - 007	Reduction of peak demand	government policy decisions on domestic use of gas and renewable power generation may affect these forecasts	Low	Controlled forecasting and maintenance of flexibility to react to unforeseen events. Detailed design solutions to minimise outages and reduce exposure.
09.15 - 008	A substantial permanent decrease of diurnal variation	This would imply a dramatic shift away	Low	Controlled forecasting and maintenance of

		from variable demand such as domestic, commercial, and even power generation so that the network became dominated by steady, round-the-clock, industrial-process consumers		flexibility to react to unforeseen events. Detailed design solutions to minimise outages and reduce exposure.

Table8: Risk Register

8.6. Outputs Included in RIIO-1 Plans

This work was not included in RIIO-1 plans.

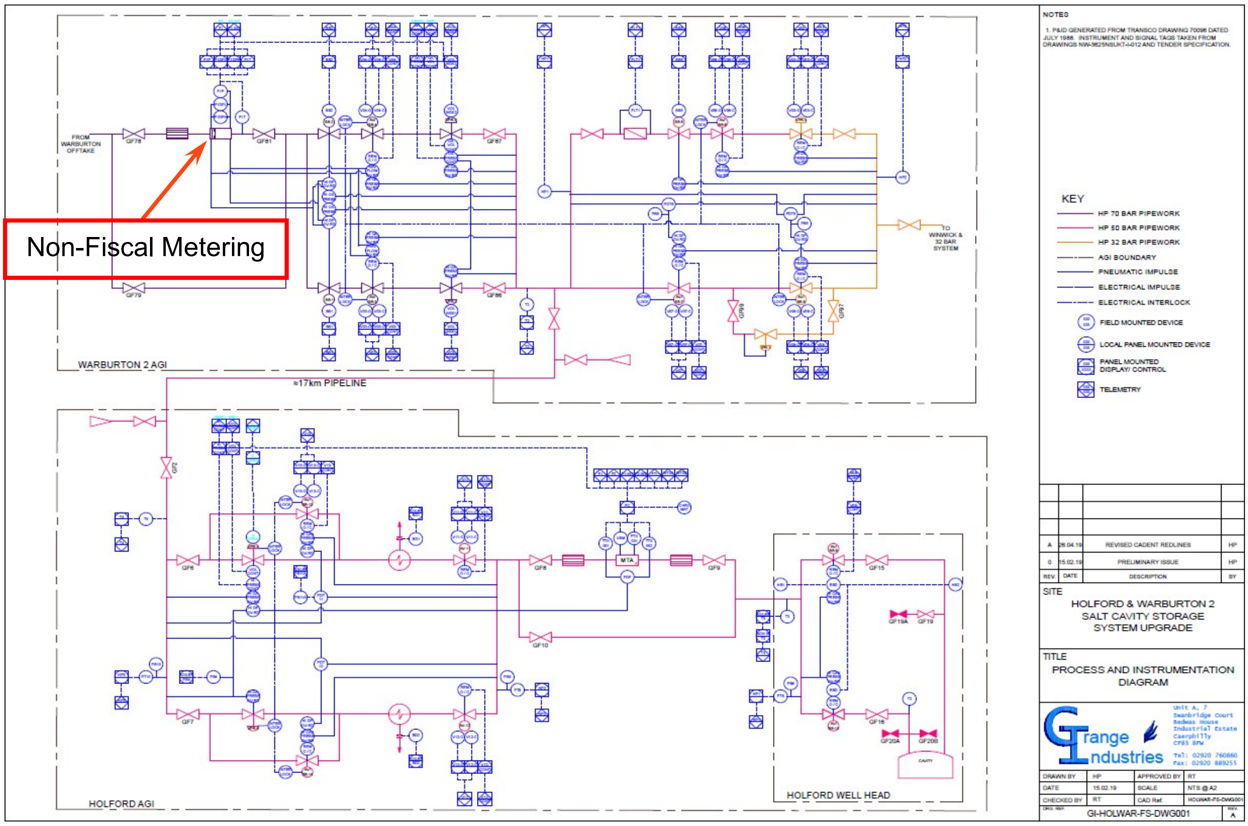
9. Regulatory Treatment

This work contains a mix of assets types, not all of which are covered by NARMs. As such this investment will not be processed through the NARMs reporting tool.

The workload will be reported through RRP and cost variance managed through the Totex Incentive Mechanism (TIM).

This investment is accounted for in the Business Plan Data Tables 3.01 LTS, Storage & Entry as a scheme XXXX.

Appendix 1. Warburton II – Holford P&ID



Appendix 2. Approach and Basis of Calculation for CBA

Introduction

Many of the options considered for Holford have been discounted because of their excessive required Capex or impacts on network resilience.

The baseline option of reactive repair on failure is not tenable because Cadent is aware that there are obsolete and end-of-life components at Holford and Warburton II. Therefore, Cadent regards the reactive repair option as being incompatible with the general duty under Regulation 5 (1) of the COMAH Regulations (2015) for operators to *'take all measures necessary to prevent major accidents and to limit their consequences for human health and the environment'*. Thus, the baseline would, in effect, mean giving up Holford SC storage with the associated consequences for network resilience that are discussed in Section 4.

However, we have carried out CBA for illustrative purposes to show that, even without this legal mandate, a proactive option is optimum.

Our approach to Cost Benefit Analysis

We have carried out a Cost Benefit Analysis (CBA) to help inform our investment decisions.

We have used a 'Switching Analysis' approach for this project. Where it is not possible or proportionate to undertake a full CBA, this approach enables us to use CBA to identify whether an option would be cost-beneficial under reasonable risk scenarios of the likelihood and consequences of failure.

Switching analysis, as set out the in HM Treasury Green Book, is a form of sensitivity analysis that identifies the input values required to change the CBA results:

> *'A switching value refers to the value a key input variable would need to take for a proposed intervention to switch from a recommended option to another option or for a proposal to not receive funding.'* (HM Treasury Green Book, p33)

This approach is particularly useful where there are significant future uncertainties, making specification of accurate risk scenarios problematic. This is the case here because of the uncertain nature of the low probability, high consequence events involved.

That is, as the benefits of maintaining the site are too uncertain to be specified with the confidence required for a standard cost benefit analysis, the approach taken is to test how big these benefits must be for the option to maintain the facility to be cost-beneficial. We then review this level of benefits to understand whether they are a reasonable description of the uncertain benefits associated with maintenance of the facility. If so, it is judged to be cost-beneficial to make the investment.

This approach avoids the need to make central assumptions about the failure rate and the consequences of failure, which would be required under a more traditional approach of sensitivity testing the switching values of different input assumptions. For this project the likelihood of failure and the scale of the consequences of failure are so uncertain that it is not possible to specify central estimates. Hence, we have developed this 'reasonable minimum' approach to implement switching analysis.

In developing our switching analysis approach, we have followed the Ofgem approach, spreadsheet template and societal benefit values and calculations. In order to test the switching points for a number of key variables, we have modelled a range of scenarios in the templates. Table B1 sets out the scenarios taken into CBA modelling with the costs and benefits modelled.

In Table B1:

- The Option 1 scenarios demonstrate the switching points for two of the key consequences of failure:
    - Reactive costs (scenarios 2 and 3), and
    - Interruptions to supply (scenarios 4 and 5).
- As repair is not possible because of obsolescence, a reactive strategy would mean replacement rather than repair.
- Reactive costs are assumed to be 20% above proactive costs. This is consistent with our experience of such urgent projects.
    - Our experience of undertaking urgent, reactive projects where our ability to negotiate commercially is weakened by time pressures is that reactive replacement is significantly more expensive than planned work.
- If the facility were to be inoperable for any length of time, and if this coincided with a period of high demand, then interruptions to supply to a significantly large population could occur.
    - Scenarios 4 and 5 demonstrate the switching point for the probability of supply interruptions of between 24 hours and 1 week at 5,000 properties.
    - The Willingness to Pay (WTP) to avoid one interruption to supply of longer than 24 hours but less than a week is XXXX per property (see Section 6 of Appendix 09.00 Overview of Investment).

To compare the net present values (NPVs) of different options, the costs and benefits associated with each option must be entered in Option tabs of the template. As both the costs and benefits of the options are included in the relevant Option tab, no data is entered in the Baseline tab.

Options Used in Document	Option Used in CBA Template	Costs Used	Benefits Used (scenario figures used to pinpoint switching point)
Option Baseline: Reactive Repairs	Baseline	N/A	Redacted due to commercial sensitivity
Option 1: Proactive Replacements	Option 1: Proactive Replacement	RIIO-2 costs as submitted.	
	Scenario 2: Proactive replacement (Asset Failure 1 in 18)	RIIO-2 costs as submitted.	
	Scenario 3: Proactive replacement (Asset Failure 1 in 19)	RIIO-2 costs as submitted.	
	Scenario 4: Proactive replacement (Impact Supply 1 in 53)	RIIO-2 costs as submitted.	
	Scenario 5: Proactive replacement (Impact Supply 1 in 54)	RIIO-2 costs as submitted.	
Option 2: Decommission in 2023	N/A: Options discounted prior to CBA as described in Section 6		
Option 3: provide new storage facility			
Option 4: increase line-pack			

Table B1: Basis of calculations in CBA template

All benefits were assumed to commence in 2024 and to last for 23 years in line with average asset lives across the business, as well as being between the design lives of the components of the project (10 years for E&I and 30 years otherwise). Benefits start from immediately after completion of the project.

The CBA results

The Net Present Value (NPV) of the preferred option (Scenario 1: Proactive replacement) is shown in Table B2.

As no benefits are included in this option, we have presented the PV of the costs in the table below. These are XXXX. As set out above, no benefits have been included in this option due to the high degree of uncertainty in the likelihood and consequences of a failure. However, we are confident this is cost beneficial.

CBA Scenario No.	Option Name	PV of expenditure	RIIO-2 Spend	NPV
Baseline	Baseline	Redacted due to commercial sensitivity		
1	Proactive replacement			

Table B2: RIIO-2 Spend and PV for preferred option (£m) (2018/19 cost base with efficiency)

Switching point calculations

Table B3 sets out NPV results of CBA for the four alternative benefits scenarios described in Table B1 to support the Switching Analysis.

The switching point for avoided costs of reactive response to failure is demonstrated by comparing the results of Scenarios 2 and 3. This shows that the Proactive Maintenance option is cost beneficial under Scenario 2 (a reactive fix required within 18 years) but not Scenario 3 (a reactive fix required within 19 years). It is our engineering judgement that, without intervention, a reactive repair is likely to be required in less than 18 years as the E&I is now 34 years old and obsolete.

In this calculation rather than having to estimate the likely failure frequency (e.g. 1 in 10 years, 1 in 30 years etc.) we have used the switching analysis to find the tipping point. This tipping point, at a frequency of between 1 in 18 and 1 in 19 years, creates a cost neutral NPV calculation. Our engineering judgment is that failure is likely within the limit set by the switching analysis for the work to be cost beneficial.

Similarly, the switching point for interruptions to supply is demonstrated by comparing the results of Scenarios 4 and 5. This shows that the Proactive Maintenance option is cost beneficial under Scenario 4 (with the frequency of an interruption 1 year in 53) but not Scenario 5 (frequency of an interruption 1 year in 54).

This second, separate, analysis focused on interruptions. It is again complex to estimate the combination of high demands and network failure which would trigger loss of supply. We have identified that a loss of supply to 5,000 customers once in 53 – 54 years as a result of failure of these assets would make the project cost beneficial.

The switching analysis necessarily considers each input variable individually and so the results for the probability of a reactive fix assume there are no other benefits associated with the scheme. Similarly, the results of the switching point for the interruption to supply variable also assume there are no other benefits. In practice any incident would be likely to lead to consequences in more than one of these areas, and to impact on other factors such as health and safety. This means that a break-even scenario might be defined by a lower frequency of each of the drivers than the switching points set out in the table if figures were to be considered in combination.

CBA Scenario No.	Scenario Name	Total NPV	Cost beneficial	Payback Year	RIIO-2 Spend	Ratio NPV to RIIO-2 spend
2	Proactive replacement (Asset Failure 1 in 18)					
3	Proactive replacement (Asset Failure 1 in 19)		Redacted due to commercial sensitivity			
4	Proactive replacement (Impact Supply 1 in 53)					
5	Proactive replacement (Impact Supply 1 in 54)					

Table B3: Switching Analysis NPV (£m) (2018/19 cost base with efficiency)

Assessment of switching points

The results from Table B3 are summarised in Table B4.

Benefit	Cost Beneficial	Not Cost Beneficial
Reactive fix required within:	*18 years*	*19 years*
OR		
Frequency of failure leading to an interruption to supply:	*1 year in 53*	*1 year in 54*

Table B4: Results of switching analysis

Switching analysis has also been undertaken for health and safety which demonstrates that if a fatality associated with the equipment to be replaced was to occur more frequently than once in 200 years, then this driver alone would make the scheme cost beneficial. This has not been included in the templates at this point because of the way that these benefits are accounted for in the templates.

Therefore, **if** it is considered that

- A reactive fix will be required in less than 19 year's time, **or**
- We will have a failure at the Holford Salt Cavity that leads to a >24-hour interruption of supply to 5,000 properties within the next 54 years, **or**
- An asset failure will lead to a fatality (for example, by electrocution, fire, etc.) within the next 200 years.

Our engineering judgement is that these frequencies form a reasonable minimum description of event frequencies associated with the Holford Salt Cavity. For example,

- We judge that a reactive fix[7] is likely to be required in less than 19 years because the E&I equipment is currently 34 years old and obsolete.
- If the facility was to be inoperable for any length of time, and if this coincided with a period of high demand, then interruptions to supply to a significantly large population could occur. In our judgement, given the age and obsolescence of the equipment, combined with number of customers served and the relatively low storage capacity in the region[8], 1 in 50 years is a reasonable minimum estimate of this likelihood.

On this basis Option 1 is cost beneficial, is the only option that ensures compliance with our obligations under COMAH Regulations (2015), and maintains the current level of network resilience for NW Network.

[7] Including in response to safety-critical equipment not meeting performance standards, as well as works to remediate inoperability.
[8] As set out in Table 3 Holford supplies 3.5% of peak day demand in the NW Network. Without Holford only 4% of peak day demand would be available from stock and storage, which is less than half of the availability in other Cadent networks.