Cadent
Your Gas Network

Non-operational IT Capex Re-opener Submission

September 2023

Classification: Confidential

In this application we have redacted most of the cost information based on commercial sensitivity. Other areas have been redacted based on information security and/or confidentiality.

Table of Contents

Ofgem Requirement

The table below outlines which section of the application relates to the individual requirements set out in Special Condition 3.7 and 9.4 of our Gas Transporter licence as well as Ofgem's requirements as set out in their Re-opener Guidance and Application Requirements document.

Ofgem requirement	Application chapter / section
GT licence: Special Condition 3.7, Part C: Non-operational IT Capex re-opener / Special Condition 9.4.3, Part A: Requirement to comply with the Re-opener Guidance and Application Requirements Document	
Circumstances for applying to Ofgem for re-opener (Para 3.7.5)	Chapter 1.0 – Exec Summary
Application requirements *(para 3.7.7 (a-e) and 3.7.8b)*	Chapter 1.0 – Exec Summary Chapter 2.0 – Alignment with our RIIO-GD2 Business Plan Chapter 3.1 – Project 1: Problem Statement & Needs Case Chapter 3.7 – Project 1: Cost Information Chapter 4.1 – Project 2: Problem Statement & Needs Case Chapter 4.7 – Project 2: Cost Information Chapter 5.1 – Project 3: Problem Statement & Needs Case Chapter 5.7 - Project 3: Cost Information Chapter 6.1 – Project 4: Problem Statement & Needs Case Chapter 6.7 – Project 4: Cost Information Chapter 7.1 – Project 5: Problem Statement & Needs Case Chapter 7.7 – Project 5: Cost Information Chapter 8.0 – Appendices
Re-opener Guidance and Application Requirements Document (Feb 2023)	
Introduction *(para 3.1)*	Chapter 1.0 – Exec Summary
Gas Distribution Sector *(para 3.6)*	Chapter 3.7 – Project 1: Cost Information Chapter 4.7 – Project 2: Cost Information Chapter 5.7 – Project 3: Cost Information Chapter 6.7 – Project 4: Cost Information Chapter 7.7 – Project 5: Cost Information
Needs case and preferred option (para 3.8-3.9)	Chapter 3.1 – Project 1: Problem Statement & Needs Case Chapter 4.1 – Project 2: Problem Statement & Needs Case Chapter 5.1 – Project 3: Problem Statement & Needs Case Chapter 6.1 – Project 4: Problem Statement & Needs Case Chapter 7.1 – Project 5: Problem Statement & Needs Case
Consideration of options and methodology for selection of the preferred option (para 3.13)	Chapter 3.3 - Project 1: Option Selection Chapter 4.3 - Project 2: Option Selection Chapter 5.3 - Project 3: Option Selection Chapter 6.3 - Project 4: Option Selection

	Chapter 7.3 – Project 5: Option Selection
Preferred Option (para 3.14-3.15)	Chapter 3.4 - Project 1: Option Selection Chapter 3.5 – Project 1: Technical Feasibility and consumer benefit Chapter 3.6 – Project 1: Project Delivery and Monitoring Chapter 4.4 - Project 2: Option Selection Chapter 4.5 – Project 2: Technical Feasibility and consumer benefit Chapter 4.6 – Project 2: Project Delivery and Monitoring Chapter 5.4 - Project 3: Option Selection Chapter 5.5 – Project 3: Technical Feasibility and consumer benefit Chapter 5.6 – Project 3: Project Delivery and Monitoring Chapter 6.4 - Project 4: Option Selection Chapter 6.5 – Project 4: Technical Feasibility and consumer benefit Chapter 6.6 – Project 4: Project Delivery and Monitoring Chapter 7.4 – Project 5: Option Selection Chapter 7.5 – Project 5: Technical Feasibility and consumer benefit Chapter 7.6 – Project 5: Project Delivery and Monitoring
Stakeholder engagement and whole system opportunities (para 3.6)	Chapter 3.5 – Project 1: Technical Feasibility and consumer benefit Chapter 4.6 – Project 2: Project Delivery and monitoring Chapter 5.4 – Project 3: Preferred Option Chapter 6.6 – Project 4: Project Delivery and monitoring Chapter 7.6 – Project 5: Project Delivery and monitoring
Cost Information (3.19-3.20)	Chapter 3.7 – Project 1: Cost Information Chapter 4.7 – Project 2: Cost Information Chapter 5.7 – Project 3: Cost Information Chapter 6.7 – Project 4: Cost Information Chapter 7.7 – Project 5: Cost Information
Appendix 2: Non-operational IT Capex Re-opener guidance	
Alignment with overall business strategy and commitments *(para A2.2-A2.3)*	Chapter 1.0 – Exec Summary Chapter 2.0 – Alignment with our RIIO-GD2 Business Plan
Demonstration of needs case *(para A2.4)*	Chapter 3.1 – Project 1: Problem Statement & Needs Case Chapter 4.1 – Project 2: Problem Statement & Needs Case Chapter 5.1 – Project 3: Problem Statement & Needs Case Chapter 6.1 – Project 4: Problem Statement & Needs Case Chapter 7.1 – Project 5: Problem Statement & Needs Case
Options Selection - Consideration of project options and methodology of how preferred project option selected *(para A2.6)*	Chapter 3.3 - Project 1: Option Selection Chapter 4.3 - Project 2: Option Selection Chapter 5.3 - Project 3: Option Selection Chapter 6.3 - Project 4: Option Selection Chapter 7.3 – Project 5: Option Selection
Options Selection – Preferred project option details *(A2.7-A.28)*	Chapter 3.4 - Project 1: Preferred Option Chapter 4.4 - Project 2: Preferred Option Chapter 5.4 - Project 3: Preferred Option Chapter 6.4 - Project 4: Preferred Option

	Chapter 7.4 – Project 5: Preferred Option
Options Selection – Technical feasibility and consumer benefit *(para A2.9-A2.10)*	Chapter 3.5 – Project 1: Technical Feasibility and consumer benefit Chapter 4.5 – Project 2: Technical Feasibility and consumer benefit Chapter 5.5 – Project 3: Technical Feasibility and consumer benefit Chapter 6.5 – Project 4: Technical Feasibility and consumer benefit Chapter 7.5 – Project 5: Technical Feasibility and consumer benefit
Options selection – Project delivery and monitoring *(para A2.11-A2.12)*	Chapter 3.6 – Project 1: Project Delivery and Monitoring Chapter 4.6 – Project 2: Project Delivery and Monitoring Chapter 5.6 – Project 3: Project Delivery and Monitoring Chapter 6.6 – Project 4: Project Delivery and Monitoring Chapter 7.6 – Project 5: Project Delivery and Monitoring
Cost Information – Consideration of options *(para A2.13-A2.16)*	Chapter 3.3 - Project 1: Option Selection Chapter 4.3 - Project 2: Option Selection Chapter 5.3 - Project 3: Option Selection Chapter 6.3 - Project 4: Option Selection Chapter 7.3 – Project 5: Option Selection Chapter 3.7 – Project 1: Cost Information Chapter 4.7 – Project 2: Cost Information Chapter 5.7 – Project 3: Cost Information Chapter 6.7 – Project 4: Cost Information Chapter 7.7 – Project 5: Cost Information
Cost Information – Breakdown of costs of preferred option *(para 1.13-1.15)*	Chapter 3.7 – Project 1: Cost Information Chapter 4.7 – Project 2: Cost Information Chapter 5.7 – Project 3: Cost Information Chapter 6.7 – Project 4: Cost Information Chapter 7.7 – Project 5: Cost Information

For security reasons and commercial sensitivities, such as cost information, some of the content in this application submission will be redacted prior to publication on our website.

Point of Contact

We have included the point of contact for this re-opener application in our cover letter.

Chapter 1.0
Exec Summary

This paper is Cadent's application to the Authority requesting an adjustment to our RIIO-GD2 allowances under the Non-operational IT Capex (**NOITC**) re-opener mechanism. This modification is necessary to support Cadent's compliance with mandated changes instigated by government (statutory and regulatory); ensure continued resilience in our network; deliver operational improvements through increased automation; improve data capture and therefore quality of data; drive towards net zero and support our growing maturity against the Data Best Practice Guidance and to ensure that we can comply with our obligations under our Gas Transporter Licence across the RIIO-GD2 period.

Cadent Gas Limited ("**Cadent**") is making this re-opener submission under Special Licence Condition 3.7.5 (b) and (c) under the triggers: the licensee identifying activities capable of improving the efficiency or performance of its Non-operational IT Capex; any changes to statutory or regulatory requirements relating to Non-operational IT Capex.

Following discussions with Ofgem, the Open Data project was the only one of Cadent's NOITC projects submitted in the January 2023 re-opener window. Ofgem's final determination in July 2023 confirmed that two out of three of the workstreams within the Open Data project were to be funded. Following Cadent's response to Ofgem, it was agreed that Cadent could re-submit the disallowed workstream for re-consideration alongside the remaining NOITC projects that were deferred from January 2023, to the summer window (28 August 2023 – 15 September 2023). This re-opener therefore covers five projects: the re-submission for the unfunded Open Data project workstream, three of the deferred projects from January 2023, and an additional project not included in the July 2022 pipeline but submitted as part of the July 2023 pipeline log.

This re-opener application is split into five separate projects:

1. Satellite End of Life Replacement ("**Project 1**"),
2. Operations Transformation: Multiple Occupancy Buildings ("**Project 2**"),
3. Operations Transformation: Standardisation and Automation of the Reinstatement Process – Streetworks ("**Project 3**"),
4. Network Emissions Management ("**Project 4**"),
5. Open Data – Interoperability (**Project 5**").

Project 1: Satellite End of Life Replacement

Cadent relies on [software] connectivity, in which a [CNI-sensitive data] station is used in the transmission and receipt of data, over a satellite communication network at our CNI sites as part of our telemetry network. Both the remote sites and receiving stations communicate via a satellite which provides capacity, and relays signals between the transmitting and receiving

stations. This satellite, designated [CNI-sensitive data], was provided and managed by [third-party]: a supplier for [third-party], our incumbent partner for CNI Telemetry services.

This telemetry network provides our business with operational visibility and dynamic control of the pressure, flow, and quality of the gases in our networks. Effective delivery of these capabilities is critical to maintain our service levels and enable the safe operation and maintenance of our gas networks. Essentially this service provides monitoring and regulation capability that includes pressure, flow, and quality of gas.

This project is retrospective in nature and satisfies the following trigger for reasons that are set out herein: Special Condition 3.7.5(b) "the licensee identifying activities capable of improving the efficiency or performance of its Non-operational IT Capex".

The adjustment requested is for additional funding for the retrospective costs of replacing the satellite communications service not included within our RIIO-GD2 Business Plan submission, as a consequence of the notification from [third-party] in July 2021, announcing that the [CNI-sensitive data] satellite would be at the end of its usable life and out of service as of April 2023 (Appendix 01).

The costs incurred in this project amounted to **£815,479.45** in 18/19 prices.

Project 2: Operations Transformation – Multiple Occupancy Buildings (MOBs)

Around 5% of Cadent's customers (up to 13% in London) live in a Multiple Occupancy Building (**MOB**)**.** Accordingly, MOBs have been a key focus area for Cadent; especially since the 2018 Health & Safety Executive (**HSE**) findings[1], which led to a revamp of the entire technology landscape that supports effective management of gas assets in MOBs. Vast improvements have been made in ensuring critical data is captured; accurate; managed correctly, and is accessible for use in asset investment decisions. Investment in technology is vital to keeping the gas flowing and maintaining our customers' safety.

To date, focus has been on safely managing gas assets in High Rise Buildings (**HRB**) and Medium Rise Buildings (**MRB**)**.** Now in 2023, the industry has undertaken even more research, investigation, and analysis of MOBs as an asset, and how to effectively manage the asset lifecycle from installation through operation to decommission. There are new subsets in the MOBs domain requiring specialised skills and processes, as well as new engineering standards to be adhered to. There have also been changes to building regulations in England, covering fire safety matters within and around buildings[2] which highlights further risks. Therefore, new datasets need to be captured and managed centrally. Furthermore, operational and IT teams have identified opportunities to automate manual processes and implement data quality improvements that will benefit MOBs asset investment decisions, consequently protecting customer safety and delivering value for money.

[1]Chapter 31, Shutting off the supply of gas to the tower, Grenfell Tower Enquiry Phase 1 Full Report
[2]Fire Safety: Approved Document B - Gov.uk

In light of the information above, this application is being made under the relevant re-opener triggers Special Condition 3.7.5 (b) "The licensee identifying activities capable of improving the efficiency or performance of its Non-operational IT capex" and Special Condition 3.7.5 (c) "Any changes to statutory or regulatory requirements relating to Non-operational IT Capex".

The requested adjustment is to fund the investment in technology that is required to mitigate new risks and realise opportunities around customer safety, asset health and operational efficiency. This project incurs a cost of **£3,585,382.47** (Option 3) for the remainder of the RIIO-GD2 period, in 18/19 prices.

Project 3: Operations Transformation – Standardisation and Automation of the Reinstatement Process - Streetworks

In 2019 the Department for Transport (**DfT**) replaced the Electronic Transfer of Notices (EToN) with Street Manager, which centralises information pertaining to streetworks activities across the country for both statutory undertakers and highway authorities (**HA**s).

Street Manager became mandatory in April 2020[3] since then Cadent and HAs have been required to provide streetworks notices via Street Manager. In keeping with Government's digital service standards, Cadent decided to implement an Application Programming Interface (API) to integrate its core internal systems with Street Manager. However, Street Manager was introduced as a minimum viable product, and its users are now bound to comply with the DfT's API specification as "revised or reissued from time to time"[4]. Investment is therefore required to ensure that we can resource sufficiently to maintain compliance with our aforementioned legal obligations.

Additionally, following the conclusion of Government's consultation in May 2021 [5], amendments with effect from April 2023 were made to both The Street Works (Miscellaneous Amendments) Regulations 2022[6] and The Street Works (Inspections Fees) Regulations 2022[7] as follows:

- Start and Stop notices for works on weekends and bank holidays are required within the same timeframes as works on working days.
- Performance-based inspections are no longer limited to 30% of inspection units, instead they can increase/decrease each quarter from a minimum of 20% to maximum of 100% of inspection units.

Supplemental functionality was introduced in Street Manager with effect from April 2023, such that non-compliant inspection notices from the HAs are now subject to an accept/dispute process with statutory undertakers[8]. Investment is therefore required to ensure that we have

[3] The Street and Road Works (Amendments Relating to Electronic Communications) (England) Regulations 2020 (legislation.gov.uk)
[4] Street Works (Amendments Relating to Electronic Communication) Regulations 2020 (6(b))
[5] Street manager and permit scheme changes - GOV.UK (www.gov.uk)
[6] The Street and Road Works (Miscellaneous Amendments) (England) Regulations 2022 (legislation.gov.uk)
[7] The Street Works (Inspection Fees) (England) Regulations 2022 (legislation.gov.uk)
[8] Changes to Street works Regulations 2023 - Plan and manage roadworks information (department-for-transport-streetmanager.github.io)

improved systems and processes in place to comply with these new obligations and process, whilst avoiding unnecessary costs.

Adjustment rationale

At the time we submitted our RIIO-GD2 business plan, we had no detail concerning the legislative changes which mandate compliance with continual updates of the DfT's API specification, nor were we aware of the changes implemented with effect from April 2023. As such, the costs associated with these requirements did not form part of our original submission.

Consequently, we are asking for an adjustment under the relevant re-opener trigger Special Condition 3.7.5 (c) "Any changes to statutory or regulatory requirements relating to Non-Operational IT Capex" as follows:

1. Funding allowance to resource the assessment and implementation of API upgrades.
2. Funding for a Work Management System (**WMS**) solution that will:
    a. facilitate compliance with new Start and Stop notice requirements, and
    b. facilitate compliance with new performance-based inspection requirements.

The total adjustment requested is **£2,481,404.53** in 18/19 prices.

Project 4: Network Emissions Management

Cadent is committed to managing its network-wide fugitive emissions and Net Zero responsibly whilst providing a safe, secure and affordable network over the long term. In our 2022/23 Regulatory Reporting Pack (**RRP**), Cadent reported fugitive leakage emissions of 969.4GWh, which equates to 1,188,907.3 tonnes of carbon dioxide equivalent (**tCO2e**) and is the equivalent typical annual consumption of 77,500 domestic properties. We have been actively exploring and trialling commercially viable and innovative technologies to manage and reduce such a huge volume of fugitive emissions on our network. For context, Cadent leakage is nearly half (46%) of the current Gas Distribution Network (**GDN**) total (Appendix 02).

In RIIO-GD2, the regulatory baselines include an ambitious target to reduce Shrinkage by 14%. Although our emissions are declining through the HSE-mandated Iron Mains Risk Reduction Programme (**IMRRP**), leakage from mains and services on the low pressure (**LP**) and medium pressure (**MP**) networks contribute to 80% of the total fugitive emissions from Cadent's operational area (Figure 1). Whilst we will continue to reduce this figure through the IMRRP, we must deploy more mature technologies to accurately identify the location of our leakiest assets and intervene in a timely manner.

By innovating to continuously manage our network emissions effectively and efficiently, we also aim to contribute towards the Global Methane Pledge (to reduce methane emissions by 30% by 2030), which the UK signed up to at COP26.

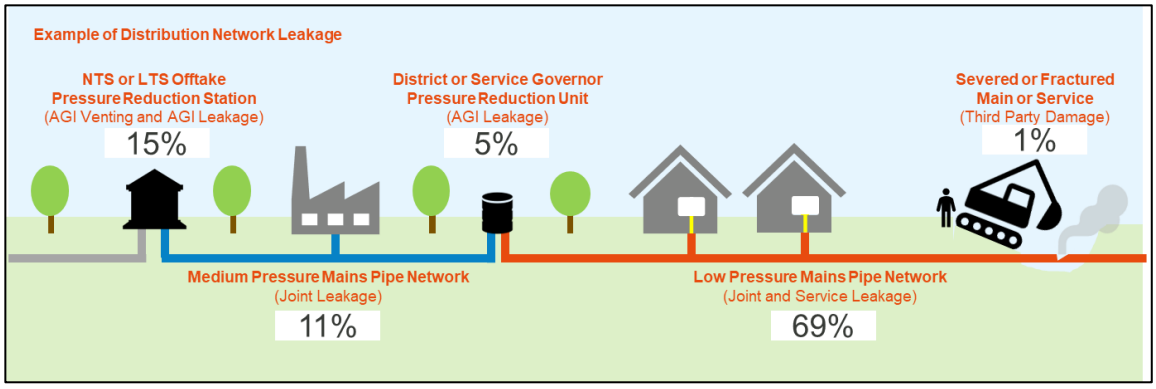

Figure 1 – Breakdown of the components that constitute fugitive emissions, based on an assessment of the 2022/23 performance year.

The proposed solution provides a step change in how we can proactively detect and manage network emissions at scale and near-real time, helping us to deliver further emissions reductions for our customers and communities and enabling our ambition to play a key role in the UK's transition to Net Zero. The benefits will include the commodity cost of shrinkage gas whilst there is also a significant societal benefit associated with the cost of carbon.

In addition to the clear environmental benefits case there are wider benefits including:

- Safety Benefits: A reduction in uncontrolled gas escapes and increasing public safety as a result
- Changing workload mix: we would expect an increase in proactive workload with a corresponding decrease in our reactive workload (this will allow us to better profile work across the year and throughout the day)
- Reduction in call volumes: corresponding reduction in call volumes to the national gas emergency line

Since the RIIO-GD2 business plan was submitted, there have been technological advances to supplement or enhance the current Shrinkage and Leakage Model (**SLM**), which had not (at the time of writing) been explored sufficiently as scalable enterprise solutions, therefore were not included in the submission. The developed maturity, and availability of relevant case studies, has opened opportunities for reform. New approaches to quantifying and locating leaks using a combination of machine learning and non-invasive technologies have become commercially available, enabling Cadent to explore those as viable options to reduce emissions.

In 2022, following careful evaluation of the market-based options, Cadent decided to invest in a pilot for the preferred option. This project therefore seeks an adjustment to recover the investment made to date, and to fund the wholesale adoption of the successful solution across all networks. In light of the information above, this application is being made under the relevant re-opener trigger Special Condition 3.7.5 (b) "Any identifying activities capable of improving the efficiency or performance of its Non-operational IT capex", and Special

Condition 3.7.5 (c) “Any changes to statutory or regulatory requirements relating to Non-operational IT Capex”.

The total adjustment requested for this project, in 18/19 prices, is **£14,430,041.09**.

Project 5: Open Data: Interoperability

At the time Cadent submitted its RIIO-GD2 business plan submission the Data Best Practice Guidance had not been formally agreed, neither had a consensus been reached within the energy sector regarding the best ways and mechanisms to adopt the recommendations of the Energy Data Taskforce Report (“A Strategy for a Modern Digitalised Energy System[9]”), concerning how data can assist with unlocking the opportunities provided by a modern, decarbonised and decentralised Energy System at best value to consumers.

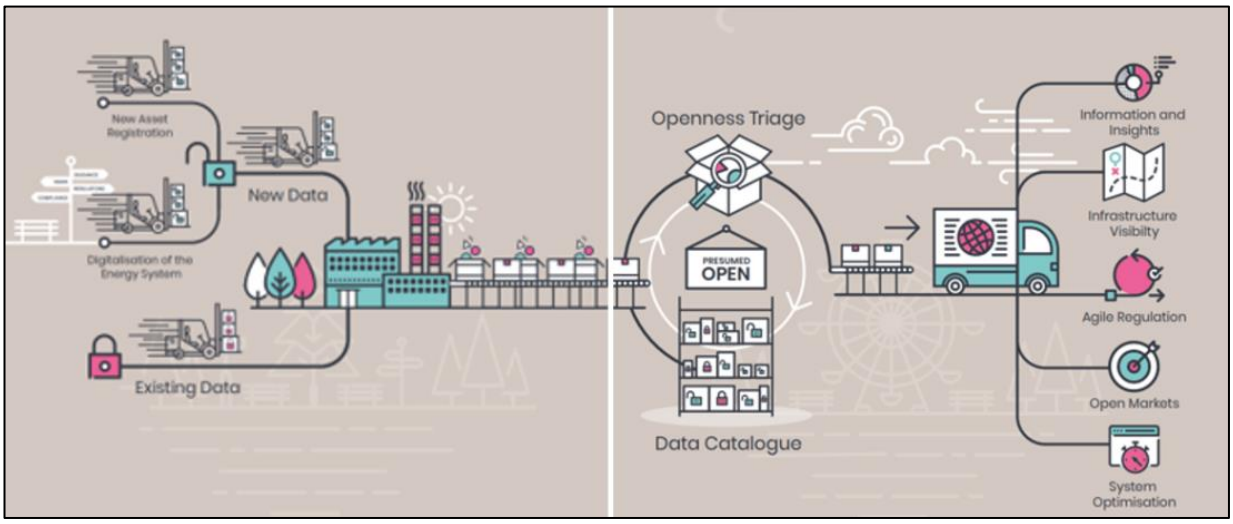

Figure 2: A Strategy for a Modern Digitalised Energy System

As part of the data maturity journey in line with the recommendations of the Energy Data Taskforce report and to support national data strategies, Cadent submitted a re-opener in January 2023 relating to Metadata tooling, Open Data Portal and Data Interoperability.

This re-submission is in response to Ofgem’s final determination on Cadent’s January 2023 submission [10], and herein we hope to have addressed the feedback provided regarding Data Interoperability.

Whilst we welcome Ofgem’s decision regarding Metadata tooling and the Open Data Portal; we are concerned that without a focus on Data Interoperability at the same time, the outcomes will not bring about the mutually desired sustained changes for the consumer or an increasing return on investment. We believe Data Interoperability is key to the successful implementation of the workstream projects awarded funding from the January 2023 Non-

[9] A Strategy for a Modern Digitalised Energy System (PDF)
[10] https://www.ofgem.gov.uk/publications/riio-2-non-operational-it-capex-re-opener-final-determination-and-direction-cadent

Operational IT Capex re-opener submission in regard to the planning, development and supportability of Open Datasets.

Data Interoperability facilitates a more seamless exchange by integrating data across various technology landscapes, which is fundamental to developing data sophistication in the sector as well as across industries for the generation of insights and continually increasing core asset infrastructure visibility. It is also a prerequisite, in alignment with our RIIO-GD2 business plan (including Re-openers), on our ability to deliver Principle 8 of Data Best Practice Guidance: “Ensure Data Assets are interoperable with Data Assets from other data and digital services.” as part of our obligations under Special Condition 9.5.13 and 9.5.16. One of the outcomes of this project will be a catalogue of re-usable enterprise APIs that adopt a industry aligned common data model that's abstracted from the system of record.

Furthermore, interoperability will enhance operational efficiency and avoid customised point-to-point integration build and maintenance costs of data transfer both within and external to Cadent, whilst ensuring that the data transfer is secure given the evolving nature of cyber security related risks.

Cadent is therefore re-submitting a funding request for the data interoperability workstream previously requested in January 2023, under Special Conditions:

3.7.5(b): *the licensee identifying activities capable of improving the efficiency or performance of its Non-operational IT Capex*

3.7.5(c): any changes to statutory or regulatory requirements relating to Non-Operational IT Capex.

The total adjustment requested is **£817,838.42** in 18-19 prices.

Total Non-operational IT Capex allowance adjustment proposal:

18/19 prices	2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Project 1 - Satellite End of Life	£170,232.65	£645,246.80	£0.00	£0.00	£0.00	**£815,479.45**
Project 2 - MOBs Operations Transformation	£0.00	£544,418.55	£1,061,254.77	£1,186,675.85	£793,033.29	**£3,585,382.47**
Project 3 - Streetworks Reinstatement Transformation	£66,834.74	£763,634.41	£689,097.87	£516,166.61	£445,670.91	**£2,481,404.53**
Project 4 - Network Emissions Management	£0.00	£30,255.05	£2,710,066.83	£3,700,212.14	£7,989,507.06	**£14,430,041.09**
Project 5 - Interoperability	£0.00	£0.00	£66,409.72	£387,124.59	£364,304.11	**£817,838.42**
TOTAL	**£237,067.39**	**£1,983,554.81**	**£4,460,419.47**	**£5,403,054.60**	**£9,228,211.26**	**£21,312,307.53**

Chapter 2.0
Alignment with our RIIO-GD2 business plan

Chapter 2.1 – Introduction

Cadent's gas network plays a critical role in delivering affordable, safe and reliable heating to over 80% of domestic homes and in fuelling major industry, businesses, schools and hospitals in England. The main aim of the RIIO-GD2 business plan is to be at the forefront of shaping and delivering the road to Net Zero through facilitating clean gas and demonstrating a hydrogen pathway for our current and future customers.

The high-level objectives of the business plan are:

- Delivering a resilient network to keep the energy flowing safely and reliably.
- Providing a quality experience to all our customers, stakeholders, and communities
- Tackling climate change and improving the environment
- Trusted to act for our communities

IT Strategy, Data & Digitalisation

Within Cadent's RIIO-GD2 business plan, Cadent's strategic intent was noted within the Data & Digitalisation Strategy[11]. The Data & Digitalisation Strategy exists to support Cadent's purpose of delivering a resilient network to keep the energy flowing safely and reliably, and providing a quality experience for our customers, stakeholders, and communities. It also states that Cadent is committed to building a data-driven organisation, engaging with users and opening up Cadent's data.

The strategy emphasises four pillars that guide Cadent's investment decisions. New investments must support at least one of these themes to demonstrate how delivery of the Data & Digitalisation strategy and Cadent's Business Plan will be achieved. The themes are:

- Enhance the Experience of our Customers
- Simplify the Life of our Employees
- Optimise our Operations
- Explore and Innovate

Any proposed IT solution at Cadent must meet the high-level objectives of the Data & Digitalisation Strategy. Moreover, at a technology level, solutions should conform to IT Architecture standards (please see Appendix 03).

[11] Cadent-Digitalisation-Strategy-2022-Update.pdf (cadentgas.com)

Chapter 2.2 – Project 1: Satellite End-of-Life Replacement for CNI Telemetry

Ongoing changes to the gas network described in our RIIO-GD2 network investment packs are increasing the number of sites requiring Supervisory Control and Data Acquisition (**SCADA**) monitoring and control, thus satellite connectivity is critical. We have seen growth in new sustainable (bio-gas) sites, the introduction of emergency isolation valve sites and offtake-shared site separation. Furthermore, satellite connectivity is an essential enabler for future investment in Hydrogen Networks, futureproofing our business whilst we deliver our Net Zero commitments and initiatives.

The requested investment is a critical prerequisite to support other systems which have been identified for our data collection, network analysis and SCADA systems in the following RIIO-GD2 Investment Papers (**INVP**)[12]**;** INVP 5101 Asset Health (**AH**) Sensor Telemetry & Smart Devices; INVP 5101 Innovation (**IN**) Sensor Telemetry & Smart Devices and INVP 5407 Critical National Infrastructure (**CNI**) Strategy & Distribution Network Control System (**DNCS**) SCADA-As-A-Service. Thus, this investment meets our high-level objective to ensure that we deliver a resilient network, to keep the energy flowing safely and reliably.

Chapter 2.3 – Project 2: Operations Transformation – MOBs

The activities proposed in this project contribute towards Cadent's high-level objective to provide a quality experience to all of our customers, stakeholders and communities, supported by the pillars identified above.

Within this project, the objectives centre on achieving high data quality and automating data handling processes. This aligns directly to the Data and Digitalisation Strategy and thus Cadent's strategic ambitions, as demonstrated in Figure 3, particularly around simplifying how our employees work and optimising our operations. Additionally, this investment helps Cadent to meet Ofgem's Data Best Practice Guidance and apply this to MOBs information.

Here is an excerpt of relevant IT architecture standards that apply to this investment:

- ✓ Data is an Asset, Data is Shared, Data is Accessible, Data is Secure
- ✓ Applications and Services are easy to use
- ✓ Manual processes are reduced and removed
- ✓ Reuse, before we rent, before we buy, before we build
- ✓ Applications and services are robust and fault-tolerant

This investment contributes to the delivery of the business objectives driven by the needs case, and the strategic themes of the Data & Digitalisation Strategy and the Cadent Business Plan. This is achieved while maintaining IT best practice and architecture standards as per Figure 3.

[12] Business plan 2021 - 2026 | Cadent (cadentgas.com)

Business Objective	Strategic Alignment	Business Plan Alignment	IT Architecture Standards
Improve quality and efficiency of collecting, storing and accessing MOBs asset and operational data	Simplify the Life of our Employees Optimise our Operations	A quality experience for all our customers and stakeholders	Data is an Asset, Data is Shared, Data is Accessible, Data is Secure Applications and Services are easy to use
Automate manual processes to remove waste and further improve data quality	Optimise our Operations Explore and Innovate	Keeping the energy flowing safely and reliably	Manual processes are reduced and removed
Increase resiliency and supportability of the technology solution	Simplify the Life of our Employees	Keeping the energy flowing safely and reliably	Reuse, before we rent, before we buy, before we build Applications and services are robust and fault-tolerant

Figure 3 – Alignment with Business Objectives

Chapter 2.4 – Project 3: Operations Transformation – Streetworks

Business Objectives

The purpose of this adjustment is to obtain the investment necessary to respond to changes that are made to the Street Manager system, and to increase data capture, automate data transfer and enhance our processes for stop/start notices and non-compliance notices, and to comply with recent regulatory changes at least cost.

This investment will also align to our business objectives to provide a quality experience for our customers and stakeholders. The investment will achieve this by ensuring that:

- consumers receive the most up-to-date information available about streetworks activities, through near-real-time data sharing with Street Manager
- sites are left in the desired state following streetworks activities, through enhanced data capture at site
- start and stop notices are made within the required timescales, through automated data transfer and
- re-visits and thus disruption is reduced, due to the use of enhanced data capture at site in validating non-compliance notices from HAs

Additionally, this will support the first three pillars of Cadent's Data & Digitalisation Strategy.

The investment for this standardisation and automation of the reinstatement process contributes to the delivery of the business objectives driven by the needs case, and the strategic themes of the Data & Digitalisation Strategy and the Cadent Business Plan. This is achieved while maintaining IT best practice and architecture standards as per Figure 4 below:

Business Objective	Strategic Alignment	Business Plan Alignment	IT Architecture Standards
Maintain compliance with Street Manager API Specification	Enhance the Experience of our Customers	A quality experience for all our customers and stakeholders Keeping the energy flowing safely and reliably	Applications and services are robust and fault-tolerant Manual processes are reduced and removed Data is an Asset, Data is Shared, Data is Accessible, Data is Secure
Improve IT systems and processes supporting streetworks to comply with new obligations	Enhance the Experience of our Customers Simplify the Life of our Employees Optimise our Operations	A quality experience for all our customers and stakeholders Keeping the energy flowing safely and reliably	Applications and Services are easy to use Data is an Asset, Data is Shared, Data is Accessible, Data is Secure

Figure 4 – Alignment with Objectives

Chapter 2.5 - Project 4: Network Emissions Management

Cadent's aspiration is to proactively manage emissions based on accurate science and advanced data analytics. This is aligned to our RIIO-GD2 Data & Digitalisation Strategy:

- Invest in advanced analytics and innovative tooling to maximise the value of our data
- Look for ways to share with our strategic partners
- Move our default position on data sharing to 'presumed open'

The above commitments are also aligned to Ofgem's Data Best Practice principles[13] and the preferred solution will enable availability of Open Data relating to Cadent's operations ensuring:

- Greater transparency concerning emission management in relation to our net zero targets
- Demonstration that value-driven interventions are prioritised
- Understanding of local area emissions profiles, to aid planning and delivery of the IMRRP
- Planned disruption notifications for our customers; Government Authorities; Policy Makers, Energy Industry and Other Utilities

We want to provide capabilities for our stakeholders to utilise Data Assets in a self-serve manner and in a format and frequency that they require with accompanying metadata. Cadent therefore recognises the need to have the capability to develop, publish and support data

[13] Principle 11 Data Best Practice

exchanges (both internally/externally) in a secure, reusable, and scalable way, in accordance with our RIIO-GD2 Data & Digitalisation Strategy.

Successful adoption of the proposed technology, and its integration with Cadent's IT platform and business processes will enhance our leakage detection and response capability, such that it reduces reliance on customers to report a leak, provides quantified detection of leaks, and enables an optimised intervention programme. Our preferred solution will also provide high-quality data to be fed into other applications to facilitate systematic and data-driven decision-making.

Alignment and interdependence with Digital Platform Leakage Analytics Project.
Through the Strategic Innovation Fund (**SIF**), Cadent have successfully received funding to continue with the Beta phase of the Digital Platform Leakage Analytics (**DPLA**) project. The DPLA aims to develop modelling capabilities using a combination of:

1. Hydraulic leakage modelling and advanced algorithms - using machine learning technologies to replace the current Shrinkage and Leakage Model, which uses a static, theoretical approach.
2. Trialling innovative sensor technologies to determine the efficacy of use of generated data: to allow machine learning algorithms to be validated.

Cadent has therefore begun trialling the non-invasive vehicle-mounted technology (**NIVMT**), in the North London network to test its efficacy and collect leakage data points to support the DPLA.

This submission involves network-wide deployment of NIVMT, aligning, complimenting, and further building on the DPLA project.

Chapter 2.6 - Project 5: Open Data: Interoperability

Within Cadent's RIIO-GD2 business plan, Cadent's strategic intent was noted within the Data & Digitalisation Strategy. The Data & Digitalisation Strategy emphasises four pillars that guide Cadent's investment decisions. New investments must support at least one of these themes to demonstrate how delivery of the Data & Digitalisation strategy and Cadent's Business Plan will be achieved. The themes are:

- Enhance the Experience of our Customers
- Simplify the Life of our Employees
- Optimise our operations
- Explore and innovate

Any proposed IT solution at Cadent must meet the high-level objectives of the Data & Digitalisation Strategy. This investment case aligns directly to the above themes and thus Cadent's strategic ambitions. Additionally, this investment helps Cadent to meet Ofgem's **Data Best Practice** (**DBP**) Guidance requirements.[14]

[14] Data Best Practice Guidance v2.0

Moreover, at a technology level, this project aligns to all of the IT principles that underpin any solution:

- Data is an Asset, Data is Shared, Data is Accessible, Data is Secure
- Applications and Services are easy to use
- Manual processes are reduced and removed
- Reuse, before we rent, before we buy, before we build
- Applications and services are robust and fault tolerant

Cadent is committed to building a data driven organisation, engaging with users and opening up Cadent's data, ensuring data is readily and securely available to all our employees and customers in the format that is suitable for them, reducing the time in manipulation and consumption of the data to generate reliable insights that facilitates informed important decision making.

Key to proposals for data sharing and the availability of data in a suitable format is applying 'whole system thinking' for the development and maturity of the future energy system architecture to drive the industry forward.

The traditional energy system is transitioning towards a smarter digital energy system calling for decarbonised, decentralised, and digitalised resources. We believe *Data Interoperability* underpins these commitments and note this proposed investment will help to bridge the gap to Ofgem's Data Best Practice Guidance requirements – which was published after Cadent's RIIO-GD2 business plan submission.

Throughout our digital transformation journey it has become apparent that we need to both mature our data integration capability and invest significantly in interoperability, to ensure expedience and adaptability in responding to changing internal and external demands. Our current ability to develop reusable and secure interfaces, enabling an open data sharing culture, and to manage the lifecycle of these critical digital assets, is not sufficient to enable us to progress into and beyond the next price control. There are levels of duplication and inconsistency in the technical quality and standards of Application Programme Interfaces (**APIs**) across our landscape. This is exacerbated by the reality that Cadent are wholly reliant on 3rd parties that are working in isolation and are not being guided by an API strategy that reflects the longer-term needs of Cadent as we transition to the future of Hydrogen and Operations 4.0[15].

The Open Data Portal initiative has a critical dependency on data integration capabilities, to develop and implement wider interconnectivity capabilities and the pre-requisite data pipelines, in accordance with Cadent's Enterprise Architecture (**EA**) principles and Ofgem's 'Data Best Practice Guidance'.

Data integration capabilities are a fundamental enabler of Cadent's broader digitalisation strategy, as well as the future ecosystem interoperability requirements set out by Ofgem.

[15] Deloitte_Review_26_Fourth_Industrial_Revolution

Chapter 3.0
Project 1 – Satellite End-of-Life Replacement for CNI Telemetry

Chapter 3.1 - Project 1: Problem Statement and Needs Case

Cadent relies on [software] connectivity for [CNI-sensitive data] CNI sites; a mixture of [software] only ([CNI-sensitive data]) and dual connected sites with [software] and [software]. Our [software] solution comprises a [software] unit and dish on remote sites, and a pair of receiving dishes at [CNI-sensitive data] and [third-party] [CNI-sensitive data] Satellite receiving station. Both the remote site and receiving station dishes communicate via a satellite which provides capacity, and relays signals between the transmitting and receiving stations.

To safely operate our network, we need to maintain our ability to collect data and deliver control signals from across our networks via satellite. Thus, following the notification from [third-party] in July 2021, an exploration into a replacement was undertaken immediately to ensure that Cadent could continue to provide a safe and reliable network and mitigate potential support and security issues, whilst continuing to provide critical connectivity to its CNI landscape.

Any absence or non-availability of this critical system would result in Cadent being unable to manage the pressures in our multi-pressure networks. If this were to happen, it could result in the following:

- Loss of visibility of demand and therefore potential to overspend to compensate for this
- Declaration of a major incident if allowed to continue, which could impact up to circa 11 million of our customers
- Potential surge in calls from customers that could impact our ability to adhere to standards of service
- Inaccurate capacity booking, which has consequences for consumer charges
- Loss of earnings/production for industrial and commercial customers, and the loss of service to other critical providers including hospitals
- Breach of the following Gas Act 1986 requirement: “develop and maintain an efficient and economical pipe-line system for the conveyance of gas” (Part 1, Section 8S, 9(1)(a)[1])
- Non-compliance with and breach of, Standard Special Condition A11(3) of the Gas Transporter's Licence in relation to the Uniform Network Code (**UNC**)

- Financial liability under our statutory regulations of Guaranteed Standards of Performance (**GSoP**) which sets out the minimum levels of service that distribution network companies must provide to their customers[16]
    - GSoP 1 - Gas supply restoration following an unplanned interruption: Cadent's financial liability could be as much as £847m for every 24-hour period during which the service failure continues (assumption based upon 11 million customers with a 70/30 split between domestic and commercial customers respectively). Please see the "GSoP 1 Payment" tab of Appendix 04 for the calculation
      The above worst-case scenario would arise where offtakes, reliant upon the [software] communication as the primary comms network, are having to run solely on the secondary comms system. If that system then fails there is no back-up therefore no resilience, leading to Cadent managing demand without any operational visibility.
    - GSoP 3 - Domestic customers on the Priority Services Register (**PSR**): liability in this case would be up to £525 per affected customer from this register, in addition to the GSoP 1 liability
- Loss of revenue on the current Leakage & Shrinkage / Emissions incentives, and increased risk of safety related incidents such as increased gas escapes

These telemetry networks are separate to other business data networks and are limited to providing SCADA control communications. The network utilises a combination of satellite communications and hill-top radio, coupled with [hardware] / [hardware], [hardware] and [hardware] for back-up. The communications network and associated energy management systems are classified as CNI.

The primary objective of this investment is to maintain our critical data collection system connectivity, enabling us to monitor and control our networks, and collect operational data to ensure safety and reliability.

Chapter 3.2 - Project 1: Risks Identified

When this risk emerged in July 2021, we set up a project to mitigate it, and in doing so we carried out a risk assessment on financial and reputational impacts versus likelihood of the risk becoming an issue. This gave us an overall risk score, and a target score of where we would want to be once all mitigating actions and controls were put in place.
Since the project began, we started to implement mitigating actions and controls, and have subsequently reduced our overall residual (current) risk score. This can be seen in the figure below:

[16] 2021-22 Notice of Rights for GSoP payments

Figure 5 - Analysis of Relevant Risk

In Cadent the risk is assessed on and calculated against three specific criteria: the risk score is calculated by multiplying the likelihood by the higher of the financial or reputational impact. For further detail please refer to Cadent's Risk Management Standard (Appendix 05).

The proposed intervention to mitigate the inherent or principle risk provided a target score 4 which was driven by the reputational impact and likelihood of the risk. However, after having applied the controls through the delivery of this work to mitigate the principle risk when this was assessed, we discovered we had surpassed our target score by lowering the reputational impact and the likelihood.

Cadent is currently in contract with [third-party] and has been since before decoupling from National Grid. The contract sets out the provisions of a fully managed CNI telemetry service, and Cadent were therefore contractually bound to evaluate options in conjunction with [third-party] through their supplier framework. If Cadent were to have sought an independent contract directly with the Satellite provider, this would have been subject to a full tender procurement process, including the provision of sustainable support for the enduring service. This would have taken in excess of 12 months to conduct from start to finish: drafting and tailoring the necessary tender documentation; a minimum of a two-month window on the Find a Tender portal to allow suppliers to submit responses of a sufficient quality; subsequent response evaluation; shortlisting and interviewing/presentations from shortlisted candidates; award and two-week standstill period; contract negotiations and conclusion. This would have been financially inefficient and would have increased the risk of not delivering pre-requisite migration work before [CNI-sensitive data] was decommissioned. Having explored these options, Cadent decided that the value to our customers resided in leveraging the existing contract we have with [third-party].

Chapter 3.3 - Project 1: Option Selection

Upon receiving the notification regarding service termination, Cadent began working with the [third-party] satellite team to investigate viable replacement options. These are detailed below but in summary, the analysis demonstrated that transitioning to [third-party]'s replacement [CNI-sensitive data] satellite was unviable: the [CNI-sensitive data] does not offer service within the [CNI-sensitive data] the so called [software] [CNI-sensitive data] which is [CNI-sensitive data] and is the [CNI-sensitive data] used today [CNI-sensitive data] by the Cadent GRSC network on [CNI-sensitive data]. Furthermore, [CNI-sensitive data] are subject to

increased interference, which creates frequency co-ordination issues, increases network complexity by using a combination of both polarisations, and requires a [hardware] refresh for all remote terminals.

Consequently, an alternative satellite was selected, which required only a change of frequency on the [software] equipment (remote sites and hub) and a realignment of remote site [software] antennae.

Satellite Replacement Options – Detailed analysis

For comparison, the satellite reaching end-of-life was [CNI-sensitive data] (Launched 2009)

The key services:

- Professional Video
- Broadband
- Business Networks
- Telecommunications

The Cadent application used to provide Gas Distribution telemetry services is SCADA. The satellite capacity of [CNI-sensitive data] sits in the [CNI-sensitive data] for [software] services in the UK, as below:

Figure 6 – [CNI-sensitive data] Footprint

Options Analysis Methodology

To determine the most suitable solution to deliver the capability required, each potential option was evaluated against the overall Cadent business objectives, and the technical fit required. The definitions of each business objectives can be found in Cadent's Options Analysis Methodology (Appendix 06).

Each option was assessed against the business priorities as shown in the figure below:

Figure 7 – Overview of Options Assessment – Business Objectives

*Due to the time-critical nature of finding a replacement solution, technical feasibility was afforded greater priority in terms of option analysis and selection. Consequently, both options 2 and 4 were discounted as viable options prior to cost information being gathered. We felt it would have been remiss of us, regarding resource and value-for-money, to continue exploring options that were technically unviable for our estate.

Technical Criteria:

The summary for each option (below) provides the rationale for either discounting or shortlisting:

Figure 8 – Overview of Technical Feasibility Assessment

Option 1: Do Nothing – Discounted

We have discounted this option because from end March 2023 the current Satellite will no longer be available resulting in a 'go dark' situation, in which CNI sites relying on this technology will no longer transmit business-critical data back to the central SCADA system.

There are a number of sites which have a secondary backup, and a 'go dark' situation will result in them becoming the primary, with no backup, thus no contingency. Under The Network and Information Systems (**NIS**) Regulations 2018, business continuity and crisis management measures must be in place to manage cyber security risks and resilience; the absence of a satellite service would not allow Cadent to meet this requirement, leaving it vulnerable in the event of a cyber-attack.

The 'do nothing' option, in addition to the consequences set out above (Chapter 4.1 - Needs Case), would therefore put us at risk of breaching NIS requirements and/or weakening the controls we have in place.

Furthermore, Cadent manages capacity through a mechanism of submitting Offtake Profile Notices (**OPN**) to ensure there is sufficient gas in addition to the Line pack, to meet anticipated customer demand. The calculation of the demand is dependent on actual data from site and historical data on customer consumption behaviour.

The absence of data from these critical points means Cadent would either have to secure engineers at every one of the affected sites, to take hourly manual readings within the Statutory Gas Day or rely solely on historical data to manage demand and submit the OPN's at each offtake.

This would impact our resource capacity and could result in Cadent booking capacity above the agreed allowance at a premium cost to our customers. Conversely, booking insufficient capacity could result in an increased number of calls into our Emergency Call Centre, and the deployment of our First Call Operative Engineers (**FCO**) to deal with loss of pressure or supply to our customers under our Emergency Standards of Service (**ESOS**) obligation. This would likely result in an increase in our Operational expenditure (**OPEX**) and thus costs to our customers.

Option 2: [CNI-sensitive data] - Discounted

[third-party] procured [CNI-sensitive data], a new [CNI-sensitive data] satellite built on the [CNI-sensitive data] platform. Launched in 2022, the satellite is located at [CNI-sensitive data], an orbital position that offers a unique visibility spanning from the [CNI-sensitive data]. Responding to strong growth in demand for mobile connectivity, [CNI-sensitive data] carries two new multi-beam High-throughput satellite (**HTS**) [CNI-sensitive data] payloads:

- a high-capacity payload, covering the [CNI-sensitive data], offering significant throughput in the busiest air and sea traffic zones; and

- a second payload to extend coverage across the [CNI-sensitive data].

The satellite's HTS payloads can process more than 50 GHz of bandwidth, offering a throughput of approximately 35 Gigabytes per second (**Gbps**). [CNI-sensitive data] also carries two widebeam [CNI-sensitive data] payloads to ensure service continuity for existing customers on the [CNI-sensitive data] satellite.

Key services

- Broadband
- Data
- Government affiliation
- Mobility
- Professional Video

Migration to [CNI-sensitive data] Assessment:

[CNI-sensitive data] does not offer service within the [CNI-sensitive data], the so called [software] [CNI-sensitive data], which is exempt from [CNI-sensitive data] and is the [CNI-sensitive data] used today by the Gas Remote Site Communication network on [CNI-sensitive data].

Instead [CNI-sensitive data] operates in the [CNI-sensitive data] (Terminals) and [CNI-sensitive data] (HUBs/GW Earth Stations), requiring a [hardware] license for each [software] site as well as the hubs. To operate each [hardware] a license must be granted by [CNI-sensitive data]; the fees for which range from [CNI-sensitive data], in the specified bandwidth[17]. The license can incorporate any number of earth stations that are located within 500 metres of a nominated centre point for the license, but the additional license fees mean this option presents less value for money than the other options considered.

Furthermore, the length of the antenna is directly related to the wavelength of the working frequency, and the minimum antenna size is [CNI-sensitive data]. [third-party] subsequently offered the use of [CNI-sensitive data] for the National Grid (**NG**) Network. However, to operate in the [CNI-sensitive data] [CNI-sensitive data], the current [CNI-sensitive data] network requires an antenna polarisation change, which would necessitate a visit to every site including hubs.

Figure 9 – [CNI-sensitive data] downlink footprint

A transfer of service to [CNI-sensitive data] would require the following:

- Creating a new network on the opposite polarisation using the [CNI-sensitive data] hub, as per the newly issued transmission plan
- Visiting all sites to change [hardware] polarisation and transfer [software] to the new network

[17] Section 4.12 - 4.21 Spectrum pricing (OfCom.org.uk)

- Once transfer is completed, realigning the [CNI-sensitive data] hub to [CNI-sensitive data] on the opposite polarisation
- Arranging [hardware] licenses for all [software] terminals and adjusting the existing Hub [hardware] license if required
- Once [CNI-sensitive data] is ready, [third-party] would issue a new transmission plan and on a planned outage, would change the hubs' frequency to that of the new transmission plan. The uplink frequencies would then either be in the licensed extended [CNI-sensitive data] (HUB), or the [CNI-sensitive data] for the [software] terminal

This option was discounted because it was discovered that the replacement satellite would have had a different configuration (spot-beam), which means that the antenna radiation pattern would only serve coverage to a small or isolated geographical area. Furthermore, operating outside of the [CNI-sensitive data] risks interference from other competing services. Consequently, this option fails to provide Cadent with the resilient communication network needed to enable the safe operation and maintenance of our gas networks, rendering it unviable for the Cadent [software] estate.

Option 3: Satellite [CNI-sensitive data] – Preferred Option

Realignment to an alternative satellite – [CNI-sensitive data] (Manufactured by [third-party]; Launched: 2013)

[CNI-sensitive data] shares orbital position with [CNI-sensitive data], providing a [CNI-sensitive data] constellation which results in enhanced coverage, flexibility, and connectivity. As part of [third-party] fleet performance polarisation and technology evolution, it may not be possible to guarantee continuity of frequency and polarisation of both satellites, however there is no indication that either will be retired; on the contrary, due to their orbital position [third-party] has seen significant growth in customers. [third-party] therefore expect to continue operation of the [CNI-sensitive data] position for the foreseeable future, making this constellation a viable option for future proofing Cadent's satellite connectivity.

Key services: [CNI-sensitive data]

- Broadband
- Data
- Direct-to-Home
- Professional Video

Key services: [CNI-sensitive data]

- Broadband
- Data
- Government affiliation
- Professional Video

The input (receiver) and output (transmitter) frequencies of [CNI-sensitive data] are pre-assigned to a range which is incompatible with the [CNI-sensitive data] frequency range

Cadent would want to operate to ensure a robust and reliable communication network. This is not true of [CNI-sensitive data], which additionally will not reach end-of-life until 2039.

Figure 10 – [third-party] [CNI-sensitive data] Downlink footprint

[CNI-sensitive data] is our preferred option because it is the most cost-effective option to secure a good technical fit for our existing services:

- Transition to [CNI-sensitive data] does not require any design changes to the current platform other than adjustment to the antenna until the [CNI-sensitive data] signal is achieved.
- Allocated capacity is within the UK [software] [CNI-sensitive data] to negate the risk of interference by another third-party using the same frequency.
- The satellite is only [CNI-sensitive data] degrees orbital location from [CNI-sensitive data] so line of sight issues is unlikely, meaning similar levels of robust connectivity.
- Transition to [CNI-sensitive data] does require a site visit to repoint all [software] to the new satellite, but the cost impact of this is somewhat mitigated by the efficiency savings that result from having no design changes.

In summary, the [CNI-sensitive data] satellite provides very similar coverage to [CNI-sensitive data], giving assurance of service reliability, resilience, and performance. Furthermore, because the [CNI-sensitive data] is retained, additional licence fees and potential third-party interference issues are avoided.

Option 4: Satellite [CNI-sensitive data] – Shortlisted, but discounted due to availability

Realignment to an alternative satellite – [CNI-sensitive data]

The key services are:

- Direct to Home (**DTH**)
- DTH Television
- Voice/Data Networks
- Broadband Applications

Figure 11 – [third-party] [CNI-sensitive data] Downlink footprint

Although [CNI-sensitive data] is within the UK [software] [CNI-sensitive data] with similar coverage to [CNI-sensitive data], and transition to [CNI-sensitive data] does not require any design changes to the current platform (beyond a frequency change), it is not a good technical fit for our existing services:

- The satellite orbital location is [CNI-sensitive data] degrees further [CNI-sensitive data] from [CNI-sensitive data], so line of sight issues is very likely at a number of sites which risks our connectivity

[CNI-sensitive data] would be unable to deliver the reliability required for our CNI due to potential line of site issues, however this option was essentially discounted because the satellite will not be launched until [CNI-sensitive data]. The current satellite service ends in 2023 thus this option would have resulted in a 'go dark' situation in which those CNI sites relying on this technology, would no longer transmit business-critical data back to the central SCADA system, therein compromising our ability to safely operate our networks.

Option 5: Defer evolutionary solution until funding awarded.

We have discounted this option because from [CNI-sensitive data] the current Satellite will no longer be available thus resulting in a 'go dark' situation. This option would therefore have the same risks and consequences as Option 1 (Do nothing) and would not be in the best interests of our customers or our business.

Chapter 3.4 - Project 1: Preferred Option

Cadent's preferred option is Option 3 – Realignment to an alternative satellite [CNI-sensitive data]

This was our preferred option because it was the best technical fit for our existing services whilst providing the longevity of service to ensure value for money. This is a modern, high-

powered satellite that provides robust connectivity, supports the same [CNI-sensitive data] as used today, and is available in time to ensure no loss of service during transition. By moving to this solution, we will:

- Only need to make frequency changes at site, the costs of which are mitigated by both efficiency savings resulting from having no design changes and thus retaining existing physical infrastructure and avoided costs in terms of not having to undertake hardware refreshes, polarisation changes, or incur additional licence fees.
- Negate the risk of third-party interference because allocated capacity is within the UK [software] [CNI-sensitive data].
- Avoid line of sight issues and thus retain robust connectivity because the satellite is only [CNI-sensitive data] degrees orbital location from [CNI-sensitive data].
- Retain the same level of service reliability, resilience, and performance as our current service because the satellite coverage is very similar.
- Future-proof Cadent's satellite connectivity because [CNI-sensitive data] will not reach end-of-life until 2039

To mitigate against loss of business-critical data and the associated consequences (Chapter 3.1 – Needs Case), existing contracts were novated across to the new [CNI-sensitive data] solution from 2023.

The investment requested is for the implementation of the proposed solution, including:

- Identification of an alternative satellite communications service
- Pilot and Migration schedule planning
- Non-Routine Operations (**NRO**) procedural preparations
- Site access resource allocation
- Migration of the temporary ([CNI-sensitive data]) satellite hub infrastructure to a new location within the [third-party] [CNI-sensitive data] site
- Realigning the remote site [software] antennae to the replacement satellite
- Transition to the new satellite

CNI Assets in scope:

The [CNI-sensitive data] CNI sites that are in scope are categorised as below:

- Offtakes
- Above Ground Installations (**AGI**)
- Biomethane Injection sites (**BIO**)
- Hilltops (**HT**)
- Pressure and Volumetric sites

The telemetry installed at our operational sites is varied; the codes used to refer to these technologies are listed below:

- [CNI-sensitive data] – This code means [software] communication only – no secondary back up communications or resilience at site
- [CNI-sensitive data] – This code means [software] primary communications with [software] back up – site resilience due to criticality of the site, Offtake or large Pressure Reduction Site

- [CNI-sensitive data] – This code is for [software] primary communications with [software] back up – site resilience due to criticality of the site, Offtake or large Pressure Reduction Site
- [CNI-sensitive data] – [CNI-sensitive data] sites that are hanging off hilltop sites, visible on the SCADA System Interface pages

Chapter 3.5 - Project 1: Technical Feasibility and Consumer Benefit

As part of our Solution Delivery Framework, Cadent tracks and documents project risks and opportunities through a project's lifecycle, ensuring that they are reviewed and managed appropriately. Under this risk management framework, we identified a number of project risks whilst considering project options; these are provided in the table below:

Figure 12 – Risks to Project Delivery

Technical Approach:

The approach to migrating to the replacement satellite is split into two discrete elements:

- Reconfiguration of satellite hub and process for migration
- Remote site migrations

Items in Scope:

- Relocation of [CNI-sensitive data] satellite hub
- Configuration of [CNI-sensitive data] satellite hub to production status
- Configuration of 1 of the 2 existing satellite hubs ([CNI-sensitive data] & [CNI-sensitive data]) to the new satellite
- Configuration of local and remote management for the hubs
- Migration of [software] sites to the new satellite e.g., alignment of the dishes to the new satellite:
    - site access and validation by Competent and Authorised Engineers under Safe Control of Operations (**SCO)**

  - raising change requests, per site, in [software]
  - signing off change requests in line with agreed processes
  - reviewing and approving documentation promptly to ensure timescales are met.
  - conducting NROs for sites as required
- Provision of circa 20% spare dishes, and [hardware] and [hardware], to account for any that cannot be realigned without damage.
- Provision for repeat visits at 10% of sites

To enable communication with the replacement satellite ([CNI-sensitive data]) from existing satellite hubs, the hub configuration needed to be updated to the frequency of the new satellite. To mitigate the risk of a 'go dark' situation and ensure geo resilience and contingency, Cadent used a temporary hub at the [CNI-sensitive data] site to ensure connectivity throughout the migration. Specifically, Cadent reconfigured the hubs at [CNI-sensitive data] and [CNI-sensitive data] to the new satellite, leaving the temporary hub ([CNI-sensitive data]) at the [CNI-sensitive data] site configured for the existing satellite. Once all sites had migrated to the new satellite, the hubs at both [CNI-sensitive data] and [CNI-sensitive data] were pointing to the new satellite and the temporary hub was returned to its storage location.

The change from the [CNI-sensitive data] satellite to the [CNI-sensitive data] required an alignment change of [CNI-sensitive data] degrees [CNI-sensitive data], as well as a minor vertical alignment change. This necessitated a visit to each [software] site, to physically reposition the dish on site to align to the new–satellite, and to change the frequency configuration of the [software] equipment.

A line-of-sight risk was identified with regard to the [CNI-sensitive data] degree alignment change, which could have resulted in the relocation of the dish on site to an alternate location or mounting point. Rather than conducting sample surveys at 20% of sites to identify any unexpected issues such as this ahead of site work commencement, Cadent decided to account for the potential of a 10% revisit rate to address any issues found on the basis that it is more cost-effective to incur costs for issues that have materialised than for investigating whether there may be issues to address.

A further risk was identified concerning mountings, bolts and other components being beyond their usable life due to the age of our on-site dishes. To mitigate this risk, it was decided that 45 spare dishes (including dish [hardware]) and mounting equipment, were to be carried by engineers throughout their site visits. Thus, if a dish were unsuitable for repositioning or was damaged during the process, it could be replaced by one of the dishes from the spare holding, mitigating both the need for, and the costs associated with, additional site visits.

Stakeholder Engagement

External stakeholder engagement was not appropriate for this project due to the assets in question being categorised as CNI. From a customer perspective, the most important objective of this project is to maintain safety and security of supply.

Internal stakeholder engagement was undertaken with the Energy Control Centre (**ECC**) to define up-front technical and non-functional requirements.

The options analysis was presented to the IT leadership team and approval was sought based on the recommendation provided. Costs were sanctioned accordingly.

Chapter 3.6 - Project 1: Project Delivery and Monitoring

As given, Cadent's incumbent supplier for the management of satellite technology is [third-party]. Therefore, the delivery of data collection systems relating to our CNI network sits with [third-party], who utilise a waterfall methodology.

The table is an extract of the rollout following the successful migration of [CNI-sensitive data] sites starting from February 2022:

Figure 13 – Extract of Rollout Plan

Key:

- Offtakes
- Above Ground Installations
- Biomethane Injection sites
- Hilltops
- Pressure and Volumetric sites

Work Breakdown Structure (WBS)

All projects in our IT&T investment plan have an initial WBS developed. The approach taken is guided by our Solution Delivery Framework. This investment case shows the delivery plan developed using the initial WBS, which was also used to develop resourcing and cost profiles. Full detail of the latter is available within the "User Guides" tab on the excel document provided as Appendix 07.

The process of developing the Work Breakdown Structure also supports the identification of Risk and Opportunity within and across our investments.

Team Structure and Resources required for this project were as follows:

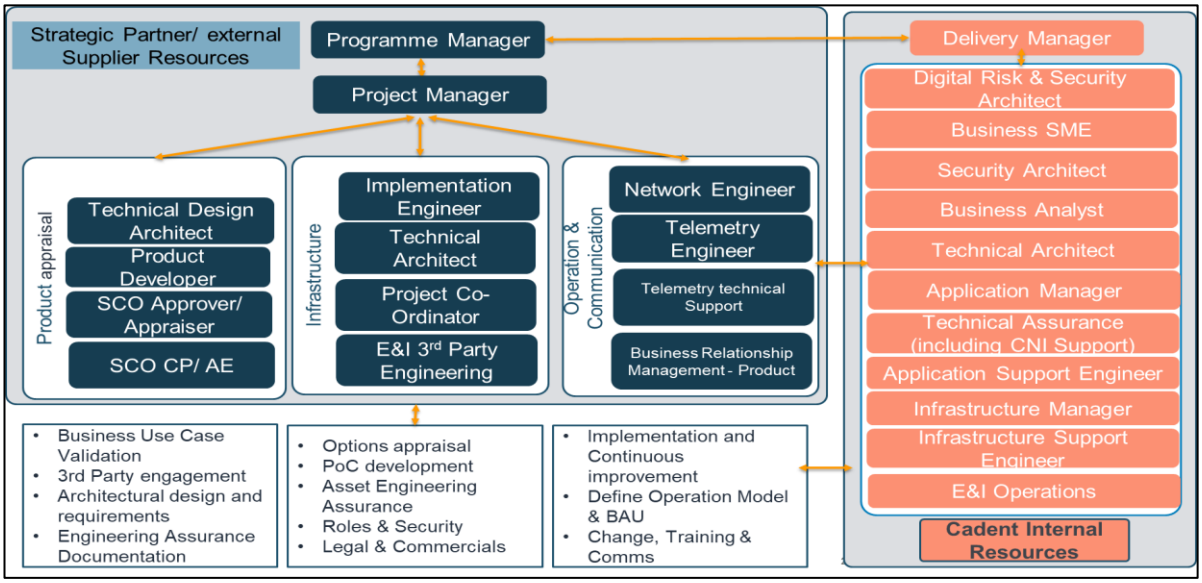

Figure 14 – Team Structure and Resources

Detailed Method Statement:

1. Introduction

This work instruction will describe the methodology of the required works to realign the satellite antenna by [CNI-sensitive data] degrees from [CNI-sensitive data] to [CNI-sensitive data].

2. Site Induction

On arrival at site, the [third-party] engineers will be met and escorted from the gates by Cadent Key Holder/Engineer. Covid procedures to be followed - Reference Doc 21.19 Rev2 Risk Assessment COVID 19 & COVID-19 Safe Operating Procedures February 2021.

[third-party] are to wait for confirmation from the Cadent Operations Competent Person that the site is approved to go. This will be a daily call between Cadent and [third-party] at approximately 08:30. A Work/Safety permit is to be obtained prior to starting work.

3. Health and Safety inspection

The [third-party] engineers and Cadent site contact will carry out a visual inspection of the work areas, satellite antenna and ISS Kiosk/Telecoms rooms to ensure there are no H&S concerns in addition to those covered in the permit issued, preventing the work from taking place. If there are additional H&S concerns, work will stop work and the [third-party] engineers will refer to the Cadent site contact for advice, and amendments to the permit where applicable.

Documents to be referred to:

- [third-party] Health and Safety Plan

- Setting up the work area - Doc 21.15 Rev 1 Risk Assessment Exclusion of Unauthorised Personnel
- Access to the satellite Antenna - Doc 21.5 Rev 3 Risk Assessment Use of Mobile Scaffold Tower
- Manual Handling requirements - Doc 21.10 Rev 3 Risk Assessment Manual Handling

For the detailed method of working, please view Appendix 08.

Key Performance Indicators

Project Progress Reports were published monthly internally to Cadent operation leads, to provide assurance and confidence in tracking the project delivery. Below is an example of indicators which were used against known sites: To Be Completed Vs Completed sites (by Network and Technology):

Figure 15 – Current Performance of Preferred Option

Post Delivery Testing & Acceptance

Cadent successfully completed the activities outlined as in-scope, under the Technical Approach (Chapter 4.5 – Technical feasibility and consumer benefit). Daily site monitoring to assure that Service Level Agreements (**SLA**s) had not been breached were undertaken to assure security of supply to our customers.

Telemetry Statistics of availability against SLAs for ([CNI-sensitive data]) **2023, post realignment**:

- All communication technologies are within SLA at between 99-99.8% and all within expected levels, as reflected in the table below:

Figure 16 – Telemetry Stats for Availability post realignment
('[software] – all' is a cumulative average of the [software] only part of all gas remote sites which have a [software] element ([software] only))

- Cadent monitoring has demonstrated that in some areas there has been a marginal improvement in service thus providing improved resilience for our customers.
- There have been 'zero' Satellite loss incidents since realignment.

Telemetry Statistics of availability against SLA, by technology and service criticality for ([CNI-sensitive data]) 2023, post realignment:

Figure 17 – Telemetry Stats for technology and service post realignment

The preferred solution for our CNI telemetry has provided confidence concerning the control of our networks, to deliver safety and reliability for our customers.

Chapter 3.7 - Project 1: Cost Information

As this is a retrospective application and Cadent has completed the work, the costs borne by Cadent, as reflected in the "Cost Summary 18/19 prices" tab in the tracker in Appendix 04, are actual costs incurred.

A summary of the cost, in 18/19 prices, is shown below:

Figure 18 – Total Overall Adjustment Required (18/19 prices)

The network split is shown in the “Network Split” tab of Appendix 04.

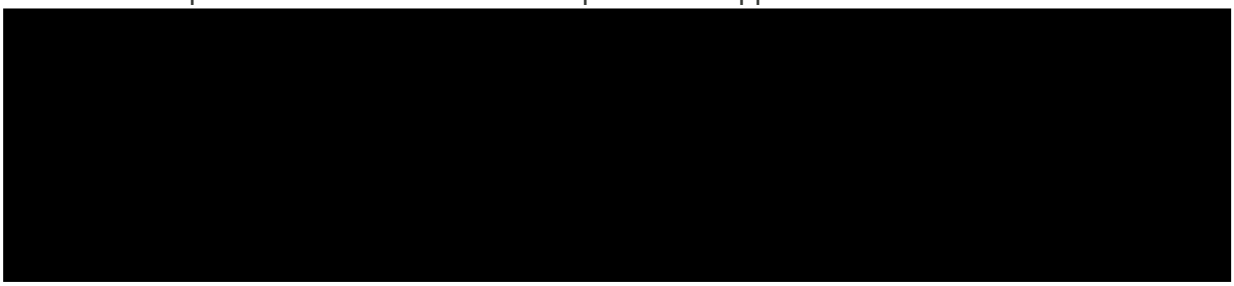

Figure 19 – East of England Adjustment Required (18/19 prices)

Figure 20 – London Adjustment Required (18/19 prices)

Figure 21 – North West Adjustment Required (18/19 prices)

Figure 22 – West Midlands Adjustment Required (18/19 prices)

Chapter 4.0
Project 2 – Operations Transformation: Multiple Occupancy Buildings

Chapter 4.1 – Project 2: Problem Statement and Needs Case

Adjustment rationale

An adjustment to Cadent's RIIO-GD2 business plan is requested for the following:

1) **Update to G5 Edition 3 policy**

Given recent focus on and advances in MOB safety, and to ensure that we are trusted to act for our communities, are delivering a resilient network that keeps energy flowing safely and are providing a quality experience to our customers, Cadent has adopted the full G5 Edition 3 policy, set out by the Institution of Gas Engineers and Managers (**IGEM**)[18]. This new standard combines the most up to date best practice and guidance from legislation and existing gas industry standards, to improve safety design and operation throughout the asset lifecycle. The decision to adopt this new standard comes with several direct impacts to Cadent systems that were not known at the time of the original business plan submission:

- Professional competence of individuals
- MOBs risk hierarchy
- Construction Design and Management (**CDM**) regulations roles and responsibilities
- Recording/sharing of data with building owners or responsible persons
- Changes to asset design process

2) **Requirement to capture data and digitalise asset management processes for new classes of MOBs**

Recent industry research and the evolution of building standards has uncovered further levels of granularity that must be considered when looking at the management of gas assets in MOBs. As a result, the scope of MOBs has been extended to include specific processes and management of certain subsets of MOBs gas systems. Previously, these subsets were managed in the same way as either HRBs or MRBs; however, these subtypes of MOBs have emerged with specific challenges that mean a new risk model is required if Cadent is to continue following industry best practice and putting customer safety first.

[18] IGEM/G/5 Edition 3 - Gas in multi-occupancy buildings with amendments April 2023 (https://www.igem.org.uk/resource/igem-g-5.html)

The existing risk model and process only mitigates risks to HRB and MRB, leaving a gap where safe asset management of the new MOB subtypes cannot be guaranteed for customers if this is not addressed now. Therefore, a new risk model must be implemented to ensure customer safety interests are being properly mitigated. A refined risk model means new source data, processes, outputs, and subsequent operational activities, and technology investment is necessary to deliver these unique and targeted processes. The subsets of MOBs are as follows:

a. Multi-Occupancy Commercial Structure (**MOCS**) – MOCS cover large establishments, sometimes with multiple meter points and certainly with intricate internal gas supply systems, for example: hospitals, shopping centres, office blocks. The risk model is significantly different to an MRB or HRB which are typically residential, thus there are additional data capture requirements as well as modifications to asset models and reports.
b. Large Diameter Services (**LDS**) – LDS are exceptionally large service pipes, delivering higher volumes and pressures of gas than are normally delivered to a MOB. As well as needing effective identification in asset management systems, these subtypes have additional data capture requirements to inform investment models.
c. Meter Banks (**MB**) – MBs occur when all the residents in a MOB have their gas meters grouped together on a single piece of gas infrastructure, typically in a basement or utility space, instead of individual gas meters next to each property. Cadent must maintain this infrastructure safely, necessitating the requirement to capture specific data attributes and update investment models

3) **Requirement to track and report on new types of operational activity, not previously in scope.**

Cadent is planning significant operational investment into surveying and remediating MOBs asset systems. To understand the full extent of this workstack and plan the most effective interventions, more comprehensive data sets and volumetrics are required. This investment is to deliver the technology that will inform this process, ensuring Cadent operations deliver the right interventions, at the right time to safeguard our customers and deliver value for money. Moreover, this information is vital for accurately forecasting the operational effort and resource required for future years. The focus areas for new technology and field data capture are:

a. Fault remediation for HRB and MRB – previously, focus for MOBs was on the gas distribution assets (risers, laterals, valves) critical for safe delivery of gas to properties. However, there are many indirect supporting assets such as brackets, labels and valve cover, as well as less tangible maintenance activities such as removing trip hazards, which require operational effort to maintain or rectify. Capturing this information supports the full delivery of Cadent's MOBs programme to ensure safe and reliable gas supply to Cadent's customers.
b. MOCS fault remediation and interventions
c. LDS fault remediation and interventions
d. MB fault remediation and interventions

Business Objectives

The purpose of this adjustment is to provide the investment necessary to implement the Information Technology (**IT**) change required to deliver business outcomes and objectives in managing MOBs assets; workforce; risk and data effectively. These can be summarised as:

1. Improving quality and efficiency of collecting MOBs asset and operational data
2. Automating manual processes to remove waste and further improve data quality.
3. Increasing resiliency and supportability of the technology solution

Desired Business Outcomes

An independent review of MOBs operational and asset management processes, carried out by the external consultancy group [third-party], defined a set of key business outcomes that are required to transition to the target operating model (Appendix 09). These recommendations were a mixture of people, organisation, process and technology themed outcomes. The technology outcomes that this investment is intended to deliver are as follows:

1. Enhanced audit capabilities for all work undertaken at a MOBs building level
2. Systematised end-to-end works management system for LDS and MBs
3. Removal of unsupported IT from delivery of the core process
4. Systematised end-to-end works management system for MOCS
5. Delivery of MOCS survey field data capture solution (incl. risk model and question set)
6. Efficiency improvements via the automation and cleansing of the survey process
7. Automation of Data & Risk Score update to [software] (geospatial and mapping systems [software]) & [software]
8. Adoption of G5 Edition 3
9. Improving the efficiency and accuracy of the Annual Safety Case review regarding candidate buildings and out of scope evidence delivered
10. Centrally capturing minor faults identified/ rectified during survey at a more granular level
11. Centralisation of work status tracking across all network survey completions into core systems
12. Data to be held in core systems and reported on from single source of truth

These outcomes are repeatedly referred to when outlining the strategy; scope; plan and cost estimates described later in this project.

Investment Needs Case

Cadent maintains a vast network of interconnected assets and complex systems that have to deliver gas safely and reliably to customers. Each gas system on a high-rise building, medium rise building, commercial structure or a building with a meter bank is an example of an intricate engineering system with specific maintenance requirements and regulations. The complex nature of these constructions requires special attention and increased investment to ensure safety, compliance and reliability are preserved for Cadent's customers.

Failure to invest in the IT systems that support this process can lead to:

- Creation and propagation of data silos: operational and engineering decisions are taken out of context. This could impact the integrity of a MOBs system and the efficiency of asset investments
- Inefficient, manual processes: increased overheads and manual data entry errors that reduce the customer's value for money and negatively impact asset investment decisions
- Inability to maintain compliance with G5 Edition 3 standards as best practice, impacting safety, risk and cost decisions as well as increasing the likelihood of interrupted gas supply to the customer due to planned or unplanned work resulting from suboptimal investment decisions
- An inability to demonstrate G5 compliance with regards to the management of skills and accreditations: without adaptation our current systems and processes could lead to G5-unqualified employees designing or maintaining complex MOBs systems.
- Increased risk of interruption to customer gas supply due to planned or unplanned work resulting from suboptimal investment decisions

All of these potential deficiencies lead to multiple operational risks that directly impact the safety of the customer and the security of their gas supply. Investment in our IT systems is essential to avoid these consequences.

Finally, there is an opportunity to reduce the future costs of investment and maintenance on behalf of the customer, by streamlining processes and acting upon more accurate data and modelling. By investing in the IT systems, less time would be spent capturing, cleansing and checking data, with more time spent understanding models, risks and impacts of each asset investment decision.

Chapter 4.2 - Project 2: Risks Identified

Figure 23 displays the major risks, and respective mitigations, associated with this investment.

Figure 23 – Identified Risks

Overall IT Plan Dependencies

Notwithstanding the IT strategic alignment, this investment cannot be realised in silo and there are several dependencies on other inflight RIIO-GD2 Cadent IT business plan investments that need to be mitigated and monitored. There are options to diverge from the solutions provided by existing investments (*Chapter 4.3 – Option Selection*), however this represents poor value for money for the customer and contradicts Cadent's architecture principles and IT strategy. It is therefore important to consider and plan in line with these dependencies. Moreover, there are future investments that will be dependent on the success of this investment.

Specific details of the dependencies are detailed in the project scope. At a high level, the 'Operations Transformation – MOBS' investment is dependent on the following RIIO-GD2 investments[19]:

- INVP 5404 [software] Replacement Retender
    - This investment will deliver the modernised geospatial and mapping systems. This is required to provide the tools that give Field Operatives spatial awareness and the ability to capture data with a spatial context, e.g. locating an isolation valve for a MOB. [software] and [software] are examples of tools that will be reused

- INVP 5409 HR Payroll and Workforce Transformation
    - This investment will transform how Cadent manages, delivers, and monitors employee certifications and training. This includes an enhanced systemised approach, with automation and direct links into operational processes
    - To fulfil this requirement and the changes to MOBs policy, this investment will leverage the Learning Management System (**LMS**) delivered by INVP 5409

- INVP 5501 Operations Transformation
    - This investment delivers continuous improvement and efficiency to Cadent's work management system [software], as well as rationalising and integrating standalone mobile applications
    - This field mobile technology will be reused and built upon. It is therefore vital to the success of future-proofing the proposed adjustment, as well as to securing efficiency gains in future investments that build upon this technology

- Non-operational IT Capex Re-opener – Open Data Portal
    - This investment delivers the required technology to achieve Cadent's target data architecture that will support the Open Data Portal
    - Data is central to successful asset and operations managements, and this investment will provide the tools for MOBs information to be prepared and distributed successfully across the organisation and externally where appropriate

[19] Appendix 09-30 Technology IT and telecoms v2.0- REDACTED (cadentgas.com)

- Moreover, there is growing pressure from local authorities and building owners for access to information about the gas assets within their jurisdiction; the Open Data Portal will prove vital for this purpose

The following investment to be delivered by this project, is a prerequisite to enable future investments in the 'Operations Transformation – MOBS' project:

- MOBs Safety
  - This investment is to carry out the necessary operational interventions that will maintain MOB assets to a safe and secure level for our customers. This includes resolution of faults identified through the survey process and additional work required as a result of legislative changes. The applications deployed by this Operations Transformation – MOBs investment will be vital for capturing critical datasets, interpreting them accurately and acting on the recommendations output via asset investment models. The data will also ensure complete and cost-efficient investment to protect customer safety and value for money.

Chapter 4.3 - Project 2: Option Selection

Options Analysis
At a high level, the options considered were:

1) **Maintain current processes and systems (Do Nothing Option):**
   - Maintain existing manual processes
   - Maintain disparate MOBs data capture and asset management systems

2) **Automation, and procurement of new IT – greenfield (Market-Based Option)**:
   - Market test and tender event
   - Automation of existing manual processes
   - Procure new MOBs data capture and asset management system
   - Full integration with existing IT landscape
   - Re-engineer existing MOBs process to fit new landscape
   - Blend of waterfall and agile methodologies
   - Rationalise disparate MOBs data capture and asset management systems
   - As part of this option analysis, two sub-options were explored to validate whether there would be any further advantages or disadvantages:
     A. **2a:** *Market sourced [software] certified IT solution*
     B. **2b:** *Market sourced [software] certified IT solution*

3) **Automation and reuse of IT – evolutionary (Preferred Option):**
   - Automation of existing manual processes
   - Reuse and continually improve existing MOBs data capture and asset management systems
   - Agile software and process improvement
   - Leverage existing IT integration and infrastructure

- Rationalise disparate MOBs data capture and asset management systems
- As part of this option analysis, four sub-options were explored to validate whether there would be any further advantages or disadvantages:
    A. **3a:** Field Service Management: [software]
    B. **3b:** Cadent Community Platform: [software]
    C. **3c:** [software]
    D. **3d:** [software]

4) Defer evolutionary solution (Minimum Viable Product Option):

- Assume Solution Option 3 would be selected but the delivery deferred until the next price control
- A minimum viable product **(MVP)** must still be delivered to mitigate the risks to customers as best as possible with limited investment
- Limited automation of the current process
- Reuse existing, legacy IT applications and technology
- Maintain asset health of legacy IT applications during the intervening years to ensure continuity of business operations
- Current understanding and assumptions of costs and technology could change in future

The various options differ slightly in the technology solution proposed to deliver the data capture and automation capabilities. This is displayed below:

Figure 24 – Snapshot of Solution Differences between the Options

Each of the above options was compared against a range of metrics and success criteria as part of a rigorous options analysis process (Appendix 10), the summary of this output is described in Figure 25. The methodology for arriving at this point and the rationale behind option selection is described below.

	#1 Do Nothing	#2 Greenfield solution	#3 Evolutionary solution	#4 Defer evolutionary solution
Delivers business outcomes	Inadequate	Good	Good	Good but delayed
Change Impact	None	Maximal	Minimal	Minimal
Effort to implement	None	Maximal	Average	Average
Cost to implement (18-19 prices)	None	£3.9m	£3.6m	> £4.7m
Time to realise initial benefits	No benefits are realised	> 3 years	< 1 year	> 3 years
IT strategic alignment	Not aligned	Weak alignment	Strong alignment	Strong alignment
Operability / Supportability	High complexity and risk	High complexity and risk	Medium complexity and risk	High complexity and risk
Overall Alignment	Inadequate	Inadequate	Preferred option	Suboptimal

Figure 25 – Options Analysis against Cadent Business Outcomes

Options Analysis Methodology

Firstly, before drawing conclusions, a gap analysis starting with an end-to-end evaluation of the operational processes associated with MOBs and the current capabilities was undertaken (Appendix 11). This method identified pinch points and supported the creation of a target state of available capabilities. In addition to in-house Cadent Operations and IT stakeholders, the 3rd party engineering consultancy [third-party], was engaged (December 2021) to ensure an independent, industry best practice view would be applied to the assessment (Appendix 12).

Using this information, it was possible to conceive candidate solution options primarily based on the principles of re-using existing capabilities and technology wherever possible. The candidate solutions were compared using the metrics in Appendix 06.

Based on the strongest metrics, an architecture roadmap for the preferred solution was formed, the content of which is detailed in subsequent chapters.

The impact of other investments, external factors and governance controls were also considered during the selection process. The assessment of business and IT strategic fit accounted for existing and ongoing projects that could support or block this investment. External factors such as contractor capacity, relations with government and external bodies were also considered and further supported the driver for a solution within this price control.

To obtain operational and IT sign-off, Cadent has a review and approval process for technology and process change. Business change impacting operations is discussed and signed off by the Operations Transformation Committee (**OTC**), chaired by the Chief Operating Officer (see slide 14, Appendix 12); IT architecture change is signed off by the Technical Design Authority, chaired by the Head of Enterprise Architecture; and the priority

order for delivering various IT initiatives across the Cadent enterprise falls to the Lean Portfolio Management (**LPM**) group. Each of these stakeholders supports the options analysis process by ensuring: all requirements are considered, risks and dependencies are identified and mitigated, and alignment to business and IT strategy is secured. Lastly, budget is approved by Cadent Investment Committee (**CIC**) or by Executive Transformation Committee (**ETC**) if there is also a transformative business change impact.

Chapter 4.4 - Project 2: Preferred Option

Preferred Option Rationale

The option to do nothing (Option 1: *Maintain current processes and systems*) is always considered as part of a solutions options assessment to demonstrate the baseline position. In this case, the business outcomes set out by the independent [third-party] review are not achieved. This means that the key risks associated with the lack of investment in technology would not be mitigated, leading to comparatively increased risk of asset failure, interruption to gas supply, or danger to customer safety.

Both of the following solution options, a brand new, greenfield implementation (Option 2: *Automation and procure new IT*) versus a more iterative and evolutionary approach (Option 3: *Automation and reuse IT*), would support the successful realisation of the recommended business outcomes. Nonetheless, there are some specific challenges that mean Option 3 is more advantageous than Option 2.

Firstly, procuring a new IT solution is not in itself a complex process and is not necessarily notably expensive compared to reusing existing systems, particularly if these are legacy and highly bespoke. In this case, however, the new solution would need extensive integration with multiple existing systems and processes to align to wider Cadent operations. This greatly increases the potential cost and timescale of such a solution; on the other hand, Option 3 proposes reusing existing investments that have already overcome these challenges and are deeply embedded within the IT landscape and business operations. Solutions such as [software] (asset data management), [software] (operational work management) and [software] (spatial field data capture) are examples of significant prior investments that can be reused. System reuse not only decreases the initial investment but yields additional cost savings. These savings are realised through operational efficiency that is a consequence of minimising process change, reducing end user training requirements and down-time, and less complex technical cutovers and post go-live support.

Secondly, because Cadent is subject to Utilities Contracts Regulations (**UCR**) to ensure fairness and transparency, a new IT solution (Option 2) would need to be sourced through market research followed by a lengthy legal tender process, before implementation can commence. Consequently, business outcomes could not even start to be delivered until at least 2 years from commencement, and full delivery of all the commitments would likely be later. Conversely, reusing existing investments as proposed in Option 3, means that short term benefits can be realised sooner and the end goal for achieving all business outcomes would be much closer to initial investment.

Thirdly, there are multiple risks with introducing a new technology to the landscape (Option 2). Cadent would target a service-based solution to reduce this risk, however, the amount of bespoke integration that would likely be required presents a significant unknown to the complexity and overall supportability of the solution. Furthermore, Cadent's IT strategy and principles focus on reusing existing investments, procuring new solutions only as a last resort where there is a suitable business case and a clear capability gap. In the current state, there are no capability gaps that cannot be filled with adequate investment. The disparate nature of the current solutions and their inherent data silos, merely means that these capabilities are not being fully exploited at present.

Alternatively, there is a potential to defer investment (Option 4). This option would achieve many of the benefits of our preferred option in terms of business outcomes and strategic alignment with our IT strategy, but as with any deferral option, cost effectiveness would be intrinsically impacted by the time value of money. A minimal investment in IT systems would still be required to maintain a minimum viable product, security patches and compliance requirements. The combination of these factors makes this option a poor choice with regards to value for money. Furthermore, Cadent would be subject to the risks and consequences of failing to invest sufficiently in these IT systems (as noted in *Chapter 4.1 – Problem Statement and Needs Case*) for the duration of the deferral period, which could directly impact the safety of the customer and the security of their gas supply. Thus, this option is not considered appropriate.

In conclusion, Option 3: *Automation and reuse IT* is being recommended as the least-risk, most cost-effective option to secure value for money and realise consumer benefits in the near-term.

Preferred sub-option

There are several sub-methods and technologies available to deliver the expected outcomes aligned to the concept of Option 3; these are labelled as 3a, 3b, 3c and 3d in Figure 24 and each represents an existing solution in Cadent's technology landscape. All the solutions, a to d, have a role in meeting the business objectives tactically and strategically as described in Figure 25. This is because they have individual capabilities and levels of maturity that will be an optimal fit for different scope items.

[software] (Option 3a) is Cadent's strategic field service management tool that is already used very successfully in emergency, repair and maintenance operations. It is tightly coupled with asset management ([software]), scheduling ([software]) and geospatial ([software]) solutions, it has a mature agile release train process (*Chapter 4.6 -– Project Delivery and Monitoring*) and is a familiar tool for end users. This gives Option 3a a significant advantage in terms of reducing risk, complexity, and cost to achieve. For this reason, it is proposed that [software] will be used for workforce management and asset data capture, while existing interfaces and processes for [software] and [software] can be leveraged. The alternative solutions require additional integration development or have a low level of maturity; both aspects would compound the risk of increasing the time and cost to deliver an acceptable solution.

Project Scope

This investment must deliver on the 12 aforementioned business outcomes (*Chapter 4.1 – Problem Statement and Needs Case*). The project scope has been derived in order to deliver part or all of each of these business outcomes, noting that some deliverables are dependent upon other areas of work (*Chapter 4.2 – Risks Identified*). Each deliverable is grouped around the capability that is intended to be delivered.

To deliver the stated objectives, the project has the following key deliverables:

1. **Asset Hierarchy and Work Management structure**:
    - Updates to Cadent's system of record for asset data in Plant Maintenance ([software]) to be optimised for MOBs: HRB, MRB, MOCS, LDS, Meter Banks
    - New and updated work order types to capture accurate data on specific MOBs activities

2. **HRB, MRB Enhancements**
    - Simplify structure and usability of the HRB and MRB field survey application and master asset data updates
    - Implementation of systemised data validation and data quality checks in the field at point of capture, and upon update in the back office
    - Training and engagement with field operatives to refresh their knowledge of the technology, asset types and data requirements

3. **Process Automation**
    - Automation of asset data updates into [software]
    - Automation of asset data updates into [software]
    - Automation of MOBs work management processes, currently using [software] and [software]
    - Automation of missing Topographic Identifier (**TOIDs**) process, currently hosted on [software]

4. **Field Data Capture for MOBs**
    - Enhancements to scheduling and allocation of survey work to field users
    - Dynamic field data quality assurance
    - Reduce back-office checks and administrative overheads
    - Integration of follow-on work processes to enable a closed data loop with no interruption or manual intervention
    - Training and engagement with field operatives to enable smooth adoption of new technology

5. **MOBs business application rationalisation**
    - Migrate standalone MOBs field data capture systems and data processing to the target IT landscape described in *Chapter 4.4 – Preferred Option*
    - Transition services to IT Service Operations for ongoing management and support

6. **MOCS, Fault Remediation applications**
    - Accelerate the capture of minor fault remediation activities to inform MOBs intervention planning and implementation
    - Accelerate the capture of MOCS survey data to accurately inform the MOCS risk model
    - Incorporate MOCS operations and asset management capabilities into the enterprise IT landscape, including migration of captured data

7. **Data Lifecycle enhancements**
    - Enhance data pipeline from field capture, through asset risk models, to Asset Investment models
    - Refine asset investment decision support models for MOBs (including MOCS)
    - Configure new data pipelines and reports for management of MOBs operations
    - Develop new data reports for asset investment decision making and models, e.g., for the prioritisation of remediation work and MOBs risk management

Figure 26 shows the Cadent IT assets that are in scope, a description of the change and how this is related to the key deliverables above:

Figure 26 – Assets in scope

Chapter 4.5 – Project 2: Technical feasibility and consumer benefit

Project Benefits

This project is expected to bring a number of benefits contributing to customer safety, service and value for money.

Firstly, the main benefit will be improving the quality of the data about our MOBs assets. There will be a higher volume of more accurate data, with automated rules and checking as well as human oversight of exceptions. This will lead to more optimal investment decisions

from the Investment Planning Office teams (**IPOs**) that will ensure supply is secured, customer safety is protected and the best value for money is realised.
Secondly, this investment will deliver automation to manual processes which will increase throughput and efficiency of back-office teams. Quality assurance and planning processes will require less overheads and contain fewer errors from human intervention. People remain a vital asset to the process for their subject matter expertise, however, they will be realigned to focus on exceptions and priority work only. This reduction in error and processing time will ensure asset management decisions deliver safe, reliable and cost-effective MOBs systems to our customers.

Thirdly, the number of IT solutions used in MOBs asset management will be reduced as solutions are modernised and rationalised. This will lead to increased usability, meaning Field Operatives will waste less time juggling different IT solutions and be driven to use systems as designed. The increased user engagement will ensure good process behaviours and better-quality data records; all of this benefits the customer by driving safe and cost-effective asset management decisions. Moreover, a reduction in IT systems will decrease IT operational costs, further benefiting the customer's value for money, as well as increasing the supportability and resilience of the overall IT landscape; this reduces the risk and impact of technology failures to both field operations and asset management teams.

Project Delivery Risks

No IT delivery project is without risk. With this in mind, Figure 27 describes the key risks to the delivery of this investment that have been considered and mitigated:

Risk Description	Impact	Likelihood	Mitigation / Control
There is a risk that dependent investments do not deliver key milestones to support this investment. For example: by overrunning or de-scoping elements.	Dependent milestones in this investment would be missed leading to benefits being deferred or risks not being mitigated	Medium	Dependent investments are inflight with baseline plans and budget. Cadent IT solution delivery monitors key metrics across all interlocking projects and programmes such as budget, scope and risk. Any key decisions are taken with business sponsors and stakeholders to mitigate project risks and dependencies.
There is a risk that internal resource and capability will not be sufficient to deliver this investment to the required quality and timescale.	The scope of this investment cannot be delivered to the required quality or in an acceptable time leading to a suboptimal mitigation of the needs case and the resulting safety, customer and financial impacts.	Low	The scope and roadmap for this investment aligns to Cadent's target capability model. The necessary organisation, design and recruitment is already underway.
There is a risk that costs incurred with external vendors increase due to market factors.	The overall cost of this investment would increase above the requested amount.	Medium	A level of inflation is assumed in the budgetary forecast. Cadent adheres to UCR to ensure fair competition and that the best value is being secured for the customer.

Figure 27 – Project Delivery Risk Table

Chapter 4.6 – Project 2: Project Delivery and monitoring

Project Governance

Recognising the gap between the current HRB/ MRB processes and the target state, a Programme Working Group (**PWG**) was set up by business Operations to manage the change effectively and efficiently. Sponsored by the North London network, where MOBs are most prevalent, and chaired by [third-party] consultancy, the group brings together stakeholders from across the enterprise, once per fortnight, to track deliverables, milestones, risks, and cost. The following stakeholders are represented (operational attendees represent the interests of all 5 networks):

- Network Operations
- Engineering Services
- MOBs Operations Management
- Investment Planning Office (**IPO**)
- IT
- Asset Data Management
- Regulation
- Business Change

In addition to making programme delivery decisions, PWG maintains a regular flow of information to senior Operations leadership stakeholders at OTC. This provides an escalation route and ensures alignment to overall Operations strategic change. The ETC also receives updates on progress of the programme in order to track finances and impacts to other change projects across the enterprise. For further detail on Cadent IT Governance, please see Appendix 13.

IT outcomes are delivered through the methods detailed in the next section; progress updates and escalations are still reported through the PWG to ensure alignment with wider business change.

Agile IT Delivery Methodology

Technology change will be delivered through Cadent IT's agile methodology which is based on Scaled Agile Framework (**SAFe**)[20].

A scrum team specialising in change to [software], [software] and [software], known internally as the **Fusion** team, are responsible for delivering enhancements on these systems. For example, MOBs asset data hierarchies, work order data and field data capture. A second scrum team, known as the [software] team (**[software] Dev**), are responsible for delivering new technology on the Cadent Community Platform.

[20] SAFe 6.0 (scaledagileframework.com)

Prioritisation of the workload is defined every quarter with all impacted stakeholders at an enterprise level led by the Lean Portfolio Management group. The highest priority initiatives are taken forward to the next Planning Interval (**PI**) which lasts for one quarter. The initiative is broken down into features that deliver tangible business value. Features are then separated into smaller user stories which can be estimated more accurately and are planned for delivery during the PI. Initiatives, features, and stories are tracked using [software].

Both teams then follow the scrum methodology, delivering incremental change in sprints lasting two weeks. This includes the typical scrum ceremonies: planning, daily scrum, playback, and review. Each scrum team consists of a Product Owner, Scrum Master, a Test Lead as well as function specialists in [software], [software], [software] and [software] integration and test lead; Fusion includes an IT System Specialist and Business Analyst as well. Figure 28 displays the different agile scrum ceremonies that Fusion and other IT delivery teams follow.

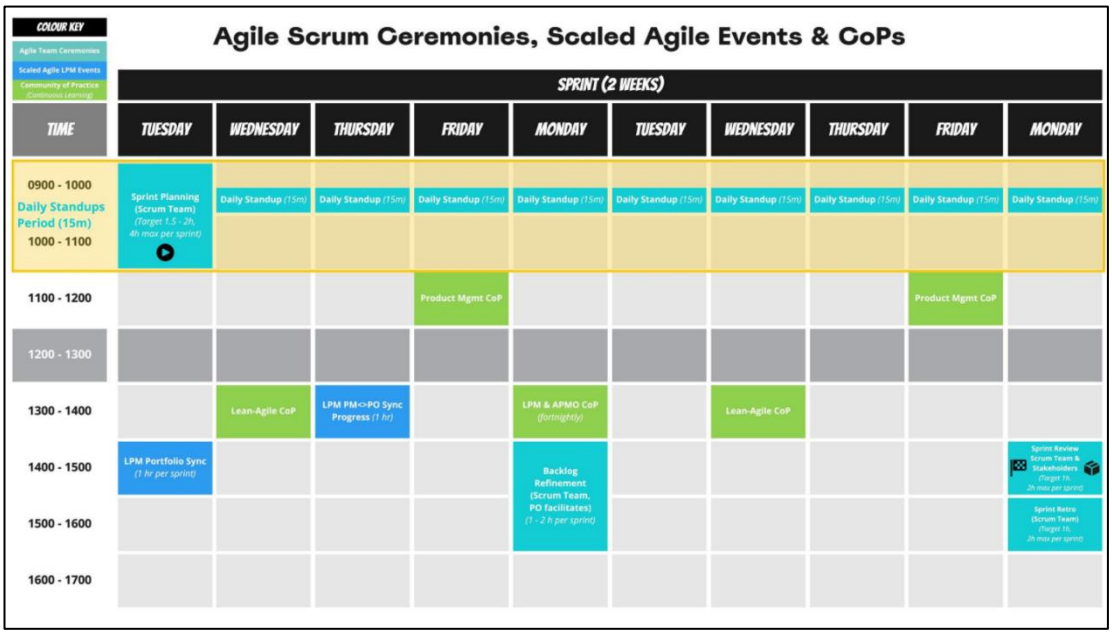

Figure 28 – Agile Scrum Ceremonies at Cadent

Progress is monitored through automated reports comparing the value of work done against the original estimate. Risks can be flagged and tracked in [software] to be immediately picked up by the leadership team for action. Figure 29 shows how the initiative for the current MVP is represented in [software]. Note that initiatives are scheduled for up to a maximum of 4 quarters; if longer is required, the expected value is first examined before a new initiative is raised.

The figure below shows how this initiative is represented in [software] at the SAFe Initiative level. Network Operations and Field Force (**NOFF**) relates to an internal naming convention linked to the team carrying out the works.

Figure 29 – [software] Initiative tracking view

Figure 30 shows an example report that would be updated in real-time, showing progress against the committed deliverables during a sprint. Similar metrics exist to track progress against initiative and feature level deliverables.

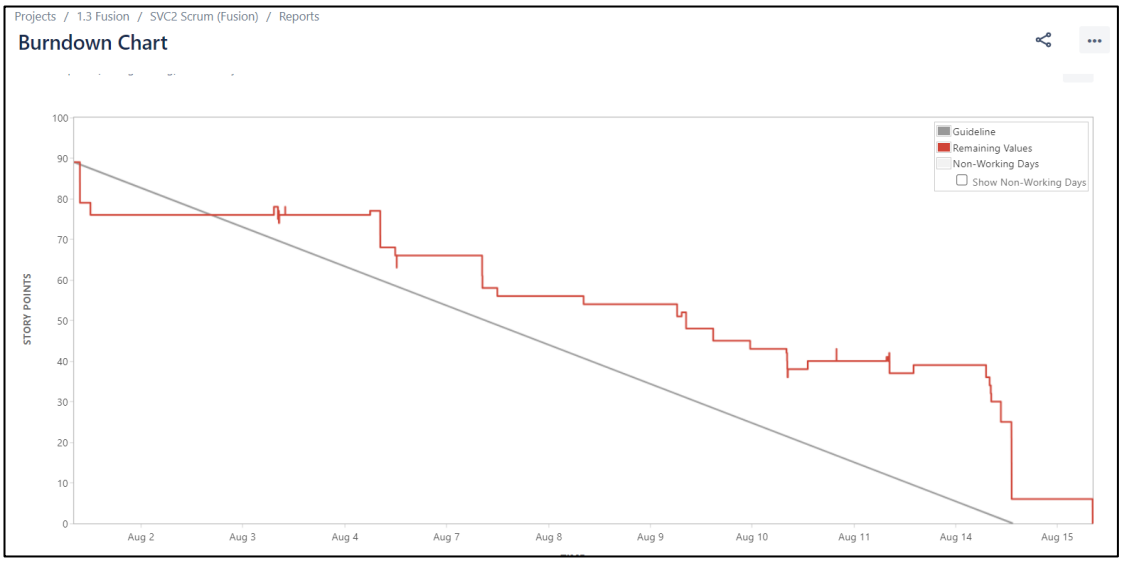

Figure 30 – [software] delivery progress report example

Finally, for any deliverables that fall outside of the scope of the two scrum teams, the Network Operations product line team can adapt to use the optimal methodology for each use case which could be agile or waterfall. Initiatives are still broken into features, epics and use cases, as in scrum. The Network Operations team consists of a Product Manager, Business Analyst, Delivery Manager, and a PMO analyst, but they can also engage and manage external vendors. The team follows the same scaled agile ceremonies as Fusion; however, the focus is on commitments and outcomes rather than using user stories and story point estimation. This allows more tradition waterfall style initiatives to progress, but with greater input from stakeholders and quarterly playback sessions.

Risks are managed in a central log by the Delivery Manager, scored using Cadent's enterprise-wide risk evaluation methodology (same as [software]) and regularly updated

during the aforementioned reviews. Delivery progress is measured regularly by assessing the following project health criteria and giving a red, amber, green rating:

- Time against baselined project plan
- Cost against baselined project budget, using value of work down to total forecast cost on project completion.
- Scope against baselined project requirements
- Resource availability against baseline resource plan
- Status of key risks on the risk register
- Status of key issues on the issue register

Red ratings lead to immediate escalation and urgent resolution while amber ratings are accepted on the condition there is a plan to return to green in an agreed timeframe.

Project Schedule

Figure 31 below details which enhancements and deliverables are expected to be delivered in each quarter (financial year):

- To date, Cadent has already delivered MVP that is essential to be able provide confidence that the new classifications of MOBs are being managed safely and effectively for Cadent's customers. This includes the delivery of new operational work types in field service management, accelerated MOCS and Fault Remediation applications and tactical automation of the current process. These deliverables were prioritised since they achieve the greatest benefit to safety, customer and cost-efficiency in the shortest time

- Following this, the immediate priority is to enhance to the HRB and MRB survey and asset update process as well as implement the target MOBs asset hierarchy. These deliverables are essential building blocks for the overall success of this investment

- Process automation, built on top of the key building blocks, will also deliver great operational benefit. This is forecast to be delivered next

- MOBs application rationalisation will commence later in the RIIO-GD2 period due to the realistic capacity of IT teams as well as Cadent Operations' ability to accept and manage the business change. Again, the previous key building block investment must be delivered first

- Field Data Capture for MOBs is dependent on the [software] Refresh project deliverables (*Overall IT Plan Dependencies – Chapter 4.2 – Risks Identified*), so can only begin after this is complete in 2023/24

- Data Lifecycle enhancements can be split into two parts: part one follows on from the updates to the HRB, MRB surveys and Asset Hierarchy; part two delivers when Field Data Capture for MOBs is complete. There will also be a requirement to migrate the data captured by the aforementioned tactical MOCS and Fault Remediation

applications, as well as the capabilities, into the strategic technology and data model created by the Asset Hierarchy and Survey Enhancement initiatives

Figure 31 – Ops Transformation – MOBs Roadmap

Stakeholder Engagement

The need to invest in IT systems that support the end-to-end MOBs asset lifecycle is immediately driven by the problem statements from directly impacted stakeholders, these are: the network IPO and network operations (**Ops**).

The OTC, made up of senior Operations directors and chaired by the Chief Operating Officer, identified some of the risks surrounding Cadent's MOBs assets. OTC then sponsored a discovery project to understand pinch points and potential solutions. The outcome of this discovery forms the scope of this investment. The stakeholders engaged, and their roles, are described below:

Figure 32 – Stakeholder Engagement

The OTC-commissioned discovery project was led by [third-party], working on behalf of Cadent. The brief was specifically to examine the end-to-end process for managing MOBs assets, and to make recommendations for how Cadent could meet the new challenges posed by:

- Adoption of G5 Edition 3 policy
- Successful asset management processes for new classes of MOBs
- Successful tracking and reporting on new types of operational MOBs activity

The project engaged all the above stakeholders and produced a series of outputs and artefacts that have been used to validate the information in this document.

4.7 – Project 2: Cost Information

As explained in the "Consideration of Options" section, Option 2 (Greenfield solution) and Option 3 (Evolutionary solution) were shortlisted, with costings developed for both of those:

Option 2 Costs

Figure 33 – Project 2 Option 2 Total Cost, in 18-19 prices

The full detail can be found in the tab "Option 2 Cost Summary Table 18-19" of the Financial Tracker in Appendix 14.

Option 3 Costs

Figure 34 – Project 2 Option 3 Total Cost, in 18-19 prices

Cost Information for the Preferred Option:

The overall adjustment required is summarised in Figure 35 below.

Figure 35 – Project 2 Option 3 Total Cost (Preferred Option) in 18-19 prices

For more detailed information on the CAPEX/OPEX splits, please view the "Option 3 Cost Sum Table 18-19" tab of Appendix 14.

Project Deliverables

As stated in previous sections of this paper, this investment commits to deliver seven key project scope areas:

- Asset Hierarchy and Work Management structure
- HRB, MRB Survey Enhancements
- Process Automation
- Field Data Capture for MOBs
- MOBs business application rationalisation
- MOCS, Fault Remediation applications
- Data Lifecycle enhancements

This section demonstrates the cost estimate and the methodology behind deriving these estimates.

Cost Methodology

The costs in this paper have been derived from estimates of similar or identical investments that have taken place in RIIO-GD2. This provides a strong level of confidence in their accuracy. Since the IT components in scope are to be reused, there is no requirement for an external tender process. Full detail of the cost estimates can be found in the project's financial tracker.

Cadent has been running a successful, agile, continuous improvements programme on Field Force and Work Management Systems ([software] and [software]); as committed to in INVP 5501 Operations Transformation. The specialised agile Scrum team responsible for delivering this work is known internally as Fusion; this term will be used in this paper for brevity (see *Chapter 4.6 – Project Delivery and monitoring*). Based on the actual costs

incurred by the Fusion team to deliver this work, as well as the scale and quality of the deliverables, it is possible to infer a reasonable cost estimate. The Fusion delivery methodology would be responsible for project scope:

(1) Asset Hierarchy and Work Management structure
(2) HRB, MRB Enhancements
(3) Process Automation
(5) MOBs business application rationalisation
(6) MOCS, Fault Remediation

The burn rate observed for Fusion is between [cost-sensitive data] per month depending on workload and the mix of internal and external staff. Fusion delivers functional use cases, not only for MOBs, but also for the wider enterprise, specifically in other operational processes like Maintenance and Customer Safeguarding. Approximately 50% of Fusion's deliverables will be dedicated to deliverables in this investment, which leads to an average monthly burn rate close to [cost-sensitive data]. The target roadmap (see Figure) and backlog initiatives that will deliver continuous improvement for the remainder of the RIIO-GD2 period leads to the estimate of [cost-sensitive data].

Next, Cadent has an in-house, expert Power Platform development team known internally as [software] Dev (described in detail in *Chapter 4.6 – Project Delivery and monitoring)*. This Scrum team has successfully delivered a number of applications and system enhancements. Based on the actual costs incurred by the [software] Dev team as well as the scale and quality of the deliverables, it is possible to infer a reasonable cost estimate. The [software] Dev delivery methodology would be responsible for:

(2) HRB, MRB Survey Enhancements (2 delivery features)
(5) MOBs business application rationalisation (2 delivery features)
(6) MOCS and Fault Remediation application (3 delivery features)

The current observed cost to deliver an agile feature is on average around [cost-sensitive data]. There are 7 delivery features forecast in the backlog of initiatives detailed in this paper which leads to the estimate of [cost-sensitive data]. The [software] Dev team, since its inception, has greatly reduced its operating costs by insourcing more and more scrum team roles. Nonetheless, with variable contractor day rates and elastic infrastructure requirements, the average run rate is forecast to remain stable for the rest of the RIIO-GD2 period.

Finally, the proposal to reuse Cadent's spatial Field Data Capture solution is estimated based on a similar initiative that took place during 2021/22. Cadent invested [cost-sensitive data] to build, test and deploy field data capture for As-Built drawings for Mains Replacement. The complexity and user volumes are comparable to the requirement for (4) Field Data Capture for MOBs, so the estimate of [cost-sensitive data] is appropriate considering the observed increase in vendor and internal costs due to inflation. To illustrate this, the day rate for the 3rd party involved in delivery of the initial Field Data Capture investment increased by 9% from April 2022 to April 2023. On the other hand, further expenditure will be avoided since additional end user licenses and hardware will not be required but will be reused from other investments.

Costing Breakdown Per Network:

Figure 36Figure below provides an overview of the adjustment per network and is calculated using a formula based upon the number of multi-occupancy buildings within each network. This figure includes the number of HRB, MRB, MOCS and buildings flagged as having a Meter Bank. Further detail on this split can be found on the “Network Splits 18-19” tab of the tracker in Appendix 14.

Figure 36 - Adjustment Required East of England Network in 18/19 prices

Figure 37 - Adjustment Required London Network in 18/19 prices

Figure 38 - Adjustment Required North West Network in 18/19 prices

Figure 39 - Adjustment Required West Midlands Network in 18/19 prices

Chapter 5.0
Project 3 – Operations Transformation: Streetworks

Chapter 5.1 – Project 3: Problem Statement and Needs Case

1) Funding allowance to resource the assessment and implementation of API upgrades

The DfT maintain a single version of the Street Manager API which is usually decommissioned in May[21], when a new version is implemented. The functionality changes that are implemented with each new version are not typically confirmed until February, which provides little time for design, build and test (**DBT**) activities ahead of deployment.

The time, effort and costs associated with these API changes are exacerbated by the complexity of managing the consequential changes that our Reinstatement Partners (**RPs**) need to make, to ensure that their data feed to us (for onward submission via the API) is compliant. As such, we need to invest in additional resource to ensure that we can undertake the necessary planning, coordination and DBT activities to maintain compliance with the API specification, within a short turn-around time.

Failure to invest as above may result in:

- Increased operational costs for additional employees required to manually enter information into Street Manager
- Inefficiencies within the regulatory reporting process due to a lack of information exchange between central internal systems ([software]) and Street Manager, which increases operational costs due to the double-handling of data transfer
- Financial penalties via Fixed Penalty Notices (**FPNs**) or prosecutions issued by HAs

Conversely, it is expected that this investment will result in the following benefits:

- Improved availability of information to road users, such as near-real-time updates for satellite navigation systems which rely on up-to-date information from the Street Manager system
- Prioritising these changes when they are released allows both Cadent and the DfT to minimise disruption to the customer during streetworks activities, and streamlines remedial work so that it is completed on the first visit, keeping occupation of the highway to a minimum

[21] API specification V4.0 - Plan and manage roadworks information (department-for-transport-streetmanager.github.io)

- There will be a single version of the truth for reporting purposes which we expect will yield operational efficiencies with regard to data validation, and should additionally reduce data quality risks associated with manual data transfer
- Automated data transfer reduces permitting compliance risks, therein reducing the risk of associated financial and reputational penalties, securing better value for money for our consumers

2) Funding for a Work Management System solution

Cadent and their contractual partners are required by the New Roads and Street Works Act (NRSWA) 1991[22] to provide notice of civil works start and stop times within a prescribed timeframe. This requirement changed in 2020 via Amendments to the Street Works (Charges for Unreasonably Prolonged Occupation of the Highway) (England) Regulations 2009[23] as follows:

Works Start/Stop Time	Notice Sent by
00:00 - 07:59 on a working day	10am same day
08:00 - 16:30 on a working day	Two hours after start/stop time
16:31 - 23:59 on a working day	10am on next working day
On a non-working day	10am on next working day

Figure 40 – Start/Stop Notices 2020

This requirement changed again with effect from April 2023, following an amendment to The Street Works (Miscellaneous Amendments) Regulations 2022[24]. Since April 2023, Cadent, as a statutory undertaker, have been required to issue stop and start notices for works between 08:00 and 16:30 within two hours, regardless of whether the works occur on a working day, a weekend, or a bank holiday:

Works Start/Stop Time	Notice Sent by
00:00 - 07:59 everyday	10:00 Same day
08:00 - 16:30 everyday	Two hours after start/stop time
16:31 - 23:59 everyday	10:00 next day

Figure 41 – Start/Stop Notices April 2023

Each change to the start and stop notice requirements within this price control period has resulted in a reduction to the notification window, with the latter removing the distinction between a working and non-working day.
The current process for a works starts notice involves information being transferred from the mobile application of our [software] Works Management System ([software]) to our back-office, where requests are raised for reinstatement works. These reinstatement requests are extracted from our [software] Works Management System manually by our RPs, and then uploaded into their own systems for delivery. Our start notices are consequently subject to manual processes which do not lend themselves to the new timescales required for non-working day notices.

[22] New Roads and Street Works Act 1991 (legislation.gov.uk)
[23] The Street and Road Works (Amendments Relating to Electronic Communications) (England) Regulations 2020 (legislation.gov.uk)
[24] https://www.legislation.gov.uk/uksi/2022/831/contents/made

Once reinstatement works are completed and the site is clear, information of a works stop notice is passed from the operational reinstatement teams on site, to the back office for onward submission of stop notices into Street Manager via our API. Thus, our stop notices are also subject to manual processes opposed to automation, with the same drawbacks as above.

To comply with the new requirements for non-working days, we must be able to automate the issuance of start and stop notices.

Furthermore, an amendment to the performance-based inspections regime effective from April 2023[25] removed the cap on the volume of inspections that a HA can undertake. Unfortunately, HA's have been inconsistent in their approach to recording non-compliant exceptions, and there are no automated controls or validations set against the volume of inspections a HA can issue to a statutory undertaker. A change to Street Manager was implemented in April 2023 to address this, via the accept or dispute process for non-compliance notices issued by a HA. On an enduring basis, only agreed non-compliances will contribute towards adjustments in inspection volumes. Hence, Cadent is required to introduce a new operational process to validate every non-compliance notice issued, by any of the 104 HAs within our operating area.

The performance-based inspection changes mean that the % of site-inspections can increase or decrease by 5% in each performance quarter, from a minimum of 20% to a maximum of 100% of a utility's inspection units (a calculation on the volume or length of excavations completed in the public highway):

Compliance (Pass) Rate	Adjustment
84.99% or below	+ 5%
85.00 - 90%	No Adjustment
90.01 - 100%	- 5%

Figure 42 – Performance-Based Inspections

The notices received from HAs concerning non-compliant inspections have limited information relating to the specific reason for the inspection, and do not include physical evidence depicting the defect. Cadent therefore undertakes site-visit investigations with little prior information, to ascertain whether the defect arose from Cadent works or those of another statutory undertaker. In doing so, we are incurring unnecessary costs which can be mitigated with additional data capture from site when our works are completed.

As such, we need to invest in a solution which will:

- Introduce additional data capture (progress updates, photographs etc) within our [software], such that site inspections can be quality-checked and validated without requiring an additional site-visit
- Automate our start and stop notices using on-site data capture
- Integrate on-site data capture with our [software] to support fully mobile, live updates of the site works and relevant permit notices

[25] The Street Works (Inspection Fees) (England) Regulations 2022 (legislation.gov.uk)

- Enable additional data capture to be used within the new accept/dispute process for non-compliant inspections

Failure to invest as above may result in:

- Increased operational costs to administer notices on non-working days within the required timescales
- Increased risk of error in manual data processing with regard to notice submissions
- Operational inefficiencies in data handling-times where data is waiting to be transferred from one system to another, potentially jeopardising our ability to comply with the new timescales introduced with effect from April 2023
- Increased timescales for acceptance/rejection of non-compliance notices due to manual data transfer across our Reinstatement Partners into our central system
- Additional costs for joint site-visits with HAs, resulting from a proportion of non-compliance notices that cannot be validated without a site-visit due to the lack of site data available within central systems

Conversely, it is expected that this investment will result in the following benefits:

- Near-real-time data transfer will reduce both the risk of non-compliance with the new notice timeline requirements and the associated administration activities thereof, which will avoid inefficient costs associated with potential FPNs*
- Improved data capture will increase customer service standards in terms of reducing the amount of call-backs required for information that has yet to be obtained from site
- Improved data capture will support the investigation of inspections, which should limit invalid non-compliance notices and therein avoid the time and costs associated with unnecessary site visits under the new performance-based inspection regime
- Improved data capture will also proactively assure that the works being completed are to the correct standard, again reducing the need to re-visit site to remediate works, thereby minimising disruption to customers and avoiding potentially unnecessary costs

*Whilst FPNs cannot be issued for works undertaken on non-working days under the current legislation, it has been made clear through industry discussions and correspondence (see Appendix 15) that the upcoming DfT consultation will consider making FPNs applicable to works undertaken on any day[11].

Chapter 5.2 – Project 3: Risks Identified

An impact assessment was completed for the new regulatory requirements confirmed in the conclusion to the aforementioned May 2021 consultation [26]. The risk identified as part of this assessment is in the table below, setting out the respective mitigating actions and controls associated with this investment, and this is managed through our corporate risk management system.

Cadent will continue to document and track project level risks and opportunities throughout the project lifecycle in line with our corporate risk management approach.

[26] Street manager and permit scheme changes - GOV.UK (www.gov.uk)

Figure 43 – Identified Corporate Risk

Overall IT Plan Dependencies

Whilst there are no functional dependencies between this and any other project within the IT Plan, we are going to sequence delivery of the WMS investment such that it follows implementation of our '[software] Work Types' initiative.
The latter initiative is deploying new operational work types across all WMSs to break down backfill and reinstatement tasks to a greater level of granularity for our RPs. The initiative will increase the number of work types within our WMS quite significantly, thus, to avoid amending the WMS solution within this project post-implementation, we will apply the new work types to our WMS prior to implementing the WMS solution within this project.
This efficiency does however mean that any delay to the '[software] Work Types' initiative presents a delivery risk to this investment. We are mitigating this via the application of appropriate IT delivery governance, as given in the project delivery section below. (Appendix 13). Moreover, to ensure that the delivery of this project's WMS solution can commence upon completion of the '[software] Work Types' initiative, the latter will be subject to end-to-end system testing as well as user acceptance testing.

Synergy with other projects

This Operations Transformation: Streetworks project is linked to, but not dependent on, Project 5 – Open Data: Interoperability. To make efficient use of technology, the Street Manager API upgrade will use the same strategic integration platform as required by the Interoperability project. This uniformity will ensure no cost is wasted on standing up and maintaining different integration solutions. Despite the strategic IT alignment, the projects are not interdependent. Upgrading the Street Manager API is a mandatory requirement, so would be actioned regardless of the status of the Interoperability project. Equally, the Interoperability project does not require the Street Manager API upgrades to be delivered such that its own outcomes are realised.

Chapter 5.3 - Project 3 – Option Selection

Options analysis was undertaken for both needs cases:

1) Funding allowance to resource the assessment and implementation of API upgrades.
2) Funding for a solution that will:
    a. facilitate compliance with new Start and Stop notice requirements, and
    b. facilitate compliance with new performance-based inspection requirements.

1) Funding allowance to resource the assessment and implementation of API:

To address mandatory version upgrades of the DfT's Street Manager API, 4 options were considered as below.

Note: Street Manager is a mandatory system for statutory undertakers, as such 'market-based' options are not appropriate.

1. Do not upgrade (do nothing)

Under this option, Cadent would have no resource dedicated to taking ownership of the Street Manager API and its annual iterations. Our current Street Manager API would thus depreciate and become non-functional when DfT release the next version of their API in 2024.

If this were to happen in the absence of any other change, Cadent would stop raising and responding to permits notifications, which would be a direct contravention of regulatory requirements as well as an end to our streetworks activities in most HA areas (since most now require permits for works).

Whilst there are financial and reputational consequences of regulatory breaches, the cessation of streetworks activities presents an unacceptable risk to the safety of our customers. This option has therefore been discounted.

2. Replace Street Manager API with manual processes (Minimum Viable Product)

Under this option Cadent's API would deprecate as above, however a series of cross-team, enterprise-wide, manually driven processes would be established to raise, update and close permits and notices.

The benefit of manually driven processes is that future API version upgrades would have no IT impact. However, there are a plethora of operational consequences to consider:

- Data quality controls, jeopardy and compliance reports would all be manually driven based on static data extracts. The increased risk of data errors via out-of-date data and manual handling perpetuates a risk of non-compliance
- Manually driven processes across operational teams could introduce single points of failure to the streetworks process, which may increase both safety risk in terms of validating that sites have been left safe, and the risk of non-compliance.

- Cross-team, enterprise-wide, manually driven processes would vastly increase the costs of running effective streetworks, especially to accommodate resources for out-of-hours' notice requirements.

This option flouts our IT Architecture Standards because services would be neither easy to use, nor robust and fault tolerant, and manual processes are neither reduced nor removed. Further, this option again presents unacceptable risk to the safety of our customers in so far as potential non-compliances taking longer to identify, investigate and resolve. The risk of non-compliance under this option could also lead to avoidable FPNs and/or prosecutions, and therefore higher operating costs for Cadent. For these reasons, this option has been discounted.

3. Maintain currency with Street Manager API version (preferred option)

Under this option Cadent continues to use and maintain an API compliant with DfT's latest API specification. The Street Manager API upgrade roadmap is followed, and each time an old version is depreciated, Cadent upgrades accordingly.

This option does require additional effort, thus resource, to maintain the API in accordance with the latest specification; however, this option has the following benefits:

- Current processes are maintained, so our operations experience minimal disruption.
- Data flow to-and-from Street Manager is as fast, secure, and accurate as possible, ensuring that Cadent can continue to deliver safe and compliant streetworks at least cost.
- There will be a single version of the truth for reporting purposes, which should yield operational efficiencies with regard to data validation, therein reducing risks related to data-handling errors.
- Near-real-time data transfer enables our customers to make informed-decisions when planning their journeys so as to minimise disruption, and they enable us to minimise risks of non-compliance with our regulatory requirements.

Contrary to option two, our services under this option would be easy to use, robust and fault-tolerant, optimising our operations. Manual processes would be reduced, simplifying the life of our employees, and our Data Assets would easily accessible and shared securely, enhancing the experience of our customers via near-real-time updates. This option therefore facilitates our business objectives whilst aligning with both our IT Architecture Standards and our Data and Digitalisation Strategy. Since resource and effort under this option is limited to a single area of the business (IT) for a single activity (DBT), we believe that this option represents the best value for money, whilst mitigating risk to customer safety and risk of non-compliance. For these reasons, this is our preferred option.

4. **Delay until next price control (defer option)**

   As with option one, our API would depreciate and cease functioning with effect from DfT's next specification release. Thus, we would have no effective process for managing streetworks permits, and therefore could not deliver safe and compliant operations to customers. Consequently, option two would be required as an interim solution until next price control.

   This option has the same drawbacks as options one and two, but with additional, and inflated costs, incurred within the next price control period to deliver option 3. Thus, this option is the least favourable in terms of value for money, and risks to both customer safety and non-compliance. This option has therefore been discounted.

Figure 44 below compares the options across a range of criteria:

	#1 Do Nothing	#2 Manual process	#3 Upgrade API	#4 Defer until RIIO-GD3
Delivers business outcomes	**No**	Yes	Yes	**No**
Change Impact	**Maximal – non-compliant**	**Maximal**	Minimal	**Maximal**
Effort to implement	None	**High**	Average	**High**
Cost to implement	None	**> £1m**	< £0.4m	**> £1m**
Time to realise benefits	**No benefits**	**>1 year**	Immediate	**>1 year**
IT strategic alignment	**Not aligned**	**Not aligned**	Strong alignment	**Not aligned**
Operability/ supportability	Nothing to support	**High complexity and risk**	Low complexity and risk	**High complexity and risk**
Overall alignment	**Inadequate**	**Inadequate**	**Preferred option**	**Inadequate**

Figure 44 – Needs Case 1 Summary of options analysis against criteria

From a technical perspective, the options are significantly different which makes selecting the recommended option simpler. The major difference is in the operational change impacts which has been the most important factor.

The definition of each Cadent business outcome, against which the options were evaluated, are explained in Appendix 06.

The red, amber, green colours provide a rough guide to each metric as per its positive (green) or negative (red) weighting on the final recommended solution. Assuming that a candidate solution does deliver the critical business outcomes, which is mandatory to be considered, then the most positive metrics combine to lead to the recommended solution.

In order to obtain operational and IT sign-off, Cadent has a review and approval process for technology and process change. Business change impacting operations is discussed and signed off by Operations Transformation Committee (**OTC**), chaired by the Chief Operating Officer; IT architecture change is signed off by the Technical Design Authority, chaired by the Head of Enterprise Architecture; and the priority order for delivering various IT initiative across the Cadent enterprise falls to the Lean Portfolio Management (**LPM**) group - formerly the Enterprise Product Prioritisation Group (**EPPG**).

Each of these stakeholders supports the options analysis process by ensuring that: all requirements are considered; risks and dependencies are identified and mitigated, and alignment to business and IT strategy is secured. Lastly, budget is approved by Cadent Investment Committee (**CIC**), or the Executive Transformation Committee (**ETC**) if there is a business change impact.

2) Funding for a Work Management System (WMS) solution:

To address compliance and efficiency challenges described in the Needs Case for this requirement, 4 options were considered as below. Further technical details on each of the options is described in the Appendix 16.

1. **Continue with manual processes (do nothing)**

Our Reinstatement Partners would continue to be sent and retrieve data through manual data extracts under this option. Quality control and reporting remain completely manual.

For start and stop notices on non-working days we completed a time and motion survey exercise based on 2021/22 notice volumes (see Appendix 17), and were able to forecast that an additional 16.09 FTE days would be required to achieve compliant start and stop notices on non-working days:

FTE Days	Starts	Stops	Total
EA	0.21	2.61	2.82
EM	0.10	3.72	3.82
EN (EA+EM)	0.31	6.33	6.64
NL	0.24	5.18	5.42
NW	0.46	2.41	2.87
WM	0.13	1.03	1.16
Total	**1.14**	**14.95**	**16.09**

Figure 45 – Time and Motion Survey for FTE days

It is difficult to predict the resource-burden of the new accept/dispute process for non-compliance notices, but we again conducted a time and motion survey exercise with a sample of five live-site non-compliance investigations, and five reinstatement non-compliance investigations to forecast an average time taken to complete an investigation (Appendix 18 and Appendix 19). The average investigation time is 71.6 minutes. Thus, we cannot quantify all of the additional resource required for this option, but we expect this option to require a high level of additional resource.

Whilst this additional resource may enable start/stop notices and non-compliance notices to be processed, it has the following drawbacks:

- Increased operational costs to administer notices on non-working days within the required timescales
- Increased manual-handling will likely reduce operational efficiency, which may hinder our ability to meet the new timescales for notice submissions
- Increased risk of error in manual data entry may result in suboptimal submissions and the potential for re-work, again increasing operational costs
- Increased manual data transfer across our RPs will likely increase timescales for the non-compliance notice accept/dispute process, which again may hinder our ability to meet the 10-working day response time
- Customer satisfaction scores may deteriorate where additional joint site-visits with HAs are required to investigate siteworks that cannot be validated due to a lack of site data available within central systems. Any additional site-visits will also increase operational costs

This option does not secure our business objectives because neither IT nor operational processes are improved, and compliance with our regulatory obligations is not guaranteed. This option also fails to remove or reduce manual processes, to ensure our services are easy to use, robust and fault-tolerant, and therefore to achieve optimised operations which simply the life of our employees or enhance the experience of our consumers. Consequently, this option is aligned to neither our business plan nor our architecture standards. We therefore feel that this option does not represent value for money and for the reasons given, we have discounted this option.

2. WMS Solution (preferred option)

Under this option, Cadent would implement an off-the-shelf data orchestration or middleware solution to simplify the collation and distribution of streetworks operational data. The solution would bridge Cadent's enterprise system landscape and the Reinstatement Partners' works management systems, ensuring that streetworks activities are available for all RPs in a consistent format. It would also provide centralised reporting capability for a holistic view of performance across all networks, allowing jeopardy management of work closures and registration of reinstatements, which should facilitate compliance with our new regulatory obligations.

This option requires high effort and stakeholder engagement to implement, and involves a degree of disruption to embed within our operations, but it has the following benefits:

- Increased data capture from streetworks on-site can be stored centrally to enable validation of both site-works information (state of work completions) and non-compliance notices from HAs. This should reduce the risk of non-compliance with regulatory timelines due to optimised operations, as well as yielding efficiencies in the form of avoided site-visits
- Integration between Cadent and the RPs should reduce the time and effort required to comply with our new regulatory requirements for start/stop, and non-compliance notices

- Provides a works management system for smaller RP contractors without a strong IT capability, which reduces the complexity and cost of implementing a solution which should achieve regulatory compliance
- Automated data transfer between Cadent and the RPs, and Cadent and Street Manager will enable us to achieve compliance with our new regulatory obligations for start/stop notices and should facilitate compliance with the new accept/dispute process, which will enhance the experience of our customers by ensuring that streetworks activities cause minimal disruption
- Requires minimal change to current processes, which will simplify the life of our employees and reduce the burden of change for our RPs

This option therefore delivers our objectives whilst aligning with our strategy and standards. As a consequence of realising benefits faster under this option than any other considered, we expect this to option to achieve the greatest value for money for our customers. This is therefore our preferred option.

3. APIs for RPs (minimum viable product)

Under this option Cadent would build and deploy bespoke APIs for all of our RPs to integrate their works management systems with our central system. RPs would be required to procure their own electronic work management systems where none are currently being used.

This option has similar benefits to our preferred option in terms of additional data capture and automated data transfer thus strategic alignment and enabling compliance with our regulatory obligations. However, this option has additional drawbacks:

- Bespoke APIs would cause a high impact to business users in managing reinstatement contractors, failing to simplify life for our employees and increasing overheads
- Bespoke APIs will likely cost more than a single solution as under option two, not only in implementation but in maintenance as well, which fails to optimise our operations
- Bespoke APIs represent a significant change to ways-of-working for both Cadent and the RPs, and the increased complexity introduces new risks of delivering non-compliant streetworks during transition, which may hinder our ability to fully deliver against our business objectives

The complexity of this option may create as many risks as it mitigates, and it has increased costs for implementation and maintenance without any additional benefits when compared to option two. Although this option should enable us to comply with our regulatory obligations in the long-term, we do not believe that it represents good value for money. We have therefore discounted this option.

4. **Delay until next price control (defer option)**

Under this option, we would wait until the next price control to implement either Option 2 or Option 3. Thus Option 1 would have to be implemented in the interim to try to ensure compliance with our new obligations for start/stop and non-compliance notices.

This option has the same drawbacks as option one, but with additional, and inflated costs, incurred within the next price control to deliver option two or three. Thus, this option is the least favourable in terms of value for money, and it retains the risk of non-compliance with our new obligations in the near-term. As such, we have discounted this option.

Below summarises a comparison of the solution options:

	#1 Do Nothing	#2 WMS Solution	#3 APIs for RP	#4 Defer until RIIO-GD3
Delivers business outcomes	Inadequate	Full	Mostly	Delayed
Change Impact	None	Moderate	Maximal	Moderate (deferred)
Effort to implement	None	Maximal	Maximal	Maximal (deferred)
Cost to implement	None	£2.1m	> £3m	> £3m
Time to realise benefits	No benefits are realised	2 years	> 3 years	> 5 years
IT strategic alignment	Not aligned	Strong alignment	Strong alignment	Strong alignment
Operability/ supportability	Not operationally feasible	Moderate complexity and risk	High complexity and risk	High complexity and risk
Overall alignment	Inadequate	Preferred option	Sub-optimal	Inadequate

Figure 46 – Needs Case 2 Summary of options analysis against criteria

Chapter 5.4 - Project 3: Preferred Option

We have set out below our preferred options for both needs cases:

1. Funding allowance to resource the assessment and implementation of API upgrades.
2. Funding for a solution that will:
    a. facilitate compliance with new Start and Stop notice requirements, and
    b. facilitate compliance with new performance-based inspection requirements.

Needs Case 1: Funding allowance to resource the assessment and implementation of API upgrades.

Option 3 - Preferred Option for Street Manager API Upgrades

The preferred option to mitigate the risks of non-compliance with streetworks legislation is to maintain currency with Street Manager API version.

The benefits of direct integration between the DfT Street Manager solution and Cadent operational IT systems are significant in terms of automation, reducing the overheads of manual data processing, and having real-time data to support quality of streetworks for customers. Direct API connectivity reduces the risk of non-compliant streetworks which in turn reduces the risk of associated financial and reputational penalties. This cost avoidance likely offsets costs associated with the maintenance of the API, and the API ensures that Cadent is delivering against their Data and Digitalisation strategy and optimising their operations.

Overall, this option represents the best value and strongest risk mitigation controls to ensure compliant streetworks. This ultimately benefits the customer and our stakeholders, providing confidence that safe, high-quality streetworks are being delivered.

The following deliverables are within scope of this investment request:

Street Manager API Specification:
The DfT's Street Manager API specification is currently updated on an annual basis, and the changes may impact business process, data and/or technology.

- This investment includes resource time to undertake a detailed impact analysis of the changes included within the API upgrade, to ascertain the changes that need to be made.

[software]:
This suite is the orchestration component of [software]; it manages all data interfaces between Cadent-hosted systems and the DfT Street Manager solution.

- This investment includes effort to reconfigure, test and deploy changes on Integration Suite, to ensure continued communication with the latest version of the Street Manager API.

[software]:
[software] is the core enterprise component used by Cadent, to create and store asset and operational data (work orders) that represents real-world activities impacting streetworks, such as an excavation for a gas repair or reinstatement of said excavation. Due to the interface with Street Manager (using the [software] middleware), [software] can automate permit and notice creation and updates.

- This investment includes resources required to make any changes to the [software] data or application, to accommodate changes to the Street Manager API version and maintain business operations.

[software]:
Cadent end users and 3rd parties interact with [software] through a web-based application built on [software] technology, and the [software] functions as a backup in the event that [software] is unavailable.

- This investment includes resources required to update or re-configure the [software], to accommodate changes to the Street Manager API version and maintain business operations. Which will ensure that integrity and efficiency are maintained when raising

and actioning streetworks operations, therein assuring our ability to provide customers with a safe, high-quality service.

[software]:
Cadent field operatives interact with operational data through the [software] client solution on their devices. [software] allows users to create, update and view permits and notices, enabling real-time synchronisation between field operatives and Street Manager

- This investment includes resources required to update or configure [software], to accommodate changes to the Street Manager API version and maintain business operations.

Real-time field updates are essential to providing a fast, safe and compliant streetworks service to customers. Investment in the field solution, [software], will ensure these benefits are maintained because work-orders and streetworks information from field operatives will pass through [software] to [software], before being securely transferred in near-real-time to Street Manager, using the [software] middleware. This integration will remove inefficient manual processes, meaning that the associated data errors, risks and costs can be avoided. Moreover, the flexibility of [software] means that the Street Manager API version upgrades can be achieved more efficiently, and the maintenance of [software] in line with the other components ensures the integrity of operational and streetworks data such that Cadent can continue to deliver compliant streetworks at the most efficient time and cost.

Needs Case 2: Funding for a solution that will facilitate compliance with new Start and Stop notice requirements and facilitate compliance with new performance-based inspection requirements.

Option 2 – Preferred Option for WMS Solutions

The preferred option is to build a solution that allows automated data flows between multiple systems and captures key information in a consistent format, visible in near-real-time to Cadent employees, Reinstatement Partners, Highway Authorities and the Department for Transport. As such, a selection process was led by Cadent's procurement team, following an activity to gather business requirements through several workshops with key stakeholders from each network. The topic of each workshop is captured in the below table:

Figure 47 – Business Requirements Workshop Topics

The selection process involved a Request for Information (**RFI**) to gather market insight across a total of 439 suppliers, a Pre-Qualification Questionnaire (**PQQ**), which 11 suppliers completed, and a Request for Proposal (**RFP**) in which 4 suppliers competed. The RFP was a competition in which negotiation was based on the Most Economically Advantageous Tender (**MEAT**) criteria. Following this procedure, a contract was awarded to the top-ranking supplier as per Figure 48 below showing post-moderation scores. The outputs of the procurement exercise and recommendations for contract award can be found in Appendix 20.

Post Moderation Scores	Average Technical Score	Commercial	Total	Rank
Supplier A	49%	32%	81%	1
Supplier B	46%	19%	65%	2
Supplier C	41%	16%	57%	4
Supplier D	33%	31%	64%	3

Moderation session is carried out by the nominated evaluators to ensure an impartial and objective evaluation process

Figure 48 – Final ranking of suppliers

Supplier A can provide Cadent with their desired architectural solution:

Figure 49 – High Level Solution Architecture: Work Management System

This solution will use on-site data capture to:

- automate the issuance of start and stop notices, as well as our reinstatement registration process
- comply with the requirements of the new accept/dispute non-compliance notices process in the most efficient way due to the enhanced validation that can be undertaken from desk-tops

The ‘to be’ system will allow automation of workflows and real time updates to be visible to all approved system users, as demonstrated in Figure 50. It will be a single solution for all Cadent work information to be stored, including:

- current statuses of work
- details of work required
- supporting photographic evidence
- real time production of performance reports

By having the above data to hand, we will be able manage permits to ensure information is sent to HAs as required by legislation: within two-hours of works starting or stopping, and within 10 working days for reinstatement registration.

Figure 50 – WMS ‘to-be’ Workflow Diagram

The WMS solution will allow updates from field-based teams to flow through our [software] and the DfT Street Manager API, removing manual planning processes and re-work, while allowing work to flow from the Cadent [software] into the RP WMSs’. This benefit will be measured as a reduction in the operational full-time resources needed to carry out these manual tasks.

Amendments to our [software] are complicated, costly, and require extensive stakeholder engagement and project management. The proposed solution is much more agile and will allow quicker off-line updates with greater flexibility for our operational processes to respond to further legislative amendments. This responsiveness not only future proofs our operational WMS but minimises the costs of future changes as well. Moreover, it will be possible to reduce the number of peripheral IT systems supporting data capture and operational processes. The consequent reduction in software license costs can be measured here to demonstrate progress.

Increased, automated and near-real-time data transfer between Cadent and our RPs should yield operational efficiencies in terms of allowing our RPs to quickly view and plan their work, accelerating their productivity. RPs will also be able to check requested works against pictures from site to confirm if the work requested is correct, therein reducing abortive visits and helping to reduce the time taken to complete reinstatement works. This will be measured

as a reduction in the percentage of total jobs aborted due to incomplete data or manual error after the preferred solution is implemented.

Automated data transfer will allow Cadent to comply with the new start/stop notice and reinstatement registration timeline requirements, which will avoid costs associated with potential FPNs, and should reduce the likelihood of prosecutions, again avoiding the associated costs. This will be measured as a reduction in the percentage of fines that are incurred as a result of missing data or manual errors.

Furthermore, improved data capture will enable near-real-time updates to the Street Manager system which will help customers stay up-to-date with the situation on-site, and therefore increase customer service standards by reducing the amount of call-backs required for information that has yet to be obtained from site.

Improved data capture also allows desktop checks to be undertaken, which will enable us to both comply with the new accept/dispute non-compliance notice process and assess the quality of works being competed. As well as avoiding costs associated with FPNs, this should reduce the need for, costs associated with, joint site-visits with the HAs, and ensure that Cadent's performance is reflective of the work that has been undertaken. Findings from desk-top checks can also be utilised to improve training and increase 'right first time' jobs, further reducing operational inefficiencies.

5.5 - Project 3: Technical Feasibility and Consumer Benefit

Technical feasibility

The capabilities and technologies outlined in this submission have been considered following a study (see Appendix 16) of their technical feasibility. Technical options analysis examined various approaches to deliver a seamless flow of reinstatement operational data and cater to the needs of Cadent Operations and Reinstatement Partners.

The ability to integrate with Street Manager through APIs is a standard capability that has been proven multiple times by other investments and systems. For example, most significantly, Cadent has already successfully integrated and updated the Street Manager API version twice.

With regards to the feasibility of implementing a cloud-based WMS, the ability to integrate cloud applications through [software] with Cadent's core [software] system of record, has been proven multiple times, as demonstrated via successful IT delivery projects. For example: [software] to [software] and [software] to [software] integration projects. Moreover, from an extensive market test and procurement process, there are multiple 3rd party solutions that can provide technical capabilities to deliver the middleware requirements of the WMS investment.

The demonstration of technical feasibility for an IT solution provides confidence that the strategic approach will be suitable to realise the benefits of this investment.

Project Benefits

This investment is expected to deliver a number of benefits, most significantly contributing to compliance, customer experience, and cost efficiency.

Firstly, Cadent is obliged by law to comply with NRSWA. All streetworks must be delivered to a defined standard, otherwise fines and penalties can be imposed. Maintaining standards benefits the customer and wider community of stakeholders who are impacted by streetworks, directly or indirectly, to ensure minimal impact to their activities. The IT investment in this submission greatly enhances Cadent's ability to demonstrate compliance with NRSWA and reduces the risk of non-compliance. Furthermore, Cadent will be able to work closer and faster with local authorities and utilities to prioritise a successful outcome for our customers. This is achieved through investment in IT systems that make streetworks information more accessible, in near-real-time.

Secondly, the improvements to the speed of access and quality of streetworks information mean that it is possible to drive down the time taken to reinstate excavations after an intervention by Cadent. Thus, more same day reinstatements will be possible, which will further reduce the impact Cadent has on customers and local infrastructure. This will greatly improve the perception of Cadent and the gas industry as well as customer satisfaction, which is a key regulatory measure. Guaranteed Standards of Performance 2 requires reinstatement to be completed within 5 working days or 3 working days for Priority Service Register (**PSR**) customers, failure to meet this standard will result in compensation to domestic customers of £115, or £230 to non-domestic customers[27]. This investment should mitigate instances of GSoP2, thus avoiding unnecessary costs to Cadent.

Thirdly, manual processes carry high additional overheads, longer lead times, and risks of errors which can be eliminated by system automation. The reduction of manual administrative support required for this process following investment, will enable greater resource capacity to focus on managing exceptions and delivering the best result for Cadent's customers. Moreover, decreasing information processing time and augmenting the quality of streetworks information is expected to reduce the volume of fines and penalties that Cadent is exposed to.

Fourthly, the system will allow Cadent to dictate what information is required to be captured consistently from all of its RPs. One such area would be off-site information and images which will require operational teams to evidence how they leave site setups for roads users. This off-site data can be used to ensure sites have been left in a safe manner, helping reduce potential slip, trips and falls from any misplaced equipment or unguarded excavations.

Lastly, the ability for Cadent to undertake focused inspections, via the new functionality of the WMS, allows live works to be easily identified and scheduled for a visit. Topics to help drive improvement can be captured in the new inspections forms such as customer satisfaction relating to site tidiness. Operational teams can be assessed consistently across all networks and performance can be measured and monitored. Having visibility of data allows performance to be fully understood and allows standards to be monitored and targets set for improvements where required.

[27] https://cadentgas.com/nggdwsdev/media/Reports/2023/Notice-of-Rights-2022-23.pdf

5.6 - Project 3 – Project Delivery and monitoring

Street Manager API Upgrade

Deployment of system change due to the impact of a major Street Manager API version upgrade (e.g. v2 to v3 in 2019) follows a typical waterfall IT delivery project methodology. Due to the critical operational role of the impacted systems, extensive testing and careful deployment is necessary. All scoped change must be deployed at once to achieve the full benefit. There is no minimum viable product, and any errors can have vast ramifications for safe and compliant streetworks operations. For these reasons, a more agile delivery approach is not appropriate in this case.

From previous investments in RIIO-GD1 where the Street Manager version upgrade required changes to Cadent's operational IT systems, we deduce that the delivery timeline will typically run as follows for each major version release:

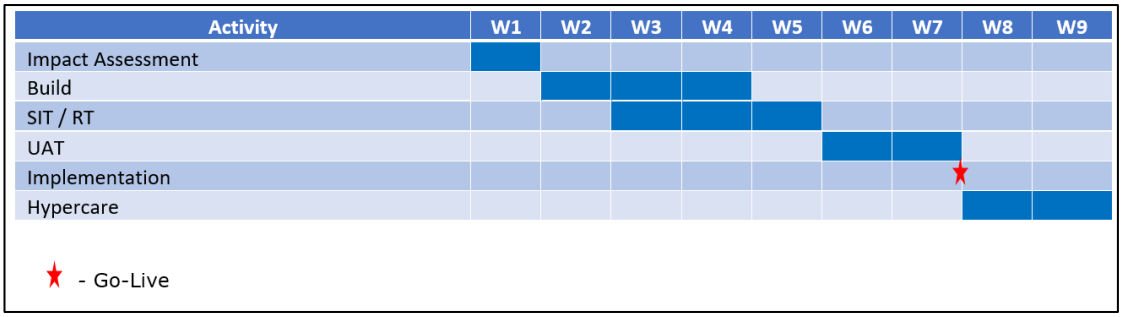

Figure 51 – typical delivery plan for Street Manager API upgrade

The Department for Transport publishes detailed documentation about the new API, which reduces the impact assessment phase. Build can commence almost immediately with routine Systems Integration Testing (**SIT**) and Regression Testing (**RT**) in test environments to ensure new code is stable. This is then open to User Acceptance (**UAT**) with the impacted operational stakeholders. Finally, after a change is approved by the Change Approval Board (**CAB**), the new code can go live, and a period of hyper-care or post go-live support commences until the impacted business stakeholders accept the change has gone live without any open issues.

WMS Middleware Solution

Following the selection of the vendor to provide the data orchestration solution, an implementation period is required. The plan follows a mixture of Prince2-style waterfall IT solution delivery for deployments that will impact Operations directly, and a series of iterations to ensure the configuration of the solution is fit for purpose.

Since Operational teams have fixed obligations to remain compliant, coupled with the advantage of procuring a solution that is out of the box, this change is not suitable for a fully agile style deployment. Nonetheless, by configuring the middleware solution in three iterations will ensure a regular feedback loop with Operations and confirm the solution is moving in the right direction.

IT Solution Delivery is managed by a Cadent IT Delivery Manager. This role is supported by an internal team: Business Analyst, Test Analyst, Service Transition Analyst, Solution Architect, as well as technical implementation teams provided by the middleware vendor and Cadent IT System Integration partner. External parties also provide a Project Manager to lead delivery workstreams and be held accountable by Cadent for this delivery. The Cadent IT Delivery Manager retains authority on day-to-day project decisions. Finally, a sponsor from Operations has authority on decisions impact operations and also provides a direct link to the required Operational stakeholders needed for testing the deliverables. IT and Operations leadership teams are kept up to date with progress and available for any escalations or major decision points that are required.

In order to deliver the full scope to the standard required by Operations, appropriate governance checks, such as stage gates, will be applied. The risk is that time and cost may have to flex to enable this; these risks are mitigated by regular stand-ups and risk reviews. Risks are managed in a central log by the IT Delivery Manager, scored using Cadent's enterprise-wide risk evaluation methodology (same as [software]) and regularly updated during the aforementioned reviews. The below are some of the internal and external risks identified at project level.

Risk Description	Impact	Likelihood	Mitigation / Control
There is a risk that dependent investments do not deliver key milestones to support this investment. For example: by overrunning or de-scoping elements.	Dependent milestones in this investment would be missed leading to benefits being deferred or risks not being mitigated	Low	Dependent investments are inflight with baseline plans and budget. Cadent IT solution delivery monitors key metrics across all interlocking projects and programmes such as budget, scope and risk. Any key decisions are taken with business sponsors and stakeholders to mitigate project risks and dependencies.
There is a risk that, due to immediate Operational priorities, internal resource and capability will not be sufficient to support the delivery of this investment to the required quality and timescale.	The scope of this investment cannot be delivered to the required quality or in an acceptable time leading to a suboptimal mitigation of the needs case and the resulting safety, customer and financial impacts.	Medium	Cadent Operations leadership actively monitor project status and manage escalations, as well as managing team priorities to focus capacity on supporting the project.
There is a risk that costs incurred with external vendors increase due to market factors.	The overall cost of this investment would increase above the requested amount.	Medium	A level of inflation is assumed in the budgetary forecast. Cadent adheres to UCR to ensure fair competition and that the best value is being secured for the customer.

Figure 52 – Internal and External Risks to Project

Delivery progress is measured regularly by assessing the following project health criteria and giving a red, amber, green rating:

- Time against baselined project plan
- Cost against baselined project budget, using value of work down to total forecast cost on project completion.
- Scope against baselined project requirements

- Resource availability against baseline resource plan
- Status of key risks on the risk register
- Status of key issues on the issue register

Red ratings lead to immediate escalation and urgent resolution while amber ratings are accepted on the condition there is a plan to return to green in an agreed timeframe.

At a high level, the project schedule covers a design, build, test, and deploy path. Business requirements have already been captured as part of the procurement event. Where possible, activities have been scheduled to continue in parallel to shorten the timeline, for example, the distinct build of the [software] integration and the middleware solution until they are required to join in iteration two and three.

Testing is vital to ensuring a secure, operable service is handed over to business Operations and the IT Service Operations team to manager. Cadent employs different environments of connected systems to undertake increasing levels of testing complexity. This saves time identifying fundamental issues and also provides confidence that the solution is ready to progress or requires rework. This also allows for live conditions to be replicated as closely as possible. This initiative follows this standard testing pattern:

- Unit Testing in the Development environment on individual components
- System Integration Testing in the connected Test environment for end-to-end testing
- User Acceptance Testing, Performance Testing, and Cutover Dress Rehearsal, and in the connected, dedicated Staging or Pre-Production environment for end-to-end business testing and load testing
- Cutover and deployment to Production, business as usual, environment

A dedicated system environment for this project (a copy of Cadent's production systems) will be stood up which will allow the different teams to continue with the development and build which in turn will mitigate dependencies caused by other IT change projects or fixes. The work being undertaken will be managed via daily 'stand-up calls' with a further weekly 'project working group' calls to monitor progress alongside a risk log which allows the different aspects of the project (e.g., work types) to be managed as part of the overall works. This dedicated environment work is an additional cost, but it allows business operations to continue unhindered, especially processes supporting Cadent's Emergency Response obligations, thus mitigating dependencies from other IT change initiatives. Throughout the project, there will be different pieces of work being completed at the same time (e.g. amendments to work types & WMS middleware solution build) which is where the dedicated environment provides an advantage as other IT programmes of work can continue allowing focus by specific resource aligned to this project.

The figure below shows the high-level plan on a page (**POAP**) to deliver the WMS middleware solution. This has been split into two capability drops to reduce risk to business operations and also realise value faster. The first drop will deliver the completed WMS, enabling [software] work orders to flow through the middleware, be actioned and visible. The second drop focuses on refining the automated commercial validation process, where direct input from Reinstatement Partners will be assessed against original forecast data to ensure quality works have been carried out and are correctly paid for. There is a 3-4 week period over the [system-sensitive data] were test environments are refreshed to maintain synchronicity with

production; this plan has to work around this. Finally, the rollout to all Cadent Operational networks will be staggered to reduce the impact on Operations as a whole and apply lessons learned from previous rollouts. The result will be a smoother adoption for later rollouts.

Figure 53 – Plan on a Page

To protect Cadent's operations and the IT service, IT Service Operations maintain a Service Transition Board (**STB**) and CAB. These forums check multiple criteria of any IT change, in particular STB assures that any deployment will be suitable for operation after go-live. CAB's role is to protect production systems during a change and assures that proposed IT changes will not impact this.

Central project plans are owned by the IT Delivery Manager work with third-party vendor plans for their deliverables to the project. Projects are agreed between Cadent and third parties then shared and agreed at steering groups.

Costs are reviewed on a monthly basis. Actuals are updated and forecasts reviewed to confirm these are still valid. Finances are then shared with finance team. Risk meetings are held each week where risks and issues are actively managed. Any critical risks are issues are flagged on project reports and steering.

High level Governance Structure:

- Product Manager / Steering Committee - Escalation point.
- Business owner - Manages business activity and collaborates with IT delivery manager
- IT Delivery manager - Co-ordinates all activities
- 3rd Party Project Managers - Manages third-party deliverables and plans. Feeds updated into overall delivery manager
- Team - Reports status to delivery manager

Project Governance

Within Cadent IT there is strict project governance which is applied to all projects whether they are waterfall or agile. Please see Appendix 13 to understand the Cadent IT Governance that is applied to all IT Change.

Cadent uses the Scaled Agile Framework (**SAFe**) as our delivery framework for both iterative waterfall and Agile delivery. Standing up the WMS as a new capability will be delivered using a traditional iterative waterfall approach. This will be handed over to a Product Team to manage and deliver business value. Any changes to deployed solutions on the WMS or to APIs will be through Product Team via Agile delivery.

Projects are managed by using a product tool called [software]. [software] is used to detail and manage all aspects of a project from inception, through to build, test & deployment and used widely for managing works using an agile methodology. It is a centralised hub that allows for collaboration between teams and individuals and a single source of information relating to the project.

The initiative for Streetworks is already included in Cadent's Enterprise Backlog within [software]. The initiative is currently at Analysing stage whilst the external vendor carries out consultancy work in collaboration with Cadent's Enterprise Architecture team, including a review of the Cadent estate to advise which capabilities Cadent should implement. The figure below shows how this initiative is represented in [software] at the SAFe Initiative level.

Figure 54 – [software] snapshot of Streetworks agile initiative

5.7 - Project 3 – Cost Information

The following options were analysed for their cost and comprise the chosen Street Manager API upgrade solution (Needs case 1 Option 3) as the unchanged line item in the tables below, together with the costs provided for the four different suppliers of Middleware Solution (Needs case 2, Option 2).

Additional detail for each of the options, including CAPEX and OPEX split, can be found in Appendix 21. All costs shown below are in 18/19 prices.

Figure 55 – Needs case 1, Option 3 plus Needs case 2 Option 2 – Street Manager API Upgrade + WMS Middleware Supplier A (preferred option)

*F*igure 56 – Needs case 1, Option 3 plus Needs case 2 Option 2- Street Manager API Upgrade + WMS Middleware Supplier B

Figure 57 – Needs case 1, Option 3 plus Needs case 2 Option 2 – Street Manager API Upgrade + WMS Middleware Supplier C

Figure 58 – Needs case 1, Option 3 plus Needs case 2 Option 2 – Street Manager API Upgrade + WMS Middleware Supplier D

Cost Breakdown for the Preferred Option

The preferred option for the WMS Middleware solution was Supplier A. The full breakdown of costs is as follows:

Figure 59 Total Adjustment Requested in 18/19 prices

Network Splits:

Figure 60 Adjustment Requested East of England - in 18/19 prices

Figure 61 Adjustment Requested London - in 18/19 prices

Figure 62 Adjustment Requested North West - in 18/19 prices

Figure 63 Adjustment Requested West Midlands - in 18/19 prices

Chapter 6.0
Project 4 – Network Emissions Management

Chapter 6.1 – Project 4: Problem Statement and Needs Case

Context

Case studies have shown that contrary to what is calculated within the Leakage Model that typically 4-5% of leaks would account for 35-50% of emissions for a typical geographic region (Appendix 22). However, the accurate location of such 4-5% of leaks is difficult to identify without a scalable and supportive technology solution. Cadent-specific data is provided later in this section.

This submission proposes a solution to responsibly manage network emissions accurately through NIVMT instead of modelling via static leakage rates built on historical averages.

Investment Needs Case

This project presents an opportunity, as a minimum, to avoid economic and environmental costs due to the shrinkage and leakage of natural gas. For example, in 2022/23 our shrinkage emissions totalled 1,045.8 GWh (74% of which is associated with LP and MP mains and services), this resulted in circa [cost-sensitive data] of gas procurement that could have been avoided under a SLM utilising dynamic, actual data, being socialised across the transportation element of customer bills. The breakdown is shown in Figure 64 below, with further detail available in Appendix 23 – Shrinkage gas cost per component.

Figure 64 – The 2022/23 and associated Shrinkage Gas Cost per Component, in 18/19 prices

Approximately 80% of Cadent's fugitive leakage emissions are attributable to ~125,000km of LP and MP mains and services (2022/23 assessment). Given the huge scale of the network, investment in innovative technology solutions is required to accurately identify and locate the 4-5% leakiest assets and manage emissions responsibly. This analysis values the

commodity cost of shrinkage gas, there is also a significant societal benefit associated with the cost of carbon that will further enhance this benefits case.

One way of demonstrating that we are indeed managing emissions responsibly is through the Oil & Gas Methane Partnership (**OGMP**) framework (Appendix 24). It provides a credible means to demonstrate that emissions are being responsibly reduced to the greatest extent possible and in a cost-effective manner and Cadent are committed to adhering to the framework.

In addition to the clear environmental benefits case there are wider benefits we have not valued as part of this business case including:

- Safety Benefits: A reduction in uncontrolled gas escapes and increasing public safety as a result
- Changing workload mix: we would expect an increase in proactive workload with a corresponding decrease in our reactive workload (this will allow us to better profile work across the year and throughout the day)
- Reduction in call volumes: corresponding reduction in call volumes to the national gas emergency line

We have not valued these potentially significant benefits due to the uncertainty in how these will impact on our forecast workload and underlying costs. We believe these benefits are real and material however but to be prudent haven't included them in this business case.

Current Process:

To calculate the emissions from mains requires Distribution Networks to extract pipe data from the core asset repository (post D+42 digitisation) for the calendar year. For each pipe, there is a requirement to categorise it based on the material and diameter of the main, for Low Pressure mains there are 25 distinct categories, for Medium Pressure 7 categories.
For Low Pressure mains, the average system pressure is determined at a local level, and this is applied to the leakage rates to adjust these accordingly. The combination of asset lengths and the adjusted leakage rate determines the leakage volume from the asset in question. For Medium Pressure mains, a system pressure calculation is not included.

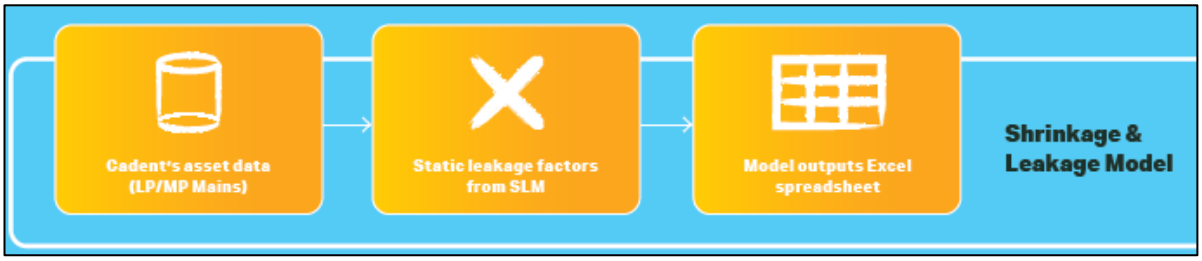

Figure 65 – Overview of Shrinkage Leakage Model

Challenges with Current Process

Within the leakage model, all mains of a similar type, operating at the same pressure, leak at the same rate. Whilst this is a suitable mechanism for determining an overall leakage picture for a network, it does not provide the granular detail required to drive asset management decision making activities. The leakage rates applied date from the National Leakage Tests

undertaken in 2002/03; impacted parties believe these rates to be out of date and misrepresentative of the current asset population (due to replacement activities and degradation over time). Repeating the National Leakage Tests would be a time consuming and costly exercise, and although would refresh the rates within the SLM would be another static picture in time and provide no individual asset performance.

Chapter 6.2 - Project 4: Risks Identified

Figure 66 displays the major risks, and respective mitigations, associated with this investment.

Figure 66 – Risks Identified

Chapter 6.3 - Project 4: Option Selection

To determine the preferred option to deliver the capability required, three options were evaluated against the overall Cadent business objectives, and the technical requirements split into these categories:

- **No Change**
  - Option 1: Continuing to solely use the approved regulatory methodology (SLM) which requires no additional investment and therefore provides no additional benefits to the current solution
- **Do Something**
  - Option 2: Expand leakage surveys
  - Option 3: Deploy mature technology for proactive network emissions management

The summaries for each option below provide the rationale for either discounting or shortlisting:

1) No Change – Current SLM Only (Discounted)

- Continue estimating emissions using a regulatory approved methodology and engineering model which applies predetermined leakage rates based on static coefficients
- Whilst the SLM meets the criteria for regulatory reporting, it does not accurately quantify and locate leaks. This limits our ability to optimise network emissions management including the programming of the IMRRP

Limitations

- No ability to drive a proactive intervention programme with this model as it provides no way of identifying or quantifying where leaks occur. Static coefficients limit the ability for targeted asset replacement

This option has been discounted because we cannot optimise network emissions management effectively due to modelling limitations in the current SLM.

2) Do Something - Expansion of Leakage Surveys (Discounted)

- The purpose of the Leakage Surveys is to primarily check low, medium and intermediate pressure assets and to ensure they are in a safe condition

- The Leakage Surveys currently take place on Cadent's highest risk assets, as defined by two management procedures (CAD/PM/REP/2 and CAD/PM/LC/18) and identified by the Main Risk Prioritisation System (**MRPS**)

- These surveys involve on-site localised detection (based on their location within a carriageway or footpath) with a methane concentration analyser to detect leakage. The survey area is generally limited to a couple of metres either side of the gas distribution asset and a leak is defined by a methane concentration reading above 500ppm

- The output from these surveys is provided to the gas emergency number (0800 111 999) and a Cadent First Call Operative (**FCO**), who will visit the identified leak within a defined SLA of 1 hour. This is a resource-intensive challenge as Cadent is obliged to prevent gas escaping from the network within the SLA, under the Gas Safety (Management) Regulations, which is challenging during peak seasonal work

- Any leaks found by leakage surveys are phoned into the gas emergency service and flow through Cadent's reactive work management. Repairs made are recorded into a historical leak database, which is used to update the risk score that MRPS gives to every metallic pipe asset that Cadent operates. When the risk score of a pipe rises above a certain level it is called Pipe Above Safety Threshold (**PAST**) and depending on its material and diameter, must be replaced. The risk score of a pipe also determines how it is monitored – for example, determining the frequency at which it is leakage surveyed

- This option considers expansion of current leakage to the entire low, medium and intermediate pressure networks at least once per year. The investment required for this option is costed in the supporting financial tracker

Limitations

- The survey outputs do not provide clarity with regards to which parts of each asset have been surveyed. Generally, it is regarded that the field of view of a leakage survey is a couple of metres wide. This means that if a gas leak does not exit the ground directly above an asset it will not be detected using this method

- Also, the fugitive emission rate of methane for each leak from the gas network cannot be quantified using this solution, as it only collects methane concentration. The benefits below cannot be realised using an expansion of leakage surveys:
    - Proactive repair programme: This requires a fugitive emission rate quantification for each leak to identify which are above an action threshold and should therefore be repaired
    - Independent shrinkage assessment: This is essentially the sum of the emission rate of all leaks found, to give a total emission for the gas distribution network
    - Emission rate per asset: This requires a fugitive emission rate quantification for each leak to be tied back to each asset. Analysis that requires this as an input (such as IMRRP prioritisation) cannot take place

- Also, the Leakage Survey programme is focused entirely on safety. The expansion of this programme would only add to the number of emergency visits attended by Cadent within the defined SLA and therefore does not allow us to prioritise the leaks we attend in a proactive manner.

- This option would also not lead to an improvement in Cadent's maturity when benchmarked against the OGMP framework.

3) Do Something – Proactive & Measured Emissions Management (Preferred Option, taken forward for Cost Benefit Analysis)

3a) Implement for remainder of RIIO-GD2

- This option enables proactive emissions management by measuring and converting real-time leakage data into useful insights for optimised asset investment decision-making.

- This is a non-invasive vehicle-mounted technology that identifies the quantity and location of leaks with sufficient accuracy by:
    - Calculating a fugitive emissions rate from the collected real-time data
    - Using advanced analytic capabilities to identify biogenic methane sources and applying machine learning algorithms to transform the captured data using standard IT systems ([software], [software], [software] interfaces)

- The NIVMT would also enable a timely and targeted programming of the safety mandated IMRRP for replacement of the highest emitting assets.

- A supplementary benefit of the proposed NIVMT is that Cadent would be equipped to formally join the OGMP with no fees and demonstrate our ambition to get the gold standard for emissions reporting.
    - OGMP 2.0 is a comprehensive, measurement-based reporting framework that improves the accuracy and transparency of methane emissions reporting.
    - Cadent scored itself level 3 (emissions reported using generic, but source specific emission factors) based on an internal assessment against the OGMP framework (Appendix 25).
    - The use of real-time sensor technology would ensure Cadent progresses towards the international gold standard of emissions reporting (Level 4+).

- There is less reliance on Cadent customers to identify gas leaks. Additionally, interested stakeholders are likely to benefit from the open, transparent and accurate leakage data to credibly inform and coordinate their policy and investment decisions.

Limitations

- The preferred solution is provided by a third-party technology provider as a service, of which the bespoke development is not in our control.

- Although this has been successfully implemented by international utilities such as [third-party] and [third-party], Cadent are currently the only UK GDN who have trialled it on their North London network.

- Requires well-trained vehicle drivers to map the network with a high degree of retention risk due to the current shortage of drivers in the market

- Whilst we can measure and express the environmental benefits of these targeted interventions, they will not be recognised within the RIIO-2 framework (shrinkage pass through costs or reported shrinkage/leakage).

3b) Defer until next price control.

- This option enables proactive emissions management by measuring and converting real-time leakage data into useful insights for optimised asset investment decision-making, but a full phased roll-out cannot commence prior to the next price control.
- Full surveying capability would be established by the end of the first year of the next price control period and the entire Cadent network would be surveyed for the first time by the end of the second year.

Limitations

- This solution has the same benefits as option 3a except realising them will be delayed by almost two years.

- The cumulative release of methane from Cadent's network with this method will be higher than option 3a, as neither reprioritised mains replacement nor proactive repair programmes will be able to commence until surveying capability is established.

Each of the above options was compared against a range of metrics and success criteria as part of a rigorous options analysis process. The summary of this output is described in Figure 67. The methodology for arriving at this point and the rationale behind the preferred option selection is described below. The preferred option has been taken forward for cost-benefit analysis.

Figure 67 – Comparison of options for Network Emissions Management

The candidate solutions were compared using the metrics in Appendix 06.

Based on the strongest metrics, an architecture roadmap for the preferred solution was formed, the content of which is detailed in subsequent sections.

Chapter 6.4 - Project 4 – Preferred Option

Proactive and Measured Emissions Management (option 3) has been selected as the preferred option; an overview is illustrated below:

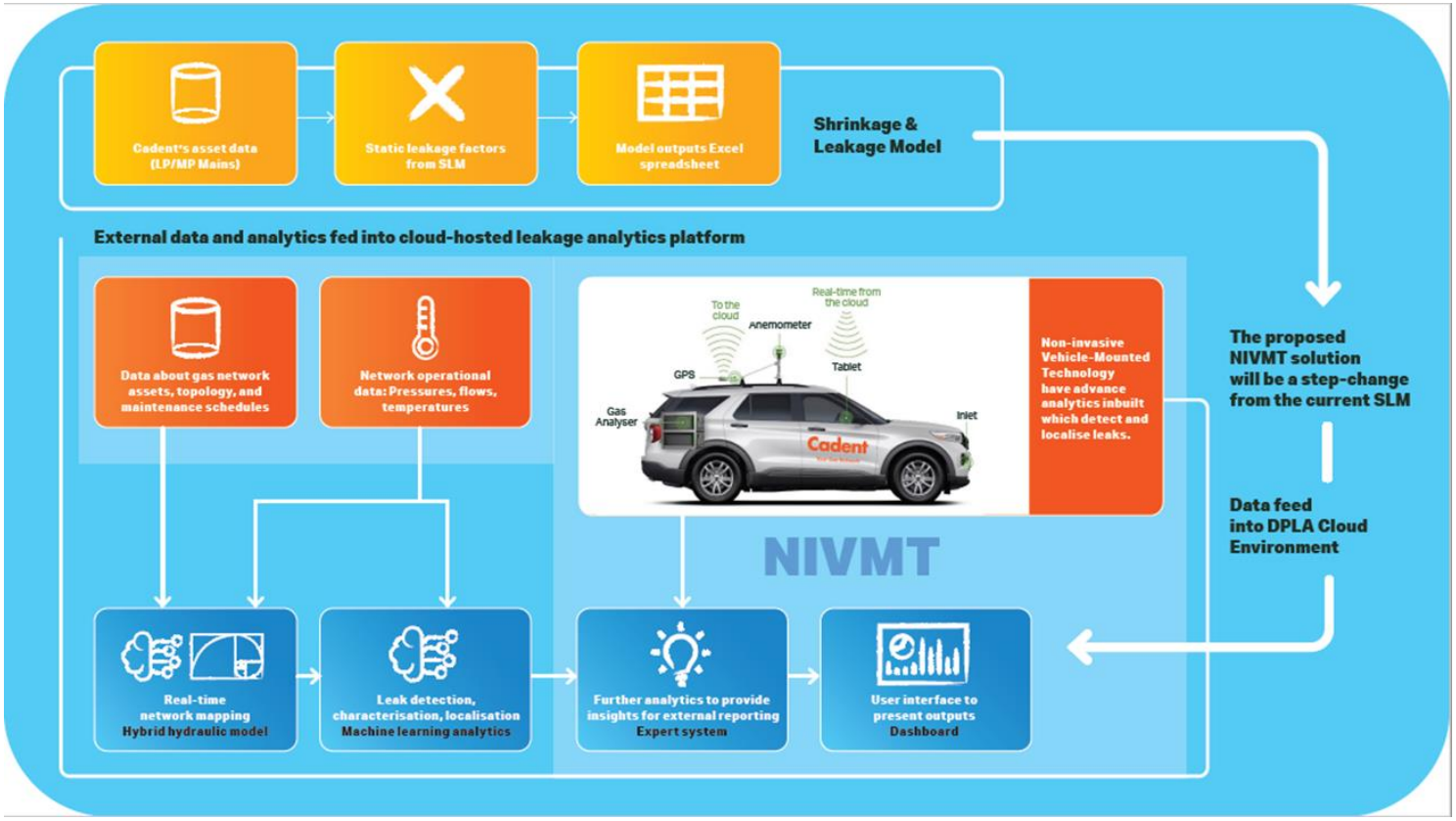

Figure 68 – Proactive & Measured Emissions Management

The NIVMT enables the accurate identification of difficult to locate 4-5% of leakiest assets which overwhelmingly contribute to the overall emissions from the gas distribution network, especially when compared to the average fugitive emission rate of a leak. Figure 69 below provides further confidence based on the Pilot carried out in our North London network (Appendix 26).

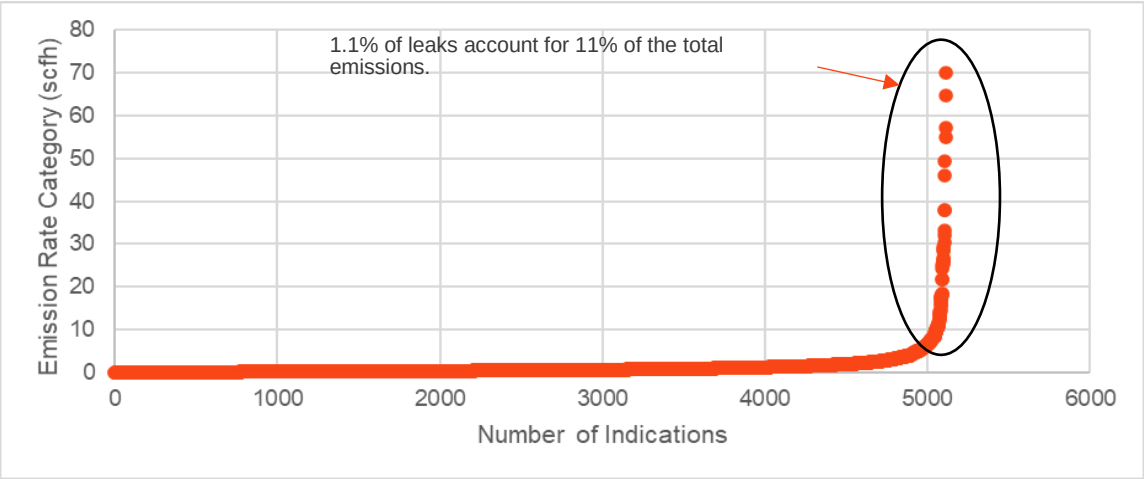

Figure 69 – Results from the North London Pilot in July 2023

Preferred Option Rationale

The only supplier of the preferred option, Supplier A, started to develop NIVMT when its local gas distribution network ([third-party]) had a fatal explosion in the early 2010's. Their proposed technology was developed to enable proactive and measured emissions management, and therefore to be able to operate in a safer position. Since its conception, it has proven to help provide a step change in how gas networks manage and react to their fugitive emissions.

Supplier A's solution includes mobile technology to capture leak data at scale into its SaaS platform. Its integration into Cadent's IT architecture will ensure workflow automation for effective leakage response, utilising Cadent's strategic applications, as well as feed the near real-time data into our [software] to perform powerful pattern-based data analytics and build machine learning logic which, over time, will be crucial in predicting seasonal changes in asset performance to streamline the entire process.

North London Trial (November 2021 – May 2022)

Cadent held a meeting with Supplier A in 2021. Following an initial meeting, Cadent wrote an application to the Transport for London (**TfL**) Lane Rental fund to secure funding for a trial with one unit, starting in November 2021, and finishing in May 2022 to understand the benefits of their technology.

North London Pilot (April 2023 - Present)

Following the success of the trial an internal investment paper was submitted to the Cadent exec seeking [cost-sensitive data] to invest in a NIVMT Pilot phase. The location of this pilot was chosen to be Cadent's North London network due to expertise held from the trial phase among individuals with the network, as well as an ambition to understand the effects of the new technology in one of Cadent's most challenging areas for emergency and repair in West London.

After the investment decision to go ahead, a procurement event was held to ensure the most appropriate supplier was chosen for the Pilot phase in accordance with The Utilities Contracts

Regulations 2016[28]. Procurement started with a Pre-Qualification Questionnaire on the 24th June 2022, followed by an Expression of Interest on the 8th September 2022. After this stage only two suppliers remained. Technical presentations were held in November 2022, where Supplier B failed to meet the specified essential technical criteria, leaving only supplier A in the procurement process as shown below:

Figure 70 – Analysis of Supplier A vs Supplier B

Cost Benefit Analysis of Preferred Option

One of the key benefits to using a NIVMT solution is the ability to target repair towards the largest leaks in a network, which drives multiple benefits:

1. Reduced fugitive emissions at a lower unit cost than replacement
2. Managing the swing in reactive emergency/repair workload between summer and winter
    - Cadent typically see a biannual swing in their emergency and reactive workload. For example, in financial year 21/22, when comparing June to November we saw a 40% increase in its emergency and reactive repairs, resulting in increased operational costs and service inefficiencies (Figure 71).

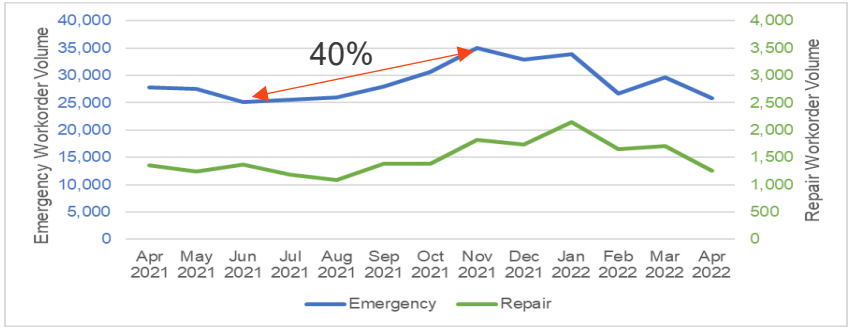

Figure 71 – Biannual increase in emergency and reactive workload

[28] The Utilities Contracts Regulations 2016 (legislation.gov.uk)

Reducing reactive call volumes.

- By using NIVMT to proactively discover leaks in the summer, that are typically reported by a member of the public during the winter, it should be possible to reduce this biannual workload shift and optimise our emissions management. This in turn should lead to greater reliability via a reduction in interruptions, thus increased safety, and reduced bills, as a consequence of reduced reactive repair costs.

North London Pilot (April 2023 - Present)

- Analysis of the preferred option has taken place in the areas surveyed by the North London Pilot so far (4,000km of gas main), which represents one fifth of the London network by length and approximately 3% of the Cadent network length.
- The options presented are for the Pilot area only and model the impact of performing proactive repairs each year against a baseline of only replacement (figure 72 below). Further details can be found in Appendix 27 and 28).

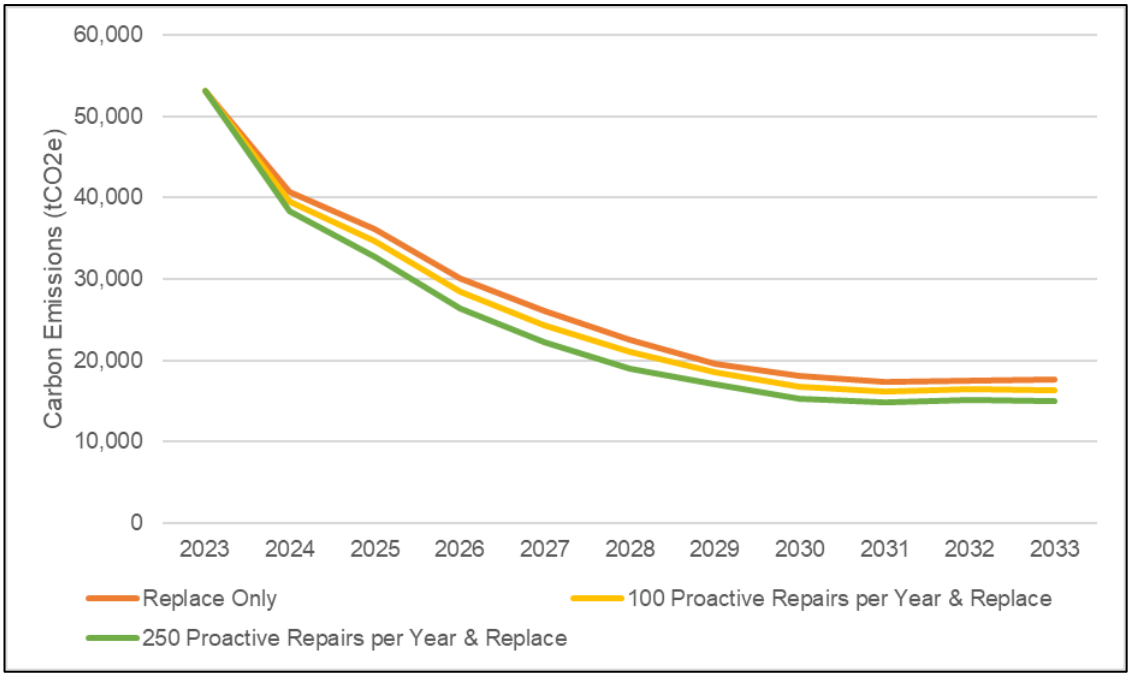

Figure 72 – Proactive Repairs vs. Replacement Only (North London Pilot)

- Conducting a programme of 250 Proactive Repairs per year yields results in an extra 10% reduction in emission savings when compared to the replacement only scenario.

Scenario	£/tCO2e removed
Replacement	294
100 Proactive Repairs	156
250 Proactive Repairs	203

Figure 73 – Emission Reduction Scenarios

The proactive repair scenarios focus on fixing the largest leaks first. The average emission rate of leaks targeted by the 100 Proactive Repairs per year scenario is larger than the 250 scenarios, which is reflected in the £/tCO2e removed unit cost. Both Proactive Repair programmes demonstrate good value when compared to replacement.

- A net present value analysis including all key cost and benefit streams demonstrated the net present value of the project in 2050 to be in the region of [cost-sensitive data] for both the 100 and 250 Proactive Repairs per Year scenarios. The 100 Proactive Repairs per year scenario paid back within 1 year, with 250 paying back by 2030.

- Avoided loss of natural gas (benefit to the end consumer) was found to be 18 GWh by 2050. Avoided greenhouse gas emissions (benefit to the environment and society) was found to be 29,700 tCO2e by 2050.

Chapter 6.5 - Project 4: Technical feasibility and consumer benefit

Project Delivery Risks

No IT delivery project is without risk. With this in mind, Figure 74 describes the key risks to the delivery of this investment that have been considered and mitigated:

Risk Description	Impact	Likelihood	Mitigation / Control
There is a risk that dependent investments do not deliver key milestones to support this investment. For example: by overrunning or de-scoping elements.	Dependent milestones in this investment would be missed leading to benefits being deferred or risks not being mitigated	Medium	Dependent investments are inflight with baseline plans and budget. Cadent IT solution delivery monitors key metrics across all interlocking projects and programmes such as budget, scope and risk. Any key decisions are taken with business sponsors and stakeholders to mitigate project risks and dependencies.
There is a risk that internal resource and capability will not be sufficient to deliver this investment to the required quality and timescale.	The scope of this investment cannot be delivered to the required quality or in an acceptable time leading to a suboptimal mitigation of the needs case and the resulting safety, customer and financial impacts.	Low	The scope and roadmap for this investment aligns to Cadent's target capability model. The necessary organisation, design and recruitment is already underway.
There is a risk that costs incurred with external vendors increase due to market factors.	The overall cost of this investment would increase above the requested amount.	Medium	A level of inflation is assumed in the budgetary forecast. Cadent adheres to UCR to ensure fair competition and that the best value is being secured for the customer.

Figure 74 – Project Delivery Risks

Supporting Case Studies

Further details of the case studies summarised below can be found in Appendix 29

North London Trial and Pilot

Data collected as part of the North London Trial and Pilot so far has demonstrated that an increased understanding of gas network behaviour can be achieved, such as asset level emission rates and how emission rates change during seasons. Analysis shows that by reprioritising the gas mains replacement programme using the NIVMT data, CO2e emission can be reduced to 47% of their 2021 baseline, as compared to just 77% of the 2021 baseline when using the Shrinkage and Leakage Model by 2026, with overall emission reductions of up to 40% by 2030 when comparing programmes prioritised by each method.

[third-party]
[third-party] have reduced the number of calls they receive by greater than 50% in 2022 when compared to a 2017 baseline, as well as reducing their fugitive emission by 18% when compared to 2020 by using NIVMT technology.

Chapter 6.6 - Project 4: Project Delivery and monitoring

Figure 75 – Network Emissions Conceptual Architecture

Project Governance

The Project Governance Group (**PGG**) brings together stakeholders from across Cadent to track deliverables, milestones, risks, and cost:

- Asset Data Management
- Asset Investment
- Business Change
- IT
- Networks

In order to obtain operational and IT sign-off, Cadent has a review and approval process for technology and process change. Business change impacting operations is discussed and signed off by the Operations Transformation Committee **(OTC),** chaired by the Chief Operating Officer; IT architecture change is signed off by the Technical Design Authority, chaired by the Head of Enterprise Architecture; and the priority order for delivering various IT initiatives across the Cadent enterprise falls to the Lean Portfolio Management (**LPM**) Group Each of these stakeholders supports the options analysis process by ensuring: all requirements are considered, risks and dependencies are identified and migrated, and alignment to business and IT strategy is secured. Lastly, budget is approved by Cadent Investment Committee **(CIC)** or by Executive Transformation Committee **(ETC)** if there is also a transformative business change impact.

Network Hardware Deployment Methodology

The supplier will perform the installation of the hardware in the vehicle and provide technical assistance and supervision for the selection and preparation of the vehicle. The supplier will also provide a licence to use the software and access to leak survey data visualisation and data reporting services.

Agile IT Delivery Methodology

The digital delivery project aspects encompassing data ingestion from the sensor technology, integration, software development and configuration for the generation and dispatch of work orders as well as data flow for analytics purposes will be grounded in the Scaled Agile Framework (**SAFe**) product-centric delivery model using planning increment cycles, iterative delivery principles and monitored/governed via Lean Portfolio Management cadence. The core digital delivery team will consist of the following resources/skills as well as vendor expertise:

Role	Number	Role Function
Programme Manager	One	■ Deliver the strategic direction ■ Engage with central Cadent functions ■ Ensure robust and effective processes are built and maintained for the NIVMT roll out ■ Manage relationship with NIVMT supplier ■ Drive continuous improvement across the team
Project Manager	One per Network	■ Engage with local network functions ■ Support IT Integration ■ Manage the fleet of NIVMT vehicles ■ Provide local support for the NIVMT hardware ■ Report on the effectiveness of proactive repair and reprioritised mains replacement programmes ■ Decide on network threshold levels
Analyst	One per Network	■ Build appropriate survey plans ■ Manage threshold levels across the network ■ Analyse the effectiveness of proactive repair and reprioritised mains replacement programmes
Operator	One per NIVMT	■ Drive the NIVMT survey vehicles around the network

Figure 76 – Core digital delivery team

NB. Note on SAFe

Technology change will be delivered through Cadent IT's agile methodology which is based on SAFe**.**

An Integration Platform team will focus on delivering platform capabilities around Interoperability and work with a SME (Integration Architect) around standards and patterns pursuant to consuming these capabilities across Cadent. A second team will be consuming these standards and patterns and producing components on the Platform - delivering on business use cases and increasing the return on investment and speed-to-market through re-use of these components.

Prioritisation of the workload is defined every quarter with all impacted stakeholders at an enterprise level. Both teams then follow the SAFe methodology, delivering incremental change in increments (sprints) lasting two weeks. Typical ceremonies include planning, daily scrum, playback, and review.

Explanation of Operational Costs

An operational team is required to drive the survey vehicles, build survey plans, support IT integration, conduct data analysis and link in with local network teams. The proposed support structure is below and illustrated as an organogram:

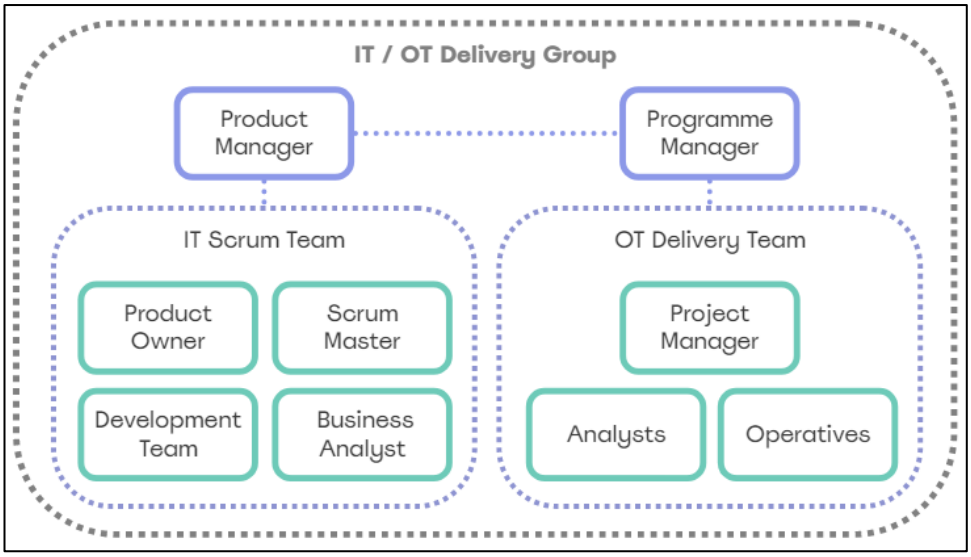

Figure 77 - Operational organogram

Explanation of IT Integration Costs

To support the delivery of this project, investment into IT technology and resource will be required. The costs to achieve this are comprised of internal and external resources, software licenses and cloud storage. This section explains how the cost estimate has been derived and is broken down.

Firstly, the IT Scrum team will be responsible for delivery of the functionality to automate the generation of work orders based on data and spatial analysis of gas readings. This scrum team has already successfully delivered multiple features using a SAFe methodology and is now mature in the estimation of effort. Associated costs for this work is illustrated in detail in under "Resources" on the "2018-2019 Cost Tracker" tab of the workbook in Appendix 30.

Next, to support the IT Scrum team, there is a requirement to engage Cadent's 3rd party partners for their specialist expertise. The cost estimates for this labour is based on rough order of magnitude quotations from each vendor, and is the total predicted cost of the vendors to deliver the integration from [software] to [software]. Cadent's partners have agreed day rates and previous engagements are compared to ensure these estimates represent value for money.

It is proposed to invest in expanding the existing capability of Cadent's [software] platform by procuring an off-the-shelf add-on module called [software]. [software] is to be used as a tool to integrate and ingest the geospatial gas readings data we collect via [third-party]. [software] is a cloud-native add-on capability for [software]. It enables users to ingest data from the Internet of Things (**IoT**) platforms, message brokers, or third-party APIs. It will also help Cadent to process, visualize, and analyse real-time data feeds, such as those from [third-party] (and other platforms – there is some re-use opportunity); store those feeds as big data; and perform fast queries and analysis. We are proposing that Cadent use this software-as-a-service (**SaaS**) IoT application to better leverage our real-time [third-party] spatial data for essential operational decisions such as remote proactive monitoring of leaks, assets, predictive maintenance, and process optimisation.

Since the module would be a standardised, subscription-based product, the implementation costs will be very low, with only limited configuration required. Nonetheless, there is a requirement for an annual license and cloud storage cost increase. Such rates are published and transparent, so a reasonable estimate for the remainder of the RIIO-GD2 period can be derived.

Finally, in order to support Operational Performance, monitor progress and success of this project, there is a requirement for new data analysis and reports to be developed and published. Cadent has a mature management information capability and development team and has calculated the cost for this activity based upon previous costs from similar requirements.

Project Schedule

Due to the scale of the project, a plan on a page would be too small to showcase any meaningful information, so please review Appendix 31 for details of the key activities and milestones for delivery of the project. The expansion to Cadent wide coverage by NIVMT survey vehicles will occur in two 6-month phases: Phase 1 (Starting August 2024), Phase 2 (Starting February 2025).

Key Performance Indicators (KPIs)

Several KPIs have already been established for the North London Pilot. A Cadent wide expansion would see these metrics rolled out for use across the business. The current KPIs include:

KPI	Unit	Description
Length of Network Surveyed	km	The length of the network surveyed using the NIVMT within the current financial year. Once full surveying capability is established, targets for this will be set at the total length of the entire Cadent network.
Length of Network Surveyed per Operator	km	The length of network surveyed using the NIVMT within the current year per Operator. Used to track Operator performance.
Fugitive Emission Rate	Litres/hour	The total fugitive emission rate of the areas surveyed within the current financial year. It is possible to drill down to individual leak level with this KPI. It is used to identify leaks that should be visited with the proactive repair programme.
Estimate In Year Emission Rate	Litres/year	Using the Fugitive Emission Rate, this KPI uses several assumptions to calculate the estimated in year emissions of the area surveyed. Emission abatement due to the proactive repair programme can also be estimated.

Figure 78 – Key Performance Indicators

Stakeholder Engagement

Cadent has a strong commitment to the overall energy transition both in the immediate and long term. Our recent research highlighted how 79% of consumers believe energy companies have the expertise to take the lead on sustainability. Please see Appendix 32 for the source data. The way in which we can drive carbon reduction today is to ensure leaks are prevented or dealt with efficiently and proactively. This initiative ensures we keep the public safe, reduces emissions and ensures there is less waste in the energy network. All of which benefits the consumer and honours this commitment to provide expertise.

In January 2023, Cadent undertook an omnibus whereby over 2000 customers responded about their level of support for innovative technologies which detect fugitive emissions. The survey results support an overall positive story with 64% supporting the use of NIVMT (see Appendix 33).

Cadent first trialled the use of NIVMT in London, starting in November 2021. The trial was funded through an application to the Transport for London (TfL) Lane Rental Scheme and is an example of where trialling a new technology has been successful and taken into further development. The following is an excerpt from the testimonial. For further detail please view Appendix 34.

"Natural Gas, used by many for cooking and heating, is mainly made up of methane. This powerful greenhouse gas is approximately 21 times that of CO_2. With the requirement to bring global emissions to net zero by 2050 and London's ambition to achieve this by 2030, being able to limit its escape from the gas distribution network from aging pipes is vital to achieving our collective goals. That's why trials of new innovations, like Cadent's [third-party] project, are so important. We are delighted to have been able to support Cadent's activity via Transport for London's (TfL) Lane Rental Scheme, Cadent has proven the [third-party] technology and its ability to detect methane concentrations as small as parts per billion within the atmosphere. This emissions based approach would target the mains that emit the most, limit the number of reactive repairs, reduce disruption to the travelling public and revolutionising the way mains replacement is carried out in the Capital, which Transport for London are fully in support of …"
Lane Rental Manager, TfL Operations

Showcasing the NIVMT to local councils has also been an effective tool to demonstrate the step change Cadent is taking in the management of its network and its shift from reactive to proactive network management. This has been effectively recently when we successfully secured an expedited permit for the mains replacement project mentioned in the North London Trial and Pilot Case Study.

Cadent has created networks to collaborate and learn from a plethora of gas distribution and transmission companies that operate outside of GB, mainly within Europe and North America. This work culminated in Cadent's first Global Technology Conference in June 2023, where networks and supply chains, both domestic and international, met to discuss the future of the industry and help Cadent to understand and push for new, innovative technology that can transform its business.

Through networking internationally, we have also signed a collaboration agreement with [third-party], [third-party-sensitive data] largest gas distributor to enable learning across both organisations.

The Project will allow us to meet the stakeholders' needs identified as part of our Digitalisation Strategy in the following ways:

- **Access**: Allow our stakeholders to access relevant network emissions data and intervention updates to our network.
- **Visibility**: Allow our stakeholders to visualise and understand the emissions data to prepare the appropriate information for asset interventions. This will also serve as the medium in communicating the expectations about plans for future asset interventions to our internal and external stakeholders.
- **Collaboration**: There is a potential to make the network emissions data Open and be available to our partners via appropriate portals.

Chapter 6.7 - Project 4: Cost Information

Person Resource:

When new positions are required in Cadent, the relevant business area will work with its HR business partner to evaluate the job role to establish the salary scale or banding for the position. External benchmarking is used annually to ensure that Cadent can perform and recruit competitively in the market. For a comprehensive understanding of the recruitment process please see Appendix 35.

Option 2

Costs for option 2 have been built based on the current leakage survey programme taking place in North London, built upon its forecast unit rate and expanded for the whole of Cadent. This option is forecasted to start from August 2024, the same roll out date as option 3 (not including the Pilot which is currently ongoing in North London). Further information can be found in Appendix 36.

Figure 79 – Total cost of Option 2 in 18-19 prices

Option 3

There are three key investment pathways to ensure the success of a NIVMT rollout across Cadent:

- Operational Costs
- IT Integration Costs
- Direct costs for Supplier A

Further information can be found on tab “Option 3 Cost summary 18-19” tab of Appendix 36.

Figure 80 – Total Cost for Option 3 in 18-19 prices

Costs for the preferred option

Direct Costs for Supplier A

This section provides details of the direct costs for supplier A based on our North London pilot including its actual capex and opex cost splits. For the purpose of this submission, we have scaled these costs to our network-wide deployment.

The overall adjustment required is summarised in 18/19 prices below. For more detailed information on the CAPEX/OPEX splits, please view the “Option 3 Cost Summary 18-19” tab of [Appendix 36 cost tracker]:

Figure 81 – Total Adjustment Required – 18-19 prices.

Costing Breakdown Per Network:

Figure 82Figure below provides an overview of the adjustment per network and is calculated using a formula based upon the number of meter points within each network. Please refer to the “Option 3 Network Split 18-19” tab of [Appendix 36].

Figure 82 – Adjustment Required – Eastern Network – 18-19 prices.

Figure 83 – Adjustment Required – London – 18-19 prices

Figure 84 – Adjustment Required – North West – 18-19 prices

Figure 85 – Adjustment Required – West Midlands – 18-19 prices

Chapter 7.0
Project 5 – Open Data: Interoperability

Chapter 7.1 – Project 5: Problem Statement and Needs Case

As the largest GDN in the UK, our business has long been committed to setting the standard for operational excellence, safety, and innovation. However, a critical challenge facing not only us, but the entire industry is the lack of mature data interoperability. Interoperability is essential because it enables efficient data exchange, reduces costs, promotes innovation, supports decision-making, and enhances the overall functionality and usability of systems and technologies. It plays a fundamental role in modern business and technology ecosystems, allowing organisations to thrive in an interconnected world.

The current landscape sees multiple players operating utility pipeline networks, each with their own data systems, protocols, and processes. This fragmentation results in inefficiencies, reduced collaboration, and suboptimal decision-making due to ineffective data sharing arrangements/immature data interoperability. For instance, during emergency situations that involve coordinated remedial action by several organisations, the delay in accessing and sharing critical data across different systems can lead to significant consequences such as difficulties in optimising gas flows or compromised safety measures without accurate information.

Metadata and its tooling is an enabler to interoperability - helps providing a common understanding of how datasets are structured, how the various components relate both to each other and to the components of other datasets in order to effectively exchange it across systems. However, if these are designed without interoperability in mind from the outset we will experience challenges on how to represent data and metadata from different sources in a consistent way when exposed to other users and third-party applications. Cadent wants to avoid structuring our data and metadata assets on a case-by-case basis, or adopting models of data storage and exchange that respond only to the immediate operational needs of our own processes and applications, without consideration of interoperability needs across the broader energy and asset data ecosystems which we are a part of.

Unless interoperability-as-a-disciplined-approach is addressed we will continue to create and exacerbate data silos because we have focussed almost exclusively on the efficiency in recording and updating information related to our day-to-day business processes, prioritising the integrity and accuracy of that information – ignoring/minimising the analysis needs of external users, and the need to integrate their data with external applications and other sources of information which could have benefitted our Customers.

To address this pressing need, it is imperative that we take the lead in advocating for and driving the maturation of data interoperability across the industry. By supporting good and best practice industry-wide standards and frameworks for data exchange, we can promote seamless

communication among all stakeholders, enabling rapid response to incidents, predictive maintenance, and holistic risk management. This not only enhances our reputation as an industry leader but also helps elevates the entire sector, making gas distribution networks safer, more efficient, and better equipped to meet the challenges of tomorrow.

Needs and requirements of our stakeholders / data community

Page 9 of our Digitalisation Strategy [29]defines digital personas that guide us in recognising stakeholder types and allows us to systemise their data needs:

Figure 86: Stakeholder Ecosystem

These data needs are, in particular:

Access to:

- Relevant gas network data (Energy Industry and Other Utilities)
- Gas network updates and changes (Supply Chain)

Visibility of:

- Cadent network planning and new connections (Domestic Customers, Business Customers, Low Carbon Connecting Parties, Supply Chain, Energy Industry and Other Utilities)
- Disruption to service, work that will affect communities or put pressure on other energy networks (Domestic Customers, Government Authorities and Policy Makers, Energy Industry and Other Utilities)
- Cadent Network capacity (Low Carbon Connecting Parties)

Collaboration:

- In defining the needs to enable Net Zero targets (Energy Industry and Other Utilities, Government Authorities and Policy Makers, Low Carbon Connecting Parties)
- To support inclusivity (Safeguarding Organisations)

Standardisation of:

- Processes to deliver services (Low Carbon Connecting Parties)
- Products to ensure interoperability (Energy Industry and Other Utilities, Government Authorities and Policy Makers)
- Communication channels to share updates and changes (Supply Chain)

[29] https://cadentgas.com/nggdwsdev/media/Reports/Cadent-Digitalisation-Strategy-2022-Update.pdf

Furthermore:

- The proposed investment is directly linked to our obligation with the Gas Transporter Licence Special Condition 9.5 (Digitalisation). Specifically, the licence condition mandates compliance with the Data Best Practice guidance – which requires Cadent to ensure 'Data Interoperability' of the Data Assets and to make Data Assets discoverable and available to stakeholders.
- Cadent's Open Data Portal initiative funded through the re-opener application from January 2023 also has a critical dependency on data integration capabilities to (a) develop (b) implement and (c) maintain the required data pipelines, re-useable components, and wider interconnectivity capabilities, in line with the IT Architecture guiding principles for Cadent and the 'Data Best Practice Guidance' published by Ofgem[30]. By designing these data pipelines for re-use, and inserting 'Interoperability' into the flow of work through to an Open Data Portal, we move away from costly-to-build (and maintain) point-to-point bespoke solutions, improve upon our return on investment by ensuring these components are built for re-use (multiple use cases), and avoid carrying technical debt into the next price control period whilst serving our colleagues and customers 'today' (and tomorrow) in a safe and efficient manner.
- We know there is a clear and present 'ask' from wider industry and Government for Interoperability and technical data-sharing standards and we feel these must be addressed immediately and systematically in RIIO-GD2 in line with the Data Best Practice.

Challenges with the Current System Illustrated by Important Use Cases:

Examples of one off and/or point-to-point integrations ripe for Interoperability improvements are described below:

1. Open Data Portal

The below is an excerpt from the Open Data Portal Project Plan submitted in Cadent's NOITC January submission; Open Data Portal is one of the workstreams awarded funding in Ofgem's final determination. Within this project plan, Cadent demonstrates that delivery is constructed as a number of iterative releases, with each release having a component of two fundamental activities: API authoring and API end point publishing, as shown below. The deliverability of the Open Data Portal plan is thus predicated upon the development of APIs, the most efficient way of secure integration.

Without the development of appropriate API standards **upfront**, Cadent will need to invest in alternative integration methods (yet to be agreed), which requires additional work from the delivery team to design an appropriate integration mechanism to enable Data Assets to seamlessly flow from our [software] to Open Data Portal. Due to current resource constraints (that this Project seeks to address), it is likely that the chosen method will not be an API as Cadent does not have this capability internally.

[30] https://www.ofgem.gov.uk/publications/decision-updates-data-best-practice-guidance-and-digitalisation-strategy-and-action-plan-guidance

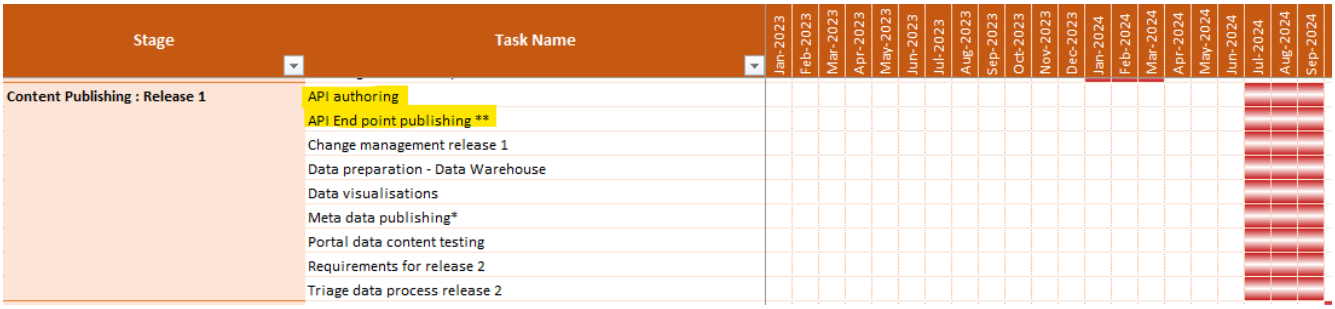

Figure 87 - Excerpt from Open Data Gantt Chart – see Appendix 37

In addition to the Open Data Portal and Metadata use cases, which are dependent on interoperability maturity to be truly effective, the below list provides further examples of IT plan initiatives for which effective and efficient integration is necessary:

2. Street Manager Service

A platform for local highway authorities, utility companies or contractors within England to plan, manage and record street and road works. Cadent is both a customer and a contributor to this. The roadworks data added to this system by companies is available for public viewing free of charge via API land registration. Currently this is a manual upload to populate an API.

3. National Underground Asset Register (NUAR)

A digital map of underground pipes and cables that will revolutionise the way we install, maintain, operate, and repair our buried infrastructure (the below Greater London Authority use case is part of the NUAR initiative - whole system thinking). Cadent is both a customer and a contributor to this.[31] At present, the demand for data is being met with custom integration, underpinned by a manual process for refreshing the data. To satisfy the envisaged future demand, there will be an increased need for an automated approach that has minimal risk of data inaccuracy, that is inherent in manual processes, such that all users of the system have robust information on which to base the excavation work.

4. Additional Welfare Needs Decision Tool

An application that puts the information in relation to customers with additional needs at the fingertips of our engineers and partners alike (removing the current central team manual interaction) - seamlessly integrating with the Priority Services Register (**PSR**) every 24 hours and internal ordering systems.

5. Network Emissions Management Solution

A vehicular solution for network operators that measures methane plumes in the air, maps them, and then immediately alerts users and repair teams upon leak detection while traveling at normal driving speeds in real-time using integrations/interoperability standards and methods. This proactive approach is looking to enhance/replace the current approach relying on Public Reported Escapes (**PREs**) which is reactive and does not necessarily give visibility to low levels of gas being released.

[31] https://www.gov.uk/government/news/first-uk-areas-access-new-digital-map-of-underground-pipes-and-cables

6. [software]

Requires an off-the-shelf SAAS solution reconfigured to a Cadent interoperable standard (for 'further' 'future' interoperability use cases) that will be able to identify liability, assist commercial reporting, assist with the Regulatory Reporting Pack and reduce the manual input of data.

7. [software]

Cadent is both a customer and contributor to this (whole system thinking). [software] will host a web application to handle third-party enquiries to automatically produce asset plans for Cadent. This application will also assess risk & escalations for the enquiries which falls within a predetermined buffer distance from Cadent's sensitive assets e.g., High-Pressure Gas pipelines. Cadent currently requires an automated integration of the latest [software] asset and non-asset [software] data (updated every quarter with daily deltas) to address the high-risk enquiries to be flagged and scheduled for engineer investigation.

8. Backfill & Reinstatement (BAR)

The provision of back-office integration capabilities to Reinstatement Partners that will allow them to integrate Cadent work order information either directly to their own Work Management Systems (and return updates) or use the Cadent system – negating the current manual process with its adjoining data quality risks.

9. Move away from [software] and [software]

Much of Cadent's ERP integration architecture currently utilises the [software] platform and [software] legacy products, [software] have declared that these platforms will move into end-of-life support in 2027/28. The total number of interfaces Cadent currently has on the landscape are in excess of 280-300 (see tab "Cost Breakdown" of the finance tracker in Appendix 38 for more details), with an estimated effort in the region of 19 days per interface to redevelop, to reduce support risk this redevelopment would need completing well in advance of the support end date.

External APIs

On the supply side we also take advantage of external APIs (e.g. [software]; [software]; [software] etc.) and would want a standard pattern for owning, accessing, storing, scanning, securing, cataloguing and monitoring these APIs for managed distribution (and re-distribution) across the Company.

10. Greater London Authority (GLA) Request

To bring this to life using a typical example of these growing future requests for Interoperability from external organisations across England, the following is a request from the GLA who require our data as a standard API.[32]

- *GLA request:* [system-sensitive data]. FTP is generally considered to be an insecure protocol for both sender (Cadent) and receiver (GLA) because it relies on clear-text usernames and passwords for authentication and does not use encryption. Data sent via FTP is vulnerable to sniffing, spoofing (man-in-the-middle attacks), and brute force attacks, among other basic attack methods. GLA have requested to move away from this sub optimal process and make the data available using an API (whole system thinking), [system-sensitive data].

[32] https://www.london.gov.uk/programmes-strategies/better-infrastructure/data-and-innovation-tools

The format of the data: [system-sensitive data], can also possibly use [system-sensitive data]

Data volumes: currently the [system-sensitive data] are less than 1gb but will be larger if converted to [system-sensitive data]

How frequently the data changes: every 3 months. The data is prepared manually now every 3-6 months.

Internal source systems data: Geospatial system ([software]), Work management system ([software]), (It is a mixture of data that is transformed and combined, a [system-sensitive data] or [system-sensitive data] is generated.

- **GLA benefit:** Their process and systems that consumes Cadent data can work in an automated way by integrating the API. GLA would have a secure, efficient transport of data minimising the surface area of where something can go wrong and allow GLA colleagues to concentrate on higher end work rather than repetitive manual data acquisition to extract, transform, checks and loads.
- ***Current Cadent response/capability:*** The process of data preparation is manual. It involves manual steps of extracting data from a number of source systems ([software], [software], [software]), transformations, manual upload to [software] and generating files from [software].

We know this request is for GLA planning purposes and we know other Authorities will have similar if not like-for-like needs. By building these needs using re-useable components in the first place, the 2nd and 3rd requests become exponentially faster-to-resolve as the underpinning building blocks are already available to be re-used – thereby reducing time-to-market relative to building from scratch.

By focusing on data interoperability and maturing our integration capabilities, this will allow us to improve our services in accessing and visualising pertinent data sets, collaborate with our stakeholders in improved ways and internally and externally standardise and secure our offerings – taking advantage of modern architecture thinking, underpinned by data pipelines and so taking advantage of economies of scale and reusability.

Present state and Future state:

The following diagrams illustrates:

1. Our present data interoperability maturity (red boxes); in the context of Metadata and Open Data Portal without maturing data interoperability.
2. And the second diagram represents the Target/Future state with data interoperability maturity (green boxes) to meet the known internal and external secure and sustainable integration demands, and to successfully position Cadent in this key area for enduring future needs. The diagram shows the target architecture capabilities of how we want to approach this capability gap using the Open Data Portal use case as an example of a pressing need and how “Data Management” and “Interoperability” capabilities form the bedrock of data sharing through the “Open Data Portal”.

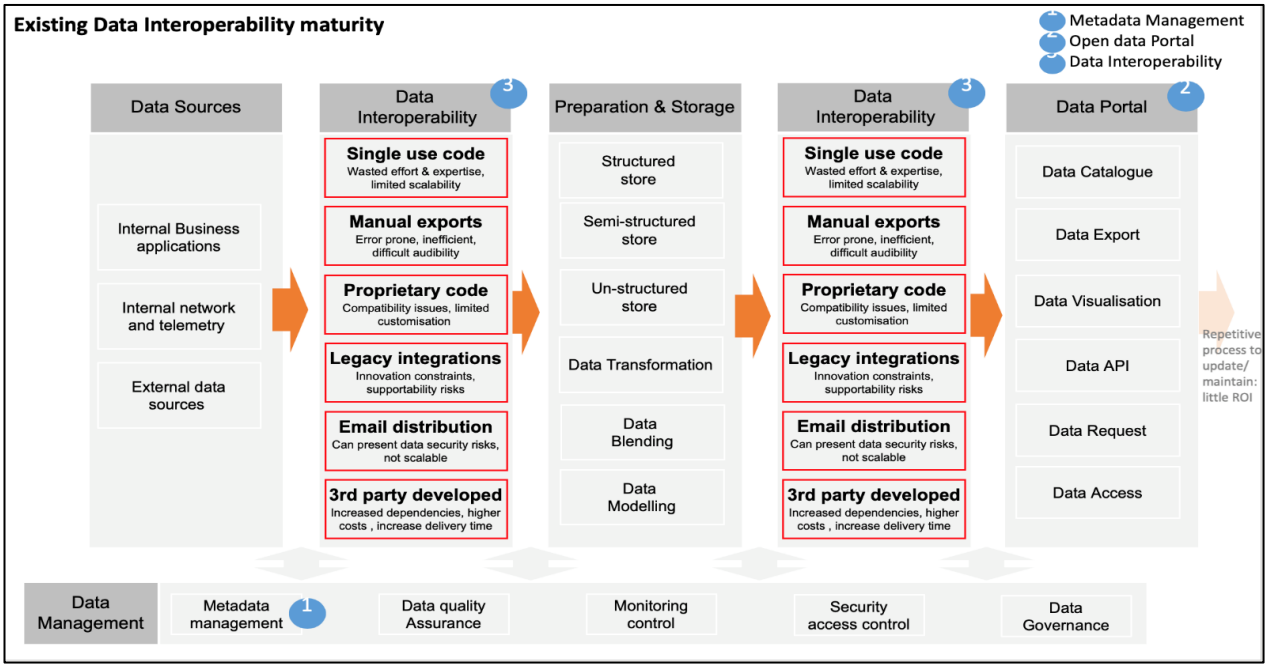

Figure 88: Existing immature Data Interoperability capability with high level challenges/risks (red boxes)

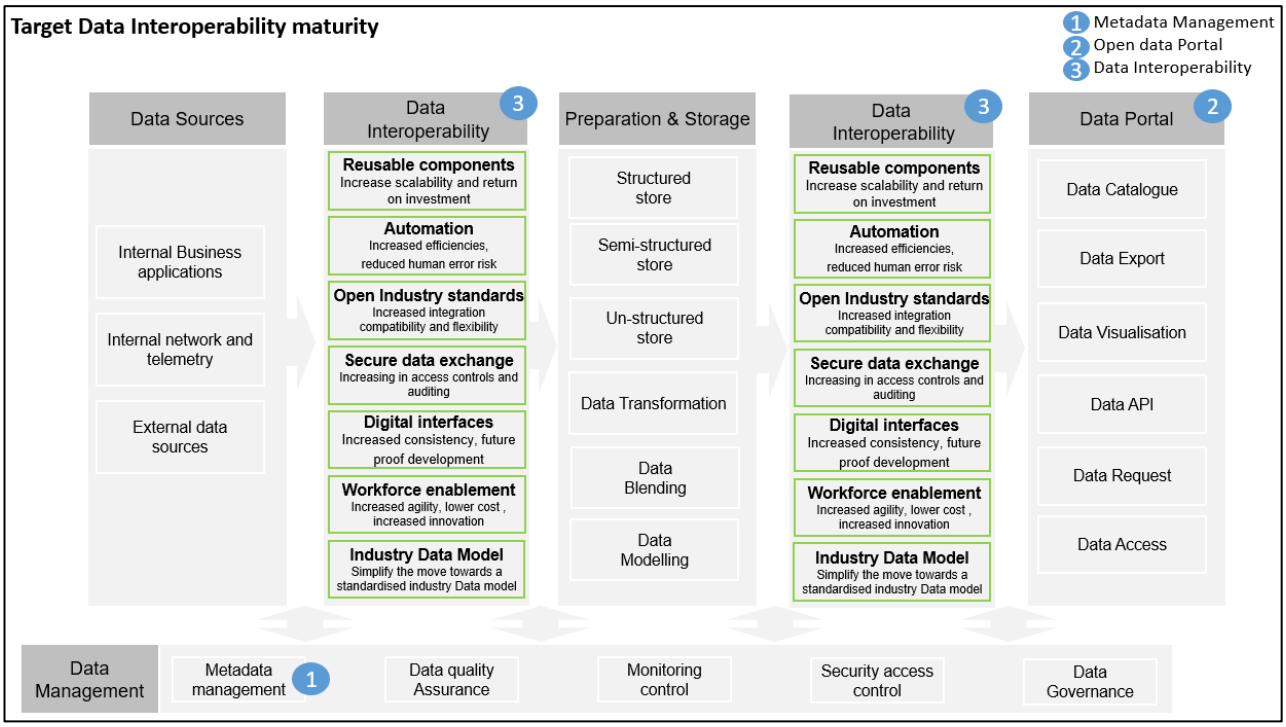

Figure 89: Mature Data Interoperability demonstrating risk and error mitigation, scalability, security, development efficiency, reduced maintenance overhead and sustainability advantages

Present State:

Challenges with Current level of maturity:

Lack of Internal Capability:
There is a lack of technical capability to make data available to Data Users, in a way that can easily exchange Data Assets between different solutions, or interface with Data Assets held in the systems or join Data Assets with other Data Assets (such as by using standard interfaces, standard data structures and/or common reference data). The root cause is a skills-gap of Cadent personnel to execute this work coupled with a lack of subject matter experts within Cadent IT to lead on the strategic design thinking and the longer-term investment case related to interoperability.

Lack of cohesive strategy:
As depicted in the above diagram, the process is disparate, individual, and ad hoc with custom script, manual uploads, and replication to push the data around internally and externally. Depending on the ask it can take weeks/months to coordinate a minimal open data set for a customer It is then difficult to manage updates to the data which in turn necessitates another unique updated dataset compounding the issue. Existing integration pipelines and data movement involving bespoke development or legacy products are often costly, time consuming, unfit for re-use outside of their initial use case and not in line with ambitions to adopt more open, reusable integration standards and tooling. There are levels of duplication and inconsistency in the technical quality and standards around interoperability across the landscape. This has been compounded by the reality that Cadent are reliant on 3rd parties that are working in isolation and are not being guided by an interoperability strategy that reflects the longer-term needs of Cadent as we transition to the future of Hydrogen and Operations 4.0.

Lack of agreed/common tooling:
As a result of the above failings, there are a plethora of tools and ways of working with them which increases complexity and fragility and slows down our ability to intuitively react to a customer development or support need.

Lack of a Data Movement 'Standard':
There is no common data movement 'standard' to work from thereby diluting customer confidence in the data artefacts that we do produce as they are developed to 'best endeavours' which does not scale or easily translate across to customer standards for onwards distribution – thereby slowing their business/government processes and/or adding time delays /costs to their endeavours.

Future State:

The first 18 months of the RIIO-GD2 period proved that the sector-wide hyperfocus on the adoption of digital thinking in the energy sector, with rapid development of data products and services, and the role these products play in delivering a digitalised, net-zero energy system requires a drastic change in the way we traditionally approach the IT project investments. We see a need to keep at the forefront of this rapid data revolution, and require an uplift in modern digital skills, capabilities, and solutions to meet Cadent's and the wider sector objectives. As

such we strongly believe interoperability is key to the successful implementation of Data focused roadmaps and in particular the workstreams that formed part of the re-opener submission of January 2023 in regard to Open Data.

Focusing on Building internal Capability:
Currently, Cadent is heavily dependent on 3rd party expertise from its commercial partners that will change overtime. For a capability that is a fundamental enabler to becoming a fully digital organisation this is a clear risk as does not guarantee a sustainable and consistent interoperability strategy for Cadent, and its customers longer term interests in how they choose to interact and engage. It has become apparent that to become a mature data organisation which can consistently and sustainably serve and derive value out of its data, we need to invest in internal enduring resource/skillset to mature our integration capabilities to be more expedient, cost effective and more adaptable to the changing internal and external demands.

Focusing on Reusability:
Our current ability to develop re-useable and secure interfaces, enabling an open data sharing culture, and to manage the lifecycle of these critical digital assets, is not sufficient to enable us to effectively progress into and beyond the next price control, risking our commitment to bring "value for money for the customer". An enduring capability to build and support streamlined integration that can be re-used again and again – driving down costs and increasing return on investment is a fundamental enabler to the digitalisation strategy of Cadent, as well as to the future ecosystem interoperability requirements set out by Ofgem – benefitting the customer with robust, tested, and supported re-useable foundation components and artefacts that can be used repeatedly to build numerous customer focused solutions. By deliberately embracing the concept of 'reusability' we are rejecting costly to run (and maintain) bespoke data solutions and scaling at a competitive price using increasing returns on the investment.

Common Components and Standards:
Key to this is the development of automated, reusable, and composable integration components that are core to ensuring the propagation of high quality easy to use data products both internally and externally to Cadent and to prepare Cadent for the growing demand for its information – sharp focus on interoperability standards and adjoining capabilities is called for. These can be summarised as follows:

- The ongoing capability to develop, standardise, publish and maintain data integration and data exchange (both internally/externally) in a secure, reusable, and scalable way, encompassing APIs, Data movement options and Data virtualisation.
- The implementation of data integration access controls and the processes to support them
- The capabilities to support Continuous Integration and Continuous Delivery (**CI/CD**) processes including versioning and testing
- The capabilities to monitor data integration and API usage

The implementation of the proposed capabilities will directly allow us to increase our maturity with Data Best Practice, increase our contribution in cross sector collaboration towards the digitalised energy system, and provide a better experience to existing and potential data consumers regarding access, format and visibility of our Data Assets, through the enablement of Cadent to streamline / improve the following:

Development efficiency: By creating reusable components through APIs, developers can leverage existing functionality and avoid reinventing the wheel. This can lead to faster development cycles, reduced coding effort, and shorter time-to-market for new features and products.

Security: Be confident in the security of its system-to-system data integration and internal / external exchange of data by removal of manual processes.

Maintenance and updates: Reusable components encapsulated within APIs can be updated or patched in a centralised manner. This reduces the need to modify the same code across multiple applications, making maintenance more efficient and cost-effective.

Consistency: APIs provide a standardised way to interact with different parts of a system. This can lead to greater consistency across applications, reducing the risk of errors and making it easier to implement changes.

Scalability: Reusable APIs can be scaled independently from the applications that use them. This allows to scale specific functionalities as needed, rather than scaling entire applications, thereby scaling-up the speed of our responses to external and internal requests by employing re-useable components, which can result in cost savings as the internal and external user base grows.

Resource Sharing: Different teams or projects within an organisation can leverage the same APIs, reducing redundant efforts and resource duplication. This can lead to optimised resource allocation and cost savings.

Ecosystem Integration: APIs can enable integration with third-party services, tools, and platforms. This can save development time by leveraging existing services rather than building custom solutions from scratch avoiding costly, bespoke point-to-point solutions.

Vendor Costs: When using third-party APIs, the cost of certain functionalities can be offloaded to external providers, potentially saving on infrastructure and development costs.

Testing and Quality Assurance: Reusable components that are well-tested can lead to more predictable behaviour and fewer bugs. This can result in cost savings related to debugging and quality assurance efforts.

Training and Onboarding: Once developers become familiar with the APIs and reusable components, they can work more efficiently on various projects without the need for extensive retraining.

Legacy Systems: APIs can help modernise and extend the capabilities of legacy systems without the need for a complete overhaul, saving on migration costs.

Current Dependencies and Pre-requisites

There are currently no pre-requisite projects within the overall IT plan, thus no initiatives that impact the deliverability of this project. Neither are any projects within the IT plan dependent upon this project for delivery commencement.

However, all initiatives that rely on data located in other parts of the business will have to engineer alternative methods of extraction and presentation of said data, which will result in bespoke, siloed integration, and a lack of commonality between solutions that are attempting to patch the void in capability that a lack of investment in interoperability will give us. As well as requiring additional resource, the unnecessary design phase will likely impact the time-to-value for each initiative as well. Such cumulative costs have not been accounted for and even if they transpire to be less than the costs associated with this project over the lifespan, they will reduce the value for money that can be achieved.

7.2 – Project 5: Risks Identified

The below displays the major risks, and respective mitigations, associated with this investment:

Figure 90 – Risks Identified

7.3 – Project 5: Options Analysis

At a high level, the options considered were:

Option	Option Name	Definition
#1	Do Nothing	Continue to integrate and distribute data using inconsistent methods and technologies – often manual effort using ad hoc approach with multiple partners with high risk, high resource, compromised quality, low confidence, high rework (high cost we would incur additional costs on other Ofgem reopeners (e.g., open data portal).
#2	Rationalise approach #1	Rationalise using substandard and multiple technologies but attempt to enforce a standardised approach with multiple partners across the company. This still risks the number of systems increasing/fragmenting across the estate.
#3	Implement through Third Party	Use our recommended approach and standards but ask another third party to implement and operate/maintain this. Risk: Loss of IP, fragmentation of ownership, goes against IT strategy, in-house capability strategy. No rationalisation of tools.
#4	Build internal capability (Recommended)	Build our internal capability - protecting IP, using our strategic technology partners' to augment our internal expertise where appropriate to enhance our existing portfolio. Reduction in surface area, grey IT, and technical debt; concentrating on strategic systems and build/sustain a mature in-house capability to increasingly design, develop and maintain integration.
#5	Technology choice/ partnerships agnostic	Implement #4 outside of our chosen strategic technology partners, however this would lead to fragmentation of our target architecture, architectural spine and contributing to more technical debt as we move away from our chosen (to date) architectural investments
#6	Defer until RIIO-GD3	Defer until RIIO-GD3: Continue with #1 (short-term tactical approaches) and therefore increase the risk and burden to tackle in GD3. Risk compliance; opportunity cost in GD3, increasing and carrying over technical debt into GD3. Increasing lack of confidence in the transport of data

Figure 91 – Description of Options Considered

Each of these options were analysed from the perspective of how they contributed to our ambition of embedding the principles of Data Best Practice and evolving our digitalisation ambition.

Figure 92 below presents the assessment of the six options we considered to understand which of these is the most appropriate to close the gaps we identified and mature our compliance with the Data Best Practice guidance recommendations.

Cadent Business Objectives	Option#1 Do Nothing	Option#2 Rationalise approach #1	Option#3 Implement through Third Party	Option#4 Build Internal Capability	Option#5 Technology choice/ partnerships agnostic	Option#6 Defer until RIIO-GD3
Delivers business outcomes	Inadequate	Inadequate	Inadequate	Strong alignment	Inadequate	Inadequate
Change Impact	Inadequate	Inadequate	Inadequate	Strong alignment	Inadequate	Inadequate
Effort to implement	High	High	Medium	Medium	High	High
Cost to implement	Medium	High	High	Low	High	High
Time to realise initial benefits	No benefits are realised	Inadequate	Inadequate	< 1 year	No benefits are realised	No benefits are realised
IT strategic alignment	Not aligned	Not aligned	Not aligned	Strong alignment	Not aligned	Not aligned
Operability / Supportability	Inadequate	Inadequate	Inadequate	Low complexity and risk	Inadequate	Zero Service and high risk
Overall Alignment	Inadequate	Suboptimal	Suboptimal	Preferred option	Inadequate	Inadequate

Figure 92 – Options analysis against Cadent Business Objectives

When technologies are evaluated against the Cadent business objectives, the interpretation of the objectives is applied as per the Options Analysis Methodology (Appendix 06).
Each of these options were analysed from the perspective of how they contributed to our ambition of embedding the principles of Data Best Practice and evolving our digitalisation ambition.

Figure 93 below shows how the options compare against our Architectural principles (Appendix 03):

Applicable Architecture principles	Option#1 Do Nothing	Option#2 Rationalise approach #1	Option#3 Implement through Third Party	Option#4 Build Internal Capability	Option#5 Technology choice/ partnerships agnostic	Option#6 Defer until RIIO-GD3
Empowering autonomy and self-service	Inadequate	Inadequate	Inadequate	Good alignment	Average	Inadequate
Data solutions are composable, reusable	Inadequate	Inadequate	Good alignment	Good alignment	Average	Inadequate
Data solutions are easily integrated	Inadequate	Inadequate	Good alignment	Good alignment	Average	Inadequate
Move towards common reusable data models	Inadequate	Inadequate	Good alignment	Good alignment	Good alignment	Inadequate
Design for the future	Inadequate	Inadequate	Average	Good alignment	Good alignment	Inadequate
Secure data integration	Inadequate	Average	Good alignment	Good alignment	Good alignment	Inadequate
Automate to increase quality and reduce time	Inadequate	Inadequate	Good alignment	Good alignment	Average	Inadequate
Promote reuse and strive to simplify	Inadequate	Inadequate	Average	Good alignment	Inadequate	Inadequate
Demonstrate value iteratively and often	Inadequate	Inadequate	Average	Good alignment	Average	Inadequate
Overall Alignment	Inadequate	Inadequate	Average	Good alignment	Average	Inadequate

Figure 93 – Options Evaluated Against Architectural Principles

The options analysis is predicated on the future operating model for Cadent known as our 'Digital Spine' capabilities – where our core platforms/systems are rationalised/consolidated and with our internal technical capabilities augmented by a small number of strategic partners accelerating the digitalisation journey and maturity in the most efficient way. 'Middleware' as per the diagram plays a crucial role in enabling interoperability and integration in complex environments enabling software components built on different technologies, programming languages or platforms to work together harmoniously – whilst allowing for scalability, security protocols, transaction management and abstraction (reducing complexity).

The key rationale for this Digital Spine is two-fold:

- Simplification of the IT portfolio landscape from an architectural and operational complexity, as well as from a vendor management perspective.

- Utilising native/standard out-of-the-box capabilities and integrations with pre-built business logic, enabling an accelerated path to business transformations (e.g. Operations [industry] 4.0). This target state gives Cadent the best opportunity to close the gap on our digital maturity the quickest, against current and future Ofgem expectations as well as with other GDNs and potential future competitors (e.g. in the Hydrogen space)

By landing and operating these key Digital Spine Platforms in a timely and sustainable manner, we will offer secure and empowering self-serving alternative that tackles the proliferation of "Grey IT" and drives greater cost benefit, reducing future time-to-market & releasing value more frequently as we become more agile in our mindset. This has been designed for one purpose – democratising our data to: make better informed decisions; transform our ways of working; build more intuitive employee & customer experiences.

Figure 94: Cadent's Digital Spine

A full cost-benefit-analysis was not carried out as a transformative move away from this existing Digital Spine approach would involve a significant change programme which would impact on all end-users and business areas for a significant period of time (5+ years). The business disruption and instability/adoption issues would be 'very large' in terms of indirect costs, and in terms of direct costs (commercial and technical project management, design, solutions and technical architecture, technical delivery, network changes, build changes, training, penetration testing, security validation, packaging resource, testing, archiving, sunsetting etc), followed by a co-ordinated delivery to over 6000 internal users across 4 networks[33] (whilst running the business and serving external data requests) – a change in this strategy would negate any benefits foreseen through these re-openers.

[33] Annual Reports and Accounts 2022/23 (Page 4)

Option 1 – Maintaining the Status Quo (**Discounted**)
By choosing to do nothing and maintain the current state, we risk falling out of compliance with Data Best Practice Principles 8, 9.5.13, and 9.5.16. This not only jeopardises our adherence to industry standards but also diverges from our architectural principles. Furthermore, it imposes a growing technical debt burden and opportunity cost on our customers, both now and during the next price control period. This option contradicts the industry's growing need for secure and efficient data exchange between internal and external entities. Both we and our customers (as exemplified by the Greater London Authority case study – see above), are frustrated with the bespoke nature of our current solutions. We have a strong belief that we can transition to a superior offering that yields a better return on investment.

Option 2 – Rationalising the Current Approach (**Discounted**)
This option seeks to rationalise our current approach but falls short due to its reliance on methods and technologies that lack self-service capabilities and team autonomy. The bespoke nature of development and the specific coding and tools used result in solutions that are rarely reusable and not future-proof. This approach introduces fragility and complexity into our architecture, increasing support challenges and potentially causing commercial delays. This will hinder our ability to meet internal and external customer deliverables and impede subsequent progress.

Option 3 – Implement Through 3rd Party (**Discounted**)
While this option aligns with our technology principles and strategic direction, it fails to empower our workforce to become data-driven and adhere to agile and iterative principles. By relying on a third-party, we introduce or extend intellectual property (**IP**) risks, moving away from our in-house people strategy and 'Digital Spine' approach. This fragmentation of ownership and reliance on additional commercial arrangements will slow down decision-making and support, ultimately affecting delivery to our customers.

Option 4 – Building Internal Capability (**Recommended**)
Our preferred option is to build internal capability, aligning with our architectural principles and utilising the capabilities offered by our strategic partners. This approach involves rationalising legacy technologies and methodologies, future-proofing our developments, and ensuring reusability. This will reduce complexity in both architectural and operational aspects, streamline vendor management, and expedite time-to-market. By leveraging out-of-the-box functionalities and pre-built business logic, we accelerate our journey toward digital maturity, align with Ofgem's expectations, and complement other GDNs.

Option 5 – Variant of Option 4 using outside Strategic Partners - (**Discounted**)
This option introduces fragmentation into our target architecture and architectural spine approach, contributing to more technical debt and complexity. It increases vendor management challenges, leading to higher costs, potential delivery delays, and reduced confidence in data usefulness and timeliness for our customers. It is a suboptimal choice that undermines the benefits of Option 4.

Option 6 – 'Defer to next price control' - (**Discounted**)
Choosing to wait and continue with short-term tactical approaches is unacceptable. It perpetuates the risk, burden of technical debt, and non-compliance with Data Best Practice. The

maturity gap will only widen and become more complex in the next price control period. We must address this gap promptly, rather than letting it escalate, to ensure the best outcomes for our customers.

7.4 – Project 5: Preferred Option

The rationale for Option 4 Building an internal capability to advance to becoming a Data intelligent organisation.

The structure of a Data intelligent team needs to consist of specialist data literate roles, this includes: Data science, Data Engineering, Visualisation and Enablement and a Data Platforms & Integration/Interoperability team who collectively build sustainable products and services centred around aligning data products with business value by enabling data driven business decisions for internal and external consumer of data. At present an enduring Data integration/interoperability team is the missing piece of this equation.

An investment in an enduring interoperability team would develop strategic prioritisation of integration through an integration roadmap development that is connected with business objectives to consistently and sustainably drive costs of integration down overtime as opposed to high cost of acquiring data through point solution interfaces with a dependency on 3rd party development in all cases.

Funding is therefore sought to cover Option 4: a fundamental shift to modern ways of transporting data - giving our Architects, developers, and subsequently business teams modern, secure, efficient, and costs-sensitive ways to move data inside and outside of Cadent. This in turn will boost our ability for delivery teams to build and scale modern data solutions and respond to Customer requests and opportunities. We will achieve this by:

Building an internal Platforms capability to advance as a Data intelligent organisation by delivering a ‘toolbox’ of Interoperability capabilities to Architects and self-serve developers designing and implementing data solutions for business teams These include:

- Data movement capabilities: event-driven; batch-driven; streaming
- Data Federation
- API rules and protocols
- Data Movement Orchestration
- Data Movement Lifecycle management standard

Breaking these capabilities down further:

Capability (i): Event-driven data movement:
The ability to transfer or process data in response to specific events or triggers rather than on a predefined schedule or batch process. In this context, an "event" could be any significant occurrence within a system or application that signals the need to move or process data (e.g. data updates; user interactions; system alerts; external signals such as sensor data, IoT devices etc). These events are often generated automatically by the system itself or by external sources, and they can include actions such as:

Event-driven data movement offers several advantages:

- Real-time or near-real-time processing: Data can be moved and processed immediately as events occur, enabling real-time decision-making and reducing data latency
- Scalability: Event-driven architectures can easily scale to handle increased data volume and complexity, as they only process data when necessary
- Efficiency: Resources are utilised more efficiently since data processing occurs in response to specific events, reducing the need for continuous polling or batch processing
- Flexibility: It allows for more dynamic and adaptable data workflows as they respond to changing conditions or requirements

Capability (ii): Batch-driven data movement:

Where data is processed and moved in predefined batches, typically on a scheduled basis. In this method, data is collected, grouped into batches, and then transferred or processed as a group, rather than in real-time or in response to specific events. This approach is often used when immediate or real-time data processing is not a strict requirement, and it offers several benefits:

- Scheduled Processing: Data movement occurs at predetermined intervals or times, such as daily, hourly, or weekly schedules. This regularity allows for predictable and planned data transfer and processing
- Efficiency: Batching can be efficient for handling large volumes of data because it reduces the overhead associated with initiating data transfers and processing for individual records or events
- Reduced Resource Requirements: Batching can be less resource-intensive compared to event-driven approaches since data processing occurs in bulk during specified windows of time, freeing up resources when not in use
- Simplicity: Batching is relatively straightforward to implement, making it a suitable choice for scenarios where real-time data processing is not essential or when data is already generated in batches
- Logging and Error Handling: Batches provide a natural structure for logging and error handling. Errors can be identified and addressed for entire batches rather than individual records

NB batch-driven data movement has some limitations (hence the ‘toolbox’ approach) including:

- Latency: Batches are processed at predefined intervals, so there is inherent latency in data movement, which may not be suitable for applications requiring real-time or near-real-time data
- Scalability Challenges: Handling sudden increases in data volume or adapting to changing data processing requirements can be more challenging with batch-driven approaches compared to event-driven approaches
- Complexity for Near-Real-Time Needs: For use cases requiring near-real-time processing, batch-driven approaches may need additional complexity, such as reducing batch sizes or incorporating event-driven components

Capability (iii): Streaming data:

This refers to a continuous flow of data that is generated, collected, and processed in real-time or near-real-time as it becomes available. Unlike batch processing, where data is collected and

processed in predefined batches at scheduled intervals, streaming data is processed and acted upon as individual data items or events occur. This approach enables Cadent to gain “immediate” insights, make “real-time” decisions, and respond “rapidly” to changing conditions.

Capability/approach (iv): Data Federation:

This is an approach to data management and integration that allows organisations to access and query data from multiple, disparate sources as if they were a single unified source. It aims to provide a unified and coherent view of data across various data repositories, databases, or systems without physically consolidating or moving the data into a single storage location. Metadata plays a crucial role in data federation in particular by cataloguing and describing the available data sources, their schemas, and relationships. As such Metadata helps users discover and understand the available data assets. Data Federation will allow for:

- **Reduced Data Duplication:** eliminating the need to create and maintain redundant copies of data, reducing storage costs and data consistency issues
- **Real-Time Insights:** Users can access the most up-to-date data in real-time, enabling faster and more accurate decision-making
- **Flexibility:** Data federation is adaptable and can incorporate new data sources or remove obsolete ones without major disruptions
- **Resource Optimisation:** leveraging existing data assets and infrastructure, avoiding the need for expensive data migration projects
- **Data Governance:** Centralised data governance policies can be applied to the federated data layer, ensuring compliance and security

Capability (v): Application Programming Interface Management:

This is a set of rules and protocols that allows different software applications to communicate with each other. APIs define the methods and data formats that applications can use to request and exchange information, enabling them to work together seamlessly. The main strategic benefit here is in its Interoperability: in that as long as both disparate systems adhere to the same API standards, they can work together regardless of their underlying technologies.

Other Benefits include:

- **Communication:** APIs serve as intermediaries that allow different software systems to communicate and share data or functionality
- **Abstraction**: APIs abstract the underlying complexity of software systems. They offer a simplified and standardised way for developers to access specific features or data without needing to understand the internal workings of the system being accessed
- **Functionality**: APIs can expose various functionalities, such as retrieving data from a database, sending requests to web services, controlling hardware devices, or performing complex calculations. Developers can then use these functions to enhance the capabilities of their own applications
- **Data Formats**: APIs often specify data formats for requests and responses
- **Security**: APIs can implement Cadent’s security measures and standards such as authentication and authorisation to control access to sensitive data or functions. This helps protect both the API provider and the data being accessed

It's important to note that adopting an API strategy with reusable components can offer significant cost savings, the costs associated with designing, developing, documenting, and maintaining APIs would be reduced if in-sourced.

Capability/Approach (vi): Data Movement Orchestration:

This refers to the coordination and automation of data transfer, synchronisation, and transformation tasks within an organisation's data ecosystem. It involves the management of data flows and processes to ensure that data is efficiently and securely moved from source to destination systems, transformed as needed, and made available for analysis, reporting, or other purposes.

Key advantages of data movement orchestration include:

- **Automation:** Executing data integration and migration tasks in an automated way. This reduces manual intervention, minimises errors, and ensures that data processes are carried out consistently and on schedule
- **Data Transformation:** It often includes data transformation capabilities to convert data from one format or structure to another, ensuring that data is compatible with the target system or storage
- **Connectivity:** The provision of or adapters to interface with various data sources and destinations, including databases, cloud services, file systems, and APIs
- **Workflow Design:** Users can interact around data movement workflows that specify the sequence of tasks, dependencies, and conditions for data processes. These workflows can be visualised and managed through graphical user interfaces
- **Monitoring and Logging:** Monitoring and logging capabilities to track the progress of data movements, detect issues, and provide insights into performance
- **Error Handling:** They include mechanisms for handling errors and exceptions during data transfer or transformation, enabling automated error recovery or manual intervention when necessary
- **Scalability:** the ability to handle large volumes of data and accommodate changes in data processing requirements

Capability/Approach (vii) Data Movement Lifecycle Management (DMLM) approach:

Design, build and implement an Interoperability repeatable ‘standard’ using Data Movement Lifecycle Management approach: DMLM is a comprehensive standard to managing data throughout its entire lifecycle, from creation or acquisition to archiving or deletion. It encompasses a series of processes and strategies to ensure that data is effectively and efficiently moved, stored, protected, and maintained, taking into account the changing needs and value of the data over time. Cadent’s DMLM key components and guiding principles will cover the following:

- Data Ingestion
- Data Processing
- Data Storage
- Data Protection
- Data Retention
- Data Archiving
- Data Purging
- Data Access and Retrieval controls and processes to support them.
- Data Quality Monitoring
- Data Governance
- Data Lifecycle Automation including access controls and processes to support them.

- CI/CD processes including versioning and testing

Capability/Approach (viii) Strengthening our Data Teams with specialised Integration/Interoperability roles:

The structure of a Data intelligent team needs to consist of specialist data literate roles, this includes:

- Data Science, Data Engineering, Visualisation and enablement and last but not least a Data Platforms & Integration/Interoperability team who collectively build sustainable underlying products and services centred around aligning data products with business value by enabling data driven business decisions for internal and external consumer of data. At present an enduring Data Integration/Interoperability team is the missing piece of this equation.
- An investment in an enduring interoperability team would develop strategic prioritisation of integration through integration roadmap development that is connected with business objectives to consistently and sustainably drive costs of integration down overtime as opposed to high cost of acquiring data through point solution interfaces with a dependency on 3rd party development in all cases. Notwithstanding, Cadent also recognises that despite of investment in an internal team, there may be occasions where augmentation is necessary with an external partner as we have to consider access to sufficient resources to ensure timely delivery.

To obtain operational and IT sign-off, Cadent has a review and approval process for technology and process change. Business change impacting operations is discussed and signed off by the Operations Transformation Committee **(OTC),** chaired by the Chief Operating Officer; IT architecture change is signed off by the Technical Design Authority, chaired by the Head of Enterprise Architecture; and the priority order for delivering various IT initiatives across the Cadent enterprise falls to the Lean Portfolio Management (**LPM**) Group Each of these stakeholders supports the options analysis process by ensuring: all requirements are considered, risks and dependencies are identified and migrated, and alignment to business and IT strategy is secured. Lastly, budget is approved by Cadent Investment Committee **(CIC)** or by Executive Transformation Committee **(ETC)** if there is also a transformative business change impact.

7.5 – Project 5: Technical Feasibility and Consumer Benefit

There are two dimensions of risk that have been considered when formulating the Project. The first one being the risk of not fulfilling the expectations set out in the Data Best Practice guidance. The completion of this Project is our principal means of mitigating the capacity and capability gap and demonstrating our ambition to mature our regulatory compliance.

Secondly, in line with our Solution Delivery Framework and Agile ways of working Cadent will continue to document and track the projects' risks and opportunities throughout the life of the Project ensuring that these are reviewed and managed appropriately.

The below presents risks identified at the time of submission that may affect delivery of the Project:

Ref	Risk Description	Approach to Risk
PR01	Changes to Data Best Practice Guidance (post August 2023)	Timely responses to any further consultations on changes to Data Best Practice and continue collaboration and discussion on the guidance with Ofgem and through ENA's Data and Digitalisation Steering Group (DDSG).
PR02	Changes to the Needs of our stakeholders	The Project delivery will be executing work based on priorities backlog of the features. The funnel to capture new demand will remain open to ensure that the highest priority Data Assets are prioritised for delivery.
PR03	With consideration of access to sufficient resources to ensure timely delivery and/or the inability to recruit for the roles required for the Project	Utilise our Delivery Framework partners to augment the delivery teams.

Figure 95 – Risks to the Project

The recommendations made based on the technical gaps identified in the Architecture Assessment were fundamental to the development of the preferred option 4.

Recommendation – Closing the Interoperability Gap:
There is a lack of technical capability to make data available to Data Users, in a way that can easily exchange Data Assets between different solutions, or interface with Data Assets held in the systems or join Data Assets with other Data Assets (such as by using standard interfaces, standard data structures and/or common reference data).

To close the gap, a reusable and standardised integration at Cadent is required using native integration with [third-party] (strategic partners). The rationale for this is as follows:

- [third-party] data integration solutions are tightly integrated with various [software] applications like [software] and [software]. Native integration reduces complexity and improves interoperability within the data ecosystem. In addition, its data integration solutions are pre-integrated with data quality, data governance, data preparation and data stewardship capabilities.

- [software] leverages its flagship on-premises offerings ([software] and [software]) into a hybrid data management strategy (with [software]) to meet the needs of all customers. It delivers an end-to-end integration strategy for its customers by enabling them to combine and switch between multiple integration styles across on-premises and cloud. [software] offers a unified integration platform for end-to-end process and data integration, as well as API management, among other capabilities. This aligns with Data Architecture Principles to reuse existing capability and technology where possible.

- [software] offers a rich set of metadata capabilities such as cataloguing, search, lineage, data quality checks, Personally Identifiable Information (**PII**) detection and data access logging for auditability. In addition, its active metadata capabilities enable data and metadata discovery to drive recommendation engines, warnings, rules, and semantic discovery, including a business glossary in the data catalogue.

- NB Access is based on our existing license agreement ([software] Agreement).

- NB The cost of license/credits does not outweigh the cost of procuring a new solution.

- NB Cloud hosting means the use of a pay-as-you-use model and allows users to fully trial the solution with less financial commitment and therefore risk.

7.6 – Project 5: Project Delivery and Monitoring

Project Scope

To prepare Cadent for the growing demand for its information, a change in integration/interoperability standards is required. The key deliverables of this submission are underpinning capabilities rather than project artefacts – and will set Cadent up to be a modern data organisation. The deliverables are as follows:

- The capabilities to develop, publish and support data integration and data exchange (both internally/externally) in a secure, reusable, and scalable way, encompassing:
- Data movement capabilities: Event-driven; batch-driven; streaming
- Using a Data Federation approach
- Developing and managing common API rules and protocols
- Data Movement Orchestration – access controls and the processes to support them.
- Data Movement Lifecycle management standard including CI/CD processes such as versioning and testing; and the capabilities to monitor data integration and API usage.

Project Benefits:

These deliverables – as ‘capabilities’ and ’approaches’ more than traditional project deliverables per se - are fundamental to Cadent’s future path to data maturity and will prove to be long serving and game changing for our internal delivery teams and Customers alike, promoting efficiency, cost-effectiveness, and enhanced data quality. Benefits will include:

Cost Savings for Our Customers:
Centralised, reusable components eliminate the need for costly, bespoke point-to-point solutions. Custom solutions typically demand extensive development resources and ongoing maintenance expenses. By avoiding these bespoke solutions, customers can significantly reduce their project costs. This cost-saving not only benefits their bottom line but also allows them to allocate resources more efficiently to achieve their strategic objectives.

Faster Time-to-Market:
The availability of centralised, reusable components empowers developers to streamline their projects. They no longer have to invest excessive time in reinventing solutions for each project. This streamlined approach leads to accelerated development cycles, enabling customers to introduce their products and services to the market more swiftly. Speed-to-market is crucial for Central and Local Government teams and for companies looking to gain a competitive edge and staying ahead in rapidly evolving industries.

Enhanced Scalability:
Bespoke point-to-point solutions often struggle to scale effectively, leading to disruptive and costly modifications. In contrast, centralised, reusable components are designed with scalability in mind. They seamlessly adapt to increased demands, ensuring that customers' operations remain efficient and responsive as they expand. This scalability promotes long-term growth without operational and support hurdles.

Reduced Maintenance Overheads:
Maintaining numerous bespoke solutions can be cumbersome, involving version management, updates, and compatibility issues. Centralised components simplify maintenance by enabling uniform updates and improvements across all projects. This consistency reduces the risk of errors and ensures reliable performance. The result is lower long-term maintenance costs for customers, enhancing their cost-effectiveness and long-term return on investment (**RoI**).

Consistency and Reliability:
Centralised, reusable components establish a standardised foundation for projects, promoting consistency in applications and systems. Customers can have greater confidence in the stability and performance of their solutions, which is essential for their reputation and customer satisfaction. Reliability is a cornerstone of trust, and this benefit enhances our customers' trust in our solutions.

Resource Optimisation:
Avoiding duplicate spending on processing and reprocessing custom solutions allows Cadent teams and customer teams to allocate their resources more strategically. They can redirect budget, time, and talent toward critical aspects of their business, such as innovation, customer experience enhancements, or market expansion. This resource optimisation contributes to overall success, confidence, and competitiveness in their respective industries.

Quicker Response Times:
The adoption of reusable components leads to quicker response times for external and internal requests. This agility ensures faster service delivery to customers, improving their satisfaction and demonstrating our commitment to their success.

Increased Confidence in Data:
System-to-system data integration and automated data exchange boost customer confidence in data security and quality. Trust in data integrity and reliability is vital for making informed decisions, enhancing operational efficiency, and maintaining a competitive edge.

Alignment with Data Best Practices:
The project's focus on aligning with Data Best Practices enhances customers' data-related capabilities. This includes enabling access to programmatic components, ensuring interoperability with other data services, protecting data assets and systems, and maintaining data assets in ways that deliver sustained benefits. Customers benefit from a robust data strategy aligned with industry best practices.

Enhanced User Experience:
Customers enjoy a superior experience when accessing, formatting, and visualising our data assets. This improved user experience fosters greater satisfaction and usability, translating into more efficient decision-making and operations.

Contribution to Cross-Sector Collaboration:
The project's contribution to cross-sector collaboration in the digitalised energy system opens doors to new opportunities and synergies for our government colleagues, our customers - and indeed their customers. It enables them to participate in a broader ecosystem, fostering innovation and growth.

Project Governance
Within Cadent IT there is strict project governance which is applied to all projects. For the purposes of simplicity, we will use the terminology of "Project" within this section.

Please see Appendix 13 to understand the Cadent IT Governance that is applied to all IT Change.

IT Delivery Methodology
Technology change will be delivered through Cadent IT's agile methodology which is based on Scaled Agile Framework (**SAFe**)[34].

An Integration Platform team will focus on delivering platform capabilities around Interoperability and work with a SME (Integration Architect) around standards and patterns pursuant to consuming these capabilities across Cadent. A second team will be consuming these standards and patterns and producing components on the Platform - delivering on business use cases and increasing the return on investment and speed-to-market through re-use of these components.

Prioritisation of the workload is defined every quarter with all impacted stakeholders at an enterprise level. Both teams then follow the SAFe methodology, delivering incremental change in increments (sprints) lasting two weeks. Typical ceremonies include: planning, daily scrum, playback, and review.

The initiative for Interoperability is already included in Cadent's Enterprise backlog within [software] (tooling). The initiative is ready for prioritisation through the Lean Portfolio Management process and currently awaiting a funding mechanism.

[34] Scaled Agile Framework

Figure 96 – [software] extract.

The project will be managed by using a product tool called [software]. [software] is used to detail and manage all aspects of a project from inception, through to build, test & deployment. It is a centralised hub that allows for collaboration between teams and individuals and a single source of information relating to the project.

The Interoperability initiative is prioritised as 'High' / A2 – Regulatory, as per the definition below. This priority has been selected due to the gap identified around Data Best Practice:

Prioritisation Matrix

Priority #	Priority	Description
A1	Critical	Immediate. Critical key regulatory / safety driver. Effecting the safety of operations and/or impact to our License to operate
A2	Regulatory	Regulatory must do – Future impact to our license to operate
B1	Strategic	Business Strategic - deliverers key customer/ business outcomes and value with a direct link to the company Business Plan
B2	Tactical	Business Tactical - fixes critical pain points, efficiency focused - key to business operations
C1	Discretionary	Discretionary, nice to do, identified improvements to process, efficiency, ways of working

Figure 97 – Prioritisation Matrix

Project Schedule

Below is the Gantt view of project plan. The detailed project plan is available in Appendix 39.

Figure 98 – Interoperability Gantt Chart

Monitoring and tracking of lessons learnt, improvements.

In Agile ways of working, Monitoring becomes a regular and transparent 'demonstration' of the journey of working software/added business value through.

(i) Sprint and/or

(ii) Planning Increment "demonstration meetings" to stakeholders – including but not limited to the Product Manager/Programme Management Office.

"Lessons learnt" - normally at the end of projects will become regular/formal.

(i) Sprint and

(ii) Planning Increment "Retrospectives" where actions can be quickly fed back into the following increment(s) - allowing for quick course-correction/improvement.

Performance, constraints, dependencies, risk management

Focusing on/around 'working software' as per underlying Agile principles, performance will be monitored, constraints/dependencies and risks will be managed transparently using standard tools and the regular Agile ceremonies (daily stand-up meetings; sprint planning, demos and retrospectives).

Constraints, dependencies and risk will be captured (and risk owners assigned) through PI (Program Increment) planning and managed/visualised throughout the implementation via standard tooling (e.g. [software]) and PMO reporting.

In SAFe a feature's "acceptance criteria" are usually written by the stakeholder or the product owner and will provide the framework to measure whether the benefit is being delivered by the proposition.

Testing Framework

The testing process can be divided into four key categories:

- Unit and component tests are designed to be run both before and after code changes to ensure that the system functions as intended at a granular level
- Functional tests are focused on validating that stories, features, and capabilities operate in accordance with the Product Owner or user's expectations
- System-level acceptance tests encompass various types of assessments, including exploratory, user acceptance, scenario-based, and final usability tests. These tests often involve users and testers in real or simulated deployment scenarios and are typically manual. They serve as a critical step in validating the system's usability and functionality before delivery to end-users
- System qualities tests aim to confirm that the system meets its Non-functional Requirements (**NFRs**). Automated testing tools, such as load and performance tests, will be employed for this purpose. Continuous testing of NFRs is essential to detect potential violations resulting from system changes

Key Performance Indicators (KPIs):

The below Key Performance Indicators are designed to measure the effectiveness and maturity of Cadent's interoperable architecture and how the delivered benefits will be objectively verified (business realisation). These KPIs are critical for monitoring and improving Cadent's data architecture maturity, ensuring timely access to data for customers, and maintaining data quality while minimising costs. By tracking these KPIs in a central delivery tool like [software], Cadent can continuously refine its processes and deliver more value to its customers.

Time-to-Reliable-Insights:

- **Purpose:** This KPI measures the speed at which data artefacts, which are essential components of data, are delivered to be shared both internally and externally with customers.
- **Importance:** A shorter time-to-reliable-insights indicates that Cadent can provide valuable data-driven insights to customers faster. It reflects the efficiency and agility of data delivery processes.
- **Measurement:** This KPI tracks the time it takes from the initial request for data artefacts to when they are reliably available for use. It should show a decreasing trend over time as processes become more efficient.

Time-to-Query Underlying/Presentation Technologies:

- **Purpose**: This KPI focuses on the efficiency of querying and accessing data from underlying data sources and presenting it in the desired format.
- **Importance**: Efficient querying and presentation of data are crucial for ensuring that customers can access and work with data quickly and effectively. It also reflects the adaptability of Cadent's data architecture.
- **Measurement:** This KPI measures the time it takes to set up the necessary infrastructure and technologies for data access and presentation. As Cadent becomes

more proficient in using common standards and modern data management techniques, this time should decrease.

Time-to-Lag-to-Analyse:

- **Purpose:** This KPI evaluates how quickly data from its source becomes available for analysis.
- **Importance**: Timely access to data is essential for customers to make informed decisions and perform real-time analysis. A shorter time-to-lag-to-analyse indicates better data availability (due to re-useable components).
- **Measurement:** It measures the duration between data generation or acquisition and its readiness for analysis. This KPI should show a decreasing trend over time as data delivery processes improve.

Time-to-Evolve:

- **Purpose:** This KPI assesses the speed at which Cadent's data architecture can adapt to subsequent changes in data sources/asks.
- **Importance:** In a dynamic data environment, the ability to quickly accommodate changes in data sources is crucial to maintaining data quality and relevance.
- **Measurement:** It tracks how long it takes for the data architecture to be modified or adjusted in response to changes in data sources. A shorter time-to-evolve indicates greater agility in handling data source changes.

Contribution to Data Quality Maturity Score (over time):

- **Purpose:** This KPI evaluates Cadent's efforts in improving data quality over time.
- **Importance**: High data quality is essential for accurate analysis and decision-making. Tracking the contribution to data quality maturity provides insight into ongoing data quality enhancements.
- **Measurement:** It assesses the impact of Cadent's initiatives on enhancing data quality. Over time, this KPI should demonstrate an increasing trend as data quality improves.

Stakeholder Engagement

Cadent's commitment to fostering stakeholder engagement has been integral to the success of our work to date, rooted in our experience during the RIIO-GD2 preparation phase, which laid the groundwork for our Digitalisation Strategy and this proposal.

Our approach here has been collaborative and inclusive, drawing insights and feedback from all corners of the organisation. We recognise the significance of engaging not only our internal teams but also a wider group of stakeholders as evidenced in Chapter 7.1 of the application, and particularly sub-sections: Needs and Requirements of our Data Community; Challenges with Current System Illustrated with Use Cases.

One of the key milestones in our stakeholder engagement journey was the consultation with our Customer Engagement Group, a crucial touchpoint that ensured we heard the direct feedback of stakeholders on our digitalisation proposals. This open dialogue was instrumental in shaping our strategy to align with the needs and expectations of our valued stakeholders.

To further enhance and validate our understanding of stakeholder data needs, we have introduced internal and external Digital Personas. These personas help us categorise and organise the diverse data requirements of our stakeholders, ensuring that our interoperability project is finely tuned to their specific demands.

A pivotal element of our stakeholder engagement efforts resides in our active participation in the Data & Digitalisation Steering Group. This collaborative body, comprising representatives from both electricity and gas network operators, epitomises our commitment to working collectively towards the common goal of digitalisation excellence.

This collaboration within the DDSG serves as a linchpin for ensuring that adoption, development, and new capabilities in data and digitalisation are seamlessly coordinated across all network operators. This alignment is particularly critical when considering the holistic approach needed to usher in a modern, digitised energy system.

Our commitment to collaboration extends to specific initiatives, such as the joint proposal by the SGN Gas Distribution Network to enlist third-party support for the development of a Common Information Model for Gas of which Interoperability will play a key role. Moreover, the DDSG has outlined a comprehensive proposal for the aggregation of workstreams where all network operators can collaborate. These collaborative efforts are directed towards maturing industry standards and defining a common approach to ensure compliance with Data Best Practice.

Cadent's stakeholder engagement endeavours are a cornerstone of our interoperability proposal. By actively involving stakeholders and seeking feedback, we ensure that our efforts are not only compliant with industry best practices but are also finely tuned to meet the evolving needs of our customers and partners. Through this collaborative approach, we aim to forge a path towards a more interconnected, efficient, and effective energy landscape.

7.7 – Project 5: Cost Information

The interoperability cost is a forecast based upon monthly capacity units consumed in our [software] by the delivery team and the cost we expect to incur to recruit the resources required to accelerate this work. We investigated options to do some of the work via a third-party (Appendix 40) but quickly saw this model became price prohibitive whilst also losing the strategic momentum around in-house development and ownership.

Full details and Capex/Opex splits, together with the source information, can be found in Appendix 38. Figure 99 below shows the cost in 18-19 prices.

Figure 99 Total Adjustment for Project 5 in 18/19 prices

Costing Breakdown Per Network:

Due to these costs being central across all Cadent's network we have provided a breakdown of what the costs would look like at a network level by applying an apportionment calculation using customer numbers in accordance with the principles we follow for other regulatory reporting (e.g., RRP).

Figure 100 – Adjustment for Eastern Network in 18/19 prices

Figure 101 – Adjustment for London Network in 18/19 prices

Figure 102 – Adjustment for North West Network in 18/19 prices

Figure 103 – Adjustment for West Midlands Network in 18/19 prices

Chapter 8.0
Appendices

The documents noted can be found in the accompanying Zip folder.

- Appendix 01: Project 1 - [third-party] EoL Notification
- Appendix 02: Project 4 - DN Comparison (RIIO-GD2 22/23)
- Appendix 03: Guiding EA Principles
- Appendix 04: Project 1 - Finance Tracker - Satellite EoL Replacement
- Appendix 05: Risk Management Standard
- Appendix 06: Cadent's Options Analysis Methodology
- Appendix 07: Project 1 - WBS Codes and PO numbers
- Appendix 08: Project 1 - Method of Working
- Appendix 09: Project 2 - Desired Business Outcomes
- Appendix 10: Project 2 - IT Solutions Options
- Appendix 11: Project 2 - MOBs Gap Analysis
- Appendix 12: Project 2 - [third-party] Mobs Programme Reset KO
- Appendix 13: Cadent IT Project Governance
- Appendix 14: Project 2 - Finance Tracker
- Appendix 15: Project 3 - FPN Non-working Days
- Appendix 16: Project 3 - High Level Design
- Appendix 17: Project 3 - Works Starts and Stops to Work out FTE
- Appendix 18: Project 3 - Examples of Live Inspections Time Taken
- Appendix 19: Project 3 - Examples of Re-inspections Times Taken
- Appendix 20: Project 3 - Master BR Middleware Supplier Evaluation
- Appendix 21: Project 3 - Streetworks Finance Tracker
- Appendix 22: Project 4 - Measurements of Methane Emissions from Distribution in the US
- Appendix 23: Project 4 - Shrinkage Gas Cost per Component
- Appendix 24: Project 4 - OGMP and upcoming EU emissions regulatory framework
- Appendix 25: Project 4 - Internal OGMP Assessment
- Appendix 26: Project 4 - North London Supplier A Pilot Results
- Appendix 27: Project 4 - Supplier A Proactive Repairs
- Appendix 28: Project 4 - Supplier A Proactive Repair, Net Present Value and Carbon
- Appendix 29: Project 4 - Case Studies for North London & [third-party]
- Appendix 30: Project 4 - Network Emissions Management Finance Tracker
- Appendix 31: Project 4 - Project Delivery Plan
- Appendix 32: Project 4 - DPLA Omnibus 2023
- Appendix 33: Project 4 - DPLA Omnibus 2022
- Appendix 34: Project 4 - Supplier A Statement of Support from Transport for London
- Appendix 35: Recruitment of Person Resource
- Appendix 36: Project 4 - Cost Evidence for Network Leakage Surveys (Option 2)
- Appendix 37: Project 5 - Open Data Portal Original Project Gantt chart
- Appendix 38: Project 5 - Interoperability Cost tracker

- Appendix 39: Project 5 - Interoperability Project Gantt Chart
- Appendix 40: Project 5 - SOW 175 Neo to Cloud Foundry Migration

Chapter 9.0
Glossary of Terms

Acronym	Description
[software]	[software]
AGI	Above Ground Installations
AH	Asset Health
AMCOP	Asset Management Committee for Operational Performance
API	Application Programming Interface
BAR	Backfill and Reinstatement
BIO	Biomethane Injection sites
[software]	[software]
[hardware]	[hardware]
CAB	Change Approval Board
CD	Continuous Delivery
CDM	Construction Design and Management regulations
CI	Continuous Integration
CIC	Cadent Investment Committee
CMO	Construction Management Organisation
CNI	Critical National Infrastructure
DBP	Data Best Practice
DBT	Design, Build and Test
DDSG	Data & Digitalisation Steering Group
DfT	Department for Transport
DMLM	Data Movement Lifecycle Management
DNCS	Distribution Network Control System
DPLA	Digital Platform Leakage Analytics
DTH	Direct to Home
EA	Enterprise Architecture
ECC	Energy Control Centre
ENA	Energy Networks Association
EoL	End of Life
EPGs	Expert Practitioner Groups
EPPG	Enterprise Product Prioritisation Group
ESOS	Emergency Standards of Service
ETC	Executive Transformation Committee
EToN	Electronic Transfer of Notices
FCO	First Call Operative
FPNs	Fixed Penalty Notices
FTP	File Transfer Protocol

Gbps	Gigabytes per second
GDN	Gas Distribution Network
GLA	Greater London Authority
[software]	[software]
GRSC	Gas Remote Site Communication
GSoP	Guaranteed Standards of Performance
HAs	Highway Authorities
HRB	High Rise Buildings
HSE	Health & Safety Executive
HT	Hilltops
HTS	High-throughput satellite
IGEM	Institution of Gas Engineers and Managers
IMRRP	Iron Mains Risk Reduction Programme
IN	Innovation
INVP	Investment Papers
IoT	Internet of Things
IP	Intellectual Property
IPOs	Investment Planning Office teams
[software]	[software]
[hardware]	[hardware]
IT	Information Technology
KPIs	Key Performance Indicators
LDS	Large Diameter Services
LMS	Learning Management System
[hardware]	[hardware]
LP	low pressure
LPM	Lean Portfolio Management
[software]	[software]
MB	Meter Banks
MEAT	Most Economically Advantageous Tender
MOB	Multi-Occupancy Building
MOCS	Multi-Occupancy Commercial Structure
MP	medium pressure
[hardware]	[hardware]
MRB	Medium Rise Buildings
MRPS	Main Risk Prioritisation System
[software] Dev	[software] team
MVP	minimum viable product
NFRs	Non-Functional Requirements
NG	National Grid
NIS	Network and Information Systems
NIVMT	non-invasive vehicle-mounted technology
NOFF	Network Operations and Field Force
NOITC	Non-operational IT Capex
NRO	Non-Routine Operations

NRSWA	New Roads and Street Works Act
NUAR	National Underground Asset Register
OGMP	Oil & Gas Methane Partnership
OPEX	Operational expenditure
OPN	Offtake Profile Notices
Ops	network operations
[software]	[software]
OTC	Operations Transformation Committee
PAST	Pipe Above Safety Threshold
[hardware]	[hardware]
PGG	Project Governance Group
PI	Planning Interval
PII	Personally Identifiable Information
PMO	Project Management Office
[software]	[software]
POAP	Plan on a Page
PQQ	Pre-Qualification Questionnaire
PREs	Public Reported Escapes
PSR	Priority Services Register
[hardware]	[hardware]
PWG	Programme Working Group
RFI	Request for Information
RFP	Request for Proposal
RoI	Return on Investment
RPs	Reinstatement Partners
RRP	Regulatory Reporting Pack
RT	Regression Testing
SaaS	Software-as-a-Service
SAFe	Scaled Agile Framework
[software]	[software] Works Management System
SCADA	Supervisory Control and Data Acquisition
SCO	Safe Control of Operations
SIF	Strategic Innovation Fund
SIT	Systems Integration Testing
SLA	Service Level Agreement
SLM	Shrinkage and Leakage Model
SMEs	Subject Matter Experts
STB	Service Transition Board
tCO2e	tonnes of carbon dioxide equivalent
TDA	Technical Design Authority
TfL	Transport for London
TOIDs	Topographic Identifier
UAT	User Acceptance Testing
UCR	Utilities Contracts Regulations
UNC	Uniform Network Code

[software]	[software]
[hardware]	[hardware]
WBS	Work Breakdown Structure
WMS	Work Management System