Engineering Justification Paper

LTS Capacity Works Programme Transmission Scotland and Southern Networks

Final Version

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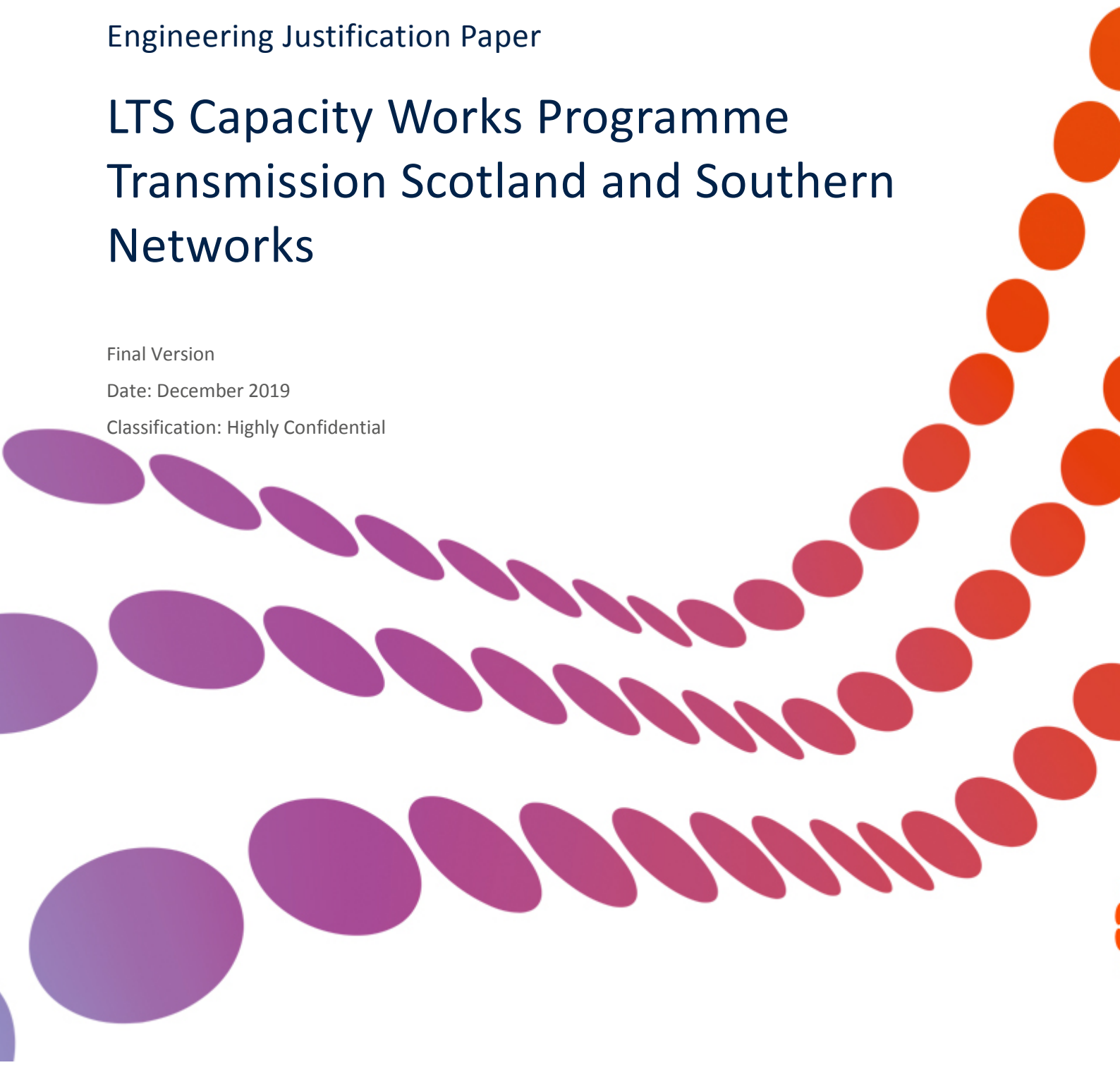

1. Table of Contents

2 Introduction

Reinforcement has been identified as necessary within the Scotland and Southern LTS networks in order to deliver adequate system capacity and avoid anticipated LTS capacity constraint. This document identifies the 5 standalone LTS capacity upgrades currently identified via LTS capacity assessments. One additional project is required as part of a programme of reinforcement associated with the RIIO-GD2 Business Plan Appendix for below 7 bar Network Growth to deliver a new PRS to reinforce the below 7 bar network in South East Edinburgh.

2.1 General Background

The SGN distribution and transmission systems are built to ensure security of supply for all our customers. Our networks operating at pressures above and below 7 bar are designed to meet a peak demand level that could be experienced under 1:20 conditions, supporting a safe, secure and reliable service to those customers and meeting requirements outlined within our Licence Condition, including, but not limited to, Condition 16 contained therein.

Link: **Gas Transporters Licence – Standard Conditions**

Where capacity constraints are identified that are likely to impact on SGNs ability to ensure security of supply to all customers, Network Planning will look to establish optimum, cost-efficient reinforcement strategies to mitigate that risk. Such constraints may arise as a result of a number of factors, but the most common is increased demand levels, typically resulting from new connections.

SGN has initiated an extensive programme of stakeholder engagement, working closely with Local Authorities, both in Scotland and the South of England, to establish a fully informed and independently sourced picture of planned development.

This engagement has provided SGN with confidence that the sites identified will progress to development and, to support this level of growth, SGN has developed a programme of reinforcement across its network.

This document details the various works assessed as necessary on the LTS networks within Scotland and Southern LTS networks in order to ensure a safe and reliable network meeting future gas demand in line with SGNs licence requirements.

2.2 Site Specific Background

This table lists the LTS works identified as necessary in GD2 in order to comply with capacity and security of supply obligations. There are 2 PRS rebuilds, 1 new PRS and a pipeline project in Scotland Network and 2 PRS rebuilds in Southern Network as summarised Table 1.

Table 1:Project Listing

Project	Required Upgrade	Driver
Dreghorn PRS (Sc)	Site rebuild	General downstream growth
Tranent PRS (Sc)	Site rebuild	General downstream growth
New PRS + 0.1 km of LTS pipeline (Sc)	New PRS supporting below 7 bar growth project.	A key element of delivering the CPM7993 South East Wedge (Edinburgh) below 7 bar reinforcement project.
T8: Pitcairngreen to Huntingtower - R04 and R05 (Sc)	4.5km pipeline replacement + 2 pig trap facilities	General downstream growth + inadequate inlet pressure at Huntingtower PRS
East Morden (So)	Site rebuild	General downstream growth
Wavendon (So)	Site rebuild	General downstream growth

3 Projects Summary

Table 2 in this section summarises the 4 projects in Scotland and 2 projects in Southern network specifically required to meet future gas demand whilst ensuring acceptable operating conditions and delivering the required security of supply for customers

Table 2:Project Summary

Project	Required Upgrade	Driver
Dreghorn PRS (Sc)	Site rebuild	GD2 capacity constraint at existing site
Tranent PRS (Sc)	Site rebuild	GD2 capacity constraint at existing site
New PRS + 0.1 km of LTS pipeline (Sc)	New PRS supporting below 7 bar growth project.	GD2 load growth (Part of CPM7993 South East Wedge (Edinburgh) below 7 bar reinforcement project)
Pitcairngreen to Huntingtower pipeline (Sc)	4.5km pipeline replacement + 2 pig trap facilities	GD2 Capacity Constraint at Huntingtower TRS due to 100mm pipeline
East Morden (So)	Site rebuild	GD2 Capacity Constraint at existing site
Wavendon (So)	Site rebuild	GD2 Capacity Constraint at existing site

4 Problem Statement

Why are we doing this work and what happens if we do nothing?
New connections to our networks reduce available capacity and when system operating conditions are predicted to fall below minimum acceptable levels it is necessary to reinforce and facilitate increased capacity in the system. Within the LTS network, necessary works may directly support below 7 bar reinforcement projects or may address a system constraint within the LTS which occurs as a result of general load growth but not requiring work on the below 7 bar network.

What is the outcome that we want to achieve?
Maintain SGN's Licence Conditions to ensure security of supply and support economic prosperity by not becoming a barrier to development.

How will we understand if the spend has been successful?
On completion of the proposed reinforcements, SGN will monitor system performance to ensure expected system operating conditions are maintained.

4.1 Narrative Real-Life Example of Problem

These projects are all associated with the inability of the LTS to deliver adequate capacity to the downstream below 7 bar network. The immediate consequence of this would be a loss of supply within the below 7 bar network.

This has not yet been caused by inadequate LTS capacity however an example of an outcome where new development was connected to the network in advance of an identified requirement for system reinforcement occurred in January 2019 at Maresfield, Uckfield.

In this instance, no immediate issues were experienced as the initial network connections were made during a period of low demand. However, as demand increased over the winter period insufficient capacity resulted in the loss of supply to 350 customers.

This situation was rectified by the installation of network reinforcement, restoring supplies and ensuring future security of supply under all demand scenarios.

Any LTS project typically requires 3 years to plan and deliver and for this reason modelling of the network and advanced planning of anticipated reinforcements is key to delivering security of supply on an ongoing basis.

4.2 Spend Boundaries

The spend associated with these reinforcement works provides capacity within the LTS at the 4 locations on the Scotland LTS and 2 on the Southern network to support projected development during RIIO-GD2, while being consistent with potential long-term development beyond 2025/26.

The capital investment associated with these works ensure security of supply for existing customers and connection of planned development to the network within the area of influence of these projects.

Costs contained within this paper have been prepared using an initial scope of works and by benchmarking with recently completed comparable projects. A full design study will be required which could highlight site specific difficulties.

Not included within this spend are the costs for subsequent phases of reinforcement required to support demand out-with the RIIO-GD2 period.

5 Probability of Failure

Table 3 gives capacity metrics for the 5 sites where standalone projects are required to alleviate identified restrictions.

Table 3:Capacity Metrics for the Sites where standalone projects are required

Site	Min let pressure w21/22 (bar g)	Stream cap (kscmh)	Required site cap W21/22 (kscmh)	Min let pressure w25/26 (bar g)	Stream capacity (kscmh)	Required capacity W25/26 (kscmh)	Year	Customers
Dreghorn PRS	12.38	33.18	36.81	11.84	31.18	39.23	w22/23	5441
Tranent PRS	12.2	18.12	22.19	11.1	15.75	23.89	w22/23	11760
Reinforce Pitcairngreen to Huntingtower pipeline (Supplying Huntingtower PRS)	Not operating with full load to provide acceptable inlet pressure on 100mm pipeline	Restricted due to inadequate inlet pressure via existing pipeline	Capacity restricted by adjustment outlet set point to bias load to Perth PRS and limit utilisation	15.1 Bar	23	20	W22/23	15164
East Morden PRS	12.55	119.4	118.9	12.55	119.4	132.39	w22/23	129464
Wavendon PRS	17.31	13.88	12.48	17.7	14.19	14.34	W25/26	3875

Table 4 identifies capacity metrics for a further project being conducted as a part of the overall Edinburgh South East Wedge Strategy.

Table 4:Capacity Metrics for the New PRS at the Edinburgh South East Wedge

Site	Min let pressure w21/22 (bar g)	Stream cap (kscmh)	Required site cap W21/22 (kscmh)	Min inlet pressure w25/26 (bar g)	Stream capacity (kscmh)	Required capacity W25/26 (kscmh)	Year	Customers
New PRS (Edinburgh South East Wedge)	-	-	-	Designed to suit	Designed for foreseeable growth	23.1	W22/23	25000

Pipeline System

Planning a system involves designing a suitable pipeline system to meet estimated forecasted consumer demands, given the consideration of limitations of any upstream system capability; this can include capacity, storage and pressure availability. This principle is true for a single pipe or for a fully integrated system, when reinforcing or extending an existing system, and planning a new system. Basic planning assumptions, for example input and output volumes and pressures, and the planning horizon, are established from the outset. Normally, a period of 10 years provides a fair balance between the risk of over investment in plant and equipment, due to uncertainties in forecasting load growth or decline and the additional cost of replacing and increasing/decreasing equipment size later.

Capacity planning of an LTS pipeline system is based on a range of factors which need to be assessed to deliver the desired outcome. These depend on the required outcomes but may include

1. Maintaining flow into the system, as closely as possible at a constant flow throughout the day, irrespective of variations in consumer demand or

2. Matching the flow out of the system i.e. the daily fluctuation in demand (known as diurnal swing)

3. A combination of the above depending on the dynamics of the system and the demands.

A system is planned to meet the 1 in 20 planning criterions for all years up to the 10-year planning horizon. This is achieved by considering the optimum combination of pipeline capability and diurnal storage facilities. Data is sourced to understand the growth/ decline in demand across all market sectors to reflect anticipated changes for gas usage on the system. Where the data cannot be broken down by market sector, the changes to demand are shared proportionally across the system. Demand levels and profiles based on the latest available data are updated annually and incorporated in the network analysis model.

Demand is sourced from the downstream system and the directly connected loads. Appropriate demand tags are used in order that suitable demand profiles and/or load growth can be applied. The total demand for the day is split in the ratio of demands imposed on each point, as required by the system downstream. Due to greater diversity on lower pressure systems, summed demands will probably exceed the total system demand. Demands are scaled to the overall total appropriate to the day being modelled and applied to each demand point.

As far as possible a planning model will reflect the way in which the system is operated. All planning models are validated at regular intervals against actual conditions.

Systems affected by the connection of a new load or an increase in load at an existing connection may require reinforcement of the pipeline system, prior to the load being taken off. This reinforcement may take the form of new pipelines being laid or the installation or modification of other equipment to increase the pressure within the pipeline system. In certain instances, system reinforcement may be required to maintain system pressures for the planning period due to general load growth. Reinforcement projects can have significant planning and construction lead-times and that as much notice as possible should be given. For example, the construction of LTS or plant will require several years planning and construction to meet the security of supply objective by the identified date.

PRI Capacity

Above Ground Installations (AGI) form part of the Local Transmission System (LTS). These deliver gas from the National Transmission System (NTS) in the form of NTS Offtakes or regulate pressures between different tiers on the LTS and deliver gas to the <7 bar distribution system in the form of Pressure Reduction Installations (PRIs). This plant is required to ensure the safe and efficient operation of our network to meet our Gas Transporters License obligations.

Annually, for each of the AGIs owned and operated by SGN, the inlet pressures, outlet pressures, current demand and projected demand figures are collated and fed into the modelling program, PRISM. This system models the 'peak demand' which may occur on a '1 in 20 peak day'. Where utilisation (demand / capacity exceeds 80%) a full 24-hour profile is run which provides hour-by-hour

simulation to achieve more results of enhanced accuracy. Where interventions are established to ensure individual AGIs have the required capacity to meet the projected demand, the model is run again with the planned interventions included to demonstrate effective management of the network.

Inlet and outlet node details are entered into PRISM (Pressure Reduction Installation Simulation Model). Initial 'batch analysis' is carried out in PRISM for each of the AGIs using this minimum inlet pressure and maximum outlet pressure to determine the capacity of the site i.e. the volume of gas that can be passed through the site. The calculated capacity is compared with peak demand requirements to determine the utilization percentage.

Any AGI with a capacity above a given threshold under worst case conditions will then be analyzed over a full 24-hour gas day. This profiling ensures that accurate capacity utilization is calculated for sites supplied by volumetric systems where peak flow may not occur at the point of minimum differential pressure.

PRISM models are validated and updated as the site changes.

5.1 Probability of Failure Data Assurance

Model Validation

To ensure the accuracy of the Network Analysis models, validation is carried out in line with the published requirement under Section 17 of SGN's Safety Case and is a fundament of SGN's Licence to Operate.

Validation ensures that the current models are an accurate representation of the actual gas transportation system and can be used to predict network behaviour under a variety of conditions, including the 1 in 20 design condition.

Model Maintenance

In addition to the Validation Programme, a robust model maintenance process and annual winter system performance checks ensure that the models continue to be accurate and fit for purpose.

6 Consequence of Failure

Loss of Supply to Customers

Failure to reinforce will initially put at risk the supply to customers supplied via the relevant asset. This deficiency will manifest itself as a downstream supply failure occurring during high demand conditions. These demand conditions are normally experienced during severe weather when vulnerable customers will be at greatest risk.

SGN design each of the reinforcement solutions to meet 1:20 demand conditions. The SGN distribution and transmission systems are built to ensure security of supply for all our customers. Our networks operating at pressures above and below 7bar are designed to meet a peak demand level that could be experienced under 1:20 conditions, supporting a safe, secure and reliable service to those customers and meeting requirements outlined within our Licence Condition.
Financially, after the first 24 hours, affected householders will be compensated for time without gas. Domestic customers will receive £30 for each 24-hour period without gas, small businesses will receive £50 for each 24-hour period without gas, up to a maximum of £1000/customer.

Safety Impact of Failure

System failure and the resulting loss of supply may have serious implications for vulnerable customers who rely on gas for heating and cooking facilities. This would lead to a multi-agency incident in order

to safeguard the community. As the lack of adequate capacity could not be resolved short term (project 3 year planning and delivery horizon) repeated failures could occur in the intervening period.

Environmental Impact
A system failure on this scale will result in a major recovery exercise, involving increased site visits, travel and disruption to local services.

7 Options Considered

In accordance with the guidelines set out in the Ofgem guidance document *'Engineering Justification Paper Frameworks for RIIO-GD2 and RIIO-GT2'* – Appendix B (Section 7), the following options have been considered:

Pre-Emptively Reinforcement/Upgrade
Identify necessary upgrades by employing network analysis and load forecasting practices in accordance with policy and procedure. Scope suitable reinforcement or upgrade works and implement the required works on the system prior to predicted network failure. The projects identified in this LTS capacity paper are all identified using this methodology as it is the only approach compliant with SGN licence conditions.

Replace on Failure
Wait until the network fails then replace the system. This option has been discounted due to non-compliance with SGN's Licence Condition.

Do Nothing
Not considered practicable as SGN has an on-going obligation to deliver adequate capacity to meet forecast demand. This approach would lead to significant loss of supplies as described above and then potential enforcement action and/or fines.

7.1 First Option Summary: Pre-Emptively Reinforcement/Upgrade

The individual projects required to deliver the necessary reinforcements are identified below in Table 5.

Table 5:Capacity Projects Cost Summary

Project	Cost (£m)
Dreghorn PRS (Sc)	2.42
Tranent PRS (Sc)	2.83
New PRS + 0.1 km of LTS pipeline (Sc)	2.77
Pitcairngreen to Huntingtower pipeline (Sc)	6.71
East Morden (So)	4.49
Wavendon (So)	4.31

The basis for the cost estimate/unit cost
Costs for these projects amounting to £23.53m, have been prepared by conducting initial feasibility studies and by benchmarking against costs for similar projects delivered in RIIO-GD1.

The perceived benefits of the option
The proposed works provide capacity for committed/planned development identified as leading to a capacity constraint during RIIO-GD2.

Delivery timescales
These projects have been scheduled to commence during RIIO GD2 in advance of the capacity constraint being realised in order to allow adequate time for planning and implementation.

Key assumptions made
Land purchase or acquisition of access rights for pipeline works can often be difficult to secure. It has been assumed that suitable sites and access can be secured through liaison in advance with the relevant parties

Any other items that differentiate the option from the others considered
This is the only option leading to ongoing compliance with licence obligations.

7.2 Other Options Summary

The work package selected for each project considered other solutions (e.g. a site rebuild would be measured against the option of an additional site elsewhere to reduce demand on that site). The options of doing nothing or undertaking work on failure have been discounted as they would both:-

- Lead to loss of supply incident at some point in the future (when high demand close to is experienced).
- Put at risk vulnerable customers and lead to multi-agency incidents in severe weather conditions
- Fail to meet SGNs license obligations

8 Business Case Outline and Discussion

Validation of the network analysis model, a robust model maintenance process and system performance checks have confirmed the network analysis.

To mitigate this risk and meet Licence Conditions it will be necessary to pre-emptively reinforce the network during the RIIO-GD2 period.

For the purposes of this report, costs have been prepared using an initial scope of works and by benchmarking with recently completed comparable projects. A full design study will be required which could highlight site specific difficulties

8.1 Key Business Case Drivers Description

Pre-Emptively Reinforcement/Upgrade: Option 1
This option delivers a robust reinforcement solution meeting gas demand requirement at these sites throughout GD2 and beyond.

8.2 Business Case Summary

Table 6 shows the drivers behind carrying out the identified projects. These along with the aforementioned statutory requirements become the basis of a business case for these projects.

Table 6:Capacity Projects, Key Drivers Only

Project	Driver
Dreghorn PRS (Sc)	GD2 capacity constraint at existing site
Tranent PRS (Sc)	GD2 capacity constraint at existing site
New PRS + 0.1 km of LTS pipeline (Sc)	GD2 load growth (Part of CPM7993 South East Wedge (Edinburgh) below 7 bar reinforcement project)
Pitcairngreen to Huntingtower pipeline (Sc)	GD2 Capacity Constraint at Huntingtower TRS due to 100mm pipeline
East Morden (So)	GD2 Capacity Constraint at existing site
Wavendon (So)	GD2 Capacity Constraint at existing site

9 Preferred Option Scope and Project Plan

9.1 Preferred option

Pre-Emptively Reinforcement/Upgrade - Option 1, For the six projects identified in this paper the only option delivering the required outputs within the budget is the selected option. Each project is outlined below in Table 7.

9.2 Asset Health Spend Profile

Table 7:Summary of Schedule of Spend

Asset Health Spend Profile (£M)							
	Pre GD2	2021/22	2022/23	2023/24	2024/25	2025/26	Post GD2
Dreghorn PRS (Sc)	0	0.75	1.43	0.23	0	0	0
Tranent PRS (Sc)	0	0.88	1.67	0.28	0	0	0
New PRS Edinburgh South East Wedge (Sc)	0	1.00	1.77	0	0	0	0
Pitcairngreen to Huntingtower Pipeline (Sc)	0	2.07	3.99	0.64	0	0	0
East Morden PRS (So)	0	0.59	1.55	2.35	0	0	0

Wavendon PRS (So)	0	0.57	1.49	2.26	0	0	0

Costs inclusive of Overheads and Efficiencies

Reinforcement costs to be split between distribution and transmission reinforcement allowance and feed into tab 3.01 and 3.02 of Business Plan Data Template.

9.3 Investment Risk Discussion

The requirement for reinforcement of these networks is demand driven, primarily committed/potential development as identified by the below 7 bar Network Planning team. However, a risk does exist that the planned development does not materialise.

The latest systems performance reviews confirm the networks to be close to capacity under 1 in 20 conditions, supporting the case for reinforcement as detailed in tables 3 and 4.

Through these reviews SGN has identified these six requirements for reinforcement in order deliver required system pressures and capacities to ensure the capability to deliver the forecast capacity requirements the RIIO-GD2 period.

Costs contained within this paper have been prepared using an initial scope of works and by benchmarking with recently completed comparable projects. A full design study will be required which could highlight site specific difficulties

Factors such as market driven demand linked to the economy, the effect of UK's exit from the European Union, emerging decarbonisation strategies and industry innovation can potentially impact on the scope of works outlined in this paper. SGN has outlined funding mechanism strategies to de-risk underspend/overspend for these works in Section 6.2 in the RIIO-GD2 Business Plan Appendix for Network Growth.

Other investment risk factors include market fluctuations in materials and labour and procurement of appropriate land.

Appendix A - Acronyms

Acronym	Backronym (spelled out acronym)	Definition / explanation
Distribution Pressure Tiers o **IP** o **MP** o **LP**	o Intermediate Pressure o Medium Pressure o Low Pressure	o Intermediate Pressure i.e. 2 – 7bar o Medium Pressure i.e. up to 2bar o Low Pressure i.e. up to 75mb
LTS	Local Transmission System	The >7 bar (85 to 12 bar) transmission system operated by SGN including Offtakes, TRSs/PRSs and pipelines which transports gas from the NTS to the distribution pressure tiers.
NTS	National Transmission System	The system operated by National Grid with transports gas from the UK gas terminals to the GDNs Offtake sites (entry points).
PRISM	Pressure Reduction Installation Simulation Model	Modelling tool used to assess >7 bar site capacity by assessing equipment and pipework capacity at relevant pressure and pipework velocities at the relevant pressure
RIIO-GD1	Revenue=Incentives + Innovation + Outputs – Gas Distribution 1	8-Year price control period (2013-2021)
RIIO-GD2	Revenue=Incentives + Innovation + Outputs – Gas Distribution 2	Proposed 5-Year price control period (2021-2026)
TRS/PRS	Transmission Reduction Station/Pressure reduction Station	Pressure regulator primarily used for reducing pressures from Local Transmission System tier to IP/MP.
1:20	1:20 Demand Conditions	Designing a network to operate whilst experiencing demand conditions historically only seen every 20 years, during severe weather events.