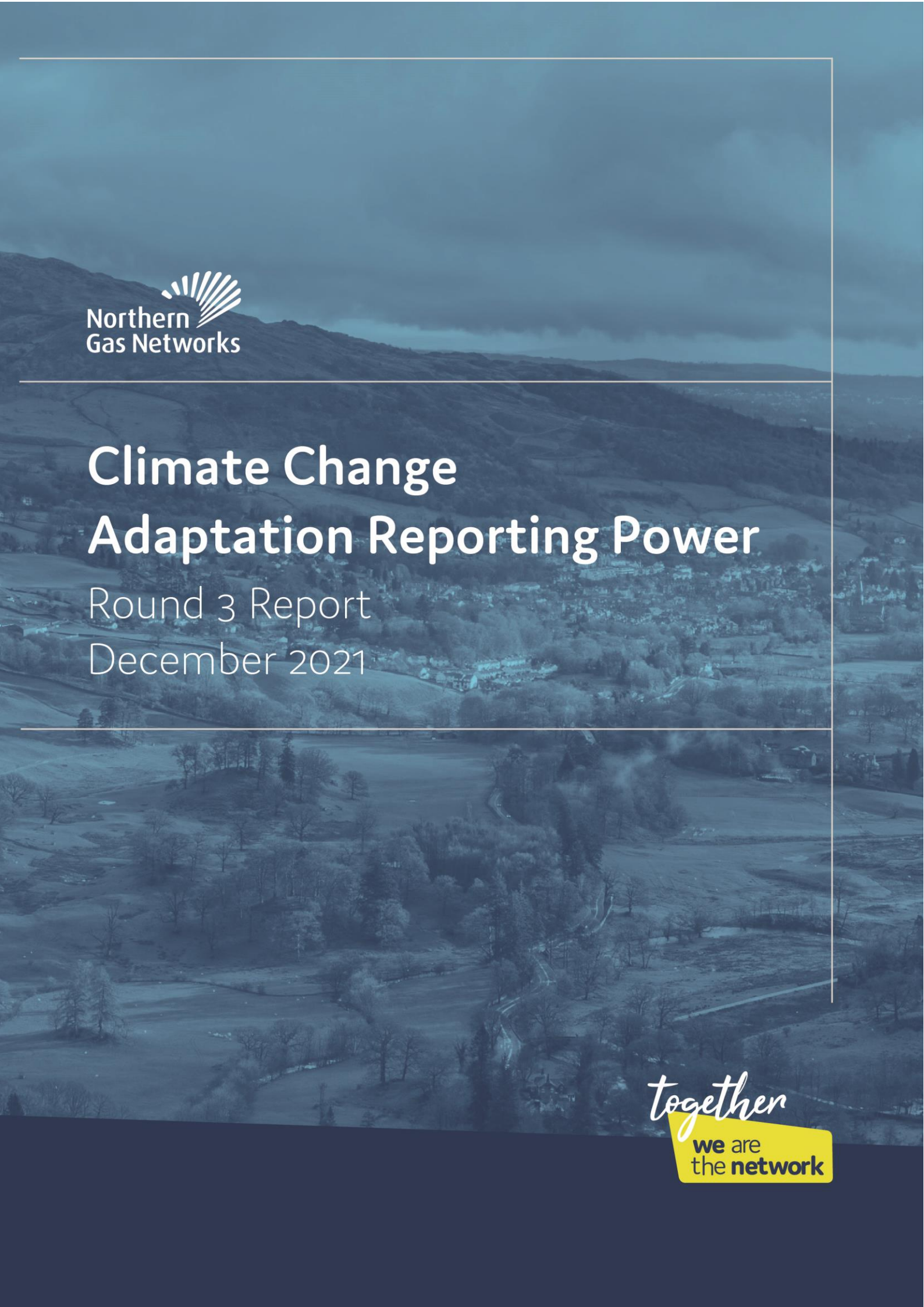

Northern Gas Networks

Climate Change Adaptation Reporting Power

Round 3 Report

December 2021

together we are the network

Document Structure

This document is structured as follows:

- **Chapter 1: Introduction**
- **Chapter 2: Changes Since CCARP Round 2 Report**
- **Chapter 3: Climate Change Adaptation Risks and Management Measures**
- **Chapter 4: CCARP Round 3 Risk Assessment**
- **Appendices:**
  - **A: Climate Change Risk Assessment Framework**
  - **B: CCARP Round 3 Climate Change Risk Assessment**
  - **C: Climate Change Adaptation Action Plan**

Report approved by:	Gareth Mills Regulation & Strategic Planning Director Northern Gas Networks
Date:	09/12/2021

1 Introduction

Northern Gas Networks (NGN) is the gas distribution network (GDN) for the north of England. NGN is designated as a reporting authority under the Climate Change Act (2008). This report constitutes NGN's response as a reporting authority to the third round of the Climate Change Adaptation Reporting Power (CCARP). NGN has also contributed to the CCARP third round report provided by the Energy Networks Association (ENA) of which NGN is a member.

1.1 Introduction to Northern Gas Networks

NGN is responsible for safely delivering gas to approximately 2.7m homes and businesses across northern England. Our network area covers approximately 25,000 km^2 across northern Cumbria, the North East of England and West, East and North Yorkshire, spanning densely populated urban areas and rural areas.

We do not produce or sell gas, rather we transport it via a network of underground pipes which is extends for approximately 37,000 km. The operation of our pipe network is supported by over 5,500 strategic above ground infrastructure sites.

Figure 1 – Our network area

Like other gas distribution networks in Great Britain, NGN is a regulated business and operates under a licence issued by the Office of Gas and Electricity Markets (Ofgem) and is also subject to common statutory requirements which are overseen by the Department for Business, Energy and Industrial Strategy (BEIS), the Health and Safety Executive (HSE) and the Environment Agency (EA). Allowed revenues for NGN, including for adaptation to climate change, are currently set by Ofgem in

periodic price reviews[1] and require submission of a detailed business plan. Our latest business plan identifies our commitments to ensure we operate a safe, resilient and sustainable network[2], which includes ensuring the resilience of assets to hazards including those posed by climate change[3]. This requirement to present our asset management plans for regulatory scrutiny at frequent, relatively short, intervals demands that we are responsive to our changing climate to ensure that we can satisfy our stakeholders that our network can continue to provide a safe, resilient and sustainable supply of energy to our customers.

Under the terms of the Civil Contingencies Act, as a gas network operator NGN is a Category Two responder and as such is required to co-operate and share relevant information with other utilities, the emergency services and local authorities. We are also active participants in the BEIS Energy Emergencies Executive Committee (E3C), National Emergency Exercise scenario and Gas Task Group emergency scenarios. In addition, given our role as an energy provider we are members of Local Resilience Forums in our region, for example in Northumbria[4] and Cleveland[5].

1.1.2 Climate Change Management Within NGN

In recognition of the significance of the wide-ranging risk posed to our network infrastructure and operations by climate change, it is included as an item in our company risk register.

We operate a Strategic Asset Management Plan framework, which requires the production of long term (25 years) asset management plans for each business asset type (for example 'network assets' such as high pressure pipelines, and 'non-network assets' such as company vehicles) to ensure they operate in a safe, resilient and sustainable manner at the optimum cost for customers. Individual asset management plans include assessment of relevant climate change risks (such as flooding or river erosion) and appropriate management measures. The individual asset management plans are used to develop our regulatory investment plans for each asset type which we submit to our regulator for approval as a part of the periodic price control reviews, for example Pressure Reduction Stations[6], Local Transmission System[7] and Overcrossings[8].

At an operational level, we follow a Severe Weather Incident Management procedure to provide a framework for deploying necessary people, physical resources and information systems to facilitate operational management and control of an incident due severe weather. A severe weather incident is defined by NGN as any event where operating conditions are such that normal management of workload is unable to maintain our key regulatory standards of customer service (gas emergency 1 and 2 hour response performance) and/or safety targets, and actions are necessary to recover the situation. This procedure has evolved over time (as discussed in Section 2.1) and is subject to regular

[1] At the time of preparation of this report, NGN are in RIIO-GD2 regulatory period which extends from 1 April 2021 to 31 March 2026: https://www.ofgem.gov.uk/energy-policy-and-regulation/policy-and-regulatory-programmes/network-price-controls-2021-2028-riio-2

[2] See Sections 4.3 and 4.4 of our RIIO-GD2 business plan: https://www.northerngasnetworks.co.uk/wp-content/uploads/2019/12/NGN-RIIO-GD2-Business-Plan-2021-2026.pdf

[3] See page 39 of our RIIO-GD2 business plan Environmental Action Plan: https://www.northerngasnetworks.co.uk/wp-content/uploads/2019/12/A8-NGN-RIIO-2-Enviromental-Action-Plan.pdf

[4] https://www.northumberland.gov.uk/About/Partners/Northumbria-Local-Resilience-Group.aspx

[5] https://www.clevelandemergencyplanning.info/cleveland-lrf/

[6] https://www.northerngasnetworks.co.uk/wp-content/uploads/2019/12/A23.A-NGN-RIIO-2-Investment-Decision-Pack-Pressure-Reduction-Stations-EJP.pdf

[7] https://www.northerngasnetworks.co.uk/wp-content/uploads/2019/12/A23.C-NGN-RIIO-2-Investment-Decision-Pack-Local-Transmission-System-EJP.pdf

[8] https://www.northerngasnetworks.co.uk/wp-content/uploads/2019/12/A23.G-NGN-RIIO-2-Investment-Decision-Pack-Overcrossings-EJP.pdf

review of adequacy (nominally every two years). We prepare an annual assessment of our company performance against this procedure to monitor our performance.

1.2 Gas Distribution Infrastructure

Gas is delivered from the beach terminal via the high pressure National Transmission System (NTS)[9], currently owned and operated by National Grid Gas Transmission, to the GDNs such as NGN. Gas is delivered into gas networks' own Local Transmission Systems (LTS) from the NTS at strategic infrastructure sites known as offtakes. Gas at high pressure (>7 bar) in the LTS is moved around the individual GDNs and subsequently reduced to intermediate pressure (2 to 7 bar), medium pressure (75 mbar to 2 bar) and low pressure (<75 mbar) via strategic Pressure Reducing Installations (PRIs). Gas is then delivered to domestic and business customers via a network of polyethylene and metallic pipes (mains and services) at low pressure.

NGN operate approximately 37,000 km of underground pipes, of which approximately 1,300km comprises our LTS operated at high pressure. We also operate over 5,500 above ground infrastructure sites to enable the operation of our network, including:

23 offtakes where gas is taken from the NTS into our LTS. These sites typically comprise secure gravelled compounds with above and below ground infrastructure covering approximately 0.5 to 2 hectares.	 

[9] https://www.nationalgrid.com/uk/gas-transmission/

178 Pressure Reduction Stations where we reduce our LTS gas pressure to feed our high, intermediate, medium or low pressure networks. These sites comprise secure gravelled compounds with above and below ground infrastructure covering approximately 0.5 hectares	 

5,673 governors where gas flow through our network is regulated. These assets are typically above ground and comprise small cabinet to kiosk size assets on plots of land covering c.100 m^2 or less.	 

This report has been prepared to identify the climate related risks to our gas network infrastructure and business operations at the current time (2021) and in the future (2050). Our assessment of risks in 2050 assumes that gas networks continue to play a critical role in the UK energy system with infrastructure assets and network operation and maintenance requirements similar to those in 2021.

For further information regarding NGN's climate change mitigation activities please refer to our latest business plan[10].

1.3 Previous NGN CCARP Submissions

In association with the ENA and it's other member companies, NGN have contributed to all rounds of climate change adaptation reporting to date.

[10] See Section 5 of our RIIO-GD2 business plan: https://www.northerngasnetworks.co.uk/wp-content/uploads/2019/12/NGN-RIIO-GD2-Business-Plan-2021-2026.pdf

1.3.1 CCARP Round 1 Summary

Working collaboratively with the other energy networks via the ENA, NGN produced an individual company assessment of existing assets and business processes to identify areas where the environment is capable of impacting the ability to meet its business objective. This formed part of the process of ensuring the businesses adapt to the expected climate changes of the future.

The assessment used information drawn from UK Climate Projections 2009 (UKCP09)[11] and working alongside the Meteorological Office Hadley Research Centre, the Environment Agency and the Scottish Environmental Protection Agency, the key risks and opportunities facing energy networks were identified. High emissions projections to 2050 and 2080 were used to determine worst case scenarios and for correlation against the lifetimes of existing assets. Account was taken of the expected increase in number, frequency and intensity of weather events.

The first round reports highlighted that gas distribution network assets and processes may be vulnerable to certain aspects of climate change, however, gas infrastructure has a significant degree of resilience to these impacts and none of the identified risks were considered to be high. The inherent resilience of the GDNs is largely due to the majority of the assets being located underground. Those assets most at risk to the weather and climate parameters are those found above ground, typically large PRIs, critical sites such as data centres, and pipelines in close proximity to watercourses. Impacts were identified to usually be localised to the asset and the process it supports and thus unlikely to lead to a loss of supply or result in a risk to the system as a whole.

In addition, the following potential climate change impacts were identified:

- prolonged periods of extreme weather could have a significant impact on the ability of the workforce to access and carry out their roles, particularly field-based engineers;
- extreme weather could impact the ability to conduct 'business as usual' activities as a result of the reliance on appropriate adaptation of other major infrastructures, such as telecommunications and transport;
- wider impacts on the operation of supply chain businesses and the continued availability of equipment; and
- the environmental impact of companies' assets could be affected by the mobilisation and migration of land contaminants from flooding and ground saturation, in particular of former town gas sites.

It was identified that these interdependencies can be mitigated through the implementation of maintenance and inspection regimes, the development of flood defence measures, the availability of necessary equipment, up to date contingency measures and ensuring Business Continuity Management Plans are in place.

1.3.2 CCARP Round 2 Summary

Our CCARP2 response built on our understanding of the risks established in CCARP1 and provided industry perspectives to specific questions regarding understanding climate risks and uncertainties, addressing barriers and understanding interdependencies, and monitoring and evaluation processes.

[11] https://www.gov.uk/government/publications/adapting-to-climate-change-uk-climate-projections-2009

An NGN specific assessment of climate change risks in 2015, 2020 and 2050 was provided, with no high risks identified for any time interval.

This report continues the progress made since the second round of CCARP reporting and should be read in conjunction with NGN's CCARP Round 2 report[12].

[12] https://www.gov.uk/government/publications/climate-adaptation-reporting-second-round-northern-gas-networks

2 Changes Since CCARP Round 2 Report

2.1 Developing Our Business Preparedness

We first developed a procedure to manage the impacts of winter weather upon our business operations during 2011 after we had failed to meet mandatory targets for attending and assessing gas escapes during the severe weather of winter 2010/11, which resulted in NGN receiving a financial fine from our regulator[13]. This management procedure has been progressively refined several times since to improve our level of business preparedness for extreme weather to ensure we meet our business performance standards regardless of weather conditions.

During the mid-2010s we observed that our business operations were becoming impacted by increasing occurrence of extreme weather outside of the winter season, for example summer time flooding incidents. In response, and since submission of our CCARP Round 2 report, we took the proactive step to evolve our management procedure to become an all year round Severe Weather Incident management procedure.

We prepare for severe weather in several ways to ensure we meet our business performance standards regardless of weather conditions, including:

- receipt of detailed weather forecast data for our individual network sub-regions at regular intervals (daily to every three days) during six months of the year;
- preparation of a daily dashboard of business performance against 14 key performance indicators from our Severe Weather Incident work management procedure to highlight potential areas of failure and trigger appropriate responses (for example additional resource allocation);
- modernising the terms and conditions of employment of our gas engineers (including working hours and patterns) to ensure we always have sufficient resources available to manage our workload;
- detailed analytical assessment of resourcing levels to ensure we have sufficient staff numbers across the network to meet the workload associated with severe weather events. This has recently led to the permanent recruitment of additional gas engineers, training our own staff as emergency reservists, and training and equipping an additional c.30 third party contractors to act as reservist emergency response engineers to supplement our own staff in times of peak demand to ensure we are adequately resourced. This analysis has been undertaken twice to date and will be repeated again in the future to review resourcing provision;
- hire of supplementary 4x4 vehicles during October to March each year, in addition to fitting all of our fleet vehicles with all-weather tyres, to provide vehicle fleet resilience to winter weather;
- investment in new and upgraded water extraction resources for managing water ingress into our pipe network as we are experiencing greater numbers of such events in recent years.

[13] https://www.ofgem.gov.uk/publications/ofgem-announces-fines-national-grid-gas-and-northern-gas-networks-failing-attend-gas-escapes-time-press-notice.

- development and investment in innovative technology to aid with water ingress removal, such as a combined camera and pump for water extraction from narrow diameter pipes and services.

We prepare an annual report of our performance against the requirements of our Severe Weather Incident management procedure and review the procedure regularly (typically biennially) to identify potential improvements.

2.2 Testing Our Business Continuity Measures

Since submission of our CCARP Round 2 report in 2015 our business continuity measures have been tested by a range of extreme weather and other external factors, including:

- the Boxing Day floods of 2015 – our network region was severely impacted by extreme weather which resulted in widespread flooding and damage to three road bridges carrying our pipes;
- the 'Beast from the East' extreme cold event in March 2018 put increased customer gas demand on our network; and
- the COVID-19 pandemic introducing significant constraints upon our customer facing operations, requiring all non-operational colleagues to work from home, and challenging our supply chain.

We are pleased to say that during the period 2015 to 2021 our network has continued to meet our customer needs with excellent customer service and safety performance[14]. Our network infrastructure has continued to operate during this period without significant impact from climatic factors.

Our substantial investments in IT software and cloud based working over the period has resulted in increasing digitalisation and automation of our company processes meaning that our business operations were able to quickly adapt to the challenges COVID-19 pandemic and ensure we continued to deliver our essential services to our customers throughout. Whilst not a climate related hazard, our COVID-19 experiences have provided a substantial test of our business continuity plans.

2.3 Adapting Our Infrastructure to Climate Related Hazards

As described above, our LTS provides a critical role in the operation of our network by providing bulk transfer and storage of gas. The majority of our LTS pipelines were built between 1960 and 1980 and given the criticality of these aged assets and the high cost of replacing them, they are subject to regular inspection and maintenance and repair to ensure their integrity and longevity. This can result in the requirement for engineering works to improve asset integrity and resilience, as per the examples provided below.

[14] See our 2021 annual performance report for further details: https://www.northerngasnetworks.co.uk/wp-content/uploads/2021/07/NGN-RIIO-GD1-Year-8-Report.pdf

Case Study 1 – Land Instability Remediation

Following evidence of land instability at Aislaby, North Yorkshire, we decided to undertake an assessment of the condition of our 19 bar pipeline which was running through the affected area. This condition assessment included a review of the current ground conditions, likelihood of further slippage and installation of mechanical strain gauges to monitor the effect of the land instability over time. Following this assessment, it was determined due to the immediate risk to the pipeline that a localised diversion was the best solution to ensure integrity of the asset. A 400m diversion was necessary to move the 6" steel pipeline away from the affected area and thick wall pipe was installed, at a cost of >£2m, to provide additional protection going forward.

Case Study 2 – River Bed Erosion Remediation

A routine maintenance inspection of our high-pressure pipeline crossing Black Burn in Cumbria identified that erosion of the river bed had exposed a section of the pipeline thereby threatening the integrity of the pipe. Following a specialist geomorphological assessment of the river and remedial options appraisal, a ramped rock weir was installed over the pipe using c.100 m^3 of boulders and cobbles during summer 2021 to protect the pipe. This option, costing c.£35k, was selected as the most sustainable solution as it provided robust protection, minimised impact on river flow and ecology, had limited perceptible visual impact and was low cost.

2.4 Collaborative Climate Change Research

In considering adaptation to climate change, to date we have used the UK Climate Projections (UKCP)[15] climate analysis tool published by the Met Office, and taken into account projections to the end of this century as network infrastructure typically has an operational life expectancy of 30 to 80

[15] https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index

years. Since preparation of our CCARP Round 2 report, the UK Climate Projections (UKCP) 2018[16] has been published, superseding the previous UKCP09 which used as part of our CCARP Rounds 1 and 2 submissions.

In spring/summer 2020, the ENA, on behalf of its members (including NGN) commissioned a collaborative project with the Met Office to undertake a review of the UKCP18 data and existing studies (including UKCP09) to understand the risk energy infrastructure assets from climate change. The report from this research has been used to assess the current risks to the UK energy network, and to guide future mitigation or management actions.

2.4.1 Headline Climate Change Patterns

The main impacts on gas and electricity networks beyond 2050 from the latest independent UKCP18 climate change projections (based on a worst-case high emissions future scenario known as RCP 8.5 compared to UKCP09) remain:

- Snow and ice – reduced occurrence with lying snow events disappearing almost completely over low elevation areas, but possibility of extreme cold events remains;
- Temperature—predicted general temperature increase and number of extreme heat temperature days, in particular in the south-east of the UK (outside of our network area);
- Precipitation—predicted general reduction in overall summer rainfall but greater occurrence of intense prolonged summer rainfall events, and overall increase in winter rainfall, with west of UK experiencing more change than the east. Extreme hourly rainfall events are expected to increase in summer (in particular in the north of the UK, which might include our network area), winter and notably during autumn.
- Sea level rise—predicted increase of up to 1m by 2100 in particular impacting the southern coasts of the UK and Northern Isles (outside our network area), Yorkshire coastline in our network area noted to be subjected to significant coastal erosion;
- Storm surge—best estimate is no change in storm surge compared to current;
- Increasing occurrence of wet and dry weather cycles – overall drier summers leading to typically drier soils. Clay soils, such as those found in the east of England (including our network area) and London area, are more susceptible to movement as a result of quick drying;
- Strong winds – no significant changes compared to today;
- Lightning – increase in lightning flash rate in summer, especially in south of UK (outside of our network area), with decreases in autumn across most of the UK and little changes in winter and spring.
- Wildfire – evidence of increasing risk as a compound result of, or exacerbated by, other climate change hazards.

2.4.2 Climate Change Research Approach

Due to the diversity of the potential climate hazards posed to energy networks it was decided to prioritise those which pose the highest risk to network assets, and the assessment process was accordingly graded to provide an appropriate focus.

[16] https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/about

A full climate assessment was produced for the highest priority hazards:

- Prolonged rainfall leading to flooding
- Extreme high temperatures
- Heavy rainfall/drought cycles

Since there is currently no strong signal within the climate projections for a change to future storm intensity, the risk of strong winds was assessed in the current climate only.

For the remaining lower priority hazards, a qualitative approach was undertaken:

- Sea level rise
- Warm and wetter conditions, followed by heavy rainfall and/or wind
- Storm surge and wave height
- Warmer and wetter conditions – longer growing/nesting seasons
- Snow and ice
- Wildfire
- Lightning
- Solar storm
- Diurnal temperature cycles
- Climate Research Outputs

The final version of the commissioned report was provided by the Met Office in November 2020.

Many of the hazards identified by ENA members are projected to increase due to future climate change over the 21st century, notably: increased frequency of high temperature days, prolonged rainfall events, hourly rainfall extremes, sea-level rise, extreme sea level events, increased risk of wildfire and increased extreme diurnal cycle events. On the other hand, the frequency of snow and ice days are expected to decrease, however it is noted that the severity of such an occurrence remains similar. Hazards for which there is not currently strong evidence for a change in frequency include strong wind events, high wave heights, wetter conditions coincident with warmer temperatures and/or strong winds, lightning and to some extent, diurnal temperature cycles. Solar storms are not affected by increased greenhouse gases, so a study of historic occurrence of this hazard has been presented.

The societal response to climate change has also been considered in the context of hazards to the energy network. Impacts of the weather hazards on the energy network are likely to come in the form of an altered dependency between weather and both supply and demand. Increasing winter temperatures could reduce the overall customer demand for gas, however the potential for extreme cold weather events, when gas demand would be high, remains.

Interconnections between different industry sectors is a source of risk for the energy network, with failures from one sector causing downstream impacts. Telecommunications and road transport are thought to be the most significant sources of risk. Telecommunications are already important for automated and remotely controlled equipment, and for communication with personnel in the field. Risk from telecommunications failure has the potential to increase in the future with greater reliance on smart systems (dependent on telecommunications). Road transport is often essential for restoration of supply and access to assets for routine maintenance and emergency restoration.

Societal responses to climate change may also increase the risk on the road network from the gas network if hydrogen vehicles were to become more commonplace.

2.5 Climate Change Adaptation Collaboration

In order to promote collaboration and sharing of best practice within the energy sector we are members of the ENA Climate Change Resilience Group and participants in the Yorkshire and Humber Infrastructure Adaptation Forum respectively.

3 Climate Change Adaptation Risks and Management Measures

This section identifies the climate change risks included in this CCARP Round 3 report and the current risk management activities undertaken by NGN to mitigate these risks. The climate risks included in this CCARP Round 3 report were selected by:

- Review and update of the risks included in our previous CCARP Rounds 1 and 2 reports with NGN infrastructure asset and operational experts, including removal of any duplicate or low significance risks;
- Collaborative review (with the other UK gas distribution and transmission networks) of the outcomes of the 2020 climate change research commissioned by the ENA with reference to gas network operations and infrastructure, including identification of emerging risks.

Table 1 represents the climate related risks to our gas network infrastructure and business operations identified at the current time (2021) based on the nature and operation of our network and prevailing forecasts for climate change impacts in the UK. Our assessment of risks in 2050 assumes that gas networks continue to play a critical role in the UK energy system with infrastructure assets and network operation and maintenance requirements similar to those in 2021.

Risk Reference	Climate Variable	Anticipated Future Climate Change Signal	Potential Impact	Included in CCAR Round 2?	Narrative and Current Management Measures
CCR21-1	Precipitation	Predicted increase in winter rainfall and summer droughts, increase in number of prolonged and short term extreme rainfall events	Flooding of above ground assets resulting in malfunction and damage	Yes - CCR 8, 9 and 16	There is a risk of physical damage to core gas assets located in flood plains (fluvial) or to other assets from extreme and extended rainfall (pluvial) with ancillary instrumentation and communication equipment being the most vulnerable, although governors and pressure reducing equipment are inherently resilient and capable of operating when submerged in water. This will be exacerbated if flood defences are ineffective and/or plant relocation is not possible. Infrastructure assets at high risk of flooding, or with previously having undergone flooding, are identified for relocation to ensure asset performance integrity.
CCR21-2			Flooding of offices and depots resulting in damage to property and equipment	Yes - CCR 10	Business continuity procedures in place to mitigate potential impacts, including remote cloud based working (as tested during COVID-19 period) and storage of supplies across multiple locations.
CCR21-3			Damage to exposed and concealed pipe crossings over watercourses as a result of flooding	Yes - CCR 3 and 4	NGN operate 2,182 pipe crossings over watercourses ('overcrossings'), of these 1830 are concealed within bridge structures and the remainder are exposed. The overcrossings include distribution mains and LTS pipelines. Damage to these pipes as a result of flooding could result in significant loss of supply and safety related incidents. All overcrossings are subject to regular inspection, with the inspection frequency determined by asset condition (every 2 to 5 years). The requirement for asset remedial measures is determined on an asset condition basis. A network wide flood risk assessment to overcrossings was undertaken in 2019 and could not confidently identify where we should invest to mitigate this risk. A reactive programme of work was included in 2021-2026 business plan as a result. Flood risk assessment to be repeated in readiness for 2026-2031 business plan preparation.
CCR21-4			Flooding of above ground assets as a consequence of catastrophic dam failure resulting in malfunction and damage	No (new)	Extreme precipitation can lead to dam overload and failure. Where assets are located far enough away from dams the impact of water inundation from a dam burst is no different from "standard" pluvial, fluvial or tidal flooding, and flooding impacts can be considered similar. Where assets are close enough to dams to be impacted by the full force of a breach, the damage would be substantial. Plant and equipment would not only be impacted by water ingress, but are likely to be physically damaged or washed away by the force of water.

Risk Reference	Climate Variable	Anticipated Future Climate Change Signal	Potential Impact	Included in CCAR Round 2?	Narrative and Current Management Measures
					NGN have very few assets located within dam related flood impact areas so this is a very low likelihood of occurrence.
CCR21-5			Flooding of critical IT systems at third party sites	No (new)	Potential impact on business operations as a result of flooding related loss of critical third party IT systems. All of the critical systems and servers utilised by NGN are hosted in high specification tier 3+ datacentres, all of these sites have significant risk assessments carried out on natural hazard items, including flooding, and risks from internal flooding, such as from burst pipes. These facilities have additional resilience via backup running a significant distance away so should there be an event like a flood or another natural or physical disaster, equipment can operate in isolation from the other site and not impact any live services in NGN. Supplier mitigation measures and business continuity plans are confirmed by NGN during tender events. NGN's migration to cloud based working has significantly reduced the financial impacts of such an event occurring.
CCR21-6			Flooding resulting in access difficulties to key assets, offices and depots and operational activities (such as responding to gas emergencies or maintenance activities)	Yes - CCR12, 13, 14 and 15	Business continuity procedures in place to mitigate potential impacts, including remote cloud based working for office and depot staff (as tested during COVID-19 period), and storage of supplies across multiple locations. Increasing amount of remotely operated equipment minimising impact of lack of site access, such as remote system pressure management. NGN coordinate with emergency services to ensure our gas emergency services can continue to be provided where required in communities impacted by flooding events.
CCR21-7			Damage to underground pipes from river erosion (bed and banks), including landslides	Yes - CCR5	Pipelines can become exposed and are then susceptible to physical damage from external impact or from being unsupported, with the main risk being the scouring and erosion of pipeline coatings. More frequent flooding and increased river and watercourse flows will increase the potential for such damage, however, management procedures are in place to prevent an overall increase in risk by 2050. Network wide assessment of landslide and river-bed erosion risks to NGN LTS pipelines were completed in 2019 and are to be repeated at regular intervals (3 to 5 years). Proactive monitoring and inspection regime in place for 2021 to 2026 period to monitor asset condition (for signs of ground movement and loss of cover soil), with frequency determined by individual

Risk Reference	Climate Variable	Anticipated Future Climate Change Signal	Potential Impact	Included in CCAR Round 2?	Narrative and Current Management Measures
					site risk. This includes line walking surveys and diver surveys for river-bed crossing, and consideration of use of drones and satellite imagery. Engineering responses undertaken to increase asset resilience to ensure integrity where necessary, such as pipeline diversions or installation of protection measures as informed by geomorphology assessment, see Case Studies 1 and 2.
CCR21-8			Groundwater or surface water flooding resulting in water ingress of below ground assets resulting in asset malfunction/damage, potential for more loss of gas events.	Yes - CCR11	Despite the inherent resilience of pipelines, more frequent and prolonged flooding will increase the risk of physical damage and the likelihood of water ingress leading to operational and supply issues. Impacts are typically observed in the low pressure network and can be managed via typical operational practices, with increases in frequency of events seen over 21st century to date necessitating innovation of new equipment and techniques (such as combined cameras and pumps for narrow diameter mains) and investment in new equipment (water extraction tankers). The move to greater proportion of plastic (PE) pipes as part of the 30 year iron mains replacement programme should help to balance the impacts of increased occurrences of flooding or high groundwater in future. Groundwater flooding can also result in increased pipeline buoyancy thereby exerting additional stresses on pipelines and increasing the potential for damage. Increased buoyancy can also increase the likelihood of third party damage to pipelines due to reduced depths of cover. This would necessitate additional pipeline cover to counteract buoyancy. Minimal examples to date. Pipeline inspection programme (see CCR21-7) would identify these situations and enable them to be addressed.
CCR21-9			Mobilisation of soil contaminants at flooded sites	Yes - CCR49	Flooding of contaminated sites (such as former gasworks sites) will lead to faster and greater transportation of materials in groundwater, especially for sites located within flood plains. This could lead to increased inspection and remediation costs to mitigate any damage and potential resultant regulatory and enforcement action. NGN's proactive land remediation management programme reduces the potential impact of contaminant mobilisation and migration. Site flood risk rating is taken into consideration in site specific contamination risk assessments which inform the requirement for remediation.

Risk Reference	Climate Variable	Anticipated Future Climate Change Signal	Potential Impact	Included in CCAR Round 2?	Narrative and Current Management Measures
CCR21-10		Significant cold spells remain - predicted decrease in frequency but more severe	Asset damage from snow and ice accumulation	No (new)	The risk to above ground assets is expected to gradually decrease due to less frequent snow and ice events. However, a risk remains of physical damage from excessive snow or ice falls, for example increased loading on building roofs.
CCR21-11			Significant / prolonged Ice and snow events resulting in access difficulties to key assets, offices and depots and operational activities (such as responding to gas emergencies or maintenance activities)	Yes - CCR17, 18, 19 and 20	Future reduction in frequency of snow and ice events is expected, however potential for extreme events remains. Dedicated extreme weather contingency measures are already in place to ensure business continuity during snow and ice events (including hiring of 4 x 4 vehicles and training reservists). Business continuity procedures are in place to mitigate potential impacts, including remote cloud based working (as tested during COVID-19 period) and storage of supplies across multiple locations. Increasing amount of remotely operated equipment minimising impact of lack of site access, such as remote system pressure management.
CCR21-12	Temperature	Predicted increase in temperatures and increase in number of extreme temperature days	Above ground asset performance impacted by raised temperatures	No (new)	Gas network assets are manufactured to international standards and designed to operate within particular temperature parameters, which include those currently experienced in the UK and the expected average increases over the course of the century. Increasing temperature impacts all plant and equipment and increases could affect rating and asset performance, most notably ancillary IT and telecommunications equipment. However, core gas equipment is inherently resilient and designed to operate at high temperatures (in excess of any expected average increase) and there should be minimal impact on the gas network controls.
CCR21-13			Above ground asset performance impacted by increased occurrence of lightning storms / strikes	Yes - CCR55	Increased storm frequency can lead to an increased lightning strike frequency, however there is no clear climate signal about likelihood or intensity of increased lightning storm frequency in the future. Where lightning strikes exposed assets, this could cause physical damage and failure. This may lead to operational failure, loss of telecommunications equipment, and a fire risk to gas venting stacks. Gas network assets are provided with high degrees of earthing protection.
CCR21-14			Heat impacts on employees, such as heat exhaustion and/or loss of productivity in extreme temperatures, and	Yes - CCR22, 23 and 24	Clear climate signal of general increasing temperature and number of extreme temperature days. Business implications anticipated to be manageable within business as usual, for example by selection of alternative PPE or review of working practices.

Risk Reference	Climate Variable	Anticipated Future Climate Change Signal	Potential Impact	Included in CCAR Round 2?	Narrative and Current Management Measures
			requirements for additional mitigation, such as air conditioning and different PPE		
CCR21-15			Heat impacts on critical operational procedures, such as performance of chemical sealants used in gas emergency repairs or PE pipe fusion performance, in extreme temperatures	Yes - CCR25 and 53	Clear climate signal of general increasing temperature and number of extreme temperature days. No currently known issues. This requires surveillance and may require future amendment to operational materials and procedures.
CCR21-16			Critical (own and third party assets) IT systems performance impacted by raised temperatures	Yes - CCR21	Potential impact on business operations as a result of temperate related loss of critical own and third party IT systems. NGN assets are provided with cooling to prevent overheating. See CCR21-5 for discussion of business continuity requirements for third party IT facility providers.
CCR21-17		Significant cold spells remain - predicted decrease in frequency but more severe	Increasing average winter temperatures overall reducing gas demand for heating potentially leading to perceived requirement for reduced investment in gas networks. Potential for intense winter cold snaps remains necessitating investment in gas network to perform appropriately (respond to 1 in 20 winter peak demand).	Yes - CCR26	NGN's gas network has an enduring requirement to be operated and maintained to meet peak demand requirements during periods of intense cold to ensure customer requirements are met in accordance with regulatory network performance requirements as set by Ofgem, BEIS and the Health and Safety Executive. NGN is a regulated business and is required to submit regular (currently every five years) regulatory business plans for approval which are required to include details of our asset management plans to ensure that we operate a safe, resilient and sustainable network to meet customer demands. In addition, we are also required to submit annual regulatory performance reports detailing our asset management activities and customer and safety performance. This regulatory framework reduces the likelihood of this risk occurring in the short term. In the longer terms, including whilst the long term future of the gas networks remains uncertain during the net zero debate, this potential remains however it remains low due to the regulatory requirements under which NGN operate.

Risk Reference	Climate Variable	Anticipated Future Climate Change Signal	Potential Impact	Included in CCAR Round 2?	Narrative and Current Management Measures
CCR21-18	Temperature and precipitation	Winters getting warmer and wetter, summers getting hotter and drier Increasing occurrence of wet-dry cycles of weather	Underground asset damage as a result of cycles of dry and wet weather resulting in ground movement. Cold temperatures can also result in ground heave and asset damage.	Yes - CCR 1 and 2	Ground movement caused by repeated cycles of soil shrinkage and swelling (particularly in clay soils) will exert tensile forces on underground assets, especially to more vulnerable joints and connections, with cast iron mains presenting the highest risk. Steel pipelines and plastic mains / services are inherently more resistant to ground movement. Ground movement could lead to mechanical damage and the potential fracture of pipelines or mains, plus also joint movement, or corrosion damage for mains, leading to a serious risk of gas release or explosion. Ground movement can also result from cold temperatures (frost heave). Any loss of ground cover above pipes could also increase the risk of third-party strikes. NGN commissioned a study in 2016 to try to identify correlations between soil and weather data and locations and occurrences of pipe fractures, however the findings were insufficient to be of use for the metallic main replacement programme. Increasing use of plastic (polyethylene (PE)) pipe for mains offers more flexibility, and therefore resilience, compared to more brittle metallic (iron) pipe which will reduce the impacts of ground movement. By 2050 it is anticipated that c.100% of distribution mains will be plastic. The high-pressure pipe network is constructed of heavy wall steel pipe which is more resistant to ground movement than iron and is also subject to an inspection programme to observe for loss of cover soils or signs of ground movement (see CCR21-7).
CCR21-19			Increased vegetation growth rates and longer vegetation growing season resulting in increased maintenance requirements to ensure gas infrastructure site performance is not impacted and customer complaints for 'untidy' sites do not increase	No (new)	Above ground assets will be impacted by any increased growth of trees adjacent to operational equipment and access/egress points. Increased vegetation management requirements are anticipated, although additional costs are likely to be relatively low. Any change in the numbers or seasons of nesting birds and protected species will need to be registered on habitat surveys and could potentially restrict work activities. Existing management procedures are in place to ensure projects can be appropriately completed around site ecological restrictions. Such management procedures will need to be regularly reviewed to ensure they review fit for purpose and continue to offer appropriate level of control as current.
CCR21-20	Wind	Increasing windstorm frequency (particularly	Storm damage to above ground assets (structural	Yes - CCR42, 43 and 47	Assets are subject to damage from extreme weather events including storms and high winds. Any increase in the frequency and severity of these events will mean a higher risk of infrastructure damage and failure and an impact on support services.

Risk Reference	Climate Variable	Anticipated Future Climate Change Signal	Potential Impact	Included in CCAR Round 2?	Narrative and Current Management Measures
		when following high intensity precipitation)	damage and resultant asset performance).		Gas network assets are mainly located underground, and above ground equipment is designed and constructed to be resilient to storms, although a level of risk remains from extreme weather events. Electrical and instrumentation control equipment are the most vulnerable assets, and may need to be protected or housed if located in exposed areas. Proactive vegetation management is undertaken to reduce the potential impact of storm damage.
CCR21-21			Storm damage to offices and depots	Yes - CCR44	Offices and buildings are subject to wind damage or damage from trees, so effective vegetation management practices and building maintenance procedures assist in reducing any risk. Limited potential business impact.
CCR21-22	Wildfire	Increased likelihood as a result of hotter, drier summers	Asset damage from increased occurrence from wildfire	No (new)	Wildfire is a consequential risk of increased temperatures and reduced precipitation and, whilst difficult to forecast, poses a significant risk to above ground assets where they are located in susceptible areas. These include open heathland, grassland or forested areas and may be in remote locations. The risk of above ground infrastructure damage is increased in the absence of vegetation clearance within 3m of site boundaries. Wildfire risks to underground pipelines is limited and previous advice provided to NGN identified that vertical heat penetration from surface wildlfire is limited to c.0.5m deep and thereby poses no significant risks to underlying pipes given the typical depths of cover. There is an interdependent risk from any impact on other utility assets such as electricity lines and substations and telecommunication lines.
CCR21-23	Sea level rise / Storm Surge	Sea levels predicted to rise Increased frequency of storm surges	Tidal flooding of above ground assets resulting in malfunction and damage	Yes - CCR29, 30, 31, 32 and 39	As per CCR21-1
CCR21-24			Tidal flooding of offices and depots resulting in damage to property and equipment	Yes - CCR33	As per CCR21-2
CCR21-25			Damage to exposed and concealed pipe crossings over	Yes - CCR27 and 28	As per CCR21-3

Risk Reference	Climate Variable	Anticipated Future Climate Change Signal	Potential Impact	Included in CCAR Round 2?	Narrative and Current Management Measures
			watercourses as a result of tidal flooding		
CCR21-26			Tidal flooding of critical IT systems at third party sites	No (new)	As per CCR21-5
CCR21-27			Tidal flooding resulting in access difficulties to key assets, offices and depots and operational activities (such as responding to gas emergencies or maintenance activities)	Yes - CCR35, 36, 37 and 38	As per CCR21-6
CCR21-28			Coastal flooding resulting in water ingress of below ground assets resulting in asset malfunction/damage, potential for more loss of gas events	Yes - CCR34	As per CCR21-8
CCR21-29			Saline groundwater contamination resulting in corrosion damage to underground metallic pipelines	No (new)	There is a risk of gradual chemical damage to pipelines from increased tidal flooding, which will affect asset integrity and could lead to water ingress and gas release. Ingress of saline groundwater may also impact the buoyancy of pipes and cause structural issues. Impacts are mitigated using cathodic protection and pipeline inspection programme (see CCR21-7).
CCR21-30	Coastal erosion		Asset damage / loss from coastal erosion	No (new)	The Yorkshire coast, located in NGN network area, is well established as a coastal erosion hotspot. Minimal NGN infrastructure located within close proximity (1km) of unprotected eroding stretches of coastline.

Risk Reference	Climate Variable	Anticipated Future Climate Change Signal	Potential Impact	Included in CCAR Round 2?	Narrative and Current Management Measures
CCR21-31	All	All of the above	Interdependencies of electricity and gas networks - such as increased temperatures resulting in increased demand for cooling and resultant increase in electricity demand from gas fuelled power stations; or flooding of electricity substations resulting in loss of supply to gas sites	No (new)	Requires close coordination between gas and electricity networks. Excess gas usage by commercial users is unlikely to occur as consumption rates are set in connections legal agreements. Potential risks from loss of electricity supply to infrastructure sites associated with issues with electricity network is limited as key NGN sites have own backup generators, and key mechanical elements of the gas network can perform key functions without electricity supply thereby limiting impact.
CCR21-32			Interdependencies with electricity and telecommunications networks - potential for loss of power and communications with asset sites during extreme weather events locally, or wider regionally, having impacts on third party network performance	Yes - CCR40, 41 and 56	Increasing digitalisation is likely to increase business criticality of telecommunications and electricity systems to gas network operation. Potential risks from loss of electricity supply to infrastructure sites associated with issues with electricity network is limited as key NGN sites have own backup generators, and key mechanical elements of the gas network can perform key functions without electricity supply thereby limiting impact. Loss of telecommunications does not impact core gas asset performance and typically results in short term disruption / small scale resource implications (such as requirement to dispatch field technicians to check site conditions as experienced currently when snow/ice interrupt site satellite dish communications). Future innovations in communications networks are likely to ameliorate potential increased future risks associated with this in the future.
CCR21-33			Supply chain impacts - vulnerability / resilience of key suppliers of goods and services to climate change impacts	Yes - CCR51	Supply chain business continuity management plans could be affected due to severe travel difficulties resulting from extreme weather events. This can result in reduced capability and support from supply chain businesses and impact on the continued network operation and maintenance in extreme cases. The adoption of new technology and equipment will assist in the ability of the workforce to work remotely and continue to manage network assets. Supply chain diversification provides increased business resilience.

Risk Reference	Climate Variable	Anticipated Future Climate Change Signal	Potential Impact	Included in CCAR Round 2?	Narrative and Current Management Measures
CCR21-34			Changes in wildlife patterns impacting network operations, for example longer nesting bird season	No (new)	The effects of climate change could lead to impacts on wildlife due to changes in environments, habitats, and behaviours. This could lead to restricted access to assets from changed nesting habits, prolonged nesting seasons, changes to species migration, subsidence from burrowing etc. Impacts are anticipated to be minimal and capable of being managed by business as usual practices.

Table 1- NGN CCARP Round 3 Climate Change Risks Identified and Current Management Measures

4 CCARP Round 3 Risk Assessment

In continuity with our responses to CCARP 1 and 2, we have produced a quantified risk assessment for this CCARP Round 3 report. The CCARP Round 3 risk assessment assesses the current risks (in 2021) and those anticipated for 2050 based on our current management procedures and activities in mitigating climate change impacts and the climate information and predictions set out in the Met Office Report provided for the energy industry in 2020 (see Section 2.3). Our assessment of risks in 2050 assumes that gas networks continue to play a critical role in the UK energy system with infrastructure assets and network operation and maintenance requirements like those in 2021, and our asset management procedures remain the same as current.

The CCARP Round 3 risk assessment has been produced in a methodology aligned with the NGN corporate risk management framework and that used in the collaborative CCARP Round 3 submission by the ENA. The risk assessment framework used in this CCARP Round 3 report is provided in **Appendix A**.

4.1 Risk Assessment Findings

As summarised in Figures 1 to 3, the CCARP Round 3 risk assessment identified no high risks and eight medium risks in 2021, with this changing to no high risks and seven medium risks in 2050. Full details of the CCARP Round 3 risk assessment are provided in **Appendix B**.

The most significant risks in 2021 are identified as fluvial and/or tidal flooding of above ground assets (CCR21-1 and CCR21-23), and significant ice and snow events resulting in access difficulties to key assets, locations and operational activities (CCR21-11). The remainder of the identified medium risks are of moderate to significant impact but rated as unlikely to occur.

The risks posed to our network by the following are expected to increase by 2050:

- fluvial and tidal flooding of above ground assets (CCR21-1 and CCR21-23);
- damage to pipe crossings over watercourses as a result of flooding (CCR21-3);
- damage to underground pipes from river erosion (bed and banks), including land slippage (CCR21-7); and
- above ground asset damage from wildfire (CCR21-22).

The risks associated with significant ice and snow events impacting the management and operation of our network (CCR21-11) are expected to remain as medium by 2050, but with a lower likelihood of occurrence as whilst temperatures will generally increase, there remains the potential for extreme cold spells. In addition, the risk of underground asset damage as a result of cycles of dry and wet weather, or frost heave, resulting in ground movement is expected to reduce from medium to low risk by 2050 as a result of completion of our long term programme of replacing aged, brittle metallic gas mains with more flexible plastic pipes.

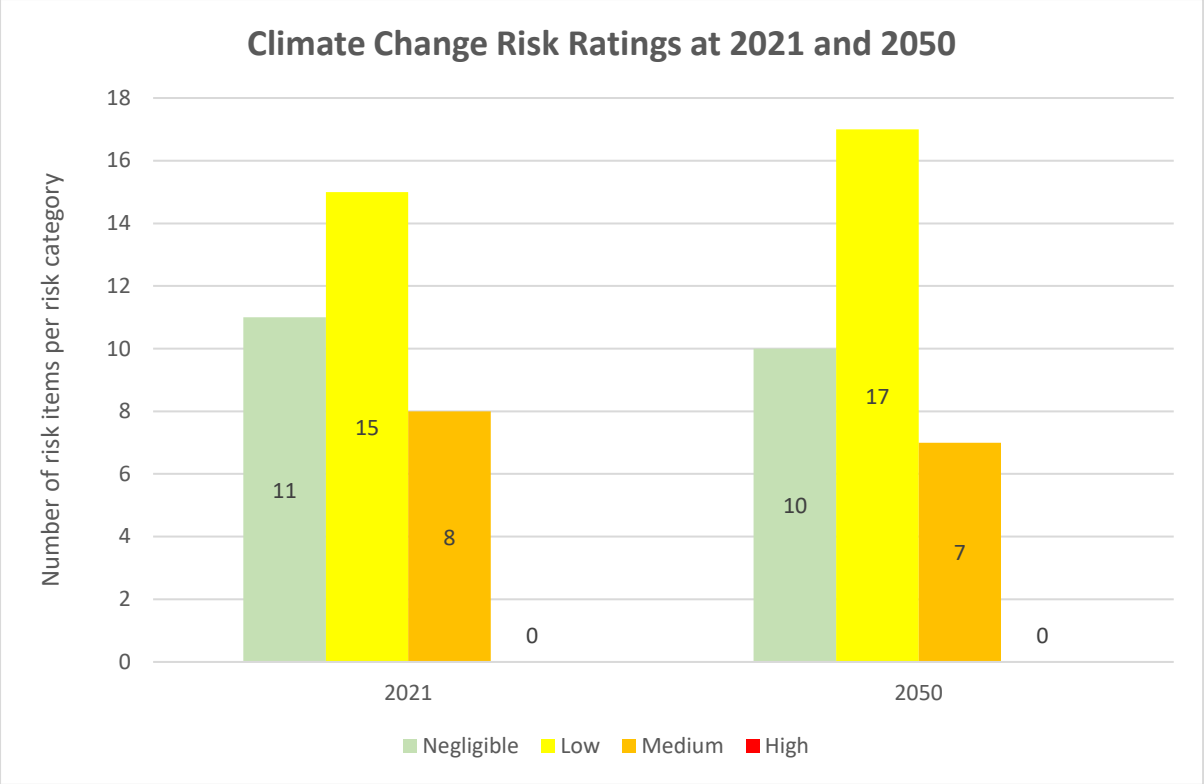

Figure 1- Summary of climate change risk categories at 2021 and 2050

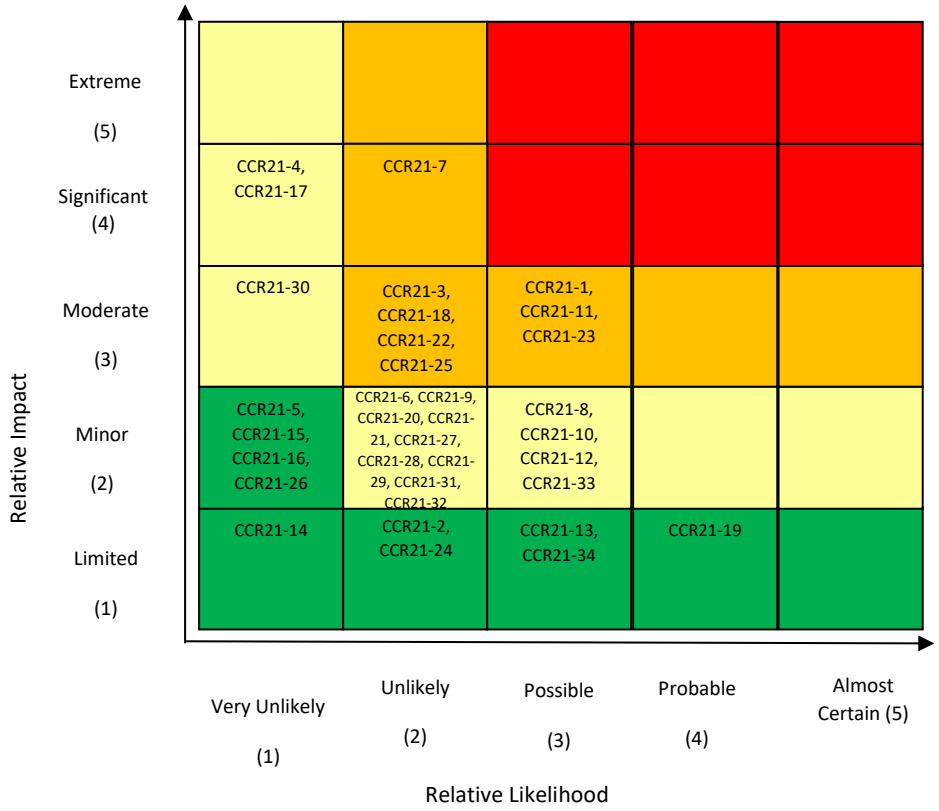

Figure 2 – Climate Change Risk Assessment for 2021

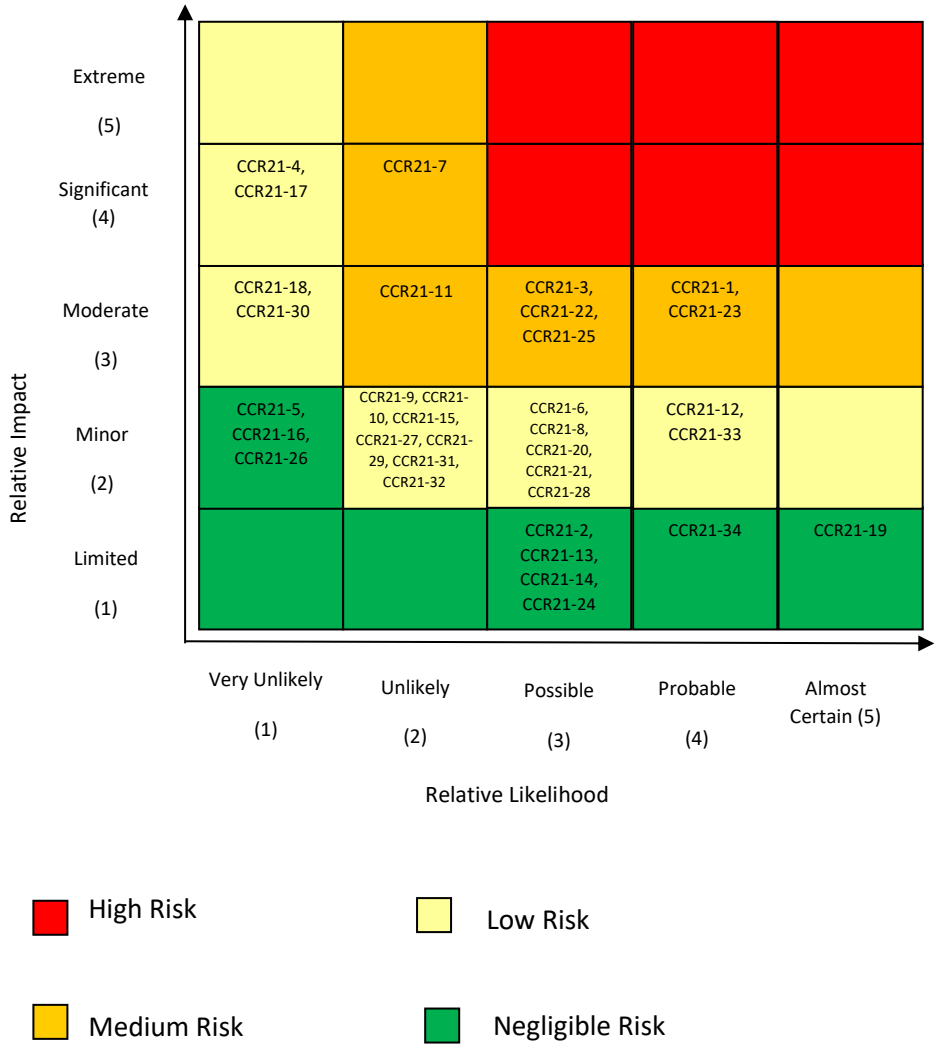

Figure 3 – Climate Change Risk Assessment for 2050

4.2 Climate Change Adaptation Action Plan

An adaptation management action plan has been prepared for those climate change risks identified as medium risk in either 2021 or 2050. This action plan is contained in **Appendix C**.

Appendix A – Climate Change Risk Assessment Framework

This CCARP Round 3 risk assessment has been produced in a methodology aligned with the NGN corporate risk management framework and that used in the collaborative CCARP Round 3 submission by the ENA. The risk assessment methodology is based on the definition and assessment of both the level of impact (see Table A1) and likelihood (see Table A2) of the identified risks being realised. The potential impact and likelihood of occurrence of each individual risk are scored and multiplied to provide an individual risk score and overall comparative risk rating using Table A3. This approach follows the same principles as the risk assessment methodology used for our CCARP Rounds 1 and 2 reports, although these reports used an addition based approach to determine overall risk from the impact and likelihood scores.

Rating	Definition
Extreme/Catastrophic	Regional area affected with people off supply or significant asset failure which exceeds ability for network intervention or reinforcement. Financial: Cost impact >£50M, typically >£20M Safety: Multiple fatality/HSE Enforcement Notice Reputation: External impact on international stakeholders, company accused of poor practice or negligence, direct blame to company leading to extensive media coverage, significant business and company value impact, loss of licence Environment: Reportable incident, serious and lasting environmental damage or loss (>10 years recovery), enforcement action and fine certain Asset/Security of Supply: Total loss of asset, major conurbation and high customer numbers off supply for lengthy period of time (major conurbation off supply >24 hours), national transmission system disruption
Significant/Major	County or city area affected with people off supply or significant asset failure which requires significant network intervention or reinforcement. Financial: Cost impact ≤ £50M, typically £10-20M Safety: Fatality/Life changing injury/HSE Enforcement Notice Reputation: External impact on national stakeholders, extensive media coverage, business and company value impact, repeated regulatory intervention, potential loss of licence Environment: Reportable incident, significant environmental damage or loss (5-10 year recovery), enforcement action expected Asset/Security of Supply: Significant asset damage or failure, geographical area off supply, major outage on distribution networks
Moderate	Significant increase in costs of response and network strengthening Financial: Cost impact ≤ £30M, typically £1-10M Safety: Major injury e.g. RIDDOR reportable Reputation: External impact on stakeholders, adverse media coverage, negative customer impact, regulatory intervention, minor company value impact Environment: Reportable environmental incident resulting from breach of consent or permit, medium damage and loss to environment (up to 5 years recovery), potential enforcement action/letter of concern Asset/Security of Supply: Asset damage of failure, significant numbers of tariff customers off supply for considerable time
Minor	Cost of network maintenance requirements and impact on business now of concern Financial: Cost impact ≤ £10M, typically £500K - £1M

	Safety: Lost time injury/HSE Letter of Concern Reputation: Internal impact within business and stakeholders, industry press and local media interest supported by regulator, some business criticism Environment: Minor, potentially reportable incident affecting local environment (< one year), quick resolution Asset/Security of Supply issues: Minor asset damage or failure leading to localised loss of supply for a short period of time, firm contract customer supply affected
Minimal	Limited impact - can be managed within "business as usual" processes Financial: Cost impact ≤ £5M, typically < £500K Safety: Minor injury/medical treatment/near miss/negligible Reputation: Internal issue from local event, negligible inconvenience, minimal local media coverage Environment: Non-reportable incident with negligible environmental impact or damage, immediately resolved Asset/Security of Supply: Limited impact on assets and supplies, limited disruption to interruptible supplies

Table A1 – Climate change impact definitions

Rating	definition
Almost certain	The risk is expected to be realised and may already be under active management as an event. No controls in place to reduce likelihood of risk being realised. Guideline: >90% or at least once a year frequency.
Likely	More likely and probably will occur, mitigations not fully effective, control weaknesses are known but being managed. Guideline: 60-90% or 1 in 5 years frequency.
Possible	Equally likely as unlikely, mitigations are in place, control measures are under active management. Guideline: 30-60% or 1 in 10 years frequency.
Unlikely	Events are rare and unlikely but could occur, required mitigations in place, controls are effective. Guideline: 10-30% or 1 in 15 years frequency.
Very Unlikely	No known event or extremely rare or remote chance of occurring, controls are fully effective to reduce likelihood of risk being realised. Guideline: <10% or 1 in 20 years or greater frequency.

Table A2 – Frequency of occurrence definitions

Horizons: 2021 and 2050		Likelihood				
Consequence		Very unlikely	Unlikely	Possible	Likely	Almost Certain
		1	2	3	4	5
Extreme/Catastrophic	5	5	10	15	20	25
		Low	Medium	High	High	High
Significant/Major	4	4	8	12	16	20
		Low	Medium	High	High	High
Moderate	3	3	6	9	12	15
		Low	Medium	Medium	Medium	Medium
Minor	2	2	4	6	8	10
		Negligible	Low	Low	Low	Low
Minimal	1	1	2	3	4	5
		Negligible	Negligible	Negligible	Negligible	Negligible

Table A3 – Risk assessment matrix used for CCARP Round 3

Appendix B – CCARP Round 3 Climate Change Risk Assessment

NGN Climate Change Adaptation Risk Assessment

Version 2
Date Oct-21

Notes
Assessment developed from 2015 CCA Round 2 report assessment bringing it in line with current NGN corporate risk assessment matrix and ENA CCA Round 3 report gas risk assessment
2015 likelihood and consequence scores (greatest where more than one risk) brought forward and used to calculate risk using 2021 multiplication method
2050 assessment based on continued operation of gas networks as current and current levels of climate change adaptation
Future climate change signal taken from findings of ENA project undertaken with Met Office
2050 assessment based on outcomes of ENA and Met Office climate projections project based on UKCP18 for 4 degree warming scenario
Above ground assets comprise offtakes, pressure reduction stations, district governors and service governors located at ground level and above
Risk assessment reflects network wide assessment of impact, local impacts on an individual asset scale may be more significantly impacted but with a relatively low overall impact to NGN network operation
Risks identified to be of medium or high currently or in 2050 are to be included in action plan

						Likelihood			Consequence			Risk					
Risk Code	**Climate Variable**	**Future Climate Change Signal (ref: Met Office Assessment for ENA 2020)**	**Potential Impact on NGN**	**Location**	**Risk identified under ARP1/2? Y/N and code**	**2015**	**Current**	**2050**	**2015**	**Current**	**2050**	**2015**	**Current**	**2050**	**Qualitative Confidence (high / medium / low)***	**Narrative**	**Assumptions (including regulatory risks)**
CCR21-1			Flooding of above ground assets resulting in malfunction and damage	Assets located close to watercourses	Yes - CCR 8, 9 and 16	1	3	4	4	3	3	4	9	12	Medium	Clear climate signal that frequency and intensity of flooding events is likely to increase in future. Impact is limited to those assets (and downstream customers) close to watercourses. Core gas assets have high degree of integral resilience to flood impacts. High risk assets at identified risk of flooding have been proactively relocated.	The nature, composition, maintenance requirements and customer (domestic and commercial) usage of a gas network continues broadly as current into the future. Continuation of HSE mandated 30 years iron mains replacement programme to 2032 as programmed. Continuation of regulation of gas distribution networks via fixed period (currently 5 yearly) regulated business plans as current. Climate projections as per UKCP18.
CCR21-2			Flooding of offices and depots resulting in damage to property and equipment	Offices and depots located close to watercourses	Yes - CCR_10	1	2	3	4	3	3	4	6	9	Medium	Clear climate signal that frequency and intensity of flooding events is likely to increase in future. Less reliance on office and depot working since COVID-19 pandemic. Business continuity processes in place to enable key staff to work remotely to minimise impact in event of lack of access. Minimal critical equipment stored at offices and depots which cannot be sourced from elsewhere.	
CCR21-3			Damage to exposed and concealed pipe crossings over watercourses as a result of flooding.	Pipe crossings over watercourses	Yes - CCR 3 and 4	2	2	3	3	3	3	6	6	9	Medium	Clear climate signal that frequency and intensity of flooding events is likely to increase in future. All overcrossings subject to regular inspection, with rate determined by asset condition (every 2 to 5 years). Network wide flood risk assessment to overcrossings undertaken in 2019 and could not confidently identify where we should invest to mitigate this risk. Reactive programme of work included in 2021-2026 business plan as a result. Flood risk assessment to be repeated in readiness for preparation of 2026-2031 business plan.	
CCR21-4			Flooding of above ground assets as a consequence of catastrophic dam failure resulting in malfunction and damage	Assets downstream of dams	No	N/A	1	1	N/A	4	4	N/A	4	4	Medium	Very few assets located within dam related flood impact areas.	
CCR21-5			Flooding of critical IT systems at third party sites	Third party IT assets located close to watercourses	No	N/A	1	1	N/A	2	2	N/A	2	2	Medium	All of critical systems and servers are hosted in high specification tier 3+ datacentres, all of these sites have significant risk assessments carried out on natural hazard items, including flooding, and risks from internal flooding from burst pipes etc. Facilities have additional resilience via backup running a significant distance away so should there be an event like a flood or another natural or physical disaster, equipment can operate in isolation from the other site and not impact any live services in NGN. Mitigation measures and business continuity plans confirmed during tender events. Migration to cloud based working has significantly reduced the financial impacts of such an event	
CCR21-6			Flooding resulting in access difficulties to key assets, offices and depots and operational activities (such as responding to gas emergencies or maintenance activities)	Assets located close to watercourses, or accessed via routes close to watercourses	Yes - CCR12, 13, 14 and 15	1	2	3	4	2	2	4	4	6	Medium	Clear climate signal that frequency and intensity of flooding events is likely to increase in future. Less reliance on office and depot working since COVID-19 pandemic. Business continuity processes in place to enable key staff to work remotely to minimise impact in event of lack of access. Minimal critical equipment stored at offices and depots which cannot be sourced from elsewhere. Increasing amount of remotely operated equipment minimising impact of lack of site access, eg remote system pressure management. NGN coordinate with emergency services to ensure our gas emergency services can continue to be provided where required in communities impacted by flooding events.	
CCR21-7			Damage to underground pipes from river erosion (bed and banks), including landslides	Assets located close to watercourses	Yes - CCR5	1	2	2	2	4	4	2	8	8	Medium	Pipelines can become exposed and are then susceptible to physical damage from external impact or from being unsupported, with the main risk being the scouring and erosion of pipeline coatings. More frequent flooding and increased river and watercourse flows will increase the potential for such damage however current management procedures are in place to prevent an overall increase in risk by 2050. Network wide assessment of landslide and riverbed erosion risks to NGN LTS pipelines were completed in 2019 and are to be repeated at regular intervals (3 to 5 years). Proactive monitoring and inspection regime in place for 2021 to 2026 period to monitor asset condition (for signs of ground movement and loss of cover soil), with frequency determined by individual site risk. This includes linewalking surveys and diver surveys for river bed crossing, and consideration of use of drones and satellite imagery. Engineering responses undertaken to increase asset resilience to ensure integrity where necessary, such as pipeline diversions or installation of protection measures as informed by geomorphology assessment, see Aisleby and Black Burn case studies.	
CCR21-8		Predicted increase in winter rainfall and summer droughts, increase in number of prolonged and short term extreme rainfall events	Groundwater or surface water flooding resulting in water ingress of below ground assets resulting in asset malfunction/damage, potential for more loss of eas events.	Areas with high water table	Yes - CCR11	1	3	3	2	2	2	2	6	6	Medium	Impacts are typically observed in low pressure network and can be managed via typical operational practices, with increases in frequency of events seen over 21st century to date necessitating innovation of new equipment and techniques (such as combined cameras and pumps for narrow diameter mains) and investment in new equipment (water extraction tankers). The move to greater proportion of plastic (PE) pipes as part of the 30 year iron mains replacement programme should help to balance the impacts of increased occurrences of flooding or high groundwater in future. Groundwater flooding can also result in increased pipeline buoyancy thereby exerting additional stresses on pipelines thereby increasing the potential for damage. Increased buoyancy can also increase the likelihood of third party damage to pipelines due to reduced depths of cover. This would necessitate additional pipeline cover to counteract buoyancy. Minimal examples to date. Pipeline inspection programme (see CCR21-7) would identify these situations and enable them to be addressed.	
CCR21-9			Mobilisation of soil contaminants at flooded sites	Asset sites situated on former gasworks sites located close to watercourses	Yes - CCR49	1	2	2	3	2	2	3	4	6	Low	NGN land remediation management programme reduces potential impact of contaminant mobilisation and migration. Site flood risk rating is taken into consideration in site specific contamination risk assessments which inform the requirement for remediation.	
CCR21-10			Asset damage from snow and ice accumulation	All above ground assets	No	N/A	3	2	N/A	2	2	N/A	6	4	Medium	Overall general future reduction in occurrence of snow and ice events.	
CCR21-11	Precipitation	Significant cold spells remain - predicted decrease in frequency but more severe	Significant / prolonged ice and snow events resulting in access difficulties to key assets, offices and depots and operational activities (such as responding to gas emergencies or maintenance activities)	All asset sites, offices and depots, and worksites, including customer premises	Yes - CCR17, 18, 19 and 20	2	3	2	4	3	3	8	9	6	Medium	Overall general future reduction in occurrence of snow and ice events. Less reliance on office and depot working since COVID-19 pandemic. Business continuity processes in place to enable key staff to work remotely to minimise impact in event of lack of access. Minimal critical equipment stored at offices and depots which cannot be sourced from elsewhere. Increasing amount of remotely operated equipment minimising impact of lack of site access, eg remote system pressure management. Extreme weather contingency measures in place to ensure business continuity.	
CCR21-12			Above ground asset performance impacted by raised temperatures	All above ground assets	No	N/A	3	4	N/A	2	2	N/A	6	8	Medium	Gas network assets are manufactured to international standards and designed to operate within particular temperature parameters, which include those currently experienced in the UK and the expected average increases over the course of the century. Increasing temperature impacts all plant and equipment and increases could affect rating and asset performance, most notably ancillary IT and telecommunications equipment. However, core gas equipment is inherently resilient and designed to operate at high temperatures (in excess of any expected average increase) and there should be minimal impact on the gas network controls.	
CCR21-13			Above ground asset performance impacted by increased occurrence of lightning storms / strikes	All above ground assets	Yes - CCR55	1	3	3	3	1	1	3	3	3	Low	Increased storm frequency can lead to an increased lightning strike frequency, however there is no clear climate signal about likelihood or intensity of increased lightning storm frequency in the future. Where lightning strikes exposed assets, this could cause physical damage and failure. This may lead to operational failure, loss of telecommunications equipment, and a fire risk to gas venting stacks. Gas network assets are provided with high degrees of earthing protection.	
CCR21-14		Predicted increase in temperatures and increase in number of extreme temperature days	Heat impacts on employees, such as heat exhaustion and/or loss of productivity in extreme temperatures, and requirements for additional mitigation, such as air conditioning and different PPE	All worksites	Yes - CCR22, 23 and 24	1	1	3	3	1	1	3	1	3	Medium	Clear climate signal of general increasing temperature and number of extreme temperature days. Business implications anticipated to be manageable within business as usual, for example by selection of alternative personal protective equipment or review of working practices.	
CCR21-15			Heat impacts on critical operational procedures, such as performance of chemical sealants used in gas emergency repairs or PE pipe fusion performance, in extreme temperatures	All worksites	Yes - CCR25 and 53	1	1	2	2	2	2	2	2	4	Low	Clear climate signal of general increasing temperature and number of extreme temperature days. No currently known issues. This requires surveillance and may require future amendment to operational materials and procedures.	
CCR21-16			Critical (own and third party assets) IT systems performance impacted by raised temperatures	Third party IT asset sites	Yes - CCR21	1	1	1	4	2	2	4	2	2	Medium	Clear climate signal of general increasing temperature and number of extreme temperature days which can impact IT system performance. NGN and third party facilities provided with climate control to reduce potential for overheating and malfunction. Business continuity requirements for third party providers discussed in CCR21-5.	
CCR21-17	Temperature	Significant cold spells remain - predicted decrease in frequency but more severe	Increasing average winter temperatures overall reducing gas demand for heating potentially leading to perceived requirement for reduced investment in gas networks. Potential for intense winter cold snaps remains necessitating investment in gas network to perform appropriately (respond to 1 in 20 winter peak demand).	All network areas	Yes - CCR26	1	1	1	4	4	4	4	4	4	Medium	NGN's gas network has an enduring requirement to be operated and maintained to meet peak demand requirements during periods of intense cold to ensure customer requirements are met in accordance with regulatory network performance requirements as set by Ofgem, BEIS and the Health and Safety Executive. NGN is a regulated business and is required to submit regular (currently every five years) regulatory business plans for approval which are required to include details of our asset management plans to ensure that we operate a safe, resilient and sustainable network to meet customer demands. In addition, we are also required to submit annual regulatory performance reports detailing our asset management activities and customer and safety performance. This regulatory framework reduces the likelihood of this risk occurring in the short term. In the longer terms, including whilst the long term future of the gas networks remains uncertain during the net zero debate, this potential remains however it remains low due to the regulatory requirements under which NGN operate.	
CCR21-18			Underground asset damage as a result of cycles of dry and wet weather resulting in ground movement. Cold temperatures can also result in ground heave and asset damage.	All underground assets, particularly metallic mains	Yes - CCR 1 and 2	1	2	1	3	3	3	3	6	3	Medium	Ground movement caused by repeated cycles of soil shrinkage and swelling (in particular in clay soils) will exert tensile forces on underground assets, especially to more vulnerable joints and connections, with cast iron mains presenting the highest risk. Steel pipelines and plastic mains / services are inherently more resistant to ground movement. Ground movement could lead to mechanical damage and the potential fracture of pipelines or mains, plus also joint movement or corrosion damage for mains, leading to a serious risk of gas release or explosion. Ground movement can also result from cold temperatures (frost heave). Any loss of ground cover above pipes could also increase the risk of third party strikes. NGN commissioned a study in 2016 to try to identify correlations between soil and weather data and locations and occurrences of pipe fractures, however the findings were insufficient to be of use for the metallic main replacement programme. Increasing use of plastic (polyethylene (PE)) pipe for mains offers more flexibility, and therefore resilience, compared to more brittle metallic (iron) pipe which will reduce the impacts of ground movement. By 2050 it is anticipated that c.100% of distribution mains will be plastic. The high pressure pipe network is constructed of heavy wall steel pipe which is more resistant to ground movement than iron and is also subject to an inspection programme to observe for loss of cover soils or signs of ground movement (see CCR21-7).	
CCR21-19	Temperate and precipitation	Winters getting warmer and wetter, summers getting hotter and drier Increasing occurrence of wet-dry cycles of weather	Increased vegetation growth rates and longer vegetation growing season resulting in increased maintenance requirements to ensure gas infrastructure site performance is not impacted and customer complaints for 'untidy' sites do not increase	All above ground asset sites	No	N/A	4	5	N/A	1	1	N/A	4	5	High	Above ground assets will be impacted by any increased growth of trees adjacent to operational equipment and access/egress points. Increased vegetation management requirements are anticipated, although additional costs are likely to be relatively low. Any change in the numbers or seasons of nesting birds and protected species will need to be registered on habitat surveys and could potentially restrict work activities. Existing management procedures are in place to ensure projects can be appropriately completed around site ecological restrictions. Such management procedures will need to be regularly reviewed to ensure they review fit for purpose and continue to offer appropriate level of control as current.	
CCR21-20		Increasing windstorm frequency (particularly when following high intensity precipitation)	Storm damage to above ground assets (structural damage and resultant asset performance).	All asset sites	Yes - CCR42, 43 and 47	1	2	3	3	2	2	3	4	6	Medium	Gas network assets are mainly located underground, and above ground equipment is designed and constructed to be resilient to storms, although a level of risk remains from extreme weather events. Electrical and instrumentation control equipment are the most vulnerable assets, and may need to be protected or housed if located in exposed areas. Proactive vegetation management is undertaken to reduce the potential impact of storm damage.	
CCR21-21	Wind		Storm damage to offices and depots	All offices and depots	Yes - CCR44	1	2	3	2	2	2	2	4	6	Medium	Offices and buildings are subject to wind damage or damage from trees, so effective vegetation management practices and building maintenance procedures assist in reducing any risk. Limited potential business impact.	
CCR21-22	Wild fire	Increased likelihood as a result of hotter, drier summers	Asset damage from increased occurrence from wildfire	All asset sites, predominantly rural sites	No	N/A	2	3	N/A	3	3	N/A	6	9	Low	Wildfire is a consequential risk of increased temperatures and reduced precipitation and, whilst difficult to forecast, poses a significant risk to above ground assets where they are located in susceptible areas. These include open heathland, grassland or forested areas and may be in remote locations. The risk of above ground infrastructure damage is increased in the absence of vegetation clearance within 3m of site boundaries. Wildfire risks to underground pipelines is limited and previous advice provided to NGN identified that vertical heat penetration from surface wildfire is limited to ≤0.5m deep and thereby poses no significant risks to underlying pipes given the typical depths of cover. There is an interdependent risk from any impact on other utility assets such as electricity lines and substations and telecommunication lines. New and emerging risk with current low risk to gas infrastructure, typically limited to rural AGIs and offtakes, but requires surveillance.	
CCR21-23			Tidal flooding of above ground assets resulting in malfunction and damage	Coastal asset sites, nominally those within 1km of coast	Yes - CCR29, 30, 31 , 32 and 39	1	3	4	4	3	3	4	9	12	Medium	Clear climate signal of sea level rise and increased storm surge occurrence likely to increase tidal flooding. Core gas assets have high degree of integral resilience to flood impacts although would be susceptible to large tidal inundations.	
CCR21-24			Tidal flooding of offices and depots resulting in damage to property and equipment	Coastal offices and depots, nominally those within 1km of coast	Yes - CCR33	1	2	3	2	1	1	2	2	3	Medium	Clear climate signal of sea level rise and increased storm surge occurrence likely to increase tidal flooding. Less reliance on office and depot working since COVID-19 pandemic. Business continuity processes in place to enable key staff to work remotely to minimise impact in event of lack of access. Minimal critical equipment stored at offices and depots which cannot be sourced from elsewhere.	
CCR21-25			Damage to exposed and concealed pipe crossings over watercourses as a result of tidal flooding	Pipes crossing tidal watercourses	Yes - CCR27 and 28	2	2	3	3	3	3	6	6	9	Medium	Clear climate signal of sea level rise and increased storm surge occurrence likely to increase tidal flooding. Network wide risk assessment undertaken in 2019 and did not identify current significant risks.	
CCR21-26			Tidal flooding of critical IT systems at third party sites	Third party IT assets located close to tidal watercourses / coast	No	N/A	1	1	N/A	2	2	N/A	2	2	Medium	All of critical systems and servers are hosted in high specification tier 3+ datacentres, all of these sites have significant risk assessments carried out on natural hazard items, including flooding, and risks from internal flooding from burst pipes etc. Facilities have additional resilience via backup running a significant distance away so should there be an event like a flood or another natural or physical disaster, equipment can operate in isolation from the other site and not impact any live services in NGN. Mitigation measures and business continuity plans confirmed during tender events. Migration to cloud based working has significantly reduced the financial impacts of such an event	
CCR21-27			Tidal flooding resulting in access difficulties to key assets, offices and depots and operational activities (such as responding to gas emergencies or maintenance activities)	Assets located close to tidal watercourses / coast, or accessed via routes close to tidal watercourses / coast	Yes - CCR35, 36, 37 and 38	1	2	2	4	2	2	4	4	4	Medium	Clear climate signal of sea level rise and increased storm surge occurrence likely to increase tidal flooding. Less reliance on office and depot working since COVID-19 pandemic. Business continuity processes in place to enable key staff to work remotely to minimise impact in event of lack of access. Minimal critical equipment stored at offices and depots which cannot be sourced from elsewhere. Increasing amount of remotely operated equipment minimising impact of lack of site access, eg remote system pressure management. Impact limited to tidal/coastal areas.	
CCR21-28			Coastal flooding resulting in water ingress of below ground assets resulting in asset malfunction/damage, potential for more loss of gas events	Coastal areas with high water table	Yes - CCR34	1	2	3	3	2	2	3	4	6	Low	Impacts typically observed in low pressure network and can be managed via typical operational practices. Move to greater proportion of plastic (PE) pipes show help to balance impacts of increased occurrences of flooding or high groundwater in future. Impact restricted to tidal/coastal areas	
CCR21-29	Sea level rise / Storm Surge	Sea levels predicted to rise Increased frequency of storm surges	Saline groundwater contamination resulting in corrosion damage to underground metallic pipelines	Below ground assets located within areas of high water table in close proximity to coast	No	N/A	2	2	N/A	2	2	N/A	4	4	Medium	There is a risk of gradual chemical damage to pipelines from increased tidal flooding, which will affect asset integrity and could lead to water ingress and gas release. Ingress of saline groundwater may also impact the buoyancy of pipes and cause structural issues. Impacts are mitigated by the use of cathodic protection and pipeline inspection programme (see CCR21-7).	
CCR21-30	Coastal erosion	Increased likelihood as a result of sea level rise and increased frequency of storm surges	Asset damage / loss from coastal erosion	Coastal asset sites, nominally those within 1km of coast	No	N/A	1	1	N/A	3	3	N/A	3	3	Medium	Yorkshire coast,located in NGN network area, is well established as a coastal erosion hotspot. Minimal NGN infrastructure located within close proximity (1km) of unprotected eroding stretches of coastline.	
CCR21-31			Interdependencies of electricity and gas networks - such as increased temperatures resulting in increased demand for cooling and resultant increase in electricity demand from gas fuelled powerstations; or flooding of electricity substations resulting in loss of supply to gas sites		No	N/A	2	2	N/A	2	2	N/A	4	4	Medium	Requires close coordination between gas and electricity networks. Excess gas usage by commercial users unlikely to occur as consumption rates are set in connections legal agreements. Potential risks from loss of electricity supply to infrastructure sites associated with issues with electricity network is limited as key NGN sites have own backup generators, and key mechanical elements of the gas network can perform key functions without electricity supply thereby limiting impact.	
CCR21-32			Interdependencies with electricity and telecommunications networks - potential for loss of power and communications with asset sites during extreme weather events locally, or wider regionally, having impacts on third party network performance		Yes - CCR40, 41 and 56	1	2	2	4	2	2	4	4	4	Medium	Increasing digitalisation is likely to increase business criticality of telecommunications and electricity systems to gas network operation. Potential risks from loss of electricity supply to infrastructure sites associated with issues with electricity network is limited as key NGN sites have own backup generators, and key mechanical elements of the gas network can perform key functions without electricity supply thereby limiting impact. Loss of telecommunications does not impact core gas asset performance and typically results in short term disruption / small scale nouxnce implications (such as requirement to dispatch field technicians to check site conditions as experienced currently when snow/ice interrupt site satellite dish communications). Future innovations in communications networks are likely to ameliorate potential increased future risks associated with this in the future.	
CCR21-33			Supply chain impacts - vulnerability / resilience of key suppliers of goods and services to climate change impacts		Yes - CCR51	1	3	4	3	2	2	3	6	8	Low	Supply chain business continuity management plans could be affected due to severe travel difficulties resulting from extreme weather events. This can result in reduced capability and support from supply chain businesses and impact on the continued network operation and maintenance in extreme cases. The adoption of new technology and equipment will assist in the ability of the workforce to work remotely and continue to manage network assets. Supply chain diversification provides increased business resilience.	
CCR21-34	All	See above	Changes in wildlife patterns impacting network operations, eg longer nesting bird season	All network areas	No	N/A	3	4	N/A	1	1	N/A	3	4	Low	The effects of climate change could lead to impacts on wildlife due to changes in environments, habitats, and behaviours. This could lead to restricted access to assets from changed nesting habits, prolonged nesting seasons, changes to species migration, subsidence from burrowing etc. Impacts are anticipated to be minimal and capable of being managed by business as usual practices.	

Risk Assessment Colour Legend

Negligible
Low
Medium
High

* Certainty matrix
High Certain about likelihood and significance
Medium Uncertain about likelihood or significance
Low Uncertain about likelihood and significance

	2015	2021	2050
Nwelisible	5	11	10
Low	16	15	17
Medium	2	8	7
High	0	0	0
N/A	11	0	0
Total	34	34	34

The following risks were previously included in the 2015 NGN Climate Change Adaptation Risk Assessment but have been removed on the basis that they are no longer considered significant

2015 Climate Risk Reference	Climate Variable	Potential Impact on NGN	Reason for Exclusion
CCR6	Precipitation	Increased precipitation limiting use of recycled and reused materials as reinstatement materials	Minor issue which can be dealt with via business as usual
CCR7	Precipitation	Increased precipitation resulting increased excavation stability	Minor issue which can be dealt with via business as usual
CCR46	Wind	Storm events disturbing streetworks furniture, ee barriers	Minor issue which can be dealt with via business as usual
CCR47	Wind	Storm events limiting / disrupting workine at heiahts operations	Minor issue which can be dealt with via business as usual
CCR48	Drought	Limited water supply durine drought	NGN operations use minimal water
CCR50	Precipitation / temperature	Increased humidity resulting in sweatine inside gas pipes	Minor issue which can be dealt with via business as usual
CCR52	Temperature	Changes to specific gravity of gas in raised temperatures	Majority of gas in transported in underground pipes and thus not susceptible to changes in air temperature. Gas typically needs to be preheated prior to pressure reduction so impact will be manageble.
CCR54	Temperature	Increase in dust generation and migration	Minor issue which can be dealt with via business as usual

Northern Gas Networks

Appendix C – Climate Change Adaptation Action Plan

Climate Change Risks Action Plan

Date Oct-21

Notes Risks identified to be of medium or high currently or in 2050 are to be included in action plan

		Risk Rating at Current Levels of Mitigation												
Risk Code	**Impact on NGN**	**Current**	**2050**	**Business Function Owner**	**Current actions to address risks (including ARP1 and 2 actions)**	**Timescale over which actions are planned**	**Category of Action: 1- scoping, monitoring and identifying impacts / risks 2- consideration of impacts, risks and likely actions with stakeholders 3 - implementation of actions to address impacts / risks 4 - monitoring actions, evaluation against original plans, reassessment of risks**	**Status of actions (planned, underway or completed)**	**Assessment of extent to which actions have mitigated risk**	**Benefits/ challenges / barriers experienced**	**Future work planned and associated timescales.**	**Possible Gaps**	**Additional Work Required to Close Gap**	**Dependencies with other organisations/sectors**
CCR21-1 and CCR21-23	Flooding (fluvial, pluvial and tidal) of above ground assets resulting in malfunction and damage	Medium (9)	Medium (12)	Asset Integrity	Flood risk assessment of all above ground fixed asset sites completed in 2018/19 incorporating evidence of current flood risk and previous flood risk incidents from pluvial and fluvial flooding sources. No significant risks to assets identified. Examples of district governors at known risk of flooding being identified for relocation to more resilient locations, eg Appleby in Westmoreland.	On-going	1	Underway	To be confirmed by continual asset evaluation via maintenance and inspection programme	IGEM industry standards (including TD13) reference requirement to consider flood risk in above ground infrastructure site selection. Flood risk on above ground assets is perceived to be relatively low, unless local knowledge tells us otherwise, due to inherent mechanical robustness of equipment and previous incident experience. As with Hexham and Snaith, site specific issues (drainage and overwhelming of local flood defences, respectively) were experienced, however it did not impair function of the assets. As such, flood risk is not currently routinely considered in infrastructure site upgrade schemes, unless existing site issues known or specifically requested by NGN Project Leader at the design stage. Portfolio based assessment of above ground infrastructure site flood risk typically undertaken periodically to inform asset management plans for regulatory business plan submission, eg done in 2018/19 for 2019 submission.	On-going programme of asset site rebuilds and renewals over 2021-2026 and as required thereafter	No NGN procedural requirement for review of asset site flood risks. No procedural requirement to assess site flood risk to identify potential requirement for mitigation measures as part of rebuild design process.	Review existing NGN policies and procedures regarding requirements for above ground asset flood risk assessment and protection. Where appropriate update NGN policies and procedures to require periodic reassessment of flood risks to above ground asset sites (eg minimum once every five years) and assessment of flood risk at key asset sites undergoing substantial refurbishment. Ensure consistent NGN requirement for degree of flood risk protection for key asset types.	Availability of up to date flood risk information from Environment Agency.
CCR21-3 and CCR21-25	Damage to exposed and concealed pipe crossings over watercourses as a result of flooding (fluvial, pluvial and tidal)	Medium (6)	Medium (9)	Asset Integrity	Database of all pipe watercourse overcrossings created (c.600 asset locations) along with condition/risk scoring methodology. Overcrossings subjected to condition risk based inspection and maintenance programme to ensure integrity. Flood risk assessment of all overcrossings undertaken during 2019 identifying no overcrossings at significant risk of flood damage. Overcrossings replacement programme (including diversion under watercourses) underway during investment periods RIIO-1 and RIIO-2 to replace high risk assets (condition based) to ensure asset integrity.	2013 to date	4	Underway	To be confirmed by continual asset evaluation via maintenance and inspection programme	Potential flood risk impacts to overcrossings difficult to model as flood depth data not widely available for all locations. Also, potential pipe damage more likely associated with debris in flood waters, rather than simply presence of flood waters at level of pipe, so can be difficult to accurately assess risk. Uncertainties regarding potential risk to asset, and thus potential risk of asset failure, make it difficult to construct a robust positive cost benefit analysis for asset protection.	Continuation of asset inspection and monitoring programme. Overcrossings remediation programme to continue during RIIO-2 investment period, prioritising crossings on a risk and condition basis.	Risk assessment may change in future dependent on changes to flood risk models, or building/improvement of public flood defences.	Revisit flood risk assessment at regular intervals in asset management planning cycles as current and identify/schedule/undertake mitigation measures as necessary to ensure asset integrity.	Availability of up to date flood risk information from Environment Agency. Completion of third party flood defences will reduce potential risks to NGN assets.
CCR21-7	Damage to underground pipes from river erosion (bed and banks), including landslides	Medium (8)	Medium (8)	Asset Integrity	400m length of 150mm diameter 19bar high pressure pipeline at potential risk of landslip damage proactively investigated and diverted at cost >£2m during 2018/19. Assessment of river bank and bed erosion and landslip risks undertaken for high pressure pipe network during 2018/19. Proactive monitoring and inspection programme developed as a result, including routine inspection of highest risk assets (pipeline river erosion exposure and landslip risk areas). Remedial measures undertaken where necessary to ensure asset integrity, such as armouring of pipes exposed in river beds.	2018 to date	3	Underway	To be confirmed by continual asset evaluation via maintenance and inspection programme	Remedial / mitigation measures can be expensive and of variable robustness, for example river bed protection has been installed at locations and subsequently failed (mobilised) due to further river bed erosion.	Continuation of pro-active risk based asset inspection and monitoring programme (line walking, diver and visual asset inspections) including investigation of potential use of drones and satellite imagery. Revisit risk assessment every three to five years to assess for changes. Allowances within RIIO-2 for diversions/remedial measures if required.	Potential for risks to change over time and instantaneously. Effectiveness of management programme to be determined over time.	To be determined dependant on outcomes of management process. Undertake mitigation works as necessary based on outcomes of management process.	Availability of up to date environmental information from providers such as British Geological Survey and Environment Agency.
CCR21-11	Ice and snow events resulting in access difficulties to key assets, offices and depots and operational activities (such as responding to gas emergencies or maintenance activities)	Medium (9)	Medium (6)	Operations	Winter weather contingency plans developed and tested over several winters during RIIO-1 investment period, including provision and training of reservists, provision of winter tyres for operation personnel vehicles. COVID-19 pandemic period has reduced reliance on office working for non-operational personnel via use of MS Teams. Investments in SAP4 HANA systems has increased automation further reducing reliance on office working.	2013 to date	4	Underway	Very good	Successful winter business performance since 2012 onwards including during 2018 'Beast from the East' extreme cold spell. Need to maintain awareness of potential for winter weather, potential business impacts and requirement for preparedness as climate continues to warm.	Continuous review and refinement of existing procedures (Severe Weather Procedure) based on business experiences and requirements	Potential for risks to change over time	To be determined - procedures subject to continuous review and improvement	Weather forecast providers (Met Office) Local authorities
CCR21-18	Underground asset damage as a result of cycles of dry and wet weather resulting in ground movement	Medium (6)	Low (3)	Asset Integrity	30 year, safety driven iron mains replacement programme commenced in 2002 and replaces c.500km of old metallic with plastic alternatives. Programme over 50% complete. Plastic pipes have inherently more resilience to ground movement due to their greater flexiblity. Assessment of soil types as indicator of potential for pipe fractures completed in 2016 in associated with Cranfield University	On-going	3	Underway	Difficult to determine	It can be difficult to determine causes of pipe damage and obtained field records of causes of pipe damage to enable correlation with ground conditions. Highly variable ground conditions in natural state and urban settings makes it difficult to assess influence of ground movement on pipe damage. Metallic pipe replacement with plastic pipe reduces likelihood of damage. Ground movement is a complex interaction of soil, weather and drainage conditions which is difficult to estimate accurately to a site specific level.	Perpetual business responsibility to respond to gas emergencies and repairing pipe damage/replacing asset, in addition to on-going replacing metallic mains replacement programme to 2032	Lack of detailed understanding of relationship between soil type, weather conditions and potential for ground movement and resultant impacts on asset condition	Continuous review of asset failure records against outcomes of 2016 study to look for correlation / indicators Collaboration with industry peers to share best practice	Availability of up to date environmental information from providers such as British Geological Survey and Environment Agency.
CCR21-22	Asset damage from increased occurrence from wildfire	Medium (6)	Medium (9)	Asset Integrity	Vegetation management at asset sites including around site perimeter	On-going	3	Underway	Difficult to determine	To date no wildfires have impacted or threatened NGN assets.	Maintain awareness of risk. Participate in emergency preparedness events as requested by relevant authorities	Potential lack of appreciation of risk in company procedures and risk assessments	Recommend inclusion in asset risk registers Review NGN above ground infrastructure site vegetation management procedures with respect to potential wildfire risks. Amend as necessary.	Fire and rescue service Local authorities

Northern Gas Networks