H2Teesside Project

Environmental Permit Application Reference: [EPR/AP3328SQ/A001]

Land at and in the vicinity of the former Redcar Steel Works site, Redcar and in Stockton-on-Tees, Teesside

Appendix K – Climate Change Risk Assessment

Environmental Permitting (England and Wales) Regulations 2016

Applicants: H2 Teesside Ltd

Date: October 2024

DOCUMENT HISTORY

Document Ref	AP3328SQ-APP-CCRA		
Revision	Revision 2 – NDM Update		
Author	Ola Matczak-Jaskolska		
Signed		**Date**	10/10/2024
Approved By	Angela Graham		
Signed		**Date**	11/10/2024
Document Owner	AECOM		

GLOSSARY

Abbreviation	**Description**
Applicant/Operator	H2 Teesside Ltd
ATR	Auto Thermal Reformer
BAT	Best Available Techniques
BAT-AEL	BAT- Associated Emission Level
CCS	Carbon Capture and Storage
CCUS	Carbon Capture, Usage and Storage
CO_2	Carbon dioxide
DCO	Development Consent order
FEED	Front-End Engineering Design
FID	Final Investment Decision
GHR	Gas Heated Reformer
H_2	Hydrogen (gaseous)
HRA	Habitats Regulations Assessment
LHV	Lower Heating Value
LNR	Local Nature Reserve
N_2	Nitrogen
NEP	Northern Endurance Partnership
NH_3	Ammonia
NNR	National nature Reserve
NWL	Northumbrian Water Limited
NZT	Net Zero Teesside
O_2	Oxygen
SPA	Special Protection Area
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
STDC	South Tees Development Corporation
WwTW	Wastewater Treatment Works

CONTENTS

1.0 Introduction 4
1.1 Purpose of the Report 4
1.2 Proposed Installation Description 4
2.0 Risk Assessment Methodology 7
2.1 Approach 7
2.2 Risk Assessment Scoring 7
2.3 Risk Scoring Matrix 8
2.4 Risk Assessment 8
3.0 Climate change Risk Assessment 9
4.0 References 12

1.0 INTRODUCTION

1.1 Purpose of the Report

1.1.1 This document has prepared by AECOM Limited ('AECOM') on behalf of H2 Teesside Ltd ('H2TS') referred to as "the Operator", in support of the application for environmental permit for the proposed Carbon Capture (CC) enabled Hydrogen (H2) Production Facility in the Teesside industrial cluster area in Redcar, Stockton-on-Tees.

1.1.2 The purpose of this document is to demonstrate that the proposed Installation will be designed and operated in a manner that can adapt to climate change impacts.

1.1.3 The main Supporting Statement provides an overall summary of the management arrangements for the proposed Installation which includes the climate change adaption measures proposed and confirmation that these will be maintained as part of the site Environmental Management System (EMS).

1.2 Proposed Installation Description

1.2.1 The proposed Installation comprises the development of a 1.2 GWth (LHV) CCS-enabled Hydrogen Production Facility. The proposed Installation will consist of two phases, 0.6 GWth per phase. CCS-enabled hydrogen production is referred to as 'blue hydrogen' production. The proposed Installation is to be sited on land in the Teesside industrial cluster area in Redcar, Stockton-on-Tees. The proposed Installation will utilise Johnson Matthey's (JM's) Low Carbon Hydrogen (LCH) blue hydrogen technology which is a combination Gas Heated Reformer (GHR) – Autothermal Reformer (ATR) process. The LCH technology surpasses the efficiency of the conventional ATR thereby requiring comparatively lower natural gas feed to achieve the design hydrogen export capacity.

1.2.2 The application for the environmental permit is therefore for a hydrogen production facility comprising:

- A new Above Ground Installation (AGI) on the Site to receive natural gas, which is common for both Phase 1 and Phase 2;
- A new AGI on the Site at the point of export of CO_2 which is common for both Phase 1 and Phase 2;
- A Hydrogen Production Unit in each phase, where the main process of reforming occurs. Reforming is the reaction of hydrocarbons with water (steam) to produce hydrogen. Each Hydrogen Production Unit also includes the following components:
  - Pre-treatment to remove sulphur species;
  - Saturator to raise steam;
  - GHR-ATR to reform methane (CH_4) and larger hydrocarbons to syngas;

- Shift reactors for water-gas-shift reaction to convert carbon monoxide (CO) in syngas to CO_2 and H_2, and heat recovery and recycle of separated condensate back to the saturator to raise steam;
- CO_2 absorber to separate the CO_2 from the syngas mixture designed to achieve the carbon capture rate (the proposed Installation is designed to deliver a carbon capture rate of 95% in accordance with current BAT guidance and has the potential capacity to further increase the capture rate to meet potential future regulatory changes);
- Compressors to increase the pressure of the CO_2 prior to drying (dehydration);
- A Pressure Swing Adsorber (PSA) where raw H_2 is further purified and dehydrated and prepared for export to the pipeline networks, after passing through a compressor to achieve the required pipeline pressure of 40 bara and cooled to 30°C for export; and
- Tail gas compressor unit.

Ancillary infrastructure, including:

- **Air Separation Units (ASUs)** Used on Phase 2 for the compression and separation of air, which is passed through a rectification column to produce O_2 and N_2 for use in the GHR – ATR combination process. It also includes provision of liquid N_2 storage on site for back up. On Phase 1 options to utilise O_2 and N_2 from a nearby supplier have been secured and removes the requirement for an onsite ASU on Phase 1..
- **Cooling Water Circulation System** including cooling water towers, pumps and circuit piping to supply cooling water where it is needed throughout the proposed Installation. This will require topping up with water due to losses from evaporation, drift and purge.
- **Auxiliary Steam Boiler** to raise steam using an H_2 rich fuel fitted with SCR and in continuous operation.
- **A Raw Water Pre-treatment Plant** will be used to treat water from the NWL raw water supply, treated water from the biological treatment plant, steam blowdown and recycled clean stormwater prior to the demineralisation stage and will include coagulation and flocculation, clarification, Dissolved Air Flotation (DAF), Ultrafiltration (UF) (for removal of fine solids), or other suitable pre-treatment technologies. Any solids will be sent off site for disposal.
- **A Demineralisation plant** to be used to treat water supplied to the Hydrogen Production Facility and also treated water from the bio-treatment plant and steam condensate from blowdown. This process would produce demineralised water (DMW) which will be pumped to all locations where it is required within the Hydrogen Production Facility, including for boiler feed water; therefore, this

water will be used to produce H_2 and make up losses from the steam system. The liquid RO concentrate will be taken off site for further treatment and disposal.

- **A Biological treatment plant** comprising a membrane bioreactor (MBR) which will treat process condensate and flare knockout drum liquid to reduce methanol and ammonia concentration using nitrification and denitrification. The treated process condensate will then be reused as makeup water in the Raw Water Treatment Plant. Sludge produced will be dewatered and solids will be sent off site for disposal.
- **A Stormwater system** which will consist of an oily water separator, neutralisation sump (for flows from the chemical drains, storm water attenuation pond and daily retention sump . All oily water produced by the proposed Installation will be sent to the oily water separator. Clean water will be recycled back to raw water treatment plant, with excess discharged to Tees Bay via NZT outfall.
- **An Effluent Treatment Plant (ETP)** which will treat demineralisation plant rejects and cooling water blowdown. This effluent will be treated using media filtration to an appropriate level in accordance with BAT-AELs and be disposed of via the NZT outfall that is to be built as part of Net Zero Teesside. . Sludge formed will be dewatered and solids will be sent for disposal offsite
- **Flares,** any flammable gas released from the proposed Installation during an emergency will be collected in the flare header system and sent to the flare drum where any liquid associated with the gas is separated. The gas from the flare drum will be sent to the flare system where it will be safely disposed by combustion. The liquid collected in the drum will be pumped by the flare pump to the bio-treatment plant.
- **A Fire Water System** consisting of fire water store on site (supplied by treated raw water), pumps and firefighting system.
- **Emergency Diesel Generator** which would be operated in the event of emergency to support safe shutdown of the plant and will be intermittently energized for periodic testing purpose. This will likely require on-site diesel storage. Storage quantities will be confirmed post-FEED when the final design for the proposed Installation is known.
- **Chemical Storage** for additives and fuel such as aqueous ammonia (NH3), amines, anti-foaming agent for the carbon capture unit, chemical dosing for water treatment and diesel, which are imported by tanker.
- **Above ground pressurised H_2 storage** shared between each phase, including high pressure compression and let down facilities.

2.0 RISK ASSESSMENT METHODOLOGY

2.1 Approach

2.1.1 The methodology employed in the climate change risk assessment is the approach produced by the Environment Agency (EA)[(1)].

2.2 Risk Assessment Scoring

2.2.1 Details of the scoring which applies to the risk assessment are summarised in the Table 2.1 below.

Table 2.1: Risk Assessment Scoring

DESCRIPTION	SCORE
Likelihood	
Unlikely : - circumstances are such that it is improbable the event would occur even in the long term.	1
Low likelihood : - circumstances are such that an event could occur, but it is not certain even in the long term that an event would occur, and it is less likely in the short term.	2
Likely : - it is probable that an event will occur, or circumstances are such that the event is not inevitable, but possible in the short term and likely over the long term.	3
Highly likely: - event appears very likely in the short term and almost inevitable over the long-term, or there is evidence of the event already happening.	4
Severity of Impact	
Minor impact : - short or long-term impact to operations resulting in additional measures for compliance.	1
Mild impact: - short-term, acute impact to operations resulting in single temporary compliance breach.	2
Medium impact: - short-term, acute impact to operations resulting in multiple temporary compliance breaches.	3
Severe impact: - short-term, acute impact to operations resulting in permanent compliance breaches.	4
Risk Categories	
Score is 1 to 3	Low
Score is 4 to 6	Low - Moderate
Score is 8 to 9	Moderate - High
Score is 12 to 16	High

2.3 Risk Scoring Matrix

2.3.1 The impacts are scored using the scoring matrix above and the risk is then scored using the risk scoring matrix (Table 2.2) by:

Risk = Likelihood x Severity

Table 2.2: Risk Scoring Matrix

		SEVERITY			
		Severe Impact (score 4)	**Medium Impact (score 3)**	**Mild Impact (score 2)**	**Minor Impact (score 1)**
LIKELIHOOD	**Highly Likely (score 4)**	16	12	8	4
	Likely (score 3)	12	9	6	3
	Low Likelihood (score 2)	8	6	4	2
	Unlikely (score 1)	4	3	2	1

2.4 Risk Assessment

2.4.1 The risk assessment considers how vulnerable the site is in current and future climates taking into consideration in site specific aspects. It has been completed on the EA risk assessment worksheet for the river basin where the site is located. The proposed Installation is situated in the Northumbria river basin district and the completed risk assessment worksheet is presented in Section 3.0.

3.0 CLIMATE CHANGE RISK ASSESSMENT

Northumbria river basin district: climate change risk assessment worksheet for the 2050s

Name (as on your part A application form): **H2 Teesside Limited**

Our permit reference number (if you have one): **EPR/AP3328SQ/A001**

Your document reference number: **AP3328SQ-APP-CCRA**

Potential changing climate variable	A Impact	B Likelihood	C Severity	D Risk (B x C)	E Mitigation (what will you do to mitigate this risk)	F Likelihood (after mitigation)	G Severity (after mitigation)	H Residual risk (F x G)
1. Summer daily maximum temperature may be around 4.6°C higher compared to average summer temperatures now.	Overheating of electrical equipment, heat damage, deformation, cracking and thermal expansion of building surfaces and pavements.	2	3	6	• Cabling will be buried underground, insulating against overheating during heatwaves; and • All buildings will be designed to UK standards and specifications[(2)].	2	2	4
	• Impacts on the thermal comfort of building users. Increase in ambient temperature of buildings, leading to higher air conditioning requirements. Poorer air quality from dust, wildfires. Commuting issues resulting from wildfires. • Potential increase in odour • Potential increase in fugitive emissions	2	3	6	• Detailed design of air conditioning units for offices would include an allowance for future rise in ambient temperature; and • All buildings would be designed to UK standards and specifications.	2	1	2
	• Reduced efficiency of Production Facility and operational plant. • Potential increase in water requirements for cooling, decrease in cooling efficiency and increased energy consumption due to the added pumping of cooling water around the site	2	1	2	The power plant is designed to operate over a large range of ambient conditions and the plant efficiency difference is less than 1% in all temperatures. Temperature change unlikely to have noticeable impact.	2	1	2
2. Winter daily maximum temperature could be 3.5°C more than the current average with the potential for more extreme temperatures, both warmer and colder than present.	• Risk of trace heating systems failing and cooling water freezing and causing blockage or process failure. • Increased risk of pipework rupture affecting process systems. • Frozen onsite roadways restricting access for staff and emergency services. • Externally situated plant or equipment freezing	1	1	1	No mitigation required as very low risk. Score under 5.	1	1	1

Potential changing climate variable	A Impact	B Likelihood	C Severity	D Risk (B x C)	E Mitigation (what will you do to mitigate this risk)	F Likelihood (after mitigation)	G Severity (after mitigation)	H Residual risk (F x G)
3. The biggest rainfall events are up to 20% more intense than current extremes (peak rainfall intensity)*.	• Surface water and flash flooding and standing waters; • Deterioration of structures or foundations due to increase in soil moisture levels; • Damage to building surfaces/ exposed utilities from increased drying/wetting and increased frost penetration; • Bunding capacity reduced due to flooding and • Damage to infrastructure through coastal erosion, storm surge and coastal destabilisation. • Sudden, intense rainfall could cause instability leading to temperature swings and potential plant upset with associated flaring	1	3	3	• Installation of a suitable sustainable surface water drainage network and management system (SuDS) to protect to Site from high rainfall events. Supported by a Surface Water Maintenance and Management Plan; • The rainfall data considered for the drainage system design will include an allowance for climate change which is based on the Environment Agency and Tees Valley Authorities guidance. • Inspection and maintenance of site drainage systems. • Flood Resistance and Resilience Measures (raised ground levels, SuDS, flood defence barriers) to be implemented scenarios including increases in extreme rainfall, flood flow and flash flooding; • Containment designed to the appropriate capacity and standards. • Bunds subject to visual inspections to ensure that there is no damage. • Bund level detection systems to be installed; and • All buildings would be designed to UK standards and specifications.	1	2	2
4. Average winter rainfall may increase by35.7% on today's averages.	• Surface water flooding, flash floods and standing waters; • Deterioration of structures or foundations due to increase in soil moisture levels; • Damage to building surfaces/ exposed utilities from increased drying/wetting and increased frost penetration; • Bunding capacity reduced due to flooding/increased rainfall; and • Damage to infrastructure through coastal erosion, storm surge and coastal destabilisation.	1	3	3	• Installation of a suitable sustainable surface water drainage network and management system (SuDS) to protect to Site from high rainfall events. Supported by a Surface Water Maintenance and Management Plan; • The rainfall data considered for the drainage system design will include an allowance for climate change which is based on the Environment Agency and Tees Valley Authorities guidance. • If necessary, in future, emergency pumps can be provided and additional protection for control and electrical systems will be considered. • Flood Resistance and Resilience Measures (raised ground levels, SuDS, flood defence barriers) to be implemented scenarios including increases in extreme rainfall, flood flow and flash flooding; and • All buildings would be designed to UK standards and specifications. • Containment designed to the appropriate capacity and standards. • Bunds subject to visual inspections to ensure that there is no damage. • Bund level detection systems can be installed. • Increase bunding if necessary.	1	2	2

Potential changing climate variable	A Impact	B Likelihood	C Severity	D Risk (B x C)	E Mitigation (what will you do to mitigate this risk)	F Likelihood (after mitigation)	G Severity (after mitigation)	H Residual risk (F x G)
5. Sea level could be as much as 0.53m higher compared to today's level *.	• Tidal flooding and standing waters; • Deterioration of structures or foundations due to increase in soil moisture levels; • Damage to building surfaces/ exposed utilities from increased drying/wetting and increased frost penetration; and • - Damage to infrastructure through coastal erosion, storm surge and coastal destabilisation.	1	3	3	• The site will be elevated to mitigate the risk of flooding • Flood risk assessment has been carried out including a sea level rise allowance based on the methodology recommended by the Environment Agency • Installation of a suitable sustainable surface water drainage network and management system (SuDS) to protect to Site from high rainfall events. Supported by a Surface Water Maintenance and Management Plan; • Flood Resistance and Resilience Measures (raised ground levels, SuDS, flood defence barriers) to be implemented scenarios including increases in extreme rainfall, flood flow and flash flooding; and • All buildings would be designed to UK standards and specifications. • - If necessary, in future, emergency pumps can be provided and additional protection for control and electrical systems will be considered.	1	2	2
6. Drier summers, potentially up to 36.6% less rain than now.	• Water shortages; • Drying out of pavement structures; • Deterioration of structures or foundations due to decrease in soil moisture levels; and • Insufficient water for plant cooling. • Increased reliance on mains water. • Increased dust emissions • More frequent top up of firewater pond due to increased evaporation losses in periods of high temperatures	2	3	6	• Integration of water circuits to ensure process condensate is recycled and recovered as steam and reduces the volume sent to the effluent treatment plant.; • Buildings would utilise water efficient fixtures; and • - All buildings would be designed to UK standards and specifications.	2	2	4
7. At its peak, the flow in watercourses could be 20%[3][4] more than now, and at its lowest it could be 80%[1] less than now.	It is anticipated that higher water levels in the River Tees would not affect the site operations. Up to 80% lower levels would however have the potential to affect the cooling water supply, and can also affect dilution of effluent.	4	4	16	The site will review the cooling options applied on site, however the water used for cooling at the installation is not considered to be significant with respect to the future catchment capacity. The site will have a Flood Management Plan to manage any flood risks.	2	2	4
8. Storms: frequency and intensity can increase	• Storms and high winds could damage building structures with increased potential for fugitive emissions • Potential for electrical storms to disturb steady operations and cause plant instability and potential flaring; could increase risk of electrical power losses to site; lightning strikes on plant infrastructure,	2	3	6	• Buildings and site infrastructure, including the drainage network, are subject to inspection and maintenance. • All buildings would be designed to UK standards and specifications.	2	1	2

4.0 REFERENCES

1. Environment Agency, April 2023, Climate change: risk assessment and adaptation planning in your management system.
2. The Building Regulations Approved Document Part H: Drainage and Waste Disposal 2010.
3. Environment Agency (2009). Tees Catchment Flood Management Plan .Summary Report.
4. Environment Agency (2016). Northumbria River Basin District Flood Risk Management Plan 2015 — 2021.