Aldbrough Hydrogen Pathfinder - Permit Application

Supporting Information Document

PREPARED FOR

SSE Hornsea Limited

DATE
18th June 2025

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0653313

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SIGNATURE PAGE

Aldbrough Hydrogen Pathfinder - Permit Application

Supporting Information Document

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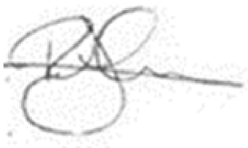

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

Acronym	Description
AA	Annual Average
AGS	Aldbrough Gas Storage
AHP	Aldbrough Hydrogen Pathfinder
AHS	Aldbrough Hydrogen Storage
AQIA	Air Quality Impact Assessment
AQMA	Air Quality Management Area
BAT	Best Available Techniques
BAT-AEL	BAT Associated Emission Level
CEMS	Continuous Emissions Monitoring System
CIP	Cleaning In Place
CO	Carbon Monoxide
DAA	Directly Associated Activities
DESNZ	Department for Energy Security and Net Zero
EA	Environment Agency
EDI	Electro-deionisation
EMS	Environmental Management System
EP	Environmental Permit
EP Regulations	Environmental Permitting (England and Wales) Regulations 2016 (as amended)
EQS	Environmental Quality Standard

Acronym	Description
ERM	Environmental Resources Management Limited
ERYC	East Riding of Yorkshire Council
ESOS	Energy Savings Opportunities Scheme
EVF	Effective Volume Flux
FOAK	First Of A Kind
GWh	Gigawatt Hours
h	Hour
HP	High Pressure
kg	Kilograms
km	Kilometres
KO	Knock Out
KV	Kilovolt
LCHS	Low Carbon Hydrogen Standard
LCP	Large Combustion Plant
LNR	Local Nature Reserve
LOD	Limit of Detection
LP	Low Pressure
m	Metres
m^3	Cubic Metres
MAC	Maximum Allowable Concentration
MAGIC	Multi Agency Geographic Information for the Countryside
MCP	Medium Combustion Plant
mODN	Metres above Ordnance Datum Newlyn
MWe	Megawatt Electric
MWth	Megawatt Thermal
NGR	National Grid Reference
NH_3	Ammonia
NO_x	Oxides of Nitrogen
NNR	National Nature Reserve
OCGT	Open Cycle Gas Turbine
OTNOC	Other Than Normal Operating Conditions
PC	Process Contribution
PEC	Predicted Environmental Concentration
PEM	Proton Exchange Membrane
ppm	Parts per million

Acronym	Description
RO	Reverse Osmosis
s	Second
SAC	Special Area of Conservation
SCR	Selective Catalytic Reduction
SHE	Safety Health and Environmental
SPA	Special Protection Area
SPZ	Source Protection Zone
SSE	SSE Hornsea Limited
SSSI	Site of Special Scientific Interest
TraC	Transitional and Coastal Estuarine
WFD	Water Framework Directive
µg	Micrograms
ºC	Degrees Celsius
%	Percent

APPLICATION CHECKLIST

Requirement	Topic	Location in Report
Form A	Company Details	See Form A and Section 1.5
Form B2 – Question 1a	Discussion before application	See Section 1.2
Form B2 – Question 3d	Environmental Management System	See Section 6
Form B2 – Question 5a	Site Plan	See Figure 2.2
Form B2 – Question 5b	Site Baseline Report	See Section 2.4 and Appendix A
Form B2 – Question 5c	Non-Technical Summary	See Non-technical summary
Form B2 – Question 6	Environmental Risk Assessment	See Section 15
Form B3 – Question 1	Listed Activities and DAAs	Section 1.3 and Section 1.4
Form B3 - Table 1a	Types of Activities	See Table 1.1 and Table 1.2
Form B3 - Table 2	Point source Emissions to air, water, sewers and land	See Section 4
Form B3 - Question 3a	Operating Techniques	See Section 5 and Appendix D
Form B3 - Question 3c and 6d	Raw Materials	Se Section 8
Form B3 - Question 4a and 4b	Monitoring	Section 14
Form B3 - Question 6a, 6b, 6c and 6d	Resource efficiency and climate change	See Section 9
Form B3 - Question 6e	Waste Management	See Section 7
Form B3 - Question 7a, 7b and 7c	Combustion Plant	See Section 3.4.3 and Section 3.5.9
Form F1	Charges and Declarations	See Form F1

NON-TECHNICAL SUMMARY

SSE Hornsea Ltd (SSE) is proposing to construct and operate an electrolytic hydrogen production, storage and energy generation facility, referred to as the Aldbrough Hydrogen Pathfinder (AHP) project. The facility will be operated at SSE's Aldbrough Gas Storage (AGS) site on Garton Road, East Riding of Yorkshire (hereafter referred to as the 'Site'). The AGS site is owned by both SSE and Equinor, and the AHP project will be a joint venture between both companies. The AHP project is an important building block in the development of a thriving Humber hydrogen economy, underpinning the region's decarbonisation and supporting economic growth locally and nationally. In the context of this application, 'the Site' is the "installation" permitted boundary.

The concept aims to store energy during periods of low carbon abundant generation and release that energy as low carbon power during periods of shortfall, such as high barometric pressure (low wind) and low solar radiation (sunlight). Therefore, the AHP project supports energy security in the UK, which is an important consideration for the UK Government and the Department for Energy Security and Net Zero (DESNZ). This concept also aims at reducing reliance on natural gas for power generation when renewable energy is unavailable. The AHP project therefore enables decarbonisation of the Humber region and should support the region economically as it becomes a hub for low carbon power.

The AHP project is an innovative power-to-power project, integrating electrolytic hydrogen production, salt cavern hydrogen storage and use of the hydrogen for the generation of low carbon power by way of an Open Cycle Gas Turbine (OCGT) (up to 50 MWe (gross) capacity). All three components of the AHP project will be located on the same site, making it a First of a Kind (FOAK) development.

The primary activity taking place at the Site is the combustion of hydrogen and natural gas in an OCGT to produce electricity. This activity is listed under Schedule 1, Part 2 of the Environmental Permitting (England and Wales) Regulations 2016 (as amended) (EP Regulations).

There are several additional activities associated with the combustion activity including electrolytic hydrogen production, hydrogen storage, water treatment, groundwater abstraction, cooling and flaring.

SSE wishes to apply for a new environmental permit (EP) for the following listed activities under Schedule 1, Part 2 of the Environmental Permitting (England and Wales) 2016 (as amended) (EP Regulations:

- Combustion activities exceeding 50 MWth under Section 1.1
- The production of inorganic chemicals (hydrogen) under Section 4.2

Following consultation with the Environment Agency permit pre-application advice service (Ref. EPR/CP3225SW), it was agreed that a new bespoke installation permit would be required for the proposed activities. The EA also confirmed the most applicable Best Available Technique (BAT) Conclusions and BAT Reference Documents (BREFs) for the Site. This includes:

- BREF Document for Large Combustion Plants (LCP), 2017
- Guidance for Speciality Inorganic Chemicals Sector (EPR 4.03), 2009
- EA Emerging Techniques on Hydrogen production by electrolysis of water (GET), 2024

- BREF Document for the Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector (CWW), 2016
- BREF Document for Common Waste Gas Management and Treatment Systems in the Chemical Sector (WGC), 2023
- BREF Document for Emissions from Storage (EFS), 2006

A review of operating techniques and the potential effects from the proposed activities on the environment are included in this application.

Separately, a full planning application was submitted in July 2024 to East Riding and Yorkshire Council (ERYC) under the Town and Country Planning Act 1990. Whilst the EP sits outside of this Act, parts of the assessment work undertaken to support the planning application have been used to support this EP application. They include air quality and noise assessments submitted for the planning application (ref. 24/02391/STPLFE).

The nearest residential receptor is approximately 400 m to the east of the Site. The nearest environmental designated site is the Greater Wash Marine Protection Area approximately 1.3 km northeast of the Site. The Site itself does not fall within an Air Quality Management Area (AQMA).

The main point source emissions to air will be gases from the combustion of fuel, such as Oxides of Nitrogen and Carbon Monoxide. An H1 assessment has been completed for emissions to air from the OCGT in normal operations. Based on the findings of this assessment, the potential impact could not be screened out as insignificant and, as such, further detailed assessment has been carried out for the emissions to air in an accompanying Air Quality Impact Assessment (AQIA). The AQIA presents an assessment of the potential for significant effects due to emissions to air from the proposed combustion plants, using an air dispersion model to assess the potential impact of the emissions on human health and ecological receptors. Results of the modelled scenarios show that operations have the potential for an insignificant impact at local sensitive receptors.

A noise impact assessment has also been conducted for the Site. Overall, noise impact at sensitive receptors is considered to be negligible and small changes in noise predicted. A noise and vibration management plan also accompanies the application to demonstrate mitigation measures that are proposed to minimise noise levels from the operation of the Site.

The main point source emissions to surface water will be surface water runoff from the Site to the Cess Dale Drain and East Newton Drain, process effluent arising from the demineralisation treatment plant to the North Sea, and cavern dewatering to the North Sea. Contents from the cavern will consist of saline water whereas effluent from the demineralisation plan will consist of concentrated brackish reject (i.e. concentrated abstracted groundwater). An H1 assessment has been undertaken to determine if the impact of the process effluent and cavern dewatering to the receiving watercourse has a significant impact. Two phases were considered for the assessment:

- Phase 1: This is expected to occur for the first 12 months, and discharge will comprise of:
  - abstracted groundwater that has been used to rewater Aldbrough 1 cavern and displace the natural gas that is currently stored in the cavern;
  - water for cooling and backflushing (Stream A)
  - process effluent (RO reject) from the demineralisation plant (Stream B).
- Phase 2: This is expected to occur after the first 12 months and will comprise of process effluent from the demineralisation plant only (Stream B).

The results of the H1 assessment indicated that for both phases, many substances were screened out at Test 1. Those substances that passed these tests indicate no significant impact to surface water and no further modelling is required. Those substances that failed Test 1 (Copper and Zinc for Phase 1; Copper, Zinc and Ammonia for Phase 2) were progressed directly to detailed modelling due to the discharge being in a protected area. Results of the marine modelling assessment show that neither phases of discharge will result in a significant ecological impact.

The Site will comprise a variety of above ground bulk storage of fuel and chemicals. All of the above ground storage tanks will have appropriate secondary containment. An environmental risk assessment has been undertaken to assess the potential impacts of emissions to air, water, odour, noise and vibration, and identify hazard, source, pathway, receptor and mitigation measures.

A full description of the condition of the Site at the time of this application is provided in the Site Condition Report.

1. INTRODUCTION

1.1 BACKGROUND

SSE Hornsea Ltd (SSE) is proposing to construct and operate an electrolytic hydrogen production, storage and energy generation facility, referred to as the Aldbrough Hydrogen Pathfinder (AHP) project. The facility will be operated at SSE's Aldbrough Gas Storage (AGS) site on Garton Road, East Riding of Yorkshire (hereafter referred to as the 'Site'). The AGS site is operated by both SSE and Equinor, and the AHP project will be a joint venture. The AHP project is an important building block in the development of a thriving Humber hydrogen economy, underpinning the region's decarbonisation and supporting economic growth locally and nationally. In the context of this application, 'the Site' is the "installation" permitted boundary.

The concept aims to store energy during periods of low carbon abundant generation and release that energy as low carbon power during periods of shortfall, such as high barometric pressure (low wind) and low solar radiation (sunlight). Therefore, the AHP project supports energy security in the UK, which is an important consideration for the UK Government and the Department for Energy Security and Net Zero (DESNZ). This concept also aims at reducing reliance on natural gas for power generation when renewable energy is unavailable. The AHP project therefore enables decarbonisation of the Humber region and should support the region economically as it becomes a hub for low carbon power.

The AHP project is an innovative power-to-power project, integrating electrolytic hydrogen production, salt cavern hydrogen storage and use of the hydrogen for the generation of low carbon power by way of an Open Cycle Gas Turbine (OCGT) (up to 50 MWe (gross) capacity). All three components of the AHP project will be located on the same site, making it a First of a Kind (FOAK) development.

1.2 REASON FOR PERMIT APPLICATION

The primary activity taking place at the Site is the combustion of hydrogen and natural gas in an OCGT to produce electricity. This activity is listed under Schedule 1, Part 2 of the Environmental Permitting (England and Wales) Regulations 2016 (as amended) (EP Regulations).

There are several additional activities associated with the combustion activity including electrolytic hydrogen production (listed under Schedule 1, Part 4 of the EP Regulations), hydrogen storage, water treatment, groundwater abstraction, cooling and flaring. All of the directly associated activities are listed in Section 1.4 of this document. Detailed descriptions of the Site activities can be found in Section 3 of this document.

SSE consulted with the Environment Agency (EA) in October 2023 to confirm the main listed activity for the Site (ref. EPR/CP3225SW). During the meeting, the following listed permitting activities were discussed as applicable and potentially primary to the Site;

- The activity of electricity generation by way of OCGT will be Schedule 1 Part (A) listed activity under Section 1.1 of the EP Regulations; and
- The activity of electrolytic hydrogen production will also be a Schedule 1 Part (A) listed activity under Section 4.2 of the EP Regulations.

During the meeting with the EA, it was advised that, as the Section 4.2 activity serves the Section 1.1 activity, the primary listed activity is considered to be the Section 1.1 activity. Other topics discussed included:

- the approach to permitting the existing consented AGS site;
- discussion and confirmation of Best Available Techniques (BAT); and
- confirmation of BAT Associated Emission Limits (BAT-AELs).

A further meeting was held with the EA in September 2024 to discuss the permitting strategy for discharges to surface water. The EA confirmed that the directly associated cavern storage and subsequent water discharge should be included as part of the AHP permit application.

This EP application and supporting information for the Site have been prepared by Environmental Resources Management Limited (ERM) on behalf of SSE. The supporting information document is based on the description of the Site provided by SSE and their engineering contractors Atkins and Black and Veach, as well as publicly available data.

Separately, a full planning application was submitted in July 2024 to East Riding and Yorkshire Council (ERYC) under the Town and Country Planning Act 1990. Whilst the EP sits outside of this Act, parts of the assessment work undertaken to support the planning application were used to support this EP application. They include air quality and noise assessments submitted for the planning application (ref. 24/02391/STPLFE).

1.3 LISTED ACTIVITIES

The primary activity at the Site will be the burning of natural gas and hydrogen to produce electricity. This activity is listed as a Part A activity in Schedule 1, Part 2 of the EP Regulations and is presented in Table 1.1 below. A new green hydrogen production plant is also being developed at the Site. Up to 666 kg/h (up to 5,834,160 kg/a) of hydrogen will be produced using electrolysis for use in the OCGT. As such, SSE is also seeking to include hydrogen production as an additional listed activity on the permit under Schedule 1, Part 2 of the EP Regulations.

TABLE 1.1 LISTED ACTIVITIES

Listed activity	Description	Limits
Section 1.1 Part A (1) (a) "Burning any fuel in an appliance with a rated thermal input of 50 or more megawatts"	1 x 125.8 MWth Open Cycle Gas Turbine fired on natural gas and hydrogen. For the production of electricity (up to 50 MWe output capacity)	From receipt of fuel (natural gas and hydrogen) to emission of combustion products and the generation of electricity for export. Includes the operation of Selective Catalytic Reduction NO_x abatement plant.
Section 4.2 Part A (1) (a) "Producing inorganic chemicals such as (i) gases (hydrogen)"	Up to 666 kg/h production of hydrogen gas using electrolysis	From receipt of abstracted groundwater for use in electrolysis, to input into adjoining OCGT plant.

1.4 DIRECTLY ASSOCIATED ACTIVITIES

EP Regulations, Schedule 1, Part 1 (2)[1] defines a 'directly associated activity' (DAA) as an operation which:

[1] UK Government (2016). *Environmental Permitting (England and Wales) Regulations 2016 Schedule 1, Part 1*. Available at: https://www.legislation.gov.uk/uksi/2016/1154/schedule/1/part/1/made Last accessed: 25/07/2023

- has a technical connection with the activity;
- is carried out on the same site as the activity, and
- could have an effect on pollution.

Table 1.2 sets out the activities that are directly associated with the activities listed in Table 1.1 above.

TABLE 1.2 DIRECTLY ASSOCIATED ACTIVITIES

Directly associated activity	**Description**	**Limits**
Hydrogen storage	Storage of hydrogen in Aldbrough 1 (ALD1) underground cavern.	From point of receipt to point of use.
Temporary flaring of H_2S	Operation of temporary H_2S flare from degassing of cavern discharge.	From combustion of H_2S gas to venting to the atmosphere.
Hydrogen purification	Hydrogen purification system upstream and downstream of the ALD1 cavern via a fixed bed catalyst. For the removal of oxygen and gas drying prior to storage, and removal of impurities carried over from cavern storage prior to combustion in the OCGT.	From produced and stored hydrogen by the electrolyser package to combustion in the gas turbine.
Hydrogen compression, deoxygenation and drying	Compression, deoxygenation and drying of hydrogen following purification through cooling and removal of oxygen and water content.	From produced hydrogen to removal of water and impurities.
Flaring of hydrogen	Operation of the hydrogen flare.	From combustion of hydrogen gas to venting to the atmosphere.
Water treatment	Raw water treatment in demineralisation (demin) plant.	From receipt of abstracted groundwater to the production of treated water for point of use.
Process effluent discharge	Wastewater discharge consisting of process effluent (RO reject) from demin plant	From demin plant to the North Sea at emission point W5.
Cavern water discharge	Water discharge from ALD1 cavern dewatering	From receipt of abstracted groundwater and collection of cavern discharge to the North Sea at emission point W5.
Surface water drainage	Discharge of uncontaminated surface water runoff (from the roof and external areas).	From handling and storage of uncontaminated runoff to discharge to the Site surface water system via interceptors to the Cess Dale Drain and balancing lagoon (to the Cess Dale Drain and East Newton Drain).

Directly associated activity	Description	Limits
Water abstraction	Abstracted borehole water for use in rewatering the ALD1 cavern, backflushing and dilution of cavern dewatering and process water.	From intake of borehole water to use in plant and final discharge to the North Sea.
Cooling Water System	Fin-fan cooling system for process cooling, mechanical, electrical and utility spaces.	From point of receipt to point of use.
Nitrogen	Inert gas for use in the electrolysis system to ensure continuous operation of the electrolyser plant by providing a safe inert atmosphere prior to commencing hydrogen production.	From point of receipt to point of use.
Compressed Air	Use in various components of the overall system including electrolysis units, the water treatment system, Deoxo-dryer, compressors, SCR unit, control valves and instruments which require dry and oil-free instrument air.	From point of receipt to point of use.
Storage and handling of chemicals, raw materials and product	Storage, handling and distribution of raw materials and final product.	From point of receipt of raw materials and final product to point of use.
Firewater management	Storage of firewater in a bulk storage tank for use in the firewater system.	From point of receipt of mains water to point of use and subsequent discharge to disposal offsite.
Diesel Firewater pump	Combustion of diesel in 1 x emergency back-up diesel firewater pump engine with a thermal rated input <1 MWth.	From receipt of fuel to emission of combustion products.

1.5 DETAILS OF THE COMPANY

The details of the secretaries and directors for SSE Hornsea Limited as listed by Companies House at the time of the application are provided below:

- Martin Beattie, Accountant/Director;
- Charles Cryans, Director;
- Michael Gillatt, Director;
- Ann Miriam Georgina Gray, Director;
- Mark Richard Hayward, Director;
- John Johnson, Director;
- Mandy Mackay, Director;
- Finlay Alexander McCutcheon, Director
- Adrian Marc James Rudd, Director;
- Zahida Zakir, Director;

SSE Hornsea Limited company registration number is 04467860.

2. SITE DESCRIPTION

2.1 SITE LOCATION

The proposed installation is to be developed at SSE's AGS site on Garton Road, East Riding of Yorkshire. The centre of the Site is approximately at National Grid Reference (NGR) TA 26099 36898.

Figure 2.1 shows the Site setting and the green line denotes the proposed geographical extent of the permit boundary.

Proposed Installation Boundary

0 20 40 60 80 100
Metres
N

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PROJECT: 0653313	CHECKED: TR
DATE: 10/03/2025	APPROVED: BT

Figure 2.1
Site Location

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PROJECTION: British National Grid

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2.2 SITE OVERVIEW

The existing AGS site consists of nine underground salt caverns storing natural gas, together with associated above ground gas processing facilities located on hardstanding. The existing facility is approximately 10 ha in area. The AHP project will be constructed within the boundary of SSE's AGS site and will utilise approximately 3 ha of land available within the AGS site.

The Site is currently comprised of predominantly hard standing, buildings and gas storage equipment. The topography of the existing AGS site is low-lying flat land at approximately 15 m AOD.

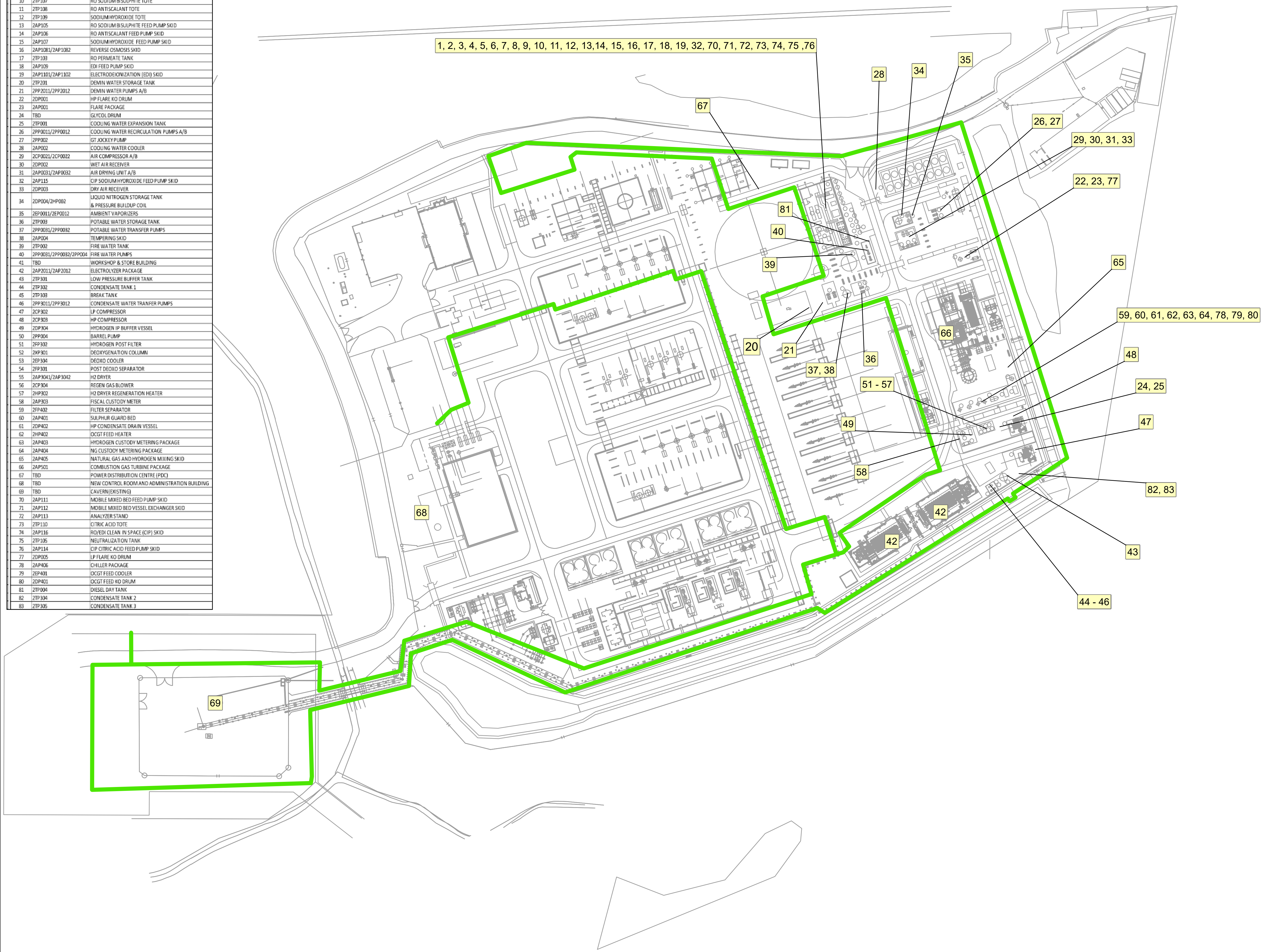
An existing salt cavern at the AGS site, ALD1 Cavern, which is currently an operational natural gas storage cavern, will be converted to store hydrogen for the AHP project.

A series of buildings where production and processing activities will take place, with several external areas that bridge the gaps between the buildings and provide access and egress routes will be located on the Site. Detailed descriptions of activities on the Site are included in Section 3. The Site will comprise the following main operational areas:

- Facility for the production, storage and retrieval of electrolytic hydrogen and its conversion into low carbon electricity by an OCGT;
- Reinstatement of an existing brine discharge pipe and associated infrastructure up to the mean low water mark; and
- Ancillary and utility equipment to support operations (including a ground flare, water treatment plant, bulk storage, nitrogen and compressed air).

Figure 2.2 presents an indicative layout for the Site.

ITEM NO	EQUIPMENT TAG NO.	EQUIPMENT DESCRIPTION
1	2TP101	BOREHOLE BUFFER TANK
2	2AP101	GREENSAND FEED PUMP SKID
3	2AP102	SODIUM HYPOCHLORITE FEED PUMP SKID
4	2TP106	HYPOCHLORITE TOTE
5	2AP1171 / 2AP1172	GREENSAND SKID
6	2TP102	GREENSAND FILTRATE TANK
7	2AP103	GREENSAND BACKWASH PUMP SKID
8	2AP104	RO FEED PUMP SKID
9	2CP1011/2CP1012	BLOWER PACKAGE
10	2TP107	RO SODIUM BISULPHITE TOTE
11	2TP108	RO ANTISCALANT TOTE
12	2TP109	SODIUM HYDROXIDE TOTE
13	2AP105	RO SODIUM BISULPHITE FEED PUMP SKID
14	2AP106	RO ANTISCALANT FEED PUMP SKID
15	2AP107	SODIUM HYDROXIDE FEED PUMP SKID
16	2AP1081/2AP1082	REVERSE OSMOSIS SKID
17	2TP103	RO PERMEATE TANK
18	2AP109	EDI FEED PUMP SKID
19	2AP1101/2AP1102	ELECTRODEIONIZATION (EDI) SKID
20	2TP201	DEMIN WATER STORAGE TANK
21	2PP2011/2PP2012	DEMIN WATER PUMPS A/B
22	2DP001	HP FLARE KO DRUM
23	2AP001	FLARE PACKAGE
24	TBD	GLYCOL DRUM
25	2TP001	COOLING WATER EXPANSION TANK
26	2PP0011/2PP0012	COOLING WATER RECIRCULATION PUMPS A/B
27	2PP002	GT JOCKEY PUMP
28	2AP002	COOLING WATER COOLER
29	2CP0021/2CP0022	AIR COMPRESSOR A/B
30	2DP002	WET AIR RECEIVER
31	2AP0031/2AP0032	AIR DRYING UNIT A/B
32	2AP115	CIP SODIUM HYDROXIDE FEED PUMP SKID
33	2DP003	DRY AIR RECEIVER
34	2DP004/2HP002	LIQUID NITROGEN STORAGE TANK & PRESSURE BUILDUP COIL
35	2EP0011/2EP0012	AMBIENT VAPORIZERS
36	2TP003	POTABLE WATER STORAGE TANK
37	2PP0031/2PP0032	POTABLE WATER TRANSFER PUMPS
38	2AP004	TEMPERING SKID
39	2TP002	FIRE WATER TANK
40	2PP0031/2PP0032/2PP004	FIRE WATER PUMPS
41	TBD	WORKSHOP & STORE BUILDING
42	2AP2011/2AP2012	ELECTROLYZER PACKAGE
43	2TP301	LOW PRESSURE BUFFER TANK
44	2TP302	CONDENSATE TANK 1
45	2TP303	BREAK TANK
46	2PP3011/2PP3012	CONDENSATE WATER TRANFER PUMPS
47	2CP302	LP COMPRESSOR
48	2CP303	HP COMPRESSOR
49	2DP304	HYDROGEN IP BUFFER VESSEL
50	2PP004	BARREL PUMP
51	2FP302	HYDROGEN POST FILTER
52	2XP301	DEOXYGENATION COLUMN
53	2EP304	DEOXO COOLER
54	2FP301	POST DEOXO SEPARATOR
55	2AP3041/2AP3042	H2 DRYER
56	2CP304	REGEN GAS BLOWER
57	2HP302	H2 DRYER REGENERATION HEATER
58	2AP303	FISCAL CUSTODY METER
59	2FP402	FILTER SEPARATOR
60	2AP401	SULPHUR GUARD BED
61	2DP402	HP CONDENSATE DRAIN VESSEL
62	2HP402	OCGT FEED HEATER
63	2AP403	HYDROGEN CUSTODY METERING PACKAGE
64	2AP404	NG CUSTODY METERING PACKAGE
65	2AP405	NATURAL GAS AND HYDROGEN MIXING SKID
66	2AP501	COMBUSTION GAS TURBINE PACKAGE
67	TBD	POWER DISTRIBUTION CENTRE (PDC)
68	TBD	NEW CONTROL ROOM AND ADMINISTRATION BUILDING
69	TBD	CAVERN(EXISTING)
70	2AP111	MOBILE MIXED BED FEED PUMP SKID
71	2AP112	MOBILE MIXED BED VESSEL EXCHANGER SKID
72	2AP113	ANALYZER STAND
73	2TP110	CITRIC ACID TOTE
74	2AP116	RO/EDI CLEAN IN SPACE (CIP) SKID
75	2TP105	NEUTRALIZATION TANK
76	2AP114	CIP CITRIC ACID FEED PUMP SKID
77	2DP005	LP FLARE KO DRUM
78	2AP406	CHILLER PACKAGE
79	2EP401	OCGT FEED COOLER
80	2DP401	OCGT FEED KO DRUM
81	2TP004	DIESEL DAY TANK
82	2TP304	CONDENSATE TANK 2
83	2TP305	CONDENSATE TANK 3



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DATE: 20/03/2025
VERSION: A01
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Figure 2.2
Site Layout

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PROJECTION: British National Grid

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2.3 SITE CONTEXT

The Site is located in the East Riding of Yorkshire administrative boundary within a rural-urban fringe area with occasional manmade industrial features. The following receptors surround the Site.

- *To the North*: Arable farmland, as well as the hamlet of East Newton (1 km northeast of the Site).
- *To the East:* The North Sea.
- *To the South:* Arable farmland, as well as a second previously engineered vacant area. East Newton Drain (stream) is located immediately adjacent to the south-eastern boundary of the Site.
- *To the West:* Arable farmland, with Garton Road c. 650 m west of the ALD1 salt cavern wellhead area. Isolated farm buildings and dwellings are present along Garton Road. The Cess Dale Drain flows in a generally southern direction to the west of the Site.

A desktop study was undertaken to identify any nationally and internationally designated sites which may be affected by the proposed activities. The results of the desktop survey using the Multi-Agency Geographic Information for the Countryside (MAGIC) interactive mapping tool are provided within Table 2.1.

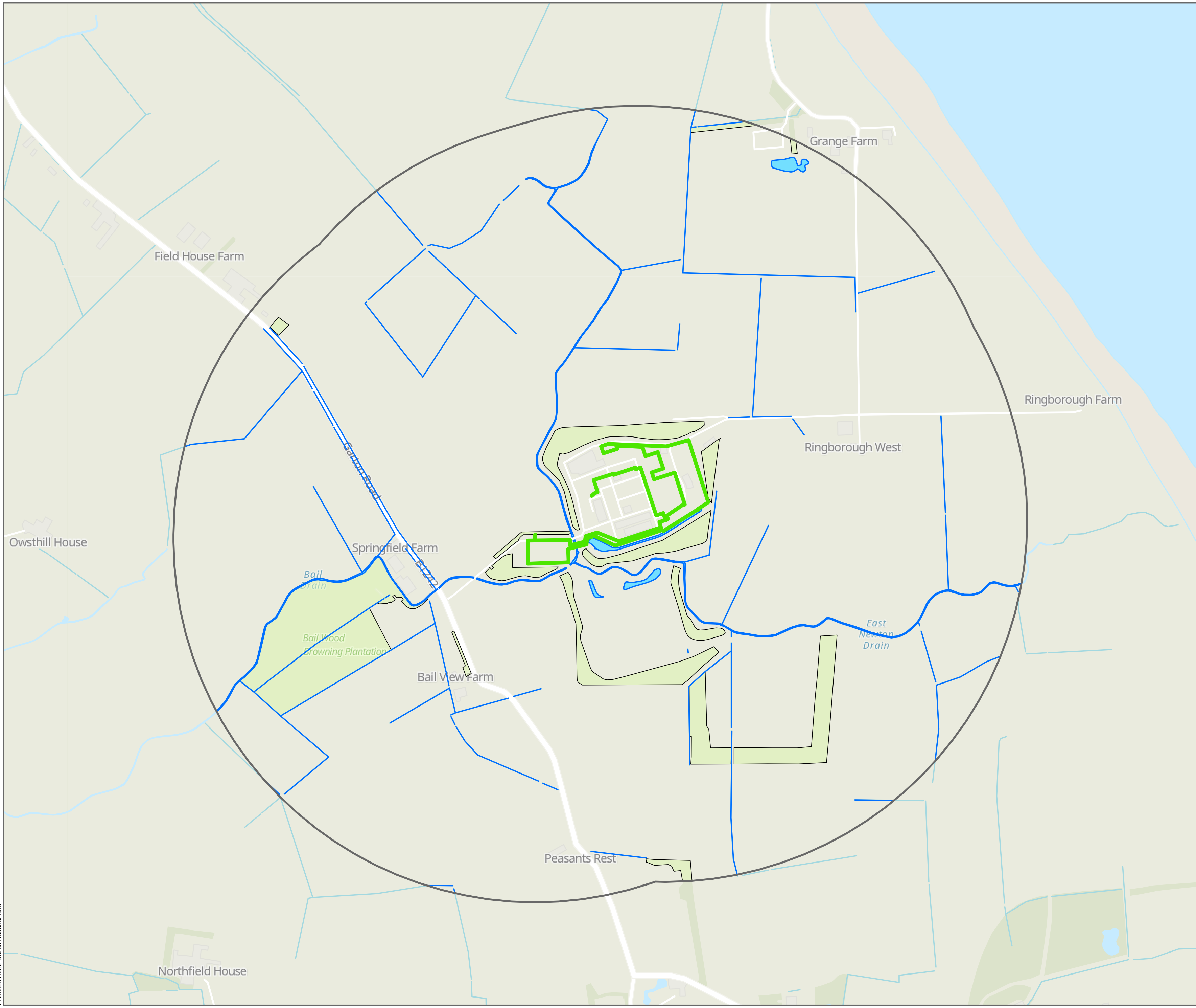
TABLE 2.1 DESIGNATED SITES

Designated Site	Search Radius	Name	Approximate Location from Site
RAMSAR	15 km	-	-
Special Area of Conservation (SAC)	15 km	Humber Estuary	12.7 km south-west
Special Protection Areas (SPA)	15 km	Humber Estuary	12.7 km south-west
		Hornsea Mere	11.3 km north-west
Marine Protection Areas	15 km	Greater Wash	1.3 km north-east
Marine Conservation Zone (MCZ)A	15 km	Holderness Inshore	1.3 km north-east
Site of Special Scientific Interest (SSSI)	15 km	Humber Estuary	12.7 km south-west
		Hornsea Mere	11.3 km north-west
		Roos Bog	7.6 km south
		Lambwath Meadows	4.9 km north-west
		Kelsey Hill Gravel Pits	9.9 km south-west
National Nature Reserve (NNR)	2 km	-	-
Local Nature Reserve (LNR)	2 km	-	-

ERYC has investigated air quality within its area as part of its responsibilities under the Local Air Quality Management regime. There are no Air Quality Management Areas (AQMA) within the borough. The Site is approximately 11.5 km away from the border with Hull City Council which has a declared AQMA. This is located in Hull City Centre approximately 18 km south-west of the Site.

In relation to groundwater sources, the Site is not located within a Groundwater Source Protection Zone (SPZ) nor a Drinking Water Safeguard Zone, and none are located within 4 km of the Site.

The Site context is shown geographically in Figure 2.3, Figure 2.4, Figure 2.5 and Figure 2.6. These figures show the search area for the Environmental Receptors, including SSSI within a radius of 2 km, European and Ramsar sites within a radius of 10 km, Sensitive Built Receptors, Geology and Hydrogeology including SPZs within a radius of 1 km.



- Proposed Installation Boundary
- Proposed Installation Boundary 1 km Buffer
- Woodland
- Surface Water

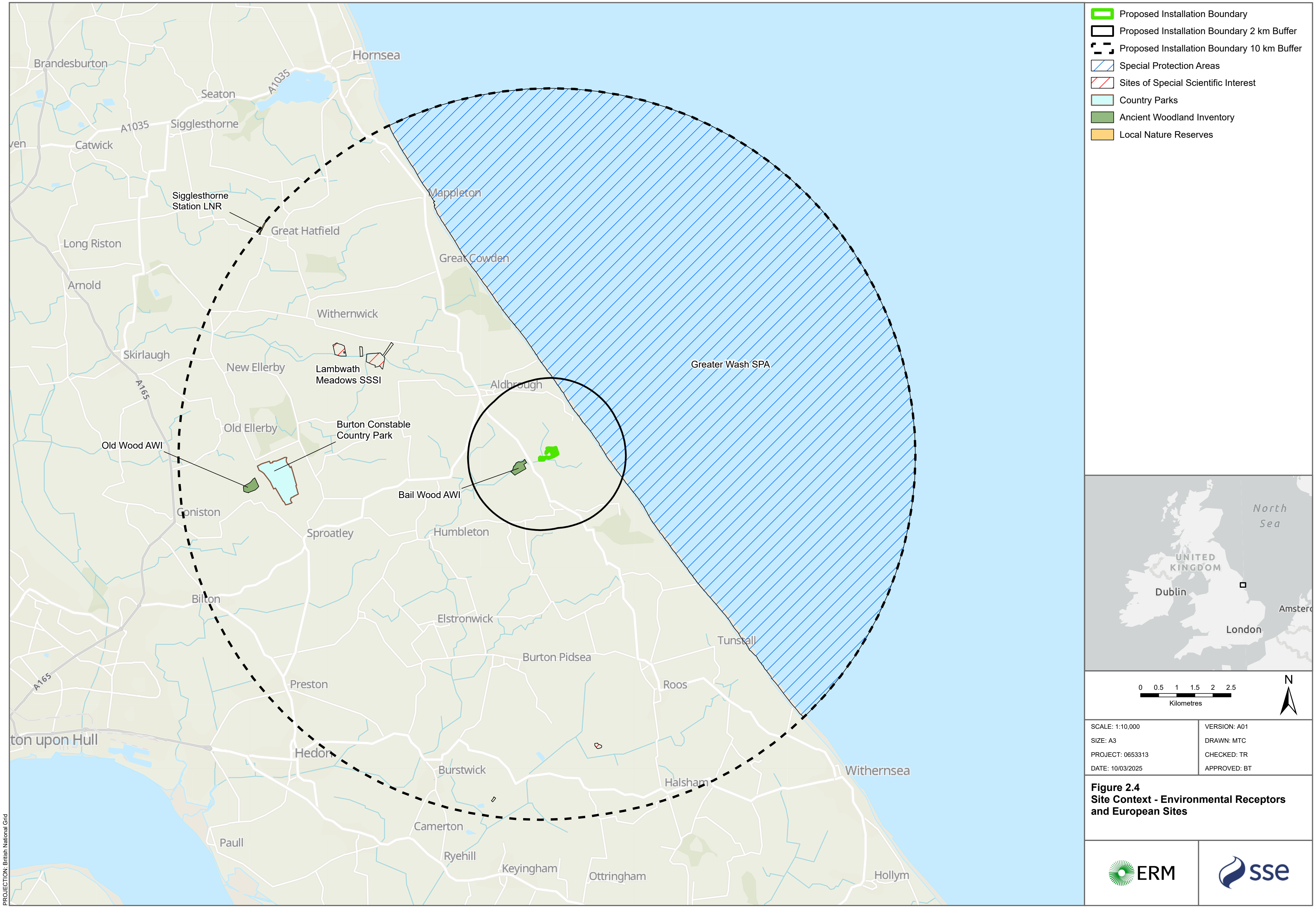
0 100 200 300 400 500
Metres
N

SCALE: 1:10,000	VERSION: A01
SIZE: A3	DRAWN: MTC
PROJECT: 0653313	CHECKED: TR
DATE: 10/03/2025	APPROVED: BT

Figure 2.3
Site Context - Environmental Receptors

ERM sse

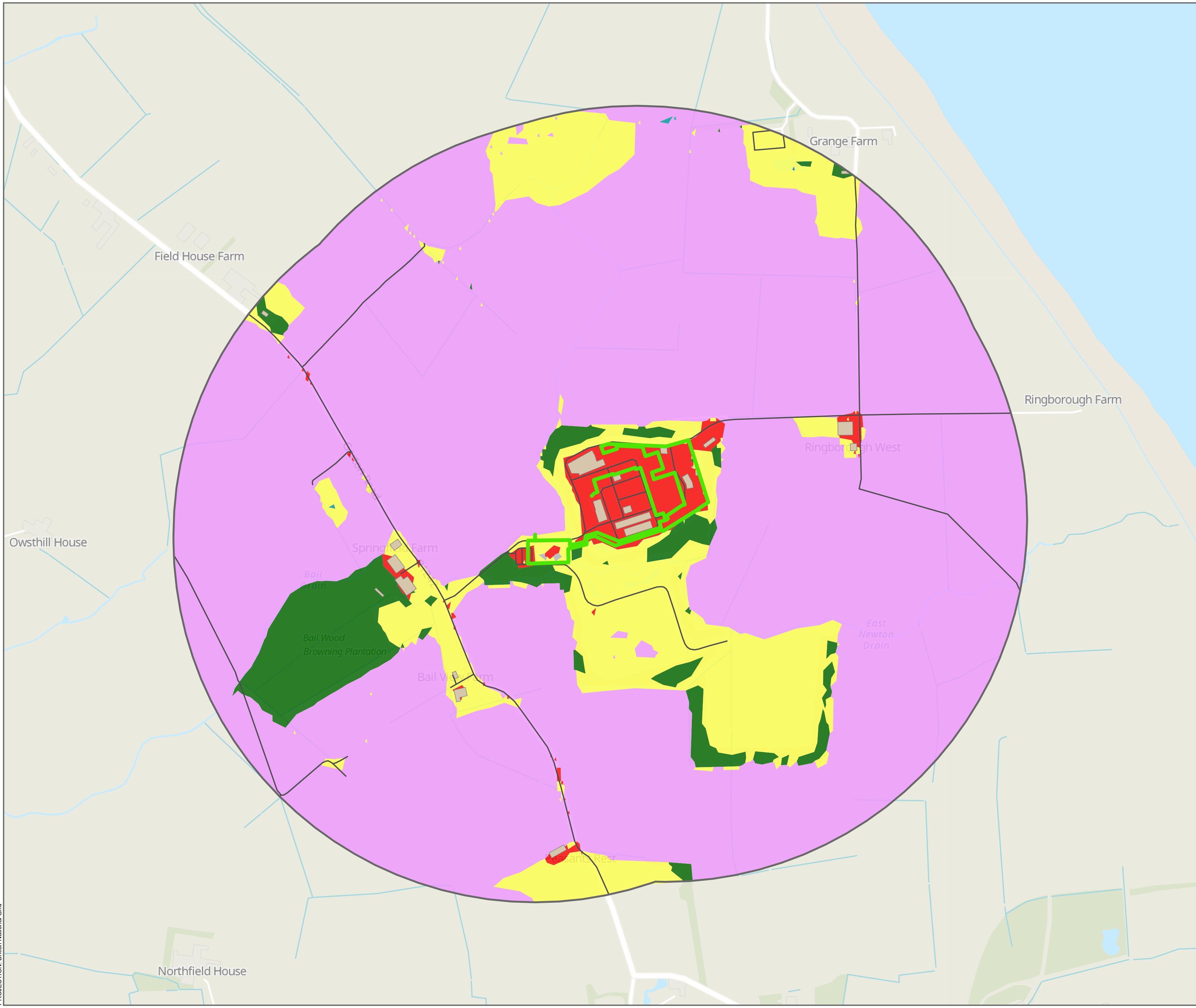
Path: \\uksprdgisfs01\Data\London\Projects\0653313 - Project Accelerator\Maps\0653313 - Project Accelerator - A01.aprx\0653313 - Pathfinder - Site Context - Environmental Receptors - A01



SCALE: 1:10,000
SIZE: A3
PROJECT: 0653313
DATE: 10/03/2025
VERSION: A01
DRAWN: MTC
CHECKED: TR
APPROVED: BT

Figure 2.4
Site Context - Environmental Receptors and European Sites

Path: \\uksprdgisfs01\Data\London\Projects\0653313 - Project Accelerator\Maps\0653313 - Project Accelerator - A01.aprx\0653313 - Pathfinder - Site Context - Environmental Receptors and European Sites - A01



Proposed Installation Boundary
Proposed Installation Boundary 1 km Buffer
Road
Buildings

Landcover

Tree Cover
Grassland
Cropland
Built-up
Bare/Sparse Vegetation
Permanent Water Bodies
Herbaceous Wetland

0 100 200 300 400 500
Metres
N

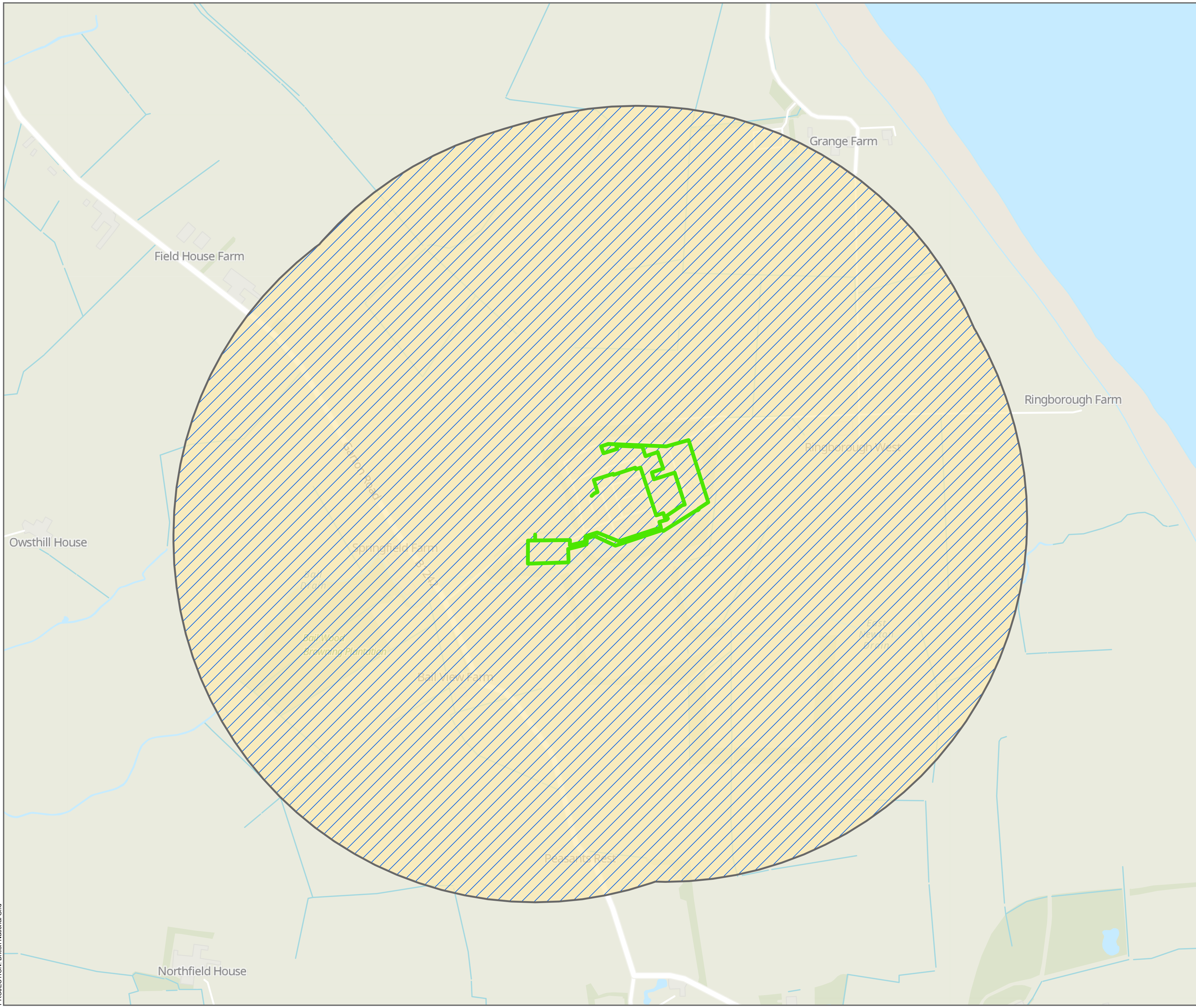
SCALE: 1:10,000	VERSION: A01
SIZE: A3	DRAWN: MTC
PROJECT: 0653313	CHECKED: TR
DATE: 10/03/2025	APPROVED: BT

Figure 2.5
Site Context - Sensitive Built Receptor

ERM sse

PROJECTION: British National Grid

Path: \\uksprdgisfs01\Data\London\Projects\0653313 - Project Accelerator\Maps\0653313 - Project Accelerator - A01.aprx\0653313 - Pathfinder - Site Context - Sensitive Built Receptor - A01



- Proposed Installation Boundary
- Proposed Installation Boundary 1 km Buffer
- Highly Productive Aquifer
- White Chalk

0 100 200 300 400 500
Metres
N

SCALE: 1:10,000	VERSION: A01
SIZE: A3	DRAWN: MTC
PROJECT: 0653313	CHECKED: TR
DATE: 10/03/2025	APPROVED: BT

Figure 2.6
Site Context - Bedrock Geology and Hydrology

ERM
sse

PROJECTION: British National Grid

Path: \\uksprdgisfs01\Data\London\Projects\0653313 - Project Accelerator\Maps\0653313 - Project Accelerator - A01.aprx\0653313 - Pathfinder - Site Context - Bedrock Geology and Hydrology - A01

2.4 SITE CONDITION

It is proposed to construct the AHP project on land which is currently within the existing AGS site boundary, both of which are owned and operated by SSE Hornsea Limited. Historical ground investigations have been completed at the AGS site. More recently, a ground investigation has been completed for the Site however this is limited to geotechnical testing only.

An interim Site Condition Report has been prepared for the Site (shown in Figure 2.1) in line with the EA's H5 requirements and is provided in Appendix A. The Site Condition Report is based on previous investigations. Since the Site is on previously owned AGS land, a pre-operational/improvement condition is proposed to further inform the Site baseline conditions and will be provided prior to the commissioning and operational start date. This is detailed in Section 16.

The Site Condition Report provides the Site's baseline ground condition at the time of the permit application. The proposed pollution prevention measures taken to protect the environment in the event of a loss of containment or major accident is provided in Section 5 of this report.

The Site will have a number of measures in place to minimise the risk of accidental releases to land/groundwater which are presented in Section 4.4 and the Environmental Risk Assessment in Table 15.1.

2.5 AGS CURRENT PERMITS

2.5.1 ENVIRONMENTAL PERMIT ERP/HP336SL/V004

SSE Hornsea Ltd currently holds a Medium Combustion Plant (MCP) permit for six MCPs and associated surface water discharges from the AGS site, variation V005 issued on 24th April 2024. Permitted emissions to water include the discharge of storm water to the Cess Dale Drain through discharge point W1, which flows into the North Sea. Emission point W2 to the Cess Dale Drain and W3 to the East Newton Drain are also included to account for overflows from the balancing lagoon basin. Process water from the Methanol Regeneration Unit is discharged through W1 via a reed bed to the balancing lagoon before discharging to the Cess Dale Drain, although this is not currently operational.

This permitted activity does not form part of the AHP project, however, the Site will utilise the existing drainage infrastructure and emission points as detailed in Section 3.5.4.5.

2.5.2 DISCHARGE PERMIT WRA8220

SSE Hornsea Ltd currently holds a permit for the discharge of trade effluent at the AGS Site, issued on 31st March 2005. The permit was issued to cover the discharge of brine arising from solution mining of salt stratum during the construction of the Phase 1 caverns to the North Sea. The pipework and outlet are still in place but currently disused and disconnected.

This consented activity does not form part of the AHP project, however, the Site will utilise the existing drainage infrastructure and emission points as detailed in Section 3.5.4.5.

2.5.3 ABSTRACTION LICENCE NE/26/0033/011

SSE Hornsea Ltd currently holds a licence to abstract groundwater from a borehole located at AGS site for the purpose of 'Industrial: Rewatering (filling) underground cavities' (originally issued on 24th March 2020).

The abstraction licence has been varied to include the AHP activities on the existing abstraction licence for the wider AGS site. The varied licence was issued 14th March 2025 and is time limited to 31st March 2037. See Section 3.5.2 for further details on the proposed abstraction.

2.5.4 EMISSIONS TRADING SCHEME PERMIT UK-E-IN-11952

SSE Hornsea Ltd currently holds a Greenhouse Gas (GHG) emissions permit, authorising the combustion activity at the installation and its associated carbon dioxide emissions. It includes conditions for monitoring and reporting carbon dioxide emissions from different emission sources using a monitoring plan.

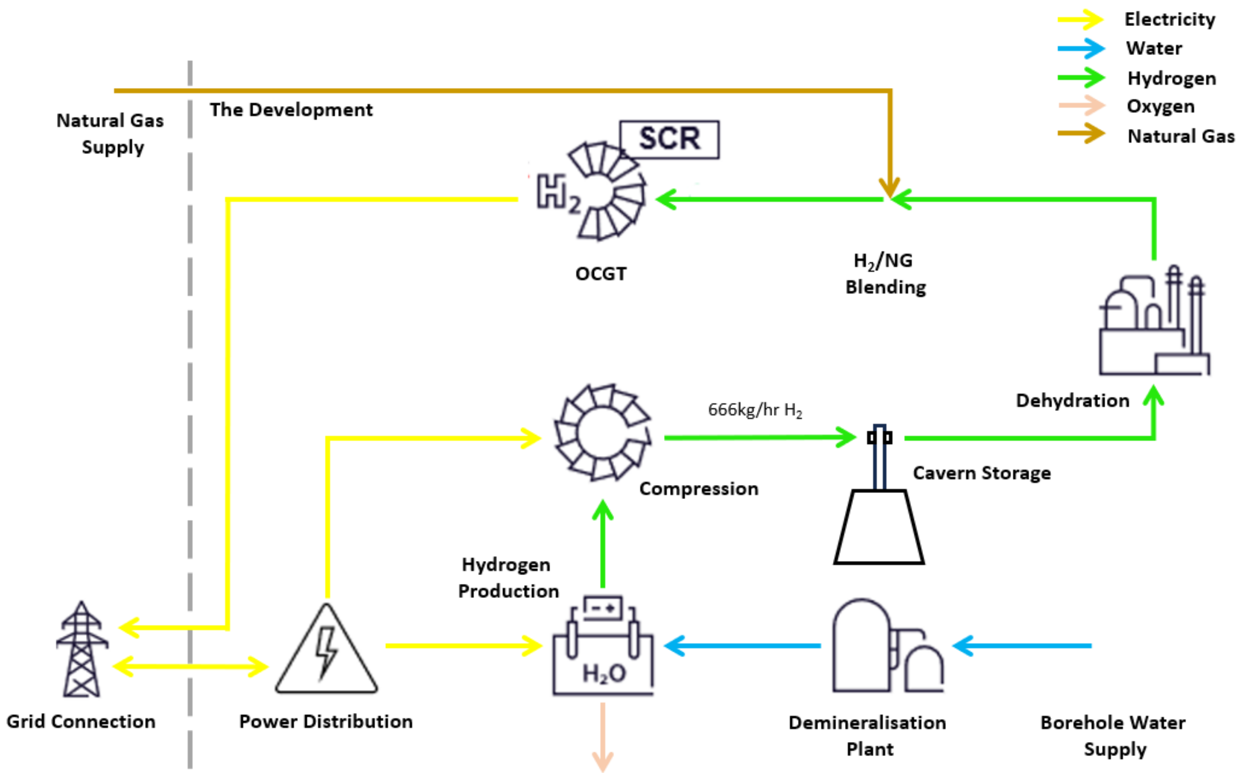
Either a new permit application or variation of the existing AGS GHG permit to include the AHP activities is being sought with the EA.

3. SITE ACTIVITY

3.1 OVERVIEW

The primary activity on the Site will be the burning of natural gas and hydrogen to produce electricity. The following sections present a description of the proposed activities on the Site. An overview is provided firstly of the primary process activities (combustion of natural gas and hydrogen including hydrogen production and storage), and secondly of the directly associated activities/utilities which support these operations. Figure 3.1 provides a high-level overview of the proposed operation.

FIGURE 3.1 OPERATIONAL PROCESS OF THE AHP PROJECT



3.2 REWATERING & DEWATERING OF ALDBROUGH 1 CAVERN

Located at SSE's AGS site, ALD1 cavern, which will be converted to store hydrogen for the proposed installation, is currently an operational natural gas storage cavern. The cavern will be rewatered under existing permissions through displacing the existing natural gas contents with abstracted groundwater (see Section 3.5.2 for more details on abstraction) and is expected to take place for the first 12 months of operation. The natural gas displaced by this water will be exported to the process plant manifold via existing plant systems, before being temporarily stored in one of the operational caverns at the AGS site prior to export to the natural gas grid.

Dewatering will be achieved through the injection of hydrogen to displace water from the cavern. The contents of the cavern – up to 300,000 m^3 of water – will be displaced with hydrogen generated from the electrolyser over a period of approximately 12 months.

As hydrogen is produced via the electrolyser it will be transferred via a new pipeline to the ALD1 cavern. The displaced water from the storage cavern will discharge to the North Sea using an existing (reinstated) underground pipeline (see Section 3.5.4 for more details on Site drainage).

As part of the ALD1 dewatering process, warm water (groundwater) will be used to backflush the dewatering strings (to remove salt build up that could impact the equipment). Additionally, groundwater will be injected into the wellhead and mixed with the displaced cavern water to cool the discharged water and prevent the precipitation of salt in lines and tanks.

3.2.1 DEGASSING & TEMPORARY FLARE

The water displaced from the cavern during the ALD1 dewatering process is expected to contain dissolved gas (including hydrogen gas, natural gas and potentially hydrogen sulphide (H_2S)), which will require separation prior to discharge to the North Sea. Interconnected open-top tanks will be provided to allow for degassing and settlement of the produced water at atmospheric pressure.

If H_2S is detected in the brine water degassing tanks, it is proposed to route this to a temporary (rental) flare package to prevent venting of the gas to atmosphere, particularly due to the density of H_2S and potential to accumulate in low lying areas. Gas to the flare will pass through a Knock Out (KO) drum to remove liquid prior to flaring of the gases. The liquid will be returned from the KO drum to the degassing tank.

It is expected that the flare will maintain a continuous pilot supplied by bottled propane. Bottled nitrogen will be used to purge the KO drum/flare prior to operation. The temporary flare will have manual ignition and will have a local control panel to monitor power supply and pilot status. Details of the temporary flare package will be confirmed at detailed design.

3.2.2 DISCHARGE TO THE NORTH SEA

Following the degassing process, the water will be discharged to the North Sea at up to 3,477 m^3 per day via the existing marine discharge infrastructure.

3.2.3 DEWATERING WELLHEAD OPERATION

The new dewatering wellhead to support cavern rewatering and dewatering shall be retained in place during operation along with its associated instrumentation.

3.3 OPERATIONAL HYDROGEN PRODUCTION & STORAGE

3.3.1 HYDROGEN PRODUCTION

Electrolytic hydrogen (ca. 35 MWe) will be produced from two Proton Exchange Membrane (PEM) electrolysers using renewable power sourced from the grid through Renewable Power Purchase Agreements, in compliance with the UK's Low Carbon Hydrogen Standard, and water abstracted from an existing onsite borehole. This will power an electrolyser to split treated (demineralised) borehole water into hydrogen and oxygen (see Section 3.5.2 for more details on abstraction).

The two electrolysers will produce around 16 tonnes (666 kg/h) of green hydrogen per day, with the potential to operate up to 24 hours a day. The oxygen resulting from the electrolysis (as a by-product) will be vented to the atmosphere.

The electrolysers will be cooled by a closed loop cooling system comprising demin water and glycol mix as further described in Section 3.5.5.

Initially, the hydrogen produced will be used to fill the cavern. Thereafter, hydrogen production will be matched to the expected demand of the OCGT at a maximum operating rate of 1500 h/a on a 5-year rolling average. The production rate of 666 kg/h is the maximum production capacity to meet 1500 hours of OCGT run time in any one year.

3.3.2 HYDROGEN COMPRESSION

Hydrogen will be compressed using a multi-stage non-lubricated piston compressor. It will be cooled between stages and pulsation dampers will reduce vibrations in the oscillating machine.

There will be slight impurities in the hydrogen generated by PEM electrolysis (<0.3 vol.% oxygen) along with water vapour. During compression, the oxygen content remains constant, however the water condenses out, reducing the entrained water quantity. The hydrogen is then under pressure and saturated with water vapor at the compressor outlet. A LP Buffer tank is used to decouple the Electrolysers and Low Pressure (LP) compressor due to their different operating dynamics.

The LP compressor will increase hydrogen pressure from nearly atmospheric pressure to an intermediate pressure level of about 30 barg, and excessive water is separated and fed back to the borehole buffer tank in the water treatment plant. From the LP compressor suction Knock Out (KO) drum, condensate water will be drained to the condensate tanks and subsequently pumped to the borehole buffer tank.

3.3.3 DEOXYGENATION AND DRYING UNIT

The compressed hydrogen passes through a deoxygenation (DeOxo) process after compression, through which the oxygen content is reduced via a fixed-bed catalyst, typically precious metal-based, where the oxygen and the hydrogen react to form water. This results in an increase in water content of the product gas stream, and a rise in temperature.

After this, hydrogen is then cooled to further reduce the moisture content, which leads to condensation (first drying process). Residual moisture is further reduced by downstream adsorption (second drying process) allowing the final target purity to be achieved at the outlet from the hydrogen purification system.

After the hydrogen goes through DeOxo and drying, it is fed to the HP compressor which increases hydrogen pressure from the intermediate pressure level to a pressure in accordance with the pressure in the Cavern, ready for storage.

3.3.4 HYDROGEN STORAGE

Produced hydrogen will be stored in the repurposed existing ALD1 storage cavern, as described in Section 3.2. This stored hydrogen is then transported to a dehydration and purification plant.

3.4 POWER GENERATION PROCESS

3.4.1 HYDROGEN PURIFICATION

The hydrogen gas purification system consists of hydrogen produced by the electrolyser package and stored in the cavern, and the equipment used to treat the hydrogen gas prior to being fed to the OCGT.

This process involves gas passing through a filter separator and Sulphur Guard Bed. The filter separator ensures that all particulates and water greater than 5 micron are removed from the inlet hydrogen gas stream. The filtered gas will be fed to a Sulphur Guard Bed. The Sulphur Guard Bed is a packed vessel designed to eliminate any hydrogen sulphide present in the hydrogen supplied from the cavern system. The hydrogen sulphide will be captured by the media, which will be replaced once it becomes saturated.

Purified, dry hydrogen will be delivered to the natural gas mixing station for gas blending.

3.4.2 HYDROGEN / NATURAL GAS BLENDING

Two separate gas lines will be used for conveying natural gas and hydrogen directly to the OCGT blending package, which will be adjacent to the OCGT; therefore, no gas storage is required external/adjacent to the OCGT.

After this, the hydrogen/natural gas blend is transported via a dedicated pipe above ground to the OCGT.

3.4.3 GAS TURBINE PACKAGE

A single OCGT generation station with a thermal rated input of 125.8 MWth will be included on the Site. The gas turbine draws in and compresses air and mixes it with heated fuel (natural gas and/or hydrogen). The resulting combustion generates a high temperature, high pressure gas mixture which is converted to rotational energy via turbine blades.

The OCGT will be capable of operating on up to 100% hydrogen and varying blends of natural gas and hydrogen (see Section 3.4.4 for more details on fuel), and will generate up to 50 MWe (gross power output) as a peaking plant for export to grid at times of low renewable energy generation to meet demand. The OCGT is envisaged to operate up to 1500 hours per year, as a rolling average over a period of five years, during times of high demand and in line with the protocol for Industrial Emissions Directive Annex V 1500 hour derogation[2].

A single exhaust stack with a height of 30 m above finished ground level will be required for the OCGT for the emission of gases resulting from the operation of the gas turbine.

3.4.4 FUEL

The OCGT will be capable of operating on up to 100% natural gas and varying blends of natural gas and hydrogen, therefore a natural gas supply of approximately 10,000 kg/h will be provided. Natural gas will be taken from the existing plant gas pipeline reception facilities to the north of the existing control building and workshop at the AGS site. The OCGT commissioning and start up will use natural gas before moving to a hydrogen / natural gas blend (75/25%) for the initial 2 – 3 years during an extended commissioning / testing phase before building up to 100% hydrogen.

3.4.5 ELECTRICITY TRANSMISSION

The OCGT is expected to produce up to 50 MWe of power for export back to the grid during times of low renewable power availability. Electricity generated will be exported to the National Grid Electricity Transmission System and/or provide house load to the existing AGS site.

Two connections will be made to the grid at the 132 kV level via motorised air-break switches and SF6 breakers. One feeder will feed a 132 kV/20 kV transformer, which will serve the electrolysers and hydrogen compressors (LP/HP), along with auxiliary loads. The other connection at the 132 kV level will provide power to the grid via generator step-up transformer.

[2] Version 5.1 Protocol for IED Annex V 1500 Limited Hours Derogation, July 2015, ref. EnvC WGEREG 08/15.

3.4.6 EMISSIONS ABATEMENT

A Selective Catalytic Reduction (SCR) system will be installed at the OCGT for the abatement of NO_x emissions in the flue gas, to ensure compliance with NO_x BAT-AELs. The SCR will be used to remove NO_x from the exhaust gas leaving the gas turbine before it is emitted to the atmosphere. This is achieved by reacting the NO_x with aqueous ammonia (NH_3) in the presence of a catalyst to produce nitrogen and water. Aqueous ammonia, which will be used as a reducing agent, will be supplied from a pressurised storage tank as a liquid and fed to the delivery system. The delivery system will be sized to provide 100% ammonia flow to the SCR unit as required for operation.

To meet emission requirements, ammonia will be injected into the exhaust gas. Any unreacted ammonia will leave the system as ammonia slip.

The SCR System will consist of:

- SCR housing
- SCR catalyst
- Ammonia injection system
- Instrumentation and control.

The SCR housing will be located between the OCGT exhaust ducting and the stack. The housing will consist of the ammonia injection grid and an SCR catalyst. The catalyst for this application will be confirmed during detailed design.

The required amount of aqueous ammonia will be controlled with a flow control valve based upon the operating conditions. The extracted flue gas temperature may be managed using air fans to meet the operational temperature range of the SCR system, and will be confirmed at detailed design.

3.5 ASSOCIATED ACTIVITIES WITH ELECTRICITY PRODUCTION

3.5.1 HYDROGEN FLARING

In normal operations, oxygen from the electrolyser building will be continuously vented to atmosphere. There will be four oxygen low-pressure vents per electrolyser. There will be no venting of hydrogen directly from the electrolysers.

The AHP project will be equipped with an enclosed ground flare system to provide a safe disposal route for gaseous emissions (hydrogen). The flare will collect hydrogen gas exhaust from the electrolysers, and the compression and distribution system. Flaring will be required to support Other Than Normal Operating Conditions (OTNOC) events such as periodic depressurisation of hydrogen systems, to allow a safe startup and shutdown for planned maintenance and emergency situations, as well as to prevent the accumulation of a hazardous atmosphere within the plant.

The enclosed ground flare will have a burner head close to ground level and enclosed inside a shell that is internally insulated or shielded. An enclosed ground flare has been selected to minimise the impact of noise, luminosity, and heat radiation and provides wind protection. Hydrogen gas is released into the flare, where combustion occurs to convert the hydrogen gas to water vapor. The enclosed flare will employ an air source system (the system type will be confirmed during detailed design), which will be controllable to allow for complete combustion of the gas. Planned use of the flare system linked with maintenance is expected at an approximate frequency of once per year, with a typical duration of 45 to 105 minutes.

The enclosed ground flare will extend to a maximum 15 m in height from ground level and will be located to the north of the Site.

By using a flare, the hydrogen gas can be safely and efficiently converted into water vapor, which has a negligible Global Warming Potential (GWP) and can be released into the atmosphere without significant environmental impact. Key emissions to air are presented in Table 4.1. The flare will be purged with nitrogen and will be fitted with an automatic ignition system.

Measures to prevent or reduce emissions to air from flaring during OTNOC are detailed in the BAT review in Section 5.

3.5.2 WATER ABSTRACTION

Groundwater will be sourced from the existing AGS site borehole which operates under SSE's existing abstraction licence (ref. NE/26/0033/011). The water will be used for the following purposes onsite:

- Industrial (rewatering) of ALD1 salt cavern;
- Cooling of cavern discharge;
- Cavern backflushing; and
- Process water via the demin plant (feedstock to the electrolyser and for cooling requirements).

Abstraction will be continuous all year round and the requirements for water abstraction are estimated to equate to a maximum of 144 m^3/day as per the existing licence. Of this, 10.5 m^3/h of water will provide a total capacity of 6.7 m^3/h of demin water to the electrolyser package.

A separate variation application has been sought with the EA to include the additional purposes on the existing abstraction licence. The licence was variation was granted and issued on 14th March 2025.

3.5.3 WATER TREATMENT

Operation of the electrolyser will require the use of demin water. Water will be supplied from the existing licensed Aldbrough borehole water supply, which is brackish and will contain other dissolved solids, so will require demineralisation.

The demin plant will provide high quality demineralised water to the electrolyser package using Reverse Osmosis (RO) treatment, plus additional filtration.

The demin plant equipment consists of 2 x 100% capacity Double Pass RO trains followed by Electrodeionisation (EDI). The water treatment system is designed to provide a total capacity of 6.7 m^3/h demin water to the electrolyser package produced from up to 10.5 m^3/h abstracted borehole raw water.

Borehole well water will initially be pumped to the borehole buffer storage tank. Prior to RO filtration, well water will be pre-treated using a Greensand Filtration system. The greensand filters are vessels filled with greensand media that is used to remove iron, manganese, and hydrogen sulphide. Water from the Greensand Filter will flow into the Greensand Filtrate Tank.

Following the Greensand Filtrate Tank are the double pass RO trains. The first pass of the RO system is designed with antiscalant, and sodium bisulfite dosing pumps. Antiscalant is used as a scale-inhibitor in the RO feed water to increase the solubility of sparingly soluble salts preventing precipitation within the RO membranes. Decarbonation of the feed water is achieved by feeding caustic to the second pass RO feed water. Each pass is provided with an RO booster pump. First pass RO reject is directed to the wastewater drain system for discharge offshore to the North Sea using the reinstated existing marine discharge infrastructure. Second pass RO reject is directed to the first pass RO booster pumps for recycle.

The EDI system will be used to further reduce the dissolved solids from the RO permeate. The water is then transferred to the demin water storage tank.

A Chemical Clean In Place (CIP) skid consists of a CIP tank with heater, CIP pumps, and CIP cartridge filters. The CIP skid serves to perform recovery cleans of the RO membranes and EDI.

Cooling water will be provided from the second pass RO unit effluent. The water will be fed with glycol and a corrosion inhibitor as needed and will be recirculated in a closed loop (fin-fan) system.

3.5.4 SITE DRAINAGE

The Site drainage system will be tied into the existing drain system at the AGS site. Site drainage system will comprise five streams:

- Chemical drain system
- Closed drainage system
- Process Effluent System
- Cavern Dewatering System
- Open drainage system
- Foul water drainage system

The subsystems are described in Section 3.5.4.1 to Section 3.5.4.4. A Site drainage plan is presented in Appendix B.

3.5.4.1 CHEMICAL DRAIN SYSTEM

All the drains from the CIP collected in the equipment areas will drain to a corner sump and will be disposed of via a third-party tanker The chemical injection packages are located indoors and therefore segregated from clean uncontaminated surface water.

3.5.4.2 CLOSED DRAIN SYSTEM

The separated liquids from the LP Hydrogen Compressor KO drums and all other separated water from the gas streams will be sent back to the demin plant for reuse.

3.5.4.3 PROCESS EFFLUENT SYSTEM

As mentioned in Section 3.5.3, process effluent (RO reject) from the demin plant will be collected and discharged to the North Sea via emission point W5 (see Figure 4.1 for emission point location). The reject stream will be piped and drained to a sump where it will then be combined with the dewatered cavern contents, before pumped discharge to the North Sea. Once ALD1 cavern has been dewatered, the AHP process stream will comprise only of RO reject from the demin plant.

Section 10 provides an overview of the expected quality and impact assessment of the discharges to the North Sea via W3.

3.5.4.4 CAVERN DEWATERING SYSTEM

Discharge of water arising from dewatering of the salt cavern will utilise the existing brine discharge infrastructure that was installed during the solution mining of the existing nine gas storage caverns of Aldbrough Phase 1, to the North Sea via emission point W5 (see Figure 4.1 for emission point location). The pipework and outlet are still in place but currently disused, however it is planned to be refurbished for use to discharge water from the rewatered ALD1 cavern.

The discharge will consist of backwash and cooled cavern water as described in Section 3.2. Section 10 provides an overview of the expected quality and impact assessment of the discharges to the North Sea via W5.

3.5.4.5 OPEN DRAIN SYSTEM

The surface water system will separately collect surface water running from building roofs, roads and process areas via W1 – W4 (see Figure 4.1 for emission point locations). Surface water from the Site will partially feed into the existing AGS site surface water drainage system which will be adapted to accommodate the Site.

Runoff is attenuated within an existing balancing lagoon to the south of the Site before discharge to the Cess Dale Drain/East Newton Drain. A separate surface water system will exist to take runoff from the Aldbrough 1 (ALD1) wellhead and cellar area direct to the Cess Dale Drain. The runoff from these areas will include existing and new oil interceptors to capture any potential escape of oil, i.e. during material delivery and/or loss of containment.

Any oil drainage from equipment onsite will be collected in a corner sump and will be disposed offsite by a third-party tanker.

External bunds and kerbed areas will not be directly connected to the open drain system. Contaminated liquids will be retained/collected and sent-off site for further treatment and/or disposal by vacuum tanker. Where bunds collect rainwater and fire water, these will be pumped out to a designated surface water manhole which will drain to the oil water separators and balancing lagoon.

3.5.4.6 FOUL WATER SYSTEM

Connection to a foul pipe operated by a statutory water company is not possible given the rural nature of the Site.

Foul drainage from permanent welfare facilities within the Site will be routed to the existing AGS Gas Storage sewage treatment package (Klargester Septic Tank). The sewage treatment plant uses screening and biological processes to treat effluent to achieve an appropriate quality for direct discharge. The treated effluent is routinely monitored and discharged (under gravity) into the balancing lagoon and will continue to be operated in accordance with SSE's existing AGS discharge permit (EPR/HP336SL).

3.5.5 COOLING WATER SYSTEM

A closed loop cooling system comprising demin water and glycol mix (approximately 60/40 vol%) will be used to fill the cooling water system through the cooling water expansion tank, which will feed the recirculation loop and water-cooling package. Process heat from this water-cooling system will be let off by a battery of fin-fan coolers.

Pre-mixed solution of glycol/water mixture will be delivered to the Site and used for the cooling water system. Demin water will be used to top up the water in the cooling water expansion tank that feeds the water-cooling recirculation loop.

The number of fans to be operated at one time will be dependent on ambient weather conditions and the engine plant temperature at the time. This will be controlled to minimise the plant's electrical energy usage.

3.5.6 COMPRESSED AIR

Compressed air will be supplied by one of the two x 100 % capacity air compressors to one x 100% capacity wet air receiver. Each air compressor will be sized to provide the compressed air required for the hydrogen production or electricity production mode. Each air compressor will operate in single or parallel operation. The compressor sequencer will be capable of operating the compressors in an alternating mode to evenly distribute the operating hours and wear.

Compressor inlet air will be supplied directly from the ambient air, with motors sized for minimum and maximum design temperatures.

3.5.7 NITROGEN

Nitrogen will be supplied by liquid nitrogen road tankers to the Site and stored in a double-walled, vacuum-insulated cryogenic storage tank as a liquid. From the tank, the liquid nitrogen will pass to the ambient air vaporiser to convert into gaseous nitrogen.

Nitrogen will be used as an inert gas in the electrolysis system to ensure continuous operation of the electrolyser plant by providing a safe inert atmosphere prior to commencing hydrogen production. This is only required after the system has been deactivated for an extended period (e.g. for regular maintenance work), or in the event of specific failures, or an emergency shutdown. Otherwise, during normal operation and ordinary shutdown periods, the electrolysers have been designed to safely contain low pressure hydrogen. Additionally, the nitrogen can be used to maintain a stable pressure and thereby avoiding under-pressure / air intake into the system.

3.5.8 BULK STORAGE, HANDLING AND DISTRIBUTION

Bulk storage facilities will be located on the Site, including facilities for:

- Import of natural gas by pipeline to the Site
- Storage and transfer of hydrogen to the OCGT
- Storage tanks for feedstock and intermediate products and utilities of the Site processes. Locations of the storage tanks are presented in Figure 2.2.

The bulk storage arrangements are set out in Table 3.1. See Table 8.1 for the full list of raw materials that will be transported to, stored and used onsite.

TABLE 3.1 BULK STORAGE SPECIFICATIONS AND CAPACITIES

Bulk Storage Location	Equipment Name	Quantity	Individual Tank Capacity (m^3)	Type of fluid	Type of storage
Aldbrough Cavern	ALD1 Cavern	1	300,000	H_2	Existing below ground salt cavern
1T80501	Cavern buffer storage tank (temporary)	1	150	Brackish water	Above ground storage tank
1T80502	Cavern buffer storage tank (temporary)	1	150	Brackish water	Above ground storage tank
2TP6016T	Degassing tank (temporary)	1	150	Brackish water	Above ground storage tank
2TP6061T	Degassing tank (temporary)	1	150	Brackish water	Above ground storage tank
2TP101	Borehole buffer storage tank	1	7.6	Borehole water	Above ground storage tank
2TP102	Greensand filtrate tank	1	3.8	Pre-treated borehole water	Process tank in demin plant
2TP103	RO permeate tank	1	3.8	RO Permeate	Process tank in demin plant
2TP104	CIP tank	1	0.75	RO Concentrate, RO permeate, EDI reject	Process tank in demin plant
2TP103	Neutralisation tank	1	0.75	Cleaning Solution to be neutralised	Process tank in demin plant
2TP301	Low pressure buffer tank	1	100	Hydrogen	Pressurised gas storage tank
2TP001	Cooling water expansion tank	1	13	Demin water	Process Expansion Tank
2TP002	Firewater tank	1	384	Potable water	Above ground storage tank
2TP003	Potable water storage tank	1	320	Potable water	Above ground storage tank
2TP303	Condensate Tank 1	1	1.5	Condensate	Above ground storage tank
2TP305	Condensate Tank 2	1	1.5	Condensate + Hydrogen Gas	Above ground storage tank
2DP304	Intermediate pressure H_2 buffer tank	1	40	Hydrogen	Pressurised gas storage tank
OCGT area	OCGT (Gas turbine and	1	14	Lubricant Oil	Lubrication recirculation tank

Bulk Storage Location	Equipment Name	Quantity	Individual Tank Capacity (m^3)	Type of fluid	Type of storage
	generator) lubrication recirculation tank				(above ground tank)
2TP004	Diesel day tank	1	0.5	Diesel	Above ground storage tank
2TP106	Demin plant – sodium hydroxide tank	1	5	Sodium hydroxide	Above ground storage tank
2TP110	Demin plant – citric acid tank	1	5	Citric Acid	Above ground storage tank
HSJ 10 BB001	Ammonia Tank	1	20	Ammonia solution (19%)	Above ground storage tank

Where storage of hazardous materials exceeds the relevant thresholds, separate permissions will be sought from the Health and Safety Executive (HSE) and local planning authority as appropriate for their storage, under the Planning (Hazardous Substances) Regulations 2015 (HMSO, 2015a), and Control of Major Accident Hazards Regulations 2015 (COMAH) (HMSO, 2015b) regimes. SSE will be seeking to update the existing COMAH report for the Site, which will cover the integrity of the cavern storage and safety mitigation.

3.5.9 FIREWATER MANAGEMENT

The AHP project, when fully operational, will store flammable materials including flammable gases, hydrocarbons (i.e. diesel and lubricant oil) and cleaning products (see Table 8.1). The Site will employ suitable fire protection measures to limit or prevent escalation of fire.

A firefighting and firewater containment system design is required to protect the plant equipment, personnel and the environment from the effects of a fire. The firewater system will consist of a firewater sprinkler system, hydrant system, spray system and extinguishers.

Firewater will be sourced from mains supply and stored in a 384 m^3 bulk storage tank to supply firewater for process and utility areas during a fire scenario and to meet minimum 2 hours of firewater demand. The approximate volume available within the Surface water drainage network (Pipes, Pits and French drain Voids) is 360 m^3. This has been assessed to be sufficient to collect 2 hours' firefighting water without causing any ponding over the surface and potential for overland flow to surface waters etc.

Oil or chemical containing equipment will be provided with bunding (secondary containment) and the contaminated spent fire water associated with that storage will be retained within the bunding. Oil bunds are equipped with Oil Sensitive Class 1 Automatic bund dewatering system which will pump out the spent fire water to surface water drains only if oil contamination is less than 5 ppm. Any accidental contamination reaching the drains with spent fire water will be separated by the Class 1 Oil Water Separator downstream in the drainage system. Additionally, to prevent firefighting water entering the balancing pond via open drains, a penstock valve will be provided on the outlet into the balancing pond from the Site. All firewater contained onsite and within drains, interceptors and bunds will be disposed offsite.

A diesel-driven firewater pump will supply power for the firewater sprinkler system in emergency situations, in the event that the electrically driven pump is not available. The firewater pump engine is anticipated to be <1 MWth. This will be a separate standalone unit and will not be used to generate electricity and therefore does not contribute to the generating capacity of the Site. The diesel firewater pump is not anticipated to operate for more than 50 hours annually. Diesel will be provided from a 0.5 m^3 above ground storage tank in accordance with CIRIA 736 guidance.

4. EMISSIONS

4.1 EMISSIONS TO AIR

4.1.1 POINT SOURCE EMISSIONS TO AIR

The principal point source emissions to air from the Site will be gases from the combustion of fuel within the OCGT, the enclosed ground flare and the backup diesel firewater pump. These include:

- Oxides of nitrogen (NO_x);
- Ammonia (NH_3); and
- Carbon Monoxide (CO);

The combustion activity onsite falls under Schedule 1 of the EP regulations since the net thermal input (MWth) of the OCGT is 125.8 MWth. The EA has proposed a banded approach to determining relevant ELVs for natural gas/hydrogen blends, which is dependent on how the plant is proposed to be operated (i.e. the proportion of natural gas to hydrogen). Emission limits proposed for the Site are based on this banded approach and are further detailed below. Secondary abatement measures as detailed in Section 3.4.6 will include SCR and dry low NO_x burners to minimise the generation of NO_x.

One backup diesel firewater pump will operate in emergency situations, i.e. in the event of loss of electrical power during a fire event. Testing of the diesel engine will take place for less than 50 hours per year and the capacity is <1 MWth. As a result, it is not considered an MCP, and is therefore not subject to emission limit values. Details of this emission point are presented below; however, this has not been included in the air quality assessment. The air quality assessment is already considered to be very conservative as it assessed the OCGT at maximum operating hours (1,500 h/a), therefore, exclusion of the small engine is not expected to affect the outcome of the air quality assessment.

Air dispersion modelling has been undertaken by ERM to estimate how emissions from the Site may disperse in the surrounding environment, and to understand the significance of those emissions. More details can be found in Section 11 0and the air quality impact assessment report in Appendix C.

Table 4.1 provides a list of point source emissions to air; the locations of each emission point are shown in Figure 4.1.

TABLE 4.1 POINT SOURCE EMISSIONS TO AIR

Emission Point ID	Emission Source	Description	Parameter	Proposed Limits	Abatement
A1	Gas turbine exhaust stack	OCGT exhaust	NO_x	50 - 68.5 mg/Nm^3 [(a)]	Selective Catalytic Reduction Dry Low NO_x Burners
			CO	100 - 137 mg/Nm^3 [(b)]	
			NH_3	10 mg/Nm^3	
A2	Hydrogen flare stack	Intermittent release of	Water Vapour, NO_x	No limits proposed.	Optimised Combustion

Emission Point ID	Emission Source	Description	Parameter	Proposed Limits	Abatement
		combusted flare gas (H_2) to atmosphere (emergency and OTNOC only)		Records will be kept of the date, duration, time and reason for flaring.	
A3	Diesel Firewater pump (<1 MWth)	Usage during an emergency firefighting event only.	NO_x, CO and particulates	No limits proposed as not an MCP	None
A4	Temporary flare Stack	Intermittent release of combusted flare gas (H_2S) to atmosphere from degassing cavern discharge (emergency and OTNOC only)	SO_2	No limits proposed. Records will be kept of the date, duration, time and reason for flaring.	None

(a) Upper limit based on allowances from IED Annex V with the use of a hydrogen combustion factor (1.37 for 100% hydrogen). IED Annex V limit 50 mg/Nm^3: Monthly average NO_x = 50 x 1.37 = 68.5 mg/Nm^3. See Section 14.1 for assessment of compliance for daily and hourly average emissions.

(b) Upper limit based on allowances from IED Annex V with the use of a hydrogen combustion factor (1.37% for 100% hydrogen). IED Annex V limit 100 mg/Nm^3: 100 x 1.37 = 137 mg/Nm^3.

As the OCGT will operate on up to 100% hydrogen fuel (this includes a blend of both natural gas and hydrogen), a banded system for ELVs from fuel blends is proposed for NO_x and CO as set out in the EA guidance[3] and the ranges provided in Table 4.2. Compliance with these ELVs through monitoring is detailed in Section 14.1.

TABLE 4.2 ELVS FOR FUEL BLENDS OF HYDROGEN WITH NATURAL GAS

Substitution of hydrogen (% v/v)	Pollutant ELV expressed as a % of the analogous natural gas ELV
0 to <20%	100%
>20 to 50%	107%
>50 to 75%	115%
>75 to 90%	125%
>90 to 95%	130%
>95 to 100%	137%

[3] Environment Agency (2024). Guidance – Hydrogen Combustion: comply with emission limit values. Available at: Hydrogen combustion: comply with emission limit values - GOV.UK Last accessed 17/10/24

4.1.2 FUGITIVE EMISSIONS TO AIR

Fugitive emissions to air can arise from storage areas, equipment opening, pipe flanges, valves and other transfer systems, tank breathing and open surfaces. For the Site, the principal source of fugitive emissions are:

- Process Venting & Flaring
- Equipment e.g. compressors
- On-Site Storage
- Leaks through pipework and joints

There is potential for localised ammonia vapour from the liquid ammonia storage tank breathers, and for hydrogen and natural gas in the event of leaks. Fugitive emissions from hydrocarbon delivery and storage are expected to be minimal due to small quantities of diesel being stored. Expected fugitive emissions to air are presented in Table 4.3 and further detail on control measures is provided in the BAT review described in Section 5 and presented in Appendix D.

TABLE 4.3 FUGITIVE EMISSIONS TO AIR

Name	Emission	Source	Frequency (continuous / periodic / emergency)
Residual hydrogen in waste stream after purification / separation	H_2	Electrolyser - hydrogen crossover into O_2, vented to atmosphere from H_2 diffusion across electrolyser membrane	Continuous
Permeation of hydrogen through compressor seals	H_2	LP and HP compressor seal leakage	Continuous
OCGT - Incomplete combustion	H_2	OCGT during start up and shutdown sequences	Intermittent
Ammonia slip during SCR injection	NH_3	SCR unit on OCGT	Continuous
Hydrocarbon delivery and storage	Hydrocarbons	Diesel fuel tank	Intermittent

An Environmental Management System (EMS) will be in place at the Site to manage and minimise the risk of fugitive emissions to air (see Section 6). Protection systems will include automatically triggered safe plant emergency shutdown in the event of major faults in equipment. Scheduled maintenance of storage tanks, lines and equipment will be incorporated into the EMS to minimise the risk of fugitive emissions of VOCs to air. These will be designed to align with Best Available Techniques as detailed in Section 5.

No handling of substances that could give rise to dust emissions are expected to be present onsite.

It is anticipated that fugitive emissions of odour will not be significant for the Site (See Section 13 for more detail on odour emissions).

4.2 EMISSIONS TO WATER

4.2.1 POINT SOURCE EMISSIONS TO WATER

The principal point source emissions to water from the Site will be segregated, clean, uncontaminated surface water drainage via W1, W2, W3 and W4, process effluent (reject from the RO plant) via W5, and temporary cavern dewatering discharge via W5.

BAT-Associated Emission Levels (BAT-AELs) from the CWW BREF (see section 5) have been assessed in relation to the process effluent discharge, however emissions do not exceed the annual thresholds and the BAT-AELs are therefore not applicable.

BAT-AELs are not considered to be applicable to the cavern discharge as this effluent does not arise from the chemical production process and it is not considered a waste activity. Proposed limits for the cavern discharge have been based on the existing AGS consent to discharge (permit reference WRA8220). The proposed flow limit is based on the expected flowrate of the discharge and assessed in the H1 assessment to water (see Section 10).

As emission points W1-W4 are expected to comprise uncontaminated stormwater run-off, no hazardous substances are expected to be released in the discharge, therefore no emission limits are proposed.

These point source emissions to water are identified in Table 4.4 and the locations of each emission point are shown in Figure 4.1.

TABLE 4.4 POINT SOURCE EMISSIONS TO WATER

Emission Point ID	Emission Source	Description	Parameter	Proposed Limits	Abatement
W1 – W3 (Existing AGS emission points)	Surface water discharge	Discharge of clean uncontaminated surface water into the AGS balancing lagoon to the Cess Dale Drain and East Newton Drain	Oil & grease	No visible grease or oil.	Oil/water separator
W4	Surface water discharge	Discharge of clean uncontaminated surface water from the Wellhead drainage area into the Cess Dale Drain	Oil & grease	No visible grease or oil.	Oil/water separator
W5 (Phase 1 & 2)	Demin plant reject	Discharge of concentrated reject from the demineralisation plant	Flow rate	93.6 m^3/d	
			pH	6-9	
			Oil & grease	No visible grease or oil.	
W5 (Phase 1 only)	Cavern dewatering discharge	Discharge of ALD1 cavern	Flow rate	3744 m^3/d	Degassing tanks for cavern
			Total Dissolved Solids	284 g/l	

Emission Point ID	Emission Source	Description	Parameter	Proposed Limits	Abatement
		dewatering into the North Sea	Temperature	27 ºC	contents prior to discharge.
			Suspended Solids	550 mg/l	
			pH	6 – 8.5	

4.2.2 FUGITIVE EMISSIONS TO WATER

The Environmental Risk Assessment assesses the potential for, and mitigation against, spills or leaks onsite reaching offsite watercourses. The potential losses from raw material storage are considered low.

Where any substance could pose a risk to the environment through uncontrolled release (e.g. via surface water drains), the substance will be stored within appropriate containment facilities including impermeable concrete surfaces and appropriately designed and sized bunds. Storage tanks will be designed to meet best practice, and where relevant, Oil Storage Regulations 2001, as well as taking into account the CIRIA C736F guidance on containment systems for prevention of pollution. This includes storing materials in appropriate containers with suitable spill protection, tanks with leak detection, moveable containers on bunded pallets, and storage in specifically designed storage units and areas. Bunding for atmospheric storage tanks will be designed to hold either 110% of the maximum capacity of the largest tank or 25% of the total capacity of all the tanks within the bund, whichever is greater, to allow for tank failure and firewater management, in line with the UK HSE Guideline HSG176. The bunds will be provided with a low point sump for removal and offsite disposal of captured liquids.

Areas at risk of spillage, such as maintenance areas, deliveries and hazardous substance stores, will be bunded and carefully sited to minimise the risk of hazardous substances entering the drainage system or the local watercourses.

To prevent contamination and to reduce emissions to water, uncontaminated wastewater streams will be segregated from potentially contaminated wastewater streams as described in Section 3.5.4.

Regular inspections of the condition of tanks, secondary containment, machinery and Site hard standing will be integrated into the Site EMS (see Section 6). The EMS and Accident Management Plan (see Section 15.2) will include procedures for controlling raw material delivery, product transportation and spill response procedures. Spill kits will be available at various locations at the Site, including the designated areas for material delivery and storage.

4.3 EMISSIONS TO SEWER

4.3.1 POINT SOURCE EMISSIONS TO SEWER

There are no emissions to sewer proposed from process or domestic sources from the Site.

4.4 EMISSIONS TO LAND AND GROUNDWATER

4.4.1 POINT SOURCE EMISSIONS TO LAND AND GROUNDWATER

Under normal operations, there will be no point source emissions to land and groundwater from the Site.

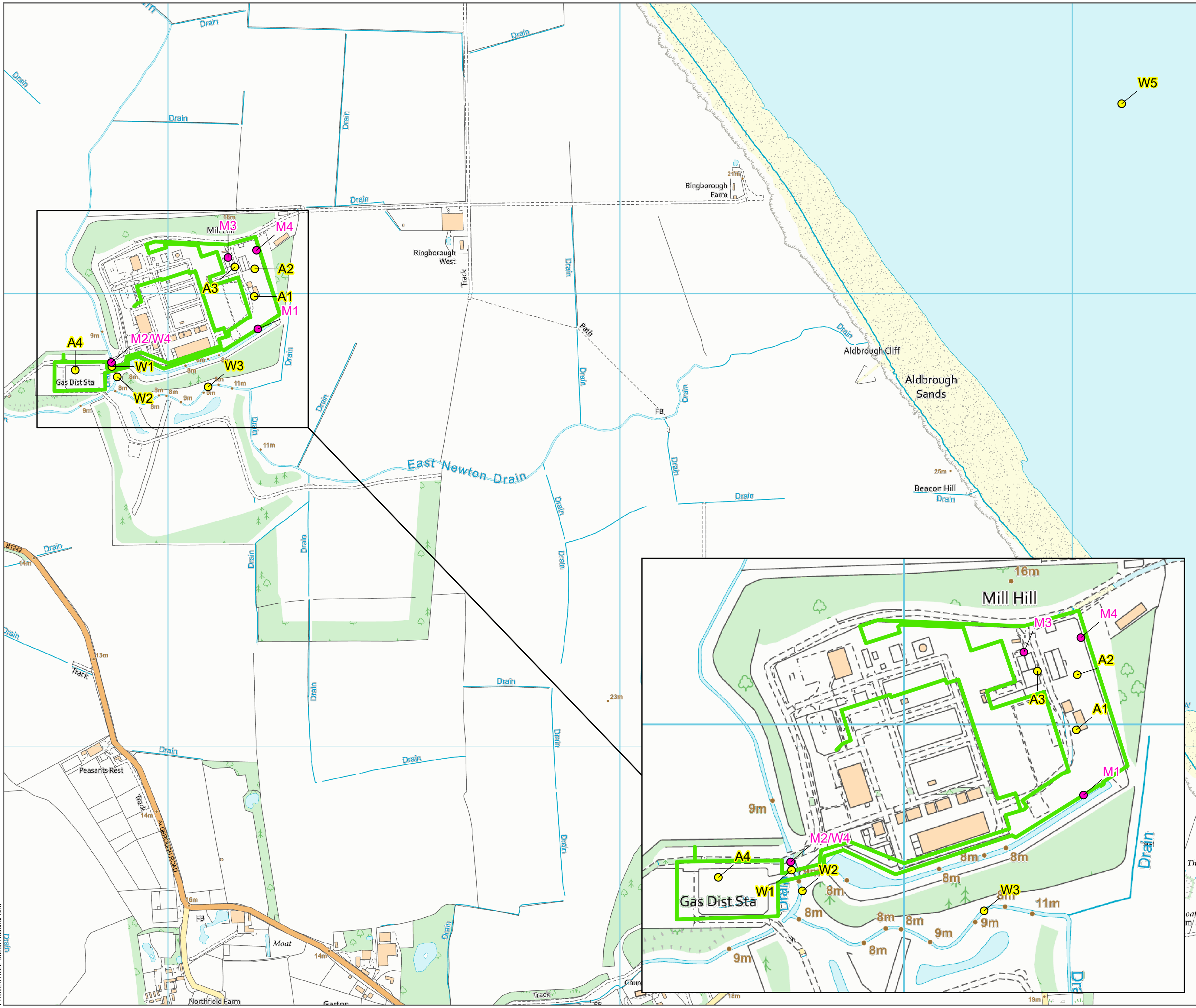
4.4.2 FUGITIVE EMISSIONS TO LAND AND GROUNDWATER

As described in Section 4.2.2, the Environmental Risk Assessment (Section 15) assesses the potential for, and mitigation against, spills or leaks onsite reaching land and groundwater.

The only anticipated, potentially significant fugitive emissions to land and groundwater from the permitted operation would be in the event of a catastrophic tank failure, leak from a tank or pipework, or a spill during tanker unloading of fuel or other raw materials and loading.

The Site will be covered by concrete hardstanding, limiting the likelihood of an overland spill reaching soil or groundwater.

Mitigation measures described in Section 4.2.2 will limit the potential for any spill to reach unmade ground and potentially impact soil and/or groundwater. Pipework containing brine water and RO reject will be refurbished to current industry standards as part of the construction phase, prior to receiving any liquid.



Proposed Installation Boundary

Air and Water Emission Points

Emission Point

Monitoring Point

0 50 100 150 200 250

Metres

N

SCALE: 1:10,000	VERSION: A01
SIZE: A3	DRAWN: MTC
PROJECT: 0653313	CHECKED: TR
DATE: 17/03/2025	APPROVED: BT

Figure 4.1
Emission Points

ERM

sse

PROJECTION: British National Grid

Path: \\uksprdgisfs01\Data\London\Projects\0653313 - Project Accelerator\Maps\0653313 - Project Accelerator - A01.aprx\0653313 - Pathfinder - Site Context - Emission Points - A01

5. OPERATING TECHNIQUES

5.1 APPLICABLE TECHNICAL STANDARDS

The primary Site activity (energy generation) falls under Section 1.1 Part (A)(1): Combustion. To demonstrate that the Site will be designed and operated according to Best Available Techniques (BAT) for the range of activities carried out at the site, a review of the European Commission's relevant BAT Reference Documents (BREFs) has been carried out. The documents reviewed were:

- Best Available Techniques (BAT) Reference Document for Large Combustion Plants (LCP), 2017

The production of hydrogen activity falls under Section 4.2 Part (A)(1)(a): Producing inorganic chemicals such as gases (hydrogen). A review of the following BREF documents and technical guidance note has been reviewed for hydrogen production:

- Guidance for Speciality Inorganic Chemicals Sector (EPR 4.03), 2009
- EA Emerging Techniques on Hydrogen production by electrolysis of water (GET), 2024

The EA guidance for Specialty Inorganic Chemicals Section (EPR 4.02) has been defined on the basis of the Production of Specialty Inorganic Chemicals BREF 2007. EPR 4.02 was advised as the most applicable BAT requirement for the Site's hydrogen production activity during pre-application engagement.

The EA also confirmed through pre-application that the following three documents should be considered in addition to the those above:

- Best Available Techniques (BAT) Reference Document for Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector (CWW), 2016
- Best Available Techniques (BAT) Reference Document for Common Waste Gas Management and Treatment Systems in the Chemical Sector (WGC), 2023
- Best Available Techniques (BAT) Reference Document for Emissions from Storage (EFS), 2006

Although the EFS BAT does not directly cover storage of gas (only liquid, liquified gases and solids), it has been considered for the cavern storage at the request of the EA, during pre-application engagement.

While the WGC BAT Reference Document is technically applicable, it was issued in January 2023 and as such is not legally enforceable in the UK. SSE will consider the requirements under UK BAT once this is issued. At present SSE consider the LCP BREF and existing EPR 4.02 responses to sufficiently describe the control of waste gases from the Site activity.

Each of the documents considered above are presented in tabular form in Appendix D.

6. ENVIRONMENTAL MANAGEMENT SYSTEM

The Site will be managed and operated under an Environmental Management System (EMS) which will be certified to ISO14001:2015 and will cover the management system requirements detailed in 'Develop a management system: environmental permits guidance' and the BAT guidance for Large Combustion Plant and relevant BAT.

The SSE EMS (SSE's own SHE Management System) will apply to the Site as required. To supplement this, site-specific management system documents will be developed to cover the processes and location-specific risks.

The commissioning process will be used to test the management procedures and ensure that any aspects required are addressed following commissioning. The SHE Management System will detail systems and procedures that Site operations are required to follow, with the objective of effective management and mitigation of the actual and potential environmental impacts of the Site's activities. A review of the overall management system will be carried out annually.

Key Aspects of the EMS include:

- Group Environmental Policy;
- 15 SHE Management Standards that provides the overarching framework for the management system;
- Risk Standards including a set of Environmental risk standards that define the overarching environmental risk controls applied across SSE's assets;
- The legislation register that identifies applicable compliance obligations and other requirements applicable to the group, businesses and sites;
- iCare – SSE's tool for:
  - The EMS Scope identification
  - The EMS Organisation and Context
  - Environmental aspects and impacts assessment
  - Identification of interested parties (stakeholders)
  - ISO 14001 clause signpost / guide; and
- SEARS (Safety Environmental Asset and Reputation System) – a hazard and incident corrective and preventative management reporting and investigation system.

Additionally, site-level SHE documents will be required by the SHE Management System for operation. Examples documents include:

- Work Instructions (procedures) to support any site-level SHE management, monitoring and control aspects;
- Operational Instructions (procedures) for the plant;
- Maintenance Instructions (procedures) for the plant;
- Planned preventative maintenance programmes;
- Emergency response and preparedness plans;
- Training and competence plans and assessments;
- SHE Plans – including environmental objectives, targets and programmes; and
- Audit plans and compliance assessments.

7. WASTE MANAGEMENT

The framework of waste management during the operation of the Site will be included within the EMS (see Appendix E for the waste management procedure which will be used for the Site).

This sets out the scope of waste management activities, from segregation of waste onsite to its removal, including responsibilities and procedures for compliant storage and handling of waste, and waste contractor duty of care. The EMS will outline the methods required to minimise waste, and manage waste produced responsibly. Waste management procedures will be communicated to all staff and sub-contractors working onsite. The frequency of waste monitoring, audits and reviews will be specified in the EMS.

7.1 WASTE GENERATION

The main sources of waste at the Site will be from operations including the manufacturing process, utilities, as well as maintenance activities. Table 7.1 presents the typical annual waste streams expected for the Site.

TABLE 7.1 EXPECTED WASTE STREAMS

Waste Stream	Source	State	Typical monthly generation	Storage Location	Class	Destination
General solid waste	General site activities / mess areas / offices	Solid	2 – 5 tonnes	Front end loader wheelie bins on hard standing in yard area	Non-hazardous	Offsite - typically energy-from-waste
Dry mixed recyclables	Wood, metal, plastic, paper and cardboard	Solid	1 – 2 tonnes	Front end loader wheelie binds on hard standing in yard area	Non-hazardous	Offsite – recycled
Sanitary/foul waste	Sanitary wastewater	Solid and Liquid	Periodic tanker collection (approx. every 6 months) (typically 5 tonne tank capacity)	AGS Septic tank system within sanitary package treatment system	Non-hazardous	Incorporated into the existing AGS site drainage system. Solids will be periodically removed by tanker.
Degassing Tank sludge	Degassing Tank	Solid and Liquid	24 tonnes	ALD1 Well pad	Non-hazardous	Offsite – Treated and disposed as applicable
Process Wastewater	Demin plant and RO plant membrane solution	Liquid	3.9 m^3/h	Wastewater loading bay	Non-hazardous	North Sea
Solid process waste	Spent filters, RO plant membranes, water treatment sands and resins	Solid	Typically, none. Only during periodic maintenance events.	Temporary skips during outage type events stored on hard standing.	Non-hazardous	Offsite - treated or recycled as applicable
Waste / spent chemicals	Glycol water mix and laboratory reagents	Liquid	Typically, none. Only during periodic maintenance events.	Designated waste area for drums and IBCs with secondary containment.	Non-hazardous	Offsite – treatment
Empty chemical containers (drums, IBCs etc.)	Drums, IBCs	Solid	60 – 120 drums / IBCs (typically up to 1.25 tonnes IBCs)	Stored within a designated area for collection. Provided with secondary containment e.g. drip trays where there is risk of residues.	Non-hazardous	Offsite - recycled

Waste Stream	Source	State	Typical monthly generation	Storage Location	Class	Destination
Hazardous waste from plant maintenance	Refrigerant gases, fluorescent bulbs, degreaser wash fluid, waste oils and oily rags, wash-water and batteries	Solid and Liquid	< 12 tonnes	Appropriate waste safe type containers within a designated hazardous waste storage area. Liquid wastes provided with secondary containment e.g. drip trays.	Hazardous	Offsite - treatment

7.2 WASTE COLLECTION AND STORAGE

Hazardous waste will be segregated from non-hazardous wastes and will be stored depending on the nature of the waste in either a hazardous container, covered or bunded. Waste will be stored in a manner to prevent:

- Corrosion or wear of waste containers
- Leaching of waste unprotected from rainfall
- Accident or weather breaking contained waste open and allowing it to escape
- Waste blowing away of falling while being stored or transported
- Scavenging of waste by vandals, thieves, children, trespassers or animals

The following waste management procedures will be implemented:

- Where applicable to prevent escape of waste, skips will be enclosed.
- All containers and skips for waste storage shall be clearly labelled so that users know what wastes can be placed in each container.
- Hazardous waste will be stored in appropriate covered containers or skips within the site boundary/fence line, which will be a high security area.
- All waste containers will be sited at least 20 m away from watercourses, ditches, and other areas of environmental sensitivity.
- Liquid wastes will be stored in containers and stored within a suitable bunded area or otherwise provided with secondary containment.
- Separate containers will be provided for each type of hazardous waste.

7.3 WASTE MINIMISATION

The principals of the waste hierarchy will be adopted where appropriate. Waste generation will be kept to a minimum onsite due to the nature of the operation. The Site inputs include mainly raw materials which will arrive in bulk to minimise packaging. Waste minimisation efforts will focus on using less new resources and materials where practicable, and requirement for a tidy workplace to prevent the unnecessary generation of waste. Waste will be segregated to maximise recycling. Waste minimisation will form part of the training for environmental awareness undertaken by all employees working at the Site.

The operational processes are being designed in accordance with BAT, such that the generation of solid wastes during operation is minimised or avoided where possible. Special solid wastes, such as spent filters and ion exchange resins, cannot be avoided and are anticipated to be produced on a sporadic basis. The framework for waste management during the operational phase of the installation will be included within the Environmental Management System (EMS).

7.4 WASTE DISPOSAL

A variety of disposal sites and waste hauliers/disposers will be used depending on the type of waste. Duty of care principles will be applied. Proposed waste disposal routes have been selected in line with the principles of the waste hierarchy considering waste quality, the availability of waste recovery routes and the consideration of generating new potential waste streams.

Where reuse or recycling of materials cannot be achieved (i.e. due to their hazardous nature), waste will be sent offsite for treatment appropriate to the type of material being disposed of.

All waste will have appropriate waste transfer documentation in line with legal requirements.

8. RAW MATERIAL USAGE AND STORAGE

8.1 RAW MATERIALS

The Site will use a number of different raw materials for the combustion and hydrogen generation process and associated activities. Table 8.1 provides details of the typical consumption values of raw materials used onsite. Safety Data Sheets (SDS) are available on request.

TABLE 8.1 RAW MATERIALS USAGE

Substance	Approximate Annual Consumption	Typical Storage Capacity	Use	Risk	Storage Location
Lubricant Oil	14,000 L	14,000 L	Lubrication and cooling in Gas Turbine System and Electrolysers	P5c Flammable Liquid (Flashpoint >60 C)	Steel tank with secondary containment on concrete hard standing in OCGT oil system
Mineral Oil	N/A – not used in normal operating conditions	35,000 L per array	Cooling in transformers	P5c Flammable Liquid (Flashpoint >60 C)	Integral secondary containment within transformer and concrete secondary containment at various transformer locations across site
Glycol solution (60:40 water:glycol)	700 L	2,000 L	Coolant in cooling system	N/A	Cooling water system north east of the site
Sodium Hypochlorite	4,380 L	1,040 L	Demin plant	E1 Hazardous to the Aquatic Environment in Category Acute 1 or Chronic 1 – 100 tonnes	IBC housed on a drip tray or within a coated concrete area with curbs or draining to a blind sump, located next to the demin plant. Segregated from acid storage.
Sodium bisulphite	3,504 L	1,040 L	Demin plant	N/A	IBC housed on a drip tray or within a coated concrete area with curbs or draining to a blind sump, located next to the demin plant. Segregated from acid storage.
Sodium hydroxide	35,040 L	5,000 L	Demin plant	N/A	IBC housed on a drip tray or within a coated concrete area with curbs or draining to a blind sump, located next to the demin plant. Segregated from acid storage.
Citric Acid	35,040 L	5,000 L	Demin plant	N/A	IBC housed on a drip tray or within a coated concrete area with curbs or draining to a blind sump,

Substance	Approximate Annual Consumption	Typical Storage Capacity	Use	Risk	Storage Location
					located next to the demin plant. Segregated from caustic storage.
Carbohydrazine	4 m^3	1.04 m^3	Demin plant	E2 Hazardous to the Aquatic Environment in Category Chronic 2	IBC housed on a drip tray or within a coated concrete area with curbs or draining to a blind sump, located next to the demin plant
Ammonia solution (19%)	80 m^3	20 m^3	SCR in OCGT	E1 Hazardous to the Aquatic Environment in Category Acute 1 or Chronic 1	Bulk storage tank (carbon steel) within concrete bund adjacent to OCGT. Segregated from acid storage.
Biocide	1 m^3	1.04 m^3	Well maintenance	E1 Hazardous to the Aquatic Environment in Category Acute 1 or Chronic 1	IBC with drip tray in chemical storage area (within building or in chemical container cabin). Segregated from acid storage.
Phosphorylated oxyalkylated polyol (KD40)	1 m^3	1 m^3	Well maintenance	N/A	IBC with drip tray in chemical storage area (within building or in chemical container cabin). Segregated from acid storage.
Oils, greases and chemical cleaning fluids	5 m^3	<0.2 m^3 per substance	Maintenance Activities	Oils - P5c Flammable Liquid (Flashpoint >60 C)	Drums or containers with drip trays, pallet bund in designated storage containers/cupboards (within buildings)
Nitrogen	762,120 Nm^3	84 m^3	Purging/blanketing	N/A	Double-walled, vacuum insulated cryogenic storage tank
Compressed air	2,190,000 Nm^3	18 m^3 Wet air tank 10.8 m^3 Dry air tank	Instrument air	N/A	North of the Site
Diesel	0.25 m^3	<0.5 m^3	Diesel firewater pump	Oils - P5c Flammable Liquid (Flashpoint >60 C)	Integrated diesel firewater pump diesel tank housed within a concrete curbed area or drip tray to the northwest of the Site

Substance	Approximate Annual Consumption	Typical Storage Capacity	Use	Risk	Storage Location
Firewater	N/A – only for routine top up/emergencies	384 m^3	Firewater	N/A	Northwest of the Site
Borehole water	91,980 m^3	10.5 m^3	Raw water for demin plant, and filling, cooling and backflushing of ALD1 cavern	N/A	Northwest of the Site
Potable water	5,000 m^3	320 m^3	Drinking, washing, toilets, eye washes etc.	N/A	Northwest of the Site
Demin water	60,000 m^3	850 m^3	Demin water supply for electrolyser	N/A	Northwest of the Site
Cooling water expansion tank	N/A – only for top up as required (closed loop cooling system)	13 m^3	Closed loop cooling system	N/A	Northwest of the Site

8.2 WATER USE

Water supply will come from abstracted groundwater and will serve a variety of users as described in Section 3.5.2. The water supply will be metered, and usage will be reviewed as part of the Site EMS.

All water supplied for use in the process will require treatment to ensure suitability prior to use. Water used in the cooling water system will be supplied by the demin plant. The chilled water system is a closed loop system comprising air-cooled (fin fan) chillers, therefore requires no cooling towers, condensers, heat trace system, or additional water usage.

Opportunities for improving efficiency of water used onsite will be regularly reviewed. A water usage profile will be maintained to provide data needed for regulatory compliance, operational risk assessment and to promote efficient operations. Further details on water usage and efficiency are provided in the BAT review described in Section 5 and provided in Appendix D.

9. ENERGY

9.1 ENERGY USAGE AND EFFICIENCY

The Site will be operated in such a way that energy is used efficiently. The OCGT, electrolyser, hydrogen compressor system and other electrically powered equipment will be supplied from the existing AGS electrical network. Low carbon hydrogen standard (LCHS) compliant power will be sourced from the grid through a Trading Services Agreement.

Table 9.1 presents the projected electricity usage for the Site for the first three years of operation, assuming 80% electrolyser utilisation.

The OCGT will initially operate on a hydrogen / natural gas blend (up to 75% H_2/25% NG) at an efficiency of approximately 38%. The OCGT will use a hydrogen/natural gas blend for the initial 2-3 years during an extended commissioning / testing phase before building up to 100% hydrogen. The OCGT is capable of operating on varying blends of natural gas and hydrogen, therefore a natural gas supply of up to 10,000 kg/h is assumed to be provided.

Table 9.2 presents the projected energy usage (natural gas and hydrogen) for the Site for the first three years of operation based on 100 start-ups per year for the OCGT. It is currently assumed that the OCGT will start up using natural gas, however this may be subject to change during design development.

Diesel usage for the diesel firewater pump has been excluded due to only being used for emergencies. Typical diesel consumption values are presented in Table 8.1.

TABLE 9.1 ANTICIPATED ENERGY USAGE – ELECTROLYSER

Operating Year	Typical annual energy consumption (GWh)
	Grid Electricity (LCHS compliant)
Year 1	283
Year 2	287
Year 3	291

TABLE 9.2 ANTICIPATED ENERGY USAGE – OCGT

Operating Year	Typical annual energy consumption (GWh)	
	Natural Gas	Hydrogen
Year 1	87	75
Year 2	87	75
Year 3	0.0233	162

The aggregated thermal input of combustion units onsite exceeds 50 MWth and thus will be regulated as an installation as defined in EP Regulations. Therefore, the energy efficiency requirements of Schedule 24 of the EP Regulations have been considered. Schedule 24 is considered for:

a) Electricity generation installations;

b) Installations generating waste heat; and

c) Heating and cooling networks.

Schedule 24[4] details that a cost benefit analysis is required where a relevant installation generates electricity but doesn't comply with the requirements under the schedule. An exclusion to this are operations under 1,500 hours per year as a rolling average over a period of 5 years. While the Site will generate electricity, the OCGT will operate for less than 1,500 hours per year as an average, therefore this category does not apply. None of the other categories apply to the Site.

Further details around energy efficiency are provided in the BAT review in Appendix D.

9.2 ENERGY MANAGEMENT SYSTEM

SSE will comply with the requirements of the Energy Savings Opportunities Scheme (ESOS).

9.3 CLIMATE CHANGE AGREEMENT

Based on the guidance from the EA – "Climate Change Agreements Operations Manual"[5], the power generation sector is not identified as an eligible sector to apply for Climate Change Levy Agreements, which enables eligible operations to claim discounts on the Climate Change Levy applied to them.

[4] GOV (2026). Schedule 2024. Available at: The Environmental Permitting (England and Wales) Regulations 2016 Last Accessed 27/11/24

[5] Environment Agency (2022). Climate Change Agreements Operations Manual. Available at: Climate Change Agreements Operations Manual (publishing.service.gov.uk) Last Accessed 02/09/24

10. H1 RISK ASSESSMENT – WATER

10.1 METHODOLOGY

An H1 risk assessment has been carried out to assess the potential associated impacts on the receiving waterbody from the Site activities. The EA H1 calculation methodology (H1) has been used following EA website guidance on “Surface water pollution risk assessment for your environmental permit” [1]

The H1 methodology entails screening tests to determine whether pollutants can be screened out as insignificant. It requires the input of both annual average (AA) and maximum allowable concentrations (MAC) of each substance of concern, for assessment of both long-term and short-term impacts. The tests check whether the Site is discharging potentially hazardous chemicals and elements to receiving waters that may be considered significant.

The H1 tool is a screening tool, seeking to identify releases with no potential for adverse effects. As a result, it is highly conservative by design.

For discharges to estuaries and coastal waters, two parts of assessment (Part A and Part B) are required to check whether the discharge is a risk to the environment. Part A comprises the following tests for discharges to estuaries and coastal waters.

- Test 1 evaluates whether the concentration of the pollutant in the discharge is more than the Environmental Quality Standard (EQS).

  Also at this stage, screening is performed for priority hazardous substances, with assessment against significant load limits.
- Test 2 checks whether the Site is discharging to the low water channel (if the water does not flow across the estuary bed at any stage of the tide) in the upper parts of an estuary where the water is mainly fresh. If the discharge is direct to the low water channel, the methodology requires use of screening tests for freshwater at Test 2.
- Test 3 checks whether the discharge is to a location with restricted dilution or dispersion.
- Test 4 applies where the receiving water does not have restricted dilution or dispersion, and the discharge is submerged at all states of the tide. The next step is to measure the minimum distance between the point the wastewater is discharged from and the point (or line) where the water depths are presented on nautical charts as zero (which is known as chart datum).
- Test 5 evaluates the effective volume flux (EVF) of the discharge against the allowable EVF for discharges that are buoyant. The maximum EVF that can be used is proportional to the water depth, for depths up to 3.5 m below the depth of water at the point where chartered water depths are shown on nautical charts (chart datum). For water depths more than 3.5 m below chart datum, the allowable EVF is fixed at 3.5 m^3/s. If the EVF is more than the allowable EVF for the discharge, then the EA require modelling to be carried out.

10.2 H1 INPUT DATA

The Site will have several point source emissions to water, as described in Section 4.2.1. W1 to W4 are only expected to comprise clean uncontaminated surface water and have not therefore been considered any further in this assessment.

The H1 assessment methodology is used to assess the potential for impact from the discharge of cavern dewatering and process effluent from the demineralisation plant. The cavern discharge and effluent from the demineralisation plant will be discharged to sea using the existing (reinstated) marine discharge infrastructure. Cavern dewatering discharge will also utilise this pipeline. The depth of the discharge is 9.5 mODN or ~ 6 m minimum water depth at CD and is approximately 750 m offshore.

The H1 tool examines the discharge in two phases:

Phase 1: This is expected to occur for the first 12 months and will comprise of abstracted water that has been used to rewater ALD1 cavern combined with water for cooling and backflushing (Stream A) as well as process effluent (RO reject) from the demineralisation plant (Stream B).

Phase 2: This is expected to occur after the first 12 months and will comprise of process effluent from the demineralisation plant only (Stream B).

A copy of the workbook is provided in Appendix F (titled "*H1 Workbook_Water Emissions_AHP Phase 1&2 10.04.25*").

10.2.1 WATERBODY TYPE

The discharge will be to the North Sea, a coastal environment where peak spring tides reach 1 m/s. It has therefore been assumed that the release is to Transitional Coastal and Estuarine (T) waters.

10.2.2 WATER RELEASE DEPTH AND LOCATION

The release depth of the water is located at grid reference TA 2811 3742 at a depth 9.5 mODN / 6m (CD).

10.2.3 EFFLUENT FLOW RATE

The quantity of water to be discharged from ALD1 is assumed to be 3744 m^3/d. Wastewater from the demineralisation plant is assumed to be 93.9 m^3/d. This equates to the following rates during each phase:

- Phase 1 (Stream A + Stream B) = 3,838 m^3/d (0.044 m^3/s)
- Phase 2 (Stream B) = 93.6 m^3/d (0.001 m^3/s)

These values have been taken as the average and maximum flow rate for each phase. This is a conservative estimate as there is likely to be variation in the daily mean flow.

10.2.4 EFFLUENT COMPOSITION

Three borehole samples were collected in 2019 and have been used in the assessment to derive expected concentrations in the discharge. Details of the sample results are provided in the workbook in Appendix F. The samples were tested by a UKAS accredited laboratory. Physical and chemical parameters included pH, alkalinity, acidity, aromatics, volatile organic compounds, petroleum hydrocarbon compounds and heavy metals.

Determinands in the samples that were below the limit of detection (LOD) are assumed to be at the limit of detection for the purposes of the assessment. Those above the LOD are considered to provide a representative assessment of the risk posed to the North Sea by the discharge(s).

The demineralisation plant will concentrate the discharge by a factor of 2.7 compared to its input.

The EQS for coastal waters have been used in this assessment. These principally relate to priority substances or specific pollutants as summarised in The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015[6]. Where determinands of concern do not have associated WFD EQS, these have been screened out from further assessment.

A list of parameters screened in the H1 tool, employed EQS, and the calculated average and maximum concentrations are detailed in Table 10.1 for Phase 1 and Phase 2. Those parameters analysed at or below the limit of detection are identified in **Bold**.

TABLE 10.1 SUBSTANCE PARAMETERS USED IN H1 TOOL

	Coastal Water EQS		**Phase 1**		**Phase 2**	
Parameter	Annual Average (AA) (µg/l)	Maximum Allowable Concentration (MAC) (µg/l)	Average Concentration (µg/l)	Maximum Concentration (µg/l)	Average Concentration (µg/l)	Maximum Concentration (µg/l)
Aluminium (dissolved)	N/A	N/A	3,020	4,687	7,830	12,150
Ammonia (unionised)	21	N/A	37.80	40.71	98.00	105.54
Ammonium	N/A	N/A	1,354	1,458	3,510	3,780
Arsenic (dissolved)	25	N/A	0.78	1.06	2.03	2.75
Barium (dissolved)	N/A	N/A	10	10	27	27
Bicarbonate	N/A	N/A	10,415	10,415	27,000	27,000
Boron (dissolved)	7000	N/A	531	542	1,377	1,404
Cadmium (dissolved)	0.2	N/A	**0.02**	**0.02**	0.05	0.05
Calcium (dissolved)	N/A	N/A	166,634	197,878	432,200	513,000
Chloride	N/A	N/A	864,415	874,829	2,241,000	2,268,000
Chromium (dissolved) (1)	N/A	N/A	**0.2**	0.3	0.6	0.8
Copper (dissolved)	3.76	N/A	5.	8.4	15.2	21.9
Dissolved Organic Carbon	N/A	N/A	2,194	2,718	5,688	7,047
Iron (dissolved**)**	1000	N/A	385	1,041	999	2,700
Lead (dissolved)	1.3	14	**0.2**	**0.2**	0.5	0.5
Lithium (dissolved)	N/A	N/A	21	21	54	54

[6] The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 (legislation.gov.uk)

	Coastal Water EQS		Phase 1		Phase 2	
Magnesium (dissolved)	N/A	N/A	91,302	98,939	236,700	256,500
Manganese (dissolved)	N/A	N/A	24	31	63	81
Mercury (dissolved) **(2)**	N/A	0.07	**0.05**	**0.05**	0.14	0.14
Molybdenum (dissolved)	N/A	N/A	1.3	1.5	3.3	3.8
Nickel (dissolved)	8.6	34	1.1	1.5	2.9	3.8
Nitrate	N/A	N/A	493	531	1,278	1,377
pH	N/A	N/A	7.2	7.6	7.2	7.6
Potassium (dissolved)	N/A	N/A	32,633	33,327	84,600	86,400
Sodium (dissolved)	N/A	N/A	579,748	593,634	1,503,000	1,539,000
Strontium (dissolved)	N/A	N/A	8,748	10,415	22,680	27,000
Sulphate	N/A	N/A	665,842	732,149	1,726,200	1,898,100
Total Suspended Solids	N/A	N/A	11,109	26,037	28,800	67,500
Total Cyanide(3)	1	5	**10**	**10**	27	27
Total Organic Carbon	N/A	N/A	2,715	3,124	7,038	8,100
Selenium	N/A	N/A	15	17	38	43
Tin	10	N/A	**0.2**	**0.2**	0.5	0.5
Zinc	6.8	N/A	55	65	141	167

(1) Chromium concentrations are based on analysis of dissolved Chromium. There is no EQS for dissolved chromium, only for Chromium VI. Chromium VI is rarely found in nature and is produced mainly from commercial and industrial processes. The chalk aquifer (source of borehole water) does not have a history of industrial development, therefore chromium VI is not expected to be present.

(2) Mercury concentrations are based on an analysis of borehole water with samples below the limit of detection (0.05 µg/l). The mercury LoD was below the EQS of 0.07 µg/l, however naturally occurring mercury is not expected to be present since there are no local geogenic sources. As with Chromium, the chalk aquifer does not have a history of industrial development, and there are no anthropogenic sources of mercury that would

give rise to this contaminant within 1 km of the site boundary, therefore mercury is not expected to be present.

(3) Cyanide concentrations are based on an analysis of borehole water with samples below the limit of detection (10 µg/l). The cyanide LoD is above the EQS of 1 µg/l (Annual Average) and 5 µg/l (Maximum Allowable Concentration). As with Mercury, the chalk aquifer does not have a history of industrial development and therefore cyanide is not expected to be present since its presence in the environment is largely linked to industrial processes.

10.2.5 BACKGROUND CONCENTRATIONS

A search was conducted by ERM of the EA archive[7] for contaminant data in the vicinity of the discharge. The table below provides a summary of the available data. There were relatively few sample locations in the coastal waters in the vicinity of the discharge.

FIGURE 10.1 SUMMARY OF WATER QUALITY DATA FOR THE ALDBROUGH AREA

Contaminant	Sampling Station	Approx. Station Location	Year	Mean Value	Units
Ammonia	HUMBER & TRIBS TO SPURN POINT - AD HOC	Humber Estuary	2016	0.01	mg/l
Cadmium	UPTIDE OF FILEY EQSD MUSSELS	Filey	2016	0.03	ug/l
Chloride	HUMBER & TRIBS TO SPURN POINT - AD HOC	Humber Estuary	2013	572.5	mg/l
Chromium	BP PROCESS-250M INTO PLUME AT HIGH WATER	Humber Estuary	2012	0.54	ug/l
Iron	EQSD 250M DOWN TIDE FILEY WWTW	Filey	2016	100	ug/l
Mercury	UPTIDE OF FILEY EQSD MUSSELS	Filey	2016	0.01	ug/l
Zinc	BP PROCESS-250M INTO PLUME AT HIGH WATER	Humber Estuary	2012	10.28	ug/l
Copper	NORTH SEA AT 500M DOWNTIDE - ALDBOROUGH	Aldborough	2021	0.53	ug/l
Lead	UPTIDE OF FILEY EQSD MUSSELS	Filey	2016	0.063	ug/l
Nickel and its compounds (dissolved)	UPTIDE OF FILEY EQSD MUSSELS	Filey	2016	0.3	ug/l

As many of these sample locations are within the Humber Estuary instead of the discharge location, data collected under the Aldbrough Hydrogen Storage (AHS) project field survey program undertaken in October 2023 was employed since this is considered to provide a better representation of background data. Below is the summary data for 12 stations surveyed under the AHS field survey program. Those concentrations highlighted in **Bold** were used as the background in the assessment. Many of the heavy metal background concentrations were below the limits of detection.

TABLE 10.2 SUMMARY SEAWATER DATA FROM 12 STATIONS AT ALDBROUGH (OCTOBER 2023)

Parameter	Units	Average Concentration	Maximum Concentration
THC	µg/l	5.08	9.66
Total Alkanes	µg/l	0.051	0.51
Total PAHs	µg/l	0.14	0.48
Dissolved Heavy and Trace Metals	-	-	<0.0001
Arsenic	mg/l	**0.00175**	**0.002**
Cadmium	mg/l	**<0.0001**	**<0.0001**
Chromium	mg/l	**<0.001**	**<0.001**
Copper	mg/l	**<0.001**	**<0.001**

[7] Open WIMS data

Parameter	Units	Average Concentration	Maximum Concentration
Lead	mg/l	**<0.001**	**<0.001**
Mercury	mg/l	**<0.0001**	**<0.0001**
Nickel	mg/l	**<0.001**	**<0.001**
Zinc	mg/l	**0.0034**	**0.004**
Aluminium	mg/l	0.12	0.25
Barium	mg/l	<0.01	<0.0001
Lithium	mg/l	0.146	0.26
Silicon	mg/l	0.233	0.4
Sulphur	mg/l	2825	2930
Nutrients, Minerals and Suspended Solids			
Nitrate (NO_3)	mg/l	<0.2	<0.2
Nitrite (NO_2)	mg/l	<0.01	<0.01
Orthophosphate (PO_4)	mg/l	0.068	0.12
Total Nitrogen (N)	mg/l	<1	<0.01
Total Suspended Solids (TSS)	mg/l	113	527

Ammonia, Iron and Mercury background concentrations were derived from the EA data set in Figure 10.1. As there is no background data for Boron and Cyanide, it was assumed that the concentration of these pollutants was 50% of the EQS as per the EA guidance[8].

10.3 RESULTS OF THE H1 ASSESSMENT – EMISSIONS TO WATER

Test 1 evaluates whether the concentration of the pollutant in the discharge is more that 100% of the EQS.

Results for Phase 1 – Arsenic, Boron, Cadmium, Iron, Lead, Nickel and Tin pass Test 1. Ammonia, Copper, and Zinc are in excess of the relevant EQS and therefore progress to the next stage of assessment.

Results for Phase 2 – Arsenic, Boron, Cadmium, Iron, Lead, Nickel and Tin pass Test 1. Ammonia, Copper, and Zinc are in excess of the relevant EQS and therefore progress to the next stage of assessment.

The fraction of ammonium that becomes unionised ammonia is a function of temperature, salinity and pH. As these parameters will change as the water is stored in the caverns, the actual concentration of unionised ammonia in the borehole water supply is not considered to be relevant but has to be calculated for each phase at the point just before discharge. The calculation is shown in the workbook provided in Appendix F, with summary information produced below for each of the streams plus the background.

[8] Surface water pollution risk assessment for your environmental permit - GOV.UK (www.gov.uk)

The equation to determine the fraction of ammonia in seawater comes from Florida EPA Chemistry Laboratory[9].

Parameter	Units	Phase 1 discharge	Phase 2 discharge	Ambient conditions
Temperature, T	°C	26	10	15.9
Salinity, S	ppt	111	5.4	34.25
pH	-	7.2	7.6	8.1
Fraction of ammonia which is unionised, fs	-	0.00404	0.00706	0.02792
Ammonium conc	µg/l	1353.90	3510.00	100.00
Unionised Ammonia conc	µg/l	5.5	24.8	2.79

Thus, the discharge of un-ionised Ammonia during Phase 1 is below the EQS of 21 µg/l and therefore does not progress any further. During Phase 2 un-ionised ammonia is 24.8 ug/l which exceeds 21 µg/l and therefore progresses to further assessment.

As the discharges are to a protected area, those substances that did not pass Test 1 (Copper and Zinc for Phase 1; Copper, Zinc and ammonia for Phase 2) are progressed to detailed modelling.

Normally Test 2 – 5 would be completed, however as modelling is being carried out for those substances that failed Test 1, these tests are not required.

10.3.1 SIGNIFICANT LOAD TEST

Cadmium requires assessment against the significant load limit.

Results: When the annual load for each of these substances is assessed against the water body limit, Cadmium pass.

10.4 SUMMARY OF DETAILED MODELLING

Marine modelling (using CORMIX version 12.0) and analysis was carried out for the two phases described in Section 10.2 (Phase 1 and Phase 2) (see Appendix G for the full report).

During Phase 1, the brine plume is dense and will sink to the seabed; therefore, could potentially have biological impacts at the seabed as aquatic receptors are exposed to elevated salinities and two metals: copper and zinc.

During Phase 2, the discharge is brackish and the plume will be buoyant: therefore, no impact to the seabed due to salinity is anticipated, thus potential impact comes from the two metals of concern (copper and zinc) and unionised ammonia.

[9] https://floridadep.gov/sites/default/files/5-Unionized-Ammonia-SOP_1.pdf

The marine modelling was used to provide dilution factors for the discharge. These have been used to determine the magnitude of the plume and the subsequent distance from the discharge for each pollutant to reach its EQS.

10.4.1 PHASE 1 MODELLING RESULTS

Overall, both copper and zinc were able to reach their respective EQSs within 13.5 m of the discharge point. For both constituents, the EQSs are annual average based. Copper requires a lower dilution to reach its EQS compared to zinc, which resulted in shorter distances from the discharge to reach the dilution. For each simulation, copper achieves the required dilution within 0.15 m of the discharge point. For zinc, simulations A-2 through A-5 achieved the required dilution within 3.5 m. For simulation A-1 (slack tide) zinc reached the EQS within 13.5 m of the discharge point.

The low temperature high salinity scenario modelled represents the worst-case density, which is the worst case in relation to mixing, and therefore produces conservative estimates for the plume extent.

10.4.2 PHASE 2 MODELLING RESULTS

For Phase 2 (Scenario B in the model), copper and zinc were modelled to reach their respective EQSs within 4 m from the discharge point. For copper and zinc, the EQSs are annual average based. Copper required a lower dilution to reach its EQS compared to zinc, which resulted in shorter distances from the discharge to reach the dilution. For each simulation, copper was able to achieve its required dilution within 0.2 m of the discharge point. For zinc, the required dilution was achieved within 4 m of the discharge point. Un-ionised ammonia discharges are near the EQS at point of discharge.

10.5 SUMMARY

An H1 screening assessment has been undertaken to determine whether the discharge associated with the Proposed Development represents a potential risk to the North Sea. Two phases were considered for the assessment:

- **Phase 1**: This is expected to occur for the first 12 months, and discharge will comprise of saline water that has been used to rewater Aldbrough 1 cavern combined with water for cooling and backflushing (Stream A) as well as process effluent (RO reject) from the demineralisation plant (Stream B).
- **Phase 2:** This is expected to occur after the first 12 months and will comprise of process effluent from the demineralisation plant only (Stream B).

The results of the H1 assessment indicated that, for both phases, many substances were screened out at Test 1. Those substances that passed these tests have returned no significant impact to surface water and no further modelling is required.

Those substances that failed Test 1 (Copper and Zinc for Phase 1; Copper, Zinc and Ammonia for Phase 2) were progressed directly to detailed modelling due to the discharge being in a protected area.

Results of the marine modelling assessment show that neither phases of discharge will result in a significant ecological impact. Distances of exceedance of EQS either in the water column or at the bed are small. In phase 1 the scenario impacts are of short duration on each tide and for a short timescale (12 months).

11. AIR QUALITY

The EA's H1 tool has been used to assess the potential for impact from emission to air as provided in Appendix H. The H1 assessment was not able to screen substances out as insignificant and therefore a detailed air quality assessment (dispersion modelling) was required to be carried out.

A full Air Quality Impact Assessment (AQIA) is provided in Appendix C. This summary described the AQIA that has been undertaken to assess the potential air quality impacts from the operations on the Site.

11.1 SUMMARY OF DETAILED MODELLING OF EMISSIONS TO AIR

The AQIA suggests that the operation of the OCGT and the maintenance flare at the AHP Site are modelled to have the potential to create only insignificant impacts at local indicative receptors.

It is important to note that the model is based on conservative assumptions with regards to meteorology, such as maintenance flaring and operations of the OCGT coinciding with unfavourable dispersion conditions. The model outputs are therefore expected to represent a conservative assessment in relation to air quality impacts arising from operations at the Site.

There were no modelled exceedances of the:

- Annual or hourly standards for NO_2 for human health beyond the site boundary;
- Annual or hourly standards for NH_3 for human health beyond the site boundary; or
- Annual standards for NO_x or NH_3 or the daily standard for NO_x for ecology at any of the identified sensitive habitat sites;
- Critical loads or levels for nitrogen or acidifying depositions at any of the identified sensitive habitat sites.

At sensitive human receptors, the operation of the OCGT (scenarios 1 and 2) is modelled to result in a process contribution (PC) of less than 2% of the short-term standards, and less than 0.05% of the long-term standards, and therefore can be screened out as insignificant. PCs from the OCGT on sensitive habitats are predicted to remain below 0.3% of Critical levels/critical loads, also considered insignificant.

At the time of modelling, the two scenarios undertaken for the stack height (25 m and 30 m) tested the potential for exceedances and provided a sensitivity analysis of the impacts to changes in the stack height. Results of the modelling were subsequently used to inform key design decisions. Whilst the results conclude both scenarios were modelled to be insignificant, SSE has taken forward a stack height of 30 m since this had the least significance.

Maintenance flaring is modelled to result in a PC of 43% of the NO_2 hourly standard and 2.9% of the NO_x daily standard. Neither impact is modelled to cause an exceedance of the AQS; in fact, the NO_2 PEC will remain below 50% and the NO_x PEC will remain below 15% of the AQS, and these impacts only occur in a very small area close to the Site boundary and on a very infrequent basis.

12. NOISE

A noise impact assessment has been undertaken and is provided in Appendix I. This summary describes the assessment that has been undertaken to identify the potential noise impacts from operation of the Site.

12.1 SUMMARY OF DETAILED MODELLING OF NOISE EMISSIONS

The nearest site of special scientific interest (SSSI) is Lambwath Meadows, located approximately 4.9 km north the AHP Site. This is considered to be too distant to be impacted by the predicted changes in noise levels. The Greater Wash Special Protection Area (SPA) is located offshore, adjacent to the wider AHP Site. Features are limited to the marine environment with red-throated diver the only known species which occurs in notable numbers. These are typically more than 500 metres offshore and the changes in noise predicted herein would not be detectable.

The industrial nature of the existing AGS site means it supports few ecology features. In and around the wider AHP Site, biodiversity interests are limited to a small assemblage of widespread bird species, and small populations of legally protected species such as bats and great crested newt. While some of these have legal protection to safeguard from harm, none are of considered of conservation importance at any more than a Site level and a detailed assessment of effects from noise is not necessary. Furthermore, any species occurring close to the Site will have a degree of habituation to noise due to existing activities in the area, both from industrial and farming activities.

Overall, due to the lack of important features and small changes in noise predicted, potential effects on biodiversity interests from increases in noise levels are considered to be negligible.

12.2 NOISE MANAGEMENT PLAN

Mitigation measures, in relation to operational noise, will be secured via a noise and vibration management plan (NVMP) which is provided in Appendix I. The plan includes measures to demonstrate that the noise rating level (as defined in BS4142) from the operation of the Site is minimised as far as reasonably practicable and is no higher than those reported in the Noise Impact Assessment (NIA). The plan includes measures such as noise monitoring and/or a further noise assessment based on the final design and supplier guarantee data or commissioning measurements.

13. ODOUR

There are limited sources of odorous emissions associated with the activities onsite, and those that could pose a risk will have appropriate mitigation measures in place. The intent of the plant design is to mitigate any fugitive emissions; hence no odours are expected from the inventory of any of the gases and liquids onsite. H_2S from the brine water degassing tanks is expected to be minimal and where H_2S is detected, it will be routed to a temporary (rental) flare package. The natural gas supply to the Site (and intended for use in the OCGT) is not odourised; therefore, minimising odour emissions in the event of gas leak on Site or a leak from the pipelines.

The principal source of odour onsite is ammonia slip from the use of the SCR abatement system. The ammonia odour threshold is approximately 5 ppm. The Process Contribution (PC) of ammonia from the OCGT stack (scenario 2) from the modelled air quality impact assessment is 2.59 $\mu g/m^3$ (0.003 ppm), which is significantly lower than the odour threshold, therefore unlikely to be detected.

The main external raw material storage with the potential to give rise to odours in the diesel storage tank with potential for emissions of diesel fumes during filling of the tank whilst air is displaced through the vent. However, this is considered insignificant due to the small quantities being stored and handled onsite. Aqueous ammonia will be stored in a bunded container and storage will be designed to mitigate odour emissions by transfer of displaced vapours back to the delivery tanker. Aqueous ammonia has low odour potential and risk management techniques are primarily through prevention of loss of containment.

Finally, there are no chemical additives to the process that are odorous or contain odour-causing materials. Therefore, inadvertent generation of odorous products or by-products is not anticipated.

While the water treatment plant has been identified as a potential source of odour, it does not utilise biological treatment and will be subject to regular planned maintenance as part of the Site’s maintenance programme.

As such, there are no anticipated odour issues with the activities onsite. The nearest residential receptor is approximately 400 m east of the Site, and the Site sits within a rural-urban fringe area with occasional manmade industrial features. The Site is not expected to give risk to odour outside of the Site boundary that will give rise to nuisance.

14. MONITORING

14.1 EMISSIONS TO AIR

14.1.1 PROPOSED EMISSIONS MONITORING

Table 4.1 presents the proposed monitoring of emissions to air for the Site. Location of emission points are described in Section 4.1.1 and presented in Figure 4.1. The main emissions to air will arise from combustion activities, flaring, oxygen from electrolysers and tank vents. Only emission points with substances/parameters listed under IED and the relevant BREFs are considered to require monitoring. All other emission points (as presented in Section 4.1.1) are considered to have negligible emissions and will not be monitored.

TABLE 14.1 PROPOSED MONITORING FOR EMISSIONS TO AIR

Emission Point ID	Parameter	Limits (a)	Monitoring frequency	Reference Period	Monitoring standard or method
A1 OCGT stack	NO_x	50 - 68.5 mg/Nm^3 (b)	Continuous	Monthly mean	BS EN 14181
	CO	100 - 137 mg/Nm^3 (b)	Continuous	Monthly mean	BS EN 14181
	NH_3	10 mg/Nm^3	Continuous	Annual mean	BS EN 14181
	Flowrate	None	Continuous	-	EN ISO 16911
	O_2	None	Continuous	-	BS EN 14181
	Temperature	None	Continuous as appropriate to reference(c)	-	
	Pressure	None	Continuous as appropriate to reference (c)	-	Traceable to national standards
	H_2O	None	Continuous as appropriate to reference (c)	-	BS EN 14181
A2 Hydrogen flare	Water Vapour, NO_x	No limits proposed.	-	-	Records will be kept of the date, time, duration and reason for flaring.
A3 Diesel firewater pump	NO_x, CO and particulates	No limits proposed as not an MCP	-	-	N/A
A4 Temporary flare	SO_2	No limits proposed.	-	-	Records will be kept of the date, time, duration and reason for flaring.

(a) Reference conditions 273.15 K, 101.3 kPa, dry gas, 15% O_2

(b) Upper limit based on allowances from IED Annex V with the use of a hydrogen combustion factor for 100% hydrogen.

(c) If required for correction to reference conditions, based on monitoring instrumentation method

14.1.2 MONITORING METHOD

The monitoring system will be designed in accordance with the requirements of IED and BAT monitoring frequencies and standards, and the requirements of EA guidance on monitoring stack emissions (formerly called Technical Guidance Note (TGN) M1)[10]. Sampling will be carried out with MCERTS approved equipment and carried out by a technically competent person where appropriate.

The monitoring of emissions from the OCGT stack will be carried out by Continuous Emissions Monitoring System (CEMS). The CEMS will continuously monitor the concentration of NO_x, CO and NH_3 in the exhaust gas. O_2, temperature, pressure and water content will also be measured (as required) to enable correction of measurements to reference conditions and the overall volume of the exhaust gas will either be measured or calculated. SSE anticipate using an extractive system to monitor the exhaust gas stream. The extractive system is expected to include a probe in the stack with a heated sample line to a CEMS analyser at ground level. This will be confirmed at detailed design. It is acknowledged that stack sample locations will not be at least 5 Hydraulic Diameter (HD) from the stack exit or at least 5 HD downstream from any bend or obstruction. However, SSE propose to demonstrate representative sampling of gases through CFD modelling of the stack flow for CEMS positioning and compliance with BS EN 15259 during detailed design, followed by verification using a homogeneity test during commissioning operations.

Gas measurements will be determined from samples taken by a probe and fed to an analyser with results output to the Distributed Control System (DCS) for the plant. All alarms will be monitored by the DCS in the Central Control Room. CEMS data will be managed within a Data Acquisition and Handling System. Records will be kept of all emissions testing results and instrumentation calibration checks or testing documentation. In the event of an alarm, the operator will investigate and take action. The Operations and Maintenance Manual will provide guidance on actions to take in the event of component failure. An operational protocol will be developed by SSE prior to commissioning, which will define the requirement for any changes to operations in case of a breach of emissions limits or a system failure. Monitoring of releases to air will be controlled as part of the EMS.

An annual periodic stack test will also be undertaken by an MCERTS certified body to confirm the performance of the CEMS.

The OCGT will be equipped with an SCR module to minimise NO_x emissions (as described in Section 3.4.6). NO_x may also be measured upstream of the SCR module by extractive measurement for system control purposes only.

ELVs for blended fuels used in the OCGT as set out in Table 4.2 (NO_x and CO) will be achieved through the following means:

1. No validated monthly average value exceeds the relevant ELVs. Where a fuel blend is used, the relevant ELV will be determined based on the corresponding monthly average volumetric proportion of hydrogen.

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[10] Monitoring stack emissions: measurement locations - GOV.UK

2. No validated daily average value will exceed 110% of the relevant ELV. Where a fuel blend is used, the relevant ELV will be determined based on the corresponding daily average volumetric proportion of hydrogen.
3. 95% of validated hourly average values over the year will not exceed 200% of the relevant ELV. Where a fuel blend is used, the relevant ELV will be determined based on the ELV corresponding to the highest volumetric proportion of hydrogen in any operating hour of the year.

An H_2S detector will be located adjacent to the brine degassing tanks. Should these instruments detect high H_2S levels, an emergency ESD trip for the dewatering process will activate. This will stop booster and HP pumps, stop the injection of H_2, shut all wellhead ESD valves and stop the brine discharge pumps to allow a temporary H_2S flare to be connected and employed. Due to the temporary nature of the flare, no periodic monitoring is proposed.

The precise location of the sampling and measurement points will be determined at the detailed design stage and details will be submitted to the EA for approval. This submission will also include an assessment of the sampling points in accordance with EA guidance[11].

14.2 EMISSIONS TO WATER

presents the proposed monitoring of emissions to water for the Site. Location of emission points are described in Section 4.2.1 and presented in Figure 4.1.

14.2.1 PROPOSED EMISSIONS MONITORING

All point source emissions to water are presented in Table 14.2 and described in Section 4.2.1.

[11] Environment Agency (2022). *Monitoring Stack emissions: measurement locations*. Available at: Monitoring stack emissions: measurement locations - GOV.UK Accessed on 19/02/25

TABLE 14.2 PROPOSED MONITORING FOR EMISSIONS TO WATER

Emission Point ID and source of effluent	Monitoring Point ID	Monitoring Point NGR	Parameter	Limits (including unit)	Reference period	Monitoring frequency	Monitoring standard or method
W1 – W3 Discharge of clean uncontaminated surface water into the AGS balancing lagoon to the Cess Dale Drain and East Newton Drain	M1	TA 26199 36922	Oil & grease	No visible grease or oil	Instantaneous (visual examination)	Daily	-
W4 Discharge of clean uncontaminated surface water from the Wellhead drainage area into the Cess Dale Drain	M2	TA 25875 36848	Oil & grease	No visible grease or oil	Instantaneous (visual examination)	Daily	-
W5 (Phase 1 & 2) Discharge of concentrated reject from the demineralisation plant	M3	TA 26196 37096	Flow rate	93.6 m^3/d	Daily average	Continuous	MCERTS compliant with IED and CWW BREF requirements
			pH	6-9	Daily average	Continuous	BS ISO 10523:2008
			Oil & grease	No visible grease or oil	Instantaneous (visual examination)	Daily	-
W5 (Phase 1 only)	M4	TA 26133 37080	Flow rate	3,744 m^3/d	Daily average	Continuous	MCERTS

Emission Point ID and source of effluent	Monitoring Point ID	Monitoring Point NGR	Parameter	Limits (including unit)	Reference period	Monitoring frequency	Monitoring standard or method
Cavern dewatering discharge			Total Dissolved Solids	284 g/l	Spot Sample	Weekly	BS 2690-121:1981 or BS EN 15216:2021
			Temperature	27 °C	Daily average	Continuous	Calibrated resistance thermometer device (RTF) UKAS approved
			Suspended Solids	550 (mg/l)	Spot sample	Weekly	BS EN 872
			pH	6 – 8.5	Daily average	Continuous	BS ISO 10523:2008

14.2.2 MONITORING METHOD

Emissions from the demin plant will be monitored at M3 using a sampling point, which will be installed downstream of the demin plant and ahead of discharge to the North Sea outfall (and before it is combined with effluent from the ALD1 cavern, monitoring point M4). In the event of an exceedance of limit i.e. due to equipment failure or control failure, the operator will decide whether shutdown of the demin plant is required (depending on the ability to restore emissions to within limits).

Emissions from the ALD1 cavern dewatering will be monitored at M4 using a sampling point, which will be installed adjacent to the cavern dewatering equipment, ahead of discharge to the North Sea Outfall (and before it is combined with effluent from the demin plant, monitoring point M3). During the dewatering activity, the dewatering control system will provide an early indication of gas migration up the dewatering pipe. An increase in pressure outside of that expected will result in the valves to shut and the control system will stop the High Pressure (HP) dilution pump system. This will protect the discharge path from seeing gas flow and prevent uncontrolled gas release. A flow transmitter will measure the cavern dewatering discharge to the North Sea with alarms set below the discharge limit. A pH meter will also be installed that will be linked to the process control system (PCS) and will monitor and record pH levels in the discharge. The monitoring systems will automatically control emission parameters as detailed above. In the event of an exceedance of limit i.e. due to equipment failure or control failure, the operator will decide whether shutdown is required (depending on the ability to restore emissions to within limits).

15. ENVIRONMENTAL RISK ASSESSMENT

15.1 IDENTIFY AND CONSIDER RISKS FROM THE SITE

An environmental risk assessment has been produced for this permit application. This has included identification of sources, pathways and receptors and is presented in Table 15.1.

Separately, the EA's H1 methodology has been used as a screening exercise to assess environment risks from normal operations to both air and water (as detailed in Section 10 and Section 11). The screening assessment has been used to inform this environmental risk assessment and the risk assessment uses the risk matrix provided below.

Severity	Consequences			Increasing Likelihood					
	Impact	People	Environment	Almost Never (A)	Hardly Ever (B)	Unlikely (C)	Possible (D)	Likely (E)	Almost Certain (F)
				Never heard of in the industry / work type	Heard of in the industry / work type	Occurred within SSE	Occurs several times within SSE	Occurs on site	Occurs several times on site
1	Incidental	• Slight Injury • Slight Heath Effect	• Incidental Environmental Impact	1 - Low Risk	1 - Low Risk	1 - Low Risk	1 - Low Risk	2 - Medium Risk	2 - Medium Risk
2	Minor	• Minor Injury (medical treatment < 3 days lost time) • Reversible Health Effect • Restriction to work activity	• Minor Environmental Impact • Minor Permit breach	1 - Low Risk	1 - Low Risk	1 - Low Risk	2 - Medium Risk	2 - Medium Risk	3 - High Risk
3	Serious	• Serious Injury (reportable) • Lost time injury (>3 days) • Irreversible Health Effect	• Serious Environmental Impact • Serious Permit breach • Prohibited activity	1 - Low Risk	1 - Low Risk	2 - Medium Risk	2 - Medium Risk	3 - High Risk	3 - High Risk
4	Major	• 1 – 3 fatalities • Serious disability • Life Threatening Health effects	• Major Environmental Breach • Major Permit breach	1 - Low Risk	2 - Medium Risk	2 - Medium Risk	3 - High Risk	3 - High Risk	4 – Very High Risk
5	Severe	• 4 – 9 fatalities • Serious disability • Life Threatening Health effects	• Impact of national environmental significance	2 - Medium Risk	2 - Medium Risk	3 - High Risk	3 - High Risk	4 – Very High Risk	4 – Very High Risk
6	Catastrophic	• > 10 fatalities • Serious disability • Life Threatening Health effects	• Impact of international environmental significance	2 - Medium Risk	3 - High Risk	3 - High Risk	4 – Very High Risk	4 – Very High Risk	4 – Very High Risk

15.2 ACCIDENT MANAGEMENT PLAN

As part of SHE management system, SSE will integrate emergency planning and response which will include risks associated with incidents that could potentially have health and safety and/or environmental effects and the control measures to be taken to minimise the impact. A copy of the existing AGS Accident Management Plan is provided in Appendix J and will be replicated or extended to cover the AHP Site.

ERM has conducted high-level risk assessments to understand the risks associated with equipment and processes according to legal requirements, including accident management. Process Hazard Assessments will be undertaken as part of the design process and for all new plant. The outcomes of these assessments will be incorporated into the Site H&S procedures and within the SHE management system where necessary.

TABLE 15.1 ENVIRONMENTAL RISK ASSESSMENT

Hazard	Operation scenario	Receptor	Pathway	Risk management techniques	Likelihood of exposure	Consequence of exposure	Overall Risk
Emissions to air *(NO_x, SO_2, CO, NH_3, H_2S)*	Normal operation OCGT	Closest residential area ~400 m east of the Site See detailed air quality modelling in Section 11 and Appendix C	Dispersion through the air	Low NO_x burners and Selective Catalytic Reduction Emissions are considered to be insignificant when assessed against air quality standards, as demonstrated in the air quality modelling report.	Possible	Incidental	Low
	Abnormal operation Hydrogen Flare	Closest residential area ~400 m northeast of the Site See detailed air quality modelling in Section 11 and Appendix C	Dispersion through the air	The operation of the hydrogen flare will only be used in OTNOC situations e.g. during startup/shutdown. Flaring will be kept to a minimum while ensuring safe operation.	Possible	Incidental	Low
	Abnormal operation Temporary H_2S Flare	Closest residential area ~400 m east of the Site	Dispersion through the air	The operation of the H_2S flare will only be used in OTNOC situations when the entrained H_2S gas content is too high in the degassing tanks and poses a safety risk. Flaring will be kept to a minimum while ensuring safe operation.	Possible	Incidental	Low
	Emergency Hydrogen Flare	Closest residential area ~400 m east of the Site See detailed air quality modelling in Section 11 and Appendix C	Dispersion through the air	Flaring will be kept to a minimum while ensuring safe operation.	Unlikely	Incidental	Low
	Emergency Temporary H_2S Flare	Closest residential area ~400 m northeast of the Site	Dispersion through the air	The operation of the H_2S flare will only be used in OTNOC situations when entrained gas content too high in degassing tanks.	Unlikely	Incidental	Low

Hazard	Operation scenario	Receptor	Pathway	Risk management techniques	Likelihood of exposure	Consequence of exposure	Overall Risk
				Flaring will be kept to a minimum while ensuring safe operation.			
	Normal Operation Testing of Diesel Firewater Pump engine	Closest residential area ~400 m east of the Site	Dispersion through the air	One back-up diesel firewater pump will only be used in an emergency situation (i.e. when there is a fire). The diesel engine will be relatively small in size and will be maintained in accordance with manufacturers requirements. Testing of engine scheduled to reduce impact (<50 hours per year).	Possible	Incidental	Low
	Emergency Operation of Diesel Firewater Pump	Closest residential area ~400 m east of the Site	Dispersion through the air	One back-up diesel firewater pump will only be used in an emergency situation (i.e. when there is a fire). The diesel engine will be relatively small in size and will be maintained in accordance with manufacturers requirements. The site will have an Uninterruptable Power Supply (UPS). The design will likely be for 60 minutes during a power failure.	Possible	Incidental	Low
	Accidental Release of fugitive emission from bulk storage tanks	Closest residential area ~400 m east of the Site	Dispersion through the air	All equipment that could potentially give rise to emissions will have preventative maintenance as part of the Site EMS. Should it be identified that damage has occurred to any equipment, repairs will be undertaken to ensure that integrity is suitably maintained. Low quantities of flammable materials stored onsite and so fire risk is considered low.	Unlikely	Incidental	Low

Hazard	Operation scenario	Receptor	Pathway	Risk management techniques	Likelihood of exposure	Consequence of exposure	Overall Risk
				Firewater (potable water) will be stored in an 888 m^3 bulk storage tank designed to meet 2 hours of minimum firewater demand. Firewater will be used in a firewater sprinkler system, hydrant and spray system to provide firewater protection measures to limit or prevent escalation of fire. Fire safety and awareness will be maintained onsite to reduce the likelihood that a fire would occur onsite as part of the EMS.			
Emissions to water *(Demin Plant)*	Normal Operation	Surface Waters North Sea (~1.1 km to the east) See impact assessment to water in Section 10 and Appendix G	Direct route to North Sea at W5	The demin plant will be designed to comply with emission standards and will be subject to regular preventative measures to ensure optimum performance. An emissions assessment has been carried out using H1 screening and marine modelling and demonstrates that the discharge is not considered to be significant when assessed against EQSs. Emissions to water will be monitored regularly in accordance with EP requirements and standards.	Almost certain	Incidental	Medium
	Accidental (Demin plant equipment failure)	Surface Waters North Sea (~1.1 km to the east)	Direct route to North Sea at W5	The demin plant will be designed to comply with emission standards and will be subject to regular preventative measures to ensure optimum performance. In the event of a failure or exceedance of EP requirements, the plant will be shut down to prevent further discharges.	Unlikely	Minor	Low

Hazard	Operation scenario	Receptor	Pathway	Risk management techniques	Likelihood of exposure	Consequence of exposure	Overall Risk
Emissions to surface water (*ALD1 Cavern dewatering*)	Normal (temporary) Operation	Surface Waters North Sea (~1.1 km to the east) See impact assessment to water in Section 10 and Appendix G	Direct route to North Sea at W5	An emissions assessment has been carried out using H1 screening and marine modelling and demonstrates that the discharge is not considered to be significant when assessed against EQSs. Records of volume and composition of discharge will be kept. A monitoring system will be maintained and tested to measure pH and temperature to ensure permit conditions are met.	Almost certain	Incidental	Medium
	Accidental (Wellhead equipment failure)	Surface Waters North Sea (~1.1 km to the east)	Direct route to North Sea at W4	Regular preventative maintenance as part of the EMS to ensure the integrity of the wellhead is maintained. Any spills or leaks near the wellhead will be contained by bunding or drip trays and tankered offsite.	Unlikely	Minor	Low
Emissions to surface water *(Bulk storage of oils and chemicals)*	Accidental Loss of containment/damage/vandalism to tanks and bunds, spillage during loading/ offloading	Surface waters Cess Dale Drain (60 m to the south) East Newton Drain (10 m to the south)	Direct or overland flow into the drainage system which discharges to the Cess Dale Drain and East Newton Drain at W1, W2, W3, W4	Bulk storage of materials will be stored on or within bunding which is capable of holding 110% of the capacity of the largest vessel and 25% of the aggregated volume. There will be no penetrations through bund walls. Rainwater will be pumped out following inspection. The plant area will be on hardstanding and will have kerbing throughout the process areas. Bulk storage volumes, even if spilled outside the bunded areas are unlikely to reach non-hardstanding areas of the Site. Tanker deliveries will be unloaded within designated bays with drainage to containment sumps.	Unlikely	Serious	Medium

Hazard	Operation scenario	Receptor	Pathway	Risk management techniques	Likelihood of exposure	Consequence of exposure	Overall Risk
				Bulk storage vessels that will be filled from tanker deliveries will have level indicators within the sight-line of the delivery driver, together with high alarms in the control room. Site drainage system will be provided with a class 1 oil interceptor. There is a final balancing lagoon on the surface water drainage system which has a valve that can be closed to prevent discharge in the event of a large-scale spillage to surface. Rapid spill response planning and training. Site security level provided is high due to the critical nature of the gas storage infrastructure (CCTV, 24 hour security personnel, high security fencing etc.)			
Emissions to water *(Firefighting water)*	Emergency Fire resulting in firefighting water	Surface waters Cess Dale Drain (60 m to the south) East Newton Drain (10 m to the south)	Direct or overland flow into the drainage system which discharges to the Cess Dale Drain and East Newton Drain at W1, W2, W3, W4	The Site will not use PFAS/PFOS firefighting foam. For retention of fire suppression water, secondary containment is provided around chemical / oil storage. Site surface water drainage with the penstock valve closed provides a tertiary containment system capable of holding the 2-hour fire fighting water response. Fire safety controls and awareness will be maintained onsite to reduce the likelihood that a fire would	Hardly ever	Major	Medium

Hazard	Operation scenario	Receptor	Pathway	Risk management techniques	Likelihood of exposure	Consequence of exposure	Overall Risk
				occur and will be incorporated into the Site EMS and Fire Prevention Plan.			
Emissions to land and groundwater *(Bulk storage of oils and chemicals)*	Accidental Loss of containment/ damage/ vandalism to tanks and bunds, spillage during loading/ offloading	Infiltration to groundwater Not located within a Source Protection Zone	Direct or overland flow into drainage system	See Emissions to water *(Bulk storage of oils and chemicals)* Regular preventative maintenance as part of the EMS will ensure that integrity of drainage systems is maintained throughout the lifetime of the Site operations	Unlikely	Minor	Low
Emissions to land and groundwater *(Firefighting water)*	Emergency Fire resulting in firefighting water	Infiltration to groundwater Not located within a Source Protection Zone	Direct or overland flow into drainage system	See Emissions to water *(firefighting)*	Unlikely	Minor	Low
Odour *(Ammonia Storage)*	Accidental release	Closest residential area ~400 m east of the Site	Direct spill through failure of tank/pipework resulting in airborne NH_3 emissions.	Risk management techniques are primarily by prevention of loss of containment (see emissions to water above).	Unlikely	Minor	Low
Odour *(NH_3 emissions from flue gas)*	Routine and emergency operations	Closest residential area ~400 m east of the Site	Dispersion through the air.	Risk of odour from ammonia slip is considered low as described in Section 0. Control system automatically controls ammonia injection according to NOx load in flue gases. Ammonia is continuously monitored in stack emissions and linked to DCS operator alarm system.	Unlikely	Minor	Low

Hazard	Operation scenario	Receptor	Pathway	Risk management techniques	Likelihood of exposure	Consequence of exposure	Overall Risk
Noise and Vibration	Normal operation from machinery, import and export vehicles	Operational staff Closest residential area ~400 m east of the Site	Sound propagation through the air and the ground	Acoustic mitigation proposed for all key noise sources including noise control measures such as acoustic enclosures, silencers, acoustic lagging, acoustic louvres and the selection of low noise versions of the equipment. Noise levels from the proposed operational equipment range from minor to moderate. A noise Management Plan will be implemented to include measures to demonstrate that noise from the Site is minimised as far as is reasonably practicable. See Section 12 for more details.	Possible	Incidental	Low
Litter / Pests	Normal operation	Neighbouring industrial units	Windblown, Birds	Housekeeping is given a high priority as company policy. Any putrescible waste generated by the Site will be appropriately stored to minimise pests. Any waste kept externally will be appropriately covered to stop wind and birds.	Unlikely	Incidental	Low
Visible emissions *(Plume from emission stacks)*	OCGT operation/ emergency operation	Neighbouring industrial units. Closest residential area ~400 m east of the Site	Dispersion through the air/visual	The potential for visible plumes from the OCGT stack is considered to be very low as a result of low water content and temperature of the flue gas. There is no steam cycle, water injection or wet cooling tower plume associated with the operation of the OCGT. Given rural nature of the receiving environment and limited number of potential receptors, comprising relatively small camping and caravanning sites and scattered communities, and no visible	Unlikely	Incidental	Low

Hazard	Operation scenario	Receptor	Pathway	Risk management techniques	Likelihood of exposure	Consequence of exposure	Overall Risk
				condensing plumes expected to occur, this is not expected to result in significant effects			
Visible emissions *(Flame or plume from flare)*	Flare operation/ emergency operation	Neighbouring industrial units. Closest residential area ~400 m east of the Site	Dispersion through the air/visual	Enclosed ground flare and smokeless design will be used to reduce luminosity and visual nuisance. Given rural nature of the receiving environment and limited number of potential receptors, comprising relatively small camping and caravanning sites and scattered communities, and the intermittent use of flaring, this is not expected to result in significant effects.	Unlikely	Incidental	Low
Visible emissions *(Plume from emission stacks)*	Diesel pump testing/ emergency operation	Neighbouring industrial units. Closest residential area ~400 m east of the Site	Dispersion through the air/visual	Minimisation of planned testing durations Given the rural nature of the receiving environment and limited number of potential receptors, comprising relatively small camping and caravanning sites and scattered communities, and the intermittent use of flaring, this is not expected to result in significant effects.	Possible	Incidental	Low
Surface water flooding from weather event	All operational scenarios Reduced capacity for spill containment in bunds that are exposed rainfall – increased risk of spill breaching secondary containment	Site operations restricted Risk of flooding due to surface water onsite is classified as ‘high’	Direct effects	Flood Risk Assessment (prepared as part of the planning application) assessed the risk of flooding, as having the potential to result in effects of minor to negligible significance. Location of key infrastructure / bulk storage away from areas at risk of surface water flooding.	Unlikely	Minor	Low

Hazard	Operation scenario	Receptor	Pathway	Risk management techniques	Likelihood of exposure	Consequence of exposure	Overall Risk
				There will be minimal additional hardstanding areas as a result of the operation of the Site. The surface water drainage system of the Site provides a suitable allowance for climate change and therefore the impact of surface water runoff on the hydrological receptors throughout operation is not considered to be significant. Measures include Sustainable Drainage Systems (balancing lagoon) to the south of the site to attenuate runoff and provide water quality treatment by intercepting sediment and providing temporary storage prior to runoff entering the watercourse.			

16. PRE-OPERATIONAL/IMPROVEMENT CONDITIONS

The following pre-operational/improvement conditions are proposed, for consideration by the EA:

- An intrusive phase II site investigation and report will be conducted for the new permit boundary to further inform baseline soil and groundwater conditions. The specifications and date of implementation are to be discussed and agreed with the EA.
- Air emissions monitoring data for 100% H_2 firing will be provided to the EA once available.
- A monitoring plan for commissioning activities will be developed and agreed with the EA prior to commissioning.

APPENDIX A SITE CONDITION REPORT

APPENDIX B SITE DRAINAGE PLAN

APPENDIX C AIR QUALITY IMPACT ASSESSMENT

APPENDIX D OPERATING TECHNIQUES REVIEW

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APPENDIX E WASTE MANAGEMENT PROCEDURE

APPENDIX F H1 RISK ASSESSMENT TO WATER

APPENDIX G MARINE MODELLING REPORT

APPENDIX H H1 RISK ASSESSMENT TO AIR

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APPENDIX I NOISE IMPACT ASSESSMENT & MANAGEMENT PLAN

APPENDIX J ACCIDENT MANAGEMENT PLAN

ERM HAS OVER 160 OFFICES ACROSS THE FOLLOWING COUNTRIES AND TERRITORIES WORLDWIDE

Argentina
Australia
Belgium
Brazil
Canada
China
Colombia
France
Germany
Ghana
Guyana
Hong Kong
India
Indonesia
Ireland
Italy
Japan
Kazakhstan
Kenya
Malaysia
Mexico
Mozambique
The Netherlands
New Zealand
Peru
Poland
Portugal
Romania
Senegal
Singapore
South Africa
South Korea
Spain
Switzerland
Taiwan
Tanzania
Thailand
UAE
UK
US
Vietnam

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