BAIRD GAS STORAGE PROJECT

ONSHORE ENVIRONMENTAL STATEMENT ON BEHALF OF BACTON STORAGE COMPANY LTD IN RESPECT OF A PLANNING APPLICATION FOR THE ONSHORE ELEMENTS OF THE BAIRD GAS STORAGE PROJECT

AT

SITE ENCOMPASSING A CORRIDOR OF LAND RUNNING FROM MLWM WESTWARDS AND TO THE NORTH OF THE SHELL UK TERMINAL TO THE PERENCO UK TERMINAL; THE PERENCO UK TERMINAL; A CORRIDOR OF LAND ACROSS PASTON ROAD BETWEEN THE PERENCO UK TERMINAL AND NATIONAL GRID GAS DISTRIBUTION STATION; AND AREAS OF LAND TO THE NORTH-WEST OF SEAGULLS FIELD; OFF PASTON ROAD, BACTON, NORFOLK

Client Ref: BD-017-EV-RPT-005

February 2010

CONESTOGA-ROVERS & ASSOCIATES (EUROPE) LTD

bacton storage company ltd

bacton
storage company ltd

Baird Gas Storage Project
Onshore Environmental Statement

CLIENT REF ES BD-017-EV-RPT-005

FEBRUARY 2010

CONESTOGA-ROVERS
& ASSOCIATES (EUROPE) LTD

Synergy House, Unit 1 Calverton Business Park Hoyle Road,
Calverton, Nottingham, UK NG14 6QL
Telephone: +44 (0) 115 965 6700 Facsimile: +44 (0) 115 965 5282
www.cra.co.uk

BAIRD GAS STORAGE PROJECT

ONSHORE ENVIRONMENTAL STATEMENT

CLIENT REF ES BD-017-EV-RPT-005

PREPARED FOR BACTON STORAGE COMPANY LIMITED

FEBRUARY 2010
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1.0 INTRODUCTION

Baird Storage Company Limited (BSCL) is proposing to develop the partially depleted Baird gas field into a natural gas storage facility. This will involve the compression of natural gas from the United Kingdom (UK) National Transmission System (NTS), re-injection into the Baird gas reservoir, and subsequent re-supply of the gas to the NTS from the Baird gas reservoir to meet market demand. This will reduce the UK's reliability on imported gas sources during periods of peak demand and increase security of gas supply.

The proposed facilities will comprise a Normally Unmanned Installation (NUI) situated offshore, the connecting pipeline with beach landfall, a tunnel and shaft through the cliff, onshore compression and processing facilities and a pipeline link to the NTS.

An Environmental Impact Assessment (EIA) of the potential influence of the proposed development on the surrounding environment has been conducted. This Environmental Statement presents the results of the EIA for the onshore elements of the proposed development.

1.1 PROJECT BACKGROUND

The Baird reservoir is located in Block 49/23 of the Southern North Sea, south of the Indefatigable (Inde) field. It is approximately 86 kilometres (km) northeast of the Perenco onshore terminal at Bacton. Figure 1 presents its location within the North Sea.

The Baird reservoir was developed in 1993 from a single well, Well 49/23-D5, and as of 30th September 2009 has produced 132 billion cubic feet (bcf). The well is still in operation but as Gas In Place (GIP) reduces it becomes more difficult to abstract the gas. The gas remaining in the reservoir after September 2010 will not be extracted, as it is proposed that gas remaining will become part of the gas "cushion" necessary for the reservoir to act as a storage facility.

The Baird reservoir is between 50 and 67 metres thick. It is composed of Rotliegends Leman sandstone located within large scale Aeolian dune crossbed sets with minor sandy sabkha deposition. No faults within the reservoir form a barrier to vertical flow and it is therefore assumed that fracturing and cementation associated with intra-reservoir faults do not compartmentalise the reservoir.

NOT TO SCALE

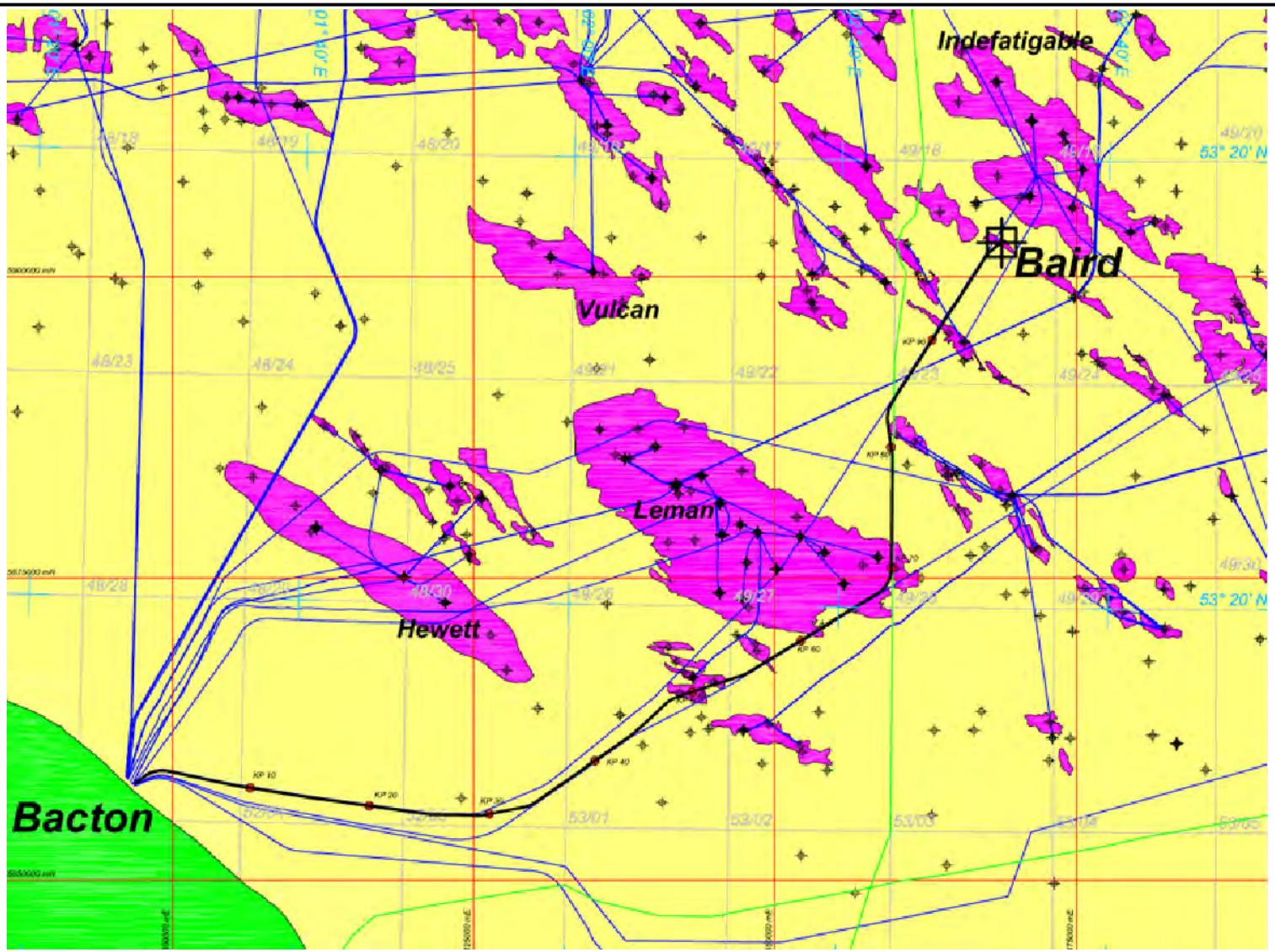

figure 1

LOCATION OF BAIRD RESERVOIR
BAIRD GAS STORAGE PROJECT - ENVIRONMENTAL STATEMENT
BACTON STORAGE COMPANY LIMITED
Bacton Gas Terminal Norfolk

1.2 BACTON STORAGE COMPANY LIMITED

Bacton Storage Company Limited (BSCL) is formed of equity partners Centrica Storage Holdings Limited (Centrica) and Perenco (UK) Ltd (Perenco). Centrica own the majority share (70 percent) and is leading the licensing and consenting process on behalf of the partners.

BSCL will use an area within the existing Perenco terminal for the onshore compression and conditioning facilities. The location of the Perenco terminal within the Bacton Terminal Complex is presented in Figures 2 and 3.

The Baird Gas Storage Facility will be operated by BSCL when completed. Operation will be under BSCL's integrated Health, Safety and Environmental Management System (HS&E MS) which adopts the principles of quality management. HS&E management procedures are incorporated into relevant business functions which reinforce the Company philosophy that management of HS&E issues is an integral part of BSCL's business activities. Further detail of the HS&E management system is provided in Section 6.

1.3 ENVIRONMENTAL IMPACT ASSESSMENT

This Environmental Statement reports the findings of the EIA undertaken for the proposed Bacton Gas Storage Project (BGSP). This ES only considers the onshore elements of the development. These include:

- The pipeline from the Mean Low Water Mark (MLWM) to the terminal
- The terminal facilities
- The pipeline to the National Grid site

A separate Offshore Environmental Statement will be provided to consider the offshore pipeline, the NUI and the wells.

The EIA is an important procedure for ensuring that the likely significant environmental effects of a new development are fully understood in the decision making process and measures to control or mitigate them are put in place. The Regulations require that the EIA identifies, describes and assesses the direct and indirect effects on humans, flora and fauna, soil, water, air, climate and landscape, material assets, cultural heritage and interactions between them.

In order to complete the EIA, information has been collated concerning the proposed design and facilities, the predicted emissions and discharges and the current local environment. This has been reviewed to identify the potential environmental hazards,

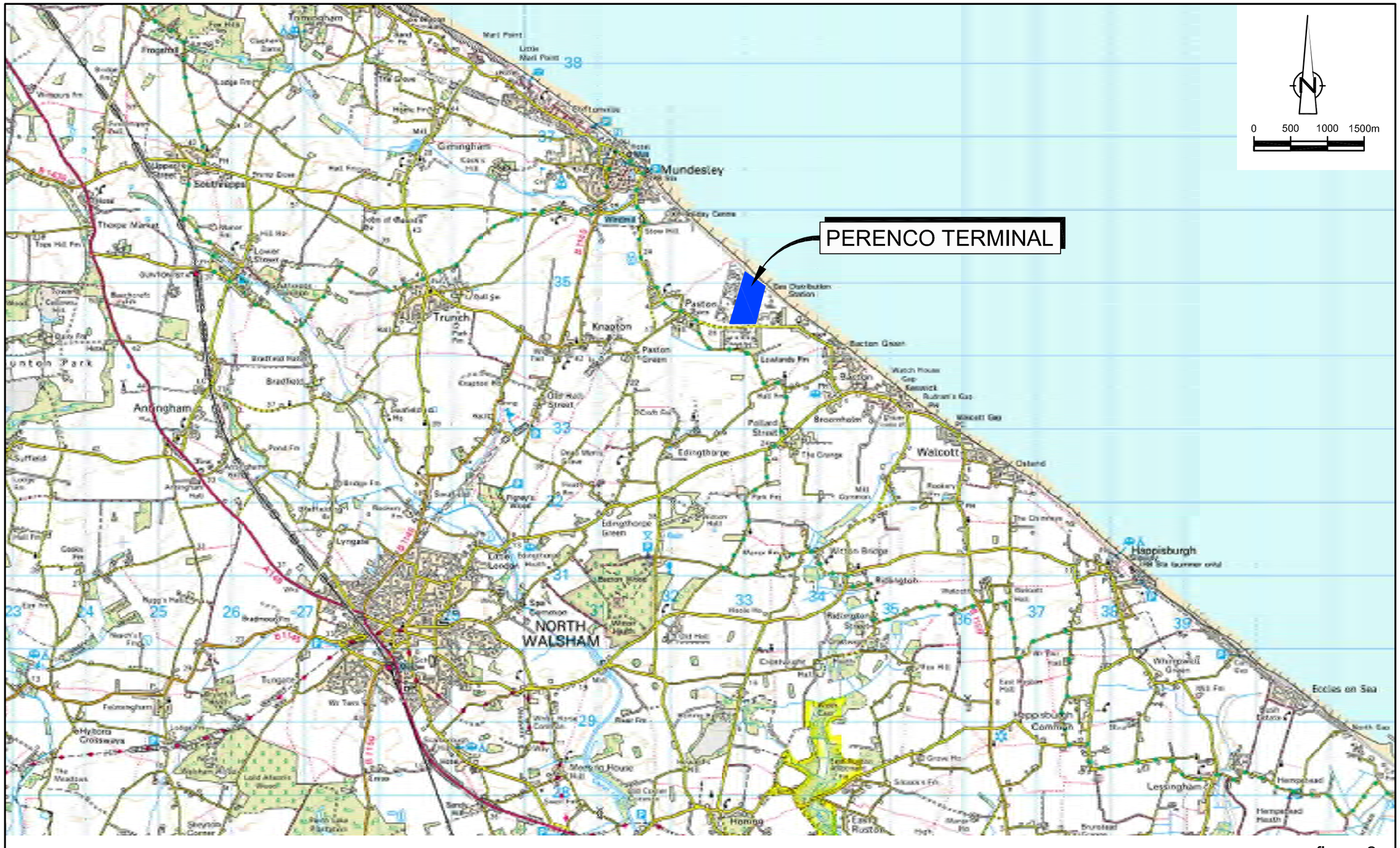

figure 2

PERENCO TERMINAL SITE LOCATION
BAIRD GAS STORAGE PROJECT - ENVIRONMENTAL STATEMENT
BACTON STORAGE COMPANY LIMITED
Bacton Gas Terminal Norfolk

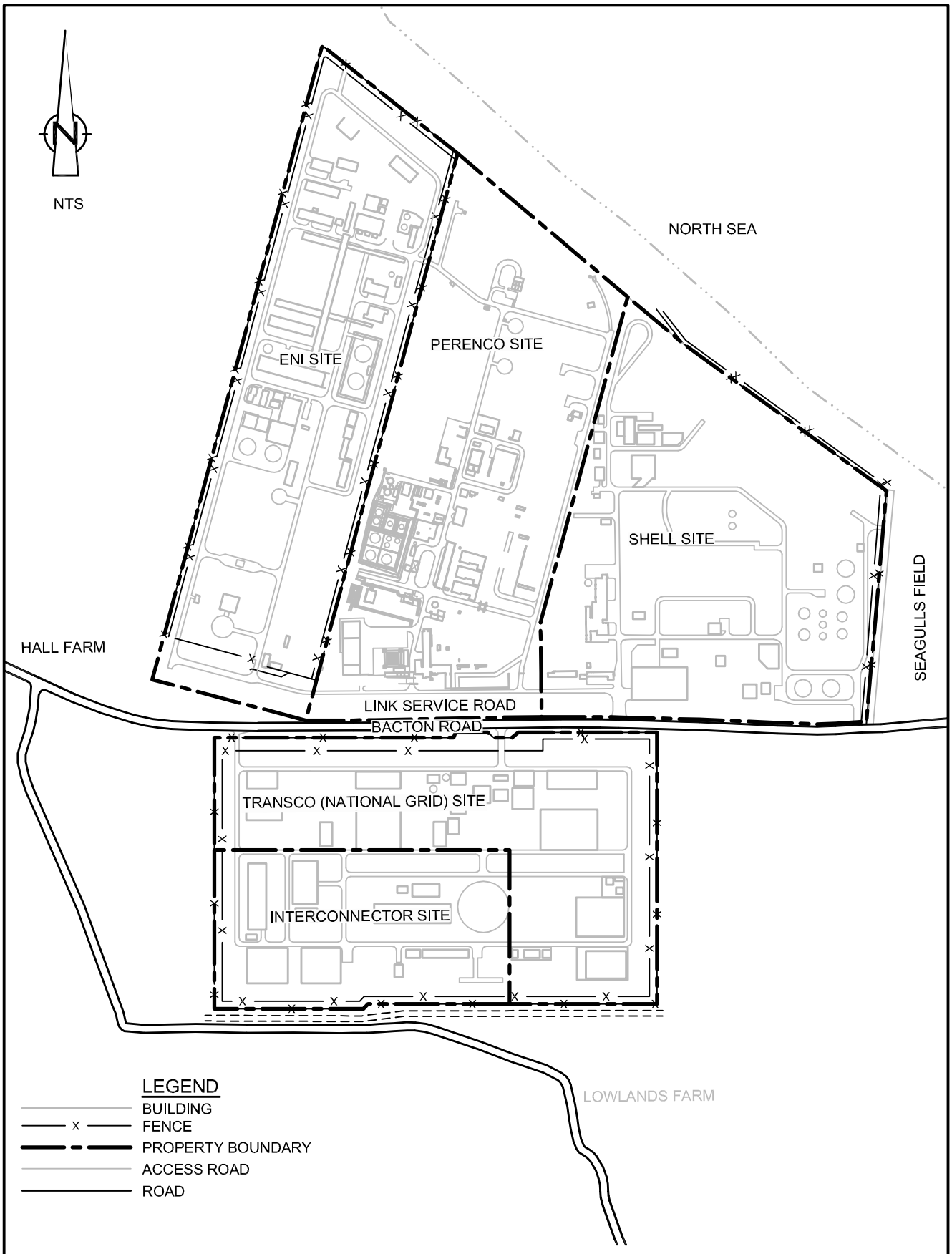

figure 3

BACTON GAS TERMINAL PLAN
BAIRD GAS STORAGE PROJECT - ENVIRONMENTAL STATEMENT
BACTON STORAGE COMPANY LIMITED
Bacton Gas Terminal Norfolk

the sensitive environmental receptors and possible interactions between them. Assessment of the significance of the impacts is made and where appropriate consideration of control and mitigation measures is provided. Control and mitigation measures may include a range of options from alternative equipment to procedural changes.

1.4 CONSULTATION

1.4.1 CONSULTATION WITH REGULATORS

Perenco originally began the consultation with North Norfolk District Council (NNDC) regarding the requirement to undertake an EIA by submitting an EIA Screening Opinion to the Local Authority in May 2008. It is of note that the proposed project was slightly different to the current plans; however, it was determined by NNDC at that time that an EIA was not required as the site is not within a sensitive area and the onshore pipeline was below the length described within Annex A (A28) of Circular 02/99.

Bacton Storage Company Ltd has continued to consult with NNDC; the project scope has changed since the Perenco EIA Screening Opinion and BSCL are submitting this Environmental Statement voluntarily. In order to ensure, however, that all relevant environmental aspects are considered in appropriate detail, and all potential concerns are addressed, a formal Scoping Opinion was requested from NNDC in October 2009.

Consultation responses were received from the following consultees:

- Natural England
- NNDC - Conservation, Design and Landscape
- NNDC – Environmental Protection
- Norfolk County Council
- Norfolk Landscape Archaeology
- Environment Agency

The responses were generally positive towards the proposals described within the Scoping Opinion Supporting Report (CRA, 2009). The comments on particular subjects fell into the following categories; landscape, ecology, archaeology, contaminated land, water quality and mitigation measures.

1.4.1.1 Landscape

It was recommended that a wider landscape character assessment is carried out in accordance to the North Norfolk Landscape Character Assessment Supplementary Planning Document (2009b) and following procedures highlighted in *Guidelines for landscape and visual impact assessment* (Landscape Institute and Institute of Environmental

Management and Assessment (IEMA), 2002). References to the impact on light levels, tranquillity and tree cover are required. A summary of the landscape and visual assessment is provided in sections 5.2.5 and 5.3.4 of this report.

1.4.1.2 Ecology

Responses from NNDC, Natural England and Norfolk County Council all emphasized the need for an assessment of the potential impacts on biodiversity with a description of mitigation measures. It was recommended that a Phase 1 Habitat Survey and Arboricultural Implications Assessment were conducted to assess the impact of the proposed development on trees in the construction area. Summaries of both the required surveys are provided in Sections 5.2.8.1 and 5.2.8.2.

The potential impact of the development on bats known to forage along the cliffs and on the beach at Bacton was specifically raised by NNDC. The statutory obligations imposed by the Habitats Regulations[2] require that a competent impact assessment of proposed development on protected species was undertaken. The Phase I Habitat Survey summarised in section 5.2.8.1 and the Initial Bat Sruvey of the Archive Building described in section 5.2.8.3 outline the potential impact on bats.

It was suggested that proposals for biodiversity enhancement are incorporated into the Environmental Statement. Sections 2.6 and 5.2.8 describe biodiversity impacts and mitigation measures in detail.

1.4.1.3 Archaeology

Norfolk Landscape Archaeology, on behalf of NNDC identify that monitoring should be undertaken by an archaeological contractor during construction. Further information concerning archaeology and sites of historic interests is provided in Section 5.2.2.

1.4.1.4 Contaminated Land

The Environment Agency emphasised that the results of the contaminated land assessment must comply with PPS 23[3] and include a preliminary risk assessment. Details of the contaminated land assessment are presented in section 5.2.3.

1.4.1.5 Water Quality

It was also recommended by the Environment Agency that the impact assessment of water quality should take into consideration pollution prevention measures associated

[2] Conservation (Natural Habitats &c) Regulations 1994 (as amended)
[3] Planning Policy Statement 23: Planning and Pollution Control. Office of the Deputy Prime Minister. 2004.

with the construction/operation of the proposed development. This is addressed in sections 5.2.14 and 5.3.3.

1.4.1.6 Traffic and transport

The use of pipelines to transport gas was supported by Norfolk County Council as it removes the need to use the road network; however, it was recommended that the impact on local highway network of construction traffic is assessed. Traffic and transport are considered in section 5.2.12.

1.4.1.7 Mitigation Measures

A number of responses recommended that the Environmental Statement should include a mitigation strategy that clarifies how identified potential impacts on the natural environment are to be mitigated; it was commented the measures should be proportionate to the perceived impacts and should include site specific prescriptions. Mitigation measures have been incorporated into this Environmental Statement where it is considered there is likely to be a relevant impact.

1.4.1.8 Cumulative Impact

In response to comments received from Norfolk County Council following the submission of the Request for a Scoping Opinion, an assessment has been made of the potential for the Baird facilities to contribute with other local developments in creating a cumulative impact. This is described within section 5.5.

1.4.2 CONSULTATION WITH THE PUBLIC

Perenco have been operating at Bacton since 2003 and continue to maintain good relations with the local community. Both Centrica and Perenco are committed to keeping the public informed about proposed developments. A Statement of Community Involvement has been produced in support of the application for planning permission. The Statement includes a summary of the guidance available and requirements for consultation, a description of the consultations held and details of further consultations proposed for completion following submission of the Application for Planning Permission. The consultations undertaken to date included meetings with NNDC Councillors, Officers and Parish Councillors, a community newsletter and public exhibition, briefing of the MP for North Norfolk and launch and publicising of a dedicated website.

The queries resulting from these consultations, in particular the meetings with Parish Councillors and the public exhibition, are presented and responded to in the Statement of Community Involvement. The most common questions regarding environmental issues were associated with traffic management; section 5.2.12 details the proposed

measures that will be taken to minimise the impact on traffic on the local area. There were a number of queries relating to coastal erosion which are addressed in section 5.2.4. Questions involving the amount of lighting at the terminal are addressed in sections 5.2.5 and 5.3.4; these sections present the findings of the Landscape and Visual Resource Assessment undertaken to estimate the potential impact of lighting from the proposed construction and operation of the Baird Facilities. Wildlife and landscaping queries were also received. Section 5.2.8 addresses the potential ecological impact of the proposed development and measures that will be taken to mitigate this. The Statement of Community Involvement presents a summary of all the questions asked and details the responses.

1.5 STRUCTURE OF ENVIRONMENTAL STATEMENT

This Environmental Statement presents the results of the EIA for the Baird Project. The regulatory and policy background that influences the project are presented; this section was prepared by CRA, with the Planning Framework provided by RPS Group Plc (RPS). A detailed description of the proposed project follows based upon information provided by Centrica, ODE, Pegasus International, Genesis and Land & Marine. The section regarding the Surrounding Environment provides details of the existing local area; this section was prepared by CRA. The potential environmental impacts and mitigation measures to be taken to minimise impacts are presented for the construction and then the operation of the proposed facilities. This assessment has been largely completed by CRA with RPS undertaking the landscape and visual assessment and the Transport Assessment. The Phase I Habitat Survey and Arboricultural Survey were conducted by Middlemarch Environmental Limited. The Environmental Management of the installation is also described.

1.6 CONTACT DETAILS

Contact with the BSCL team can be made through the BGSP website www.bairdgasstorageproject.com/contact.php or via the details below.

Centrica Storage Limited
Venture House, 42-54 London Road, Staines,
Middlesex TW18 4HF
www.centrica-sl.co.uk

Perenco UK
10, Duke of York Square, London, SW3 4LY
www.perenco.com

Local Contact**:** Jane Bailey
Wayside, Blickling Road, Aylsham
Norfolk, NR11 6DA

2.0 REGULATORY AND POLICY BACKGROUND

2.1 REQUIREMENT FOR GAS STORAGE

The gas market in the UK is experiencing fundamental changes as a result of declining UK Continental Shelf (UKCS) gas production. As illustrated in Figure 4, National Grid predicts an increasing dependency on imported gas supplies in the coming years; in 2010/11 imports are forecast to account for 47 percent of supply, increasing to 69 percent in 2018/19 (National Grid, 2009).

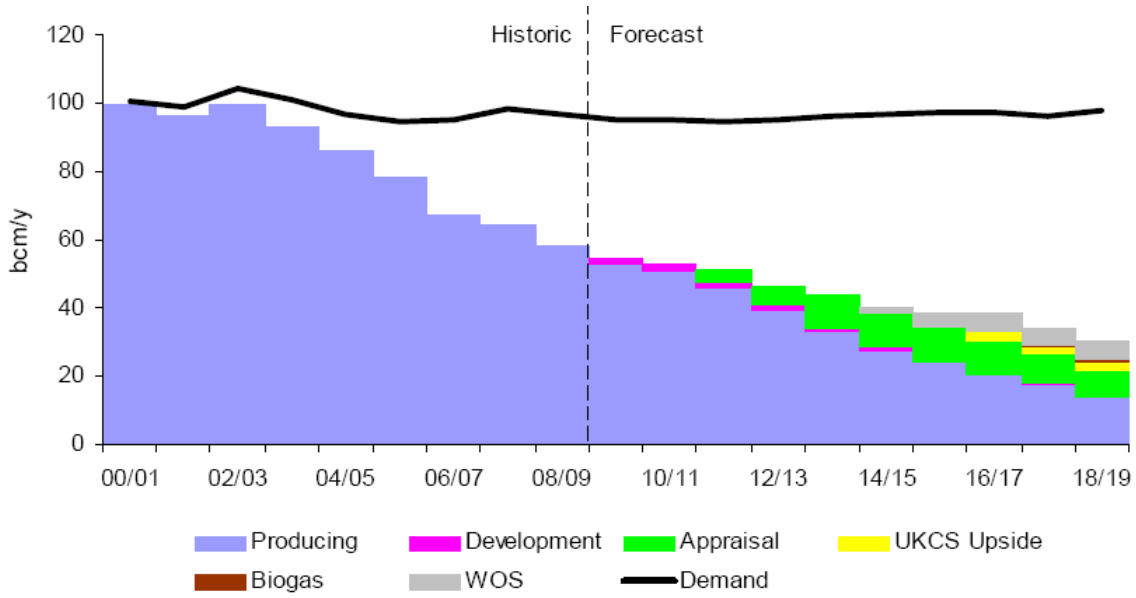

Figure 4: UKCS Annual Forecast and Import Requirement

Source: National Grid, 2009

Reliance on gas imports from Norway and continental Europe has implications for security of supply, particularly during periods of peak demand. In the UK, there is a significant difference in gas consumption between the summer, typically less than 200 million cubic metres per day, and winter; on a cold day consumption can be higher than 400 million cubic metres a day. Historically, this swing has been met by the variation of flows from producing gas fields in the North Sea. Due to the decline in UKCS gas production, in the future it is anticipated that the importance of gas storage facilities in ensuring the security of supply will increase.

This concern over security of gas supply was highlighted by the Department of Energy and Climate Change (DECC), in the 2006 Energy Review. This review recognised that the market will need to deliver new gas supply infrastructure, such as gas storage facilities, as the UK becomes increasingly reliant on imported gas in order to maintain reliable supplies to its consumers.

The relatively low level of gas storage in the UK compared to other European countries was recently highlighted in a statement to Parliament[4]. The statement confirmed that at present the UK only has 15 days of storage capacity compared to Germany with 99 days and France with 122 days. It is of note that if all of the projects under construction or consented are built, these will add less than a week of storage by 2014. Indeed, it would take the construction of all 18 commercial gas storage projects currently at different stages of development for the UK to have a storage capacity approaching that of Germany and France.

The ability to react to the "swing" in demand referred to above by increasing production from UKCS supplies will diminish as these supplies decrease. Gas storage facilities will therefore become an increasingly important management tool in helping to ensure that the UK continues to benefit from secure gas supplies and peak demand can be met. Indeed, gas storage infrastructure has been identified as a priority in the EU Trans-European Energy (TEN-E) infrastructure programme.

The Government's Energy White Paper (DTI, 2007) *Meeting the Energy Challenge* refers specifically to gas storage projects such as the proposed Baird Project. The paper concludes that '*to manage future gas security of supply risks better, the Government will take action to … increase gas storage and import infrastructure by facilitating the construction of gas supply infrastructure both onshore and offshore…*'. The need for new gas storage facilities such as the proposed Baird Project has been identified by the Government and policies have been directed towards simplifying the licensing and regulatory framework associated with it.

The above clearly points to a requirement for additional gas storage in the UK and the proposed development will contribute to this. The need for gas storage and Government energy policy is explored in further detail within the Planning Statement.

2.2 LEGISLATION FRAMEWORK

A gas storage project of this nature is subject to a range of European and UK legislation. Table 1 below provides a summary of the applicable requirements. This Environmental Statement will discuss methods of compliance with relevant legislation.

[4] Gas Storage. Standard Note SN/SC/501. B, Smith. 12th March 2009.

Table 1: Summary of Legal Requirements

Aspect	*Legislation or Guidance*	*Regulatory Authority*
Environmental Impact Assessment	The Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999 (as amended)	North Norfolk District Council
Planning Permission	Town and Country Planning Act 1990 (as amended)	North Norfolk District Council
Hazardous Substances Consent	Planning (Hazardous Substances) Act 1990 (as amended)	North Norfolk District Council
Discharge of waste waters to controlled water	Water Resources Act 1991 (as amended) Environmental Permitting (England and Wales) Regulations 2007	Environment Agency
Licence to discharge to sewer	Water Industries Act 1991 (as amended) Environmental Permitting (England and Wales) Regulations 2007	Anglian Water Environment Agency
Permit to operate combustion activities	Environmental Permitting (England and Wales) Regulations 2007	Environment Agency
Emissions and discharges to the environment	Environmental Permitting (England and Wales) Regulations 2007 Groundwater (England and Wales) Regulations 2009 Greenhouse Gas Emissions Trading Scheme Regulations 2005 Large Combustion Plant Directive 2001/80/EC	Environment Agency Department for the Environment, Food and Rural Affairs (DEFRA) and Environment Agency
Accidents/hazards associated with dangerous substances	Planning (Hazardous Substances) Act 1990 (as amended) and Planning (Hazardous Substances) Regulations 1992 (as amended) Control of Major Accident Hazards Regulations 1999 (as amended)	North Norfolk District Council (PHS) Health and Safety Executive, Environment Agency (COMAH)
Conservation of natural habitats	Conservation (Natural Habitats &c) Regulations 1994 (as amended), 92/43/EEC and 79/409/EEC	Natural England and North Norfolk District Council
Site waste management plan (Construction Waste)	Site Waste Management Plan Regulations 2008	Environment Agency
Noise	Environmental Permitting (England and Wales) Regulations 2007 The Control of Noise at Work Regulations 2005	Environment Agency Health and Safety Executive

2.2.1 CONSENTS AND LICENCES

The BGSP includes a number of activities which will require consents or licences. A summary of these are given below.

2.2.1.1 Environmental Permitting (England and Wales) Regulations 2007

The Environmental Permitting (England and Wales) Regulations 2007 (EPR) were introduced to simplify the environmental regulatory system and incorporates regulation of Pollution Prevention and Control (PPC), Waste Management (WM), Waste Batteries and Accumulators and Mining Waste. Existing PPC and WM licences were automatically converted to Environmental Permits from 6th April 2008.

The existing Perenco installation is regulated under EPR and holds an Environmental Permit (PP3633LM). The onshore processing equipment for the BGSF will be within the existing installation boundary of this Permit. It has been determined, however, that as the new facilities will not be technically linked to the existing plant and will have a separate operator, an application will be submitted for a new EPR Permit.

The EPR is a significant regulatory regime under which statutory controls exist for the normal and emergency operation of the facility and for the setting of emission limits to minimise the impacts of the operation of the facility on the environment. The EPR permit application will be submitted to the Environment Agency as the regulatory authority, and will detail the proposed facilities, the potential emissions and discharges and the anticipated environmental impacts. The Environmental Permit issued as a result of a successful application will detail the management and operational requirements including emission limits.

2.2.1.2 Discharge Consent

The Water Resources Act 1991 requires that it is an offence to cause or knowingly permit without consent any direct discharge of any poisonous, noxious, or polluting matter to enter any stream or controlled water. This includes coastal waters up to three miles offshore. The Environment Agency regulates discharges to water and any additional wastewater directed to the existing outfall during construction will require their consent. Procedures for applications are documented in the Control of Pollution (Applications, Appeals, and Registers) Regulations 1996. Consent for discharges will be regulated under the Environmental Permit once the installation is operational.

2.2.1.3 Hazardous Substances Consent

The Planning (Hazardous Substances) Act 1990 (and subsequent amendments) and the Regulations made under that Act requires that a Hazardous Substances Consent (HSC)

is obtained if hazardous substances either named specifically or which fall into one or more generic categories are to be stored or handled on site, at or above specific thresholds specified in Part A or Part B of Schedule 1 to those Regulations, or where a quantity of a hazardous substance within either Part A or Part B may be present, but only as a result of a loss of control of an industrial chemical process. The Regulations require that controls are in place to ensure that hazardous substances are only kept or used in significant quantities after the competent authority (the hazardous substances authority) have assessed the risk associated with the proposed use or storage arising to persons in the surrounding area and the environment.

The planning controls are designed to ensure that any residual risk (having taken all reasonable measures to comply with the Health and Safety at Work, etc., Act, 1974) to people in the vicinity or the environment is taken into account before a hazardous substance is allowed to be present. The extent of the risk will depend upon where and how a hazardous substance is to be present. These controls are in addition to any requirements for planning permission for development associated with storage or use of hazardous substances.

The Regulations and the requirement to obtain an HSC are therefore linked and overlap with the Control of Major Accident Hazard Regulations 1999 (as amended) (COMAH). Both sets of regulations were produced in response to the Seveso Directives and have common features. The threshold quantities of certain substances within the PHS Regulations are lower than the entry within the COMAH Regulations.

Amoco (UK) Exploration Co, the previous owner of the site, obtained two hazardous substances consents for the storage of petroleum gas (propane), hydrocarbon gas (methane) and hydrocarbon liquids. These consents are still valid for the existing Perenco installation, however they are applicable only to specific areas. The installation of new facilities for hazardous substances for the BGSF will require an application to NNDC for an additional consent. This has been submitted and further detail is provided in section 2 of the Planning Statement.

2.2.1.4 COMAH

The Seveso II Directive 96/82/EC on the Control of Major Accident Hazards of December 1996 was introduced to broaden the existing scope of regulation of industry with the potential to cause severe accidents. The directive aims to ensure that preventing major accidents and limiting the social and environmental consequences of them were taken into account in land use planning policies. It therefore requires that new establishments and modifications to existing establishments consider the potential for increased risk due to their location and existing neighbouring facilities. The land use planning requirements of the directive have been incorporated into planning legislation.

The COMAH Regulations 1999 and subsequent amendments, aim to ensure that installations holding substances in quantities with the potential to cause significant harm, have appropriate safeguards. The regulations were amended most recently in 2008. They largely apply to chemical and energy industries; the existing Perenco terminal is currently an upper tier COMAH establishment. The Baird facility will also be an upper tier COMAH establishment

As an upper tier COMAH site, the installation is required to prepare and regularly review a COMAH Safety Report. The first stage of the process is the submission of a pre-construction safety report which will be examined by the competent authorities to ensure the design of the facility is robust and safe. Following on from the pre-construction report a Safety Report will be produced prior to the operation of the facility. This report details all potential Major Accident Hazards (MAH) and Major Accidents to the Environment (MATTE) and describes plans for preventing and dealing with major accidents. The COMAH Safety Report for the BSCL facility is required to be submitted, reviewed and agreed by the joint competent authorities of the Health and Safety Executive (HSE) and the Environment Agency (EA).

An onsite Emergency Response Plan is also required to be in place which details required activities including site clean up and remediation following an incident. An offsite Emergency Response Plan will be produced and held by appropriate parties including the local emergency services and NNDC. These requirements have already been met by the existing Perenco installation and the controls in place will be similar for the BSCL facility.

The existing Perenco terminal is a Domino Effect installation and it is anticipated that the new installation will be given the same designation. Domino Effects are considered in locations where a number of COMAH sites are grouped together and the possibility of and the consequences caused by a Major Accident Hazard may be increased. As a result of the designation, a plan will be put in place detailing the response required if it is considered that an incident could escalate to influence multiple installations. The Domino Exchange Document, which is held by all of the Bacton Gas Terminals will be updated to include the proposed new facilities.

It is anticipated that the new facilities will hold a separate COMAH Safety Report but will have to interface with the existing Perenco report in order to ensure the most appropriate response to a major accident can be achieved. This will include the on-site Emergency Response Plan.

2.3 EIA REGULATORY FRAMEWORK

Environmental Impact Assessments are required to determine how a proposed development will influence the environment and to ensure that environmental information is taken into account in decision making. This requirement was introduced into the European Union (EU) as a result of Directive 85/337/EEC, 'the assessment of the effects of certain public and private projects on the environment,' which came into force in 1988. This directive requires that an EIA is conducted before development consent is granted for certain types of major project which are judged likely to have significant environmental effects. This directive was amended by 97/11/EEC which came into effect in 1999.

The directives were brought into English law by the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999 and apply to all relevant applications for consent on or after 14th March 1999. The regulations were updated in England in 2006 and again in 2008. The regulations specify that defined projects which are likely to have significant impacts on the environment are subject to an EIA. The specified projects are defined on size, purpose and location; all projects defined within Schedule 1 will require an EIA, projects in Schedule 2 should be assessed to determine whether it is required. This includes Energy Industry and Infrastructure projects.

As previously described, this project is not considered to be a Schedule 1 development. It meets the criteria of Schedule 2, section 10k (ii) '*Oil and gas pipeline installations (unless included in Schedule 1) where: in the case of a gas pipeline, the installation has a design operating pressure exceeding 7 bar gauge.*' However, in the opinion of NNDC it was not considered that the installation would have a significant environmental effect and a statutory EIA was not requested. Nonetheless, BSCL considered that an EIA was appropriate due to the nature of the project and consequently this Environmental Statement is submitted voluntarily.

2.4 PLANNING FRAMEWORK

The framework for making decisions on planning applications is provided by Government statements of planning policy, known as Planning Policy Guidance Notes (PPGs) and Planning Policy Statements (PPSs); and the 'Statutory Development Plan' for the area to which an application relates.

Although the Government's statements of planning policy are an important material consideration to be taken into account in determining planning applications, the planning Acts confirm that the Statutory Development Plan should be the starting point for such decisions.

A summary of relevant Government planning policy statements and development plan policies is provided below. The extent to which the proposal accords with planning policy more generally is examined in detail within the Planning Statement, which forms part of the planning application submission.

2.4.1 GOVERNMENT STATEMENTS OF PLANNING POLICY

The Government statements of planning policy that are of most relevance to the EIA for the proposed Baird facilities include:

- MPS1: Planning and Minerals (2006)
- PPS1: Delivering Sustainable Development (2005).
- PPS1 Supplement: Planning or Climate Change (2007).
- PPS4: Planning for Sustainable Economic Growth (2009).
- PPS7: Sustainable Development in Rural Areas (2004).
- PPS9: Biodiversity and Geological Conservation (2005).
- PPG13: Transport (2001).
- PPG15: Planning and the Historic Environment (1994).
- PPG16: Archaeology and Planning (1990).
- PPG20: Coastal Planning (1992).
- PPS23: Planning and Pollution Control (2004).
- PPS25: Development and Flood Risk (2006).

2.4.1.1 MPS1: Planning and Minerals (2006)

Minerals Policy Statement (MPS) 1 sets out the Government's planning policies for minerals planning in England. MPS1 has a number of annexes that focus on matters specific to various sectors of the minerals industry. This includes an annex (Annex 4) that specifically deals with gas storage. Although the focus of the document is onshore gas storage it is of some relevance to the development.

Annex 4 reaffirms the key themes of Government energy policy, namely to reduce carbon emissions by 60% by 2050, with real progress by 2020; to maintain the reliability of energy supplies; to promote competitive markets in the UK and beyond; and to ensure that every home is adequately and affordably heated. Reference is made to the Energy Challenge Report of 2006 and this highlights the confirmation provided by this document of the importance of gas supply infrastructure, including gas storage, in maintaining the reliability of UK energy supplies as well as highlighting the need for further gas storage in light of declining UKCS production and the practical and safety benefits of underground gas storage, including within depleted fields such as Baird.

The BGSP is clearly in accordance with the policy objectives set out in MPS1.

2.4.1.2 PPS1: Delivering Sustainable Development (2005)

PPS1 sets out the Government's overarching planning policies for the delivery of sustainable development through the planning system. The Government's objectives for sustainable development include (paragraph 4):

- social progress, which recognises the needs of everyone;
- effective protection of the environment;
- the prudent use of natural resources; and
- the maintenance of high and stable levels of economic growth and employment.

Paragraph 4 goes on to state that these aims should be pursued in an integrated way through a sustainable, innovative and productive economy that delivers high levels of employment, and a just society that promotes social inclusion, sustainable communities and personal-well-being in ways that protect and enhance the physical environment and optimise resource and energy use.

2.4.1.3 PPS1 Supplement: Planning and Climate Change (2007)

In December 2007, the Government issued a supplement to PPS1 entitled 'Planning and Climate Change'. This document states that planning should contribute toward reducing emissions and stabilising climate change and take into account the consequences of this.

2.4.1.4 PPS4: Planning for Sustainable Economic Growth

PPS4 sets out the Government's policies for economic development. For the purposes of the policies in the PPS (paragraph 4), economic development is taken to include developments within the B Use Classes, public and community uses and main town centre uses. Policies also apply to other development, which achieves at least one of the following objectives:

- Provides employment opportunities;
- Generates wealth; or
- Produces or generates an economic output or product.

Policy EC6 of PPS4 relates to planning for economic development in rural areas. It confirms that in such areas, Local Planning Authorities (LPAs) should strictly control economic development in order to minimise impacts. The PPS does though confirm that LPAs should adopt a positive and constructive approach towards planning applications for economic development and that those that secure sustainable economic growth should be treated favourably. Factors to be taken into account should include the

impact on economic and physical regeneration in the area, including the impact on deprived areas and social inclusion objectives; and the impact on local employment.

Policy EC12 relates specifically to determining planning applications for economic development in rural areas. The policy confirms that determining such applications, LPAs should be mindful of the potential impact of the countryside, landscapes and wildlife and also the need to conserve, or the desirability of conserving heritage assets.

2.4.1.5 PPS7: Sustainable Development in Rural Areas (2004)

PPS7 sets out Government policy in respect of rural areas. The objectives of the policy include raising the quality of life and the environment of rural areas and promoting the rural economy and more sustainable patterns of development.

Paragraph 15 of PPS7 confirms that in considering development proposals, LPAs should have particular regard to any areas that have been statutorily designated for landscape, wildlife or historic qualities where greater priority should be given to restraint of potentially damaging development.

Paragraph 21 relates specifically to nationally designated areas, including Areas of Outstanding Natural Beauty (AONB). It confirms that these areas are afforded the highest status of protection in relation to landscape and scenic beauty and their conservation should therefore be given great weight in planning policies and development control decisions. The conservation of wildlife and cultural heritage are also seen as important considerations in these areas.

2.4.1.6 PPS9: Biodiversity and Geological Conservation (2005)

PPS9 sets out the Government's policies on the protection of biodiversity and geological conservation. The document is concerned with the protection of both statutory and non-statutory sites of biodiversity and/or geological conservation value, as well as specific protection and biodiversity conservation in the wider environment. The general objective is to conserve, enhance and restore wildlife and geological diversity.

Paragraph 1 of the guidance sets out the key principles which should be applied, in order to ensure that the potential impacts of planning decisions on biodiversity and geological conservation are fully considered. The paragraph confirms that the aim of planning decisions should be to prevent harm to biodiversity and geological conservation interest. Where granting planning permission would result in significant harm to such interests, LPAs should be satisfied that development cannot reasonably located on any alternative sites that would result in less or no harm. Furthermore, in the absence of alternative sites, LPAs should ensure that before permission is granted, adequate mitigation measures are put in place. The guidance goes on to state that where

a decision would result in significant harm to biodiversity and geological interests, which cannot be prevented or adequately mitigated against, appropriate compensation measures should be sought.

Paragraph 6 relates to sites of international importance, including Special Areas of Conservation (SACs). The guidance states that as these sites enjoy statutory protection, specific policies in respect of them should not be included in Local Development Documents.

Paragraphs 7 and 8 relate to Sites of Special Scientific Interest (SSSI). Paragraph 8 states that where a proposed development on land within or outside the SSSI is likely to have an adverse effect on the SSSI (either individually or in combination with other developments), planning permission should not normally be granted. Where an adverse effect on the site's notified special interest features is likely, an exception should only be made where the benefits of the development, at that site, clearly outweigh both the impacts that it is likely to have on the features of the site that make it of special scientific interest and any broader impacts on the national network of SSSIs. LPAs should use conditions and/or planning obligations to mitigate the harmful aspects of the development and where possible, to ensure the conservation and enhancement of the site's biodiversity or geological interest.

Paragraph 9 refers to regional and local sites. It states that sites of regional and local biodiversity and geological interest, which include regionally important geological sites, local nature reserves and local sites, have a fundamental role to play in meeting overall national biodiversity targets; contributing to the quality of life and the well-being of the community; and in supporting research and education.

Paragraph 13 recognises that the re-use of previously developed land for new development can make a major contribution to sustainable development by reducing the amount of countryside and undeveloped land that needs to be used. However, where such sites have significant biodiversity or geological interest of recognised local importance, LPAs, together with developers, should aim to retain this interest or incorporate it into any development of the site.

Paragraph 14 states that development proposals provide many opportunities for 'building-in' beneficial biodiversity or geological features as part of good design. When considering proposals, LPAs should maximise such opportunities in and around developments, using planning obligations where appropriate.

Paragraphs 15 and 16 deal with species protection. The paragraphs highlight that many individual wildlife species receive statutory protection under a range of legislative provisions. Other species have been identified as requiring conservation action. LPAs should ensure that these species are protected from the adverse effects of development,

where appropriate using planning conditions or obligations. LPAs should refuse planning permission where harm to such species or their habitats would result, unless the need for, and the benefits of, the development clearly outweigh that harm.

2.4.1.7 PPG13: Transport (2001)

This PPG seeks to ensure coordination between land use planning and transportation policy. It acknowledges that land use planning is critical to the Government's aims of sustainable development by locating development where it can be served by non-car modes of transport. One of the key objectives of the guidance is to promote more sustainable transport choices for both moving people and goods and materials.

Paragraph 23 states that where development will have significant transport implications, Transport Assessments (TAs), should be prepared and submitted with the planning application. The coverage and detail of the TA should reflect the scale of the development and extent of the transport implications. Paragraph 25 goes on to state that where proposals are clearly in line with planning policy (for instance where they accord with the preferred locations in the development plan) a TA should increase the likelihood of planning permission being granted.

Paragraphs 87 to 90 promote the use of Travel Plans to encourage more sustainable transport choices.

2.4.1.8 PPG15: Planning and the Historic Environment (1994)

PPG15 deals with the identification and protection of historic buildings, conservation areas and other elements of the historic environment. Paragraph 1.4 highlights that conservation and sustainable economic growth are complementary objectives and should not generally be seen as an opposition to one another.

Paragraph 2.1 deals with the setting of listed buildings. It highlights the duty on LPAs considering applications for planning permission or listed building consent works, which affect a listed building to have special regard to certain matters, including the desirability of preserving the setting of the building. The guidance goes on to confirm that setting is often a central part of the building's character. The guidance also deals with Conservation Areas at paragraph 4.14, which confirms that special attention should also be paid to the desirability of preserving or enhancing the character or appearance of Conservation Areas. It also confirms that in the Secretary of State's view this is a material consideration in relation to where LPAs are handling development proposals outside a Conservation Area, but which might affect its setting, or views into or out of the area.

2.4.1.9 PPG16: Archaeology and Planning (1990)

This document advises that archaeological remains are an irreplaceable resource and should be a material consideration in applications for new development. It does accept that in some cases development will impact on archaeological deposits but states that any effects should be mitigated. It also stresses the importance of the evaluation of sites for their archaeological potential in advance of development in order to inform future management decisions. Such an evaluation may be non-intrusive, such as desk-based studies or archaeological geophysics or more direct methods such as trial-trenching.

The guidance offers two main solutions to preserving any significant archaeological deposits founds on a development site. The preferred method is to preserve in-situ, where the archaeological remains are left beneath the new development. Where preservation in-situ is not feasible, PPG16 permits preservation by recording. The preservation methods adopted depend upon the significance of the archaeological deposits. The preservation or recording should be secured by attaching appropriate planning conditions to any grant of planning permission.

2.4.1.10 PPG20: Coastal Planning (1992)

PPG20 deals with issues relating to planning within a coastal zone. The document confirms that a range of economic and social activities require coastal locations (paragraph 1.1) and that it is the role of the planning system to reconcile these development requirements with the need to protect, conserve and where appropriate, improve the landscape, environmental quality, wildlife habitats and recreation opportunities of the coast (paragraph 1.2).

Paragraphs 1.10 to 1.12 highlight that many areas of the coastline have been specifically designated as areas of higher landscape value or as being of major conservation or scientific interest. The guidance highlights that specific policies apply to these areas and that in some areas conservation interests of particular importance need to be reflected in development plan policies and in determining planning applications.

These designations include Heritage Coasts, which applies to the Norfolk coastline. Although this is a non-statutory designation, of the 44 stretches of Heritage Coast, 8 are within National Parks and 29 contain AONBs. Significant parts of the Heritage Coasts are also designated as SSSIs, some of which are National Nature Reserves. Paragraph 1.17 sets out the main objectives of Heritage Coasts, which include to conserve, protect and enhance the natural beauty of the coastline its flora and fauna and other features and also to facilitate enjoyment and appreciation of these areas by the public.

Paragraph 2.2 identifies the key policy issues for coastal planning. These include conservation of the built and natural environment; development, especially that which

requires a coastal location; risks, including flooding, erosion and land stability; and improving the environment, particularly of urbanised or despoiled coastlines.

In relation to conservation, paragraphs 2.3 to 2.8 confirm that policies should aim to protect and enhance the natural character and landscape of the undeveloped coastline. In areas designated for their natural or historic landscapes, policies will tend to limit development, particularly those which would be visually intrusive. The guidance states that coastal areas are particularly vulnerable to visual intrusion, because of the higher visibility of development on the foreshore, on the skyline and effecting views along stretches of the undeveloped coast. The guidance also emphasises the importance of protecting and enhancing heritage and nature conservation interests within the coastal zone.

Paragraphs 2.10 and 2.11 state that few developments require a coastal location, but where this is the case, the developed coast will usually provide the best option, provided that due regard is paid to the risks of erosion and flooding. Areas of nature conservation interest on the developed coast will also normally require protection.

Paragraphs 2.13 to 2.19 deal with risks relating to the coastal zone. These paragraphs highlight that the nature of coastal geology and landforms means that these areas are subject to risks, including erosion by the sea; landslips and falls of rock and also flooding. The policy in these areas should be to avoid putting further development at risk. In particular, new development should not generally be permitted in areas which would need expensive engineering works, either to protect developments on land subject to erosion by the sea or to defend land that might be inundated by the sea. The guidance also highlights that there is the need to consider the possibility of such works causing a transfer of risks to other areas. Paragraph 2.14 goes on to state that the degree of risk involved will have to be carefully considered and policies will be needed to control or restrict development in low-lying coastal areas; on land close to eroding cliffs or other eroding coastlines; and on land in coastal areas subject to instability.

Specifically in relation to erosion and land instability, paragraph 2.16 states that in the case of receding cliffs, development should not be allowed to take place in areas where erosion is likely to occur during the lifetime of the development. These areas should be clearly identified and mapped and shown in development plans. Paragraph 2.17 goes on to state that LPAs should not normally permit built development where there is potential for landslips during the lifetime of the structure. Furthermore, paragraphs 2.18 and 2.19 relate to coastal protection and defence and highlight the importance of assessing the impact of proposals on the environment and on the natural movement of material along the coast in reaching planning decisions.

Section 3 of PPG20 recognises that some developments require a coastal location by their very nature. This includes energy projects. It sets out policies for developments that

require a coastal location. In relation to major developments such as oil refineries and gas installations, paragraph 3.10 states that before such developments are permitted, it will be essential to demonstrate that a coastal location is required. Proposed developments of national or regional importance that require a coastal location will normally be included in development plans. Examples of such projects include refineries, ports, barrages and oil and gas terminals.

2.4.1.11 PPS23: Planning and Pollution Control (2004)

PPS23 confirms that any consideration of the quality of land, air or water and the potential impacts arising from development, possibly leading to impacts on health, is capable of being a material planning consideration, in so far as it arises or may arise from or may affect any land use (paragraph 2). It goes on to state that the planning system plays a key role in determining the location of development, which may give rise to pollution, either directly or indirectly and ensuring that other uses and developments are not, as far as possible, affected by major existing or potential sources of pollution. The document does, however, stress that the controls under the planning and pollution control regime should complement rather than duplicate each other.

Paragraph 9 states that development control decisions on individual planning applications, particularly those involving potentially polluting processes, can have an immediate impact on the local environment, human health and well-being. In considering such proposals for development, LPAs should take account of the risks of and from pollution and land contamination, and how these can be managed or reduced. Paragraph 10 does though stress that the planning system should focus on whether the development itself is an acceptable use of land and the impact of those uses, rather than the control of the processes or emissions themselves. LPAs should work on the assumption that the relevant pollution control regime will be properly applied and enforced. They should seek to complement not duplicate it.

2.4.1.12 PPG24: Planning and Noise (1994)

PPG24 provides advice to LPAs on the use of their planning powers to minimise the impact of noise. It outlines the considerations to be taken into account in determining planning applications both for noise-sensitive developments and for those activities, which generate noise.

Paragraph 2 confirms that the impact of noise can be a material consideration in the determination of planning applications. It highlights the role of the planning system to guide development to the most appropriate locations, but recognises that it will be difficult to reconcile some land uses, such as housing, hospitals or schools, with other activities that generate high levels of noise. Paragraph 2 does though recognise that

much of the development that is necessary for the creation of jobs and the construction and improvement of essential infrastructure will generate noise.

Paragraph 13 provides guidance on measures to control the source of, or limit exposure to noise. These can include engineering measures (e.g. insulating buildings), layout and administration measures (e.g. limiting operating times).

Paragraphs 15 to 19 refer to the use of conditions. The guidance makes clear that LPAs should consider using planning conditions to enable development proposals to proceed, where it would otherwise be necessary to refuse planning permission.

In terms of actual noise levels, the 'Glossary' to PPG24 states that a change of $3dB_{(A)}$ is the minimum perceptible under normal conditions. A change of $10dB_{(A)}$ corresponds roughly to a halving or doubling of the loudness of a sound.

2.4.1.13 PPS25: Development and Flood Risk (2006)

PPS25 aims to ensure that flood risk is taken into account at all stages of the planning process to avoid inappropriate development in areas at risk of flooding and to direct development away from the areas at highest risk. Where new development is, exceptionally, allowed in such areas, the guidance aims to make it safe without increasing flood risk elsewhere and where possible, reducing flood risk overall (paragraph 5). Planning applications should be supported by Flood Risk Assessments where appropriate.

The guidance introduces the concept of the 'Sequential Approach' (paragraphs 14 to 17) to determine the suitability of land for development in flood risk areas. The 'Sequential Test' seeks the allocation of land for development in the flood areas of least risk, where practicable (e.g. Flood Zone 1). If there are no reasonably available sites in Flood Zone 1, the flood vulnerability of the development should be taken into account in locating development in Flood Zone 2 and then Flood Zone 3.

PPS25 also promotes the use of Sustainable Urban Drainage Systems (SUDs) in development. The aim is to ensure the sustainable management of surface water drainage and to minimise run-off.

2.4.2 STATUTORY DEVELOPMENT PLAN

The Statutory Development Plan for the application site consists of the following:

- The East of England Plan (2008).
- Saved policies of the Norfolk Structure Plan (1999).
- The adopted North Norfolk Core Strategy (2008).

2.4.2.1 The East of England Plan (2008)

The East of England Plan (the Regional Spacial Strategy) was published by the Secretary of State for Communities and Local Government in May 2008. It covers the East of England, including Norfolk.

The Regional Spatial Strategy (RSS) covers the period to 2021 but sets a vision, objectives and strategy for the longer term. In particular it seeks to reduce the Region's impact on, and exposure to, the effects of climate change to realise its economic potential; and to improve and conserve its environment.

Policy SS1 of the RSS (Achieving Sustainable Development) seeks to promote sustainable development through the application of a number of key principles. These include living within environmental limits; achieving sustainable economic growth; and being environmentally sensitive.

Policy SS2 (Overall Spatial Strategy) states that in seeking more sustainable development, the spatial strategy directs most strategically significant growth to the Region's major urban areas. The policy also promotes the re-use of previously developed land.

Policy SS9 (The Coast) is of particular relevance. The policy confirms that the strategy for the coast is to adopt an integrated approach that recognises the needs of environmental protection and enhancement; the economic and social world of the Region's ports, seaside towns and coastal areas important to tourism; and predicted sea level rise and the adaptation challenges it presents to coastal communities and decision makers. The policy directs LPAs and other agencies to seek the conservation of the coastal environment and coastal waters, particularly in areas of coastline and estuary designated as sites of European or International importance for wildlife. Local development documents should ensure that new development is compatible with shoreline management and other longer term flood management plans; and protect important coastal and environmental assets. Significantly, paragraph 3.41 to the policy recognises that offshore oil and gas are important economic activities within the coastal areas of Norfolk and Suffolk.

Policy E1 (Job Growth) sets indicative targets for net growth in jobs for the period, of which North Norfolk is expected to generate 4,000 additional jobs between the period 2001 to 2021.

Policy E4 (Clusters) states that local development documents should support the sustainable and dynamic growth of inter-regional and intra-regional sectors and business clusters, including the 'energy cluster' on the Norfolk/Suffolk coast.

Policy T1 (Regional Transport Strategy Objectives and Outcomes) gives a clear priority to increasing the use of sustainable transport modes. One of the key aims of the strategy is to ensure that the transport sector makes an appropriate contribution to reducing greenhouse gas emissions. In this respect, Policies T2 and T3 relate to changing travel behaviour and managing traffic demand. Together these seek to bring about a significant change in travel behaviour with a shift to more sustainable roads and to manage existing highway space.

Policies T6, T7 and T8 relate to strategic and regional road networks, transport in rural areas and local roads respectively. In general, these policies seek to reduce congestion, promote more sustainable modes and ensure that a greater proportion of freight is carried by rail or waterway so as to minimise its impact on the environment and local transport networks.

Policy ENV2 relates to landscape conservation within the Region. This policy confirms that LPAs and other agencies should, in accordance with statutory requirements, afford the highest level of protection to the Region's nationally designated landscapes, including AONBs and the Heritage Coast. Within the AONBs, priority should be given to conserving the natural beauty, wildlife and cultural heritage with each area.

Policy ENV3 (Biodiversity and Earth Heritage) states that LPAs should afford a high level of protection to sites of International and European nature conservation importance. LPAs should also ensure that the Region's wider biodiversity, earth heritage and natural resources are protected and enriched, in particular, by ensuring that new development minimises damage to biodiversity and earth heritage resources by avoiding harm to local wildlife sites and, wherever possible through the retention of existing assets, enhancement measures and new habitat creation.

Policy ENV5 (Woodlands) states that LPAs should seek to achieve an increase in woodland coverage by protecting and achieving a better management of existing woodland and promoting new planting where consistent with landscape character. The policy focuses primarily on ancient semi-natural woodland and other woodlands of acknowledged national or regional importance and states that these should be identified in local development documents, with a strong presumption against development that would result in their loss or deterioration.

Policy ENV6 relates to the historic environment and states that LPAs should identify, protect, conserve and where appropriate, enhance the historic environment of the Region, its archaeology, historic buildings, places and landscapes. This includes the historic environment of the coastal zone.

Policy WAT4 (Flood Risk Management) states that local development documents should use Strategic Flood Risk Assessments to guide development away from flood plains, other areas at medium or high risk or likely to be at future risk from flooding, and areas where development would increase the risk of flooding elsewhere. In addition, the policy requires that sustainable drainage systems are incorporated in all appropriate developments.

2.4.2.2 Saved Policies of the Norfolk Structure Plan (1999)

A number of Structure Plan policies still have effect (are 'saved'). The only policy of direct relevance to the project is Policy T2, which relates to the transport impact of new development.

Policy T2 confirms that new development will be assessed against its effects on traffic generation. Furthermore, developers will be required to address the transport consequences arising from their proposals.

2.4.2.3 Adopted North Norfolk Core Strategy Incorporating Development Control Policies (September 2008)

The Core Strategy and Development Control Policies document sets out the key elements of the planning framework for North Norfolk that will be used when considering individual planning applications. It covers the period to 2021. The document covers the whole of the administrative area of North Norfolk, except that part lying within The Broads Executive Area, for which the local planning authority is The Broads Authority.

The policies contained with the Core Strategy and Development Control Policies document that are of most relevance to the EIA of the project are summarised in Table 2.

Table 2: Summary of North Norfolk Core Strategy Incorportating Development Control Policies

Policy Ref.	*Policy Title*	*Policy Summary*
SS 1	Spatial Strategy for North Norfolk	The majority of new development in North Norfolk will take place in the towns and larger villages and to a lesser extent within the smaller villages. The remainder of the district will be designated as 'Countryside' and development will be restricted to particular types of development to support the rural economy, meet affordable housing needs and provide renewable energy.
SS 2	Development in the Countryside	In areas designated as 'Countryside' development will be limited to that which requires a rural location and is for one or more purposes, including extensions to existing businesses; new-build employment generating proposals where there is a particular environmental or operational justification; and development by statutory undertakers or public utility providers, amongst others.
SS 4	Environment	All development proposals will contribute to the delivery of sustainable development, ensure protection and enhancement of natural and built environmental assets and geodiversity and be located and designed so as to reduce carbon emissions and mitigate and adapt to future climate change. Opportunities to improve river water quality and minimise air, land and water pollution will be taken where possible. Open spaces and areas of biodiversity interest will be protected from harm, and the restoration, enhancement, expansion and linking of these areas to create green networks will be encouraged through a variety of measures, including conservation and enhancement of Sites of Special Scientific Interest (SSSIs). The Council will minimise exposure of people and property to the risks of coastal erosion and flooding and will plan for a sustainable shoreline in the long-term that balances the natural coastal processes with the environmental, social and economic needs of the area. Sustainable Drainage Systems will be encouraged, to reduce flood risk, promote groundwater recharge and improve water quality, enhance biodiversity and provide amenity benefit.
SS 5	Economy	At least 4,000 additional jobs to be provided between 2001 and 2021 in line with indicative jobs targets in the East of England Plan.

Policy Ref.	*Policy Title*	*Policy Summary*
EN 1	Norfolk Coast Area of Outstanding Natural Beauty and The Broads	The impact of individual proposals, and their cumulative effect, on the Norfolk Coast AONB, The Broads and their settings, will be carefully assessed. Development will be permitted where it: ▪ is appropriate to the economic, social and environmental well-being of the area or is desirable for the understanding and enjoyment of the area; ▪ does not detract from the special qualities of the Norfolk Coast AONB or The Broads; and ▪ seeks to facilitate delivery of the Norfolk Coast AONB management plan objectives. Proposals that have an adverse effect will not be permitted unless it can be demonstrated that they cannot be located on alternatives sites that would cause less harm and the benefits of the development clearly outweigh any adverse impacts. Development proposals that would be significantly detrimental to the special qualities of the Norfolk Coast AONB or The Broads and their settings will not be permitted.
EN 2	Protection and Enhancement of Landscape and Settlement Character	Proposals for development should be informed by, and be sympathetic to, the distinctive character areas identified in the North Norfolk Landscape Character Assessment and features identified in relevant settlement character studies. Development proposals should demonstrate that their location, scale, design and materials will protect, conserve and, where possible, enhance: ▪ the special qualities and local distinctiveness of the area (including its historical, biodiversity and cultural character); ▪ gaps between settlements, and their landscape setting; ▪ distinctive settlement character; ▪ the pattern of distinctive landscape features, such as watercourses, woodland, trees and field boundaries, and their function as ecological corridors for dispersal of wildlife; ▪ visually sensitive skylines, hillsides, seascapes, valley sides and geological features; ▪ nocturnal character; and ▪ the setting of, and views from, Conservation Areas and Historic Parks and Gardens.
EN 3	Undeveloped Coast	In the Undeveloped Coast only development that can be demonstrated to require a coastal location and that will not be significantly detrimental to the open coastal character will be permitted.

Policy Ref.	*Policy Title*	*Policy Summary*
EN 8	Protecting and Enhancing the Historic Environment	Development proposals, including alterations and extensions, should preserve or enhance the character and appearance of designated assets, other important historic buildings, structures, monuments and landscapes, and their settings through high quality, sensitive design. Development that would have an adverse impact on their special historic or architectural interest will not be permitted. Where required, development proposals affecting sites of known archaeological interest will include an assessment of their implications and ensure that provision is made for the preservation of important archaeological remains. The character and appearance of Conservation Areas will be preserved, and where possible enhanced.
EN 9	Biodiversity and Geology	All development proposals should: ▪ protect the biodiversity value or land and buildings and minimise fragmentation of habitats; ▪ maximise opportunities for restoration, enhancement and connection of natural habitats; and ▪ incorporate beneficial biodiversity conservation features where appropriate. Development proposals that would cause a direct or indirect adverse effect to nationally designated sites or other designated areas or protected species will not be permitted unless: ▪ they cannot be located on alternative sites that would cause less or no harm; ▪ the benefits of the development clearly outweigh the impacts on the features of the site and the wider network of natural habitats; and ▪ prevention, mitigation and compensation are provided. Development proposals that would be significantly detrimental to the nature conservation interests of nationally designated sites will not be permitted. Where there is a reason to suspect the presence of protected species, applications should be accompanied by a survey assessing their presence and, if present, the proposals must be sensitive to, and make provision for, their needs.
EN 10	Development and Flood Risk	The 'Sequential Test' will be applied rigorously across North Norfolk and most new development should be located in Flood Risk Zone 1. New development within Flood Risk Zones 2 and 3a will be restricted to certain categories of development, such as 'Water Compatible Uses', minor development and 'Less Vulnerable' uses where the Sequential Test has been passed. Development in Flood Zone 3b will be restricted to Water Compatible Uses only.

Policy Ref.	*Policy Title*	*Policy Summary*
		A site-specific Flood Risk Assessment which takes account of future climate change must be submitted with appropriate planning applications in Flood Zones 2, 3a and 3b and for development proposals of 1 hectare or greater in Flood Zone 1. Appropriate surface water drainage arrangements for dealing with surface water run off from new development will be required. The use of 'Sustainable Drainage Systems' will be the preference unless, following adequate assessment, soil conditions and/or engineering feasibility dictate otherwise.
EN 11	Coastal Erosion	In the Coastal Erosion Constraint Area new development, or the intensification of existing development or land uses, will not be permitted, except where it can be demonstrated that it will result in no increased risk to life or significant increase in risk to property. Development proposals that are likely to increase coastal erosion as a result of changes in surface water run-off will not be permitted.
EN 13	Pollution and Hazard Prevention and Minimization	All development proposals should minimise, and where possible reduce, all emissions and other forms of pollution, including light and noise pollution, and ensure no deterioration in water quality. Proposals will only be permitted where, individually or cumulatively, there are no unacceptable impacts on: ▪ the natural environment; ▪ health and safety of the public; ▪ air quality; ▪ surface and groundwater quality; ▪ land quality and condition; and ▪ the need for compliance with statutory environmental quality standards. Exceptions will only be made where it can be clearly demonstrated that the environmental benefits of the development and the wider social and economic need for the development outweigh the adverse impact. Development proposals on contaminated land (or where there is reason to suspect contamination) must include an assessment of the extent of contamination and any possible risks. Proposals will only be permitted where the land is, or is made, suitable for the proposed use.

Policy Ref.	*Policy Title*	*Policy Summary*
		Development that increases the risk to life or property, except for that which is necessary to the operation of the use causing the hazard, will not be permitted within: ▪ Major Hazard Zones (as identified by the Health & Safety Executive); and ▪ in the vicinity of existing developments that require particular conditions for their operation or that are authorised or licensed under pollution control or hazardous substances legislation (including hazardous pipelines) where new development would be likely to impose significant restrictions on the activities of the existing use in the future.
EC 3	Extensions to Existing Businesses in the Countryside	Extensions to existing businesses in the 'Countryside' will be permitted where it is of a scale appropriate to the existing development and would not have a detrimental effect on the character of the area. Development at 'Bacton Gas Terminal' that is ancillary to the terminal uses will be supported within the defined area as shown on the Proposals Map.
CT 5	The Transport Impact of New Development	Development will be designed to reduce the need to travel and to maximise the use of sustainable forms of transport appropriate to its particular location. Development proposals will be considered against the following criteria: ▪ the proposal provides for safe and convenient access on foot, cycle, public and private transport addressing the needs of all, including those with a disability; ▪ the proposal is capable of being served by safe access to the highway network without detriment to the amenity or character of the locality; ▪ outside designated settlement boundaries the proposal does not involve direct access on to a 'Principal Route', unless the type of development requires a 'Principal Route' location. ▪ the expected nature and volume of traffic generated by the proposal could be accommodated by the existing road network without detriment to the amenity or character of the surrounding area or highway safety; and ▪ if the proposal would have significant transport implications, it is accompanied by a Transport Assessment, the coverage and detail of which reflects the scale of development and the extent of the transport implications, and also, for non-residential schemes, a Travel Plan.

2.5 AIR QUALITY STANDARDS

The Government's Air Quality Strategy (DEFRA, 2007) provides Air Quality Standards and Objectives for key air pollutants, which are designed to protect human health and the environment. It also sets out how the different sectors (industry, transport, and local government) can contribute to achieving the Air Quality Objectives. The objectives are prescribed within The Air Quality (England) Regulations 2000 and The Air Quality (England) (Amendment) Regulations 2002. Air Quality Standards and Objectives are set for seven atmospheric pollutants; 1,3-Butadiene, lead, carbon monoxide (CO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), benzene, and particulate matter (PM_{10}). The 'standards' are set as concentrations below which health effects are unlikely even in sensitive population groups, or below which risks to public health would be exceedingly small. They are based purely upon the scientific and medical evidence of the effects of a particular pollutant. The 'objectives' set out the extent to which the Government expects the standards to be achieved by a certain date.

The primary sources of air emissions within the proposed facilities are the combustion equipment; natural gas does not have a high sulphur or particulate content and therefore the principle atmospheric pollutants which would be emitted from the proposed gas compression and processing facilities are oxides of nitrogen (NO_x) as nitrogen dioxide (NO_2). This EIA will therefore only consider the Air Quality Objective for NO_2. A summary of the NO_2 Air Quality Objectives is presented in Table 3.

Table 3: Air Quality Objectives for Nitrogen Dioxide

Status	*Pollutant*	*Time Period*	*Objective / Value*	*To be Achieved by* (A)
Statutory UK Objective	NO_2	1-hour mean	200µgm^{-3} not to be exceeded more than 18 times a year	2005
	NO_2	Annual mean	40µgm^{-3}	2005
EU Limit Value	NO_2	1-hour mean	200µgm^{-3} not to be exceeded more than 18 times a year (B)	2010
	NO_2	Annual mean	40µgm^{-3} (B)	2010
	NO_2	Annual mean	30µgm^{-3} (C)	2000

NOTE A: The achievement dates for the UK objectives are the end of the specified year; achievement dates for the EU limit values are the start of the specified year.
NOTE B: EU Limit Values for protection of human health.
NOTE C: EU Limit Value for protection of vegetation and ecosystems.

Measurements across the UK have shown that the 1-hour NO_2 objective is unlikely to be exceeded, unless the annual mean NO_2 concentration is greater than 60µgm^{-3} (Laxen and Marner, 2003). Thus, an annual mean NO_2 concentration of 60µgm^{-3} or more may be used as an indicator of potential exceedences of the 1-hour mean NO_2 objective.

The European Union (EU) has also set limit values for NO_2 both for the protection of human health and vegetation and ecosystems. Achievement of these values is a national obligation rather than a local one. The limit values for NO_2 for the protection of human health are the same levels as the UK objective, but are to be achieved by 2010. The $30\mu gm^{-3}$ Air Quality Objective for the protection of vegetation and ecosystems has yet to be incorporated into UK Regulations.

2.6 LOCAL NATURE CONSERVATION DESIGNATIONS

The main government body responsible for species and habitat conservation, enhancement and management in England is Natural England. It is responsible for promoting nature conservation and for protecting and encouraging biodiversity. Natural England enforces nature conservation law, part of which involves designation and monitoring protected sites, including Sites of Special Scientific Interest (SSSI), Special Areas of Conservation (SAC), National Parks, Areas of Outstanding Natural Beauty (AONB) and National Natural Reserves (NNRs).

The Planning Policy Statement 9: Biodiversity and Geological Conservation (ODPM, 2005) sets out planning policies on the protection of biodiversity and geological conservation through the planning system. It is concerned with the protection of statutory and non-statutory sites of biodiversity and/or geological conservation value, in addition to species protection and biodiversity conservation in the wider environment. The objective of PPS9 is to conserve and enhance biological diversity in England with regards to construction, development and regeneration.

PPS9 is a complement to other national planning policies, rather than a replacement. Key principles are set out, which include the need for up-to-date environmental data, for appropriate weight to be attached to biodiversity in decision making, and to promote opportunities for enhancement of biodiversity and geological conservation within designs and to prevent harm to them.

PPS9 strengthens the requirement for local authorities to place careful consideration in conservation and enhancement of habitats and species listed under section 74(2) of the Countryside Rights of Way Act (CRoWA) 2000 as being of "principal importance for the conservation of biological diversity in England". In cases where there may be a potential effect on a protected species, adequate mitigation must be provided prior to planning permission being granted.

National legislation for protection of selected species is provided by the Wildlife and Countryside Act 1981, as amended. Sections 1(1) and 1(2) specify that all British birds, their nests, and eggs (excluding some game and pest species) are protected from intentional killing, injury, or damage. Sections 1(4) and 1(5) lay out provisions of

penalties applied to harming of bird species listed in Schedule 1 of the Act. Protection is also available for Schedule 1 species from disturbances resulting from building works, in or near a nest and disturbance to dependent young.

Selected species, other than birds, are also provided special protection under Schedule 5 of the Wildlife and Countryside Act through prohibition of damage to "any structure or place which any wild animal (included in the schedule) uses for shelter and protection" and against disturbances in these places. The CRoWA also introduced provision to make "reckless" offences, in ways of disturbance to wildlife, punishable by imprisonment. The Protection of Badgers Act 1992 provides protection to badger and their setts.

Numerous species are provided additional protection through Schedule 2 of the Conservation (Natural Habitats, etc.) Regulations 1994, as amended. These regulations transpose the European Community Habitats Directive (92/43/EEC) into UK Law, setting out measures to conserve natural habitats and wild fauna and flora. The Regulations extend protection against deliberate disturbance to species and provide tests against which a development that may have an effect on Schedule 2 protected species must be assessed before permission is granted. A Phase 1 extended habitat survey has been undertaken in order to consider the impact of the proposed development on local species.

2.7 LOCAL NOISE CONTROL REQUIREMENTS

Noise emissions from industrial installations are usually regulated by conditions set as part of any planning approval and / or through the Environmental Permitting (England and Wales) Regulations 2007. Permits can include noise emission limits or provisions for Noise Management Plans.

The five Bacton Gas Terminal Complex operators have come together in the Bacton Forum to create a 'Code of Practice on Environmental Noise – Bacton Terminals' (Perenco, 2003). This has been agreed by NNDC and the Terminal operators. The noise emissions from new development at any of the Terminals are restricted to the parameters laid out in the Code of Practice.

This Code of Practice is intended to provide a framework for managing environmental issues relating to noise arising from the Terminals. It is to be used during the planning process for new projects and in relation to the on-going improvement to the existing environment in the vicinity of the complex.

A series of community control points have been identified by the Bacton operators in conjunction with the NNDC and reference noise levels have been set for each point.

Permitted noise impacts have been defined and these are used to determine noise limits for new projects to ensure that the area is not subject to a rise in background noise level.

An assessment of noise from the proposed installation is required to determine how the background noise at the community control points will be affected and whether any variations are within the defined limits.

2.8 OVERVIEW OF OFFSHORE ENVIRONMENTAL STATEMENT

The Offshore Environmental Statement (ES) is written as a separate document to this Onshore ES. It begins at MLWM, which is where the scope of the Onshore ES terminates, and covers all environmental issues related to the project offshore.

The Offshore ES addresses all parts of the development below MLWM. As with the Onshore ES, it gives full assessment of both the construction and operational phases of the project. The report investigates and reviews all the potential environmental impacts of the proposed project on the physical, biological and human environments of surrounding areas and discusses how these will be mitigated against. Monitoring systems that will apply during the project are also described.

3.0 PROJECT DESCRIPTION

3.1 INTRODUCTION

The depleted Baird gas reservoir is located in Block 49/23 in the Southern North Sea and is approximately 86 km east of the Perenco Bacton Gas Terminal. It was first developed in 1993 using a single well. As of September 2009, approximately 132 bcf of gas has been produced; however, production is decreasing as the gas in place (GIP) declines. The Baird reservoir is considered to have excellent geological characteristics for the development of a natural gas storage facility.

3.2 OVERVIEW OF DEVELOPMENT

It is proposed that the Baird reservoir will be developed for storage of natural gas during periods of low use such as the summer, with gas returned onshore during high use periods, in particular during the winter. This will require two discrete modes of operation:

- Injection – gas is routed from the NTS, via the compression facilities at the Bacton Terminal, to the Baird reservoir.
- Production – gas stored in the reservoir is transferred onshore, conditioned and returned to the NTS.

It is expected that withdrawal will be undertaken for approximately 155 days per year with injection accounting for approximately 175 days per year. This allows 20 days of flow reversal.

In order to achieve these modes of operation four main elements will be required:

- A NUI with 18 slots and 14 wells;
- A 38" subsea gas pipeline and a 4.5" Mono Ethylene Glycol (MEG) pipeline;
- New facilities within the Perenco Bacton terminal; and
- 36" pipeline connection to the NTS at Bacton.

It is not within the scope of this Environmental Statement to consider the offshore elements of the development and therefore only the pipeline and equipment from the MLWM, through to the National Grid site will be described.

The gas supplied by NTS for injection will require compression prior to transfer to the reservoir. Gas returned from the reservoir will need treatment to ensure it is within the NTS specification range. These facilities will be located within the existing Perenco

terminal on an area of land that currently contains a small amount of mothballed equipment but is largely unused.

3.3 ONSHORE DEVELOPMENT AND OBJECTIVE SCOPE

The Onshore Environmental Statement describes the results of the EIA of the following elements of the onshore project:

- Installation of a 38"gas pipeline and 4.5" MEG pipeline from the MLWM into the Perenco facility;
- Installation of compression, dewpointing, gas heating, venting and fiscal metering facilities;
- Installation of MEG regeneration facilities;
- Construction of a 36" gas pipeline to connect the new facilities to the National Grid site;
- Operational control and maintenance regimes; and
- Decommissioning.

3.4 SELECTION OF DEVELOPMENT OPTION

The selection of the development option was undertaken following a concept study. Options were considered for the following elements:

- Reservoir selection
- Onshore location selection
- Pipeline route
- Onshore layout
- Process engineering design

3.4.1 RESERVOIR SELECTION

Following an extensive review of gas reservoirs in the Southern North Sea the Baird reservoir was selected for natural gas storage as it displays the following favourable characteristics:

- The porosity and permeability of the reservoir rock is excellent meaning that the gas may be easily injected and quickly recovered;

- It is well defined and contained geological structure thus preventing gas migration;
- It is a single reservoir rather than being divided into compartments, thereby making the location of the wells much simpler;
- It is of a medium size which is economically viable (small reservoirs cannot justify the capital cost of development whereas the capital cost of cushion gas to fill large reservoirs is prohibitive); and
- It is not too distant offshore to make the capital cost of the pipeline exclusive.

Further details concerning the selection of the reservoir are provided in the Offshore Environmental Statement.

3.4.2 ONSHORE LOCATION SELECTION

The Bacton Terminal has been selected as the location of the onshore processing facility. There were potentially three landfall sites for this development: Bacton, Theddlethorpe (Lincolnshire), and Easington (East Yorkshire). Bacton is the closest facility to the Baird reservoir and will therefore require the shortest pipeline route. The Bacton Gas Terminal Complex of five installations includes the National Grid NTS facility. The close proximity minimises transportation distances and the Bacton NTS node has the highest gas transport capacity of the three locations.

Use of the Theddlethorpe terminal would require a longer pipeline and a traverse of the shallow sensitive waters between The Wash and the Humber. Easington would require an even longer pipeline than Theddlethorpe and involve crossing an area of unstable seabed; this area has active sand waves that would significantly increase engineering challenges and potential environmental impacts of the pipeline.

It was therefore determined that Bacton would be the most appropriate landfall location for this development.

The onshore facilities will be located within the Perenco site, on an area that contains some mothballed equipment but is largely unused. The development will be located within an existing industrial brownfield site, preventing the requirement to convert further land to industrial use. Figure 5 presents the proposed site layout.

The Bacton Gas Terminal Complex has been operational for approximately 40 years and the infrastructure in the area is well developed for gas processing and transport. Several large development projects have been undertaken at the Complex in the past and the surrounding road networks have been designed or altered to manage the movement of equipment and resources required for construction projects of this nature. A Traffic

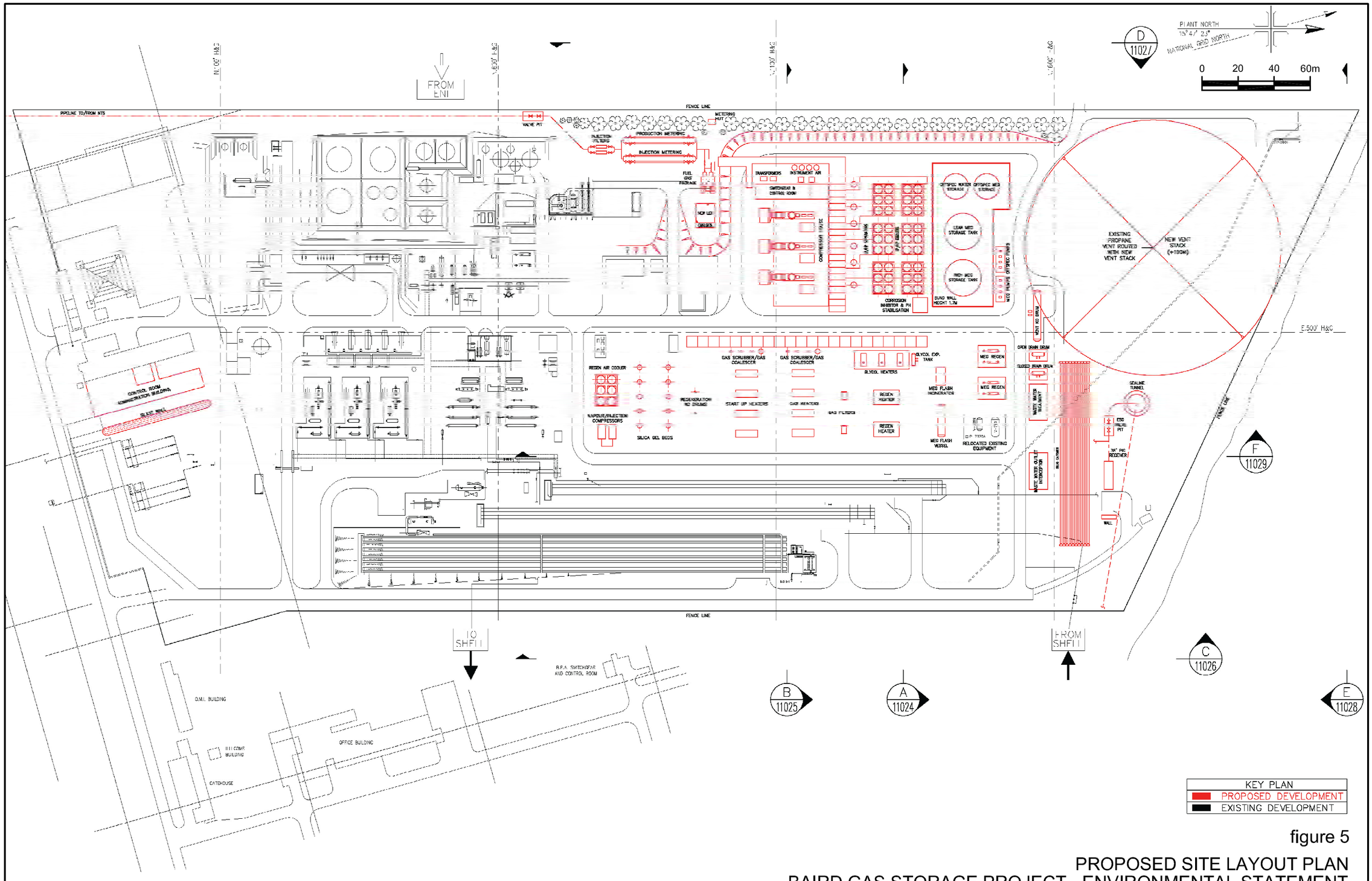

figure 5

PROPOSED SITE LAYOUT PLAN
BAIRD GAS STORAGE PROJECT - ENVIRONMENTAL STATEMENT
BACTON STORAGE COMPANY LIMITED
Bacton Gas Terminal Norfolk

SOURCE: GENESIS DRAWING C09134-BC00-00-00-201-11033, 25.01.10.

Management Plan (TMP) will be put in place to ensure that the impact of construction activities on the local environment will be minimised.

There is an existing skilled workforce already employed at the Bacton Gas Terminal Complex and also a specialised supply-chain in the wider area, in particular Norwich and Great Yarmouth. The Perenco installation is already regulated by the Environment Agency, Health and Safety Executive (HSE) and DECC for their existing activities. It is therefore considered that the Perenco installation at Bacton is an appropriate onshore location.

3.4.3 OFFSHORE PIPELINE ROUTE

Selection of the offshore pipeline route was based upon distance, pipeline crossings, near-shore pipeline congestion, and environmental sensitivity of the seabed. The selected route minimises crossings and avoids the very shallow sand banks which are found in this area and considered to be environmentally sensitive. Further information concerning pipeline route selection is provided in the Offshore Environmental Statement. The location for the landfall was selected to avoid other existing pipelines and outfalls and to minimise the tunnelling distance between the terminal and the beach.

3.4.4 OFFSHORE FACILITIES

It is proposed that 18 slots with 14 wells will be required for the injection into and withdrawal of gas from the reservoir. An NUI has been selected to provide the required offshore facilities; an NUI minimises safety issues, maintenance requirements, environmental impact, and reduces costs. Further information concerning the selection and proposed plans for the NUI and offshore facilities are provided in the Offshore Environmental Statement.

3.4.5 ONSHORE LAYOUT

The use of an NUI to provide the offshore facilities requires that gas conditioning and compression facilities are available onshore at Bacton. Figure 5 provides the proposed layout of the onshore facilities.

The pipeline will landfall at the beach to the south of the Perenco terminal and will be connected by shaft and bored tunnel. There are a large number of pipelines that landfall at Bacton and similar techniques to those used in previous projects will be undertaken to

minimise the impact of the construction and ensure that no other pipelines are affected. The design selected minimises tunnel length.

The pig receiver and Emergency Shut Down Valve (ESDV) will be located at the top of the tunnel; the exit of the pipeline tunnel will be located behind a grass mound which will conceal it.

The export/import line route has been designed to minimise pipe runs and will be directed south to enter a new process area. This area currently contains the helipads which are no longer used. The development will require removal of the existing hard standing areas and movement of three vessels and a vent stack. These will be relocated within the existing installation. A new tarmac road will be constructed within the terminal to allow access.

The three gas compressors housed in the compressor building, as well as the air fin fan coolers, will be situated to the northeast of the Site. Access to this area will be completed with a new road connecting the existing east/west and north/south roads.

The new Local Equipment Room (LER) and standby generator will be situated to the south of the compressor building. On the other side of the north/south road will be the slug catchers, start-up heaters, regeneration heaters, adsorption vessels, regeneration fan coolers, regeneration separators, and regeneration compressors.

South of the compressor building will be the injection metering package and filters, the LER and emergency generator. The fuel gas package will be to the north west of the injection metering skid. The pipeline to NTS will run inside the west fence line and pass under the road separating the two terminals.

The new MEG storage facilities will be situated towards the western perimeter fence at the northern end of the installation along with the MEG export pumps and the vent stack.

The design of the layout of the onshore facilities within the Perenco terminal has taken into account the following:

- Classification of hazardous areas;
- Minimisation of above ground gas inventory and sources of ignition;
- Elimination of process lines and minimisation of utility lines passing through hazardous to non hazardous areas;
- Containment of fire incidents; and
- Accessibility of escape routes.

Administration and utilities areas will be located as far away from hydrocarbon process areas as possible. A new control room will be constructed close to the existing one. A new building within the Baird facilities area will provide temporary control. An Occupied Buildings Risk Assessment (OBRA) will be undertaken and manned buildings will be constructed to survive and provide protection from all credible incident scenarios.

The proposed layout ensures that easy access will be possible to all areas of the new equipment. It also has minimal impact on the existing facilities and develops areas of the installation that are currently not in use.

A Front End Engineering Design (FEED) study will be conducted to identify opportunities for energy conservation and heat integration design. It is not expected that this study will lead to significant changes in the layout previously described as efficiency factors have already been taken into consideration, for example the gas dehydration unit and start-up heaters have been located to create a consolidation of heaters together. The study will however identify other areas where further improvements can be made.

3.4.6 PROCESS ENGINEERING DESIGN

A gas storage project comprises a number of common equipment requirements. It is considered, however, that there are two options for design and operation of the withdrawal of gas; wet pipeline operation and dry pipeline operation. The selection of either of these operating modes will have significant impact upon the on- and offshore processing facilities. This is therefore the most strategic of process engineering options considered and is described below.

3.4.6.1 Wet Pipeline Operation

Wet pipeline operation involves the withdrawal of gas from the reservoir with no offshore processing. The dry gas injected into the reservoir becomes saturated by water within the formation; although it is unlikely that the gas will become fully saturated. It is expected that, depending on ambient seawater temperatures, greater than 90 percent of the water will condense in transit in the pipeline during this period. This presents three major operating problems:

- Hydrate formation as gas cools to seawater temperatures requiring a reliable hydrate inhibition programme;

- Carbon dioxide (CO_2) corrosion of carbon steel requires a significant corrosion allowance with a reliable corrosion inhibition programme; and
- Liquid loading resulting from condensed water and injected hydrate inhibitor will be high, potentially resulting in high liquid volumes. This will require intermittent pigging.

Hydrates are complex crystalline structures which build up under certain conditions of temperature and pressure when water is present and can cause severe restrictions in the gas line. Indicative Best Available Techniques (BAT) describes the use of either mono ethylene glycol (MEG) or methanol as standard hydrate inhibitors; both have been considered. Methanol is usually used when gas flows/water saturation are low and small quantities of inhibitor are required; it has a significantly lower recovery rate compared to MEG and is usually used in a once through system. Use of methanol is likely to result in large quantities of methanol either being discharged via the outfall or removed from the installation by tanker. In addition, the hazardous nature of methanol in comparison with MEG is seen as an increased risk. MEG can also be used as a carrier for corrosion inhibitors. MEG has therefore been selected over methanol as the hydrate inhibitor. MEG will be supplied by a 4.5" pipeline from the terminal for controlled injection offshore then regenerated on return to Bacton with the transported gas.

Pigging will be required to remove liquid slugs in the wet pipeline. An automatic pig launcher will be installed at the NUI. It will be designed to hold up to 6 spheres in line with the requirements of indicative BAT. Liquids transferred from offshore during pigging and operation will be separated in a slug catcher to let down pressure and therefore allow liquids to drop out of the gas phase. The NUI will have a slug catcher to ensure that no liquids are returned to the reservoir during injection. The use of the vapour recovery system in the onshore slug catcher to minimise emissions to air during letdown will be considered in a FEED study.

3.4.6.2 Dry Pipeline Operation

The alternative to wet pipeline operation is dry pipeline operation. The dry pipeline design is based on ensuring that no liquid water condenses in the sub-sea pipeline. The dry pipeline would be 42" diameter; the larger diameter is possible as significantly less corrosion would be expected.

A number of options were considered to achieve dry operating conditions:

- Gas chilling and dehydration using mechanical refrigeration;
- Absorption process;
- Adsorption process; and
- Gas autochilling.

The first three options were excluded based on the requirements for manned operation, rotating equipment, or large heavy equipment offshore; these are not in line with the project specification of a NUI which has minimal maintenance requirements. The fourth option, gas autochilling, requires a pressure drop to allow coincident temperature drop; this causes the condensation of liquid water and results in dry gas entering the pipeline. The pressure drop however, will impact on reservoir deliverability towards the end of withdrawal cycles and would therefore require additional equipment to minimise the impact of this.

Sub-options were considered to minimise the impact of the pressure drop caused by gas autochilling; a number of options were discounted at an early stage of screening, however the following were investigated further.

Joule-Thompson (J-T) Valve – Gas/gas heat exchange and gas expansion/chilling across a J-T control valve reduces temperature to -1°C and 93.9 barg. The pressure drop would still impact deliverability of the reservoir; up to 44 percent of the withdrawal cycle could be affected. MEG injection would be required.

Turbo-expander – A turbo-expander/re-compressor set could perform gas auto-chilling by isentropic expansion of the gas stream. The expander recovers energy from the gas expansion which is used to drive the coupled re-compressor and therefore reduces overall pressure drop through the process. This, however, requires rotating equipment.

Hybrid – The J-T valve operates for approximately 66 percent of the withdrawal cycle and a wet pipeline operation is used for the remaining period. This would minimise the impact on deliverability; however, it was identified that none of the disadvantages of the wet pipeline operation were addressed and therefore it was not an appropriate solution.

The removal of liquids offshore, as required by the dry pipeline, poses a number of additional issues, including the handling and disposal of separated liquids on the NUI. This would require the installation of a water treatment package offshore and the storage of a small quantity of liquid hydrocarbons. MEG is still required to prevent hydrate formation in the offshore process; injected quantities are significantly reduced compared to wet gas and therefore a 400 cubic metres (m^3) capacity tank would be used to store MEG offshore. This would be a once through system which would be discharged to sea and would therefore have environmental considerations for resource use and disposal offshore. This option, however, would not require any MEG regeneration facilities at Bacton.

3.4.6.3 Option Selection

It has been determined that both wet and dry pipeline operations are feasible but both present significant technical challenges. The output from investigations, modelling and reports produced by Offshore Design Engineering Limited (ODE) and Universal Pegasus were used in a concept selection process. Hazard identification (HAZID) studies have been conducted for both cases and no major issues that would affect concept selection were identified. The differences in onshore and offshore facilities requirements were considered including corrosion inhibition, hydrate formation, gas dehydration and the use of start-up heaters; these will be discussed in Section 3.5. It was determined by BSCL, when all factors were considered, that the project would go forward to the Front End Engineering Design (FEED) on the basis of wet gas operation.

3.5 PROJECT DESIGN AND OPERATING CHARACTERISTICS

The proposed gas reception and processing facilities will be located within the existing site boundary of the Perenco site at Bacton, but will require the installation of new equipment. This will ensure that the Baird Gas Storage Facility, which will be designed for an operating life of 50 years, will be able to stand alone should the existing Perenco facilities cease operation sometime in the future.

The new facilities will filter, meter, and compress dry gas received from the NTS prior to transport to the NUI for injection into the Baird reservoir. The onshore facilities will ensure the gas is of a suitable quality for injection and provide the appropriate pressure for flow to the NUI. Gas returning from the reservoir will be treated onshore to remove water, MEG, corrosion inhibitor, and hydrocarbon condensate to ensure it complies with the specifications of the NTS.

The development of a gas storage project requires a number of processing components in order to operate. These are as follows:

- Injection gas filtering and metering;
- Injection gas compression;
- Withdrawal gas flow control at the Offshore Wellhead chokes;
- Pipeline hydrate inhibition;
- Withdrawal gas onshore reception incorporating an onshore slug catcher to remove liquids accumulating in the pipeline;
- Onshore gas dehydration;
- Withdrawal gas metering to the NTS;
- Onshore start-up heaters required at the start of each withdrawal cycle; and

- Onshore slug catcher for injection cycles.

3.5.1 DESIGN PHILOSOPHY

The design philosophy for this development is to create a stand-alone gas storage facility that can provide service for up to 50 years without reliance on existing production equipment, but which is incorporated within the Perenco site to minimise visual and environmental impact and maximise efficiency.

3.5.2 GENERAL BASIS OF DESIGN

The design parameter overview is provided in Table 4. The sizing and selection of equipment has been based on these design parameters.

Table 4: Design Parameters

	Parameter	***Value***
Reservoir Parameters	Minimum pressure in normal operations	114.5 bara
	Initial pressure	277 bara (B)
	Average re-pressurisation pressurisation	264 bara (B)
	Reservoir temperature	94.8°C (A)
	Water saturation	100 percent
Sea Temperature	Temperature	~4-16°C
NTS Parameters	Maximum pressure	70 barg
	Typical pressure range	45-70 barg (A)
	Temperature	1-38°C (A)
	Water dewpoint	-10°C at 75 barg (C)
	Hydrocarbon dewpoint	-2°C at pressure $\leq$75 barg (C)
Flow rates	Maximum withdrawal rate	1400 Mmscfd (A)
	Injection rate	767-1101667 Mmscfd (D (60 bcf in 90 days)

NOTE A: Concept Basis of Design (Pegasus International, 2009).
NOTE B: Basis of Design – Wet Pipeline Operation (ode, 2009a).
NOTE C: Proposed Contact from the Baird Gas Storage FEED (Centrica, 2009).
NOTE D: To be confirmed based on compressor selected.

The process required for injection and withdrawal are presented in figures 6 and 7 respectively.

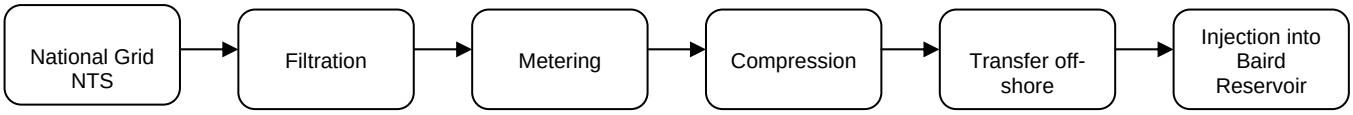

Figure 6. Process Flow of Injection

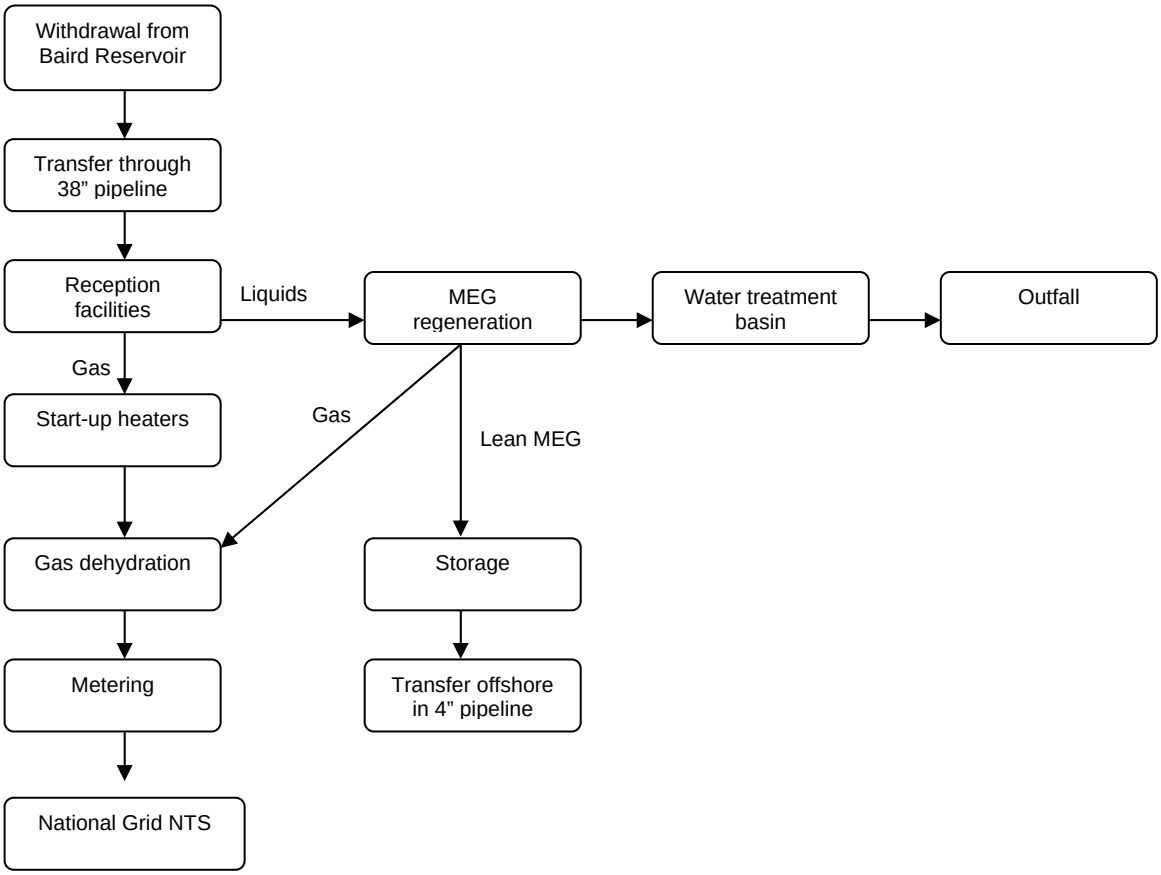

Figure 7 Process Flow of Withdrawal

3.5.3 INJECTION

Gas injected into the reservoir will be taken from the NTS. As such it will be clean and will not contain any pyrophoric dust; however, filters will be put in place to prevent any solids arriving from or being transferred to the NTS. The pressure of the arriving gas will be between 45 barg and 70 barg. Temperature will be 21°C.

3.5.3.1 Gas Metering

An onshore injection gas metering package is required to measure the total gas flow drawn from the NTS during injection cycles. This will include both gas injected into the

reservoir and fuel gas used within the facilities. The injection rate will range from 767 to 1101 Mmscfd over the injection period because the reservoir pressure rises through the cycle. The estimated fuel gas consumption for injection compression is 17 Mmscfd per cycle.

The metering package will include bi-directional elements so that gas withdrawal is also monitored. Redundancy will be incorporated to ensure metering is not impacted by maintenance. The package will use robust equipment that requires minimum maintenance and simple calibration and operating techniques.

3.5.3.2 Injection Gas Compression

Re-injection requires compression of the gas through the cycle from 145 barg to 225 barg. Compression will be provided by three onshore trains; each train will consist of a two stage centrifugal compressor, air-cooled aftercoolers for each stage of compression, suction/discharge scrubbers for each stage and gas turbine drivers. The total compression load required is 60 MW (hydraulic power output to gas); electrical drivers were considered, however the capacity required for this is not available from the existing electricity distribution system and would require a new transmission line, the need for the security of supply of gas means that the onshore terminal must be self-sufficient. Gas turbines will therefore be used; these will be an aero-derivative design each will have a 90MW thermal input and an output of 82MW providing a 33MW (hydraulic power output per machine to gas). These have been selected as they are the largest tried and tested packages currently available for this type of service. A FEED study will be undertaken to confirm the design and specification of the compressors and to ensure they will meet operating requirements. Under most operating conditions, two compressors will be used, with each operating at approximately 50 percent of the total service capacity required. The third compressor will be required in some circumstances, for example during the summer. The compressors will be designed for the conditions presented in Table 5.

Table 5: Design Conditions for the Three Gas Turbine Driven Compressors

Mode	***Condition***	***Start of Cycle***	***End of Cycle***
Injection	Total Flow rate	1101 Mmscfd	767 Mmscfd
	Inlet Pressure	43.5 barg	
	Discharge Pressure	146 barg	225barg
Withdrawal	Total Flow rate	1400 Mmscfd	
	Inlet Pressure	45 barg	
	Discharge Pressure	75 barg	

Abridged from *Basis of Design – Wet Pipeline Operation* (ode, 2009a).

The compressors will largely be used during the injection phase but may be required during withdrawal, if delivery demand exceeds the reservoir's capacity to deliver under free-flow conditions. In addition, compressors will be required for evacuating the pipeline during maintenance and to deal with hydrate formation. The Environment Agency Combustion Sector Guidance EPR 1.01 (EA, 2009a) identifies that the most appropriate gas turbine should be selected for the operational conditions, including the installation of multiple smaller engines to allow more efficient loading. Aero-derivative engines are more adaptable to variable loads and are more efficient at operating under high pressure than industrial units. It is therefore considered that the selection of this type of gas turbine is in line with the requirements of indicative BAT.

Indicative BAT also identifies that waste heat should be recovered from the exhaust and used elsewhere in the installation. An assessment has been made of the potential for heat recovery from gas compression (ode, 2009b and 2009c). Fuel gas demand has been estimated at 16.83 Mmscfd or 3.69 bcf per year. The potential for waste heat recovery is 112.5 MW during gas injection; however, injection is only undertaken for 175 days per year and the additional heat users are not operational at this time. It is therefore considered that there is no efficient use for this waste energy.

A combined cycle system producing electricity or steam from the compressors is not considered appropriate for the proposed facilities. The compressors will only be operational for 175 days per year; there is no steam requirement that would be concurrent with this production regime and electricity demand is continual. The exhaust from the compressors also cannot replace the function of the gas heaters due to the timing of the heat requirement. The other major energy users including the MEG regeneration system are not operational at the time of compression or are used only for short periods.

A fuel gas superheater to permit start-up and operation of the compression trains with the use of Waste Heat Recovery Units in the turbine exhausts was considered but was determined to be an inefficient design due to the short and infrequent duration of use.

Energy storage from one mode of operation to the other has not been considered at this stage, as technologies are not sufficiently well developed.

The above conclusions regarding heat recovery shall be reviewed and confirmed as appropriate during the FEED study.

3.5.3.3 Pipework

The pipework within the installation will be reviewed in the FEED and detailed design stages to minimise pipe runs, associated energy and pressure losses, and noise generation. This is in line with the requirements of indicative BAT.

The piping within the installation will be ANSI/ASME B31.3 (ASME, 2008). These standards describe requirements for materials and components, design, fabrication, assembly, erection, examination, inspection and testing for piping carrying gas and petroleum products within petroleum refineries and associated process plants.

3.5.3.4 Pipelines

After passing through the air coolers, gas is directed to the pipeline start point, adjacent to the pipeline tunnel end shaft. The pipeline end shaft is connected by a tunnel to the pipeline start shaft, on the beach below the Bacton Gas Terminal Complex. The tunnel will be at a depth that will not interfere with any other pipeline or obstruction in the area. The gas pipeline, although it will not be described in great detail here, will be 100 km long and 38" in diameter. It will have bi-directional allocation metering to ensure the quantity of gas arriving at and leaving the reservoir is accurately known.

The MEG pipeline will be 4" in diameter and laid separately. It will initially 'piggy back' the gas pipeline but will be trenched and buried for protection offshore.

The pipelines must be of a specification appropriate for the pressure of the substances they contain. The pipelines from the NUI to the landfall will be designed to acceptable North Sea pipeline specifications; DNV OS-F101 Submarine Pipeline Systems (DNV, 2008) or BSI PD 8010 Part 2 (BSI, 2004).

3.5.4 WITHDRAWAL

During withdrawal from the reservoir, gas received onshore is directed to dedicated dehydration facilities and then to metering.

3.5.4.1 Reception Facilities

The gas arriving onshore will have a high moisture content. In order to provide gas of saleable quality to the NTS, the arriving gas will be separated into two phases: gas and MEG/water and condensate. It is not expected that any significant quantities of condensate will be present in the stream; however, a FEED study will be undertaken to

confirm this. If small amounts of condensate are present it will be separated and metered and processed within the existing facilities on the Terminal.

The first means of separation is the slug catcher. A slug catcher is a vapour/liquid separator which provides a liquid surge buffer; its use is in line with the requirements of indicative BAT. It is anticipated that a new slug catcher will be installed adjacent to the heater package and east of the compressor building, as identified on Figure 5. The slug catcher is expected to be a finger type for construction reasons. A FEED study will be undertaken to verify the type and sizing basis for the slug catcher in line with the requirements of indicative BAT.

In order to prevent build up of liquids within the pipeline, pigging will be required periodically. This directs any liquid slugs in the line to the slug catcher improving the efficiency of the pipeline and minimising corrosion. The pig receiver will allow for pigging during routine operation and when intelligent pigging is carried out. The frequency and timing of sphere pigging procedures will be assessed in a FEED study. This will ensure that pigging is undertaken at the optimum frequency to ensure efficient operation but to minimise pigging events, in line with the requirements of indicative BAT.

A new vapour recovery system will be installed in line with the requirements of indicative BAT. A FEED study will be undertaken to determine the technical detail but it is expected that the pig receivers will be let down to this system to minimise emissions to air.

Liquids separated in the slug catcher will be directed to the MEG regeneration system. Gas is transferred to the start-up heaters.

3.5.4.2 Start-Up Heaters

At the end of an injection cycle, the pipeline will be filled with gas at approximately 222 barg; upon the commencement of the withdrawal cycle, the pressure will be reduced to the onshore operating pressure of around 75 barg. The let down in pressure will cause a temperature drop in the gas to as low as -35°C. In order to heat the gas to a temperature suitable for further onshore processing and introduction to the NTS, it must be heated.

One of the options considered to provide this heat was to use four separate water bath heaters. This was reviewed as part of a heat integration study which evaluated possible opportunities for rationalising the plant cooling and heating loads including waste heat recovery in line with the requirements of indicative BAT. It was concluded that a central

heating medium circuit of a MEG/water mixture will provide the best opportunity for optimising heat integration.

The water baths will be warmed by three fired heaters; these will operate to meet the widely varying loads of the consumers serviced by the central heating circuit. The fired heaters will be located on the north side of the site, near to the heat requirements to minimise losses, but sufficiently far away not to present a high risk of igniting any accidental leaks of hydrocarbons.

As the fired heaters are gas fired, combustion gases will be released including CO_2, CO, and NO_x. The fuel gas used will be of saleable quality, as required by indicative BAT. The particulate and sulphur content of fuel gas is low and therefore the particulate and SO_2 emissions from combustion sources are generally considered to be insignificant hence monitoring of these pollutants is not usually required. Further details concerning the emissions from these sources are provided in Section 5.3.2.

An emergency vent will be installed for emergency depressurisation of the plant and pipeline; further information about this can be found in section 3.5.4.5. The installation currently operates with the philosophy of containment and minimising releases of hydrocarbons through local, safe vents; the commissioning of an emergency vent will allow depressurisation of particular sections of the new facilities, but will maintain the current operating philosophy as venting will only occur to prevent an emergency situation. The vent will be located in the north western corner of the installation. Controlled depressurisation will be managed largely by gas recovery and High Pressure (HP)/Low Pressure (LP) interfaces will be protected by High Integrity Pressure Protection System (HIPPS).

3.5.4.3 Gas Dehydration

Gas arriving at Bacton following withdrawal from the reservoir will have a water content that exceeds the NTS specification of $45mgm^{-3}$ as the wet pipeline option has been selected. Onshore gas dehydration will therefore be required to achieve the NTS gas entry dew-point specification.

An initial screening exercise was performed to evaluate the available technologies for gas dehydration against set criteria. The technologies investigated were:

I. Adsorption – Solid desiccants (e.g. silica gel, activated alumina, molecular sieves)
II. Absorption – Liquid desiccants (e.g. glycols) and solid desiccants (deliquescent dehydration e.g. calcium chloride)
III. Refrigeration – Condensation of the excess component at low temperatures using mechanical refrigeration
IV. JT cooling by gas pressure reduction.

V. Gas Permeation – Membrane technology

From the initial screening exercise the first two processes were identified for further evaluation. These were adsorption by solid desiccant (silica gel) and absorption by liquid desiccant (Triethylene Glycol (TEG)).

Refrigeration was rejected mainly because of the extra energy load and the large amount of space required to accommodate the additional equipment. JT cooling was rejected due to its high pressure drop; this would affect the ability to remove gas from the reservoir at the tail end of the withdrawal process therefore affecting gas deliverability. Gas permeation could not be used as this process would not achieve the hydrocarbon dewpoint specification required.

Economic models of the silica gel and TEG adsorption were developed, based on vendor quotations for similar systems in the past. The two systems were found to be very similar. Both systems are considered to have negligible environmental impact. The selection was therefore made based upon the remaining technical criteria; the better operability, controllability and flexibility of the silica gel option identified it as the more appropriate technology. The use of this technology is in line with the requirements of indicative BAT.

The standards of dehydration specified by NTS will require that only a proportion of the gas returned onshore will require treatment in the Adsorption Bed Drying process. The gas to be dryed is taken from the main stream, cooled to remove as much water as possible prior to entrance into an on line silica gel bed. The silica will adsorb water from the gas, which will then be returned to the process stream. The blend of the dry treated gas and the wetter gas from the reservoir will bring the whole gas stream into specification for delivery to the NTS.

Regeneration of the silica gel adsorption beds is required periodically to ensure efficiency. A proportion of the gas taken from the main process stream for dehydration is diverted to a regeneration gas heater. The warmed gas is directed through the off line silica gel adsorption beds; this dries the silica, desorbing the water into the gas stream. The resulting wet gas goes through a cooler and gas regeneration scrubber prior to being returned to the on line silica gel adsorption beds. The water is passed to the effluent treatment system. The regeneration system requires a gas compression package; this will be revisited during a FEED study to consider if this is the most appropriate option.

The system will comprise:

- Ten adsorption drier bed vessels;
- Three gas discharge fine solids filters operating at 50 percent;

- Gas fired regeneration gas heater;
- Air cooled regeneration gas cooler;
- Regeneration gas Knock Out drum; and
- Two regeneration gas compression packages operating at 100 percent.

Potential waste heat recovery from this system has been estimated at 7.53 MW. The heat will only be produced intermittently and, therefore, there are no potential uses as it will only be available for five hours in every twelve.

3.5.4.4 Metering

Gas metering has previously been described; however, metering and measurement will also be undertaken for a range of other streams including:

- Piped potable water;
- Imported electricity;
- Fuel, purge and sample gas;
- Vented gas;
- Chemical injection to process;
- Export condensate; and
- Other utility and effluent streams where appropriate and viable.

Facilities will be provided to ensure that sampling or measuring required during operation can be undertaken safely without risk of exceeding occupational exposure limits of personnel.

3.5.4.5 Emergency Venting and Layout Considerations

The Baird system is designed to cycle between injection and production mode of operation. This requirement leads to a wide range of pressures and temperatures as part of normal operations, throughout the operational life of the plant. The design specification therefore has been set taking note of the two operating modes.

The project design philosophy is to take all reasonably practicable measures to limit the risk from Baird operations to 'as low as reasonably practicable' (ALARP). This philosophy is primarily aimed at personnel protection, although it is noted that such measures also provide benefits for environmental and asset protection. Within this context the purpose of the vent system is to collect any gas discharges and to route them to a safe location (position and height).

Vent Usage and Available Options

The risk control measures typically focus on reducing the likelihood of initial loss of containment and, secondly to control the potential for knock-on escalation (e.g. fire impingement). In this regard, a number of design approaches are available that have an impact on venting requirements. These are summarised in Table 6, along with their impact on the Baird vent requirements, under the following main categories:

- Initial leak avoidance
- Escalation avoidance

Table 6: Vent Design Options and Applicability to Baird Gas Storage

Issue	***System Function***	***Application on Baird***
Initial Leak Avoidance (accidental loss of containment due to breach of design envelope)		
HP / LP interface protection	HP / LP interfaces are typically protected by using multiple layers of protection, with the final layer comprising either, • Full flow relief, or • Instrumented protection (e.g. HIPPS) Full flow relief is conventionally considered preferable since this relies on a mechanical device as opposed to an instrumented function. The downside of full flow relief is the requirement to provide a discharge location for the vented inventory.	In the case of Baird the discharge rate to accommodate full flow relief would be 1.4bcf, which is the design maximum production flow rate.
Mechanical equipment protection	The main Injection Compressors will settle out in pressure and the sealing gas systems will cease to function correctly. This has a potential to cause damage to the sealing system, as unfiltered process gas escapes from the compressor housing into the sealing chamber. It is typical to vent the compressor inventory on its shutdown.	Baird has three Injection Compressors and two Dewpointing Compressors, which will all need a shutdown venting provision.
Gas blow-by	This is typically an issue when a loss of level control on an HP item of equipment can cause damage to a LP receiving vessel.	The Baird facilities have sought to avoid gas blow-by situations within the design.

Issue	*System Function*	*Application on Baird*
Escalation Avoidance		
Blowdown	To discharge gas from an inventory section that is either the source of a leak, or is being targeted by an external fire. API 521 is typically used to guide the rate of emergency depressurisation, which depends on the initiating pressure, required final pressure and the time to achieve the pressure.	The Baird process has been segregated into a number of isolatable sections of varying size. The slugcatcher has been identified to be the largest inventory. The impact on vent design of depressurising this inventory under emergency conditions has been investigated to reduce the risk of escalation to ALARP
Fire case relief	Code requirement to provide relief on a vessel exposed to an external fire. This is typically based on sizing a pressure safety valve to discharge any extra vapour and the pressure rise due to its expansion as a result of the heat input by the fire.	All Baird process vessels will be reviewed to ensure the relief facilities are sufficient to accommodate this requirement as a minimum. The PSV (pressure safety valve) discharges will need to be piped into a collection and vent disposal system.

Vent Location

In view of the space constraints at the onshore Baird terminal, the vent stack location has been selected to limit the risk to personnel and the public to ALARP. Governing discharge rates and the level of occupancy in the affected areas has been considered. The stack has therefore been placed as far as reasonably practicable from the permanently manned onsite buildings, noting the lower occupancy of the offsite areas.

The height has been set to allow sufficient dispersion so that flammable concentrations are avoided on the ground. It has also been determined to limit the extent of the sterile area required; this is the area below the stack in which routine activities will be prevented. The sterile area is calculated by considering the potential radius of radiation should the vent accidentally ignite. A taller stack will have a reduced radius of radiation on the ground as the point of ignition is further away, limiting the potential injury to people below the stack. The governing case for the Baird vent is a full flow venting requirement of 1.4bcf, which results in a stack height of 100m and a sterile area of 70m radius.

3.5.5 UTILITIES

Instrument air will be provided by a new system to meet all air requirements of the Baird facilities. A new stand-alone Hydraulic Power Unit (HPU) may be considered for operation of large bore Emergency Shut Down (ESD) valves.

The following utilities will be separate from the existing Perenco installation utilities.

3.5.5.1 MEG Regeneration and Injection

As previously described, MEG has been selected for use to prevent hydrate formation in the pipeline.

MEG Regeneration System

Import gas from the NTS will be dry therefore, there will be no significant hydrate formation in the injection mode. Hydrates are likely to cause an issue within the offshore pipeline during the production mode, ultimately restricting flow and potentially causing blockages,

Hydrates in the offshore pipeline in the production mode are likely to arise since the gas produced from the Baird reservoir will be wet. Offshore dehydration facilities have been ruled out due to their relative complexity and knock-on impact on operations and maintenance requirements which have the associated impact on personnel safety due to increased intervention requirements. Offshore MEG injection with onshore dehydration has therefore been selected as the hydrate prevention strategy for the offshore pipeline.

As a consequence, MEG regeneration facilities onshore are required to reprocess the MEG in order to minimise waste and the disposal of MEG to the environment.

Water rich MEG solution will be brought onshore with the associated export gas from the transfer pipeline with sphering / pigging to be used to clear the pipeline of residual liquids at the end of an export campaign.

The MEG regeneration system has been located in the north eastern part of the plot near to the other processing equipment to minimise process complexity and unnecessary inventory on site.

Liquids will be received onshore from the 38" pipeline, separated in the slug catcher and directed to MEG Regeneration system. The liquids will include water, rich MEG and hydrocarbon condensate. It is not anticipated that significant quantities of hydrocarbon

condensate will be present in the flow, however for design purposes it has been assumed that there will be a stream of approximately 64m^3 per day. This will be confirmed in a design FEED. The liquids will be transferred to a knockout drum and separator to remove hydrocarbon condensate and entrained hydrocarbon gas.

Onshore storage of rich and lean MEG solutions will be used to smooth out the regeneration duty so that the system can be operated independently of the rest of the facility's operating modes.

- Duty requirement = 1.9MW based on 15m3/hr regeneration rate
- Operating temperature = 121°C for 80wt% MEG

The gas will be returned for further processing and the condensate will be metered and processed using the existing Perenco facilities. New facilities are not considered appropriate due to the small quantity anticipated. The remaining rich MEG will be directed to storage.

The rich MEG will contain up to 40 percent water and will be stored on return from the pipeline; this ensures that regeneration facilities are not overloaded at peak times but can be operated efficiently at appropriate capacities. There will be two new rich, as well as, two lean MEG storage tanks located within a bunded system on the existing grassed area to the northwest of the site. The working liquid volume of the slug catcher is 890m^3 and the new storage facilities will be sized to hold this volume. The new storage facilities will be in line with the requirements of indicative BAT including the provision of appropriate bunding and capacity controls. The MEG will be moved between the storage tanks and the regeneration package by transfer pumps.

The MEG regeneration package is likely to consist of:

- Reboiler/evaporator column;
- Condenser;
- Reflux drum;
- Reflux pump;
- Lean MEG transfer pump;
- Rich/lean MEG heat exchanger;
- MEG surge drum;
- Lean MEG air cooler; and
- MEG filters.

The rich MEG will be directed to the reboiler/evaporation column. The water contained within the incoming rich MEG vaporises at the top of the column and the lean MEG overflows from the reboiler at the column base, to the MEG surge drum. It is then pumped via the lean MEG air cooler to the lean MEG storage tank. Lean MEG will eventually be returned to the NUI via a 4" pipeline for reinjection. The Lean MEG export pump will be transferred offshore and will be metered.

Storage of lean MEG ensures that it is available for use at any time; the storage facilities have been sized in order to provide five days of lean MEG and to fill the 4.5" pipeline from empty. This would require 2,144m^3 of storage space. The storage facilities will meet the requirements of indicative BAT and will include appropriate bunding to minimise the risk of spills.

The water vapour from the reboiler/evaporator column will be condensed and disposed of via the water treatment facilities.

An estimate of the required MEG regeneration rates and resulting thermal requirements has been made prior to the full investigation to be undertaken as a FEED study. An average of 80 percent MEG hydrate inhibitor of approximately 245m^3 per day (with a maximum of 286m^3 per day) will require an average heat input of approximately 7.2MW. It is assumed that regeneration will be undertaken by a closed loop heating medium with fuel gas firing and an efficiency of 75 percent. This would require a fuel gas demand of 0.861Mmscfd or 0.121bcf per year. Potential waste heat recovery of 2.4MW is estimated from the high temperature flue gas. The potential for using the heat in the onshore processing facilities has been considered; the greatest potential for waste heat recovery occurs during the injection periods but these will be of unpredictable duration and timing and it is not considered appropriate as a source of waste heat recovery.

The exact design and specification of the MEG regeneration facilities will be determined during the FEED process; a re-assessment of MEG injection rates will be conducted to determine the final design parameters for supply, storage and regeneration.

It is estimated that MEG losses during regeneration will be one percent or approximately 2.3m^3 per day of pure MEG. New MEG will be delivered to the installation by tanker however, no new MEG loading facilities are envisaged at this time; the existing Perenco facilities will be used.

3.5.5.2 Corrosion Inhibition

Corrosion of the pipeline could potentially be a significant issue and will affect the facilities provided at Bacton. Alterantive options for managing corrosion were

considered, however it was determined that the injection of corrosion inhibiting chemicals is the most appropriate option. This is standard in the industry as described within Environment Agency Sector Guidance as indicative BAT and will be undertaken at Bacton using MEG as a carrier. An initial estimate of the equivalent of 44.3 litres (L) per day of pure corrosion control chemical will be used. The corrosion inhibitor will be remain within the MEG and will be recycled.

In addition to inhibitor injection, corrosion allowance will be made in the pipeline. This has been calculated for the bottom of the line as 6.2 millimetres (mm) at Bacton and 5.7 mm at Baird, and 5.0 mm for the top of the line for the 50 years of expected operation using the method given in NACE paper 07555 (2007). This has led to the selection of a 38" pipeline for the wet pipeline.

3.5.5.3 Power

Fuel Gas

Fuel gas use is estimated in Table 7 below.

Table 7: Estimated Fuel Gas Requirements

Equipment	*Estimated Fuel Gas Consumption (Mmscfd)*
Gas compressor drivers	16.83
Start-up heaters	2.81
Adsorption regeneration gas heater	2.70
Regeneration gas compressor turbine	0.83
MEG regeneration	0.86

The HP fuel gas system for supply of the gas compression turbines and the adsorption dehydration regeneration process will be let down from the process pressure of 75 barg to operate at approximately 30 barg. The fuel gas system will feed the HP users before let down, superheating, and filtering.

The LP system will supply 5 barg gas to the regeneration gas heater, the start-up heaters, and the MEG regeneration facilities. This gas may also be used for purging and tank blanketing services.

Fuel gas will be withdrawn downstream of the injection gas metering package or downstream of the onshore slug catcher. A FEED study is required to determine whether there is sufficient gas inventory in the onshore slug catcher to permit warm-up of the start-up heaters for the pipeline de-pressurisation procedure at the commencement of the withdrawal cycles. Fuel gas will be of appropriate quality in line with the requirements of indicative BAT and metered in both the HP and LP systems.

Electrical Supply

The existing electrical supply to the Perenco installation is via an 11 kV intake of 2,040 kVA. This is the maximum capacity of the feed; the present maximum demand on the system is approximately 800 kW (or 1000 kVA), therefore only approximately 50 percent of the feed is being used. It is expected that electricity requirements for the new facilities will be met by new feeders from EDF Energy Networks to the EDF switch facilities. EDF will extend their existing facilities to accommodate the BSCL requirements independent of the existing Perenco facilities. Electric drives will be required for a range of equipment including starter motors, pumps, fans, heaters, instrument air compressors, and Heating Ventilation Air Conditioning (HVAC) systems. It is anticipated that the maximum running load will be up to 3937kW or 4471kVA and peak load will be up to 6645kW or 7529kVA.

A standby generator will be provided to ensure that adequate power is available to continue normal operation in the event of a disruption to the mains power supply. The communication system and control room will be connected to the Uninterrupted Power Supply (UPS) and generator. Lighting and other small users will be provided with battery back up and so no additional emergency power generation is required.

3.5.5.4 Control System

A new control room will be provided to ensure appropriate monitoring and management can be undertaken. The control system for the Baird Facilities will be entirely independent of the existing plant controls, however the operator interfaces will have a similar appearance to those of the existing Perenco facilities including the graphic presentation and control system layout. This will minimise operator error in line with the results of Human Factors Analysis.

The control room will have responsibility for the operation of both the onshore and offshore facilities; co-ordination between off- and onshore action is vital in order to achieve the rapid response required for this type of facility.

The facility will utilise Digital Control System (DCS) technology with full redundancy and self-checking functions for all injection and withdrawal critical operations. All valve movements and drive actuations for routine start-up, shut-down, and turn-round will be controlled by the DCS and compressors will be designed so that start up and stop is managed by the main control room. The DCS will be used to operate all process controls, Process Shut Down (PSD), Emergency Shut Down (ESD), and fire and gas inputs and actions. A data historian package will also be incorporated into the system to record all events and variables. This will be enabled to allow monitoring from a remote

location and will have a long term storage capacity to prevent data from being overwritten. A separate system will be used for override actions for PSD, ESD and fire and gas classed above Safety Integrity Level (SIL) 1.

3.5.5.5 Lighting

The Baird facilities will be located within the existing Perenco site. Perimeter lighting is already available for security purposes; however, additional lighting of the new facilities will be required for safe operation. Although the Baird facilities will be operated 24 hours per day, the automated nature of the process means that lighting can be minimised to avoid unnecessary light pollution; light will only be required in safety critical areas and for maintenance purposes.

Lighting will be required during construction for safe operating. Further information concerning the potential impact and mitigating measures is provided in Section 5.2.5.

3.5.5.8 Vapour Recovery System

A new vapour recovery system will be installed. This is in line with the requirements of indicative BAT and will be used to minimise emissions to atmosphere. The technical detail of the system will be determined as part of a FEED study.

3.5.5.7 HIPPS and Emergency Shutdown

A High Integrity Pressure Protection System (HIPPS) will be required at the interfaces between high and low pressure systems and at areas where temperature protection systems are required. HIPPS uses instruments in series to provide redundancy and prevent failure of one instrument causing a loss of system integrity.

Emergency Shut Down Valves will be high integrity, gas tight shut-off, fire rated valves designed to fail safe.

The HIPPS systems will be Safety Integrity Level (SIL) rated; the probability of instrument failure will be considered by examining each component. The probability of failure must be acceptably low for operation to be allowed. This system will be entirely separate from normal plant operating systems and will be tested regularly.

3.5.5.8 Piping Specifications

In line with the requirements, high pressure piping will be 900# rating. The pressure and temperature of the gas between the second stage of compression for injection and the pipeline to offshore will require that 2500# rating will be used for this section.

3.5.5.9 Communications

Communications with the offshore NUI will be conducted using a new communication line of site or satellite system. This will be separate from the Perenco system but the dishes will be mounted on the existing telecoms tower.

3.5.6 SHARED UTILITIES

The operating philosophy for the BGSF is to have operational independence from the existing Perenco facilities; however, there are a number of utilities where this is not feasible. Further assessment is required; however, it is likely that the following utilities will be shared:

- Security;
- Potable water;
- Sewage treatment system;
- Emergency response systems;
- Welfare facilities;
- Road infrastructure;
- Upkeep of the grounds; and
- Firewater.

3.5.7 MAINTENANCE

The facilities will be designed to minimise maintenance requirements; however, maintenance is vital in ensuring continuing operational integrity over the lifetime of the equipment. Equipment will be available for maintenance during periods when it is not operational; for example injection equipment will be maintained during withdrawal. This will minimise any impact on operational requirements. Any equipment that is required for both injection and production service will have built-in redundancy to enable maintenance to be undertaken whilst operations remain online. This will avoid the requirement for a full facility shut-down for routine maintenance.

Table 8 below presents the maximum number of days where operational availability is reduced.

Table 8: Target Maintenance Days

Parameter	*Requirement*	*Time Allocated*
Withdrawal maintenance requirement	Maintenance which reduces or interrupts the withdrawal performances shall be performed outside the periods October to April	40 days in any three consecutive years
Injection maintenance requirements	Maintenance which reduces or interrupts the injection performance shall be performed outside the periods March to October	14 days per year
		40 days in any three consecutive years

Abridged from *Statement of Requirements* (BGSL, 2009).

The design of the maintenance system is yet to be confirmed; however, it will be a bespoke BSCL system that is separate from the existing Perenco system. All maintenance and operational procedures will be managed and performed by BSCL. The maintenance system will be designed to ensure that regular maintenance is undertaken to safeguard the continuing efficient operation of equipment and allow prioritisation of maintenance to critical equipment.

3.5.8 HEAT INTEGRATION

As stated in section 3.4.5, a Front End Engineering Design (FEED) study is required to identify opportunities for energy conservation and heat integration design. In assessing the feasibility of heat integration during the gas withdrawal process, the study evaluated opportunities for integrating the cooling and heating loads on the project. A summary of the heat integration evaluation is given below.

First, the sources of heat available in the process (cooling requirements) and the heating requirements were reviewed. Then the study reviewed which heating and cooling requirements could be combined to integrate heat usage and its impact on project cost, schedule layout etc. Where an energy conservation scheme was identified a technical review was completed to identify any concerns associated with its implementation.

Energy efficiency design options recommended are;

- Adsorber insulation; use of internal insulation on the adsorber vessels has been chosen to minimise energy consumption during regeneration.
- Combined heating & cooling: utilising adsorber vessels being regenerated by heating and cooling sequentially with gas to be used for regeneration being preheated by passing through the hot regenerated bed (hence cooling it) prior to

be heated further before being passed through the wet bed. This helps minimise the energy consumption of the silica gel system.

- Number of gas compression packages: Installing 3 instead of 2 gas compression packages means that less gas recycling is required to maintain pressure at low load and thus less energy is consumed due to the smaller size of each compressor package.
- Combine the gas heating duties for the start-up, product and HP fuel gas heating into a common hot water/glycol system (instead of individual direct fired heaters).

The energy efficiency improvement options not pursued due to technical reasons;

- The recovery of heat from the gas turbine exhaust gas system is not feasible from an economic/layout viewpoint. This is because of the cost and space required for equipment to generate steam and the associated electricity.
- The installation of a gas expansion system (turbo-expander) is not feasible for similar reasons as the waste heat recovery from the gas turbines.
- The recovery of heat from the gas compression packages is not feasible from an economic/layout point of view. Installation of a heat pump is not feasible in view of the high temperature lift requirement.

3.6 CONSTRUCTION

Construction of the onshore development will be considered as four elements:

- Shaft and tunnel construction between the cliff top and the beach;
- Landfall beach works;
- Gas compression and conditioning facilities within the Perenco site; and
- Connection with NTS.

It is anticipated that, subsequent to receiving the appropriate development consents, construction will commence in 2011. The beach works will be undertaken in the winter of 2011/12 subject to prevailing meteorological conditions and sea state, with construction within the Perenco terminal and construction of the pipeline to the NTS being conducted between 2011 and 2013. It is considered that commissioning should occur in early 2013.

The scope of the construction activities includes:

- Creation of office accommodation;
- Construction of tunnel drive, reception structures and pipeline to the NTS;

- Driving of a tunnel to the beach;
- Installation of the 38″ and 4.5″ pipelines in the tunnel and shaft;
- Grouting of the tunnel annulus;
- Installation of temporary sheet piled arrangements on the beach for the landfall works;
- Inshore trench dredging[5];
- Pull-ashore of the landfall pipelines;
- Tie-in of the landfall pipelines to the pipelines in the tunnel;
- Removal of all sheet piling and other temporary works;
- Beach Reinstatement;
- Transfer or decommissioning of existing equipment in construction area and demolition of existing building;
- Construction of foundations, skids and new buildings;
- Installation and integrity testing of equipment and associated pipework;
- Installation and integrity testing of pipeline and connect to NTS

3.6.1 OFFICE AND CONSTRUCTION COMPOUND AREAS

It is expected that temporary office and welfare facilities for the pipeline landfall works will be provided at the end of Seagulls Road, adjacent to the Shell UK Ltd (Shell) outer perimeter fence. This is identified on Figure 8.

This figure also identifies the proposed location of the temporary storage area for materials and equipment. The cliff path will be diverted to allow access through the works with the route marked accordingly. A site tunnel office will also be located within the Perenco Terminal. Office facilities will be temporary portacabins in both locations; electricity will be provided by a silenced generator and water will be taken either from the nearest mains or from the Terminal. The facilities within the Perenco site will be connected to the onsite sewerage system and those on Seagulls Field will use a temporary septic tank facility.

The construction compound at the north west end of Seagulls Field will be accessed via Seagulls Road. The entrance to the track is from Paston Road. The compound will be located adjacent to the road and parallel to the existing bund. It will not extend beyond the bund. The compound will be fenced to prevent unauthorised access for security and safety reasons.

[5] The environmental effects of dredging below Mean Low Water are considered within the Offshore Environmental Statement.

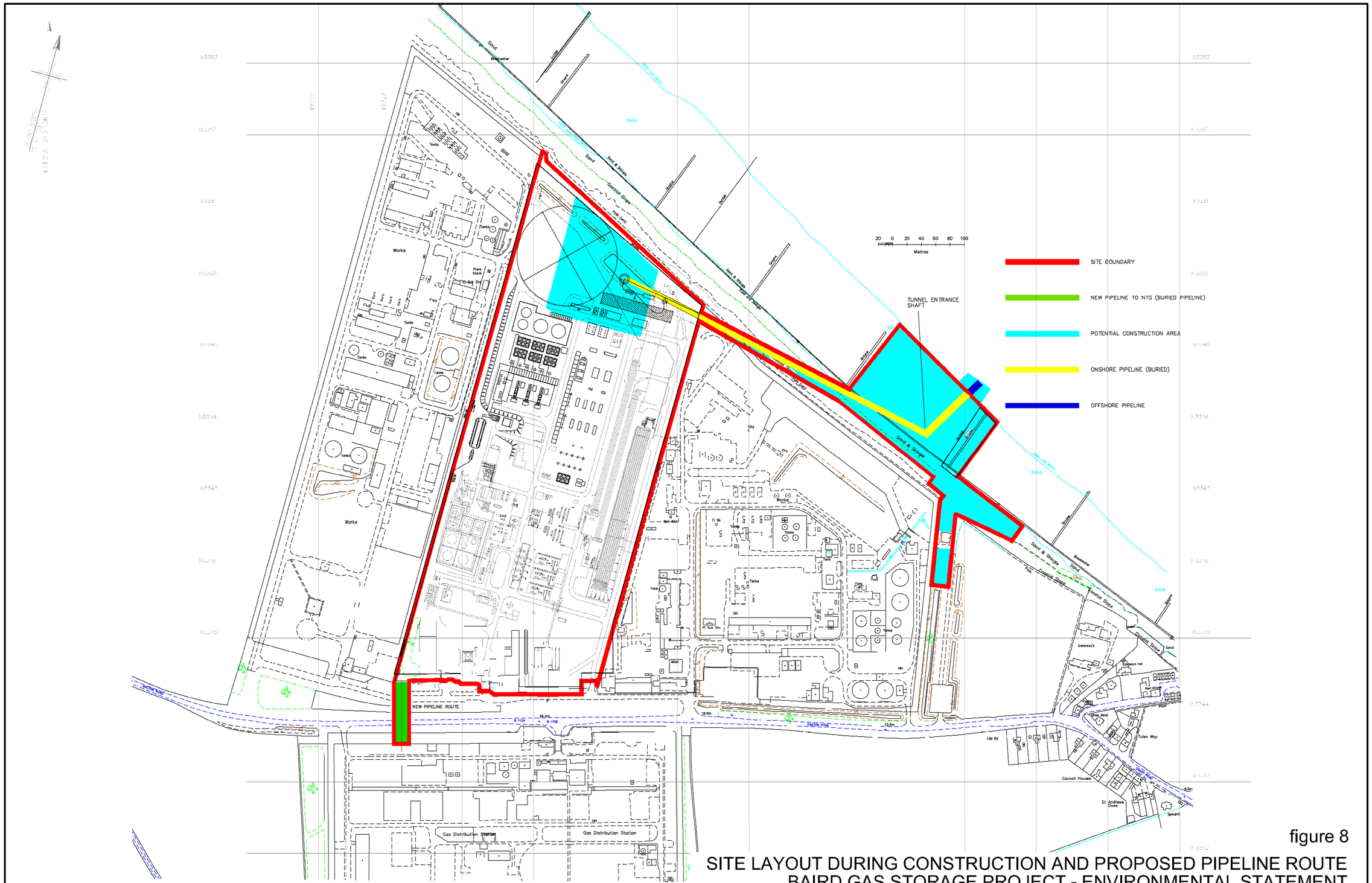

figure 8

SITE LAYOUT DURING CONSTRUCTION AND PROPOSED PIPELINE ROUTE
BAIRD GAS STORAGE PROJECT - ENVIRONMENTAL STATEMENT
BACTON STORAGE COMPANY LIMITED
Bacton Gas Terminal Norfolk

SOURCE: GENESIS DRAWING C09134-BC00-00-00-201-11001, 27.01.10.

The facilities will be constructed within the existing Perenco Terminal boundary hence requirements for site preparations will be minimal. The construction compound will be situated in an open area near to the site of the new gas processing facilities, hence there will be limited demolition. There will be no car parking or bulk storage at this location. Access roads within the terminal will provide access for construction of the facilities, however, it may be necessary to upgrade some of these roads including levelling and temporary surfacing (crushed stone/hardcore).

The area of the entire Perenco Terminal site is 17.5 hectares (175,000m^2) and the proposed temporary construction area within the Terminal is 1.9 hectares (19,000m^2). The site layout plan during operation is shown in Figure 8, which presents the temporary construction compound area.

Diesel refuelling will occur within the compound area. Diesel storage tanks will have appropriate bunding or be of an appropriate construction to meet secondary containment requirements in compliance with the Control of Pollution (Oil Storage) (England) Regulations 2001.

The construction contractor would install any necessary ancillary facilities such as paving, building pads/footings, telecommunications cable installation, connections to mains utilities for power, potable water and sewerage. Construction areas will be reinstated where appropriate and the work for this is anticipated to be minimal.

3.6.2 SHAFT AND TUNNEL CONSTRUCTION

The drive structure for the tunnel will be located in the south-eastern corner of the Perenco terminal; Figure 8 identifies the route.

The tunnel drive structure will be constructed to the required depth, to be determined when the details are engineered, excavated, and the base prepared for the tunnel boring machine. The drive structure has not yet been determined but will be either circular reinforced concrete shafts of approximately 10.3 to 12.5 metres in diameter or a temporary sheet-piled cofferdam.

The concrete shaft would be constructed using caisson techniques where the addition of rings of the pre-cast concrete to the top of the shaft drives it into the ground as the shaft is excavated. The shaft may be up to 35 metres deep and be completed with a reinforced concrete base, head, and thrust walls.

A sheet piled cofferdam would comprise steel sheet piles driven into the ground to form a rectangular box with bracing frames fixed as necessary for the design. It would be

approximately 10 to 15 metres deep and have a reinforced concrete base, head, and thrust walls.

Excavated soil from both options will be re-used on site in other civil or engineering works where appropriate. If this is not possible, it will be removed from the site for re-use or recycling elsewhere. Excavated soil will only be directed to landfill where no alternative use is feasible.

The tunnel will then be driven to the beach reception structure. It will be constructed using pipe-jacking techniques where a tunnel boring machine is mounted on guide rails and uses hydraulic rams reacting against the thrust wall to mine forward through the headwall into the ground. When the hydraulic rams are withdrawn, special reinforced concrete jacking pipes are placed on the guide rails and are pushed into the ground as the boring progresses. The tunnel will be approximately 450 metres long with an internal diameter of 1.8 metres. The tunnel will be bored to meet the tunnel reception structure.

The tunnel reception structure must be installed at the base of the cliff to terminate the tunnel. The type of structure and location on the land or sea side of the revetment has not yet been determined. It will be constructed in such a manner as to minimise the risk of the works being flooded by high tide. This may require the construction of a sheet-piled protection platform in which the tunnel reception structure will be constructed. This structure will be used to recover the tunnel boring machine driven to the beach from the drive structure.

Water ingress into the shaft will be managed through pumping to the surface, although volumes are expected to be small. Any water removed will be either allowed to soak away in a designated area within the terminal away from the cliff edge or directed to the surface water drainage system. This will be treated in settling tanks prior to discharge.

The 38" pipeline and piggybacked 4.5" pipeline will be inserted into the tunnel from the terminal end and pulled through by a winch mounted at the beach. This minimises the impact on the beach. Riser pipes will be installed in the shaft to bring the pipes up to near ground level within the Perenco Terminal in preparation for connection to the terminal pipework.

The pipeline will be pressure tested using water (hydrotested) according to an agreed and approved procedure. It is anticipated that water for this test will be taken from the Perenco Terminal supply and will be discharged offshore at the platform location. The hydrotest seawater from the tunnel section will be discharged back to the sea via the Perenco outfall. A discharge consent will be obtained from the Environment Agency prior to the commencement of the hydrotesting.

During installation grout tubes will be attached to the top of the pipeline. Following the hydrotesting, both ends of the tunnel will be sealed using bonded brick or block work built into the annulus of the tunnel around the pipes. A mobile grouting unit will be used to mix and deliver the grout.

3.6.3 LANDFALL BEACH WORKS

In order for the pipeline to landfall, sheet piling will be used to construct a cofferdam and winch platform which will be filled with beach sand, tie-in cofferdam, and back-anchorage. The sheet piling will be linked to the tunnel reception structure and will allow the tunnel pipework to be tested prior to the work to pull ashore the offshore pipeline. The landfall works will be similar to the beach works undertaken by Gasunie for the Balgzand-Bacton Pipeline Project which connected into the Shell Terminal.

Two lines of sheet piles, parallel to the pipeline centre, approximately 6 metres apart, will reach between the low water mark to the tunnel reception structure. Wing-walls will terminate the pipeline at the seaward end to protect the beach from the inshore dredging operations.

Piling will be conducted using a piling rig; vibratory, jacking, or auger techniques will be used to minimise noise and vibration. The piling rig will work tidally to drive the sheet piles on the beach to form the cofferdam.

The cofferdam will be excavated prior to pulling the pipeline ashore; the excavated material will be spread along the beach.

The offshore element to the pipe laying will be described in detail within the Offshore Environmental Statement. A summary of the proposed pipe laying process is provided below.

A pipe-lay barge will be used to lay the offshore sections of the pipeline. The section of the seabed between the beach and the pipe-lay barge position will be pre-excavated in order that when the pipeline is winched onshore, it can be pulled into the dredged trench; this will provide the pipeline with the necessary security. The landfall trench will be dredged generally from offshore towards the beach although high tides will be used to dredge shallower areas. The dredged material will be pumped along a floating pipeline and deposited by a spreader pontoon approximately 200 metres from the dredged trench.

A winch spread will be set up on a winch platform on the beach and secured to the anchorage points of the sheet piling. Wires will be extended out to the dredged trench where the pipe-lay barge will connect them to the pull head. The winch will then haul

in the wires and the first pipe section to the beach. The next section will be welded on the barge and then hauled onshore; the operation will continue in the same manner until the pipeline reaches the winch spread. This will require work to continue 24 hours per day.

The trench will be backfilled using the removed material as soon as the pull in operation is complete. Further detail is provided in the Offshore Environmental Statement. During the trench backfilling the tie-in cofferdam, which links the pulled in pipeline and the tunnel portal, will be excavated and sections of 38" and 4.5" pipework installed to complete the pipeline.

3.6.4 REINSTATEMENT

The beach will be reinstated by backfilling the tie-in area with beach material. If concrete shaft segments are used for the reception facilities, all sections above pipeline level will be removed. All sheet piling will be extracted and removed to the laydown area at Seagulls Field. All construction materials, equipment and signage will be removed. The sea defence revetment will be reinstated with new timber. Any areas of damage will be repaired.

The laydown area at the seaward end of Seagulls Field will be cleared of all construction materials. Any stored topsoil will be returned across the areas affected by the construction work.

The temporary offices on the laydown areas at the seaward end of Seagulls Field and within the Terminal will be dismantled and taken away and temporary hard standings will be progressively removed.

The excavation around the terminal pipework will be backfilled and working areas cleared of construction materials and equipment. As reinstatement progresses surveys shall be undertaken to ensure that these areas generally conform to the original profiles and are in a condition similar prior to the commencement of construction.

3.6.5 GAS COMPRESSION AND CONDITIONING FACILITIES

A detailed construction methodology will be developed during FEED/detailed design. However, the key principles are summarised below.

It is anticipated that the majority of equipment for the onshore facilities will be fabricated and tested offsite, then transported to site for installation. Integrity testing will be undertaken as required.

To minimise onsite preparation works, the pipe spools delivered will normally be supplied in a finish coat. The paint finish will be selected to provide maximum corrosion resistance, in colours in line with existing site standards. Thermal insulation will be required on some pipes for personnel protection and/or heat conservation purposes and other pipe systems will require acoustic insulation to minimise noise emissions.

It is anticipated that the major component parts of the onshore facilities, such as compression equipment, will be constructed in a modular fashion offsite, minimising works at site. Equipment will generally arrive at site with final paint finishes, which may require minor remedial work following installation along with insulation, as required.

To enable safe working during construction, temporary supports and access platforms will be required. Where it is considered appropriate, scaffolding will be used for temporary structures and access platforms.

To ensure all lifting activities are in accordance with applicable legislation, the management of major lifting activities shall be undertaken by a specialist contractor. Other specialist construction services required during construction will be provided by contractors and include painting and insulation of pipework, installation of major components and scaffolding installation and modification, bolt torquing/tensioning and nitrogen leak testing.

3.6.6 CONNECTION WITH NTS

In order to connect the Baird Facilities to the NTS a pipeline between the gas processing facilities and the National Grid installation on the opposite side of Paston Road will be required. The pipeline will be directed along the western perimeter and leave the site in the south west corner. It will be directed below the bund, under Paston Road and roadside grassed area to the National Grid site. A pipeline already connects the Perenco installation with National Grid and the Baird pipeline will follow a similar route.

It is envisaged that a trenchless technique will be used to traverse Paston Road, however if it is considered that this is not technically feasible a road cut will be required. This will be conducted during a weekend to minimise the impact on traffic in the area. The connection between the Baird facilities and NTS will be conducted by National Grid who have considerable experience in completing this type of work.

3.7 SUMMARY OF EMISSIONS

Below is a summary of emissions from the construction and operation of the proposed facilities.

3.7.1 CONSTRUCTION

Air emissions from construction are likely to be:

- Carbon monoxide (CO);
- Carbon dioxide (CO_2);
- Oxides of nitrogen (NO_X); and
- Particulates (PM_{20}).

The number of vehicle movements will be minimised to reduce air emissions from this source. Section 5.2.12 describes the Traffic Management Plan. The environmental impacts from road traffic emissions are described within section 5.2.12.3 (k).

Temporary road surfaces will be sealed where feasible to reduce vehicle movements on unsealed roads re-entraining dust. Beach works will be conducted in winter, therefore with expected prevailing weather conditions it is not anticipated that dust re-entrainment along Seagulls Road will be a significant problem.

Emissions to surface water during construction will include surface water in the installation; this will be captured in a surface water drainage system and directed to the new water treatment basin before discharge to sea via the existing outfall. A discharge consent will be sought from the Environment Agency prior to commencing the work.

Dewatering of the tunnel is not expected to produce significant quantities of water. If it is considered appropriate, this water will be returned to the groundwater by allowing infiltration in designated areas of the installation, again with the consent of the Environment Agency. If this is not feasible, the water will be directed to the existing outfall with the consent of the Environment Agency.

The pipelines from the Baird NUI to the Baird onshore facilities will require hydrotesting. The hydrotest will involve flooding the pipelines with sea water and pressurisation of the lines to the working pressure, plus the required safety margin, to check the integrity of the line. Once the hydrotest has been completed the seawater used for the test will be discharged offshore at the platform location. The hydrotest seawater from the tunnel section will be discharged back to sea via the Perenco outfall. Consents to allow this discharge will be obtained from the Environment Agency prior to any releases taking place.

3.7.2 OPERATION

The proposed development incorporates a number of combustion emission sources including:

- Gas turbines;
- Fired heaters;
- Adsorption regenerators;
- Regeneration heaters;
- MEG reboilers;
- Overheadvapour combustor;
- Dewpointing compressor; and
- Standby generator.

The emissions from these sources will include CO_2, NO_x and CO. It is considered that emissions of SO_2 and particulates will be low due to the nature of the fuel gas. Emissions to air are restricted by Air Quality Standards and are regulated by the Environment Agency under the Environmental Permitting (England and Wales) Regulations (EPR) 2007; the application for operation under these regulations will incorporate an air quality assessment. Further information concerning the potential impact of air emissions from the proposed installation is provided in section 5.3.2.

There will not be an additional outfall associated with the new facilities, however wastewater from the process and surface water from the process area will be directed to the existing outfall after treatment. It is not considered that there will be a significant increase in emissions to water; this will be regulated by the Environment Agency under the Environmental Permit but it is not anticipated that a request will be made to increase the existing emission limits. Further information concerning emissions to water is provided in section 5.3.3.

There will not be any emissions to land or groundwater during operation.

3.8 EMERGENCY PLANNING AND RESPONSE

Ensuring the safety of staff and people within the vicinity of the installation is paramount and health safety, security, and environment (HSSE) will be addressed at all stages of the project. All FEED and detailed design stages will be reviewed by a multidisciplinary team to ensure safety and environmental hazards are eliminated or reduced to levels as low as reasonably practicable (ALARP).

The facilities will be designed to meet performance standards for all safety critical systems, including:

- Hydrocarbon containment;
- Process supports;
- Passive fire protection;
- Occupied buildings;
- Emergency Shutdown system;
- Active fire fighting system;
- Fire and gas detection;
- Power generation;
- Process shutdown;
- Process blow down;
- High Integrity Pressure Protection System;
- Escape routes;
- Emergency lighting;
- Ventilation of non-hazardous and hazardous areas;
- Hazardous area controls;
- Uninterrupted Power Supply; and
- Security.

The existing fire water system will be evaluated to determine if it can provide the required capacity to include the new facilities. If this is not the case, provision of new separate facilities will be reviewed.

The onshore facility will fall under the COMAH Regulations 1999 (as amended) and as such, appropriate safety planning will be undertaken. This is regulated by the Competent Authority; the Health and Safety Executive and the Environment Agency acting jointly. The same standards of hazard identification, Safety Critical Element identification, Performance Standard application and Independent Verification will be applied and documented in the COMAH Safety Report and are also required for the Offshore Safety Case and Design and Construction Regulations.

The existing Perenco installation is already regulated under the COMAH regulations and has a COMAH Safety Report in place. The Baird facilities will require a separate COMAH Safety Report; however, there will be an interface with the Perenco Safety Report in terms of emergency response. The Perenco installation has a comprehensive emergency response procedure in place; staff regularly undertake emergency response

exercises and drills and meetings are held with key stakeholders including local emergency services and NNDC to ensure all parties are able to respond appropriately during an emergency. The Domino Information Exchange Document is compiled for use by all five of the installations in the Bacton Gas Terminal Complex in response to a major accident. The Baird facilities will be incorporated into the existing emergency response procedure at the Complex.

3.9 DECOMMISSIONING

The design life of the Baird facilities is 50 years. Replaceable equipment has a design life of 25 years unless whole-life economic analysis dictates a shorter life. Good operational and maintenance practice could potentially extend the life of the facilities beyond 50 years, however at the end of their useful life the facilities will be decommissioned inline with legislative requirements and BAT at the time.

It is of note that the existing facilities within the Perenco terminal are likely to be decommissioned before the Baird facilities. The Baird facilities are designed to be stand-alone with only a small number of utilities and some management functions being shared therefore it is considered that decommissioning of the existing Perenco facilities will not influence Baird operations.

A site decommissioning plan will be created to describe the closure of the installation. This will be provided in accordance with the prevailing law and consultations will be undertaken prior to commencement of the decommissioning.

Decommissioning will require the removal of all residual gas, including any retrievable cushion gas in the reservoir. All equipment will be shut down and moth-balled with any residual substances removed and re-used or recycled where possible. Equipment will be isolated and then dismantled. Where possible plant will be re-used at alternative locations, however where this is not feasible remaining equipment will be demolished and the materials recycled. The options for the pipeline will be considered; it is usual to either dismantle and re-use it or decommission and leave it *in situ*, however the selection will depend on the prevailing economic, social and environmental considerations at the time. Any remaining equipment, hard standing or surface pipework will be removed and either re-used or recycled and the land will be returned to a condition for suitable use. This will be determined within the EPR Permit or other licenses in operation at the time.

4.0 THE SURROUNDING ENVIRONMENT

4.1 INTRODUCTION

In order to appropriately assess the impact of a proposed development on the environment, it is vital that information concerning the surrounding area is available. This is usually in the form of background information, where data concerning the existing environment is reviewed to determine the potential interactions and possible impacts. Following assessment of potential impacts, appropriate mitigation measures can be identified.

The following areas are discussed within this section, with regards to their current conditions:

- Air quality;
- Water quality;
- Land use;
- Landscape;
- Noise;
- Ecological;
- Socio-economic;
- Transport Infrastructure; and
- Archaeology and heritage.

These aspects of the environment are viewed to be most likely to be impacted by the proposed development, or of the greatest concern to local people and visitors.

4.2 AIR QUALITY

In order to determine the impact of the existing installations on air quality, monitoring is undertaken on behalf of all of the Bacton Gas Terminal Complex operators through the Bacton Forum.

The emissions from the installations are primarily combustion gases. Natural gas is used for most fuel requirements. Natural gas has low sulphur and particulate contents and therefore these substances are not monitored.

Carbon monoxide is not monitored by NNDC following the conclusions reached in the 2006 Air Quality Updating and Screening Assessment (NNDC, 2006). The report concluded that the traffic flow threshold criteria, used as an indicator of CO

concentrations arising from vehicle emissions, was not breached in the Local Authority area and no industrial sources of CO were located within the district. As such, monitoring of CO concentrations was not deemed to be necessary for the protection of public health.

NNDC historically monitored benzene emissions in the Bacton area using a network of diffusion tubes. Although there are potential emissions from fugitive release and through unburnt hydrocarbons in stack gases, it was determined by the Council that benzene levels at the locations most likely to be affected, were significantly below the 2010 Air Quality Objective (NNDC, 2009a).

4.2.1 NITROGEN DIOXIDE

The Bacton Gas Terminal Operators jointly operate a network of four passive NO_2 diffusion tubes within the vicinity of the Bacton terminal through the Bacton Forum. The diffusion tubes are used to monitor NO_2 concentrations on a monthly basis. NNDC also monitors NO_2 concentrations in the vicinity of the gas terminal, using three passive NO_2 diffusion tubes and one real-time chemiluminescence analyser, co-located at Church Farm, Church Road, Bacton.

The 2008 annual mean NO_2 concentrations recorded at these monitoring locations are presented in Table 9.

Table 9: 2008 Annual Mean NO_2 Monitored Concentrations

Site Location	*Grid Reference*	*2008 Annual Mean NO_2 Concentration (μgm^{-3})*	*Distance from Existing Perenco Installation Boundary (metres)*
Paston Barn (W)	32114:34575	15.5 (A)	690
Bacton Castaways	33728:34408	19.0 (A)	850
Paston Barn Compound	32247:34529	15.2 (A)	690
St. Andrews Close	33829:34255	15.3 (A)	950
Bacton 12 – Church Farm	33344:33667	15.4 (B)	1150
Bacton 13 – Church Farm	33344:33667	12.5 (B)	1150
Bacton 14 – Church Farm	33344:33667	15.6 (B)	1150
Bacton 15 – Church Farm	33344:33667	8.2 (C)	1150

NOTE A: Uncorrected annual mean NO_2 concentrations (μgm^{-3}) as presented in *'Air Quality monitoring around the Bacton Gas Terminal – 2008'* (AEA, 2009).

NOTE B: Diffusion tube monitoring data bias adjusted (0.92 correction factor) and supplied by NNDC, 2009a).

NOTE C: Annual mean NO_2 concentration monitored using a chemiluminescence NO_2 analyser (NNDC, 2009a).

The results of the NO_2 monitoring conducted by both the Bacton Forum and NNDC indicate that concentrations of NO_2 within the vicinity of the terminal are significantly below the $40\mu gm^{-3}$ annual mean UK Air Quality Objective. Annual mean concentrations

ranged between 8.9µgm^{-3} recorded by the chemiluminescence analyser at Church Farm to 19.0µgm^{-3} recorded by the diffusion tube at the Bacton Castaways monitoring location.

It should be noted that the two monitoring networks, Bacton Forum and NNDC, utilise different diffusion tube preparation methods. The Bacton Forum diffusion tubes are prepared by Gradko, using 50 percent triethanolamine (TEA) in water, whilst the NNDC diffusion tubes are prepared by Scientifics Ltd at Harwell, using 20 percent TEA in water. The 2008 bias adjustment factor for the NNDC data is 0.92, based on the results of co-location studies (AQC, 2009). This correction has been applied to the monitoring results presented in Table 9.

AEA Technology has been commissioned by Bacton Forum to operate and manage the diffusion tube network and report all results as uncorrected concentrations. The 2008 bias-adjustment factor for the Bacton Forum method of preparation (50 percent TEA in water), based on the result of twelve co-location studies is 0.79 (AQC, 2009). The application of this correction factor would result in a reduction in the reported annual mean NO_2 concentrations to 12.2µgm^{-3}, 15.0µgm^{-3}, 12.0µgm^{-3}, and 12.1µgm^{-3} at Paston Barn (W), Bacton Castaways, Paston Barn Compound, and St. Andrews Close, respectively. The use of non-bias adjusted annual mean NO_2 diffusion tube results has been raised with the Bacton Forum members. The decision on whether to report bias or non-bias adjusted NO_2 annual mean concentrations is pending. For the purposes of this EIA the non-bias adjusted NO_2 concentrations will be utilised.

4.2.2 RELEVANT RECEPTORS

Relevant receptor locations are required to be considered as part of the assessment of air quality. The UK Air Quality Objectives presented in Table 3 for the protection of human health only apply where members of the public are likely to be regularly present for the averaging time of the objective (i.e., where people will be exposed to pollutants). The definition of a relevant receptor is detailed within LAQM.TG [09] (DEFRA 2009). For annual mean objectives, relevant exposure is limited to residential properties, schools, and hospitals. The 1-hour objective applies at these locations as well as at any outdoor location where a member of the public might reasonably be expected to stay for 1-hour or more, such as shopping streets, parks, and sports grounds, as well as bus stations and railway stations that are not fully enclosed.

The 2006 Bacton Gas Terminal dispersion modelling identified six receptor locations at which the impact of NO_2 concentrations on local air quality should be assessed. Five of these locations are considered to meet the criteria prescribed by DEFRA for the selection of relevant receptors; they are all residential properties. The sixth receptor utilised in the 2006 modelling, Mundesley Cliffs, does not meet the relevant receptor criteria, as it is a

SSSI designated for its geological rather than ecological importance. Mundesley Cliffs has therefore not been considered as a relevant receptor location within this EIA. The five relevant receptor locations are detailed within Table 10.

Table 10: Relevant Receptors Considered in EIA

Receptor No.	*Description*	*Distance from Existing Perenco Installation Boundary (metres)*
1	Lowlands Farm	790
2	Hall Farm	650
3	Nearest Residential Property; opposite Castaways Caravan Park	850
4	Paston Barn	690
5	Castaways Caravan Park	810

The relevant receptors are located between 650 metres and 850 metres from the existing Perenco installation boundary.

4.3 EXISTING BACKGROUND CONCENTRATIONS

The NO_2 background concentration utilised in the 2006 Bacton Forum atmospheric dispersion modelling was determined using the annual mean NO_2 concentration measured in 2005 at four monitoring locations: Paston Farm West, Church Farm, Wicken Fen, and St. Osyth. The annual mean NO_2 concentration recorded at these four monitoring sites are presented in Table 11, alongside the 2008 annual mean concentrations.

Table 11: Annual Mean NO_2 Concentrations from Background Monitoring Sites

Monitoring Location	*2005 Annual Mean NO_2 Concentration (μgm^{-3})*	*2008 Annual Mean NO_2 Concentration (μgm^{-3})*
Paston Barn West (A)	15.4	15.5
Church Farm (B)	13.0	8.9
Wicken Fen (C)	11.0	9.9
St. Osyth (C)	16.0	11.0
Mean Annual Background NO_2 Concentration (μgm^{-3}) (D)	**14.0**	**11.3**

NOTE A: Bacton Forum operated NO_2 diffusion tube monitoring site.
NOTE B: NNDC operated chemiluminescence NO_2 analyser.
NOTE C: Automatic Urban and Rural Network (AURN) monitoring site.
NOTE D: Average of annual mean NO_2 concentrations recorded at four monitoring locations.

The annual mean NO_2 concentrations recorded in 2005 at the four monitoring sites ranged between 11.0μgm^{-3} and 16.0μgm^{-3} at the Wicken Fen and St. Osyth monitoring sites respectively. When averaged, the four concentrations recorded resulted in an

annual mean NO_2 concentration of 14.0µgm^{-3}. This 2005 annual mean concentration of 14.0µgm^{-3} was utilised in the Bacton Forum atmospheric dispersion modelling, conducted in 2006.

The annual mean concentrations recorded in 2008 were lower at three monitoring sites, Church Farm, Wicken Fen, and St. Osyth, than those recorded at the same sites in 2005. The annual mean concentration recorded at Paston Barn West was 0.1µgm^{-3} higher in 2008 than recorded in 2005; 15.5µgm^{-3} and 15.4µgm^{-3} respectively. The average of the annual mean background NO_2 concentration recorded at the four sites in 2008 was 11.3µgm^{-3}. This background concentration will be utilised within the EIA. Sections 6.2.1 and 6.3.2 provide further details of the assessment of air quality.

4.4 WATER QUALITY

4.4.1 SURFACE WATER

There are no natural watercourses within the immediate vicinity of the Perenco installation. There is a drainage ditch running along the north western edge of Seagulls Field which drains the adjacent agricultural field. This is generally dry; it is assumed that the majority of water percolates to the water table before reaching the end of the drain. In addition, a field drain runs along the edge of the Seagulls Field parallel to Seagulls Road.

The nearest natural surface water feature is Mundesley Beck, which culminates in a pond off Paston Road in Mundesley approximately 2 km northwest of the installation. There are also a number of small ponds in the area, but all are over 2 km from the installation.

4.4.2 GROUNDWATER

The 1:100,000 scale groundwater vulnerability map for the area (Sheet 26), published by the Environment Agency classifies the drift deposits underlying the site as a Minor Aquifer, which is defined as;

"*Fractured or potentially fractured rocks which do not have a high permeability, or other formations of variable permeability including unconsolidated deposits. Although these aquifers will seldom produce large quantities for water abstraction, they are important both for local supplies and in supplying baseflow to rivers*".

The Cretaceous White Chalk, which underlies the drift deposits at approximately 50 metres is described as a Major Aquifer (highly permeable), which is defined as;

"Highly permeable formations usually with a known or probable presence of significant fracturing. [Major Aquifers] may be highly productive and able to support large abstractions for public supply or other purposes".

Based on previous reports perched groundwater is present to varying degrees within the drift deposits beneath the site. It would appear that water laden sediments are not vertically continuous with dry clay layers separating layers of wet sands. The nature of the deposits indicates that groundwater may be present within sand lenses which interconnect allowing vertical and horizontal migration of shallow groundwater. Consequently the groundwater flow regime within the drift deposits is not well defined but is assumed to move in a northerly direction towards the sea.

Groundwater monitoring data collected from the Bacton Gas Terminal as a whole showed that the shallow and deep (Chalk bedrock) groundwater flows towards the north to the northwest. The natural groundwater flow pattern may be disrupted due to the groundwater abstraction at the Perenco facility and adjoining groundwater abstraction at the adjacent sites (Shell and ENI).

The nearest public water abstraction point is approximately 3km to the northwest in Mundesley. Groundwater source protection zones, designated by the Environment Agency to protect areas of abstraction, are located in Mundesley, Swaffield, Horning and south east of North Walsham. Zone 1 is designated around the abstraction point and its limit is the point at which pollution can reach the borehole within 50 days. Zone 2 is determined by pollution reaching the borehole within 400 days. The total catchment area is the total area needed to support abstraction from the borehole and to support any discharge from the borehole. The total catchment areas of all of the sources within the vicinity of Bacton are northwest or west of the zone 1 locations; Bacton Gas Terminal Complex is not within a groundwater source protection zone and it is not expected that the proposed development will have an adverse impact on public water supplies.

The nearest private licensed groundwater abstractions are those of the Bacton Gas Terminal Complex. The Perenco terminal borehole is situated to the south of the installation at TG 3296 3453 and is licensed to abstract up to 8,200m^3 per year. ENI has two bore holes located to the north and south of their installation at TG 3278 3491 and TG 3268 3463 respectively; its abstraction licence permits removal of up to 47,700m^3 per year. Shell has two boreholes located near to the perimeter in the southwest and the north however it has surrendered its abstraction licences and is no longer permitted to remove water from this source. A further borehole is located at TG 3181 3430, approximately 1.4km from the installation. This is operated by FJ Clabon and Partners and is used for agricultural purposes. They are licensed to abstract up to 90,000m^3 of water per year. There are no other abstraction licences issued for locations within 2km of the Perenco installation.

North Norfolk District Council has confirmed the presence of two other private water supplies within 1km of the installation. Table 12 presents their locations.

Table 12: Private Water Supplies within 1km of Perenco Installation

Location	*Grid reference*	*Classification*	*Distance from Site (metres)*
Bacton House, Church Road	TG 3359 3350	Borehole Single Private Dwelling (Class F)	1020
Hall Farm, Bacton Road	TG 3238 3453	Borehole Single Private Dwellings (Class F)	433

It is not considered that there will be emissions to groundwater that will influence the quality of the water extracted from these boreholes; further information concerning water quality is provided in section 5.2.14 and 5.3.3.

4.5 LAND USE

The proposed gas reception and processing facilities will be based wholly within the existing Perenco Terminal boundary. Figure 2 presents the location of the existing Perenco Terminal.

The Perenco installation is located between the Shell and ENI installations on Paston Road, northwest of the village of Bacton. The site location in relation to the surrounding area is presented in Figure 3. The complex comprises five operators: Perenco, Petrofac Offshore Engineering & Operations Ltd (Petrofac) (who operate the Site on behalf of ENI), Shell, National Grid, and Interconnector UK Ltd (Interconnector).

The Perenco installation covers an area of approximately 17.5 hectares (ha). The majority of the buildings are located to the south of the site and include administrative offices, control room, laboratory, raw material storage, maintenance and process buildings, such as compressor and boiler houses. External areas comprise tarmacadum and concrete hard standing around most of the process area, chemical and raw material storage and waste storage. Several above ground storage tanks (ASTs) containing condensate and glycol are located in the tank farm and other smaller ASTs are located in the waste storage area. The northern area of the site is mostly vacant and consists of hardstanding and grassed areas with some above ground pipelines. It is proposed the new onshore facilities will be located in this area.

The north of the site is bounded by the North Sea. The western perimeter of the site is bordered by ENI, the eastern perimeter by Shell, and the southern perimeter by Bacton Road, Interconnector and National Grid.

The areas that are proposed for the Baird onshore facilities consist of largely open grass. A limited amount of process plant will require decommissioning or moving to new locations within the existing Perenco site.

The Bacton Gas Terminal Complex is surrounded by predominantly arable farm land. The Paston Great Barn is located in the hamlet of Paston, situated approximately 700 metres southwest of the site. Paston Great Barn is a SAC, SSSI, and an NNR for its maternity colony of Barbastelle Bats. The barn is a medieval thatched building made of flint and limestone and is also a Scheduled Monument. The village of Bacton is located approximately 1.25km southeast along the coastline. A 'Holiday Centre' is situated on the northwest outskirts of Bacton village, 500 metres from the Perenco Site. Stow Mill, an operational windmill, is situated on the south-eastern side of the coastal village of Mundesley.

4.6 LANDSCAPE

4.6.1 INTRODUCTION

A Landscape and Visual Resources Assessment (LVRA) has been undertaken by RPS to consider the existing landscape, identify visual receptors and assess the significance of the direct and indirect impacts on the landscape character and visual resources. This is presented in Appendix A.

The site is located close to the boundary of the Norfolk Coastal Area of Outstanding Natural Beauty (AONB) and within 5km of The Broads National Park, therefore it is important to assess the potential impacts of the development on the landscape character and visual settings.

The landform generally consists of gently rolling relief with much diversity to the northwest and west of the complex. The general surrounding area is predominantly agriculture; which has led to loss of a large number of hedgerows and permanent pastures. The area is rich in cultural heritage possessing historical buildings, windmills, churches, conservation areas, scheduled monuments and listed buildings. These are discussed further in Section 4.11.

4.6.2 LANDSCAPE CHARACTER ASSESSMENT

The landscape character is a low plateau that slopes gently towards the sea and lies within Natural England's 'North East Norfolk and Flegg' Countryside Character Area (79) as defined within the Countryside Agency's Countryside Character (1999).

This includes a settled landscape of small nucleated and dispersed villages, small to medium scale fields with small farms and high hedges, strong vernacular style of domestic and agricultural buildings and tourist development along the coast as key characteristics. Within 15km of the Bacton Terminal Complex are the 'Central North Norfolk' Countryside Character Area (78) and 'The Broads' Countryside Character Area (80). The areas are within the Coastal Plain landscape type and the 'Bacton to Sea Palling' Character Area (CP1) as defined by NNDC as part of the Local Development Framework (NNDC, 2009b).

The landscape of the area is relatively low in comparison with neighbouring coastal areas further north. The landform generally declines from Cromer to Sea Palling, becoming sea level fen around Horsey.

The settlement pattern along the coast is linear, with areas of development straggling along roadways between settlements, including caravan and chalet parks. Further away from the coast the settlement pattern is more semi-nucleated. Many of the buildings provide distinctive character to the area, including old wood and asbestos style bungalows; the vernacular architecture in Happisburgh, Lessingham and Ingham Corner, and the large Bush Estate at Eccles. There are no major roads in the area.

Other distinctive landscape characteristics include views of the Happisburgh Lighthouse, water tower and Churches and the pre-Enclosure field patterns.

4.6.3 LANDSCAPE DESIGNATIONS

The development lies within 5km of The Broads National Park and is very close to the Norfolk Coast AONB; the AONB ends at the ENI Terminal boundary. The Bacton Terminal is surrounded by 'Undeveloped Coast', a designation of county importance. Development on an 'Undeveloped Coast' may be considered detrimental to the appearance or character of an area. In addition there are two sites of Historic Parks and Gardens within 5km; these are Witton Hall (2km from the site) and Crostwright Hall (approximately 4km from the site). These locations are not registered by English Heritage but are of local importance.

The development site is designated for industrial use, but the terminals lie within the area designated as Countryside. The NNDC SS1 Spatial Strategy for North Norfolk within the Core Strategy for North Norfolk (NNDC 2008) defines all the areas with Countryside designation. The NNDC core strategy SS2 Development in the Countryside identifies acceptable levels of development within these Countryside designated areas. The project falls under '*extensions to existing businesses*' and is therefore a permitted development in accordance with Policy SS2. Policy EC 3 specifically refers to Bacton Gas Terminal identifying that development within the terminal will be

supported within the existing area. All permanently visible aspects of the Baird Facilities will be located within the Terminal boundaries.

4.6.4 TOPOGRAPHY AND VEGETATION

The Bacton Terminals lie on land that has been levelled and slopes gently north. To the south and west the land gently rises to 40 metres above Ordnance Datum (mAOD). Land to the east is virtually flat reaching 10mAOD approximately 5km from the Terminals.

Inland of the site the land use is largely agricultural with medium sized regular fields bounded by ditch and bank field boundaries or sparse hawthorn and mixed hedgerows. These are generally managed to between 1.5 and 2.5 metres high and trees coast to the coast are windblown. Further inland the landscape is a more intricate field system with winding lanes. Hedgerows include frequent trees including prominent oaks.

4.6.5 ZONE OF VISUAL INFLUENCE

The Zone of Visual Influence (ZVI) is formed by the area of land from which there is a view of the existing structures within the Bacton Terminals. This has been determined using a combination of site based visual assessment and computer based analysis using Digital Terrain Modelling. This does not take into account vertical elements of the built environment or mature vegetation; aerial photography has been used to determine how these elements are likely to influence the extent of the visual envelope.

The highest structure is the telecommunications tower on the Perenco Terminal which is 115 metres above ground level. The LVRA notes that only the top part of this tower is visible in views 5km to 15km away due to the flat topography and effect of intervening vegetation. The second telecommunications tower on the Shell Terminal is 125 metres above ground level. The thermal oxidiser on the ENI Terminal has a stack reaching 53 metres high. The ZVI to the west is along the coast road to Beacon Hill and inland to Gimingham and Trunch. The southern boundary of the ZVI is bounded by the North Walsham Canal valley and woodland at Pigneys and Bacton Wood. The North Walsham Road extends the ZVI to the south east with intermittent views up to 5km and from the area of Walcott.

The ZVI for the landfall and onshore pipeline route extends from the coastline at the offshore pipeline landfall location across the beach and cliff to the terminal boundary.

4.6.6 EXISTING VIEWS

The LVRA identifies that views from the cliff top path looking east and from the footpath from the village of Paston are dominated by the Bacton Gas Terminal complex

and include stacks, vents, towers, tanks, buildings and masts. The vegetation provides some internal screening within the Perenco Terminal and the ENI Terminal dominates this view. From the cliff top path views to the north are of the sea. Beaches and the built up area of Bacton extend beyond the terminal complex with open agricultural landscape to the south.

The highest existing structure on the Perenco site is the telecommunications tower at 115 metres above ground lever. There is a second telecommunications tower on the Shell Terminal which is 125 metres above ground level. To the west of the Terminals it is possible to see the tops of the telecommunications towers and the thermal oxidiser stack (53 metres) on the ENI installation from the Paston Way to the south of Knapton. At greater distance, in particular from Gimingham and Trunch, the topography and vegetation screen the majority of the Terminal other than the telecommunications towers. No existing views of the telecommunications towers were identified in the LVRA beyond 10km of the Bacton Terminal Complex.

To the south some properties within Edingthorpe fall within the ZTV and therefore have views across agricultural land to the Terminal Complex. Further south there are intermittent views of stacks and towers from public rights of way and roads at breaks in the vegetation.

The closest point east of the Terminals that was assessed was at the corner of Seagulls Field adjacent to Castaways Caravan Park. Views to the northwest are dominated by the terminal, although the planted bund, boundary vegetation and planting within the Perenco Terminal provide screening for some low level aspects of the Terminals. Views from Mill Common to the east, are of agricultural land and the Terminal Complex although there are significant features of vegetation in the foreground. Further away to the east only the tops of the telecommunications towers are visible above roof tops and vegetation.

Views of the landfall and onshore pipeline route are most likely to be from the properties south east of Seagulls Field. These view across the grassland field to the cliff top but not to the beach. Users of the cliff top path and Castaways Caravan Park will gain views to the beach.

Distant views beyond 5km from the Terminal are extremely restricted by the extensive intervening vegetation cover. No views were identified from within the Norfolk Broads AONB or from the Weavers Way.

From the beach looking upwards between the revetments and the foot of the cliff some glimpse views occur of the security fence, lamp posts, CCTV cameras and the tops of existing vent stacks. However, beach users at low level at the base of the cliff are generally unaware of the terminal above. At low tide, with the opportunity to move

further away from the cliff base, looking back towards the cliff, the security fencing, high towers, vent and other existing industrial features of the terminal are more prominent in the view.

The proposed development is of a smaller scale compared to the current proposed workings at the Terminal. The LVRA has reviewed the potential impact of the proposed Baird facilities on the local landscape and is summarised in section 5.3.4.

4.7 NOISE

The Bacton Forum recognised the collective impact of noise emissions from the Bacton Gas Terminal Complex on the surrounding community. The Forum commissioned an assessment of noise and following the results of this, agreed to the 'Code of Practice on Environmental Noise – Bacton Terminals' (Perenco, 2003). The Code of Practice identified that noise limits for individual projects on the Terminal Complex should be based on the reference noise levels at designated community control points. Details of the local noise control requirements are presented in Section 2.7.

The community control points are presented on Figure 9. These are locations selected to provide an indication of the level of noise reaching the local community. Reference noise levels were created by assessing background noise levels at the time the Code of Practice was drafted. The reference noise levels have become defined levels acceptable by all of the Gas Terminal operators, NNDC and the Environment Agency.

Table 13 below identifies the community control points, their location and distance from the Terminal, and the reference noise levels.

Table 13: Community Control Points

Community Control Point	*OS Reference*	*Distance from Perenco Terminal (metres)*	*Reference Noise Levels*	
			dB L_{Aeq}	*dB L_{Ceq}*
Church Farm, Bacton	63 3270E 33 3625N	1150	40	63
Abinger Cottage, Paston	63 2125E 334820N	790	45	68
Lay-by opposite 'Castaways Caravan Park;	63 3650E 33 4370N	850	45	68

The impact of noise from the proposed facilities will be considered by comparing estimated sound pressure levels with the reference noise levels.

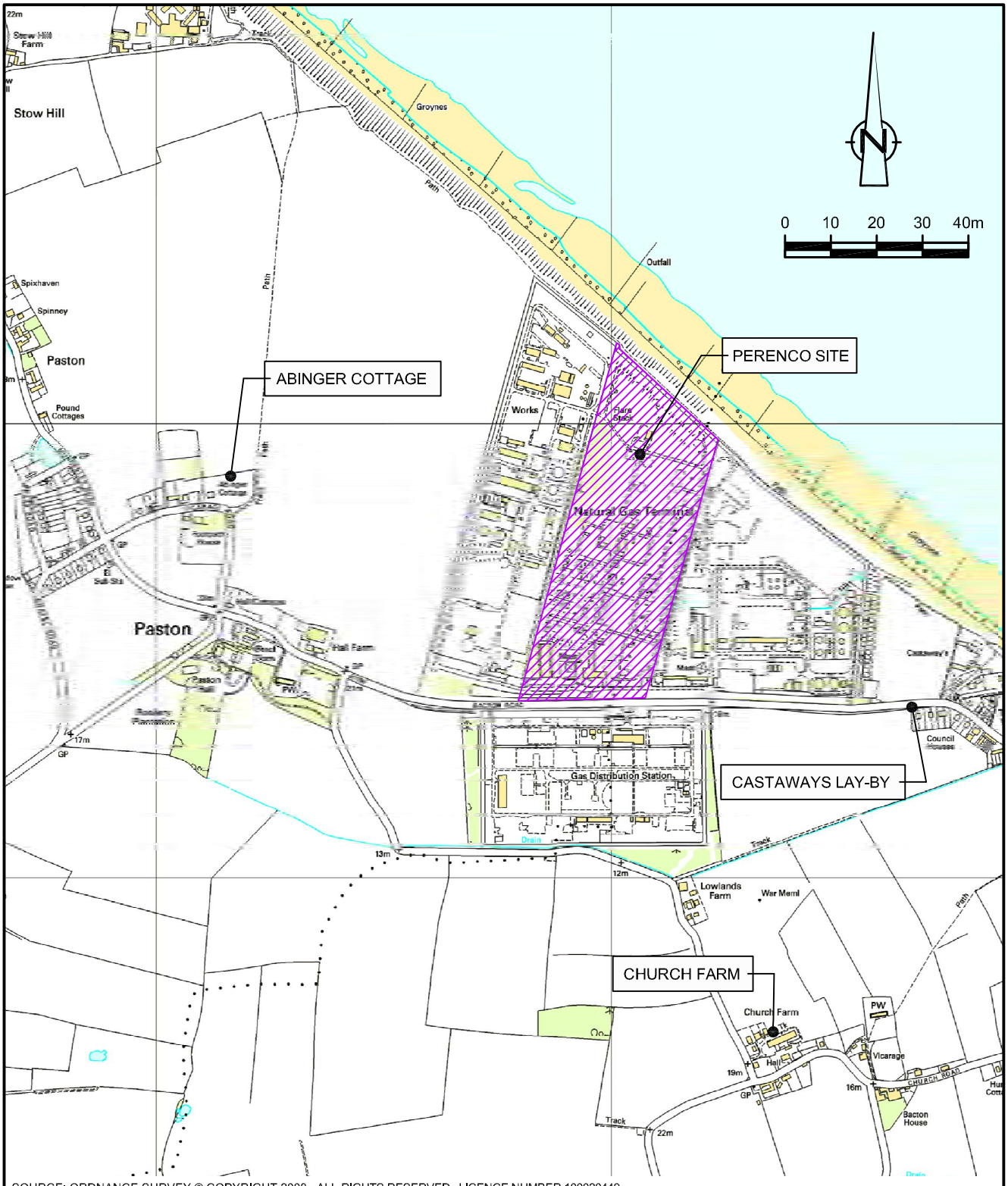

figure 9

COMMUNITY CONTROL POINTS
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4.8 PLANTS AND ANIMALS

The Bacton Gas Terminal Complex is an industrial area surrounded by farmland and coastal habitats. The areas to be developed for the Baird Project include a range of habitat types: amenity grassland, buildings, fencing, hard standing, improved grassland, intertidal sand and mud, a partly vegetated bank,hedgerows and mixed plantation woodland.

The amenity grassland is mown and includes clover (*Trifolum* species), creeping buttercup (*Ranunculus repens*), daisy (*Bellis perennis*) and meadow grass (*Poa annua*). Amenity grassland is located within the Perenco site and in a 5 metre strip between the sand berm and the cliff. There is anecdotal evidence that bee orchids *(Ophrys apifera)* are found in the strip of amenity grassland adjacent to the western perimeter.

The fence and hard standing areas are considered to be in good condition and support very little vegetation. There are three buildings within the area to be developed in the Perenco site. All of these buildings are in good condition. The Archive Building is the only one of the three that will be demolished as a result of the proposed works.

Improved grassland is found in Seagulls Field and includes a range of grass and herb species including weld (*Resedacea luteola*), clover and spear thistle (*Cirsium vulgare*). This area is regularly used during construction works at the Bacton Gas Terminal Complex and it is obvious from the species present that it has been disturbed recently. The construction compound will be adjacent to the road and parallel with the bund. It will not extend beyond the bund and therefore the area of improved grassland will not be affected.

The intertidal sand and mud does not support any vegetation. A timber sea defence revetment crosses this habitat along the coastline.

The partly vegetated bank is located between the beach and the amenity grassland area. It is slope of approximately 60 degrees and is dominated by rough grass on the upper slope and sand and pebble substrate without vegetation on the lower slope. Species in the rough grass include clover, creeping thistle and marram grass (*Amminphila arenaria*).

Two early mature hedgerows are located on the bund adjacent to Paston Road. They are approximately 2 metres wide and 3 metres tall. They are species poor and include hawthorn *(Cretaegus monogyna)*, sea buckthorn (*Hyppophae rhamnoides)* and field maple *(Acer campestre)*. The hedgerows form part of a larger screening feature.

The mixed plantation woodland contains a number of tree species including sycamore (*Acer pseudoplatanus*), Corsican pine (*pinus nigra* subspecies *laricio*) and elder (*Sambucus nigra*). It is approximately 30 to 40 years and extends approximately 250 metres adjacent

to the perimeter fence, separated only by a strip of amenity grassland. The plantation is currently 30 to 40 metres wide.

Fauna present on the site include a range of common bird species including house sparrow (*Passer domesticus*), black-headed gull (*Larus ridibundus*), carrion crow (*Corvus corone*) and rabbit (*Oryctolagus cuniculus*).

In order to assess the impacts of the proposed development on these habitats, a Phase I Habitat Survey and an Arboricultural Survey were undertaken. Following the preliminary findings of the Phase I Habitat Survey an Initial Bat Survey of the Archive Building was also conducted. A summary is provided in section 5.2.8.

4.9 SOCIO-ECONOMIC

4.9.1 LOCAL DEMOGRAPHICS

North Norfolk is a large rural district comprising of almost 96,547 ha and is bounded by 73km of North Sea coastline. The 2001 census data showed the population of Norfolk increased by 13.5 percent between 1981 and 2001. This is high compared with an 11.1 percent rise in the East of England and a 5.0 percent rise in England. The District of North Norfolk has an estimated population of approximately 153 people per square km, based on 2007 data. This is regarded as a good representation of the population of Bacton. Approximately 44 percent of the District's population lives in the larger market towns of Cromer, Fakenham, Holt, North Walsham, Sheringham, Stalham and Wells-next-the-Sea. Approximately 47 percent of the District's population live in parishes with populations of over 300 people, and the remainder in smaller parishes.

Further to supporting a strong diverse tourism industry, the region is popular as a retirement location. This was reflected in the 2001 Census findings, which revealed 25.4 percent of the District's population was aged 65 or over, compared with 20 percent and 16 percent for Norfolk and England and Wales, respectively.

4.9.2 EMPLOYMENT

The economy in the District is characterised by the large number of people (84 percent) employed in small businesses. Table 14 presents the structure of the business stock in North Norfolk. There has been growth in employment in the manufacture of plastic and timber products and marine engineering over recent years (NNDC, 2009c).

Table 14: Structure of Business Stock

Number of Employees	*Business Type*	*Number of Businesses*	*Percentage (%)* [A]
0	Sole Traders	706	23
1-9	Micro Small	1,741	57
10-49	Small	530	17
50-249	Medium	94	3
250-449	Large Corporate	11	0
500+		-	0

Abridged from NNDC, 2009c.

NOTE A: 100 percent = 3,082 Total VAT Registered Businesses.

Over recent years, the District's seven traditional market towns have been under increasing pressures from Norwich with regards to local employment and service centres. In attempts to mitigate competition, new supermarkets and other retail developments have been provided in some of the market towns. North Norfolk District Council has recently been implementing initiatives to promote the economic, environmental and social well-being of these smaller settlements. The majority of people currently employed at the Bacton Terminal are highly skilled and local to the area. The current operational life expectancy of the existing facilities is approximately 15 years. In light of this, the proposed Baird Project will make a significant contribution to extending the life of the Bacton Gas Terminal Complex, enabling existing jobs to be sustained for a further 50 years. Additional job opportunities will be created during the construction phase. During the operational phase the majority of employment opportunities that are created as a result of this project will be highly skilled and long-term positions and it is expected that approximately 37 positions will be created.

There are numerous small commercial businesses along the HGV route into the Terminal, including a wool shop, petrol station and mechanics workshop, the village school, a newsagent and a public house. There is also a small chain of shops and amusements. The public houses, hotels, amusements, caravan sites and various other surrounding amenities rely heavily on tourism as their key income generator.

4.9.3 LEISURE AND TOURISM

The economic impact of tourism in Norfolk is presented in Figure 10. Research conducted by the East of England Tourist Board estimated that there were 29,851,000 visitors in Norfolk in 2007; 4,220,000 staying visitors and 25,631,000 day trippers.

In North Norfolk, the most common tourist and leisure activities are:

- Beaches;

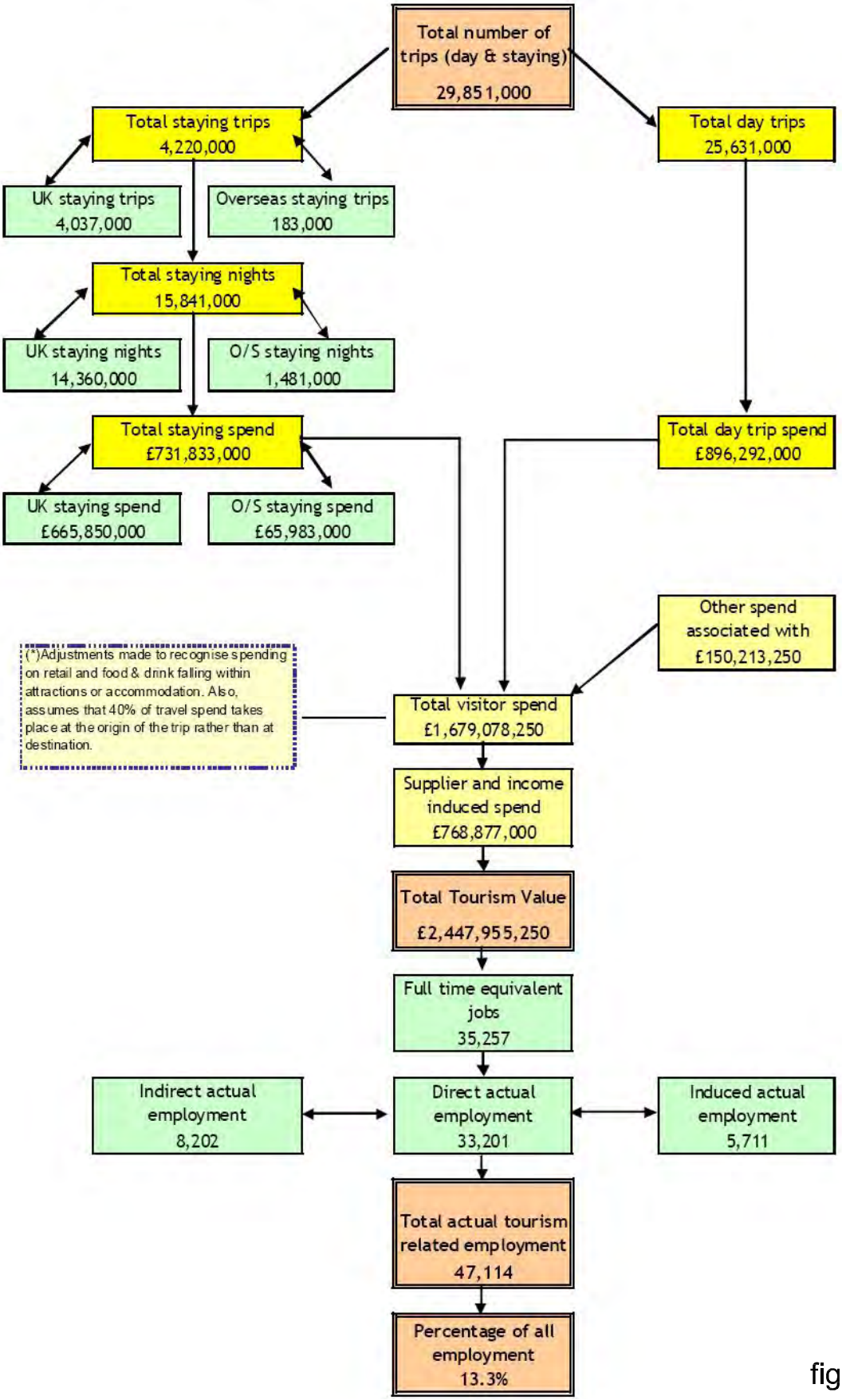

figure 10

ECOMONIC IMPACT OF TOURISM IN NORFOLK, BASED ON 2007 DATA (EAST OF ENGLAND TOURISM, 2008)

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- Walking;
- Cycling;
- Sports/leisure centres;
- Sight seeing;
- Shops;
- Restaurants/pubs; and
- Attractions (e.g. arts, crafts and galleries, visitor centres, water based attractions, wildlife and nature, theatres and entertainment).

Employment associated with the visitor spending (Figure 10) has been calculated by the turnover generated through tourism.

During the tourist season, i.e. late July to early September, the local population may increase to 500 residents within 1 km of the Terminal Complex. This is over three times the typical population density. As with most coastal communities, Bacton village relies heavily upon income generated through tourism during these summer months.

At the time of the 2001 census, approximately 25,566 people in the East of England were employed in tourism related industries. The overall contribution of tourism, as an export measure, to North Norfolk District economy in 2009 is estimated at £371 million, underpinning 8,000 jobs. Of these jobs, 84 percent are sustained as result of direct visitor spending, with the remainder being supported indirectly through tourism business linkages and the resultant expenditure on local goods and services (NNDC, 2009c).

The closest holiday sites to the Terminal are Castaways Caravan Park and Redhouse Chalet and Caravan Park, which are approximately 600 metres from the east boundary. The Mundesley caravan and chalet park is approximately 900 metres from the west boundary.

4.9.4 LAND USE

Twelve semi-detached houses on the south side of the Bacton Road are the closest dwellings. There are nine properties adjacent to this in St. Andrews Close and a privately owned bungalow. Opposite is a holiday complex comprising residential caravans, chalets, bungalows and flats. There are a number of isolated dwellings in the area, including Lowlands Farm to the south, Hall Farm to the west, a small cluster of semi-detached properties to the west and Paston Church, which lies in a slight dip off the Bacton Road adjacent to Hall Farm.

The majority of the land around Bacton is intensively farmed and therefore only provides low grade natural habitats. The land use around the terminal is predominantly

agriculture, with villages, namely Paston, Knapton and Edingthorpe, and a few small dwellings as discussed above. The main crops cultivated are cereals and sugar beet. A small proportion of livestock, including sheep, pigs and cattle, are farmed in addition to the predominantly arable land use.

4.9.5 RIGHTS OF WAY

A coastal path runs parallel to the cliff edge next to the Bacton Gas Terminal Complex perimeter fences. This is not a public right of way however the public are allowed to use it and access is from the north via the cliffs or the east side of Seagulls Field to the southeast. The footpath from Vicarage Road to the northwest of the Terminal Complex to the corner of the ENI Terminal is a public right of way. These paths are used regularly by walkers, particularly local residents, throughout the year.

There is currently access to the beach via Seagulls Road and a concrete ramp; this is not a public right of way, but is owned by Shell, who allow public access.

4.10 TRANSPORT INFRASTRUCTURE

Over the years a number of roads in the area have been upgraded to accommodate the associated vehicle movements to the Bacton Gas Terminal. These roads form part of the designated Heavy Goods Vehicle (HGV) route to Bacton from Norwich. The designated HGV route to the Bacton Terminal is presented in Figure 11. The main HGV access road is from the A149 at Stalham, along the B1159 through to Walcott, Bacton and Bacton Green before reaching the Terminals.

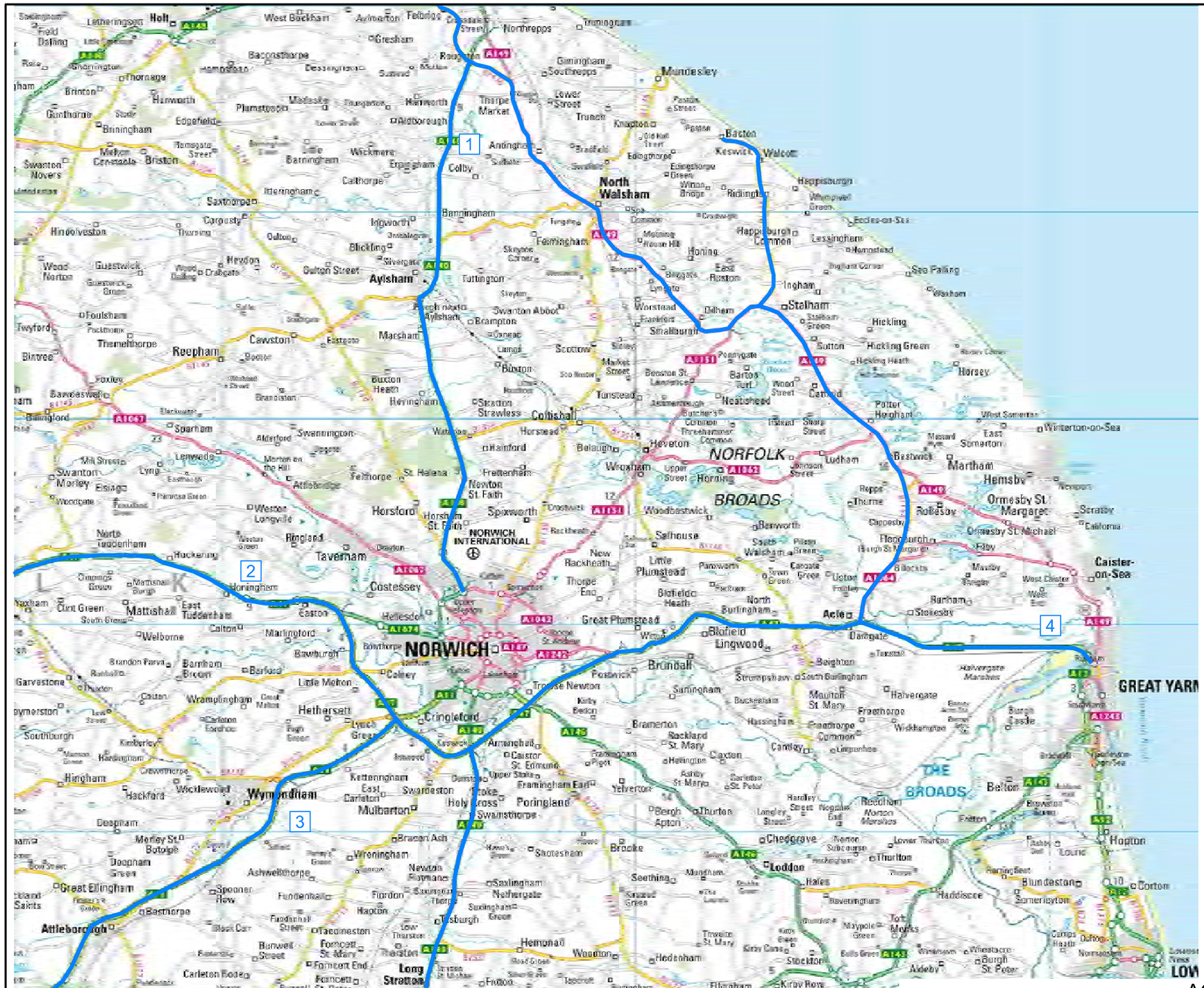
There is also an emergency access route from North Walsham to Bacton, which is also maintained, however it is not used as main access for HGVs.

The types of vehicles using the main access route to the terminal are generally cars, light vans delivering goods and services to shops and businesses in Bacton, agricultural plant working on farms in the area, and a small number of HGVs working at Bacton.

4.11 ARCHAEOLOGY AND HERITAGE

As a county, the archaeology of Norfolk is very rich, recording 20 percent of all the archaeological treasures found in England. Artefacts are often found in ploughed soil.

A limited number of archaeological sites are located within the vicinity proposed development area, however the development poses potential for buried artefacts to be unearthed during works.



LEGEND: ROUTES

1 FROM NORTH

2 FROM WEST

3 FROM SOUTH

4 FROM EAST

figure 11

ACCESS ROUTE TO AND FROM SITE
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BACTON STORAGE COMPANY LIMITED
Bacton Gas Terminal Norfolk

The proposed development area includes cropmarks of undated archaeological features, findspots of prehistoric artefacts and the site of Second World War defences. There are seven Scheduled Monuments within 10 km of the terminal, which are listed in Table 15. These all contribute to the character of the area.

Table 15: Scheduled Monuments within 10km of Proposed Development

Parish	*Monument Number*	*Name*	*Approximate distance from Perenco Terminal (kilometres)*
Bacton	NF169	Broomhall Priory	2.5
North Walsham	NF204	Market Cross	7.0
North Walsham	31141	Cross 120 metres south west of Tollgate Farm	7.0
North Walsham	32091	Cross 300 metres north west of Tollbar Cottages	7.0
North Walsham	31140	Water Works	7.0
Paston	NF168	The Great Barn	0.7
Southrepps	31120	Wayside Cross known as Stump Cross	8.8

North Norfolk is a Heritage Coast from Holme-next-the-Sea to Weybourne, approximately 15 miles northwest of the Terminal Complex. It is a marshland coast and a popular bird watching destination. The Heritage Coast includes a Ramsar site, Biosphere Reserve, a SSSI, a Special Protection Area, a candidate SAC and Marine SAC. There are no World Heritage Sites located within Norfolk.