Gold Hydrogen

Natural Hydrogen Exploration Drilling and Well Testing

PEL 687 - Yorke Peninsula

Draft Environmental Impact Report

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Summary

Gold Hydrogen Ltd (Gold Hydrogen) is exploring for natural hydrogen generated from geological processes occurring in parts of the Earth's crust. As a replacement for carbon-based fuels, naturally occurring hydrogen (also known as 'gold' or 'white' hydrogen) offers significant cost and emissions advantages relative to other sources of hydrogen production, with the potential to be a clean, low-cost energy source into the future.

Gold Hydrogen holds Petroleum Exploration Licence (PEL) 687, which covers large sections of Yorke Peninsula and Kangaroo Island. This Environmental Impact Report (EIR) has been prepared under the *Petroleum and Geothermal Energy Act 2000* to cover exploration well drilling and testing for natural hydrogen in the Yorke Peninsula component of PEL 687.

Background

PEL 687 covers known occurrences of natural hydrogen on Yorke Peninsula and Kangaroo Island which were discovered during the 1920s and 1930s during hydrocarbon exploration activities, including at the Minlaton Oil Syndicate Bore 1 (also known as Ramsay Oil Bore 1) east of Minlaton.

Gold Hydrogen's exploration program (the 'Ramsay Project') aims to initially validate the natural hydrogen occurrences of the 1920s and 1930s and prove that natural hydrogen is present within PEL 687 on Yorke Peninsula; and demonstrate that natural hydrogen is present in sufficient volumes to be extracted for commercial use.

Over the five-year span of this EIR and the accompanying SEO, Gold Hydrogen expects to drill approximately five exploration wells. The number and location of the wells will depend on drilling and testing results as the exploration program progresses.

Scope

This EIR and the accompanying SEO cover activities involved with exploration drilling for natural hydrogen and testing of any occurrences of hydrogen that are detected, within PEL 687 on Yorke Peninsula. The following are excluded from the scope of these documents:

- the portion of PEL 687 located on Kangaroo Island
- activities in reserves established under the *National Parks and Wildlife Act 1972* or exploration activities immediately adjacent to a Marine Park established under the *Marine Parks Act 2007*
- activities in mining production tenement regulation areas identified in Schedule 14 of the *Planning, Development and Infrastructure (General) Regulations 2017.*

A number of other areas that would specifically be avoided by exploration drilling activities have also been identified in the EIR. These include Wardang Island Indigenous Protected Area, Native Vegetation Heritage Agreement areas, land where access has not been agreed with the landowner, land in close proximity to towns or sensitive receptors, areas of high-quality native vegetation, significant wetland areas and areas of identified cultural heritage significance.

Land Use and Environment

Yorke Peninsula is one of Australia's most important primary production regions. Agriculture is the dominant land use, mainly comprising broadacre cropping of wheat, barley, lentils and canola and sheep farming. Yorke Peninsula is also a popular holiday destination, particularly over the warmer months. Tourist attractions include beaches, coastal towns and national parks. Other land uses include conservation, mining and renewable energy generation.

Yorke Peninsula is characterised by an undulating plain of generally low relief. Soils mainly consist of loam over clay, shallow calcrete or calcareous loams. There is very little drainage definition and many surface water catchments terminate in landlocked saline lakes, which are particularly common near the west coast and in the south of the Peninsula.

Groundwater is used for stock and domestic supply across southern Yorke Peninsula in areas where salinity levels are suitable. Groundwater in shallow aquifers is generally brackish, except in the south-west, where fresh groundwater is found. Deeper aquifers are generally brackish to saline. Depth to groundwater is typically over 20 m in the central and eastern part of PEL 687, but is much closer to the surface along the west coast and in the area south and west of Minlaton and Yorketown.

There has been widespread native vegetation clearance across the peninsula and the majority of PEL 687 is cleared agricultural land. Large tracts of vegetation occur only in the south-west of the PEL, with native vegetation elsewhere typically present as isolated patches in paddocks and on roadsides. A number of threatened flora and fauna species have been recorded in PEL 687, and are generally associated with areas of remnant vegetation or the coast.

Maitland is the largest centre within PEL 687. Other population centres include Price, Ardrossan, Port Victoria, Port Vincent, Stansbury, Minlaton, Yorketown, Coobowie, Edithburgh, Warooka, Point Turton and Marion Bay. There are also numerous localities with smaller permanent populations.

PEL 687 is located on the traditional lands of the Narungga people. Archaeological evidence of their ties to the land and water is recorded in numerous entries for Aboriginal heritage within the area of PEL 687 on the Register of Sites and Objects (administered by Aboriginal Affairs and Reconciliation).

The licence area is within the area of the Narungga Nation native title claim. This claim was determined in March 2023 by agreement with the State and recognises the claimants as native title holders for native title land in the claim area.

Environmental Impact Assessment

This EIR assesses the potential impacts posed by hazards that may result from exploration well drilling and testing for natural hydrogen. The risk assessment contained in this EIR indicates that potential impacts are generally short term and localised, the level of risk is generally low, and the activities can be adequately managed to prevent unacceptable environmental impacts. In particular:

- Potential impacts to land use and property management are mitigated through consultation with landowners regarding the location, management and timing of proposed activities, with the aim of minimising disturbance. Sites will be rehabilitated to the satisfaction of landowners following the conclusion of activities, with stockpiled topsoil re-spread, site contours re-instated and crop / pasture or vegetation re-established, unless landowners request that paved areas or access tracks are left in place.
- Traffic management and noise limitation procedures will be implemented, and adequate buffers will be maintained between well sites and residences. Impacts to landholders and communities will be mitigated through ongoing consultation regarding the proposed activities, with the aim of identifying potential issues and minimising disturbance.
- Significant impacts to flora and fauna are avoided through the environmental assessment and planning process undertaken for individual well sites. This will include locating wells in

previously disturbed or cleared areas, fencing to prevent fauna (or stock) access, weed and fire prevention measures and transport procedures.

- Drilling locations are expected to be located in agricultural land with a long history of cultivation, where the risk of damage to Aboriginal heritage is typically low. Consultation would be carried out with the Narungga Nation Aboriginal Corporation regarding the risk of damage to Aboriginal heritage at drilling locations, and a cultural heritage survey would be carried out where required.
- Spills or leaks of fuels, oils or chemicals are mitigated by restricting the storage and handling of fuel and chemicals to designated areas on the drill pad, use of appropriate secondary containment and immediate clean-up and remediation of any spills. Drilling muds would be water-based and non-toxic to low toxicity additives would be used. Sumps would be lined with an impermeable liner as a precautionary measure and sump contents will be removed on completion of the activities.
- Aquifers will be protected by casing and cementing of wells. Well integrity will be maintained via appropriate design, installation and monitoring during drilling and throughout the well's life. The drilling operation and the design of the well and well test would give particular consideration to the interface with hydrogen gas, to ensure that appropriate equipment and materials are utilised. During well decommissioning, cement plugs are installed in the well to isolate all aquifers and prevent cross flow, contamination or pressure reduction.

A range of management measures that will be implemented are listed in the EIR and will be incorporated into the accompanying Statement of Environmental Objectives.

Stakeholder Consultation

Gold Hydrogen is committed to early, genuine and transparent engagement with the Yorke Peninsula community. Gold Hydrogen takes seriously its responsibility to provide the community with timely, accurate, accessible information and opportunities to learn more about natural hydrogen and the proposed exploration activities in PEL 687.

Early engagement priorities have included detailed discussions with key landowners (e.g. whose properties are either potential sites for drilling or adjacent) and meetings with the Yorke Peninsula Council, local State and Federal MPs, and the Narungga Nation Aboriginal Corporation. Gold Hydrogen will continue to work closely with key landowners to understand and address any concerns, provide compensation as required, and to realise any opportunities or benefits that may arise from the proposed activities.

Drafts of the EIR and accompanying SEO have been made available on Gold Hydrogen's website for a period of public comment. During this time there will also be an opportunity for the community to personally make submissions, raise issues or ask questions of Gold Hydrogen representatives at community drop-in sessions which will be held locally on Yorke Peninsula. The EIR and SEO will be updated in response to this phase of engagement and then formally submitted to DEM for further review and consultation under the formal PGE Act consultation process.

Gold Hydrogen will continue to engage with and update affected landowners, the community and other stakeholders should exploration drilling activities be approved

Gold Hydrogen is confident that with the implementation of the management measures outlined in the EIR, the proposed exploration activities do not present a significant level of environmental risk.

1. Introduction

Gold Hydrogen Ltd (Gold Hydrogen) is operator and 100% working interest owner of Petroleum Exploration Licence (PEL) 687, which covers large sections of Yorke Peninsula and Kangaroo Island (refer Figure 1-1).

Gold Hydrogen is exploring for natural hydrogen generated from geological processes occurring in parts of the Earth's crust. As a replacement for carbon-based fuels, naturally occurring hydrogen (also known as 'gold' or 'white' hydrogen) offers significant cost and emissions advantages relative to other sources of hydrogen production, with the potential to be a clean, low-cost energy source into the future.

Exploration for natural hydrogen is regulated under the *Petroleum and Geothermal Energy Act 2000* (PGE Act). This Environmental Impact Report (EIR) has been prepared to cover exploration well drilling and testing for natural hydrogen in the Yorke Peninsula component of PEL 687.

1.1. Background

Gold Hydrogen's PEL 687 covers known occurrences of natural hydrogen on Yorke Peninsula and Kangaroo Island which were discovered during the 1920s and 1930s during hydrocarbon exploration activities.

Historically, oil and gas exploration activities were undertaken on Yorke Peninsula in the 1930s by entrepreneurial drilling syndicates which were often funded by local farmers. In 1931 the Minlaton Oil Syndicate Bore 1 (Ramsay Oil Bore 1) was drilled and high levels of hydrogen were detected in gas samples, later determined by laboratory analysis to be approximately 80% at depths of up to 500m (refer Plate 1-1 and Plate 1-2).

Gold Hydrogen's exploration program (the 'Ramsay Project') aims to:

- Initially validate the natural hydrogen occurrences of the 1920s and 1930s and prove that natural hydrogen is present within PEL 687 on Yorke Peninsula.
- Demonstrate that natural hydrogen is present in sufficient volumes to be extracted for commercial use.

Gold Hydrogen's preliminary exploration activities which have been previously approved and undertaken prior to the proposed exploration drilling include:

- Airborne gravity-magnetic surveys of PEL 687 undertaken in March-April 2023 to measure and capture natural variations in the strength and other characteristics of the Earth's gravity and magnetic fields. This information will assist Gold Hydrogen geoscientists to understand the sub-surface geological structures in the PEL 687 licence area.
- Non-invasive soil gas surveys carried out by Gold Hydrogen and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in the southern portion of Yorke Peninsula in April 2023. These surveys were designed to detect very small amounts (parts-per-million) of natural hydrogen in near-surface soil, generated from various geological processes that could be occurring in parts of the Earth's crust.

Plate 1-1: Location of Ramsay Oil Bore 1

Plate 1-2: Collecting gas from the Ramsay Oil Bore 1 near Minlaton in 1931 (SADEM photograph N001671).

1.2. Gold Hydrogen Company Profile

Gold Hydrogen is an ASX-listed company focused on the discovery and development of world class natural hydrogen gas in a potentially extensive natural hydrogen province in South Australia. Gold Hydrogen is headquartered in Brisbane, Queensland.

The combined natural hydrogen permit area of the Gold Hydrogen group is approximately 75,332 km^2. Gold Hydrogen holds one granted petroleum exploration licence (PEL 687) and its two 100% owned subsidiary companies (White Hydrogen Australia and Byrock Resources) hold an additional seven applications for natural hydrogen exploration licences within South Australia.

Gold Hydrogen is also the preferred applicant for four gas storage exploration licenses applications (GSELA) covering an additional 8,107 km^2 within the renewable energy zone of PEL 687 of the Yorke Peninsula region of South Australia.

Figure 1-1: Location of PEL 687 on Yorke Peninsula

1.3. About this Document

This document has been prepared to satisfy the requirements of an EIR under the PGE Act. It has been prepared in accordance with current legislative requirements, in particular Section 97 of the Act and Regulation 10 of the *Petroleum and Geothermal Energy Regulations 2013*.

Table 1-1 gives a brief outline of the content and structure of each section of this EIR.

Table 1-1: Environmental Impact report outline

Section	Title	Content
1	Introduction	• Introduces the purpose and format of this document • Provides background, resource and operations information
2	Legislative Framework	• Provides a brief description of the relevant legislation and the assessment and approval process
3	Overview of Natural Hydrogen	• Provides an overview of natural hydrogen concepts
4	Description of Activities	• Describes drilling activities and well testing operations in detail
5	Description of the Environment	• Describes the existing physical, biological and social environment of PEL 687 on Yorke Peninsula
6	Environmental Impact Assessment	• Outlines the environmental assessment methodology and summary of environmental risk assessment
7	Environmental Management Framework	• Outlines Gold Hydrogen's management system and relevant management strategies
8	Stakeholder Consultation	• Documents Gold Hydrogen's consultation approach and activities undertaken for development of the EIR and SEO
8.3	References	• Lists reference material used in the preparation of this document
10	Abbreviations and Glossary	• Lists definitions of abbreviations and terms used in this document
Appendix A	Flora and fauna Information	• Provides a list of species listed under the *Environment Protection and Biodiversity Conservation Act 1999* and *National Parks and Wildlife Act 1972* that may occur in the region
Appendix B	Summary of Issues Raised (Gold Hydrogen consultation)	• Provides details on stakeholder comments on the EIR and SEO and Gold Hydrogen responses

1.3.1. Scope of the EIR and SEO

This document (and the accompanying Statement of Environmental Objectives (SEO)) covers the activities that would be involved with exploration drilling for natural hydrogen and testing of any occurrences of hydrogen that are detected, within PEL 687 on Yorke Peninsula. These activities are described in Section 4.

The following are excluded from the scope of this EIR and the accompanying SEO:

- the portion of PEL 687 located on Kangaroo Island
- activities in reserves established under the *National Parks and Wildlife Act 1972* or exploration activities immediately adjacent to a Marine Park established under the *Marine Parks Act 2007*

- activities in mining production tenement regulation areas identified in Schedule 14 of the *Planning, Development and Infrastructure (General) Regulations 2017*[1].

A number of other areas that would specifically be avoided by exploration drilling activities have also been identified throughout this EIR. These are summarised in Section 4.1.1.

This document has been written to cover activities in a broad geographical area. As discussed in Section 2.1.4, prior to the commencement of any drilling activities, additional site-specific and technical detail for activities at individual well sites must be provided to the Department for Energy and Mining (DEM) under the activity notification / approval requirements of the PGE Act, including a demonstration that the activities are covered by (and are compliant with) an applicable SEO.

[1] Mining production tenement regulation areas (MPTRA) incorporate the coastline and several other areas on Yorke Peninsula. The *Planning Development and Infrastructure Act 2016* requires referral of new SEOs (and mining production tenement applications) for activities in MPTRAs to the Planning Minister for advice. These areas have not been identified by Gold Hydrogen for exploration drilling and testing under this EIR and SEO and have been excluded from the scope to simplify the SEO approval process.

2. Legislative Framework

This chapter briefly describes the legislative framework that currently applies to activities regulated under the *Petroleum and Geothermal Energy Act 2000* in South Australia.

2.1. Petroleum and Geothermal Energy Act

The legislation governing onshore exploration for natural hydrogen in South Australia is the *Petroleum and Geothermal Energy Act 2000* (PGE Act) and *Petroleum and Geothermal Energy Regulations 2013* (PGE Regulations). This legislation is administered by the DEM.

Key objectives of the legislation include:

- to create an effective, efficient and flexible regulatory system for exploration and recovery or commercial utilisation of petroleum and other regulated resources
- to minimise environmental damage from the activities involved in exploration and recovery or commercial utilisation of petroleum and other regulated resources
- to establish appropriate consultative processes involving people directly affected by regulated activities and the public generally
- to protect the public from risks inherent in regulated activities.

The Act and Regulations are objective-based rather than prescriptive. An objective-based regulatory approach principally seeks to ensure that industry effectively manages its activities by complying with performance standards that are cooperatively developed by the licensee, the regulatory authority and the community. This contrasts with prescriptive regulation where detailed management strategies for particular risks are stipulated in legislation.

Regulated resources, as defined in Part 1 of the Act, are:

- a naturally occurring underground accumulation of a regulated substance
- a source of geothermal energy, or
- a natural reservoir.

A reference in the Act to petroleum or another regulated substance extends to a mixture of substances of which petroleum or other relevant substance is a constituent part. Regulated substances as defined in Part 1 of the Act are:

- petroleum
- hydrogen sulphide
- nitrogen
- helium
- carbon dioxide
- any other substance that naturally occurs in association with petroleum; or
- any substance declared by regulation to be a substance to which the Act applies.

The PGE Regulations declare hydrogen, hydrogen compounds and by-products from hydrogen production to be regulated substances under the PGE Act.

Regulated activities, as defined in Section 10 of the Act, are:

- exploration for petroleum or another regulated resource
- operations to establish the nature and extent of a discovery of petroleum or another regulated resource, and to establish the commercial feasibility of production and the appropriate production techniques
- production of petroleum or another regulated substance
- utilisation of a natural reservoir to store petroleum or another regulated substance
- production of geothermal energy
- construction of a transmission pipeline for carrying petroleum or another regulated substance
- operation of a transmission pipeline for carrying petroleum or another regulated substance.

2.1.1. Statement of Environmental Objectives

As a requirement of Part 12 of the Act, a regulated activity can only be conducted if an approved Statement of Environmental Objectives (SEO) is in force for the relevant activity. The SEO outlines the environmental objectives that the regulated activity is required to achieve and the criteria upon which achievement of the objectives is to be determined.

The SEO is developed on the basis of information provided in an EIR (unless activities are classified as 'high impact' as discussed below in Section 2.1.3).

2.1.2. Environmental Impact Report

In accordance with Section 97 of the Act, an EIR must:

- take into account cultural, amenity and other values of Aboriginal and other Australians insofar as those values are relevant to the assessment
- take into account risks to the health and safety of the public inherent in the regulated activities
- contain sufficient information to make possible an informed assessment of the likely impact of the activities on the environment.

As per Regulation 10 of the Regulations, for the purposes of an EIR, a licensee must provide:

- a description of the regulated activities to be carried out under the licence (including their location)
- a description of the specific features of the environment that can reasonably be expected to be affected by the activities, with particular reference to the physical and biological aspects of the environment and existing land uses
- an assessment of the cultural values of Aboriginal and other Australians which could reasonably be foreseen to be affected by the activities in the area of the licence, and the public health and safety risks inherent in those activities (insofar as these matters are relevant in the particular circumstances)
- if required by the Minister – a prudential assessment of the security of natural gas supply

- a description of the reasonably foreseeable events associated with the activity that could pose a threat to the relevant environment, including information on:
  - events during the construction stage (if any), the operational stage and the abandonment stage
  - events due to atypical circumstances (including human error, equipment failure or emissions, or discharges above normal operating levels)
  - information on the estimated frequency of these events
  - an explanation of the basis on which these events and frequencies have been predicted
- an assessment of the potential consequences of these events on the environment, including information on
  - the extent to which these consequences can be managed or addressed
  - the action proposed to be taken to manage or address these consequences
  - the anticipated duration of these consequences
  - the size and scope of these consequences and
  - the cumulative effects (if any) of these consequences when considered in conjunction with the consequences of other events that may occur on the relevant land (insofar as this is reasonably practicable); and
  - an explanation of the basis on which these consequences have been predicted
- a list of all owners of the relevant land
- information on any consultation that has occurred with the owner of the relevant land, any Aboriginal groups or representatives, any agency or instrumentality of the Crown, or any other interested person or parties, including specific details about relevant issues that have been raised and any response to those issues, but not including confidential information.

2.1.3. Environmental Significance Assessment and SEO Consultation Requirements

The EIR is submitted to DEM and an Environmental Significance Assessment is undertaken in accordance with criteria established under Section 98 of the Act[2], to determine whether the activities described in the EIR are to be classified as 'low', 'medium' or 'high' impact. Following this classification, a corresponding SEO is prepared, reflecting the impacts and measures identified in the EIR or other assessments that may be required as determined by the classification. The SEO will outline the environmental objectives that must be achieved and the criteria on which achievement of the objectives is to be assessed.

The classification also determines the level of consultation DEM will be required to undertake prior to approval decisions being made on the SEO as follows:

- **Low impact activities** do not require public consultation and are subjected to a process of internal government consultation and comment on the EIR and SEO prior to approval.

[2] Criteria for classifying the level of environmental impact of regulated activities are published on the DEM website: https://www.energymining.sa.gov.au/industry/energy-resources/regulation/approvals-process#classification

- **Medium impact activities** require a public consultation process for the EIR and proposed SEO, with comment sought for a period of at least 30 business days.
- **High impact activities** are required assessment and consultation under an environmental impact statement (EIS) under the impact assessed development provisions of the *Planning, Development and Infrastructure Act 2016*. An SEO for high impact activities must be prepared on the basis of this EIS.

The level of impact of a particular activity is assessed on the basis of the predictability and manageability of the impacts on the environment. Where the environmental impacts are predictable and readily managed, the impact of the activity is considered low. Where the environmental impacts are less predictable and are difficult to manage, the impact of the activity is potentially high.

Once the approval process is complete, all documentation, including this EIR and its associated SEO, must be entered on an environmental register. This public Environmental Register is accessible to the community from the DEM website.

2.1.4. Activity Notification / Approval Process

Prior to commencing a regulated activity, Section 74(3) of the PGE Act requires that:

- The Minister's prior written approval is required for activities requiring high level official surveillance (as per Regulation 19), and
- Notice of activities requiring low level official surveillance is to be given at least 21 days in advance (as per Regulation 18).

The proposed activities would fall in the high-level official surveillance category (all new licensees are initially high-level official surveillance operators for all activities).

In order to obtain written approval for activities requiring high level official surveillance, an application and notification of activities (in accordance with Regulation 20) must be submitted to the Minister at least 35 days prior to the commencement of activities.

The notification of activities must provide specific technical and environmental information on the proposed activity and include an assessment to demonstrate that it is covered by an existing SEO.

This activity notification and approval process is often referred to as Stage 3 of the approval process under the PGE Act, as it follows licensing (Stage 1) and the EIR and SEO approval process (Stage 2).

The Stage 3 activity notification and approval process provides an additional opportunity for DEM to ensure that the proposed activities and their impacts can be effectively managed and are consistent with the approvals obtained in the EIR and SEO approval process. This is particularly relevant for activities that are conducted under an SEO that applies to a broad geographical area, as it provides site-specific detail that is not usually contained in the generic documents.

The site-specific detail provided would include an environmental assessment report (EAR), which provides details on site-specific issues and their management and detailing how the proposed activities will meet the requirements of the approved SEO. The EAR would address potential impacts and management for all relevant issues identified in the EIR / SEO and during site surveys, such as land use, cultural heritage, noise, traffic, surface water, shallow groundwater, native vegetation, threatened species, groundwater dependent ecosystems, weeds and pests.

2.2. Other Legislation

A variety of legislation applies to exploration activities. Legislation that is particularly relevant to exploration is listed below (note that this is not a comprehensive list of all applicable legislation) and additional detail on key legislation is provided following the list.

Commonwealth

Aboriginal and Torrens Strait Islander Heritage Protection Act 1984

Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

Native Title Act 1993

South Australia

Aboriginal Heritage Act 1988

Crown Land Management Act 2009

Dangerous Substances Act 1979

Environment Protection Act 1993

Explosives Act 1936

Fire and Emergency Services Act 2005

Heritage Places Act 1993

Landscape South Australia Act 2019

National Parks and Wildlife Act 1972

Native Title (South Australia) Act 1994

National Trust of SA Act 1955

Native Vegetation Act 1991

Planning, Development and Infrastructure Act 2016

Radiation Protection and Control Act 2021

South Australian Public Health Act 2011

Work Health and Safety Act 2012.

Commonwealth Environment Protection and Biodiversity Conservation Act (EPBC Act)

Approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is required for activities that are likely to impact matters of national environmental significance including World Heritage properties, National Heritage places, Ramsar wetlands of international importance, listed threatened species and ecological communities, migratory species, Commonwealth marine areas, the Great Barrier Reef Marine Park, nuclear actions and a water resource in relation to coal seam gas development and large coal mining development.

With regard to operations in PEL 687 on Yorke Peninsula, issues that may trigger approval requirements under the EPBC Act are expected to be readily avoidable by appropriate site selection. Based on current expectations, Gold Hydrogen believes that a requirement for approval under the Act is not likely to be triggered.

Native Vegetation Act

Exploration activities that are approved under the PGE Act do not require approval under the *Native Vegetation Act 1991* for clearance of native vegetation, provided that they are undertaken in accordance with industry standards endorsed by the Native Vegetation Council (NVC) that are directed towards minimising impact and encouraging regrowth of any cleared native vegetation (see Regulation 15 of the *Native Vegetation Regulations 2017*).

If there are no applicable industry standards, or if it is not possible to undertake the operations in accordance with applicable industry standards, the clearance is permitted if undertaken in accordance with a management plan, approved by the NVC, that results in a significant environmental benefit, or if the person undertaking the operations makes a payment into the Native Vegetation Fund of an amount considered by the Council to be sufficient to achieve a significant environmental benefit.

As discussed in Sections 4.1.1 and 6.5.1, Gold Hydrogen plans to avoid activities in areas of high quality or significant remnant vegetation.

Environment Protection Act

The *Environment Protection Act 1993* imposes a general duty of care not to undertake an activity that pollutes, or might pollute, the environment unless all reasonable and practicable measures have been taken to prevent or minimise any resulting environmental harm. Environmental authorisations are required to undertake activities prescribed under the Act.

The Environment Protection Act does not apply to exploration activity undertaken under the PGE Act or to wastes produced in the course of an activity (not being a prescribed activity of environmental significance) authorised by a lease or licence under the PGE Act when produced and disposed of to land and contained within the area of the lease or licence.

Landscape South Australia Act

Drilling of a new water sourcing bore would require a permit under the *Landscape South Australia Act 2019* (Landscape SA Act). As there are no prescribed wells areas in PEL 687, a licence / allocation under this Act for extraction of groundwater is not required[3].

The Landscape SA Act and the Water Affecting Activities Control Policy (N&YLB 2020) also set out a number of water affecting activities that must not be undertaken without a permit. These are usually avoidable by careful planning and siting of infrastructure to avoid watercourses and surface water features and maintain water flows. The Landscape SA Act also governs the control of declared pest plants and animals.

National Parks and Wildlife Act

The *National Parks and Wildlife Act 1972* provides for the establishment and management of reserves and the conservation of wildlife in a natural environment. There are a number of reserves established under this Act within and adjacent to PEL 687, the majority of which do not allow access for activities regulated under the PGE Act.

Gold Hydrogen do not propose to conduct activities in any reserves established under the National Parks and Wildlife Act.

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[3] Note there is also an authorisation in place under s128 of the Landscape SA Act (published in the SA Government Gazette 30 August 2001) to take groundwater for use in drilling, construction and testing of hydrocarbon exploration wells that applies in prescribed wells areas.

Planning, Development and Infrastructure Act

The *Planning, Development and Infrastructure Act 2016* (PDI Act) has special provisions relating to activities carried out under the PGE Act and it only applies in some cases. Activities classified as 'high impact' are required to be assessed under the provisions of the PDI Act. DEM must also refer applications for production tenements or SEOs to the relevant Minister in some cases (e.g. in areas identified in Schedule 14 of the PDI (General) Regulations – refer Section 1.3.1).

Under Section 161 of the PDI Act, the Building Rules apply to some classes of building work carried out under the PGE Act (including buildings for housing / shelter and office accommodation) and building consent must be granted by the council or an appropriate accredited professional.

Aboriginal Heritage Act

The South Australian *Aboriginal Heritage Act 1988* provides protection for all Aboriginal sites, objects and remains across the state. The Act applies to all land and bodies of water and vests the powers to protect and preserve Aboriginal heritage to the Minister for Aboriginal Affairs and Reconciliation, who is required to take such measures as are practicable for protecting and preserving Aboriginal sites, objects and remains.

Authorisation is required for any damage, disturbance or interference to Aboriginal sites, objects or remains. Penalties apply for failure to comply.

3. Overview of Natural Hydrogen

Naturally occurring hydrogen represents an alternative low-cost source of hydrogen which can potentially be produced using proven engineering practices, with minimal environmental impacts, and offers significant cost and emissions advantages (relative to other sources of hydrogen production) as a replacement for carbon-based fuels.

3.1. Hydrogen Use

Hydrogen is regarded as a safe, flexible, transportable and storable energy carrier that has been used across a range of industries for many years. More recently, hydrogen has been identified as having significant potential to support new pathways for decarbonisation in essential but energy-intensive sectors that are otherwise largely dependent on fossil fuels, such as heavy transport and industry, chemical feedstocks, industrial process heat and long-term energy storage.

Hydrogen is the most abundant element in the universe, however it does not commonly occur in its pure form on Earth. Instead, it usually forms part of other materials, such as water, biomass, fossil fuels or minerals.

As the world rapidly transitions to a decarbonised economy, the global demand for hydrogen is accelerating. Although hydrogen is increasingly being seen as the clean fuel of the future, production of pure hydrogen to use as a source of energy can be expensive and energy and emissions-intensive.

3.2. Hydrogen Production

There are three principal methods for commercial production of hydrogen using water[4]. Two of these methods involve thermochemical reactions using coal or natural gas (known as 'brown' or 'grey' hydrogen), which also produce carbon emissions. Most hydrogen is currently produced these methods.

The third method is through electrolysis, where hydrogen is extracted from water using electricity to split water into hydrogen and oxygen. If the electricity is generated from renewable energy sources (e.g. solar or wind), electrolysis has the potential to produce hydrogen without carbon emissions (known as 'green' hydrogen).

Hydrogen is also produced naturally by sub-surface processes and can be found as a free gas in underlying geology (known as 'gold' or 'white' hydrogen). While it has been found to be present in a wide range of rock formations and geological regions, the natural processes of hydrogen creation are yet to be fully understood.

3.3. Natural Hydrogen

The presence of hydrogen in the sub-surface of the Earth is well-documented in all types of geologic environments, however economic accumulations of natural hydrogen have generally been assumed to be non-existent. This could be for a range of reasons including:

- Absence of sampling for free hydrogen during exploration programs due to lack of expectation of it being present. Even today, sensor systems and analysing techniques are not necessarily calibrated to detect hydrogen.

[4] www.aemc.gov.au/hydrogen-new-australian-manufacturing-export-industry-and-implications-national-electricity-market

- As oil and gas is found in sedimentary geology, most exploration wells around the world have been drilled in these formations, however as hydrogen is not likely to be abundant in these rocks it has generally not been encountered during exploration for hydrocarbons.
- Hydrogen diffuses rapidly in air and other environments and therefore may not be retained for long periods of time in some geological traps.

Recent reviews of existing data around the world show that naturally occurring hydrogen may be much more widespread than previously thought.

Natural hydrogen is produced by processes occurring below the Earth's surface, where it is released through the interaction of water with surrounding geology. The known accumulations are located in a diverse range of geological environments, which suggests that there may be a variety of mechanisms for generating natural hydrogen (Bendall 2022). The main mechanisms are currently understood to be:

- Diagenesis - water-rock interactions which release hydrogen from water during oxidation. Serpentinization[5] is considered to drive most natural hydrogen production.
- Radiolysis – where hydrogen contained in water is separated from oxygen by the natural radioactivity of the earth's crust (Sherwood *et al.* 2014)
- Other sources which include friction on geological fault planes and the activity of certain bacteria which release hydrogen but in smaller quantities.

It is thought that the vast majority of the Earth's hydrogen (~80%) is potentially produced by serpentinization, while radiolysis may generate most of the remainder (Sherwood *et al.* 2014).

The distinguishing feature of naturally occurring hydrogen is that, unlike accumulated but finite fossil resources such as oil or gas, it is likely to be a genuinely renewable resource which (if the right type of rocks is present along with water), is continually generated, percolating up through the crust and potentially accumulating in reservoirs or traps from which it can be produced.

3.4. Finding Natural Hydrogen

Naturally occurring hydrogen has been found in many locations globally in groundwater, oil and gas drillholes, and mines which have intersected significant hydrogen fluxes or accumulations, and as naturally occurring hydrogen seeps located on land and the seabed.

Historical drilling

Historically many natural hydrogen occurrences are likely to have been missed by explorers in Australia and globally as samples taken from drillholes and deep mines have not been routinely sampled and analysed for hydrogen. Oil and gas drilling rigs can also only detect natural hydrogen with specialised hydrogen detection units, which have historically been calibrated to prioritise hydrocarbon detection.[6]

In South Australia there have previously been detections of natural hydrogen in oil and gas drillholes in Yorke Peninsula, Kangaroo Island, the Otway Basin and the western flank of the Cooper Basin. In 1931, the Ramsay Oil Bore 1 exploration well was drilled on Yorke Peninsula east of Minlaton during unsuccessful ventures looking to discover oil. Gases were captured at the rig site and later sampled by

[5] Serpentinization is a natural process which occurs in a variety of tectonic settings on the Earth, when water reacts with rocks containing a high concentration of iron and magnesium at high temperatures, producing gaseous methane and hydrogen.

[6] www.energymining.sa.gov.au/industry/energy-resources/media2/shared/pdf/petroleum/presentations/PESA-SA-Branch-Natural-Hydrogen-presentation-23-June.pdf

South Australia Government geologists which determined that these gases had very high natural hydrogen of up to 84% (at 500 m depth). This site forms the initial focus of Gold Hydrogen's exploration activities.

Hydrogen seeps

Hundreds of thousands of shallow, circular depressions in the land (known as 'fairy circles' and ranging from tens or hundreds of metres across) have been identified across the world in association with hydrogen seeps. Numerous occurrences of these features are observable in Australia on Yorke Peninsula, Kangaroo Island and in Western Australia (refer Plate 3-1).

Scientists think that these features may be directly connected to an actively producing hydrogen source or leaking reservoir (Bendall 2022). Seeping hydrogen from cracks in the bedrock below can dissolve minerals in underlying rocks, leading to slumping at the surface, while the suppressed vegetation within the circles could potentially be associated with hydrogen-loving microbes consuming other nutrients[7].

At this stage there are no direct soil gas data indicating an active hydrogen flux at the circular structures (i.e. fairy circles) documented in South Australia, however CSIRO are closely studying these potential surface seeps and monitoring potential surface evidence of hydrogen free gas seepage to better understand the Australian hydrogen system.[8]

Plate 3-1: A salt lake on Sundown Lake Rd during summer 2021, Yorke Peninsula.
(Source DEM:

www.energymining.sa.gov.au/industry/energy-resources/geology-and-prospectivity/natural-hydrogen)

South Australian context

South Australia is regarded as highly favourably placed in geological terms for the generation of natural hydrogen due to the presence of the ancient Gawler Craton, with its significant iron and uranium deposits (i.e. the source rocks needed for serpentinization and radiolysis), and fractured and seismically active source areas which can channel hydrogen migrating up from deep sources to the surface and introduce water downward for further chemical reaction with exposed iron-rich rocks[6].

[7] www.science.org/content/article/hidden-hydrogen-earth-may-hold-vast-stores-renewable-carbon-free-fuel

[8] www.research.csiro.au/hydrogenfsp/our-research/projects/natural-hydrogen-exploration/

The ancient iron-rich and natural ionising basement rocks beneath PEL 687 are the same as those extracted at Olympic Dam and therefore have favourable characteristics for potential hydrogen serpentinization and radiolysis.

3.5. Future investigations for natural hydrogen

It is early days in Australia and globally for natural hydrogen exploration with hundreds of hydrogen indications in wells, mines and seeps, but as yet only one producing field in Mali, west Africa.

There is much yet to be learned about how much hydrogen is produced daily on Earth by the pathways discussed above, the reactions that would produce hydrogen and how much of it accumulates in reservoirs or traps where it would be easy or commercial to produce[9].

Hydrogen exploration techniques and methodologies are currently being developed and tested, and a diversity of hydrogen plays in South Australia are anticipated to be explored and evaluated over the next several years, increasing understanding of this potential new source of energy.

Gold Hydrogen aims to build on historical natural hydrogen data and, with the assistance of CSIRO, develop new techniques and processes to potentially identify natural hydrogen near potential seeps (fairy circles), structures, reservoirs and potential active natural hydrogen generation in regional source rocks on Yorke Peninsula within PEL 687.

[9] www.renewablematter.eu/articles/article/natural-hydrogen-a-geological-curiosity-or-the-primary-energy-source-for-a-low-carbon-future

4. Description of Activities

The following section provides a description of activities that would be involved with exploration drilling for natural hydrogen and testing of any occurrences of hydrogen that are detected.

4.1. Activity Planning

4.1.1. Selection of drilling locations

The first steps in drilling for natural hydrogen are the identification of the sub-surface target and selection of the surface location for drilling.

Potential sub-surface targets for drilling for natural hydrogen would be identified based on an interpretation of the underlying geology from geophysical data (including data from previous gravity, magnetic and seismic surveys), as well as the results from wells that have previously been drilled nearby.

Once a potential sub-surface target is identified, a surface drilling location would be selected, with some flexibility in the surface location, that considers factors such as land use, proximity to residences, access, topography, vegetation, cultural heritage and other features at the surface. The location would be selected in consultation with the landowner, as discussed in Section 4.1.2 below. If there is no suitable drilling location where the drilling rig can be located and reach the sub-surface target, the target may be modified, or rejected and another target selected.

Initial sub-surface targets would be near historic wells that reported natural hydrogen occurrences. The initial drilling locations are likely to be east of Minlaton, near the Ramsay Oil Bore 1 well, which encountered hydrogen when it was drilled in 1931 (see Plate 1-1). Any further wells would be located where prospects have been identified based on sub-surface geological parameters that indicate potential natural hydrogen accumulations.

Over the five-year span of this EIR and the accompanying SEO, Gold Hydrogen expects to drill approximately five exploration wells. The number and location of the wells will depend on drilling and testing results as the exploration program progresses. Potentially ‘twinning’ the historic wells that encountered natural hydrogen is currently considered a priority; these prospects have been identified in the Prospective Resources report[10] (Rodrigues *et al.* 2021). At least two additional wells will either follow-up near a prospect, depending on drilling and testing results, and / or new locations selected in lead areas that have been also identified in the Prospective Resources report.

Areas that would be avoided

As noted above and in Section 2.1.4, a range of site-specific issues would be considered in the selection of the drilling location (and in the assessment of potential impacts and their management at the activity notification and approval stage). The following have been identified in this EIR (in Sections 1.3.1, 4.1.3, 5.7.6, 6.5.1, 6.7.1 and 6.8) as areas that would specifically be avoided by exploration drilling activities[11]:

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[10] The Prospective Resources Report is appended to the Gold Hydrogen Initial Public Offer documentation and can be accessed at https://www.asx.com.au/asxpdf/20230111/pdf/45kkpqv6hs4z9n.pdf

[11] Note: This is not an exhaustive list of all potentially sensitive areas. Details on site-specific issues and avoidance or management would be provided to DEM at the activity notification and approval stage (see Section 2.1.4).

- reserves established under the *National Parks and Wildlife Act 1972* or land immediately adjacent to a Marine Park established under the *Marine Parks Act 2007*.
- activities in mining production tenement regulation areas identified in Schedule 14 of the Planning, Development and Infrastructure (General) Regulations.
- Wardang Island Indigenous Protected Area
- Native Vegetation Heritage Agreement areas (established under the *Native Vegetation Act 1991*)
- land where access has not been agreed with the landowner
- land in close proximity to towns or sensitive receptors
- areas of high-quality native vegetation and significant wetland areas
- areas of identified cultural heritage significance.

4.1.2. Landowner consultation

Consultation with the landowner where a potential drilling location has been identified would commence early in the planning stage. This consultation would typically include initial discussion regarding the possibility of drilling on the land, selection of a suitable drilling location (and access to the location), negotiation of a land access and compensation agreement and discussion of specific strategies for minimising any impacts to land use operations.

Land access and compensation agreements would be agreed and put into place before any activities are undertaken on private land. Gold Hydrogen would not drill on land where access has not been agreed with the landowner.

The formal Notice of Entry process under Part 10 of the PGE Act would also be followed, with all owners of land where regulated activities will be carried out provided a Notice of Entry at least 21 days prior to the commencement of activities.

4.1.3. Site survey

After a drilling location (and access route) has been agreed with the landowner, Gold Hydrogen personnel and contractors would need to access the site before drilling commences to undertake initial site investigations. The investigations required would depend on the nature of the site, but may include land survey, geotechnical assessment, ecological assessment and cultural heritage clearance.

Surveys would be coordinated with the landowner to minimise any disturbance to their activities. Formal Notices of Entry would be provided under the PGE Act before personnel enter land to undertake survey work.

Some survey results (e.g. ecology or cultural heritage) may be used to help refine the location of the well site and access where appropriate.

4.1.4. Drilling activity application

Once the final well location is selected and site surveys are completed, the well design and detailed drilling program would be finalised and submitted to DEM, along with all other relevant information required to obtain approval (as discussed in Section 2.1.4).

4.2. Well Site, Access and Camp / Accommodation

4.2.1. Well site

Drilling operations to explore for natural hydrogen would use the same type of drilling rig that is used to drill for oil and gas. This type of rig is designed to safely control pressurised liquids and gases if they are encountered underground.

Drilling operations require the construction of a stable area for the placement of the drilling rig, with areas for associated equipment including generators, fuel and chemical storage, casing and pipe storage and site offices.

The total size of the well pad would be dependent on the size and design of the drilling rig. It is expected that rigs for Gold Hydrogen's initial exploration wells could require a well pad in the order of 100 m x 100 m.

Subject to existing ground conditions and landowner agreements, the well pad would be cleared and levelled and the area around the rig base (approximately 40 m x 20 m) would be paved with crushed rock to a depth of approximately 30 cm. The removal of topsoil would be discussed and agreed with the landowner. Generally, topsoil would be removed from areas to be paved or excavated and would be stockpiled adjacent to the pad for use in site rehabilitation. Topsoil may also be removed from access tracks for later reinstatement.

In some circumstances, alternate construction methods such as laying paving materials on geotextile or directly on topsoil may be used (e.g. where the landowner has requested that the pad remains after drilling) or the entire well pad may be paved. Any subsoil removed (e.g. from excavations) would be stockpiled separately. The pad would be constructed so that any runoff from upslope of the pad is be directed away from the pad.

Depending on rig configuration, a shallow sump (typically in the order of up to 10 m x 20 m x 2 m deep) may be constructed to hold drill cuttings and waste drilling muds. Some types of rigs use tanks to hold drill cuttings and waste drilling muds, in which case a sump would not be required. The sump would be lined with a polyethylene liner which would be removed when the sump is rehabilitated.

A 'turkeys nest' (a circular dam, lined with plastic to prevent water loss) may also be constructed to hold clean, fresh water on site prior to use in drilling, if required. If a turkeys nest is used, the liner would be removed at the end of drilling. Alternatively, temporary above ground tanks may be used for water storage for drilling operations.

A flare or vent line would be located on or adjacent to the well pad for emergency situations during drilling operations or for short-term testing during drilling (if carried out). A firebreak would be ploughed or graded around the flare or vent where required.

A fence would be constructed to prevent unauthorised access to the drilling operation. The fence location would be agreed with the landowner so that the well site area and the access track (as appropriate) are not accessible to unauthorised personnel or third parties. Lockable gates would typically be placed across the start, or an appropriate section, of the access track. All activities would be confined to within the fenced area. A firebreak may be ploughed or graded along the outside of the fence.

Figure 4-1 shows an indicative layout of a well pad for a drilling rig of similar size to rigs that may be used to explore for natural hydrogen in PEL 687.

4.2.2. Access track

An access track would be constructed from a nearby public road to the well pad, along an alignment approved by the landowner. Depending on ground conditions and landowner agreements, this track may be paved with material (e.g. road base). Access tracks would typically be approximately 4 m wide except on bends and at entry and exit points to the camp and pad where the width would be up to 8 m. Subject to pad and access configuration, there may be a ring road built for safety and to keep trucks to gravelled areas rather than causing wheel ruts in undisturbed lease areas. If adjacent grass is dry, a graded or ploughed firebreak along each side of the access track would be constructed.

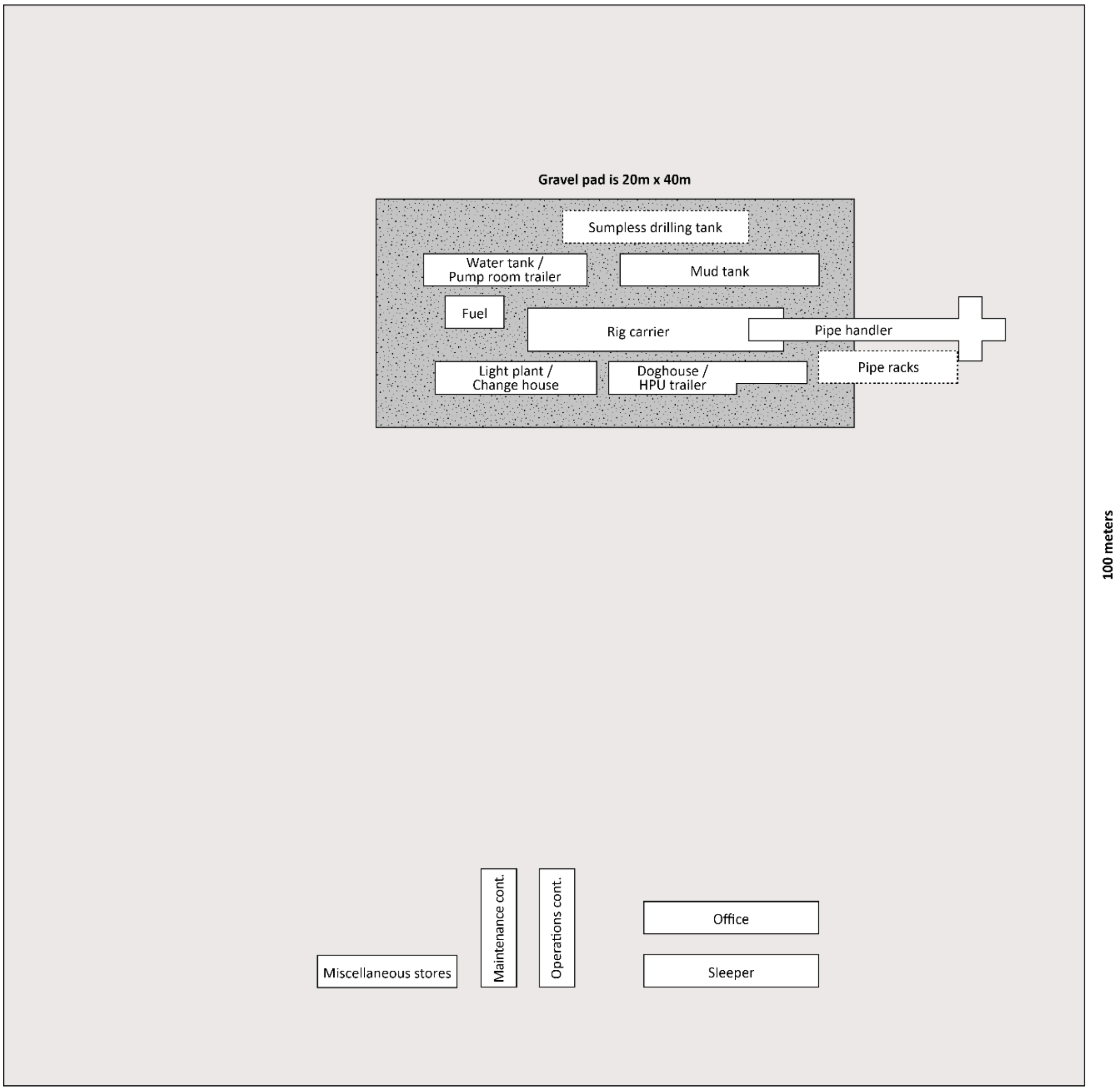


Figure 4-1: Example of a well pad layout

4.2.3. Camp / accommodation

The drilling crew may be housed in local accommodation if feasible, however it is possible that a camp could be required. In this case, an area of approximately 50 m x 50 m in reasonable proximity to the well pad would be used for a self-contained approximately 40-person re-locatable camp, equipped with wastewater processing units and septic tanks. Disturbance to the soil surface would be kept to a minimum. Depending on ground conditions at the camp location, it may be necessary to lightly pave the camp area with gravel.

Should a camp be required, its location would be agreed with the landowner during consultation.

Sewage wastes are typically handled using septic tanks or on-site treatment systems that are approved and managed under the *South Australian Public Health (Wastewater) Regulations 2013* and in compliance with the South Australian Health On-site Wastewater Systems Code. Toilet facilities with wastewater processing units and septic tanks would be provided at the camp and the well site. Septic tanks would be used to contain all wastewater (black water and grey water) and would be pumped out by licensed contractors as required for disposal at a licensed facility. Small pits would be constructed to house the tanks which would be removed after drilling operations are completed. Any necessary approvals (e.g. local council) for the installation of the septic tanks would be obtained.

4.2.4. Laydown areas

Laydown areas may be required adjacent to or near the well pad, for temporary storage of equipment and materials to be used in drilling and testing. Laydown areas, if required, would be located in existing cleared areas and would typically require limited or negligible earthworks (e.g. light grading) for establishment. Laydown areas (if required) would be in the order of 50 m x 80 m. The location and management of laydown areas would be subject to landowner approval.

4.3. Drilling Operations

4.3.1. Drilling activities

Overview

Drilling operations would involve drilling to a projected depth with a rotary drilling rig using recirculated water-based muds. During drilling, strings of casing (steel pipe) are installed in the hole and cemented in place.

Wells to explore for natural hydrogen are expected to be in the order of 500 m to 2,000 m deep with the first exploration well anticipated to be up to approximately 1,200 m deep. Drilling and logging / testing[12] of a 1,200 m deep well would typically take 20 to 30 days and would be carried out on a 24-hour, seven day per week basis.

Plate 4-1 shows a drilling operation using a rig similar in size to that which may be used in PEL 687.

[12] Testing in this instance refers to tests run while the drilling rig is on site (e.g. drill stem tests).

Plate 4-1: Example of an onshore drilling rig[13]

Drilling process

The rig drills the well by rotating a drill bit while exerting downward force on a drill pipe. The well is drilled deeper by adding lengths of drill pipe until the total planned depth is reached.

A well is typically drilled in several sections, with the diameter of deeper sections smaller than the sections above. After each section of the well is drilled, casing (steel pipe) slightly smaller than the hole diameter is lowered into the hole and cemented into place. As a result, the shallow portions of the well have several concentric layers of steel casing installed (see Figure 4-2).

During the exploratory drilling phase, natural hydrogen detection equipment would be installed on the rig to read and measure gases that are liberated from various sub-surface formations. This type of equipment can distinguish the various liquids and gas that may be encountered, including hydrogen, helium, nitrogen, carbon dioxide, methane and other hydrocarbons (up to C6). Based on historic wells drilled, Gold Hydrogen anticipates potentially high concentrations of hydrogen and also potentially some methane, carbon dioxide and nitrogen.

Casing and well design

The number of strings of casing, their diameter, their material specifications and the depth to which they are installed (i.e. the well design) is determined by specialist engineers.

The well design for Gold Hydrogen's exploration wells is focussed on exploratory and testing purposes (i.e. not long-term production, where a development well design would be required). The well design must consider factors such as the total depth of the well, the required hole size for evaluation tools, the number of casing strings planned or potentially to be run, temperatures and pressures expected

[13] This drill rig image (obtained from https://investorhub.armourenergy.com.au/announcements/3940363) is considered to be of a similar size and configuration to that which GH would engage.

down-hole and sub-surface factors (e.g. faults) which may be mitigated through the use of casing / cement.

An exploratory well decision tree (see Figure 4-3) has been developed to help guide the technical team in making decisions during the drilling operation (e.g. to decide whether a 7-inch steel casing string should be run at total depth or the well suspended or plugged). The drilling operation would be planned to allow flexibility and time appropriate to the exploratory nature of this work, to ensure the right decisions are made.

The following casing strings may be installed in exploration wells, depending on the well design and decisions made during drilling:

- the **conductor pipe** would be installed at the surface, which prevents surface soils from caving into the hole, and is cemented in place. The conductor also serves to isolate the surface water table and perched aquifers, if present.
- the **surface casing** would be installed to protect shallow formations and to stabilise the well for the later drilling phases of deeper sections of the hole. This casing is also cemented to surface to isolate the various formations behind the casing from each other and from the surface. The surface casing is designed to isolate groundwater and also to contain pressures that might occur during the subsequent drilling process. Pressure control equipment (i.e. blow out preventers – BOPs) is installed on this casing string.
- an **intermediate casing** may be installed in some wells. This is typically dictated by mud weight, pore pressures and fracture gradient profiles but can also be required to mitigate expected hole problems. This casing would also isolate deeper aquifer systems (if present). As with the shallower casing strings, this casing is also cemented in place to ensure the various formations behind the casing are separated from each other and the surface.
- a **suspension casing** string may be installed after the hole has been drilled and logged, if the decision is made that the well needs further testing through a different mechanical technique (and consequently needs to be suspended following drilling). This casing would be cemented in place, from bottom to inside the previous casing (and sometimes to the surface). The purpose of this casing would be to provide structural stability to the hole and provide isolation between the target reservoir and all other overlying formations.

As discussed in Section 4.4, wells that are to be subject to further testing may have tubing installed inside the suspension casing during well completion (which would occur some time after drilling). This tubing would carry produced liquids and/or gases to the surface.

The composition of cement that is pumped behind the casing would be determined by specialist technical engineers, taking into consideration the well conditions and liquids and gases encountered, using established engineering standards and regional and local geological information. Specialist technical engineers would also design the cementing program for each well and placement of the cement slurries in accordance with international standards.

Gold Hydrogen would ensure that equipment used on the exploration drilling operation is selected to ensure safe operations, with particular consideration given to the interface with hydrogen gas. This would include drill pipe, casing pipe, cement, the wellhead tree and surface materials that would interface with liquids and gases that may flow to surface.

Figure 4-2 shows an example of a well design with surface casing and suspension casing installed. The initial well is expected to follow a very similar design, but this depends on results during the drilling operation. Suspension casing would not be installed if the well is decommissioned immediately after drilling.

Well designs that would be used for any subsequent wells may vary depending on the depth and objective of the well, however the general principles of drilling, casing and cementing would remain the same.

Detailed well design information for each well would be provided to DEM during the activity notification and approval stage (see Section 2.1.4).

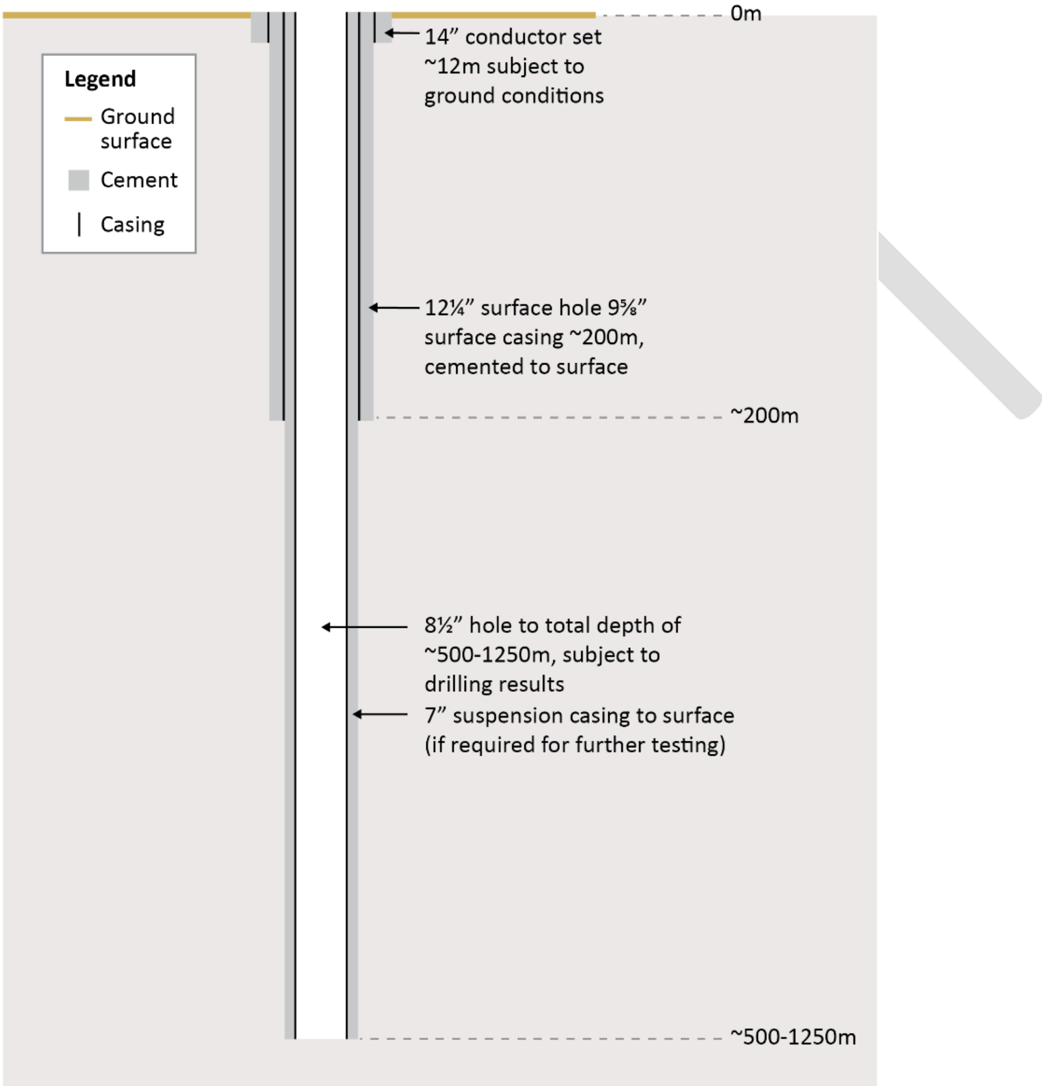


Figure 4-2: Indicative well design (cross-section through well) showing various casing strings

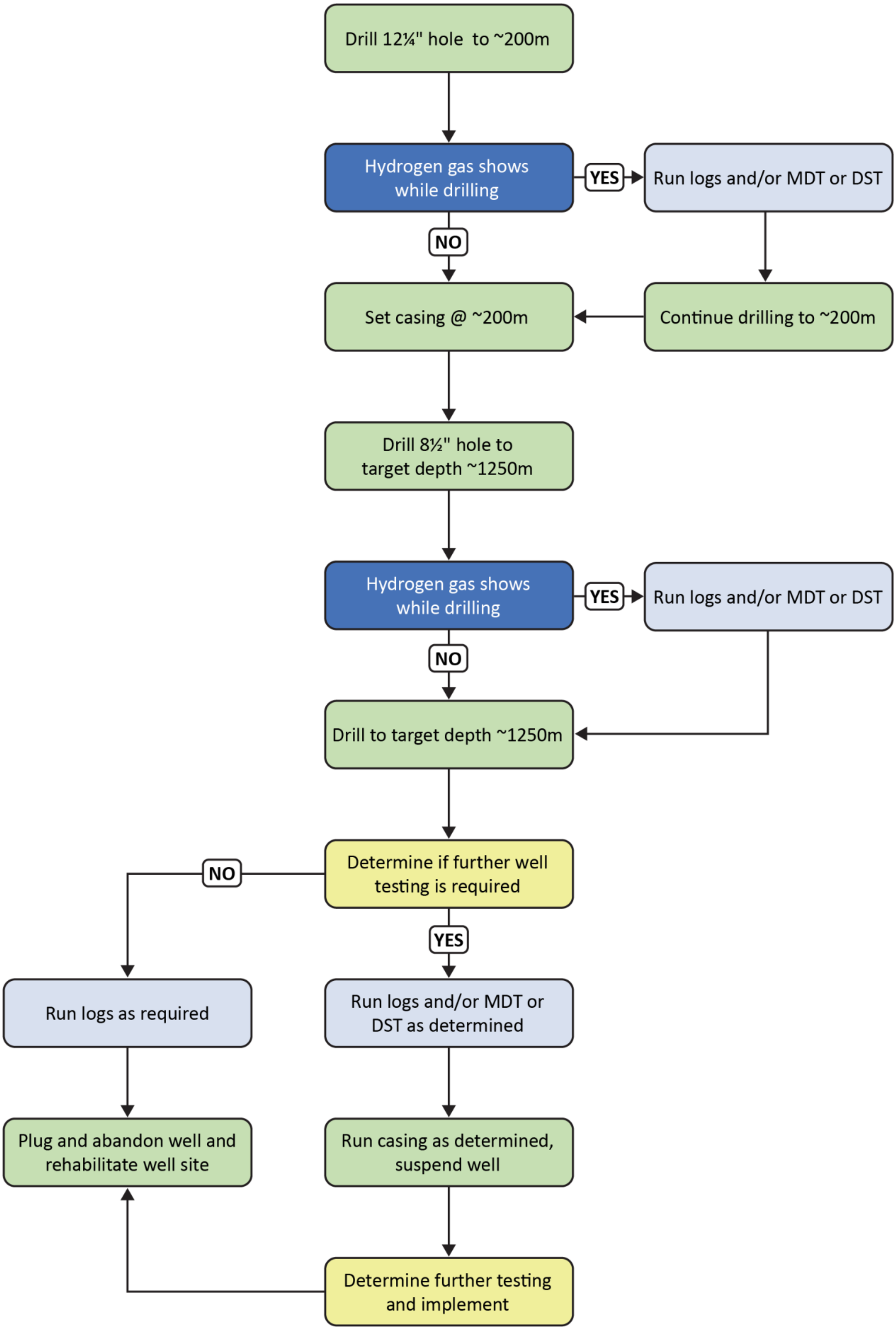


Figure 4-3: Overview of Gold Hydrogen's exploratory well decision tree

Wellhead

The wellhead provides the structural and pressure-containing interface for the drilling and testing equipment, and connects to the casing strings. It enables the well to be sealed off and the flow of reservoir fluids to be controlled. Figure 4-4 shows an example of a wellhead similar to that which may be used on Gold Hydrogen's wells.

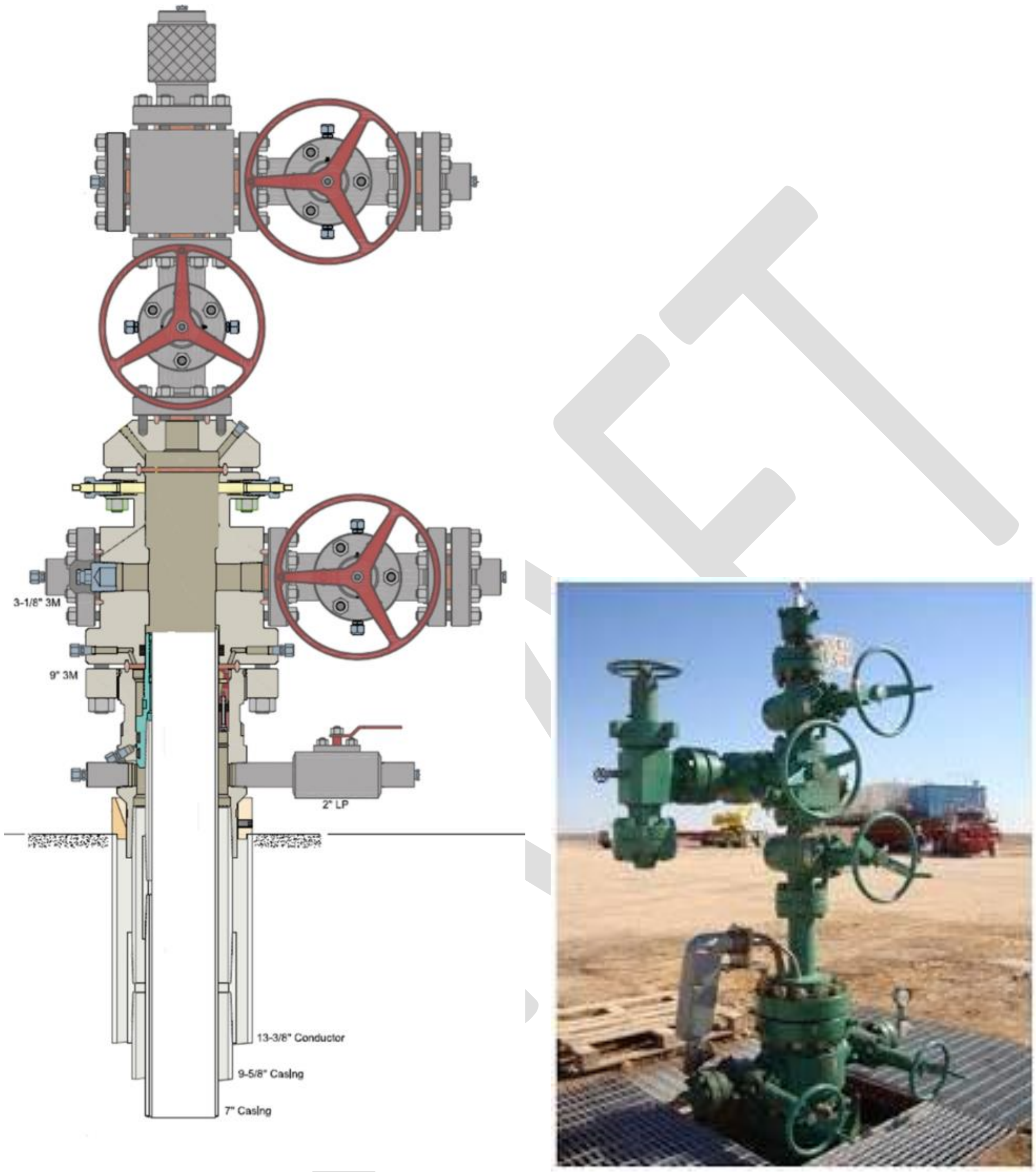


Figure 4-4: Example wellhead diagram and a typical wellhead in the field

Logging and drill stem testing

Logging is carried out during and after drilling, to measure the physical properties of the various formations to provide information on aspects such as the lithology, formation fluid, formation porosity and formation permeability. Various instruments and tools are in used in the logging process to suit specific requirements and objectives, and are lowered into the well bore to take measurements. Sidewall cores may also be taken to obtain samples of the rock at specific depths. Reservoir pressure data and fluid samples may also be acquired. Logging can be performed whilst drilling or using wireline logging tools (special tools or equipment that are lowered into the well). Cased hole logging may also be performed prior to any further testing.

Downhole logging tools would be selected based upon well results and a decision tree has been generated to help guide which tools should be run at various stages of the exploratory program for a well.

It is likely that modular formation dynamics tester (MDT) tools would be deployed. This tool's application is well suited for exploratory works at it can be deployed over several reservoir intervals in a shorter period of time and does not require any surface testing equipment. The MDT can measure formation pressure and fluid contact information, fluid sampling, permeability measurement, multi-drill stem testing and productivity assessment. The benefits of using this tool in an exploratory well include testing and sampling low permeability, fractured and heterogeneous formations, gathering pressure, volume, and temperature formation fluid samples, fast and repeatable pressure measurements, and real-time fluid gradients.

Drill stem testing may be used to evaluate pressures, fluid flows, fluid samples and rates from any potential hydrogen producing formation(s) while the drill rig is in place. Drill stem tools would be set to cover the zone of interest, and if the well flows to surface, that flow would be measured. If the well is flowed to surface during the drill stem test, flow would be directed through a separator tank and gases safely dispersed or combusted (e.g. via a vent or flare depending on gas composition and safety considerations). Any water that flows to surface would be directed to a sealed tank and removed off site for appropriate disposal at a licensed facility.

If implemented, drill stem testing would be carried out over short periods (of up to several hours) to understand potential reservoir performance and to help guide further decisions (e.g. running suspension casing for further testing programs). Any drill stem testing program would be subject to rigorous assessment to confirm that materials, equipment and processes are suitable to ensure safe operations, particularly where they would interface with liquids and gases that may flow to surface.

Chemical use

A range of chemicals may be used during drilling, completion and testing operations, predominantly in drilling fluids. These include:

- polymers e.g. PHPA (partially-hydrolysed polyacrylamide)
- barites
- biocide
- bentonite
- caustic soda
- LCM (lost circulation material)
- salt (typically sodium chloride and/or potassium chloride)
- sodium carbonate
- sodium sulphite.

Drilling fluids

During drilling, drilling fluids (also referred to as drilling muds) are pumped down the inside of the drill pipe and up the outside of the drill pipe (in the space between the bore hole and the drill pipe). Drilling fluids are used to transport drilling cuttings to the surface, prevent well-control issues, preserve wellbore stability, and to cool and lubricate the drill bit and drill string during drilling.

Water-based drilling fluids (water-based muds) would be used for drilling operations. Water-based fluids consist of water mixed with potassium chloride, bentonite clay and barite to control mud density. Other substances are added to gain the desired drilling properties to assist with drilling parameters and removing drilled cuttings from the hole.

Drilling fluid selection and management aims to ensure that handling, management and disposal of drilling fluids does not pose an unacceptable risk to the environment. Details of drilling fluid additives proposed for use in drilling operations are provided to DEM as part of the activity notification process.

Cuttings and drilling fluid handling

During drilling, drill cuttings (small pieces of rock removed by the drill bit) are lifted out of the hole with the drilling fluid and directed into tanks or lined sumps, where drilling fluid is separated, treated and then returned down hole in a continuous process. Cuttings and excess drilling fluids are contained in tanks or lined sumps during drilling operations. They would ultimately be removed for reuse, industrial recycling, use as fill or disposal as waste as described in Section 4.9.

Post-drilling testing and decommissioning

If potentially moveable quantities of hydrogen are discovered, further well testing may be carried out using various mechanical techniques available, as discussed in Section 4.4. The mechanical technique would be selected once the most effective technique required for further testing is determined.

If a well is not identified as a potential candidate for further testing it would be decommissioned as discussed in Section 4.8.

4.3.2. Traffic movements for drilling operations

The drilling rig would be mobilised to site using public roads and the landowner approved well access track. Traffic movements for a drilling operation are dependent on the depth of the well (and size of the drilling rig). For a 1,200 m deep well, movements would typically include 15-30 trucks for the drilling rig move, 5-10 trucks for the camp move, 15 trucks for drilling equipment, 2 trucks for cement jobs, water trucks for drilling fluid, dust suppression and the camp, fuel deliveries every 5 days and food supply delivery weekly.

The rig, camp and ancillary services would generally arrive on site over a period of several days at the start of the well drilling program and depart in a similar fashion upon its conclusion. Stakeholders (e.g. landowners, local councils, potentially affected residents) and emergency services will be informed of significant activities such as rig mobilisation and demobilisation.

Daily traffic movements to and from the well site are relatively limited once drilling starts and are generally restricted to low numbers of light vehicles and the supply truck movements noted above. Cementing, logging and testing contractor personnel would be mobilised as required and visitors may access the site under control of the drilling supervisor. Access by the general public would be restricted.

4.3.3. Water supply

Approximately 160 kL of water would typically be required to drill a well of 1,200 m depth. Additional water would also be required for purposes such as cement water, dust suppression and camp supply. Water is expected to be purchased from the SA Water network or a commercial supplier, which also ensures that quality control for the water-based drilling fluids is effectively managed. If a nearby water bore is acceptable, water may be pumped from it, subject to agreement of the landowner.

4.3.4. Fuel and chemical storage

A variety of fuels and chemicals are required for drilling and well operations and include lubes, oils, solvents and drilling fluid additives (discussed above). The volumes and types of chemicals used are dependent upon the type of operation.

Fuels, oils and chemicals are stored in accordance with applicable standards and guidelines (e.g. Australian Standard AS 1940, EPA guideline 080/16 *Bunding and Spill Management,* the Australian Dangerous Goods Code and product Safety Data Sheets), typically in approved containers in polythene lined bunded areas or on bunded pallets.

If an escape of fuel or chemicals occurs, it would be immediately contained, and either removed, or assessed in accordance with National Environment Protection (Assessment of Site Contamination) Measure (NEPM) guidelines and remediated in a timely manner. Contaminated soil would either be treated on site in accordance with relevant guidelines (e.g. EPA guidelines for the assessment and remediation of site contamination) or transported by a licensed regulated waste contractor to a suitable EPA licensed facility for treatment or disposal.

4.3.5. Waste

A range of wastes are generated during drilling and well operations. They include:

- domestic waste (e.g. food waste and packaging, plastic, glass, cans and paper)
- industrial waste (e.g. workshop waste (rags, filters), chemical bags and cardboard packaging materials, scrap metals, used chemical and fuel drums, chemical wastes and timber pallets).

Waste streams are segregated on site and collected and stored in covered bins before being collected for transport off-site by a licensed regulated waste contractor to an appropriately licensed facility for reuse / recycling (where possible) or disposal. Waste management practices would be guided by the principles of the waste hierarchy (i.e. avoid, reduce, reuse, recycle, recover, treat, dispose).

4.4. Completions and Workovers

A completion is the process of preparing a well to flow to the surface.

In the event of natural hydrogen shows or flows, or if a discovery[14] can be determined during exploratory works, well completion activities may be carried out to allow further testing. A decision may also be made to suspend the well for later completion if data recovered from the hole is ambiguous and requires further investigation.

[14] Discovery means a hydrogen deposit or accumulation that has been identified by well penetration and demonstrated as moveable by recovery of a sample or flow to the surface of hydrogen.

As discussed in Section 4.3.1, if the decision is made that the well needs further testing, a suspension casing is likely to be installed at the end of drilling in preparation for the future completion.

A well completion would typically be carried out several months or more after drilling, after further analysis of initial results, metallurgical investigations and engineering design have been undertaken. The design of the completion would give particular consideration to the interface with hydrogen gas, to ensure that appropriate equipment and materials are utilised to safely conduct the test.

Completion activities may include cleaning out the casing, perforating zones of interest, running tubular, setting packers, installing wellhead components and production valves on the wellhead system.

Workover operations may also be carried out. These would typically occur later, but may be required soon after a completion. They may include cleaning out the well, replacing liners, plugging the well, repairing casing, drilling deeper, drilling around any obstructions in the well, and re-perforating existing zones. Some workovers require only wireline equipment to lower tools into the hole to conduct operations, but others require a workover rig to be moved to the location. Pumps and storage tanks are required for operations that need to circulate workover fluids in the well.

4.5. Well Testing

As discussed in sections 4.3.1 and 4.4, well testing may be carried out to evaluate potential hydrogen discoveries.

A well test could range in duration from several days to up to 6 months. In the early stages of exploration, these tests would be used to understand the nature of the reservoir and the natural hydrogen resource. In the case of a successful discovery, shut-ins and flowing of the well could be required to understand the drawdown area, often referred to as reservoir boundary, which the exploration well has penetrated. These types tests can help define future exploration and appraisal activities.

The design of the well test (including test parameters and equipment to be used) would be guided by the analysis of drilling results, including downhole temperatures and pressures and composition of fluids produced from the well. As discussed in Section 4.4, the engineering design would give particular consideration to the interface with hydrogen gas, to ensure that appropriate equipment and materials are utilised to safely conduct the test.

Installations for well testing would be small-scale, mobile and temporary in nature. They would typically be confined to the well pad and may consist of one or more separator and storage tanks, with inter-connecting pipework and valving. Over-pressure shutdowns, spill protection and other risk mitigation measures would be incorporated as required. Testing activities may be manned or unmanned, subject to testing requirements and risk assessment.

Any hydrogen produced during testing would be likely to be flared or vented off.

Any water that is produced during testing would be stored in above-ground tanks. Produced water could potentially be reused if water quality meets applicable criteria for the reuse (e.g. *Environment Protection (Water Quality) Policy 2015*, ANZECC/ARMCANZ 2000 and ANZG 2018 criteria) and any relevant approvals (e.g. DEM / EPA) have been obtained. Alternatively, produced water would be removed by a licensed contractor to an EPA licensed disposal facility.

Detailed information on the well test, including engineering design and safety and environmental aspects, would be provided to DEM during the activity notification and approval stage for each well test (see Section 2.1.4).

The establishment of permanent or semi-permanent surface infrastructure for longer term production operations is not covered by this EIR.

4.6. Well Integrity Monitoring

Wells that have not been decommissioned (e.g. wells that are suspended or undergoing well testing) would be subject to a well integrity testing and monitoring program. This would include routine monitoring of downhole pressures and temperatures to verify barrier integrity. If potential integrity issues are identified, the well would be subject to detailed assessment and well repair, suspension or decommissioning would be undertaken where required.

4.7. Vertical Seismic Profiling

Vertical seismic profiling may be used to generate additional information on the sub-surface geology after a well has been drilled. It involves use of a geophone that is lowered inside the wellbore and an energy source at the surface near the well.

The geophone measures the timing and magnitude of vibrations received from the energy source, which allows a more detailed interpretation of the geological layers that the well passes through. This technique is very useful in converting seismic data (that is often in units of time) to units of depth.

The energy source (which could be a weight drop system, seismic vibrator[15], air gun or small explosive charge) would typically be located on or near the well pad. If an air gun or explosive charge is used, it would typically be deployed in a pit several metres deep located on the well pad.

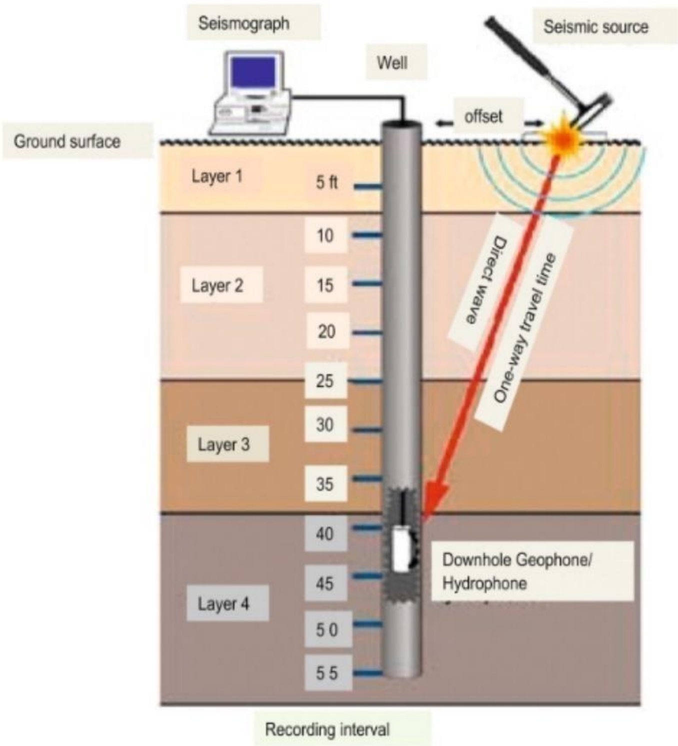


Figure 4-5: Vertical seismic profiling

15 A seismic vibrator or 'vibroseis' system is an adjustable mechanical source that delivers low frequency vibrations to the earth, using steel plates mounted on trucks or buggies which are vibrated when in contact with the ground.

4.8. Well Decommissioning[16]

Wells would be decommissioned following drilling if they do not encounter natural hydrogen or if a decision is made not to proceed with well testing. Alternatively, wells would be decommissioned once the well is no longer required after completion of well testing (as the exploratory well design is not a development or production well design).

The primary objective of well decommissioning is to isolate natural hydrogen reservoirs and isolate different water bearing formations. Wells are decommissioned to avoid crossflow that could result in environmental harm to aquifer systems.

Decommissioning programs are submitted to DEM for prior approval.

4.8.1. Decommissioning following drilling

Following completion of drilling, a decision may be made to plug and decommission the well (i.e. suspension casing would not be installed). The following steps would be undertaken:

- plugs would be set to isolate all formations that have hydrogen present
- plugs would be set across separate aquifers
- a plug would be set at the surface prior to cutting off the surface casing bowl
- a decommissioning plaque may be posted (generally on the nearest fenceline).

The well site would then be cleaned up and reinstated as described in Section 4.9 below.

4.8.2. Decommissioning following well testing

Once well testing is completed, a decision would be made on whether to decommission the cased well bore or leave it in a suspended state until it can be decommissioned. Wells would be evaluated individually to design the decommissioning program.

The decommissioning program would usually involve the following:

- all perforated zones would be isolated from other perforated zones with cement plugs and / or bridge plugs
- the cement bond logs would be evaluated to ensure that the cement behind the suspension casing is adequate to avoid crossflow of aquifers with other aquifers or hydrogen producing zones. A decision may be made to perforate and squeeze off the aquifer to ensure there is no crossflow
- an additional cement plug would be placed in the surface casing prior to cutting off the wellhead below ground level
- a decommissioning plaque may be posted (generally on the nearest fenceline).

The well site would then be cleaned up and reinstated as described in Section 4.9 below.

[16] Decommissioning of wells is equivalent to ‘abandonment’, which is the technical term used in the Petroleum and Geothermal Energy Regulations.

4.9. Site Rehabilitation

Rehabilitation and restoration of the access road, camp, laydown and well pad would be completed to meet the landowner's approved requirements. Following rehabilitation, previous land uses can be resumed.

If the well is decommissioned following drilling and the landowner does not seek to use the paved area, all paving material brought to the site would be removed. Paving material would be retained if well testing is carried out. If well testing is likely to extend over a longer period (e.g. six months or more) the site may be partially restored and reduced in size to the minimum area required. Sufficient pad and access would be retained to undertake planned activities, until final restoration is carried out.

Following drilling, a fence would be installed around the sump (unless there is no sump and tanks have been used to contain drilling fluids and cuttings). Contents of the sump (or tanks) would be tested to analyse their suitability for reuse, industrial recycling, fill or disposal as waste. Water from the sump (or tanks) could potentially be removed for reuse if water quality meets applicable criteria for the reuse (e.g. *Environment Protection (Water Quality) Policy 2015*, ANZECC/ARMCANZ 2000 and ANZG 2018 criteria) and landowner agreement and any relevant approvals (e.g. DEM / EPA) have been obtained. Sump (or tank) contents to be disposed as waste would be removed by a licensed contractor to an EPA licensed waste disposal facility, as soon as possible after drilling is completed. The sump liner would be removed and the previously excavated sump materials would be returned in the correct order.

All pits including excavations for septic tanks would be backfilled with previously excavated and stockpiled materials in correct order, the original topography and slope of the well site restored, and topsoil evenly redistributed across the disturbed area to ensure original drainage and cropping / grazing potential are restored and land use practices can resume after decommissioning of the site.

The whole area previously gravelled would be tine-ripped before replacing stockpiled topsoil, to alleviate soil compaction and enable good rehabilitation back to pasture or crops. Small stones not picked up by front end loaders or excavators would be rolled into the soil. A final shallow ploughing / harrowing would be carried out to ensure soil aeration and permeability. A crop / pasture would then typically be sown for additional soil stabilisation. Perimeter fencing is generally left in place until vegetation is well established.

If well sites are established in areas where native vegetation is present, site-specific rehabilitation methods would be developed. These may include re-spreading of cleared vegetation, reseeding or revegetation with local native species, or encouragement of natural regeneration by appropriate site preparation in areas where this is likely to be successful. Restoration is usually carried out in autumn to avoid the summer heat and dry soil conditions and to make the best use of autumn and winter rains to achieve the maximum vegetation regrowth.

All restoration and rehabilitation activities would be undertaken in consultation with, and to the satisfaction of the landowner. If the landowner wishes to retain suitable infrastructure such as tracks or hard stand areas, they may be handed over under a deed of transfer or similar.

5. Description of the Environment

This section provides an overview of the environment on the portion of Yorke Peninsula within PEL 687. Environmental impacts are discussed in Section 6.

5.1. Climate

The Bureau of Meteorology (BOM) classifies Yorke Peninsula as having a warm summer and cold winter climate, and the region is considered temperate under the Köppen classification (BOM 2023).

Climate data for Minlaton (near the centre of PEL 687) indicates that the mean daily maximum temperature ranges from approximately 15.3°C in the coolest months (June to September) to 29.6°C in the hottest months (December to February). Mean daily minimum temperatures range from between 6.8°C in the cooler months to 15.4°C in the hottest months.

Average annual rainfall at Minlaton Aero is 353.7 mm. Maximum average rainfall occurs during June and July. The highest monthly rainfall recorded is 92.0 mm, in September 2010. The highest daily rainfall event on record is 90.6 mm (in July 2021).

A summary of climate records for Minlaton Aero (Station no. 022031; BOM 2022a) is provided in Table 5 1.

Climate data for Warooka (Station no. 022018; BOM 2022a) which is in the south-west of Yorke Peninsula and has a longer period of record (162 years), show a similar pattern of temperature and rainfall, but with higher rainfall averages. The average annual rainfall for Warooka is 442.9 mm and monthly rainfall averages are also consistently higher than recorded at Minlaton Aero. The highest maximum monthly rainfall for at Warooka is 181.8 mm (recorded in February 1946).

Wind data for Warooka indicates that winds tend to come predominantly from the south and south-east during summer, and the north-west and west in winter.

Table 5-1: Temperature and rainfall records for Station # 022031 (Minlaton Aero)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Daily Max (°C)	29.6	28.5	26.6	23.4	19.4	16.3	15.3	16.3	19.1	22.6	25.9	27.8	22.6
Mean Daily Min (°C)	15.4	15.2	14.0	11.9	9.9	7.8	7.0	6.8	7.8	9.4	11.9	13.5	10.9
Mean Rainfall (mm)	15.7	18.6	14.4	25.8	40.7	49.7	46.4	45.2	33.0	26.8	20.6	17.5	353.7
Median Rainfall (mm)	9.0	10.0	9.5	23.8	44.2	46.8	42.6	47.9	29.3	23.6	15.4	12.6	354.1
Highest Rainfall (mm)	64.6	86.8	57.4	92.0	69.2	85.8	89.6	88.4	93.6	76.4	64.8	60.2	494.6

Records at Minlaton Aero (Station # 022031) commenced in 2001.

5.2. Bioregions, Landform and Soils

PEL 687 falls within the Eyre Yorke Block (EYB) bioregion as defined by the Interim Biogeographical Regionalisation for Australia (IBRA), which classifies Australia's landscapes into geographically distinct regions based on climate, geology, landform and vegetation.

Within the EYB bioregion, PEL 687 spans the Southern Yorke and St Vincent IBRA subregions and the Innes, Corny, Yorketown, Urania, Weetulta, Arthurton and Boor Plain IBRA Associations (DEW 2013). These areas are shown in Figure 5-1.

The landform of Yorke Peninsula is characterised by an undulating plain of generally low relief (Roberts 2007). It rises to approximately 244 m above sea level in the centre (near Maitland) with an average elevation of 91 m (Graham *et al.* 2001). Soils broadly consist of loam over clay, shallow calcrete or calcareous loams, with some areas of dunefields and saline land (Landscape SA Northern and Yorke 2022c). Yorke Peninsula has an extensive coastline that includes beaches, cliffs and rocky shores (Roberts 2007).

Table 5-2 summarises the landform and soil in each of the IBRA Associations.

Table 5-2: IBRA subregions and associations

IBRA Subregion	IBRA Association	IBRA Association description*
St Vincent (EYB02)	Weetulta	Landform: A gently undulating plain with low dunes, bounded along the coastline by a complex of active dunes and former lagoons. Soil: Brown calcareous loams, brown calcareous sands, white calcareous sands, crusty red duplex soils.
	Arthurton	Landform: A gently undulating plain with gentle rises on metasediments, discontinuously overlain by sand, and with low cliffs along the coast. Soil: hard pedal red duplex soils, reddish calcareous earths, grey self-mulching cracking clays.
	Boor Plain	Landform: An undulating calcreted plain with occasional outcrops of bedrock, and a complex of dunes, salt lakes and mangrove flats along the coastline. Soil: Reddish calcareous loams, whitish calcareous sands, black non-cracking plastic clays, crusty red duplex soils.
Southern Yorke (EYB01)	Urania	Landform: A calcreted plain with low rises and tracts of dunes. The coastline is backed by low cliffs or a complex high dunes and salt lakes. Soil: Friable red loams with rough-ped fabric, reddish calcareous earths, brown sands, whitish calcareous sands, grey calcareous loams.
	Yorketown	Landform: An undulating to hilly plain on tillite and calcrete with numerous salt lakes and sand dunes. Soil: Reddish calcareous loams, grey calcareous loams, brownish sands, sandy pedal mottled-yellow duplex soils, whitish calcareous sands.
	Corny	Landform: An undulating to hilly plain, with sand dunes, swamps and low cliffs along the coastline. Soil: Red friable loams with rough-ped fabric, whitish siliceous sands, grey calcareous loams, whitish calcareous sands.
	Innes	Landform: A sandy undulating plain, with dunes and salt lakes or low cliffs along the coastline. Soil: Whitish calcareous sands, brown friable loams with rough-ped fabric, whitish siliceous sands, grey calcareous loams.

*Source: DEW (2013), Laut et al. (1977)

Figure 5-1: IBRA subregions and associations in PEL 687
Port Augusta
Whyalla
Spencer Gulf
Port Wakefield
Adelaide
St Vincent
Price
Balgowan
Maitland
Ardrossan
Port Victoria
Port Julia
Port Rickaby
Curramulka
Minlaton
Port Vincent
Hardwicke Bay
Stansbury
Corny Point
Southern Yorke
Point Turton
Warooka
Wool Bay
Yorketown
Coobowie
Edithburgh
Port Moorowie
Marion Bay
Legend
Towns
State Maintained Roads
PEL 687 Boundary
IBRA Subregions
IBRA Associations
Arthurton
Boor Plain
Corny
Innes
Urania
Weetulta
Yorke Town
N
0
25
50 km

5.3. Surface Water

Yorke Peninsula has very little drainage definition and many surface water catchments terminate in landlocked saline lakes (N&Y NRMB 2009). The most prominent drainage outlet is the ephemeral Winulta Creek (Roberts 2007) which drains into the coastal strip north of Ardrossan. Between Ardrossan and Stansbury, a number of small ephemeral drainage lines flow from elevated near-coastal areas to Gulf St Vincent. The largest of these is Pavy Creek (located south of Ardrossan).

Small farm dams are used to collect surface water in some areas on the peninsula, mainly in the more elevated and undulating areas in the north.

Saline lakes are common near the west coast and in the south of Yorke Peninsula, and are a prominent landscape feature in the area around Minlaton and Yorketown. These lakes range in size from less than a hectare to over 900 hectares. The larger lakes are located south and west of Yorketown and include Lake Fowler, Diamond Lake and Dhalliwanggu - Lake Sunday.

There are no wetlands of international importance (listed under the Ramsar convention in PEL 687. Three identified wetlands of national significance in PEL 687 (Landscape SA Northern and Yorke 2023):

- Gum Flat, adjacent to Minlaton, which contains the only remaining seasonally flooded River Red Gum forest on Yorke Peninsula
- Native Hen Lagoon, north of Yorketown, which is a linear wetland fringed by remnant South Australian Swamp Paper-bark
- Clinton, in the north-east of PEL 687, which consists of a mangrove/samphire estuarine area with many large tidal channels fringed by mangroves.

Figure 5-2 shows the main surface water features within PEL 687.

Figure 5-2: Surface water features in PEL 687

5.4. Geology

5.4.1. Regional setting

PEL 687 on Yorke Peninsula is covered by the geological basins outlined in Table 5-3.

Table 5-3: Geological basins of PEL 687 on Yorke Peninsula

Name	Geological eon / era	Geological period	Age (millions of years)	Relevance to hydrogen prospectivity
St Vincent Basin	Cenozoic	Tertiary and Quaternary	55 to recent	Seal for reservoir(s)
Troubridge	Late Palaeozoic	Permian	299 to 251	Seal for reservoir(s)
Stansbury Basin	Early Palaeozoic	Early to Middle Cambrian	540 to 510	Seal for reservoir(s) Cambrian Limestone reservoirs
Spencer Shelf, Torrens Hinge Zone	Neoproterozoic		1000 to 542	Source of hydrogen Massive Fractured Basement reservoir
Gawler Craton	Archaean to Mesoproterozoic		3150 to 1450	Source of hydrogen Massive Fractured Basement reservoir

Source: Rodrigues *et al.* (2021)

The Stansbury Basin covers the majority of Yorke Peninsula (see Figure 5-3). It is a sedimentary basin from the early to middle Cambrian period which extends across Yorke Peninsula, as well as Gulf St Vincent, Fleurieu Peninsula and Kangaroo Island.

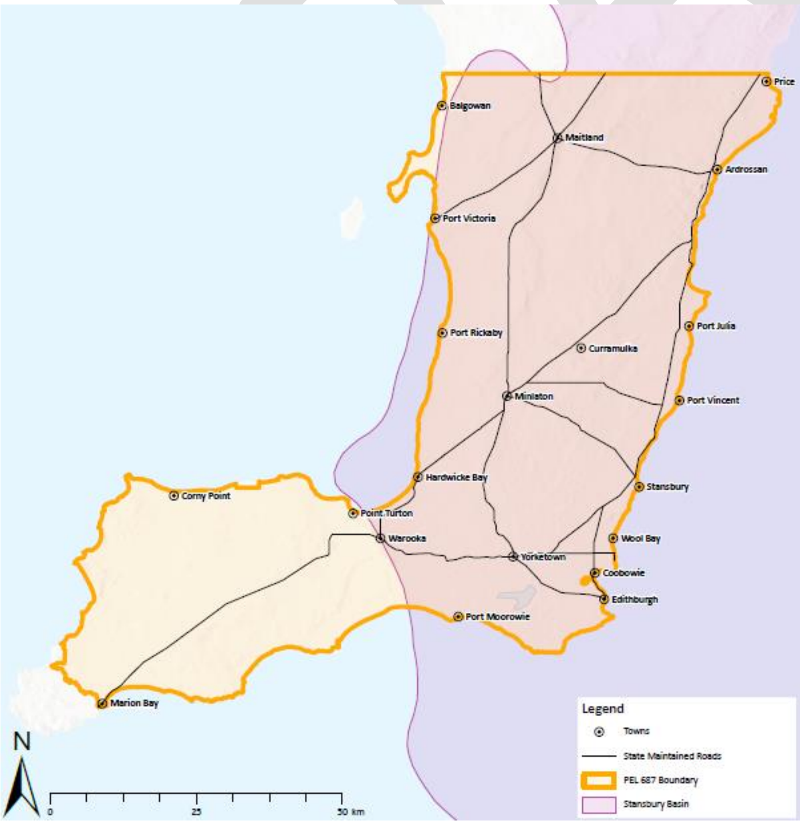


Figure 5-3: Stansbury Basin in PEL 687

Sedimentation of the Stansbury Basin was the last stage of deposition in the Adelaide Fold Belt, a belt of deep subsidence and thick sediment accumulation which began in the early Cryogenian (Neoproterozoic). The basin consists of a marginal platform in the west and the Kanmantoo Trough to the east of Gulf St Vincent. In the west, marine shelf carbonate and clastic sedimentary rocks onlap the Gawler Craton.

The Stansbury Basin overlies thick Neoproterozoic clastic and carbonate rocks of the Adelaide Fold Belt and Paleoproterozoic-Mesoproterozoic volcanic and metamorphic rocks of the southern Gawler Craton (Gravestock *et al.* 2001). It is likely that the granitic suites and metamorphosed sediments of the Neoproterozoic and older rocks could be sources for hydrogen in the region, and where fractured, they may also act as reservoirs (Rodrigues *et al*. 2021).

A regional cross-section across the Stansbury Basin is shown in Figure 5-4.

The western part of the 'foot' of Yorke Peninsula lies outside the Stansbury basin, and its geology is typified by younger (Cenozoic) sediments over Archaean / Lower Proterozoic basement.

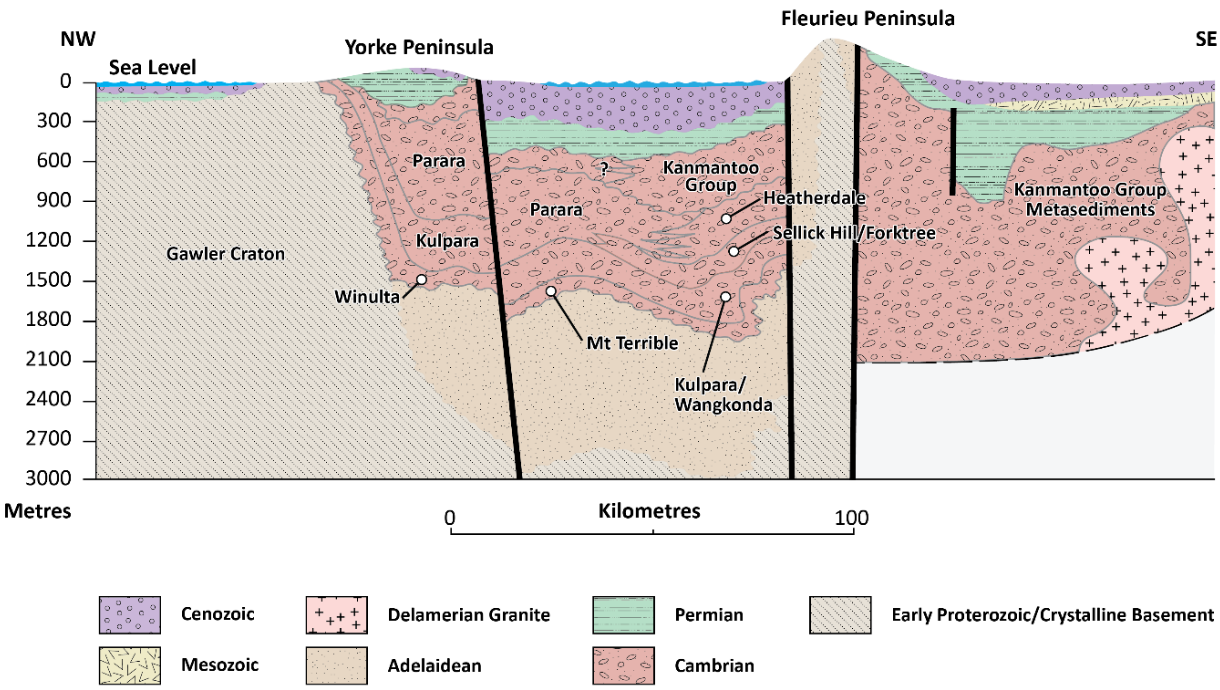


Figure 5-4: Regional structural cross-section across the Stansbury Basin (after SADME 1986)

5.4.2. Yorke Peninsula

The surface geology of Yorke Peninsula is characterised by Quaternary sediments, described as aeolian sand and lacustrine sediments where lagoons / lakes are present (Alcoe and Berens, 2011). Towards the centre and north of the licence area, there are several outcrops of Cambrian limestone and remnants of the Proterozoic Arthurton granite.

Figure 5-5 provides an overview of the stratigraphy of the Stansbury Basin on Yorke Peninsula. The Cambrian succession of sediments is divided into two sequences. The older sequence (C1) is a carbonate-dominated succession, formed by the Kulpara and Parara Formations and Koolywurtie Member. The second sequence (C2) is formed by fan-delta conglomerates (Minlaton Formation) followed by transgressive-regressive shallow marine limestone alternating with sandstone and shale (Ramsay Limestone, Corrodgery Formation, Stansbury Limestone, Moonan Formation and Coobowie

Limestone). Intertidal sands of the Yuruga Formation are the youngest Cambrian sediments preserved beneath the Permian unconformity.

The western Stansbury Basin on Yorke Peninsula contains complex fault-block mosaics associated with the Pine Point Fault Zone (see Figure 5-6), which was tectonically active during the Early Cambrian (DEM 2023).

The thick micrites of the Cambrian Parara Limestone are expected to act as excellent seals for underlying reservoir limestones (Rodrigues *et al.* 2021, DEM 2023). A regional seal was once provided by thick red beds of the Yuruga Formation, but Permian glacial topography may have locally breached some traps (DEM 2023).

In the northern part of the PEL and in the south-west the depth to the crystalline basement[17] ranges from approximately 0-100 m, while depth to basement gradually increases towards the south and south-east, reaching depths of up to approximately 2,500 m. The south-east area of the peninsula where high depths to basement are inferred follows an approximate NE-SW direction, which is shared with the strike direction of several inferred faults, including the Pine Point Fault.

Geology of the crystalline basement in the north of the PEL mostly correspond to granites of the Hiltaba Suite (including the Arthurton Granite) and gneiss and schists of the Wallaroo Group. In the south-west of the PEL, the geology of the crystalline basement is mostly represented by gneissic granite and granodiorite of the Lincoln complex (Paleoproterozoic rock of the Gawler Craton).

[17] 'Basement' is generally used to indicate igneous and metamorphic rocks, usually older than Cambrian in age, that lie below a cover of sedimentary rocks

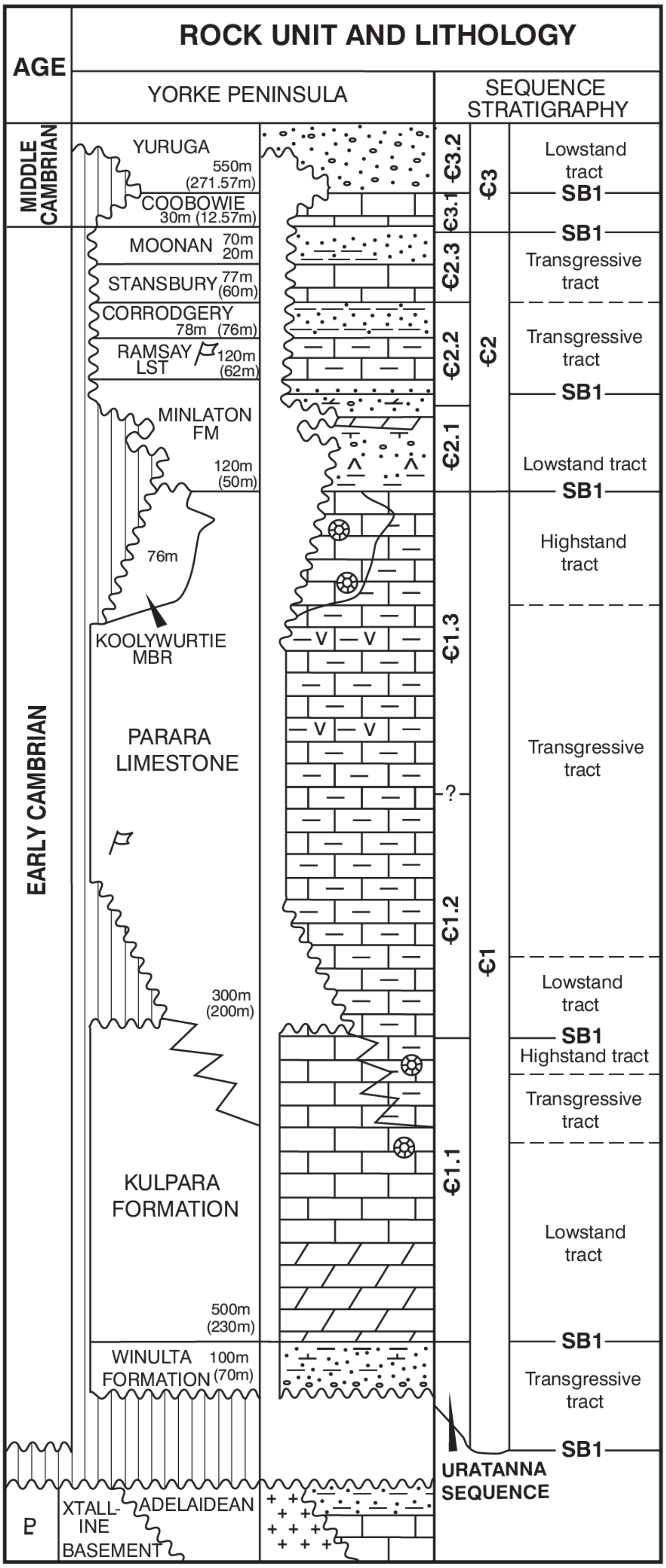


Figure 5-5: Stratigraphy of the Stansbury Basin beneath Yorke Peninsula (Source DEM 2023).

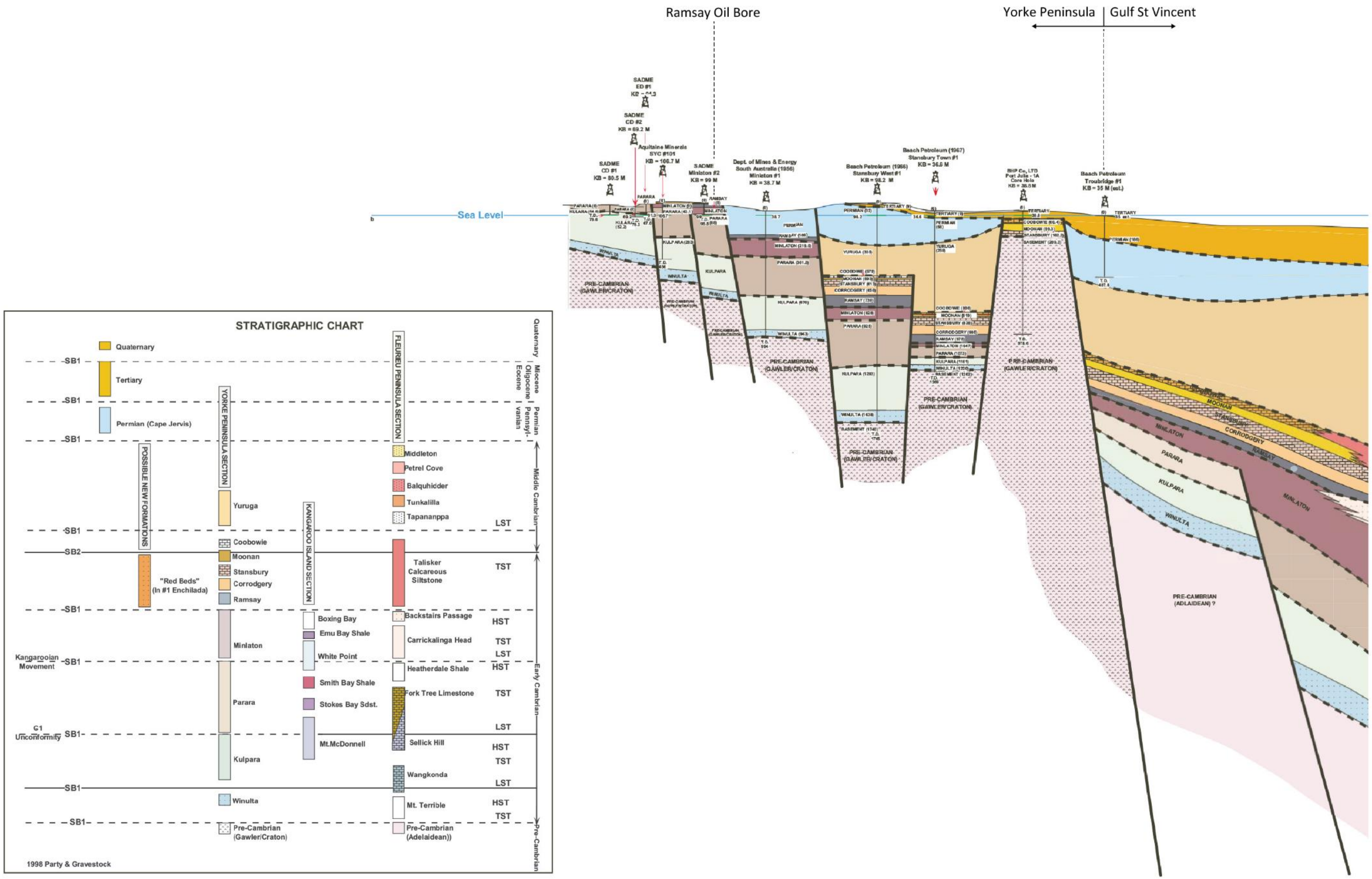


Figure 5-6: Geological cross-section of the Stansbury Basin on Yorke Peninsula showing historic wells between Minlaton and Troubridge Island (Source DEM 2023).

5.5. Hydrogeology

5.5.1. Overview

Groundwater resources on Yorke Peninsula are mostly limited to the south of the peninsula, in undifferentiated Quaternary sediments and the Pleistocene Bridgewater Formation. Groundwater in these shallow aquifers is generally brackish, except in the south-west of the peninsula, where fresh groundwater is found. The Bridgewater Formation is used for stock and domestic supply across southern Yorke Peninsula in areas where salinity levels are lower. It was also used to supply water to Warooka and Point Turton before a pipeline connection to SA Water's River Murray water supply network was constructed in 2018 (SA Water 2018).

The northern part of PEL 687 consists of undifferentiated alluvial sediments overlying basement rock of the Stuart Shelf and Gawler Craton (Preiss 1987). There are few operational water wells in this region, as low yields and high salinities (generally over 5,000 mg/L) are a limiting factor to development (Magarey and Deane 2004).

There are no prescribed water resources or prescribed wells areas under the Landscape South Australia Act (and therefore no water allocation plans or groundwater licensing) in PEL 687. There are three water protection areas[18] established under the Environment Protection Act in the south-western part PEL 687.

The following sections provide further detail on the aquifers, groundwater resources and groundwater use in PEL 687. The information is based primarily on a review of hydrogeology of the region undertaken for Gold Hydrogen for the Ramsay Project by Innovative Groundwater Solutions.

5.5.2. Aquifers and aquitards

The main aquifers that occur in PEL 687 are summarised in Table 5-4.

The most widespread and prospective aquifers in the region are the undifferentiated Quaternary sediments and aeolian (wind-formed) sediments of the Pleistocene Bridgewater Formation. Groundwater in these shallow aquifers is mostly brackish (2,000 – 6,000 mg/L), with the exception of the south-western end of the peninsula where groundwater is generally fresh (less than 1,000 mg/L).

There are a number of underlying Paleozoic limestone aquifers, including the semi-confined aquifers of the Permian age Cape Jervis Formation and the Cambrian age limestones comprising the Ramsay, Parara and Kulpara Formations. The spatial distribution of these aquifers is irregular, and groundwater is generally higher in salinity, reaching salinities of up to 20,000 mg/L.

The Minlaton Formation is an aquitard within the Palaeozoic layers that lies between the Ramsay Limestone and the Parara Limestone. It has been reported as having a thickness of 54 m and 128 m at historic exploration wells Minlaton 2 and Minlaton 1 respectively (Gravestock *et al.* 2001).

The basement rocks have low prospectivity as an aquifer unless fractures are present, and groundwater can exceed salinities of 35,000 mg/L. The basement can be found at large depths (e.g. 1,000 m around Minlaton), except in the north where it can be close to surface.

[18] Water protection areas are located in many areas across South Australia, generally where surface water or groundwater resources are used for drinking water supply (including the Mount Lofty Ranges, far south Eyre Peninsula and the entire South East). They provide additional administrative controls on approvals for new activities and additional enforcement options to protect water resources.

The presence and depth of the geological units containing these aquifers is variable within the PEL, due mainly to the complex fault-block mosaics present in the western Stansbury Basin (see Section 5.4.2 and Figure 5-6) and the variable geological setting that results from the position of the PEL across the edge of the basin.

Table 5-4: Summary of main aquifers and aquitards found within the PEL 687 area
(after Alcoe and Berens, 2011).

Name	Era	Age	Aquifer / aquitard	Description and location
Undifferentiated Quaternary sediments	Cenozoic	Quaternary	Aquifer	White-beige alluvial-fluvial fine-grained sand. Widespread across Yorke Peninsula. Unconfined.
Bridgewater Formation		Pleistocene	Aquifer	Unconsolidated aeolian calcareous sands, rounded shell fragments and limestone. Notably present in the western and southern parts of the peninsula. Unconfined.
Permian Clays	Palaeozoic	Permian	Aquitard	Confining unit generally found beneath salt lagoons/lakes in the south-eastern corner of the peninsula and beneath Cenozoic sediments in general. Mostly found around Yorketown.
Cape Jervis Formation		Permian	Aquifer	Poorly sorted and unconsolidated siltstone-sandstone-limestone, notably abundant between Minlaton and Edithburgh. Confined.
Ramsay Formation		Mid-Cambrian	Aquifer	Blue-grey limestone, mostly found in the northern part of PEL 687. Unconfined.
Minlaton Formation		Mid-Cambrian	Aquitard	Dark red-brown fine-medium sandstone, yellowish calcareous siltstone and sandy limestone, clastic conglomerates, evaporites.
Parara Formation		Early-Cambrian	Aquifer	Blue-grey limestone, mostly present in the central part of PEL 687 between Minlaton and Port Vincent. Unconfined.
Kulpara Formation		Early-Cambrian	Aquifer	Dolomite massive to thick-bedded, locally stromatolitic. Blue-grey limestone. Mostly present in the central part of PEL 687 between Minlaton and Port Vincent. Unconfined.
Hiltaba Suite	Pre Cambrian	Neoproterozoic	Aquifer	Part of the Adelaidean basement. Rarely water-bearing unless fractures are present.

Well data on the WaterConnect website (WaterConnect 2023) indicates that well yields (i.e. maximum flow rates) are generally low in all aquifer formations on Yorke Peninsula. Yields are typically between 0.5 and 1 L/s, although yields of up to 13 L/s in the Quaternary sediments, 6 L/s in the Cape Jervis Formation and 4.5 L/s in the Cambrian limestone have been recorded.

The Bridgewater Formation in the south-west of the Peninsula is the most prospective aquifer, with yields exceeding 5 L/s.

In the central and northern parts of the licence area, all wells with yields equal to or higher than 5 L/s are strictly located along the eastern coast, although no aquifer information is recorded for these wells.

Overall, in the PEL 687 area, yields are generally low and no aquifer formation can be specifically associated to having high yields (greater than 5-10 L/s), although Quaternary and Bridgewater Formation aquifers appear to be to be more prospective.

5.5.3. Groundwater salinity

Groundwater on Yorke Peninsula generally has elevated salinity and is non-potable for human consumption, with some exceptions in the south-west as noted above. Salinity data for wells within the PEL (WaterConnect 2023) indicates that most groundwater in the Cenozoic, Permian and Cambrian aquifers is brackish (2,000 – 7,000 mg/L) or saline (over 10,000 m/L) and is suitable only for stock usage.

Shallow groundwater salinity mapping (DEW 2016b) is shown in Figure 5-7[19], along with the location of active water wells (which are generally aligned with the areas of lower salinity).

Groundwater in the central area of PEL 687 is generally brackish to saline, with salinities between 6,000 and 10,000 mg/L. Fresh groundwater (less than 1,000 mg/L) is mostly found in the south of the PEL with some isolated pockets in the south-eastern and eastern side of the PEL. Salinities above 10,000 mg/L are mostly found in the north of the PEL and in coastal areas, possibly as the result of evaporative concentration in groundwater discharge areas and/or potential presence of a seawater intrusion wedge.

5.5.4. Groundwater depth

The depth to groundwater varies across Yorke Peninsula. Mapping of standing water level in the shallowest aquifer (DEW 2016a) indicates that depth to groundwater is typically over 20 m in the central and eastern part of PEL 687, but is much closer to the surface along the west coast and in the area south and west of Minlaton and Yorketown (Figure 5-8). The saline lakes that occur in this area are likely to be locations of groundwater discharge.

[19] Note that as salinity records in the north of the PEL are very sparse (only 6% of total records) and mapped interpolated salinities in that part of the PEL have relatively low confidence (such as the area of low salinity mapped in the northwest).

Figure 5-7: Shallow groundwater salinity and active water wells

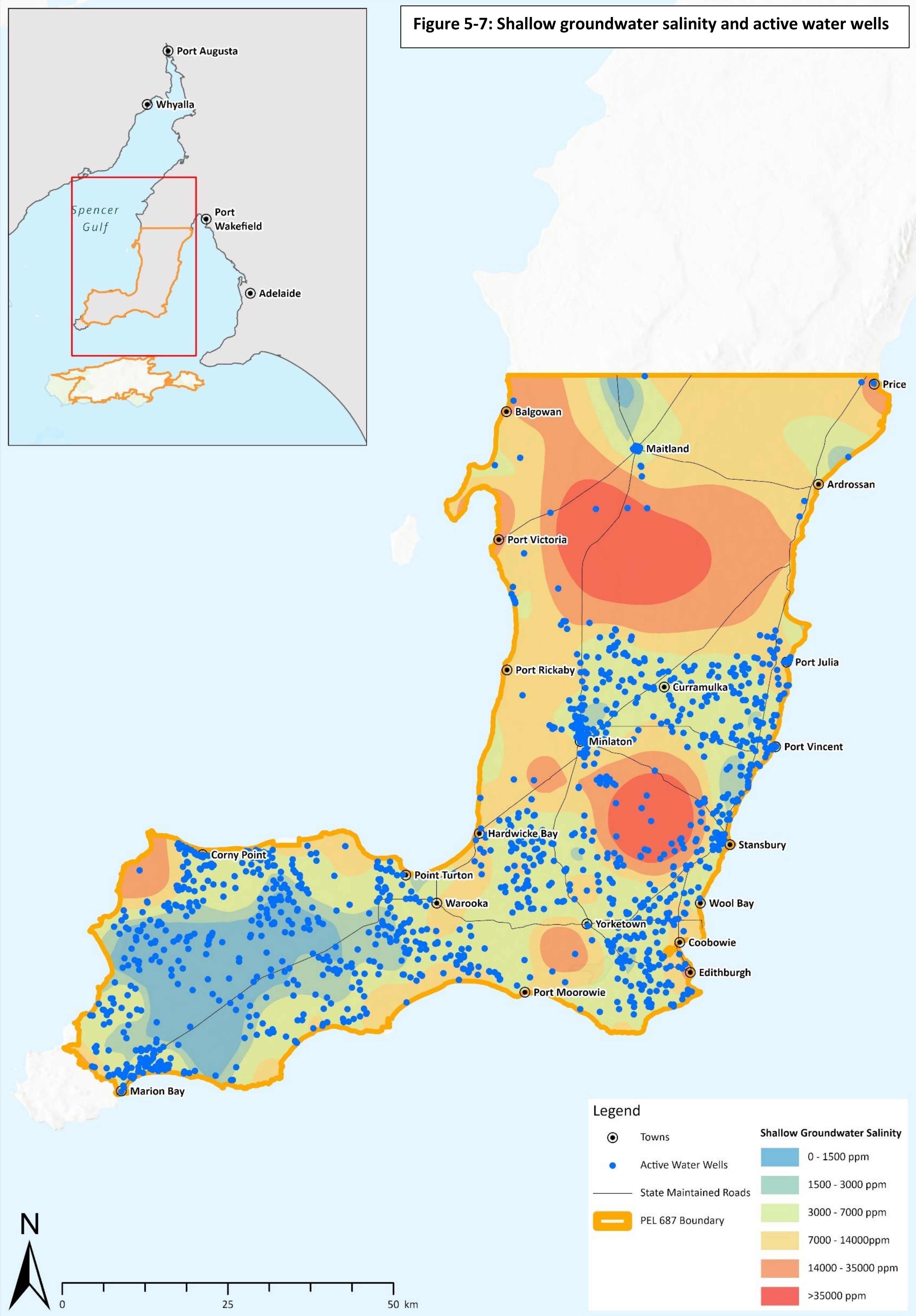
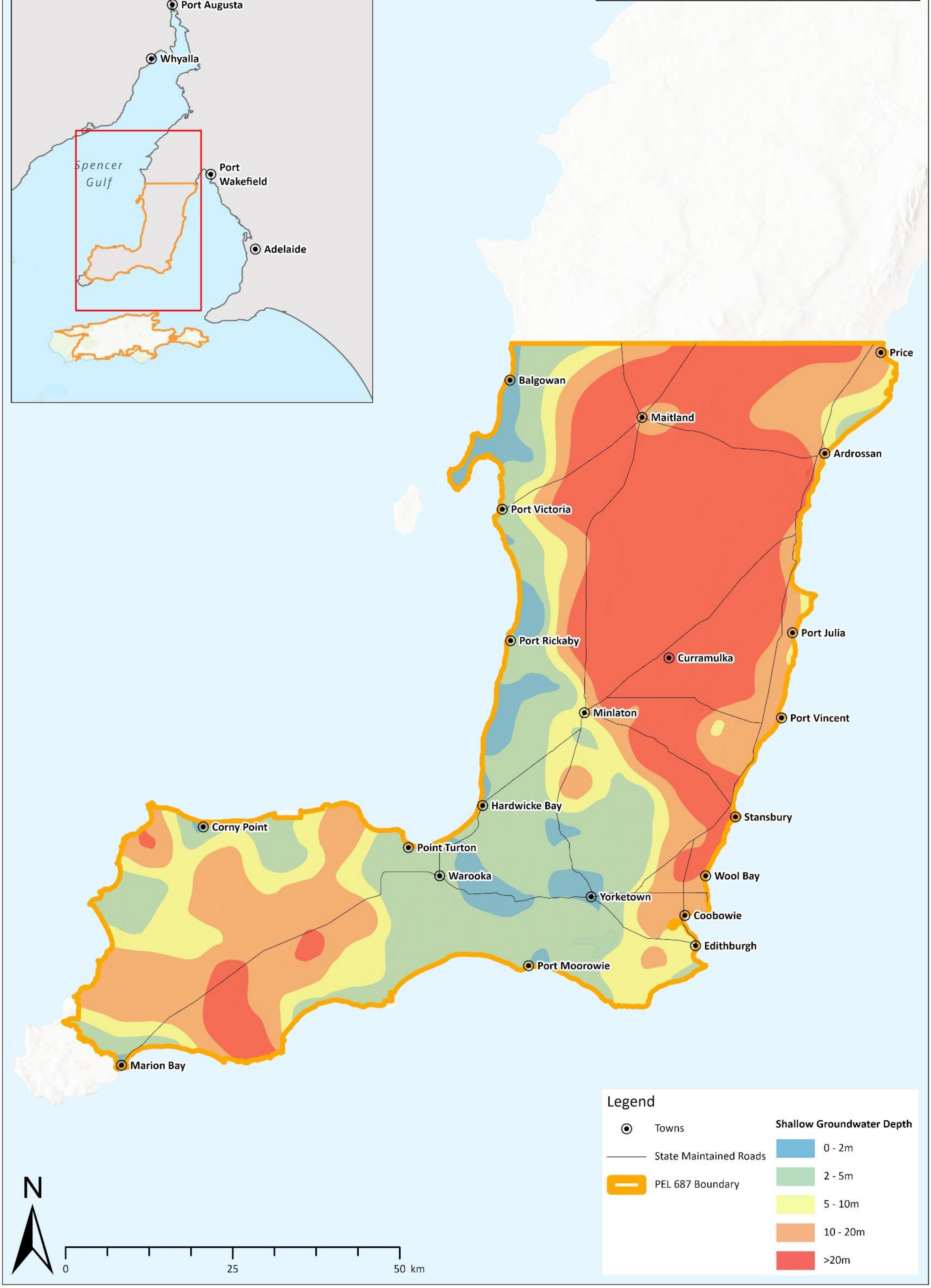


Figure 5-8: Shallow groundwater depth



5.5.5. Groundwater resources and use

As noted above, groundwater resources on Yorke Peninsula are mostly limited to the undifferentiated Quaternary sediments and the Bridgewater Formation.

Groundwater is used for stock and domestic purposes in areas of Yorke Peninsula where salinity levels are suitable[20] (see Figure 5-7). Although there are no licensed groundwater allocations or previous government estimates of unlicensed use for stock and domestic purposes in the area, it is likely that water supply for stock represents the greatest groundwater demand in the area. Approximately a third of the over 5100 wells recorded in PEL 687 have information about their purpose recorded in WaterConnect and 73% of these are recorded as stock wells (with some having a combined purpose such as domestic and stock) (WaterConnect 2023).

The Carribie and Para-Wurlie Basins in the far west of the 'foot' of Yorke Peninsula are noted as significant groundwater resources, with good water quality and salinity levels often less than 1,000 mg/L (Roberts 2007). The geology of both basins consists of unconfined Bridgewater Formation over Archaean/Lower Proterozoic basement (Magarey and Deane 2004). Water from the Carribie Basin is used for stock and domestic purposes (Magarey and Deane 2004) and the Para-Wurlie Basin was used for town water supply until it was replaced in 2018 by piped River Murray water, as noted in Section 5.5.1.

Both these basins are covered by water protection areas under the Environment Protection Act (see Section 5.5.1), along with an area near Marion Bay, where groundwater from the unconfined aquifer was historically used for water supply to entities including the landowner, the caravan park, the CFS and Dhilba Guuranda – Innes National Park (Magarey and Deane 2004). The use of groundwater at Marion Bay has largely been replaced by construction of a saltwater desalination plant at Marion Bay (Yorke Peninsula Council 2023). Water protection areas on Yorke Peninsula are shown in Figure 5-9.

The coastal strip between Pine Point and Edithburgh on the east of Yorke Peninsula, which is located on the western margin of the St Vincent Basin, has been identified as having a small groundwater resource. However, its potential uses are restricted by low yields (Magarey and Deane 2004).

[20] The *Environment Protection (Water Quality) Policy 2015* identifies groundwater of less than 1,200 mg/L salinity as having environmental values for drinking water for human consumption, and groundwater up to 13,000 mg/L as having environmental values for livestock drinking water. However, ANZECC/ARMCANZ (2000) notes that above 10,000 mg/L for sheep (and less for other animals), a loss of production and decline in animal condition would be expected with long term consumption.

Figure 5-9: Groundwater protection areas on south-western Yorke Peninsula

5.5.6. Local hydrogeology in the vicinity of the Ramsay Oil Bore

This section provides additional detail on the local hydrogeology in the vicinity of the Ramsay Oil Bore 1 (see Plate 1-1), where the initial well is likely to be drilled.

In this region, drilling would most likely encounter undifferentiated Quaternary and Bridgewater Formation sediments (generally unconsolidated fine sands) with increasing thickness towards the east, although these units have been reported to be virtually absent at Ramsay Oil Bore 1. The underlying Permian Cape Jervis Formation (unconsolidated siltstone / sandstone / limestone) is thick around Minlaton but thins to the east. It is absent at the location of Ramsay Oil Bore 1, and the Cambrian limestone of the Ramsay Formation is found directly underneath Cenozoic sediments at less than 10 m depth, followed by the Minlaton Formation (sandstone / siltstone / limestone aquitard) and Parara Formation (limestone aquifer).

Between Minlaton and Ramsay Oil Bore 1, the upper layer of the Cambrian limestone package is missing (i.e. Ramsay and Minlaton Formations), and the Parara Formation is found directly underneath the Cape Jervis Formation.

Depth to groundwater water is shallow around Minlaton but increases to between 30-50 m around Ramsay Oil Bore 1 in the Cambrian Limestone. It becomes shallower east of Ramsay Oil Bore 1.

Groundwater inflows near Minlaton are likely to be lower than 2 L/s, and available data indicates that the highest inflows are likely to be found near the top of the Cape Jervis Formation. Inflows from the Cambrian limestone formations is not expected to exceed 0.5 – 1 L/s. Salinities in Cenozoic sediments are not expected to exceed 4,000 mg/L, while groundwater salinity in the Cape Jervis Formation can be highly variable (i.e. 9,000 – 20,000 mg/L). Groundwater salinity in the Cambrian limestone formation is likely to be limited to around 10,000 mg/L.

5.6. Flora and Fauna

5.6.1. Vegetation communities

There has been widespread native vegetation clearance across Yorke Peninsula and the majority of the PEL is cleared agricultural land. The proportion of native vegetation remaining is 2-3 % in the Arthurton and Boor Plain IBRA associations in the north-east of PEL 687, 6-10 % in the Corny, Yorketown and Urania IBRA associations, and 52% in the Innes IBRA association in the south-west of the PEL. Large tracts of remnant native vegetation occur only in the south-west of the PEL, with native vegetation elsewhere typically present as isolated patches in paddocks and on roadsides.

Vegetation communities present in areas of remnant vegetation include *Eucalyptus* mallee woodland, *Melaleuca* woodland, *Allocasuarina* woodland, *Melaleuca* shrubland, samphire shrubland, tussock grassland, rushland / sedgeland and coastal shrubland (DEW 2018).

A list of vegetation communities mapped within PEL 687 in areas of remnant native vegetation is provided in Appendix A.

5.6.2. Threatened ecological communities

Two threatened ecological communities listed under the EPBC Act are predicted to occur in PEL 687 by the Protected Matters Search Tool (DCCEEW 2022b). These communities are listed in Table 5-5.

Table 5-5: EPBC Act Listed threatened ecological communities potentially occurring within PEL 687

Name	Status
Drooping sheoak grassy woodland on calcrete of the Eyre Yorke Block Bioregion	Critically endangered
Subtropical and Temperate Coastal Saltmarsh	Vulnerable*

*Note: Vulnerable threatened ecological communities are not matters of national environmental significance for the purposes of Part 3 of the EPBC Act (requirements for environmental approvals).

Vegetation mapping (DEW 2018) shows very scattered occurrences of generally small patches of Drooping Sheoak woodland across the southern part of Yorke Peninsula. Saltmarsh (i.e. samphire shrubland) is mapped at several locations around the coast, with large tracts mapped in the area around Yorketown and Warooka (however it is noted that most of these inland areas are unlikely to qualify as the listed threatened ecological community as they are not subject to tidal influence).

5.6.3. Threatened species

Flora

Searches of the Biological Databases of South Australia (DEW 2022a) and the EPBC Act Protected Matters Search Tool (DCCEEW 2022b) identified 15 plant species listed as threatened at a national level that have been recorded within or adjacent to the PEL. A further 5 nationally threatened species were predicted to occur by the Protected Matters Search Tool. Twenty-five plant species listed as threatened at a State level and a further 49 species listed as Rare have been recorded within the or adjacent to the PEL.

The vast majority of threatened plant records are associated with patches of remnant vegetation, however there are records of some species (e.g. shrubs such as Resin Wattle *Acacia rhetinocarpa,* Jumping-jack Wattle *Acacia enterocarpa* and Silver Daisy-bush *Olearia pannosa*) on roadsides.

Threatened plant species recorded or predicted within the PEL are listed in Appendix A.

Fauna

Database searches (DEW 2022a and DCCEEW 2022b) identified 23 fauna species listed as threatened at a national level that have been recorded within or adjacent to the PEL. A further 23 nationally threatened species were predicted to occur by the Protected Matters Search Tool. Thirty-three fauna species listed as threatened at a State level and a further 22 species listed as Rare have been recorded within or adjacent to the PEL.

The majority of threatened species recorded were birds (27 species, of which 18 were marine or coastal species) (DEW 2022a). Five threatened mammal species (all marine species) and five threatened reptile species (including three marine turtle species) have been recorded (DEW 2022a).

The vast majority of threatened fauna records are associated with the coastline and, to a lesser extent, patches of remnant vegetation.

Threatened fauna species recorded or predicted within the PEL are listed in Appendix A.

5.6.4. Listed migratory species

The EPBC Act Protected Matters Report (DCCEEW 2022b) identified 65 migratory species listed under the EPBC Act as potentially occurring within the PEL 687 search area. This includes 16 migratory marine birds, 12 migratory marine species, 3 migratory terrestrial species and 34 migratory wetland species.

5.6.5. Groundwater dependent ecosystems

Groundwater dependent ecosystems require access to groundwater to meet all or some of their water requirements on a permanent or intermittent basis.

Review of the Groundwater Dependent Ecosystems Atlas mapping (BOM 2022b) shows aquatic groundwater dependent ecosystems occurring within PEL 687, with concentrations along the west coast of Yorke Peninsula, south and west of Minlaton and in the region around Yorketown and Warooka. These generally correlate with the numerous salt lakes present in these areas.

Terrestrial groundwater dependent ecosystems are also mapped as occurring throughout PEL 687 with larger concentrations to the south (BOM 2019, BOM 2022b).

5.6.6. Weeds, pests and pathogens

Pest plants

Eleven weeds have been identified as priority plants for the Yorke district, including four Weeds of National Significance (WoNS) and seven declared weeds. An additional ten declared plants are identified as 'other declared local action pest plants' (Natural Resources Northern and Yorke 2022). A list of these plants is provided in Appendix A.

Pest animals

Key pest animals in the Northern and Yorke Landscape region include Rabbit, Fox, Feral Deer and Feral Goat (Landscape SA Northern and Yorke 2022b).

Pathogens

Yorke Peninsula is identified as a moderate potential threat area for phytophthora (DIT 2022a). There are no records of phytophthora on Yorke Peninsula in NatureMaps (DEW 2023).

5.7. Land Use

5.7.1. Agriculture

In the early years of the colony of South Australia and the Yorke Peninsula, the main agricultural industry was grazing of sheep with good rainfall and soil conditions conducive to wool and meat production. Cropping was progressively introduced in the second half of the 1800s and when annual legumes were introduced into rotations of sheep in the early 1900s, production increased[21].

Agriculture continues to be the dominant land use on Yorke Peninsula, mainly comprising broadacre cropping of wheat, barley, lentils and canola and sheep farming. Other crops grown include beans, peas, chickpeas and oats. Yorke Peninsula is one of Australia's prime agricultural regions, renowned for the quality of its barley, having been referred to as the 'Barley Capital of the World' (Yorke Peninsula Tourism 2023).

The 2022-2023 crop production for Yorke Peninsula was 2.3 million tonnes, which was approximately 18% of South Australia's total production (PIRSA 2023). The main crops grown in 2022-2023 were wheat, barley and lentils.

[21] https://www.pir.sa.gov.au/aghistory/dept_of_agriculture_as_an_organisation/locations/kadina2

Farms on Yorke Peninsula are typically in the order of 600 ha in size (YPVC 2022). Key periods of farming activity generally include late summer and autumn for lambing, sowing of crops in early autumn, cutting, raking and baling of hay in spring and harvesting, which usually commences in early to mid-November, with the coastal regions the first to ripen (YPVC 2022).

5.7.2. Tourism

Yorke Peninsula is a popular holiday destination, and the population of coastal towns increases significantly in summer (particularly Christmas holidays and weekends) and Easter. Tourist attractions include beaches, coastal towns and national parks (Yorke Peninsula Tourism 2022). Other attractions include surf breaks, shipwrecks, pink salt lakes south of Yorketown, small wineries and craft breweries / distilleries.

For the year ending December 2021, Yorke Peninsula had 620,000 domestic overnight visitors, consisting of 90% visitors from within South Australia, who stayed an average length of 3 nights, and 10% from interstate, who stayed an average of 6 nights. Of the visitors to Yorke Peninsula. 91% were leisure visitors, either on holiday or visiting family. The most popular activity undertaken by domestic overnight visitors to Yorke Peninsula is going to the beach, followed by eating out, fishing and visiting friends and family (SATC 2022)[22].

5.7.3. Mining

Significant mining operations within PEL 687 include the Ardrossan Dolomite Mine/Ardrossan Dolomite Quarry and the Klein Point Quarry. Mining operations licensed under the *Mining Act 1971* within PEL 687 are summarised in Table 5-6.

The Rex Minerals' Hillside Project, located within PEL 687, has an approved mining lease but is currently undeveloped (DEM 2022).

Historic gypsum mining occurred in Dhilba Guuranda - Innes National Park at sites including Marion Lake Gypsum Mine, Snow Lake and Spider Lake (DEM 2022).

Table 5-6: Licensed mining operations within PEL687

Name	Tenement Holders	Type[1]	Commodities	Status
Ardrossan Quarry	OneSteel Manufacturing Pty Limited	ML, PM	Dolomite	Operating
Carribie Whiting Mine	Agricola Mining Pty Ltd	ML	Dolomite	Care/Maintenance
Coobowie Limestone Quarry	Vigar, Peter Gerald	EML	Limestone	Operating
Crowell Sand Pit	Southern Quarries Pty. Ltd	EML	Sand	Operating
Crowell Sand Pit	Crowell, Bevan Wayne; Crowell, Lynette Jean (operators: Direct-Screens Holdings Pty. Ltd.)	PM	Sand	Operating
Crowell Sand Pit	Direct-Screens Holdings Pty. Ltd (operators: Southern Quarries Pty. Ltd.)	PMA	Sand	Operating
Curramulka Quarry	Hanson Construction Materials Pty Ltd	EML	Dolomite; Limestone	Operating

[22] Note that the 2021 statistics may have been affected by COVID restrictions and interstate border closures.

Name	Tenement Holders	Type[1]	Commodities	Status
Hillside Project	Rex Minerals (SA) Pty Ltd	EML	Sand, gravel, clay, limestone	Operating
Hillside Project	Rex Minerals (SA) Pty Ltd	ML	Iron ore - hematite DSO, gold, copper, iron ore - magnetite DSO	Approved
Hollams Sand Pit	Clay & Mineral Sales Pty Ltd	EML	Sand	Operating
Klein Point Quarry	Adelaide Brighton Cement Ltd	ML	Limestone	Operating
Lake Fowler Gypsum Mine	Adelaide Brighton Cement Ltd	ML	Gypsum	Operating
Olsson Saltfield	Olsson Industries Pty Ltd	ML	Salt	Care/Maintenance
Price	Ocsalt Proprietary Limited	ML	Salt	Operating
Price Sand Quarry	Direct-Screens Holdings Pty. Ltd.	EML	Sand	Operating
Ramsey Blue Stone Quarry	Parsons as Executor, Nerida Jean	EML	Limestone	Operating

Source: DEM (2022)

[1] Tenement types: EML – Extractive Minerals Lease, ML – Mining Lease, PM – Private Mine

5.7.4. Renewable energy

The main renewable energy infrastructure within PEL 687 on Yorke Peninsula is the 90 MW Wattle Point Wind Farm. Wattle Point Wind Farm, located near Edithburgh was opened in 2005 and has 55 turbines (AGL 2022).

ElectraNet has installed a 30 MW large scale battery energy storage system at the Dalrymple substation, which works with the Wattle Point Wind Farm and rooftop solar PV to provide back-up power in the event of any interruption to supply from the grid. In addition, 33 kW of solar panels and 54 kWh of batteries have been installed across hubs in Edithburgh and Stansbury and at two locations in Yorketown (AGL 2021).

The proposed Ceres Wind Farm (located west of Black Point) was approved in 2014 but never constructed. Spark Renewables is working on a revitalisation of the project known as the Yorke Peninsula Energy Hub (Spark Renewables 2023).

5.7.5. Roads and infrastructure

The road network on Yorke Peninsula includes sealed roads controlled by the Department for Infrastructure and Transport and sealed and unsealed roads controlled by Yorke Peninsula Council. The main highways within PEL 687 are summarised in Table 5-7.

Table 5-7: Highways within PEL 687

Name and Road Type	Class	Surface	Route number	Traffic estimates*
Yorke Highway	Arterial	Sealed	B86	220-2000
St Vincent Highway	Arterial	Sealed	B88	420-1100
Spencer Highway	Sub-arterial	Sealed	B89	600-1500

*Source: DIT (2023). Estimated average number of vehicles per day (lowest and highest volumes across all sections)

There are commercial airstrips at Maitland, Minlaton and Yorketown and aeroplane landing areas at Ardrossan, Port Victoria and Warooka.

There is a network of South Australia Power Network transmission lines and substations across Yorke Peninsula (SAPN 2022) and an ElectraNet overhead transmission line runs north-south along the eastern side of Yorke Peninsula (ElectraNet 2022).

There are no operational rail lines in PEL 687. The nearest open railway is the Adelaide to Crystal Brook line owned by the Australian Rail Track Corporation (DIT 2022b).

Other infrastructure of note includes lighthouses at Corny Point, Troubridge Point, West Cape and Cape Spencer and large silos at the main ports (Ardossan and Port Giles). Many regional centres also have smaller silos.

5.7.6. Conservation areas

There are a number of areas reserved for conservation under the *National Parks and Wildlife Act 1972* (NPW Act) in or immediately adjacent to PEL 687. On-ground activities regulated under the PGE Act are not permitted in most of these reserves (refer Table 5-8). The PEL also contains numerous Heritage Agreements established under the *Native Vegetation Act 1991* and there are several marine parks established adjacent to PEL 687. Figure 5-10 shows areas reserved for conservation in and adjacent to PEL 687.

As noted in Section 1.3.1, the scope of this EIR and the accompanying SEO excludes activities in reserves established under the National Parks and Wildlife Act or exploration activities immediately adjacent to a Marine Park established under the *Marine Parks Act 2007*.

South-western Yorke Peninsula is also home to Marna Banggara, a landscape-scale project involving predator control and large-scale predator fencing across the 'foot' of the peninsula. The project is investigating whether the reintroduction of targeted native species can restore ecosystem function and provide flow-on benefits to agriculture, local business and the community (Marna Banggara 2023).

5.7.7. Wardang Island Indigenous Protected Area

The north-western extent of PEL 687 also intersects the Wardang Island Indigenous Protected Area (see Figure 5-10Figure 5-10). This area encompasses Wardang Island (which is offshore from PEL 687) and 28 km of coastal fringe adjacent to the island on Yorke Peninsula.

The Narungga people are working to protect their connections to country, storylines and songlines for future generations in this area and rangers are working to eradicate feral animals from Wardang Island with a vision to create a sanctuary for endangered native species (NIAA 2023). As noted in Section 4.1.1, activities undertaken under this EIR and SEO would avoid the Wardang Island Indigenous Protected Area.

Table 5-8: Conservation reserves within or adjacent to PEL 687 on Yorke Peninsula

Name	Type	Location	PGE Act entry
Carribie	Conservation Park	Within PEL	×
Dhilba Guuranda-Innes	National Park	Adjacent PEL	×
Goose Island	Conservation Park	Adjacent PEL	×
Leven Beach	Conservation Park	Adjacent PEL	×
Minlacowie	Conservation Park	Within PEL	✓

Name	Type	Location	PGE Act entry
Point Davenport	Conservation Park	Within and adjacent PEL	✗
Ramsay	Conservation Park	Within PEL	✓
Thidna	Conservation Park	Within PEL	✓
Warrenben	Conservation Park	Within PEL	✗
Wills Creek	Conservation Park	Adjacent PEL	✗

5.8. Native Title

PEL 687 is within the area of the Narungga Nation (SC2013/002) native title claim which acknowledges native title rights and interests in land and waters on the Yorke Peninsula from Mundoora in the north to Dhilba Guuranda-Innes National Park in the south.

This claim was determined in March 2023 by agreement with the State. The determination recognises the claimants as Native Title Holders for Native Title Land in the claim area as set out in the Narungga Nation Determination Indigenous Land Use Agreement (ILUA)[23]. The determination includes parcels of land within PEL 687.

[23] The determination will take effect upon the final registration of the ILUA on the Register of Indigenous Land Use Agreements

Figure 5-10: Conservation reserves and other protected areas in and adjacent to PEL 687

5.9. Amenity

5.9.1. Air quality

The air quality in PEL 687 is generally expected to be good and typical of that found in a rural setting in South Australia, due to low population numbers and limited industrial activities. Existing sources of air pollution within the broader area are expected to include vehicle emissions and dust generated by traffic on unsealed roads, agricultural activities and isolated mining and quarrying activities.

5.9.2. Noise

The noise environment on Yorke Peninsula is typical of a predominantly rural setting. Background noise levels are generally dominated by natural sources such as wind and waves (in coastal areas) with some contribution from incidental traffic and intermittent or periodic agricultural activities (e.g. farm equipment movements or aerial spraying). Traffic noise levels increase near major roads and within townships there is an increase in traffic and residential noise. There are isolated areas which experience industrial noise originating from mining activities or agricultural facilities (e.g. silos) and port operations.

5.10. Socio-economic Environment

PEL 687 is located within the Yorke Peninsula Council local government area (LGA).

Maitland is the largest centre within PEL 687, with a population of 2021 (ABS, 2022). Other population centres include Price, Ardrossan, Port Victoria, Port Vincent, Stansbury, Minlaton, Yorketown, Coobowie, Edithburgh, Warooka, Point Turton and Marion Bay. There are also numerous localities with smaller permanent populations such as Pine Point, Port Julia, Curramulka, Wool Bay, Port Moorowie, Hardwicke Bay, Corny Point, Port Rickaby and Balgowan.

The population of the Yorke Peninsula Council LGA in 2021 was 11,598 comprising 5,695 males and 5,629 females. The population was distributed relatively evenly across the age brackets between 0 and 54 years and 80 years and older, with a higher number of people in the age brackets between 55 and 79 years. The median age was 57 (ABS 2022).

The median weekly household income across the LGA was $960; this compares to a median weekly household income of $1,455 across South Australia (ABS 2022).

The main industry of employment in the region is 'Other Grain Growing', with 'Grain-Sheep or Grain-Beef Cattle Farming' employing the second highest number of workers (ABS 2022). The high proportion of employment within the agriculture industry reflects the economic importance of agricultural production within the region.

5.11. Aboriginal cultural heritage

PEL 687 is located on the traditional lands of the Narungga people. Archaeological evidence of their ties to the land and water is recorded on the Register of Sites and Objects (administered by Aboriginal Affairs and Reconciliation (AAR)). A search of the Central Archive has indicated that there are entries for Aboriginal heritage within PEL 687 on Yorke Peninsula which include archaeological and cultural sites, stone quarries, arrangements, historic sites and scarred tree and burial sites.

Given the historical and current land uses across Yorke Peninsula, it is anticipated that significant ground disturbance has previously occurred, however it is acknowledged that cultural heritage (tangible and/or intangible) may still exist and for this reason strategies will be adopted to ensure compliance with the *Aboriginal Heritage Act 1988.* Gold Hydrogen's approach to its responsibilities under the Act to avoid damaging, disturbing or interfering with Aboriginal sites, objects and remains are set out in Section 6.8.

5.12. Non-Aboriginal heritage

European settlers moved onto the Yorke Peninsula from around 1840. The region has a rich heritage related to its maritime, agriculture and mining history which is reflected in the nature of the heritage places that are protected under State heritage legislation.

A search of heritage places using the South Australian Heritage Places Database[24] (DEW 2022b) identified 14 State Heritage Places and no local heritage places listed in the database within PEL 687. These are listed in Table 5-9.

Table 5-9: SA Heritage Places Database sites within PEL 687

Name	Location	State Heritage Place Number
Corny Point Lighthouse	Corny Point	10110
Corra Lynn Cave (designated place of palaeontological and speleological significance)	Curramulka	22798
Dowlingville Post Office	Dowlingville	17071
Clan Ranald Graves, Edithburgh Cemetery	Edithburgh	16675
Dry Stone Walling	Honiton-Edithburgh Road	16676
Lake Fowler Salt Works Site	Lake Fowler Road	16677
Minlaton Showground Pavilion/Grandstand	Minlaton	10186
Former Grain Shed and associated Enclosed Yard with Stone Wall	Pine Point	16682
Former Point Pearce Aboriginal Mission	Point Pearce	12723
Port Julia Jetty and Cargo Shed	Port Julia	16681
The Grainstore Galleries	Port Vincent	12536
Lime Kiln (designated place of archaeological significance)	Stansbury-Yorketown Road	16680
Orrie Cowie Homestead (main house and overseer's cottage)	Warooka	14515
Wool Bay Lime Kiln & Jetty	Wool Bay	10112

There are no World, Commonwealth or National heritage listed places within PEL 687 (DCCEEW 2022a). The closest listed place on the National Heritage List is the Australian Cornish Mining Sites: Moonta, located approximately 21 km north of PEL 687 (NatureMaps 2022). Two geological monuments[25] are located within PEL 687 (NatureMaps 2022): Horse Gully and Port Victoria.

[24] The South Australian Heritage Places Database provides a listing of State Heritage Places from the South Australian Heritage Register, and Local heritage places and contributory items from South Australian Development Plans

[25] Geological monuments are declared by the Geological Society of Australia. They represent rare, unique or representative occurrences of geological interest that are considered by the earth science community to be worthy of conservation for reference, research and training.

6. Environmental Impact Assessment

6.1. Overview

This section discusses potential environmental impacts related to exploration well drilling and testing for natural hydrogen in PEL 687 on Yorke Peninsula.

The discussion is supported by an environmental risk assessment. The risk assessment is presented in Table 6-4 (in Section 6.10), which outlines the key hazards, management measures and resulting level of risk.

The discussion in Sections 6.2 to 6.9 summarises the key risks and management measures that would be implemented, with the detail provided in Table 6-4.

Reference is made to the results of the risk assessment where relevant throughout the discussion.

6.1.1. Risk assessment process

Environmental risk is a measure of the likelihood and consequences of environmental harm occurring from an activity. The risk assessment process involves:

- identifying the potential hazards or threats posed by the activity
- categorising the potential consequences and their likelihood of occurring; and
- using a risk matrix to characterise the level of risk.

The objective of the risk assessment process is to separate the minor acceptable risks from the major risks and to provide data to assist in the evaluation and management of risks.

The risk assessment was carried out by JBS&G and Gold Hydrogen personnel, based on knowledge of the existing environment, and experience with similar operations in other areas of South Australia, Australia and overseas.

The risk assessment process was based on procedures outlined in Australian and New Zealand Standard AS/NZS ISO 31000:2018 (Risk Management) and HB 203:2012 (Managing environment-related risk).

The risk assessment captures proposed risk controls and assign a consequence and likelihood rating to the residual risk. Consequence and likelihood categories and the risk matrix adopted for use in this document are consistent with those used previously for assessment of similar projects in South Australia, and are described below.

The risk assessment process is also iterative. ‘Low’ risks were generally accepted, and ‘medium’ and ‘high’ risks were reviewed to determine if each risk was as low as reasonably practicable. Where necessary, management practices were reviewed to identify additional management options to lower risk and/or improve environmental outcomes (e.g. elimination, substitution, reduction, engineering controls and management controls). The risk was then re-assessed based on these additional management options. This EIR details the final or residual risk after management options have been applied.

Definition of consequences

To describe the severity, scale and duration of potential impacts, the five categories of consequence listed in Table 6-1 are used.

Table 6-1: Consequence definition

Category	Natural environment	Socio-economic environment
Negligible	Possible incidental impacts to flora & fauna in a locally affected land system but no ecological consequence. Possible incidental impacts to aquifers associated with the target formation(s) without ecological consequence.	Community is aware of operations and concerns have been addressed.
Minor	Changes to the abundance or biomass of flora & fauna, and existing soil and/or water quality in the affected land system, but no changes to biodiversity or ecological function. Aquifers have a small amount of exposure from other sources of fluids, negligible volume movement in or out of formations or aquifers. No measurable change to aquifer water quality or pressure in local area.	Temporary disturbance to the community.
Moderate	Changes to the abundance or biomass of flora & fauna, and existing soil and/or water quality in the affected land system, with local changes to biodiversity but no loss of ecological function. Detectable change to aquifer water quality and pressure in the local area.	Longer term disturbance able to be managed with communication to affected community.
Major	Substantial changes to the abundance or biomass of flora & fauna, existing soil and/or water quality in the affected land system with significant change to biodiversity and change of ecological function. Eventual recovery of ecosystem possible, but not necessarily to the same pre-incident conditions. Substantial changes to aquifer water quality and pressure in the local area.	Significant effect which can be mitigated by extensive rehabilitation and negotiation with community.
Critical	Irreversible and irrecoverable changes to abundance/biomass or aquifers in the affected area. Loss of biodiversity on a regional scale. Loss of ecological functioning with little prospect of recovery to pre-incident conditions. Widespread effect of reduction in aquifer pressure (i.e. reduced flow from bores in locations remote from operations). Contamination of aquifers remote from operations.	Significant and long lasting negative economic and social effects.

Definition of likelihood

The likelihood of potential environmental consequences occurring is defined using the five categories shown in the following table. The likelihood refers to the probability of the particular consequences eventuating, rather than the probability of the hazard or event itself occurring.

Table 6-2: Likelihood definition

Likelihood	Description
Almost Certain	Is expected to occur in most circumstances
Likely	Would probably occur in most circumstances
Possible	Possible that it might occur at some time
Unlikely	Unlikely, but could occur at some time
Remote	May only occur in very exceptional circumstances

Characterisation of risk

The risk associated with each hazard was characterised as low, medium or high, using the matrix below.

Table 6-3: Environmental risk matrix

Risk matrix		Consequence				
		Negligible	**Minor**	**Moderate**	**Major**	**Critical**
Likelihood	**Almost certain**	M	M	H	H	H
	Likely	M	M	H	H	H
	Possible	L	M	M	H	H
	Unlikely	L	L	M	M	H
	Remote	L	L	L	M	M

6.2. Soil and Shallow Groundwater

Potential impacts to soil and shallow groundwater arise mainly from the following risk events / hazards:

- Earthworks for well site, access track, laydown and camp site construction and rehabilitation (e.g. erosion, inversion, compaction)
- Spills or leaks associated with storage and handling of fuel, oil and chemicals, drilling procedures and well testing
- Well control incidents or loss of well integrity
- Storage, handling and disposal of waste.

6.2.1. Earthworks for construction and rehabilitation

Earthworks and site construction activities have the potential for localised impacts to soil through inversion, compaction or increased erosion.

In order to minimise surface impacts and facilitate rehabilitation, landowners would be consulted regarding the earthworks required, the location of the well site, access track, laydown and camp site and other relevant issues. The preferred location of the well site is determined by the sub-surface targets, however it can generally be moved within allowable tolerances to minimise surface disturbance.

Topsoil is removed from areas of the well pad to be paved or excavated and stockpiled for use in rehabilitation. The area for the rig is paved with gravel imported from a licensed quarry. Paving materials are usually removed during rehabilitation (unless the landowner requests that they are retained) and stockpiled topsoil re-spread over the site.

Disturbance to soil from site construction activities is relatively localised and restricted to a defined and agreed area. Rehabilitation would be undertaken in consultation with the landowner, with measures such as ripping of compacted soils, replacement of topsoil that has been removed, restoration of soil profiles and contours and reseeding implemented to ensure rehabilitation success.

The level of risk has been assessed as low (refer Table 6-4).

6.2.2. Spills or leaks

Fuel, oil and chemicals

Improper storage and handling of fuel, oil and chemicals has the potential to result in localised contamination of soil and shallow groundwater. In order to minimise this risk, fuel, oil and chemicals on site are stored and handled in accordance with relevant standards and guidelines (e.g. AS 1940, EPA guideline 080/16 Bunding and Spill Management and the Australian Dangerous Goods Code). Fuel, oil and chemicals would be stored in their product containers with appropriate secondary containment (e.g. lined, bunded areas or on self-bunded pallets). Storage and handling of fuel and chemicals is restricted to designated areas on the well pad.

Any spills would be immediately cleaned up and any contaminated material removed off-site for appropriate treatment or disposal to a licensed facility. If larger scale spills occur that cannot be immediately contained and cleaned up they would be assessed consistent with the requirements of the National Environmental Protection Measure (NEPM) and, where required, remediated in accordance with relevant guidelines (e.g. EPA guidelines).

Sumps

Drilling sumps (if used rather than tanks) would contain drilling fluids and cuttings and have the potential to result in localised contamination of soil and shallow groundwater. This potential is relatively low given the use of water-based drilling muds and the presence of fine bentonite clays in the mud, which allows the formation of a relatively impervious mud cake in the base of drilling sumps, particularly in areas where shallow groundwater is not close to the surface. As a precautionary measure, sumps would be lined with an impermeable liner of a suitable material compatible with the fluids it would be exposed to.

Drilling muds would be water-based, and non-toxic to low toxicity additives would be used. The design of the layout and equipment for drilling waste management for wells would be based on industry standards and utilise information derived from historical drilling campaigns. The layout of a typical well site is provided in Figure 4-1 and typical sump details are discussed in Section 4.2.1, with further information on mud handling described in Section 4.3.1. Details of sizes and volumes and materials would be confirmed as part of the well / project specific design phase and submitted to DEM as part of the relevant activity notification.

After drilling, excess water from the sump or tanks would not be reused on land unless it has landowner agreement and water quality meets applicable criteria (e.g. *Environment Protection (Water Quality) Policy 2015* and ANZECC/ARMCANZ 2000 and ANZG 2018 criteria) and any relevant approvals (e.g. DEM / EPA) have been obtained, as discussed in Section 4.9.

Well testing

Spills or leaks during well testing activities could also result in localised contamination of soil or shallow groundwater (depending on the quality of any water produced from the well). Well testing would be carried out on the paved well pad in accordance with industry standards. Tanks for production testing would be located in lined, bunded areas. All tanks and piping would be inspected and tested for leaks prior to use.

A separator tank is expected to be used to separate any produced liquids from gas before gas is sent to a vent or flare. If water is produced during well testing, it would be in relatively small quantities which would be directed to the sealed tank and removed off site for appropriate disposal at a licensed facility (unless it is reused with appropriate approvals in place as discussed in Section 4.5). Well testing activities (including fluid levels in tanks) would be continually monitored to avoid overfilling. As discussed in Section 4.4, the engineering design of a well testing program would give particular consideration to the interface with hydrogen gas, to ensure that appropriate equipment and materials are utilised to safely conduct the test.

In addition to the management measures outlined above, groundwater monitoring wells may be installed on a site-specific basis (e.g. if an exploration well is located in an area where a significant shallow groundwater resource has been identified).

The level of risk from spills or leaks has been assessed as medium (refer Table 6-4). It is noted that the level of risk would be low in areas where groundwater is at depth (e.g. 5-10 m or more), such as in areas east and north of Minlaton, or where groundwater has elevated salinity.

6.2.3. Well control and well integrity

Well control and well integrity risks are managed by a range of measures that are discussed in Section 6.4.

The level of risk has been assessed as medium (refer Table 6-4).

6.2.4. Waste management

Inappropriately managed waste has the potential to result in localised disturbance or contamination of soil and shallow groundwater. Storage of waste and transport to licensed disposal or recycling facilities would be undertaken in accordance with relevant legislation and guidelines. Waste generation would be minimised where practicable, waste would be stored securely and licensed waste contractors would be used for waste transport.

If a camp is used, septic tanks would be used to contain all wastewater (black water and grey water) which would be pumped out by licensed contractors as required for disposal at a licensed facility, consistent with the requirements of the *Environment Protection (Water Quality) Policy 2015*.

The level of risk has been assessed as low (refer Table 6-4).

6.3. Surface Water

Potential impacts to surface water arise mainly from the following risk events/ hazards:

- Earthworks for well site, access track, laydown and camp site construction and rehabilitation (e.g. disturbance to natural drainage patterns, increased erosion / sedimentation)
- Spills or leaks associated with storage and handling of fuel, oil and chemicals, drilling and workover operations and well testing
- Well control incidents or loss of well integrity
- Storage, handling and disposal of waste.

6.3.1. Earthworks for construction and rehabilitation

Earthworks for the well site, access track, laydown and campsites have the potential to alter natural drainage patterns or result in increased sedimentation of surface water features. This can potentially affect native vegetation and fauna as discussed in Section 6.5.

Well sites, access tracks, laydowns and campsites would be located and constructed to avoid significantly impacting surface drainage patterns or surface water features. If necessary, temporary culverts would be installed to ensure surface drainage is maintained. 'Water affecting activities' (as defined by the Landscape SA Act and the Water Affecting Activities Control Policy (N&YLB 2020)) would not be undertaken unless relevant permits have been obtained. Sites would be rehabilitated to restore natural surface profiles and original drainage patterns.

The soil types, general lack of defined drainage and gently sloping topography result in a relatively low risk of erosion or sedimentation. Sediment and erosion control structures such as sediment fences are often not necessary, but would be installed where required (e.g. if in close proximity to surface water features). Any requirements for sediment and erosion control measures are specified in site specific documentation prepared at the activity notification stage.

The level of risk has been assessed as low (refer Table 6-4).

6.3.2. Spills or leaks

The principal risk to surface water results from the potential movement off-site of material from spills or leaks. The measures discussed above in Section 6.2.2 would be implemented to ensure safe storage and handling of fuel and chemicals and appropriate management of well testing. Spill containment and clean-up equipment would be present on site and any spills immediately cleaned up.

Runoff from bunded fuel or chemical storage areas would be contained and would not be allowed to drain off-site. The risk of flooding is considered in the location and construction of well pads, and if required, additional measures such an appropriately sized berm around the sump (if a sump is used) to prevent runoff entering the sump would be implemented.

The level of risk has been assessed as medium (refer Table 6-4). This assumes that surface water features may be present; the level of risk would be low in some areas due to the lack of defined drainage and surface water features.

6.3.3. Well control and well integrity

Well control and well integrity risks are managed by a range of measures that are discussed in Section 6.4.

The level of risk has been assessed as medium (refer Table 6-4). This assumes that surface water features may be present; the level of risk would be low in some areas due to the lack of defined drainage and surface water features.

6.3.4. Waste management

Measures to ensure secure storage and handling of waste would be implemented as outlined in Section 6.2.4.

The level of risk has been assessed as low (refer Table 6-4).

6.4. Groundwater

Potential impacts to shallow groundwater also arise from surface activities including fuel and chemical storage and handling and waste management and are discussed in Section 6.2.

Potential impacts to groundwater in deeper aquifers arise mainly from the following risk events/ hazards:

- Drilling through aquifers
- Well control incidents
- Loss of well integrity (e.g. casing or cement failure)
- Other downhole issues.

6.4.1. Drilling through aquifers

There is a low risk of drilling fluids in the down-hole environment causing localised salinisation or contamination of groundwater near the well bore.

Drilling muds would be water-based, and non-toxic to low toxicity additives would be used. Any impact of near-well bore invasion by mud filtrate would be minimal, as mud properties allow for the build-up of filter cake on the borehole wall, which creates a barrier and minimises the potential for the loss of fluids to permeable formations. Groundwater in the region is also predominantly brackish or saline (with some exceptions in the south-west).

Following drilling of the top hole, surface casing is installed and cemented into place, which isolates shallow aquifers from drilling fluids used to drill the deeper sections of the hole. The deeper aquifers in the region are generally higher in salinity and have not been identified as a groundwater resource (se Section 5.5.5).

The level of risk has been assessed as low (refer Table 6-4).

6.4.2. Well control incidents

A well control incident or blowout during drilling could result in a loss of containment of drilling fluids, possible crossflow between aquifers or loss of aquifer pressure and possibly an explosion or fire (if hydrogen is present). There are considerable safety measures to avoid a blowout and they are extremely rare. All drilling and completion operations would be carried out in accordance with regulatory requirements and approved well construction standards. The drilling rig would be equipped with fully functional and regularly tested blowout preventers. Guidelines, procedures, safety practices, design considerations, certification of equipment trained individuals and an emergency response plan would be in place. As discussed in Section 4.3.1, equipment used would be selected to ensure safe operations, with particular consideration given to the interface with hydrogen gas. This would include drill pipe, casing pipe, cement, the wellhead tree and surface materials that would interface with liquids and gases that may flow to surface.

The level of risk has been assessed as medium (refer Table 6-4).

6.4.3. Well integrity

A loss of well integrity (through failure of the cement or casing in the well) could result in crossflow between aquifers, contamination of aquifers, reduction of pressure in aquifers and possibly the release of groundwater or hydrogen and other gases (if present) to the surface. The risk is restricted to as low as possible in the well design and construction process and managed through monitoring, during both drilling and the throughout the well's life.

Measures undertaken to ensure well integrity include:

- Comprehensive review of all available information is undertaken to identify all foreseeable well integrity risks that may arises during operations

- Well design and construction provides the mechanical integrity that reduces the risk to well integrity to as low as reasonably practicable
- Isolation of aquifers behind multiple casing strings that are cemented in place
- Surface casing is cemented to the surface with visible return in accordance with an engineered cementing program
- Specialist technical engineers design the cementing program for a well in accordance with international standards
- Cement bond logs or ultrasonic logs are run to confirm the integrity of cement that fills the space between the casing and the well bore and prevents migration
- Undertaking of remedial action or an integrity management plan where there is evidence of insufficient isolation
- Accessible well integrity barriers in wells that are suspended or being tested undergo monitoring and verification processes (including the well and wellhead).

As discussed in Sections 4.3.1 and 4.4, the drilling operation and the design of the well and well test would give particular consideration to the interface with hydrogen gas, to ensure that appropriate equipment and materials are utilised to safely conduct the operations. Specialist metallurgical advice would be sought to ensure that equipment and materials would not be at risk of failure due to being in a hydrogen environment[26].

During well decommissioning, cement plugs are installed in the well to isolate all aquifers and prevent cross flow, contamination or pressure reduction.

The level of risk has been assessed as medium (refer Table 6-4).

6.4.4. Other downhole issues

Other hazards associated with down hole operations predominantly include issues that can affect drilling progress but generally have very limited environmental consequences, such as lost circulation, sloughing shales, stuck pipe or drill pipe failure.

The level of risk has been assessed as low (refer Table 6-4).

6.4.5. Loss of radioactive source down hole

A loss of a radioactive source down hole can also potentially occur when the well is open hole logged after drilling. Some logging tools emit radiation into the formation and a receiver picks up the signal which is interpreted to relate the characteristics of the formation. The use of downhole radioactive sources would be risk assessed on a case-by-case basis. If the tool is lost down hole, all reasonable attempts would be made to retrieve any downhole sources. However, if it is not possible to retrieve the tool it is cemented in the hole to isolate it from adjacent formations with relevant government approval (e.g. DEM and EPA) obtained.

[26] Some metals or steels may be affected by hydrogen through a condition known as hydrogen embrittlement, which is a reduction in the ductility of a metal due to absorbed hydrogen. Hydrogen can be absorbed as a result of the manufacturing process or extended exposure to hydrogen under certain conditions. In extreme cases it can result in fracture or failure. It can be managed by steps such as reducing hydrogen exposure, selecting appropriate materials (e.g. different alloys of steel or lower yield strength steel) and reduction of residual and applied stress.

The level of risk has been assessed as low (refer Table 6-4).

6.5. Native Vegetation and Fauna

Potential impacts to native vegetation and fauna arise mainly from the following risk events/ hazards:

- Well site, access track, laydown and camp site construction and rehabilitation
- Disturbance from site activities (e.g. light, noise, presence of the drill rig, camp and personnel)
- Use of roads and movement of heavy vehicles and machinery
- Access to contaminants (e.g. from well control incidents, the drilling sump (if used) or spills and leaks) and waste
- Fire.

6.5.1. Well site, access track, laydown and camp site construction

Earthworks and clearing activities have the potential to damage native vegetation and wildlife habitats and disturb or injure fauna. On Yorke Peninsula, a large proportion of the native vegetation has been cleared or heavily modified for agriculture. Consequently, the clearance of native vegetation and wildlife habitats for well sites, access tracks, laydowns and camp sites can generally be avoided by locating well sites and access tracks in previously cleared or disturbed areas.

Well sites are subject to environmental assessment in the planning process to ensure that any issues such as native vegetation, presence of rare or threatened species or risk of introduction of weeds are identified and appropriate avoidance or mitigation strategies are developed. High quality native vegetation and significant wetland areas would be avoided[27]. Native Vegetation Heritage Agreement areas (established under the Native Vegetation Act) would also be avoided. Low quality native vegetation would also be avoided unless there are no viable alternatives (e.g. use of adjacent cleared areas). The presence of threatened species at well locations is generally unlikely given that database records (and suitable habitat) are generally restricted to the coastline and patches of remnant vegetation. As discussed in Section 6.3, activities would also be carried out to ensure surface drainage patterns and water quality are maintained, which would avoid potential indirect impacts on native vegetation, fauna and particularly wetland communities.

The level of risk has been assessed as low (refer Table 6-4).

6.5.2. Disturbance from site activities

Potential disturbance to native fauna from site activities (e.g. light, noise, presence of the drill rig, camp and personnel) is short term, localised and generally of limited significance given the existing land uses and extent of vegetation clearance and habitat modification in the region. The environmental assessment undertaken during the planning process would identify whether there are specific issues at an individual well site and develop measures to avoid or mitigate potential impacts where required. Relevant agencies (e.g. DEW, DCCEEW) would be consulted where required.

The presence of excavations on site (e.g. the drilling sump if used) also has the potential for localised impacts to native fauna. The presence of site personnel and the fencing of the drilling sump following drilling would generally preclude impacts to larger species. Well sites are likely to be located in areas

[27] Site-specific assessment by an appropriately qualified specialist would be used to determine whether vegetation meets these parameters

where there is limited habitat value for smaller species and their presence on the well pad is unlikely, however excavations would be regularly checked for trapped fauna to minimise potential impacts.

The level of risk has been assessed as low (refer Table 6-4).

6.5.3. Use of roads and movement of heavy vehicles and machinery

The movement of vehicles and machinery along existing roads and the access track has the potential to impact native fauna, principally through collisions. This is likely to be relatively insignificant due to the level of existing traffic, the short-term nature of the activities and the limited extent of significant fauna habitats. Transport procedures (e.g. speed restrictions, limitation of movements at night) would also reduce the potential level of impact.

The level of risk has been assessed as low (refer Table 6-4).

6.5.4. Access to contaminants and waste

The potential for native fauna to access contaminants and waste is limited. The well site and sump (if used) would be fenced and any contaminants from spills or leaks are likely to be confined to the area of the well pad, and would be immediately cleaned up. Waste would be stored in covered bins before being transported off-site for disposal.

The level of risk has been assessed as low (refer Table 6-4).

6.5.5. Fire

Fire initiated by site activities (e.g. flaring, sparks from vehicles or equipment, cigarette butts) has the potential to impact large areas of vegetation. Measures would be in place to prevent fires including firebreaks, restriction of vehicles to tracks and cleared areas, maintenance of suitable fire-fighting equipment on site and liaison with the CFS.

Any well tests carried out would be designed and managed to ensure that hydrogen gas is safely managed (e.g. combusted or dispersed) so that it does not pose a fire or explosion risk.

The level of risk has been assessed as low (refer Table 6-4).

6.6. Land Use

Potential impacts to land use arise mainly from the following risk events/ hazards:

- Well site, access track, laydown and camp site construction and rehabilitation
- Disturbance from site activities (e.g. light, noise, presence of the drill rig, camp and personnel)
- Access to contaminants by stock (e.g. from well control incidents, the drilling sump (if used), spills or leaks, waste)
- Fire.

Other potential impacts to landowners are discussed under Amenity in Section 6.7 below.

6.6.1. Disturbance from construction, use and rehabilitation of well site, access track, laydown and camp site

Construction, use and rehabilitation of the well site, access track, laydown and camp site have the potential to affect land use through disturbance to soil, groundwater and surface water within the footprint of the activity (as discussed in Sections 6.2.1 and 6.3.1). The measures discussed in these previous sections would be implemented to ensure that these impacts are minimised and appropriate rehabilitation is undertaken.

Poor planning and execution of construction and rehabilitation activities also has the potential to impact land use beyond the activities' direct footprint, for example if well sites and access tracks are not sited to minimise the disruption to overall property access and management. Landowners would be consulted regarding the location, management and timing of proposed activities, with the aim of minimising disturbance. Ongoing liaison with landowners is carried out following drilling (and throughout the well's life if it is successful).

Appropriate access tracks to drill sites are chosen in consultation with landowners and any deterioration of property tracks or infrastructure as a result of drilling-related traffic is rectified.

The introduction of weeds or pathogens by vehicles and equipment (particularly earthmoving equipment) is a potentially significant impact to land use. A range of measures would be undertaken to manage the potential for the introduction or spread of weeds or pathogens, including:

- consultation with landowners (and Landscape Board officers where appropriate) to identify any potential issues or specific management requirements
- ensuring that vehicles and equipment arriving at the site are clean and free of soil and plant material
- assessment of vehicles and equipment entering the region or moving between sites (especially from weed or pathogen infested areas into non-infested areas) for the risk of transporting weeds and pathogens and cleaning them down where appropriate
- using local earthworks contractors where possible rather than bringing in equipment from outside the region
- sourcing of paving materials from licensed quarries that are free of weeds
- monitoring sites and access tracks for new weed infestations, with treatment undertaken as necessary in accordance with requirements of the landowner, and if appropriate the Landscape Board.

Under the PGE Act, landowners have rights to compensation. Compensation is payable where there is:

- deprivation or impairment of the use and enjoyment of the land
- damage to the land (not including damage that has or will be made good by the licensee)
- damage to, or disturbance of, any business or other activity lawfully conducted on the land
- consequential loss.

Compensation agreements are agreed and put into place before any activities are undertaken.

The level of risk has been assessed as low (refer Table 6-4).

6.6.2. Disturbance from site activities (e.g. light, noise, presence of the drill rig, camp and personnel)

Drilling activities and transport moves have the potential to disturb and possibly injure stock. Any disturbance from drilling activities would be short term and localised. Consultation with landowners is undertaken to ensure that the location, management and timing of activities minimise the potential for impact, including disruption of farm operations (e.g. sowing, harvesting, lambing).

Measures would be in place to minimise impacts include speed limits, fencing of access tracks if required, positioning lighting to minimise light emanating from the site during drilling operations, avoidance of night transport moves as far as possible, and prompt removal of drill rigs and camps from site following the completion of operations.

The level of risk has been assessed as low (refer Table 6-4).

6.6.3. Access to contaminants by stock (e.g. from well control incidents, drilling sump, spills or leaks, waste)

The potential for stock to access contaminants and waste is limited. The well site and sump (if used) would be fenced, as discussed previously, and any contaminants from spills or leaks are likely to be confined to the area of the well pad and would be immediately cleaned up. Waste would be stored in covered bins before being transported off-site for disposal.

The level of risk has been assessed as low (refer Table 6-4).

6.6.4. Fire

Fire initiated by site activities (e.g. flaring, sparks from vehicles or equipment, cigarette butts) has the potential to significantly impact land use (e.g. via damage to pasture, crops and infrastructure). Measures discussed in Section 6.5.5 above would be in place to prevent fires including firebreaks, restriction of vehicles to tracks and cleared areas, maintenance of suitable fire-fighting equipment on site and liaison with the CFS.

The level of risk has been assessed as low (refer Table 6-4).

6.7. Landowner and Community Amenity

Potential impacts to amenity arise mainly from the following risk events/ hazards:

- Disturbance from site activities (e.g. light, noise, presence of the drill rig, camp and personnel)
- Generation of dust and air emissions
- Use of roads and movement of vehicles and heavy machinery
- Use of vibroseis or other energy source for vertical seismic profiling
- Unauthorised site access
- Fire.

6.7.1. Disturbance from site activities (e.g. light, noise, presence of the drill rig, camp and personnel)

Disturbance from site activities (e.g. light, noise, presence of the drill rig, camp and personnel) can result in short term impact to the landowner and nearby residents. A range of measures would be implemented to manage these potential impacts.

Landowners and other stakeholders (e.g. the local council) would be consulted regarding the proposed activities, with the aim of identifying potential issues and minimising disturbance through site selection and planning of activities. Well site and access track construction would be restricted to daylight hours.

Noise limitation during drilling (particularly at night) would be included as part of induction procedures (e.g. noisy tubular / pipe handling, unnecessary use of horns, reversing of forklifts). Well sites would not be located in close proximity to towns or sensitive receptors. Adequate buffer distances would be maintained between the well site and residences to minimise potential impacts. Site-specific assessment of potential noise impacts would be undertaken as appropriate during design and planning stages. Systems would be in place for logging stakeholder complaints to ensure that issues are addressed as appropriate.

Lighting would be positioned to minimise light emanating from the site during drilling operations. Any flaring during well testing would be kept to the minimum length of time necessary. Drill rigs and camps would be promptly removed from site following the completion of operations, particularly in visible locations.

The level of risk has been assessed as low (refer Table 6-4).

6.7.2. Generation of dust and air emissions

Drilling operations do not generate dust however site construction and use of unsealed roads and tracks can result in dust generation and temporary and localised impacts to air quality. Dust generation would be minimised by restriction of speeds on unsealed roads and tracks and spraying of unsealed roads and tracks with water to moderate the potential for dust generation where required.

Emissions from fuel burning equipment have the potential to cause localised impacts to air quality and contribute to greenhouse gas emissions.

Equipment would be operated and maintained appropriately in order to minimise emissions. Greenhouse gas emissions would be recorded and reported on in accordance with National Greenhouse and Energy Reporting Act requirements where required.

The level of risk has been assessed as low (refer Table 6-4).

6.7.3. Use of roads and movement of vehicles and heavy machinery

The use of roads for drilling operations has the potential to increase noise disturbance to the community and can result in an increased road hazard to local road users. Use of roads and tracks for drilling operations, particularly unsealed roads or farm tracks can also cause damage or degradation.

Impacts of road use are generally short term, with peak traffic movements occurring during rig moves. Landowners, local councils, potentially affected residents and police would be informed of significant activities such as rig mobilisation and demobilisation. Rig movements would detour around town centres where possible. Warning signs and traffic management measures would be installed where appropriate near well sites. All necessary permits would be obtained for trucks transporting drilling and other equipment. Transport moves would be restricted to daylight hours as far as possible.

Any deterioration of property tracks or infrastructure as a result of drilling-related traffic would be rectified.

The level of risk has been assessed as medium (refer Table 6-4).

6.7.4. Use of vibroseis or other energy source for vertical seismic profiling

Generation of vibration associated with use of vibrator trucks (or other energy sources) for vertical seismic profiling would have very localised and minor effects. The locations where they are used (near the well) would not be in close proximity to residences or other built infrastructure. The vibroseis system used on vibrator trucks produces a low energy density, which allows it to be used in cities and other built-up areas. It has been used in sensitive locations without damaging buildings or the environment (APPEA, 2019).

If an air gun or small explosive charge is used, it would typically be deployed in a pit several metres deep located on the well pad. Storage, handling and disposal of explosive charges would be undertaken in accordance with relevant industry codes, standards and guidelines (e.g. Australian Dangerous Goods Code) and the requirements of the South Australian Explosives Act. Explosive charges would only be handled and utilised by appropriately trained and licensed personnel (i.e. holders of a SafeWork SA Blaster's Licence). Explosive charges are required to be stored in an approved receptacle, store or magazine. Magazines typically take the form of a transportable shipping container type structure. A licence to store explosives and a magazine licence may also be required depending on the volume of charges stored at any one time.

Detonation of small explosive charges for seismic survey operations typically results in a minor localised sound (i.e. small thud). Implementation of adequate buffer distances would be maintained to ensure vibrations generated by the proposed activities do not result in significant disturbance to the community and residences or damage to buildings and other infrastructure.

The level of risk has been assessed as low (refer Table 6-4).

6.7.5. Unauthorised site access

Unauthorised or uncontrolled access to the well site, particularly during drilling, could expose members of the public to potential harm. Access to the site will be restricted during operations, the site will be fenced and 'No entry' signage warning of dangers associated with drilling operations will be placed at the entry to the site access track. The access gate to the well site will be closed during testing. Following drilling, the well site will be fenced until rehabilitation is completed. Fencing and signage will be installed to prevent unauthorised access to the well head at any well that is not decommissioned.

The level of risk has been assessed as low (refer Table 6-4).

6.7.6. Fire

Fire initiated by site activities (e.g. flaring, sparks from vehicles or equipment, cigarette butts) has the potential to significantly impact landowners and the community through damage to property or possibly loss of life. Measures discussed in Section 6.5.5 and 6.6.4 above would be implemented to manage fire risk.

The level of risk has been assessed as medium (refer Table 6-4).

6.8. Cultural Heritage

Potential impacts to cultural heritage arise mainly from earthworks during well site, access track, laydown and camp site construction and rehabilitation activities.

Drilling locations are expected to be located in agricultural land. The risk of damage to Aboriginal heritage on agricultural land with a long history of cultivation is typically low.

A search of the Central Archive including the Register of Aboriginal Sites and Objects administered by Aboriginal Affairs and Reconciliation (AAR) would be undertaken to identify whether there are entries for Aboriginal sites at or near the drilling location. Any identified sites or areas of cultural heritage significance would be avoided.

Consultation would be carried out with the Narungga Nation Aboriginal Corporation regarding the risk of damage to Aboriginal heritage, and a cultural heritage survey would be carried out where required. Any identified sites or areas of cultural heritage significance would be avoided. Protective measures (e.g. flagging or fencing) would be implemented where necessary if any sites are identified in close proximity to the drilling location.

Aboriginal and non-Aboriginal heritage issues would be covered in inductions and procedures would be in place to respond in the event that any sites, objects and remains are discovered during activities.

If Aboriginal sites, objects and remains are discovered during activities, works would halt in the vicinity of the discovery and advice would be sought from the Narungga Nation Aboriginal Corporation, a qualified heritage consultant or AAR. Mitigation measures would be implemented to ensure the discovery is avoided[28]. Any discovery would be reported as required under the Aboriginal Heritage Act[29].

Heritage registers (and the Heritage Branch, DEW, where appropriate) would be consulted regarding the location of non-Aboriginal heritage sites and any identified sites would be avoided.

The level of risk has been assessed as low (refer Table 6-4).

6.9. Local and Regional Economy

Many of the environmental risks discussed above have potential for negative economic impact on landowners and other stakeholders. However, the implementation of the measures discussed above would minimise both the environmental risk and the economic risk.

The proposed exploration drilling activities are relatively short term and small scale and with the measures outlined in this EIR in place, they are not expected to have any adverse impact on the local or regional economy.

The proposed exploration activities have the potential to result in some economic benefit, including

- Potential for utilisation of local food, fuel and accommodation services which has direct benefit to business owners and benefits the regional economy.
- Potential for engagement of local contractors for activities such as earthworks and fencing.

The proposed activities also provide a benefit to the State in the increased understanding of the geological zones under the ground. Data collected during drilling and testing must be submitted to DEM and eventually becomes open file.

If exploration for natural hydrogen is successful, there are a number of potential economic benefits for the community and the State:

- Natural hydrogen could provide a low-cost, clean energy source and play a key role in the transition to a decarbonised economy.
- There would be potential for natural hydrogen to be used locally, benefiting the local community.

[28] If the works cannot be relocated to avoid the Aboriginal site, object or remains, authorisation would be required pursuant to s23 of the Aboriginal Heritage Act.

[29] SA Police must be notified if skeletal remains are discovered.

- Production of natural hydrogen on a commercial basis would result in royalties to be paid, which benefits the State.
- Economic activity associated with successful natural hydrogen production also has the potential to directly benefit business owners and the regional economy.

6.10. Environmental Risk Assessment Summary

As discussed in Section 6.1, Gold Hydrogen has undertaken an environmental risk assessment of drilling and well testing on Yorke Peninsula. This section summarises the process and results of the assessment.

Table 6-4: Environmental risk assessment for drilling and well testing in PEL 687 Yorke Peninsula

Risk Event / Hazard	Potential Environmental Impacts	Key Management Measures / Comments	Consequence	Likelihood	Residual Risk
Well site, access track, laydown and camp site construction and rehabilitation	Impacts to soil (e.g. increased erosion, inversion, compaction) Visual impact	• Landowner to be consulted about earthworks required, location of access tracks and general information to minimise surface damage and to facilitate rehabilitation. • Locate and orientate well pad and access to minimise soil removal and area of cut and fill. • Soil removed in construction to be stored on site and returned to its original stratigraphic level upon restoration of the drill site. Separate storage of topsoil, subsoil and clays will be undertaken to assist in regeneration of pasture or crops. • Well sites are rehabilitated following drilling or the well pad area reduced to the minimum size necessary well testing is likely to extend over a longer period. • Restoration of the well site to be approved by the landowner or in accordance with landowner's wishes should retention of specific parts of the site be requested (e.g. pad or access track). • During rehabilitation the soil beneath the tracks, laydown, camp and pad will be ripped (after removal of any imported fill) and before the returning of any stockpiled topsoil. • Soil profile and contours will be reinstated following completion of operations.	Minor	Unlikely	Low
	Disturbance to natural drainage patterns Sedimentation of surface waters	• Well sites, access tracks, laydowns and camp sites are located to avoid surface water features such as saline lakes or significant wetland areas and to maintain pre-existing water flows. • Temporary drainage depressions / culverts installed where required to maintain surface runoff. • Sediment and erosion control measures (e.g. sediment fences) installed where necessary (e.g. if in close proximity to surface water features). • 'Water affecting activities' (as defined by the Landscape SA Act and the Water Affecting Activities Control Policy) would not be undertaken unless relevant permits have been obtained. • Any area artificially elevated via pad or access track construction will be lowered to original ground level by removal of paving material unless otherwise instructed by the landowner. • Original drainage patterns restored.	Minor	Unlikely	Low
	Introduction and spread of weeds or pathogens	• All reasonable and practical endeavours taken to minimise the risks of introducing weeds, exotic pest fauna and pathogens into the area of the activity. • Appropriate consultation regarding weeds or pathogens carried out with landowners (and Landscape Board officers where appropriate). • Vehicles and equipment arriving at the site must be clean and free of soil and plant material. • Vehicles and equipment entering the region or moving between sites (especially from weed or pathogen infested areas into non-infested areas) will be assessed for the risk of transporting weeds and pathogens and cleaned down where appropriate. • Local earthworks contractors used where possible rather than bringing in equipment from outside the region. • All records of vehicle or equipment inspections and cleaning will be kept for auditing. • Biosecurity procedures implemented as agreed with landowners. • Paving materials will be sourced from licensed quarries that are free of weeds. • Sites and access tracks will be monitored on a regular basis for new weed species / infestations and treated as necessary in accordance with requirements of the landowner, and if appropriate the Landscape Board. • Records of detection, monitoring or eradication of weeds or pathogens introduced by activities are kept and available for review.	Minor	Unlikely	Low
	Damage to native vegetation and wildlife habitats Disturbance to native fauna	• Appropriately trained and experienced personnel have assessed or scouted proposed well site, access track, laydown and camp locations to identify and flag significant (or rare, vulnerable or endangered) species and communities. • Native vegetation clearance avoided or minimised by locating well sites and access tracks appropriately. • Vegetation is trimmed rather than removed where possible • Areas of low-quality native vegetation are avoided unless there are no viable alternatives (e.g. use of adjacent cleared areas). • Areas of high quality or significant[30] remnant vegetation or Heritage Agreement Areas are avoided. • Activities are not carried out in parks or reserves established under the National Parks and Wildlife Act.	Minor	Unlikely	Low

[30] Significant in this context includes listed plant species, listed communities or important fauna habitat

Risk Event / Hazard	Potential Environmental Impacts	Key Management Measures / Comments	Consequence	Likelihood	Residual Risk
		• If well sites are in close proximity to a park or reserve established under the National Parks and Wildlife Act and indirect impacts are likely, consultation is undertaken with DEW to determine appropriate mitigation measures. • Excavations (e.g. sump if used) checked regularly for trapped fauna. • Sumps and well site are appropriately fenced to minimise fauna access. • Fauna mortality (if it occurs) to be captured by incident reporting system with advice from an ecologist if required. • Well sites with native vegetation are rehabilitated in consultation with DEM, DEW and other relevant stakeholders.			
	Damage to infrastructure Disturbance to stock Disturbance to land use Dust generation Noise generation	• Landowner is consulted regarding the location, management and timing of proposed activities. Ongoing landowner liaison during and following operations. • Activities are restricted to agreed / defined areas. • All gates left in the condition in which they were found (open / closed). • Well site and access track construction restricted to daylight hours. • Systems in place for logging stakeholder complaints to ensure that issues are addressed as appropriate. • Compliance with Part 10 of the PGE Act (Notice of Entry requirements). • During well site and access track rehabilitation, imported materials are removed from site and soil profiles and contours restored unless otherwise agreed with the landowner. • If necessary, unsealed roads and tracks are sprayed with water as required to minimise dust generation.	Minor	Unlikely	Low
	Damage to cultural heritage sites	• Activities avoid areas of identified cultural heritage significance • Any sites identified in searches of the Central Archive and the Register of Aboriginal Sites and Objects are avoided. • Consultation carried out with the Narungga Nation Aboriginal Corporation regarding the risk of damage to Aboriginal heritage, and a cultural heritage survey carried out where required. Any identified sites are avoided. • Known sites identified and protected from operations where required (e.g. using temporary flagging if present in the vicinity of operations). • Cultural heritage issues covered in inductions. Key personnel (e.g. supervisors, machinery operators) receive appropriate cultural heritage training. • Procedures consistent with the relevant obligations under the Aboriginal Heritage Act are in place to appropriately report and respond to any sites discovered during activities. • If Aboriginal sites, objects and remains are discovered during activities: ○ works would halt in the vicinity of the discovery ○ advice would be sought from the Narungga Nation Aboriginal Corporation, a qualified heritage consultant or AAR ○ mitigation measures would be implemented to ensure the discovery is avoided. (If the works cannot be relocated to avoid the Aboriginal site, object or remains, authorisation would be obtained under the Aboriginal Heritage Act). • Records of sites forwarded to the Aboriginal Heritage Branch in compliance with the Aboriginal Heritage Act. • Records relating to management/avoidance of any identified sites of cultural heritage significance kept and available for audit. • Heritage site registers (and Heritage Branch, DEW, where appropriate) consulted regarding the location of non-Aboriginal heritage sites and any identified sites are avoided.	Moderate	Remote	Low
Physical presence of drill rig and camp and personnel. **Light emissions (rig lighting, flaring)**	Visual impact Disturbance to native fauna Disturbance to stock Disturbance to land use Disturbance to local community	• Landowners and relevant stakeholders (e.g. local council) consulted regarding location of proposed activities. • Activities are restricted to agreed / defined areas. • High standard of 'housekeeping' is maintained to minimise visual impact. • Drill rigs and camps removed from site promptly following completion of activities, particularly in visible locations. • Decommissioned sites restored to original land surface topography with no irregularities, unless otherwise agreed with the landowner. • Any lighting required is positioned to minimise light emanating from the well site. • Any flaring during well testing kept to minimum length of time necessary. • See *Well site, access track, laydown and camp site construction and rehabilitation* above for detail on: - fauna - well site restoration.	Minor	Unlikely	Low
Air emissions	Reduction in local air quality	• Equipment operated and maintained in accordance with manufacturer specifications.	Minor	Unlikely	Low

Risk Event / Hazard	Potential Environmental Impacts	Key Management Measures / Comments	Consequence	Likelihood	Residual Risk
	Generation of greenhouse gas emissions	• If necessary, unsealed roads and tracks are sprayed with water as required to minimise dust generation. • Note: Greenhouse gas emissions recorded and reported in accordance with NGER requirements where required.			
Noise emissions	Disturbance to native fauna Disturbance to stock Disturbance to local community	• Well sites not located in close proximity to towns or sensitive receptors. • Adequate buffer maintained between well site and residences. • Equipment operated and maintained in accordance with manufacturer specifications. • Transport trucks to be restricted to daylight hours as far as possible. • Heavy truck drivers to be instructed not to use engine brake near dwellings. • Assessments of potential noise impacts undertaken as appropriate during design and planning stages. • Noise limitation (particularly at night) to be included as part of induction procedures (e.g. noisy tubular / pipe handing, unnecessary use of horns, reversing of forklifts). • Systems in place for logging stakeholder complaints to ensure that issues are addressed as appropriate.	Minor	Unlikely	Low
Use of roads; movement of vehicles and heavy machinery	Injury or death of stock or fauna Dust generation Noise generation Damage to third party infrastructure Disturbance lo local community	• Activities are restricted to agreed / defined areas. • Compliance with relevant speed restrictions on access roads and tracks. • If necessary, unsealed roads and tracks are sprayed with water as required to minimise dust generation. • Warning signage and traffic management measures installed where appropriate in the vicinity of well sites. • Driver behaviour and vehicle speed limits to be included in compulsory induction.	Minor	Unlikely	Low
	Road hazard / disturbance to local road users	• Landowners, local councils, potentially affected residents and emergency services will be informed of significant activities such as rig mobilisation and demobilisation. • Any required authorisations (e.g. local council, DIT, police) obtained where required for movement of rig along public roads, including joint inspections of roads before and after transport moves if necessary. • Rig mobilisation and demobilisation to detour around town centres where possible. • Any deterioration of property tracks or infrastructure as a result of drilling-related traffic is rectified.	Major	Unlikely	Medium
Drilling through aquifers	Contamination or salinisation of aquifers	• Wells designed (including the casing and cementing design) to ensure aquifer systems are isolated. • Water-based drilling muds used. • Information on muds and chemicals to be readily available on the rig. • Surface casing installed and cemented back to surface before drilling of deeper hole sections. • Drilling fluid selection provided to DEM as part of the activity notification process. • Non-toxic to low toxicity additives used. • Mud properties allow for build-up of filter cake on the borehole wall, creating a barrier and minimising potential loss of fluids to permeable formations. Volume of mud filtrate is insignificant relative to the volume of the aquifer. • Relevant landowners/stakeholders consulted regarding water bore locations and water use prior to drilling activity. • Any proposed water supply bores reviewed to ensure that their use does not impact adversely on existing users of groundwater or nearby groundwater dependent ecosystems.	Minor	Unlikely	Low
Well control incidents (e.g. blowout or kick)	Contamination of soil, groundwater and surface water Crossflow, aquifer contamination or reduction in pressure in aquifers Uncontrolled release of water and gas to surface Loss of reserves and reservoir pressure Injury / danger to health and safety of employees, contractors and possibly the public	• Wells designed, constructed, operated and maintained in accordance with regulatory requirements and approved well construction standards. • Drill rig, ancillary and any testing equipment to comply with Regulations, meet relevant industry standards and be 'Fit for Purpose'. • Periodic review of management systems as required based on learnings and changes to Australian and international leading practice. • Blow out prevention precautions in place in accordance with defined procedures and appropriate to the expected downhole conditions. • Competent site personnel and contractors on site at all times during drill operations. • Well control equipment, tested and verifies in accordance with international standards used during coiled tubing, wireline and workover activities. • Satisfactory kick tolerance in casing program design. • Work is performed as set out in the Drilling Program. • Emergency response procedures in place. • Emergency response procedures included in staff training.	Moderate	Unlikely	Medium
	Access to contaminants by stock and wildlife Atmospheric pollution		Minor	Unlikely	Low

Risk Event / Hazard	Potential Environmental Impacts	Key Management Measures / Comments	Consequence	Likelihood	Residual Risk
		• Personnel are trained in the use of spill response equipment. • Confinement of flammable sources, restrictions on certain procedures and ready access to suitable fire-fighting equipment.			
Other downhole drilling issues (e.g. lost circulation, sloughing shales, stuck pipe or drill pipe failure)	Contamination of soil, groundwater and surface water Crossflow, aquifer contamination or reduction in pressure in aquifers Uncontrolled release of water and gas to surface Loss of reserves and reservoir pressure	• See measures above for well control incidents	Negligible	Possible	Low
Loss of radioactive source down hole	Contamination of aquifers	• Immediate retrieval of tool. • If retrieval is not possible, tool is cemented in hole to isolate it from adjacent formations. • Relevant government approval obtained for abandonment of any radioactive tool left downhole. Approval is sought from EPA to cement any radioactive tools in hole pursuant to the *Radiation Protection and Control Regulations 2022*.	Minor	Unlikely	Low
Loss of well integrity (e.g. casing or cement failure)	Contamination or over-pressurisation of aquifers (resulting from cross-flow) Contamination of soil, groundwater and surface water Emissions to the atmosphere Injury / danger to health and safety of employees, contractors and possibly the public	• Activities performed in accordance with applicable industry and regulatory standards. • Wells designed to meet pressure, temperature, operational stresses and loads. • Drilling operation and the design of the well and well test consider the interface with hydrogen gas, to ensure that appropriate equipment and materials are utilised to safely conduct the operations. • Specialist metallurgical advice sought to ensure that equipment and materials are not at risk of failure due to exposure to a potential hydrogen environment during drilling and testing. • Specialist technical engineers design the cementing program in accordance with international standards. • Effective verified barriers exist to maintain well control and prevent crossflow between aquifers systems or hydrogen reservoirs. • Aquifers isolated behind casing strings, cemented in place. Surface casing to be cemented to surface with visible return. • Cement bond logs run on suspension casing to confirm quality of cement. • Operational verification reports in wells being suspended or tested demonstrate that barriers have been set and/or remedial cement work carried out in accordance with the work program submitted to and agreed with DEM. • Monitoring programs implemented (e.g. through well logs or pressure measurements / testing) to aid in the assessment of wellbore barrier conditions during drilling, completion and well testing activities where appropriate. • Where monitoring identifies potential issues during drilling activities, risk assessment undertaken to identify hazards / scenarios and propose recommendations and mitigation controls where appropriate to reduce or monitor risk. • Emergency response plan in place and drills conducted. • Emergency response procedures included in staff training Well Decommissioning • Well decommissioning program submitted to DEM prior to implementation. • Downhole decommissioning carried out to meet worst case expected loads and downhole environmental conditions. • Appropriate verified barriers are put in place to prevent crossflow, contamination or further pressure reduction occurring. • Pressure testing and / or negative inflow testing performed on barrier envelopes / components where feasible. • Inhibited fluid placed between barriers where applicable • Operational verification reports for barrier installation and testing submitted and retained.	Moderate	Unlikely	Medium
Spills or leaks associated with: • **drilling procedures and storage of drilling muds and cuttings in sump**	Localised contamination of soil, surface water and groundwater.	• Drilling sump (if used) to have sufficient capacity. • Flooding risk is considered in well pad location and construction and additional measures implemented if required (e.g. a small berm around the sump (if a sump is used) to prevent floodwater entering the sump). • Camp and drill rig generators to be appropriately located to contain any spills (e.g. in polyethylene lined bunded areas or with suitable alternative spill containment).	Moderate[31]	Unlikely	Medium[31]

[31] Note: This has been conservatively assessed on the assumption that groundwater is relatively shallow (e.g. less than 5 m depth) and has low salinity. The consequence would be *Minor* and the risk level *Low* if groundwater is in areas where groundwater is at depth (e.g. 5-10 m or more) or where has elevated salinity.

Risk Event / Hazard	Potential Environmental Impacts	Key Management Measures / Comments	Consequence	Likelihood	Residual Risk
• **storage of fuel, oil and chemicals** • **refuelling operations and high pressure hydraulic systems** • **well testing**	Damage to native vegetation and wildlife habitats Access to contaminants by stock and wildlife	• Flare tank and / or vent is used for emergency well control situations while drilling. • Fluid losses will be controlled during drilling. • The sump will be lined with a suitable impermeable liner. • If required the sump may be pumped and excess fluid disposed of as appropriate. • On completion of drilling the drill cuttings and sump water will be tested to analyse their suitability for reuse, industrial recycle, fill or waste and will be disposed of accordingly, along with the sump liner. Sump contents to be disposed as waste will be removed by a licensed contractor to an EPA licensed waste disposal facility. • Excess water from the sump or tanks) will not be reused on land unless it has landowner agreement and water quality meets applicable criteria (e.g. *Environment Protection (Water Quality) Policy 2015* requirements, ANZECC/ARMCANZ 2000 and ANZG 2018 criteria) and any relevant approvals (e.g. DEM / EPA) have been obtained. • Wastewater is not allowed to drain to surface water drainage features. <u>Fuel and chemical storage and handling</u> • All fuel and chemical storage areas will be in accordance with relevant standards and guidelines (e.g. AS 1940, EPA guideline 080/16 Bunding and Spill Management and the Australian Dangerous Goods Code). • Safety Data Sheet information readily available at the well site. • Hazardous materials stored, used and disposed of in accordance with relevant legislation on dangerous substances. • All hazardous materials including fuels, oils and chemicals are to be stored in approved containers in polythene lined bunded areas or on bunded pallets. • No refuelling outside designated refuelling or servicing areas. • Appropriate drip capture / spill capture methods implemented in refuelling areas (e.g. use of drip trays or liners). • Appropriate spill response equipment is available on site. • Personnel have received training in the use of spill response equipment. • Spills or leaks are immediately reported and clean up actions initiated. • All contaminated soil will either be treated in-situ or removed for treatment / disposal at an EPA approved facility. • Assessment and remediation of uncontained spills with larger scale impact is consistent with the National Environment Protection (Assessment of Site Contamination) Measure and relevant guidelines (e.g. SA EPA guidelines). • Records of any spill events and corrective actions are maintained. <u>Well testing</u> • Tanks to be located in lined bunded areas. • Piping and tanks to be inspected prior to use. • Well testing activities monitored at all times with personnel on site where required, subject to testing requirements and risk assessment. • Separator tank used during well testing to separate any produced liquids from gas before gas is sent to vent / flare. • Engineering design of well testing program considers the interface with hydrogen gas, to ensure that appropriate equipment and materials are utilised to safely conduct the test. • Groundwater monitoring wells installed on a site-specific basis (e.g. if an exploration well is located in an area where a significant shallow groundwater resource has been identified).	Minor	Unlikely	Low
Use of vibroseis or other energy source for vertical seismic profiling	Damage to infrastructure Noise generation Vibration generation Disturbance to local community	• Locations where energy sources are used (near the well) are not in close proximity to residences or other built infrastructure. • Refer to *Well site, access track, laydown and camp site construction and rehabilitation* and *Use of roads; movement of vehicles and heavy machinery* for general controls on activities and vehicle movements. <u>Storage, handling and use of explosives (if required)</u>	Minor	Unlikely	Low
	Danger to health and safety of employees, contractors and possibly the public	• Explosives use, storage, handling and disposal undertaken in accordance with relevant industry codes, standards and guidelines (e.g. Australian Dangerous Goods Code), and the requirements of the South Australian Explosives Act. • Explosives handled and utilised by appropriately trained and licensed personnel (i.e. holders of a SafeWork SA Blaster's Licence) in accordance with applicable legislative requirements. • Explosives stored in an approved receptacle, store or magazine. • Adequate buffer distances maintained between activities and residences. • Activities are restricted to daylight hours and agreed / defined areas and times.	Moderate	Remote	Low

Risk Event / Hazard	Potential Environmental Impacts	Key Management Measures / Comments	Consequence	Likelihood	Residual Risk
		• Risks and requirements associated with explosive storage, handling and use are included in the induction and all personnel are fully informed of risks and associated restrictions. • Emergency response procedures included in staff training. • Systems in place for logging stakeholder complaints to ensure that issues are addressed as appropriate.			
Unauthorised access by third parties	Injury / danger to health and safety of employees, contractors and third parties	• "No Entry" signs warning of dangers associated with drilling operations placed at the entry to the site access track. • Site area to be fenced with a gate on the access track. • Access gate to well site will be closed during testing and appropriate signage will be in place to restrict entry. • Drilling Supervisor and Drilling Contractor Manager given authority to refuse entry of unauthorised third parties. • All minor excavations (e.g. for septic tank) to be backfilled soon after rig release. • Wellhead (if installed) and sump (if used) to be individually fenced if delay in clean-up operations to occur. • Sump (if used) to be backfilled as soon as practicable after waste materials have been appropriately removed. • Necessary measures (e.g. fencing, signage) taken to prevent the public accessing the wellhead equipment or waste relating to the well. • Effective rehabilitation of the well site so that potentially dangerous variations in ground level do not remain.	Moderate	Remote	Low
Fire (resulting from activities)	Danger to health and safety of employees, contractors and possibly the public	• Confinement of flammable sources, restrictions on certain procedures and ready access to suitable fire-fighting equipment (e.g. fire unit consisting of trailer with water tank, pump and hoses in high fire danger season). • Liaise with CFS regarding operations to ensure fire concerns are addressed and any Fire and Emergency Services Act requirements are met (e.g. permits for 'hot work' on fire ban days if required). • Where necessary (e.g. in fire danger season), fire break constructed around well pad. • Any well tests designed and managed to ensure that hydrogen gas is safely managed (e.g. combusted or dispersed) so that it does not pose a fire or explosion risk. • Response to fire included in Emergency Response Plan. • Emergency response procedures included in staff training. • Ensure fire risk is included in the induction and all personnel are fully informed on the fire danger season and associated restrictions.	Major	Remote	Medium
	Loss of vegetation and habitat Disturbance, injury or death of fauna Atmospheric pollution Damage to infrastructure Disruption to land use		Moderate	Remote	Low
Storage, handling and disposal of waste	Localised contamination of soil, surface water and groundwater Damage to vegetation and habitat Attraction of scavenging animals (native / pest species) and access to contaminants by stock and wildlife Litter / loss of visual amenity	• EPA's Waste Hierarchy model (avoid, reduce, reuse, recycle, recover, treat, dispose) should be complied with and waste management undertaken with regard to the *Environment Protection (Waste to Resources) Policy 2010*. • Covered bins are provided for the collection and storage of wastes. All loads of rubbish are covered during transport to an approved waste facility. • Waste streams are segregated on site and transported to appropriate facilities to maximise waste recovery, reuse and recycling. • Production of waste is minimised by purchasing reusable, biodegradable or recyclable materials where practical. • All waste disposal is at an EPA licensed facility. • Hazardous wastes handled in accordance with relevant legislation and standards. • Licensed contractors used for waste transport. • All wastewater is disposed in accordance with the *South Australian Public Health (Wastewater) Regulations 2013* and in compliance with the South Australian Health On-site Wastewater Systems Code. • Sewage treatment units and septic tanks used at camp and drill rig ablutions. Septic tanks pumped out on an 'as required' basis by a licensed septic waste removal contractor and disposed of at a licensed facility. • Any necessary approvals (e.g. local council) are obtained for use of wastewater disposal system. • Well site is kept free of litter and rubbish.	Minor	Unlikely	Low

7. Environmental Management Framework

Exploration well drilling and testing for natural hydrogen will be undertaken in accordance with Gold Hydrogen's Health, Safety and Environment (HSE) Management Plan. It provides a framework for the coordinated and consistent management of environmental issues and addresses the:

- establishment of an environmental policy (https://www.goldhydrogen.com.au)
- identification of environmental risks and legal and other requirements relevant to the operations
- setting of appropriate environmental objectives and targets
- delineation of responsibilities
- establishment of a structure and program to implement environmental policy and achieve objectives and targets, including the development of procedures or guidelines for specific activities and education and induction programs
- facilitation of planning, control monitoring, corrective action, auditing and review of activities to ensure that the requirements and aspirations of the environmental policy are achieved.

Key aspects are discussed in the following sections.

Environmental objectives

Environmental objectives for exploration drilling and well testing for natural hydrogen have been developed based on the information and issues identified in this EIR and are detailed in the accompanying Statement of Environmental Objectives.

Responsibilities

Environmental management and compliance is the responsibility of all personnel.

The overall responsibility for environmental compliance lies with Gold Hydrogen, who will maintain a high level of on-site supervision. The drilling contractor and individuals will also be responsible and accountable through their conditions of contract. The training of all personnel will ensure that each individual is aware of their environmental responsibility.

Indicative organisation and responsibilities for environmental management are outlined in Table 7-1. It is noted that the exact nature and title of these roles may vary and positions may be amalgamated or the responsibilities shared.

Table 7-1: Indicative roles and responsibilities

Role	Responsibility
Gold Hydrogen management	Licence holders Hold overall responsibility for activities and environmental management Responsible for coordinating the management of the activities, including all environmental aspects Responsible for overall implementation of EHS Responsible for the overseeing and fulfilling of commitments contained in EIR and SEO Overall responsibility for reporting on environmental performance and due diligence

Role	Responsibility
	Coordinates environmental incident internal reporting and investigation Incident notification to authorities
Gold Hydrogen on-site drilling management (Rig Company Man)	Directly responsible for on-site management, including all environmental aspects Responsible for the overseeing and fulfilling of commitments contained in EIR and SEO Reports to Gold Hydrogen management on environmental performance and due diligence Coordinates the monitoring and audit program Environmental internal reporting and incident investigation
Drilling Manager (contractor)	Responsible for ensuring that works meet regulatory requirements and all environmental objectives contained in the SEO Directly responsible for the overseeing and fulfilling of commitments contained in relevant approvals, EIR and SEO Responsible for ensuring adequate resources are provided for constructing and maintaining environmental controls Inspection of work area to ensure appropriate environmental management Environmental internal reporting and incident investigation Reports to the Rig Company Man

Environmental management procedures

All employees and contractors are responsible for ensuring compliance with environmental procedures which are contained in the HSE Management Plan and associated documents. The HSE Management Plan and associated procedures are developed to identify environmental risks and set minimum operating standards to ensure that Gold Hydrogen and its contractors comply with the relevant environmental legislation.

Induction and training

Prior to the start of field operations all field personnel will be required to undertake an environmental induction to ensure they understand their role in protecting the environment. This induction will be part of a general induction process which also includes safety procedures. Site specific environmental requirements will be documented in the work program or work instruction.

A record of induction and attendees will be maintained.

Emergency response and contingency planning

In the course of normal operations, there is always the potential for environmental incidents and accidents to occur. To manage these incidents, emergency response plans are developed to guide actions to be taken to minimise the impacts of accidents and incidents. Emergency response plans will be reviewed and updated on a regular basis to incorporate new information arising from any incidents, near misses and hazards and emergency response simulation training sessions. These plans will also include the facilitation of fire danger season restrictions and requirements.

Emergency response drills will also be undertaken at regular intervals to ensure that personnel are familiar with the plans and the types of emergencies to which they apply, and that there will be a rapid and effective response in the event of a real emergency occurring.

Environmental monitoring and audits

Monitoring and auditing of exploration drilling and well testing operations will be undertaken to determine whether significant environmental risks are being managed, minimised and where reasonably possible, eliminated.

Monitoring and auditing undertaken will assess aspects such as:

- compliance with regulatory requirements (particularly the Statement of Environmental Objectives)
- impact upon land use
- impact on flora and fauna
- visual impact of the operations
- integrity of bunding and containment systems
- site contamination
- site revegetation / restoration following program completion
- contractor performance.

Incident management, recording and corrective actions

Gold Hydrogen and its contractors have a system in place to record environmental incidents, near misses and hazards, track the implementation and close out of corrective actions, and allow analysis of such incidents to identify areas requiring improvement. The system also provides a mechanism for recording 'reportable' incidents, as defined under the PGE Act and associated regulations.

Reporting

Internal and external reporting procedures will be implemented to ensure that environmental issues and / or incidents are appropriately responded to. A key component of the internal reporting will be contractors' progress and incident reports to Gold Hydrogen.

External reporting (e.g. incidents, annual reports) will be carried out in accordance with PGE Act requirements and the SEO.

8. Stakeholder Consultation

8.1. Context for Community Engagement

Yorke Peninsula is an economically important primary production area, with regions' rich limestone soil making it some of the most highly productive land in Australia and one of the best wheat and barley growing regions in the world. A significant proportion of the community is involved in primary production and the rural lifestyle and heritage and natural environment of Yorke Peninsula are highly valued by the local community and visitors alike.

Exploration drilling for natural hydrogen is a new development for energy production as the world moves to a decarbonised economy. Yorke Peninsula previously experienced a brief period more than ninety years ago, of exploration drilling similar to the activities proposed by Gold Hydrogen, which was short-lived and unsuccessful. Gold Hydrogen acknowledges that understanding in the Yorke Peninsula community of the concept of natural hydrogen is likely to be limited, and that the activities which are the subject of the draft EIR and the accompanying SEO may be unfamiliar. Accordingly, Gold Hydrogen takes seriously its responsibility to provide the Yorke Peninsula community with timely, accurate, accessible information, and opportunities to learn more about natural hydrogen and the proposed exploration activities in PEL 687.

As a leader in this emerging sector, Gold Hydrogen understands the importance of establishing credibility and trust in the manner in which it undertakes exploration activities and builds relationships with the community within which it wishes to operate.

8.2. Stakeholder and Community Engagement

Gold Hydrogen is committed to early, genuine and transparent engagement with the Yorke Peninsula community. Prior to commencing stakeholder engagement for the Ramsay Project, Gold Hydrogen developed a project-specific stakeholder and community engagement strategy to guide its approach to identifying and engaging with community stakeholders.

The strategy sets out key desired outcomes, a process for identifying important stakeholders and appropriate engagement strategies. The overall objectives of the strategy are to:

- Establish community and stakeholder confidence in the Ramsay Project and Gold Hydrogen's ability to deliver it
- Build relationships and foster trust through transparent, genuine two-way engagement
- Build shared value and support for the project through strong community partnerships.

The strategy identifies the stakeholders and engagement that is planned to be undertaken to underpin natural hydrogen exploration activities in PEL 687. Early engagement priorities have included detailed discussions with key landowners (e.g. whose properties are either potential sites for drilling or adjacent (refer Section 8.2.1)), and meetings with the Yorke Peninsula Council, local State and Federal MP's, and the Narungga Nation Aboriginal Corporation.

Table 8-1 outlines the stakeholders that have been identified and consultation that is being undertaken during the development of the EIR and SEO.

Table 8-1: Stakeholders and engagement being undertaken during EIR/SEO development

Category	Stakeholder / stakeholder group	Engagement
Community	Landowners at or adjacent to potential drilling locations	Discussions have been held with several landowners with a view to agreements for land access and land use. Draft EIR / SEO placed on Gold Hydrogen website inviting community comments.
	Yorke Peninsula communities	Preliminary activity details and information sheets provided on the Gold Hydrogen website, council offices and advertised in local paper. Newspaper advertisements inviting comments for EIR / SEO and planned community drop-in sessions. Draft EIR / SEO placed on Gold Hydrogen website inviting community comments.
	Local community groups	Preliminary activity details and information sheets provided on the Gold Hydrogen website, council offices and advertised in local paper. Newspaper advertisements inviting comments for EIR / SEO and planned community drop-in sessions. Draft EIR / SEO placed on Gold Hydrogen website inviting community comments.
Traditional Owners	Narungga Nation Aboriginal Corporation	Telephone calls, emails, provision of information sheets and in-person meetings regarding Gold Hydrogen and project activities. Email advice that the draft EIR / SEO are available on the website.
	Other Aboriginal groups or people who may have an interest in the Project	Preliminary activity details and information sheets provided on the Gold Hydrogen website and advertised in local paper. Newspaper advertisements inviting comments for EIR / SEO and planned community drop-in sessions. Draft EIR / SEO placed on Gold Hydrogen website inviting community comments.
Council	Yorke Peninsula Council	Meeting with council CEO and Director Development Services regarding Gold Hydrogen and initial project activities. Regular correspondence over 18 months providing updates on the project to Mayor and the CEO.
Government Departments and Agencies	Department for Energy and Mining	Meetings and ongoing engagement during preparation of the draft EIR and SEO through to formal submission.
	Department for Environment and Water (including the National Parks and Wildlife Service)	Engagement as part of airborne survey activities. Email advice that the draft EIR / SEO are available to view on the GHY website. Will be consulted as part of DEM formal consultation phase.
	PIRSA	Email advice that the draft EIR / SEO are available to view on the GHY website. Will be consulted as part of DEM formal consultation phase.
	Department of Infrastructure and Transport	Advice of proposed soil gas sampling on road reserves. Email advice that the draft EIR / SEO are available to view on the GHY website. Will be consulted as part of DEM formal consultation phase.

Category	Stakeholder / stakeholder group	Engagement
	Planning and Land Use Services (PLUS)	Email advice that the draft EIR / SEO are available to view on the GHY website. Will be consulted as part of DEM formal consultation phase.
	Environment Protection Authority	Email advice that the draft EIR / SEO are available to view on the GHY website. Will be consulted as part of DEM formal consultation phase.
	Aboriginal Affairs and Reconciliation	Engagement in relation to consultation with Traditional Owner groups and location of Aboriginal cultural heritage. Email advice that the draft EIR / SEO are available to view on the GHY website. Will be consulted as part of DEM formal consultation phase.
	SafeWork	Email advice that the draft EIR / SEO are available to view on the GHY website. Will be consulted as part of DEM formal consultation phase.
	Country Fire Service (CFS)	Will be consulted as part of planning of exploration drilling operations at specific locations.
	South Australia Police (SAPOL)	Will be consulted as part of planning of exploration drilling at specific locations (e.g. in relation to rig moves).
	Northern and Yorke Landscape Board	Email advice that the draft EIR / SEO are available to view on the GHY website. Will be consulted as part of DEM formal consultation phase.
	Regional Development Australia York and Mid North	Email advice that the draft EIR / SEO are available to view on the GHY website.
Non-government Organisations	South Australian Chamber of Mines & Energy (SACOME)	Email advice that the draft EIR / SEO are available to view on the GHY website.
	Landowner Information Service	Email advice that the draft EIR / SEO are available on the website.
	Conservation Council SA	Email advice that the draft EIR / SEO are available to view on the GHY website.
	Wilderness Society	Email advice that the draft EIR / SEO are available to view on the GHY website.
Elected representatives	Rowan Ramsey MP (Federal MP for Grey)	Multiple meetings regarding Gold Hydrogen and initial project activities and providing updates on the project
	Tom Koutsantonis MP – Minister for Energy and Mining	Meetings with policy advisors and regular briefings provided.
	Susan Close MP - Minister for Climate, Environment and Water	Minister's office to be contacted to provide briefing on the project.
	Fraser Ellis, State Member for Narungga, Independent (Yorke Peninsula)	Meeting in February regarding Gold Hydrogen and initial project activity. Regular correspondence over 18 months providing updates on the project.

8.2.1. Key landowners

As a company proposing to conduct exploration activities on agricultural land, Gold Hydrogen seeks to reassure landowners that the proposed exploration activities can generally co-exist with agricultural operations. Gold Hydrogen has begun consultation with and will continue to work closely with key landowners at or adjacent to potential drilling locations to understand and address any concerns, provide compensation as required, and to realise any opportunities or benefits that may arise from the proposed activities (refer Sections 4.1.2 and 4.1.3).

No land will be accessed or activities take place on land without a formal agreement entered into by the landowner with Gold Hydrogen. Gold Hydrogen does not intend to acquire any farming land for the purposes of exploration drilling at this stage of the project.

8.3. Stakeholder Consultation on the draft EIR and SEO

Due to the potential level of interest in the proposed natural hydrogen exploration activities on Yorke Peninsula, Gold Hydrogen have made the drafts of the EIR and accompanying SEO publicly available for comment on its website[32]. This will provide the community with the opportunity to learn more about naturally occurring hydrogen and the purpose and aims of the proposed exploration drilling activities, and provide feedback about specific or general concerns or issues before the EIR and draft SEO are formally submitted to DEM.

The online consultation page features an introductory message and indicative timeline of the EIR / SEO approval process. The page also includes a section for downloading the draft EIR and SEO documents, information on how members of the community can make a submission, a comments / feedback form and contact details for Gold Hydrogen.

The draft EIR and SEO will be available for comment for a period of three weeks and during this time there will also be an opportunity for the community to personally make submissions, raise issues or ask questions of Gold Hydrogen representatives who will hold community drop-in sessions which will be held locally on Yorke Peninsula.

To notify the community of the availability of the draft EIR and SEO and details of the community drop-in sessions, newspaper advertisements will be placed in the Yorke Peninsula Country Times in the two weeks leading up to the drop-in sessions.

8.4. Stakeholder Feedback

Following community consultation on the draft EIR and SEO, issues raised in stakeholder comments which are received via the website and at the community drop-in session will be summarised in Table B-1 in Appendix B of the EIR.

The draft EIR and SEO will be updated in response to this phase of stakeholder engagement and then formally submitted to DEM for further review and consultation under the formal PGE Act consultation process (summarised below).

8.5. Formal PGE Act Consultation Process

It is a requirement under the PGE Regulations that information on consultation with relevant landowners, Aboriginal groups or representatives, government departments or agencies, or any other interested person or parties is outlined in an EIR.

As noted above, the EIR and draft SEO will be formally submitted to DEM after being updated to address the issues raised during community consultation. DEM, through concurrence with EPA and

[32] https://www.goldhydrogen.com.au/

DEW, will then classify the level of impact of the activity (refer Section 2.1.3). Government agencies will be subsequently formally consulted by DEM under the PGE Act process. A period of further public consultation may also be conducted by DEM depending on the classification of level of impact.

All feedback received from government agencies, the community and other stakeholders through the PGE Act consultation process will be detailed and addressed in the final EIR and SEO to be submitted to DEM for approval.

8.6. Ongoing Consultation

Gold Hydrogen undertakes to continue to engage with and update affected landowners, the community and other stakeholders should exploration drilling activities be approved. This could include (but not be limited to) consulting and advising affected stakeholders of proposed activities in a timely manner, responding to any issues raised, maintaining a database of interested stakeholders in order to provide regular updates, including information on the website on progress of the Ramsay Project and provision of factsheets and other information.

9. References

ABS (2021). Yorke Peninsula – 2021 Census All persons QuickStats. Accessed 17/11/2022 at https://www.abs.gov.au/census/find-census-data/quickstats/2021/LGA48830.

AEMC (2023). *Hydrogen: the new Australian manufacturing export industry and the implications for the National Electricity Market (NEM)*. Article by R. Pendlebury, T Meares and J Tyrell. Australian Energy Market Commission. Accessed April 2023 at www.aemc.gov.au/hydrogen-new-australian-manufacturing-export-industry-and-implications-national-electricity-market

AGL (2021). *Yorke Peninsula community hubs powered by AGL*. Accessed November 2022 at https://www.agl.com.au/about-agl/media-centre/asx-and-media-releases/2021/september/yorke-peninsula-community-hubs-powered-by-agl?7zs43y=jpts1o

Alcoe, D. and Berens, V. (2011). *Non-prescribed groundwater resources assessment – Northern and Yorke Natural Resources Management Region. Phase 1 – Literature and Data Review.* Science, Monitoring and Information Division. Department for Water. Technical Report DFW 2011/17. June 2011.

Alexander, E., 2022. Natural hydrogen exploration in South Australia. PESA SA Branch technical meeting, 23 June 2022. Accessed April 2023 at www.energymining.sa.gov.au/industry/energy-resources/media2/shared/pdf/petroleum/presentations/PESA-SA-Branch-Natural-Hydrogen-presentation-23-June.pdf

ANZECC/ARMCANZ (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).

ANZG (2018). Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Canberra: Australian and New Zealand Governments and Australian state and territory governments.

APPEA (2023). Seismic Surveys. Accessed: April 2023 at https://www.appea.com.au/industry/policy/policy-positions/policy-issues-seismic/. Australian Petroleum Production & Exploration Association. Canberra, Australian Capital Territory.

ASRIS (2022). Australian Soil Resource Information System. Accessed on 17/11/2022. http://www.asris.csiro.au/mapping/viewer.htm.

Bendall 2022. 'Current perspectives on natural hydrogen: a synopsis'. MESA Journal 96, pp 37–46. Accessed April 2023 at: https://sarigbasis.pir.sa.gov.au/WebtopEw/ws/samref/sarig1/image/DDD/MESAJ096037-046.pdf

BOM (2019). Terrestrial GDE. Accessed at https://map.sarig.sa.gov.au/.

BOM (2022a). Climate data online. Accessed on 16/11/2022 at http://www.bom.gov.au/climate/data/index.shtml.

BOM (2022b). Groundwater Dependent Ecosystems Atlas. Accessed 17/11/2022 at http://www.bom.gov.au/water/groundwater/gde/map.shtml.

BoM (2023). Climate classification maps. Accessed April 2023 at http://www.bom.gov.au/climate/maps/averages/climate-classification/.

Cohen, K.M., Finney, S.C., Gibbard, P.L. & Fan, J.-X. (2013; updated) The ICS International Chronostratigraphic Chart. Episodes 36: 199-204. URL: http://www.stratigraphy.org/ICSchart/ChronostratChart2022-02.pdf

CSIRO (2023). Natural hydrogen exploration webpage. Commonwealth Scientific and Industrial Research Organisation. Accessed April 2023 at www.research.csiro.au/hydrogenfsp/our-research/projects/natural-hydrogen-exploration/

DCCEEW (2022a). Australian Heritage Database. Accessed 17/11/2022 at http://www.environment.gov.au/cgi-bin/ahdb/search.pl. Department of Climate Change, Energy, the Environment and Water.

DCCEEW (2022b). EPBC Act Protected Matters Search Tool. Accessed at https://pmst.awe.gov.au, October 2022. Department of Climate Change, Energy, the Environment and Water, Canberra.

DEM (2022). Mineral Production Tenements. Accessed at https://map.sarig.sa.gov.au/.

DEM (2023). Stansbury Basin. Accessed February 2023 at https://www.energymining.sa.gov.au/industry/energy-resources/geology-and-prospectivity/neoproterozoic-middle-paleozoic-basins/stansbury-basin#accordion-697991-2. Department for Energy And Mining, South Australia.

DEW (2013). Interim Biogeographic Regionalisation for Australia (IBRA Version 7.0) Associations (Part SA only). GIS dataset 1107. Accessed at https://data.environment.sa.gov.au/NatureMaps.

DEW (2014). Land Use (ACLUMP). GIS dataset 2072. Accessed at http://spatialwebapps.environment.sa.gov.au/naturemaps/?locale=en-us&viewer=naturemaps

DEW (2018). Native Vegetation Floristic Areas - NVIS - Statewide (Incomplete Version). GIS dataset 898. Accessed at http://spatialwebapps.environment.sa.gov.au/naturemaps/?locale=en-us&viewer=naturemaps.

DEW (2016a). Shallow Standing Water Level. GIS dataset 1021. Accessed at https://map.sarig.sa.gov.au/.

DEW (2016b). Shallow Total Dissolved Salts. GIS dataset 1026. Accessed at https://map.sarig.sa.gov.au/.

DEW (2022a). Biological Database of South Australian search. Recordset DEWNRBDBSA220517-1. Department for Environment and Water, Adelaide

DEW (2022b). SA Heritage Places Database Search. Accessed 17/11/2022 at https://maps.sa.gov.au/heritagesearch/HeritageSearchLocation.aspx.

DEW (2023). Locations of Phytophthora Infestations. GIS dataset 1080. Accessed at http://spatialwebapps.environment.sa.gov.au/naturemaps/?locale=en-us&viewer=naturemaps

DEWNR (undated). Winulta Creek Land System. DEWNR Soil and Land Program. Department of Environment, Water and Natural Resources. Accessed April 2023 at https://data.environment.sa.gov.au/Content/Land-System-reports/WIC.pdf.

DIT (2022a). Phytophthora (Dieback) Control Environmental Instruction. Department for Infrastructure and Transport, South Australia. Accessed at https://www.dit.sa.gov.au/standards?a=921168.

DIT (2022b). Railway. Department for Infrastructure and Transport, South Australia. Accessed at https://map.sarig.sa.gov.au/

DIT (2023). Traffic volumes. Department for Infrastructure and Transport, South Australia. Accessed March 2023 at https://www.dit.sa.gov.au/traffic_volumes.

ElectraNet (2022). DALRYMPLE ESCRI-SA BATTERY PROJECT. https://www.electranet.com.au/electranets-battery-storage-project/ Accessed 25/11/2022

ElectraNet (2022). Power Transmission Network (ElectraNet). GIS dataset 1912. Accessed at https://map.sarig.sa.gov.au/

Freidel J (2023). 'Is South Australia a hotbed for "gold hydrogen"'. Interview with Ema Frery CSIRO. Cosmos 24 March 2023 accessed at https://cosmosmagazine.com/news/gold-hydrogen/ .

Graham, A. Oppermann, A. and Inns, R.W. (2001). *Biodiversity Plan for the Northern Agricultural Districts*. Department for Environment and Heritage, South Australia.

Gravestock, D.I., Alexander, E.M., Demidenko, Yu.E., Esakova, N.V., Holmer, L.E., Jago, J.B., Lin, T., Melnikova, L.M., Parkhaev, P.Yu., Rozanov, A.Yu., Ushatinskaya, G.T., Zang, W., Zhegallo, E.A., and A.Yu. Zhuravlev (2001). The Cambrian biostratigraphy of the Stansbury Basin, South Australia. Palaeontological Institute RAS, Transactions 282: 1-344.

GSA (2022). Attraction – Wattle Point Wind Farm. Accessed 17/11/2022 at https://southaustralia.com/products/yorke-peninsula/attraction/wattle-point-wind-farm

Hand G. (2023). 'Hidden Hydrogen – does Earth hold vast stores of a renewable, carbon-free fuel?' Online article. Science Vol. 379, issue 6633 17 February 2023. Accessed April 2023 at www.science.org/content/article/hidden-hydrogen-earth-may-hold-vast-stores-renewable-carbon-free-fuel

Landscape SA Northern and Yorke (2022a). Native Plants. Accessed 25/11/2022 at https://www.landscape.sa.gov.au/ny/plants-and-animals/native-plants-and-animals/native-plants.

Landscape SA Northern and Yorke (2022b). Pest Animals. Accessed 18/11/2022 at https://www.landscape.sa.gov.au/ny/plants-and-animals/pest-plants-and-animals/pest-animals.

Landscape SA Northern and Yorke (2022c). Soil management. Accessed 25/11/2022 at https://www.landscape.sa.gov.au/ny/land-and-coast/land-management/soil-management.

Landscape SA Northern and Yorke (20223). Wetlands. Accessed 30/3/2023 at https://www.landscape.sa.gov.au/ny/water/managing-water-resources/wetlands

Laut, P., Heyligers, P.C., Keig, G., Loffler, E., Margules, C., Scott, R.M. and Sullivan, M.E. (1977). *Environments of South Australia*. Division of Land Use Research, CSIRO, Canberra.

Magarey, P.D. and Deane, D. (2004). *Small Groundwater Basins Risk Assessment: Northern and Yorke Agricultural District.* Department of Water, Land and Biodiversity Conservation. Report, DWLBC 2004/54.

Marna Banggara (2023). Project Overview. Accessed at April 2023 at https://marnabanggara.com.au/.

Moretti, I. and Webber, M.E. 2021. ' Natural hydrogen: a geological curiosity or the primary energy source for a low-carbon future?'. Renewable Matter, online article, 8 January 2021. Accessed April 2023 at www.renewablematter.eu/articles/article/natural-hydrogen-a-geological-curiosity-or-the-primary-energy-source-for-a-low-carbon-future

NIAA (2023). Wardang Island IPA. National Indigenous Australians Agency. Accessed April 2023 at https://www.niaa.gov.au/indigenous-affairs/environment/wardang-island-ipa.

N&Y NRMB (2009). *Northern and Yorke regional NRM plan, Volume A: State of the region report 2008.* Northern and Yorke Natural Resources Management Board, Crystal Brook.

N&Y LB (2020). Water-Affecting Activities Control Policy. Northern and Yorke Landscape Board, December 2020.

National Native Title Tribunal (NNTT) (2022). Application Details – Narungga Nation (SC2013/002). Accessed at http://www.nntt.gov.au/searchRegApps/NativeTitleClaims/Pages/details.aspx?NTDA_Fileno=SC2013/002. Accessed on 17/11/2022

Natural Resources Northern and Yorke. Managing pest plants. Accessed at https://cdn.environment.sa.gov.au/landscape/docs/ny/2019_managing_pest_plants_yorke_district_fact_sheet.pdf. Accessed on 18/11/2022

NatureMaps 2022. http://spatialwebapps.environment.sa.gov.au/naturemaps/?locale=en-us&viewer=naturemaps. Accessed 17/11/2022

PIRSA (2023). *South Australian Crop and Pasture Report, 2022-23 Final Summary, March 2023*. Department of Primary Industries and Regions.

Preiss, W. V., (Compiler, 1987). *The Adelaide Geosyncline – Late Proterozoic Stratigraphy, Sedimentation, Palaeontology and Tectonics.* Bulletin 53, Geological Survey of South Australia.

Roberts, S. (2007). *Northern and Yorke Natural Resources Management Region water monitoring review*. DWLBC Report 2006/15. Department of Water, Land and Biodiversity Conservation, Adelaide.

Rodrigues, T. Strong, P. and Horton, G. (2021). Gold Hydrogen Prospective Resources Report, PEL 687, SA. Teof Rodrigues & Associates Pty Ltd.

SADME (1986). Exploration opportunity: Stansbury Basin Data package. Department of Mines and Energy SA, April 1986.

SAPN (2022). Power Distribution Network (SA Power Networks). GIS dataset 1913. Accessed at https://map.sarig.sa.gov.au/

SATC (2022). Yorke Peninsula Regional Profile. Results for year ending December 2021. South Australian Tourism Commission. Accessed April 2023 at https://tourism.sa.gov.au/media/3e3n1zty/yorke-peninsula-december-2021.pdf.

SA Water (2018). Yorke Peninsula towns tap in to better water. Accessed January 2023 at https://www.sawater.com.au/news/yorke-peninsula-towns-tap-in-to-better-water.

Science 2023. 'Hidden Hydrogen' Science Vol 379, Issue 6633. Eric Hand 16 February 2023 (see pdf in folder)

Sherwood Lollar *et al*. (2014). Sherwood Lollar B, Onstott T, Lacrampe-Couloume G and Ballentine CJ 2014. The contribution of the Precambrian continental lithosphere to global H2 production. Nature 516:379–382. doi:10.1038/ nature14017.

Spark Renewables (2023). Yorke Peninsula Energy Hub. Accessed April 2023 at https://sparkrenewables.com/yorke-peninsula-energy-hub.

WaterConnect (2023). https://www.waterconnect.sa.gov.au/Systems/SitePages/Home.aspx.

Yorke Peninsula Council (2023). Water. Accessed 31 March 2023 at https://yorke.sa.gov.au/community-services/facilities/water/.

Yorke Peninsula Tourism (2022). Yorke Peninsula, South Australia. Accessed 25/11/2022 at https://yorkepeninsula.com.au/

YPVC (2022). A year on the Farm. Yorke Peninsula Visitors Centre. Accessed November 2022 at https://images.impartmedia.com/visityorkepeninsula.com.au/A_Year_on_the_Farm.pdf

10. Abbreviations and Glossary

Abbreviation / Glossary	Definition
AAR	Aboriginal Affairs and Reconciliation, Attorney-General's Department (South Australia)
ABS	Australian Bureau of Statistics
aeolian	Process involving erosion, transportation and deposition of sediment by the wind
ANZECC	Australian and New Zealand Environment and Conservation Council
aquitard	A bed of low permeability adjacent to an aquifer
Archaean	Geological eon: 4 – 2.5 billion years ago
AS 1940	Australian Standard AS 1940 Storage and Handling of Flammable and Combustible Liquids
basement	Crystalline rocks lying above the mantle and beneath all other rocks and sediments. Generally used to indicate igneous and metamorphic rocks, usually older than Cambrian in age, that lie below a cover of sedimentary rocks
blowout	An uncontrolled flow of reservoir fluids into the wellbore, and sometimes catastrophically to the surface. A blowout may consist of water, oil or gas (if present) or a mixture of these.
BoM	Bureau of Meteorology
bunded	Enclosed within an earth, rock or concrete wall constructed to prevent the inflow or outflow of liquids
Cambrian	Geological period: 539 – 485 million years ago
casing	Steel pipes that are screwed together to form a casing string, which is run into a core hole or well and cemented in place
casing string	A series of casing rods screwed together
cement bond log	The output from an acoustic tool that is lowered down a well to evaluate the integrity of the bond of the cement to the casing and formation
Cenozoic	Geological Era: 66 million years ago to present
CFS	Country Fire Service
Cryogenian	Geological period: ~720 to ~635 million years ago
DCCEEW	Department of Climate Change, Energy, Environment and Water (Commonwealth)
DEM	Department for Energy and Mining
DEW	Department for Environment and Water (SA)
DEWNR	Department for Environment, Water and Natural Resources (now DEW) (SA)
DIT	Department for Infrastructure and Transport
drill cuttings	Rock fragments dislodged by the drill bit as it cuts rock in the hole
drilling mud / drilling fluid	Fluids continuously circulated down the wellbore, to cool and lubricate the drill bit, lubricate the drill pipe, carry rock cuttings to the surface and control down hole pressure.
drill stem testing	A valved test tool is lowered down a well on the end of the drill string to a specific reservoir formation and the valve opened to admit formation fluids.
EHS	Environment, Health and Safety
EIR	Environmental Impact Report prepared in accordance with Section 97 of the South Australian *Petroleum and Geothermal Energy Act 2000* and Regulation 10
EML	Extractive Minerals Lease

Abbreviation / Glossary	Definition
EPA	Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
ephemeral	Existing for only a short time, often dependent upon climatic influences
flaring	The burning of gas through a pipe (called a flare).
formation	The term for the primary unit in stratigraphy consisting of a succession of strata useful for mapping or description, which possesses certain distinctive lithologic and other features
ha	hectares
IBRA	Interim Biogeographical Regionalisation for Australia
ISO	International Standards Organisation
km	kilometre
km/hr	kilometres per hour
LCM	Lost circulation material is a collective term for substances added to drilling fluids when drilling fluids are being lost to the formations downhole either due to natural or induced causes. Commonly used lost circulation materials include fibrous, flaky or granular substances (e.g. cedar, mica flakes, formica or ground marble)
LGA	Local government area
lithology	Description of the physical characteristics of a rock such as colour, texture, grain size or composition
m	metre
MDT	modular formation dynamics tester
Mesoproterozoic	Geological Era: 1.6 to 1 billion years ago
mg/L	milligrams per litre
ML	Mining Lease
mm	millimetre
MW	megawatt
Native Vegetation Council	A council established under the South Australian *Native Vegetation Act 1991* to assess vegetation clearance applications
Neoproterozoic	Geological Era: 1 billion to 539 million years ago
NEPM	National Environmental Protection Measure
NGER	National Greenhouse and Energy Reporting
NPW Act	*National Parks and Wildlife Act 1972* (SA)
packer	A device that can be run into a wellbore with a smaller initial outside diameter that then expands externally to seal the wellbore.
Palaeozoic	Geological Era: 539 - 252 million years ago
Paleoproterozoic	Geological Era: 2.5 to 1.6 billion years ago
perforating	The process of punching holes in the casing or liner of a well to connect it to the reservoir
Permian	Geological period: 299 – 252 million years ago
PEL	Petroleum Exploration Licence
PGE Act	*Petroleum and Geothermal Energy Act 2000* (SA)

Abbreviation / Glossary	Definition
PHPA	partially-hydrolysed polyacrylamide
PIRSA	Department of Primary Industries and Regions, South Australia
Pleistocene	Geological epoch: 2.58 million to 11,700 years ago
plug and abandon	To place a cement plug into a dry hole or non-economic well and decommission the well.
PM	Private mine
prescribed well	Water well prescribed under the *Landscape South Australia Act 2019*
production test	Tests in a well to determine its flow capacity at specific conditions of reservoir and flowing pressures
Proterozoic	Geological eon: 2.5 billion – 539 million years ago
Ramsar wetland	A Wetland of International Importance listed under the Ramsar Convention (held in Ramsar, Iran 1971)
ripping	The use of machinery to rake or plough soil to relieve compaction and aerate soil.
Quaternary	Geological period: 2.58 million years ago to present
SEO	Statement of Environmental Objectives
serpentinization	A natural process which occurs in a variety of tectonic settings on the Earth, when water reacts with rocks containing a high concentration of iron and magnesium at high temperatures, producing gaseous methane and hydrogen.
stratigraphy	The study of rock layers and layering (stratification)
suspended (well)	A suspended well is not currently used for assessment or production and has been shut in, that will either be returned to assessment or production or decommissioned.
Tertiary	Geological period: 66 – 2.6 million years ago
venting	The release of gases to the atmosphere, typically through a vertical pipe (called a vent or vent stack)
vibroseis	A seismic vibrator or 'vibroseis' system is an adjustable mechanical source that delivers low frequency vibrations to the earth, using steel plates mounted on trucks or buggies which are vibrated when in contact with the ground.
well completion	A generic term used to describe the assembly of downhole tubulars and equipment required to enable safe and efficient production from a well.
well head	The part of a well which terminates at the surface, where reservoir fluids can be withdrawn.
wireline logging	A measuring instrument is raised up the well on a wireline to log or record rock properties and fluids
workover	The process of performing maintenance or remedial treatments on an existing well, generally for the purpose of restoring, prolonging or enhancing production.
zone	An interval or unit of rock differentiated from surrounding rocks on the basis of its fossil content or other features, such as faults or fractures. Often used to describe a layer of reservoir rock that contains oil or gas

Appendix A: Flora and Fauna Information

Table A-1: Vegetation communities mapped in areas of remnant vegetation in PEL 687

SA Veg ID	Description
EP2606	*Eucalyptus porosa* mid mallee woodland over *Melaleuca lanceolata* tall shrubs and *Acrotriche patula* (mixed) low shrubs and *Gahnia lanigera* low sedges
EP3906	*Alyxia buxifolia* (mixed) low shrubland over *Acrotriche patula* (mixed) low shrubs
EP4701	*Triodia compacta* low hummock grassland
EP4901	*Gahnia filum* tall sedgeland over *Juncus kraussii* mid sedges
MM0901	*Eucalyptus porosa* mid open mallee woodland over *Austrostipa* sp. (mixed) tussock grasses
MM2901	*Melaleuca halmaturorum* low open forest over *Sarcocornia quinqueflora* (mixed) shrubs
MN2102	*Eucalyptus camaldulensis* ssp. mid open forest over *Lycium ferocissimum* (mixed) shrubs and *Foeniculum vulgare* (mixed) forbs
MN2301	Emergent *Acacia pycnantha* shrubs over *Austrostipa eremophila* (mixed) mid tussock grassland
MN2401	*Eucalyptus socialis* ssp., *Callitris gracilis* mid mallee woodland over *Vulpia* myuros f. *myuros* (mixed) tussock grasses
MN3703	*Eucalyptus oleosa* ssp. *ampliata* mid open mallee forest over *Sclerolaena diacantha* (mixed) shrubs
MN3705	*Eucalyptus oleosa* ssp. *ampliata* mid open mallee forest over *Sclerolaena diacantha* (mixed) shrubs
MN4001	*Avicennia marina* ssp. *marina* low open forest over *Tecticornia* sp., *Sarcocornia quinqueflora* shrubs
SE0095	*Melaleuca uncinata* mid shrubland
SM4001	*Sarcocornia quinqueflora* (mixed) low shrubland over *Atriplex paludosa* ssp. (mixed) low shrubs
SM4005	*Tecticornia* sp. low open shrubland over *Parapholis incurva* (mixed) low tussock grasses
YP0601	*Eucalyptus porosa* mid open mallee woodland over *Melaleuca lanceolata* tall shrubs and *Bursaria spinosa* ssp. mid shrubs and *Gahnia lanigera*, *Lepidosperma congestum* (NC) low sedges
YP0603	*Eucalyptus porosa* low open woodland over *Gahnia lanigera* (mixed) low sedges
YP0604	*Eucalyptus porosa* low open woodland over *Senna artemisioides* ssp. *petiolaris* (mixed) tall shrubs and *Enchylaena tomentosa* var. *tomentosa* low shrubs
YP0605	*Eucalyptus porosa* mid open mallee woodland over *Melaleuca lanceolata* mid shrubs and *Acrotriche patula* low shrubs and *Gahnia lanigera* low shrubs
YP0606	*Eucalyptus porosa* mid mallee woodland over *Melaleuca uncinata* tall shrubs and *Gahnia lanigera* low sedges
YP0608	*Eucalyptus porosa* mid open mallee woodland over *Melaleuca lanceolata* tall shrubs and *Bursaria spinosa* ssp. low shrubs and *Helichrysum leucopsideum*, *Gahnia lanigera* low tussock grasses
YP0701	*Allocasuarina verticillata* low woodland over *Olearia axillaris* mid shrubs and *Rhagodia candolleana* ssp. *candolleana* low shrubs and *Lagurus ovatus* low tussock grasses
YP0703	*Allocasuarina verticillata* low woodland over *Exocarpos aphyllus*, *Bursaria spinosa* ssp. tall shrubs and *Beyeria lechenaultii*, *Acrotriche patula* low shrubs and *Lepidosperma congestum* (NC) low tussock grasses
YP0704	*Allocasuarina verticillata* low woodland over *Bursaria spinosa* ssp. tall shrubs and *Lepidosperma congestum* (NC) (mixed) low sedges
YP0705	*Allocasuarina verticillata* low open woodland over *Acacia paradoxa* tall shrubs
YP0801	*Melaleuca lanceolata* low woodland

SA Veg ID	Description
YP0802	*Melaleuca lanceolata* low woodland over *Exocarpos aphyllus* mid shrubs and *Acrotriche patula* low shrubs
YP0803	*Allocasuarina verticillata* low woodland over *Melaleuca lanceolata* tall shrubs and *Lasiopetalum discolor* mid shrubs and *Rhagodia candolleana* ssp. *candolleana* low shrubs
YP0804	Emergent *Eucalyptus socialis* ssp. mid mallee trees over *Melaleuca lanceolata* tall shrubland and *Rhagodia candolleana* ssp. *candolleana* (mixed) low shrubs and *Threlkeldia diffusa* (mixed) low shrubs
YP0805	*Melaleuca lanceolata* low woodland over *Lycium ferocissimum* tall shrubs and *Austrostipa* sp.,*Moraea setifolia* low forbs
YP0807	*Melaleuca lanceolata, Eucalyptus porosa* mid open woodland over *Acacia ligulata* tall shrubs and *Austrodanthonia caespitosa* (mixed) low tussock grasses
YP0808	*Melaleuca lanceolata* mid mallee woodland over *Exocarpos aphyllus* mid shrubs and *Acrotriche patula* low shrubs
YP0809	emergent *Melaleuca lanceolata* low trees over *Templetonia retusa, Acacia nematophylla* mid open shrubland and *Carpobrotus rossii* (NC) low shrubs
YP1001	*Eucalyptus diversifolia* ssp. *diversifolia* mid open mallee forest over *Templetonia retusa*, *Melaleuca lanceolata* mid shrubs and *Acrotriche patula*, *Correa pulchella* low shrubs
YP1002	*Eucalyptus diversifolia* ssp. *diversifolia* low open mallee forest over *Melaleuca lanceolata* mid shrubs and *Acrotriche cordata*, *Lasiopetalum discolor* low shrubs
YP1003	*Eucalyptus diversifolia* ssp. *diversifolia* low open mallee shrubland over *Gahnia lanigera* low shrubs
YP1004	*Eucalyptus diversifolia* ssp. *diversifolia* mid mallee woodland over *Melaleuca lanceolata* tall shrubs and *Templetonia retusa* mid shrubs and *Beyeria lechenaultii*, *Lasiopetalum discolor* low shrubs and *Acrotriche patula* low shrubs
YP1102	*Eucalyptus dumosa* mid mallee woodland over *Melaleuca acuminata* ssp. *acuminata* tall shrubs and *Gahnia lanigera* low shrubs
YP1201	*Eucalyptus gracilis* mid mallee woodland over *Melaleuca lanceolata* tall shrubs and *Acacia notabilis* mid shrubs and *Rhagodia parabolica* low shrubs and *Enchylaena tomentosa* var. *tomentosa* low shrubs
YP1301	*Eucalyptus incrassata* mid open mallee woodland over *Melaleuca uncinata* tall shrubs and *Baeckea crassifolia* (mixed) low shrubs
YP1401	*Eucalyptus leptophylla*, *Eucalyptus phenax* ssp. mid mallee woodland over *Melaleuca uncinata* tall shrubs and *Melaleuca acuminata* ssp. *acuminata* mid shrubs and *Acrotriche patula* low shrubs and *Austrodanthonia setacea*
YP1502	*Melaleuca pauperiflora* ssp. *mutica* low woodland over *Melaleuca lanceolata* tall shrubs and *Rhagodia candolleana* ssp. *candolleana* low shrubs and *Threlkeldia diffusa* low shrubs
YP1603	*Eucalyptus phenax* ssp. mid open mallee woodland over *Melaleuca acuminata* ssp. *acuminata* tall shrubs and *Alyxia buxifolia* mid shrubs and *Acrotriche patula* low shrubs and *Gahnia lanigera* low sedges
YP1701	*Eucalyptus diversifolia* ssp. *diversifolia*, *Eucalyptus rugosa* mid mallee woodland over *Melaleuca lanceolata* tall shrubs and *Templetonia retusa* mid shrubs and *Acrotriche patula*, *Beyeria lechenaultii* low shrubs and *Pimelea serpyllifolia* ssp. *serpyllifolia*
YP1801	*Eucalyptus socialis* ssp. (mixed) mid open mallee forest over *Melaleuca acuminata* ssp. *acuminata* tall shrubs and *Melaleuca lanceolata* mid shrubs and *Gahnia deusta* mid sedges and *Correa backhouseana* var. *coriacea*, *Gahnia lanigera* low shrubs
YP1804	*Eucalyptus socialis* ssp. mid mallee woodland over *Melaleuca lanceolata* tall shrubs and *Gahnia deusta* mid sedges and *Acrotriche patula* low shrubs
YP1805	*Eucalyptus socialis* ssp. mid mallee woodland over *Melaleuca uncinata* tall shrubs and *Gahnia lanigera* low sedges

SA Veg ID	Description
YP2201	*Olearia axillaris* mid sparse shrubland over *Rhagodia candolleana* ssp. *candolleana* low shrubs and *Carpobrotus rossii* (NC) (mixed) low forbs
YP2302	*Olearia axillaris* mid open shrubland over *Poa poiformis* var. *poiformis*, *Lagurus ovatus* low shrubs
YP2402	emergent *Eucalyptus porosa* mid trees over *Alyxia buxifolia* mid open shrubland and *Rhagodia candolleana* ssp. *candolleana* low shrubs and *Helichrysum leucopsideum* low tussock grasses
YP2601	*Bursaria spinosa* ssp. mid sparse shrubland over *Acrotriche patula* low shrubs and *Bromus diandrus*, *Lepidosperma congestum* (NC) low tussock grasses
YP2701	*Callitris canescens* mid sparse shrubland over *Gahnia lanigera* low sedges
YP2901	*Geijera linearifolia* tall open shrubland over *Austrostipa platychaeta* low shrubs and *Enchylaena tomentosa* var. *tomentosa*, *Gahnia lanigera* low shrubs
YP3001	*Lasiopetalum discolor*, *Melaleuca lanceolata* ssp. *lanceolata* (NC) low shrubland over *Pultenaea tenuifolia* (mixed) low shrubs
YP3201	*Olearia axillaris* mid open shrubland over *Ficinia nodosa* low shrubs and *Senecio pinnatifolius* (NC) low shrubs
YP3402	*Myoporum insulare* (mixed) low open shrubland over *Leiocarpa supina* (mixed) low forbs
YP3501	*Nitraria billardierei* (mixed) low shrubland over *Mesembryanthemum crystallinum* low forbs
YP3601	*Olearia axillaris* mid open shrubland over *Senecio pinnatifolius* (NC) (mixed) low shrubs
YP3602	emergent *Allocasuarina verticillata* mid trees over *Dodonaea viscosa* ssp. *spatulata* tall shrubland and *Alyxia buxifolia* mid shrubs and *Tetragonia implexicoma* low shrubs
YP3604	*Melaleuca lanceolata* tall open shrubland over *Olearia axillaris* mid shrubs and *Adriana quadripartita*, *Lepidosperma gladiatum* low shrubs
YP3701	*Beyeria lechenaultii* low shrubland over *Senecio pinnatifolius* (NC) low shrubs
YP3801	emergent *Callitris gracilis* mid trees over *Senna artemisioides* ssp. *petiolaris* (mixed) mid open shrubland
YP4101	*Austrodanthonia caespitosa* (mixed) low open tussock grassland over *Gahnia deusta* (mixed) low forbs
YP4401	*Gahnia lanigera* (mixed) low sedgeland over *Linum strictum* ssp. *strictum* low tussock grasses
YP4501	*Lepidosperma congestum* (NC) low sedgeland over *Medicago minima* var. *minima*, *Bromus diandrus* low tussock grasses

Table A-2: Threatened flora species recorded or predicted in PEL 687 on Yorke Peninsula[1]

Scientific name	Common name	Status[2]		Source[3]
		Cth	SA	
Acacia enterocarpa	Jumping-jack Wattle	EN	E	1,2
Acacia rhetinocarpa	Resin Wattle	VU	V	1
Acacia rhetinocarpa	Neat Wattle, Resin Wattle (SA)	VU	V	2
Angianthus phyllocalymmeus	Silver Candles	VU		2
Austrostipa nullanulla	Club Spear-grass		V	1
Billardiera sp. Yorke Peninsula (P.C.Heyligers 80164)	Lehmann's Apple-berry		E	1
Caladenia brumalis	Coast Spider-orchid	EN	E	1,2
Caladenia intuta	Ghost Spider Orchid	CR	E	1,2

Scientific name	Common name	Status[2]		Source[3]
		Cth	SA	
Caladenia macroclavia	Large-club Spider-orchid	EN	E	1,2
Caladenia tensa	Inland Green-comb Spider-orchid, Rigid Spider-orchid	EN		1,2
Corybas expansus	Dune Helmet-orchid		V	1
Daviesia sejugata	Disjunct Bitter-pea		E	1
Diuris behrii	Behr's Cowslip Orchid		V	1
Dodonaea subglandulifera	Peep Hill Hop-bush	EN	E	1
Euphrasia collina ssp. *osbornii*	Osborn's Eyebright	EN	E	1,2
Leptorhynchos elongatus	Lanky Buttons		E	1
Olearia microdisca	Small-flower Daisy-bush	EN	E	1
Olearia pannosa ssp. *pannosa*	Silver Daisy-bush, Silver-leaved Daisy, Velvet Daisy-bush	VU	V	1,2
Phebalium glandulosum ssp. *macrocalyx*	Glandular Phebalium		E	1
Pleuropappus phyllocalymmeus	Silver Candles	VU	V	1
Poa meionectes	Fine-leaf Tussock-grass		V	1
Prasophyllum calcicola	Limestone Leek-orchid		V	1
Prasophyllum goldsackii	Goldsack's Leek-orchid	EN	E	1, 2
Prasophyllum validum	Sturdy Leek-orchid, Mount Remarkable Leek-orchid	VU	V	2
Pteris tremula	Tender Brake			1
Pterostylis xerophila	Desert Greenhood	VU	V	2
Ranunculus sessiliflorus var. *pilulifer*	Annual Buttercup		V	1
Sarcozona bicarinata	Ridged Noon-flower		V	1
Senecio macrocarpus	Large-fruit Groundsel, Large-fruit Fireweed,	VU	V	1,2
Stackhousia annua	Annual Candles, Annual Stackhousia	VU	V	1,2
Swainsona pyrophila	Yellow Swainson-pea	VU		2
Tecticornia flabelliformis	Bead Samphire	VU	V	1

[1] Search area encompassed the PEL and a buffer of 5 km. Database records and species conservation status were current at the time of searching (October 2022).

[2] Conservation status under the SA *National Parks and Wildlife Act* 1972 and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*: V / VU = Vulnerable, E / EN= Endangered, CR = Critically endangered, EX = Extinct.

[3] Source: 1 = Biological Databases of South Australia (Recordset number DEWNRBDBSA220517-1); 2 = Protected Matters Search Tool (https://pmst.awe.gov.au)

Note: In addition to these threatened species, a number of species listed as Rare under the NPW Act have also been recorded in the PEL.

Table A-3: Threatened fauna species recorded or predicted in PEL 687 on Yorke Peninsula[1]

Scientific name	Common name	Status[2]		Source[3]
		Cth	SA	
Birds				
Acanthiza iredalei rosinae	Samphire Thornbill or Slender-billed Thornbill Gulf St Vincent)	VU	V	1,2
Ardeotis australis	Australian Bustard		V	1
Botaurus poiciloptilus	Australasian Bittern	EN	E	2
Calidris canutus rogersi	Red Knot (ssp. rogersi)	EN	E	1,2
Calidris ferruginea	Curlew Sandpiper	CR	E	1,2
Calidris tenuirostris	Great Knot	CR	E	1,2
Charadrius leschenaultii leschenaultii	Greater Sand Plover	VU	R	1,2
Charadrius mongolus mongolus	Lesser Sand Plover	EN	E	1,2
Cladorhynchus leucocephalus	Banded Stilt		V	1
Coturnix ypsilophora australis	Brown Quail		V	1
Diomedea antipodensis	Antipodean Albatross	VU		2
Diomedea epomophora	Southern Royal Albatross	VU	V	2
Diomedea exulans	Wandering Albatross	VU	V	2
Diomedea sanfordi	Northern Royal Albatross	EN	E	2
Elanus scriptus	Letter-winged Kite		V	1
Falco hypoleucos	Grey Falcon	VU	R	2
Grantiella picta	Painted Honeyeater	VU	R	2
Haliaeetus leucogaster	White-bellied Sea Eagle		E	1
Halobaena caerulea	Blue Petrel	VU	R	2
Ixobrychus dubius	Black-backed Bittern (Australian Little Bittern)		E	1
Leipoa ocellata	Malleefowl	VU	V	1,2
Limosa lapponica baueri	Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit	VU	R	1,2
Macronectes giganteus	Southern Giant-Petrel	EN	V	2
Macronectes halli	Northern Giant Petrel	VU		2
Neophema chrysogaster	Orange-bellied Parrot	CR	E	2
Numenius madagascariensis	Eastern Curlew, Far Eastern Curlew	CR	E	1, 2
Pachyptila turtur subantarctica	Fairy Prion (southern)	VU		2
Pandion cristatus	Eastern Osprey		E	1
Pedionomus torquatus	Plains-wanderer	CR	E	1, 2
Pezoporus occidentalis	Night Parrot	EN	E	2
Phoebetria fusca	Sooty Albatross	VU	E	2
Psophodes leucogaster leucogaster	Mallee Whipbird	VU	E	1, 2
Pterodroma mollis	Soft-plumaged Petrel	VU		2

Scientific name	Common name	Status[2]		Source[3]
		Cth	SA	
Rostratula australis	Australian Painted Snipe	EN	E	2
Stagonopleura guttata	Diamond Firetail		V	1
Stercorarius antarcticus lonnbergi	Brown Skua		V	1
Sternula albifrons sinensis	Little Tern		E	1
Sternula nereis nereis	Australian Fairy Tern	VU	E	1, 2
Thalassarche carteri	Indian Yellow-nosed Albatross	VU	E	1, 2
Thalassarche cauta cauta	Shy Albatross	EN	V	1, 2
Thalassarche impavida	Campbell Albatross, Campbell Black-browed Albatross	VU	V	2
Thalassarche melanophris	Black-browed Albatross	VU		1, 2
Thalassarche steadi	White-capped Albatross	VU		2
Thinornis cucullatus cucullatus	Eastern Hooded Plover	VU	V	1, 2
Zanda funerea whiteae	Yellow-tailed Black Cockatoo		V	1
Mammals				
Arctocephalus tropicalis	Subantarctic Fur Seal	EN	E	1
Balaenoptera musculus	Blue Whale	EN	E	2
Eubalaena australis	Southern Right Whale	EN	V	1, 2
Megaptera novaeangliae	Humpback Whale		V	1
Miniopterus orianae bassanii	Large Bent-winged Bat	CR	E	1
Neophoca cinerea	Australian Sea-lion	EN	V	1
Reptiles				
Aprasia pseudopulchella	Flinders Ranges Worm-lizard	VU		2
Caretta caretta	Loggerhead Turtle	EN	E	2
Chelonia mydas	Green Turtle	VU	V	1, 2
Dermochelys coriacea	Leatherback Turtle	EN	V	1,2
Notechis scutatus	Tiger Snake	ssp		1
Tiliqua adelaidensis	Pygmy Blue-tongue Lizard, Adelaide Blue-tongue Lizard	EN	E	2
Varanus rosenbergi	Heath Goanna		V	1
Sharks				
Carcharodon carcharias	White Shark, Great White Shark	VU		2

[1] Search area encompassed the PEL and a buffer of 5 km. Database records and species conservation status were current at the time of searching (October 2022).

[2] Conservation status under the SA *National Parks and Wildlife Act* 1972 and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*: R = Rare, V / VU = Vulnerable, E / EN= Endangered, CR = Critically endangered, EX = Extinct.

[3] Source: 1 = Biological Databases of South Australia (Recordset number DEWNRBDBSA220517-1); 2 = Protected Matters Search Tool (https://pmst.awe.gov.au)

Note: In addition to these threatened species, a number of species listed as Rare under the NPW Act have also been recorded in the PEL.

Table A-4: Priority pest plants in the Yorke District[1]

Scientific name	Common name	Management Strategy	Status
Priority plants for Yorke District			
Lycium ferocissimum	African boxthorn	manage weed	WoNS[2]
Chrysanthemoides monilifera ssp. *monilifera*	Boneseed	destroy infestations	WoNS
Asparagus declinatus	Bridal veil	destroy infestations	WoNS
Cenchrus ciliaris	Buffel grass	destroy infestations	Declared plant
Oncosiphon suffruticosum	Calomba Daisy	contain spread	Declared plant
Tribulus terrestris	Caltrop	manage weed	Declared plant
Rhaponticum repens	Creeping knapweed	destroy infestations	Declared plant
Marrubium vulgare	Horehound	manage weed	Declared plant
Alternanthera pungens	Khaki weed	alert weed - eradicate	Declared plant
Diplotaxis tenuifolia	Lincoln Weed	manage weed	Declared plant
Solanum elaeagnifolium	Silverleaf nightshade	contain spread	WoNS
Other declared local action pest plants			
Pinus halepensis	Aleppo pine		Declared plant
Arctotheca populifolia	Beach daisy		Local action
Acacia cyclops	Western Coastal Wattle		Local action
Reseda lutea	Cutleaf mignonette		Declared plant
Cenchrus setaceus	Fountain grass		Declared plant
Gazania sp.	Gazania		Declared plant
Cenchrus longispinus and *C. incertus*	Innocent weed		Declared plant
Olea europaea	Olive		Declared plant
Polygala myrtifolia var. myrtifolia	Polygala		Declared plant
Ratama raetam	White weeping broom		Declared plant

[1] Source: Natural Resources Northern and Yorke. *Managing pest plants – Pest plant control in the Yorke District*. https://cdn.environment.sa.gov.au/landscape/docs/ny/2019_managing_pest_plants_yorke_district_fact_sheet.pdf

[2] Weed of National Significance.

Appendix B: Summary of Issues Raised - Stakeholder Consultation undertaken by Gold Hydrogen (May 2023)

Note: This table will be compiled (and the EIR and SEO updated where required in response to the comments) following Gold Hydrogen's initial stakeholder consultation on the draft EIR and SEO, to be undertaken in May 2023

Table B-1: Summary of stakeholder comments and Gold Hydrogen Responses

No.	Submitter	EIR / SEO Reference	Comment issue raised	Response
General				
EIR				
SEO				