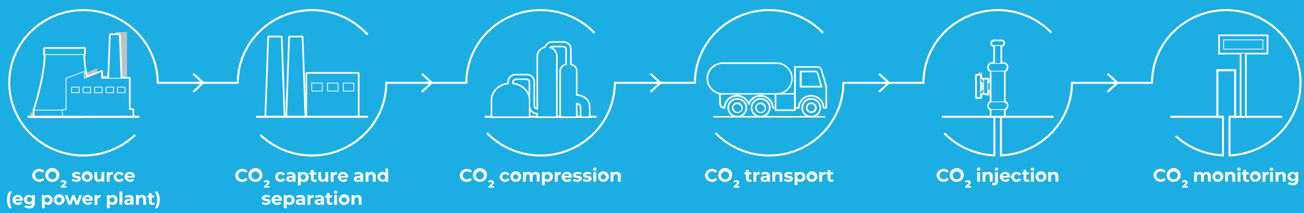
CTSCo
Carbon Transport & Storage

A GLENCORE Company



Surat Basin Carbon Capture and Storage Project

CHAPTER 02: PROPOSED PROJECT DESCRIPTION

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2. Proposed Project Description

2.1 Introduction

This chapter builds on the brief description of the Project in Chapter 1, section 1.2, and describes the Project's need, alternatives considered, inter-related projects, and infrastructure and activities.

Details on the various activities, potential impacts and mitigation measures that have already been considered and incorporated into the Project's scope are provided across the phases of construction, operation, monitoring and rehabilitation.

For context, information is also provided on the exploration and appraisal activities that are already permitted under the Environmental Authority (EA EPPG00646913) held for EPQ10.

2.2 Prospectivity of CO_2 Geological Storage

In 2011, the Queensland Government published "*An assessment of Queensland's CO_2 geological storage prospectivity – The Queensland CO_2 Geological Storage Atlas*" (Bradshaw et al 2011), identifying that the Surat Basin has the potential to store 2,962 million tonnes (Mt) of CO_2, as shown in Figure 2-1. CTSCo has subsequently explored both the northern Surat Basin (EPQ7) and the southern Surat Basin (EPQ10) for storage potential and holds the view that the southern Surat Basin is a viable region for safe and cost-effective permanent CO_2 storage.

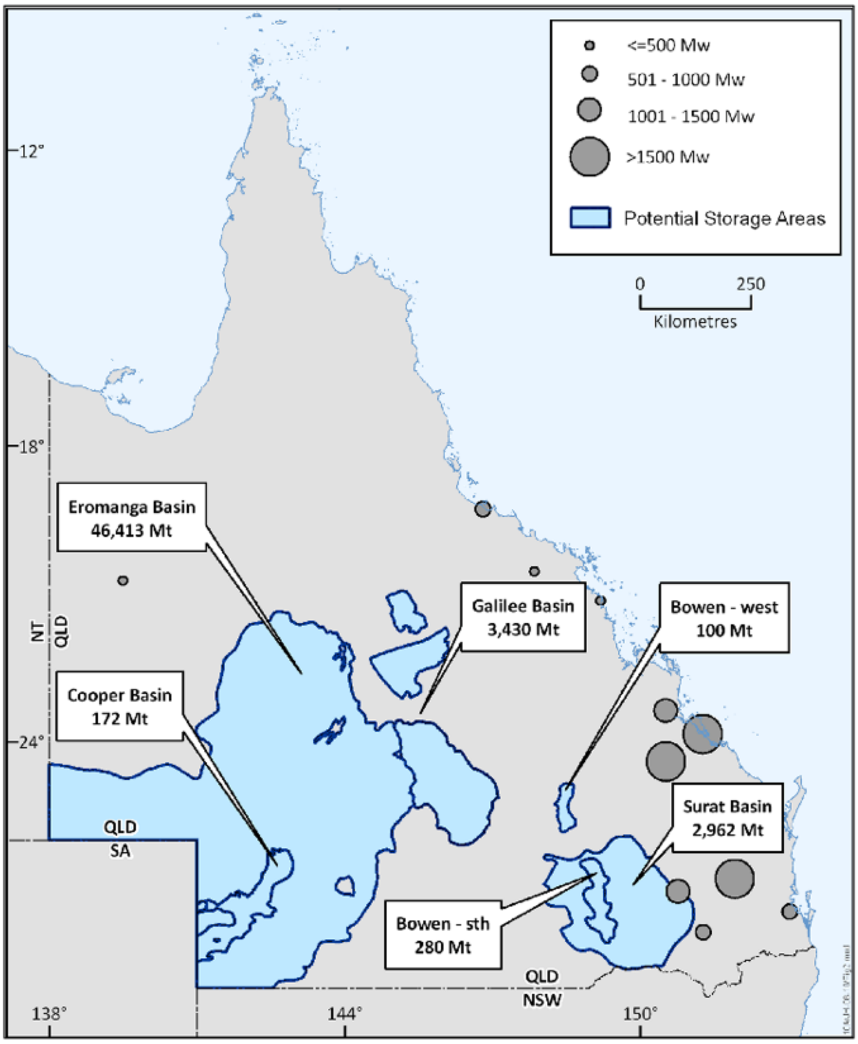

Figure 2-1 Potential Greenhouse Gas Storage areas in Queensland (Bradshaw *et al*, 2011, Figure 2)

2.3 Project Need

2.3.1 Australia's Technology Challenges and Opportunities

Australia is endowed with significant energy resources, both fossil fuel and renewable. Fossil fuels have underpinned Australia's standard of living for generations via direct and indirect employment, domestic power generation and export earnings. Building on this prosperity, Australia is now well-positioned to further benefit from this energy abundance by using newer technologies, including renewables and hydrogen. However, fossil fuels will continue to play an important part in Australia's energy mix for at least the short to medium-term. In addition, the associated CO_2 emissions from energy production and other industrial processes such as the production of cement, steel and fertiliser, present a challenge to Australia in meeting its emissions targets.

CCS presents a significant opportunity for Australia to reduce CO_2 emissions, and export emissions reduction expertise to other countries, while simultaneously building our renewable energy and hydrogen economies.

The key advantages of CCS for GHG emissions reduction include:

- direct capture of emissions from a point source could be economically feasible with a potential future price mechanism;
- potential to reduce emissions from existing hard to abate industries that generate CO_2 emissions with current technology, e.g. cement manufacturing, steel manufacturing, fertiliser production, and chemical manufacturing;
- proving the viability of CO_2 storage is an essential prerequisite if direct air capture (DAC) is required in the future;
- CTSCo's injection testing seeks to evaluate the feasibility of GHG stream storage in the Surat Basin for potential future large-scale CO_2 storage; and
- CTSCo's EPQ10 GHG exploration permit offers the ability to carry out exploration for the purpose of finding GHG stream storage sites for a future large-scale CCS Hub to enable a range of carbon capture projects within a geographical area.

The Clean Energy Regulator (CER) has developed the "*Carbon Capture and Storage Method 2021 – Simple Method Guide*" (CER, V1 September 2021) under the Emissions Reduction Fund to incentivise emissions avoidance CCS projects in Australia.

2.3.2 Technology Investment for CO_2 Abatement

2.3.2.1 INTERNATIONAL

The International Energy Agency (IEA) Report, "*Net Zero by 2050, A Roadmap for the Global Energy Sector*" (May 2021), states that for a net-zero scenario (NZE), carbon capture, utilisation and storage (CCUS) "*can facilitate the transition to net-zero CO_2 emissions by: tackling emissions from existing assets; providing a way to address emissions from some of the most challenging sectors; providing a cost-effective pathway to scale up low-carbon hydrogen production rapidly; and allowing for CO_2 removal from the atmosphere through* bioenergy equipped with CCUS *(BECCS) and* direct air capture with carbon capture and storage *(DACCS). … By 2030, 1.6 Gt CO_2 per year is captured globally, rising to 7.6 Gt CO_2 in 2050. Around 95% of total CO_2 captured in 2050 is stored in permanent geological storage and 5% is used to provide synthetic fuels. Estimates of global geological storage capacity are considerably above what is necessary to store the cumulative CO_2 captured and stored in the NZE.*" (IEA 2021, section 2.5.7).

The IEA released "*Australia 2023, Energy Policy Review*" (April 2023) which is an in-depth review providing insight and advice to the Australian Government on how to best achieve their energy and climate goals. The report discusses the Australian Government's approach to CCS, stating that "*Australia is well-suited to large-scale deployment of CCS to facilitate domestic CO_2 abatement and support regional emissions reductions*" (IEA 2023, p.101) with CTSCo's Project mentioned as one of 16 projects in operation or development. The report notes that "*CCS is now an eligible technology under Australia's Carbon Crediting Scheme. As a result, CCS projects can earn credits for every tonne of emissions reduced or stored*" (IEA 2023, 102).

Retrofitting coal and gas-fired power plants with CCS or co-firing with hydrogen-based fuels can enable existing fossil fuel fired power plants to contribute to the transition to a NZE economy.

Globally, the technology to capture, transport and inject a GHG stream into a deep reservoir is well proven.

Table 2-1 summarises the commercial CCS facilities, as of 31 July 2023 by number and total capacity (Global CCS Institute, 2023, Figure 3.1-2).

Table 2-1 Commercial CCS Facilities as of 31 July 2023 by Number and Total Capacity

	Operational	In Construction	Advanced Development	Early Development	Total
Number of facilities	41	26	121	204	392
Capture capacity (Mtpa)	49	32	144	135	361

An internationally analogous CCS project is SaskPower's Aquistore/Boundary Dam Project in Canada, an industrial-scale CCUS project capturing and storing over 4.2 Mt of CO_2 since 2015. The post combustion capture (PCC) plant was the world's first commercial-scale PCC plant, with injection of CO_2 into saline sandstone aquifers of the Winnipeg and Deadwood formations, occurring at 3,200m underground, with each formation approximately 150 m thick. Monitoring of the CO_2 plume with regular seismic surveys and down-hole logs in the monitoring wells shows that CO_2 has been securely retained in the reservoir with no adverse environmental impacts or induced seismicity observed (SaskPower, July 2023).

2.3.2.2 AUSTRALIA

In 2021, the Australian Government published "*Australia's Long-Term Emissions Reduction Plan, A whole-of-economy Plan to achieve net zero emissions by 2050*" and the associated document "*Australia's Long-Term Emissions Reduction Plan: Modelling and Analysis*" (Commonwealth of Australia, 2021 a and b). The NZE Plan identifies CCS as part of "*unlocking the critical pathways to net zero by 2050 for Australia's economic sectors*" (CoA, 2021a, p.45). The Modelling and Analysis identifies CCS as one of six priority low emissions technologies, stating that the Surat Basin, in addition to other basins within the nation, "*host carbon storage sites at an advanced stage of development, and each have genuine industry interest and support*" (CoA, 2021b, p.25).

The Modelling and Analysis built upon the Australian Government's "*Low Emissions Technology Statement 2021*" (DISER, 2021) which includes a stretch goal for CO_2 compression, transport and storage to be available for under $20 per tonne of CO_2.

On 16 June 2022, the Australian Government lodged an updated Nationally Determined Contribution (NDC) with the United Nations Framework Convention on Climate Change (UNFCCC) secretariat, as part of Australia's obligations under the Paris Agreement. The updated NDC commits Australia to reducing its emissions to 43% below 2005 levels by 2030 (DCCEEW, 2022).

On 14 September 2022, the *Climate Change Act 2022* (Cth) came into force, with s.10 stipulating:

(1) Australia's greenhouse gas emissions reduction targets are as follows:
- *a. reducing Australia's net greenhouse gas emissions to 43% below 2005 levels by 2030:*
  - *i. implemented as a point target; and*
  - *ii. implemented as an emissions budget covering the period 2021-2030;*
- b. *reducing Australia's net greenhouse gas emissions to zero by 2050.*

The *Climate Change Act 2022*, s.12 also requires that the Minister prepare an Annual Climate Change Statement within 6 months of the end of each financial year, and under Part 4 the Climate Change Authority is to give advice to the Minister on preparation of the Annual Climate Change Statement and on greenhouse gas emissions reduction targets to be included in a new or adjusted nationally determined contribution.

In April 2023 the Climate Change Authority released "*Reduce, remove and store: The role of carbon sequestration in accelerating Australia's decarbonisation*" (CCA, 2023) which outlines 23 policy insights summarising Australia's position in relation to carbon sequestration potential.

Australia's installations of CCS include:

- Western Australia: Chevron's Gorgon Carbon Dioxide Injection Project is an industrial-scale development which reported a total of 2.26 Mt of CO_2 injected for the period 1 July 2020 to 30 June 2021 from the Gorgon liquefied natural gas (LNG) facility, with capacity to inject up to 4 Mt per year of CO_2. CO_2 is injected into a sandstone formation over 2 km below surface of Barrow Island (Chevron Australia, 2021).
- Victoria: since 2003, CO2CRC has been operating the Otway International Test Centre in Nirranda South, designing and managing research in carbon capture, storage, utilisation and monitoring (CO2CRC, 2022).
- South Australia: Santos Moomba CCS Project is located in South Australia's Cooper Basin and aims to permanently store 1.7 Mt CO_2/y from 2023. Capture of CO_2 is from natural gas processing, and storage in former oil and gas reservoirs (IEA, 2023).

2.3.2.3 QUEENSLAND

In September 2022, the Queensland Government released the "*Queensland Energy and Jobs Plan*" (Queensland Government, 2022) outlining a vision of "*clean, reliable and affordable energy providing power for generations*" (2022, p.5). The Plan provides a number of goals, including that by 2035 there is no regular reliance on coal-fired generation (2022, p.7), and reducing electricity emissions to be 50% lower on 2005 levels by 2029-30 (2022, p.9). To make the ambitions of the Queensland Government clear, legislation will enshrine into law a 50% renewable energy target by 2030, and two new renewable energy targets, being 70% by 2032, and 80% by 2035. The Plan sets out actions across three focus areas to transform the Queensland energy system, being:

- *clean energy economy;*
- *empowered households and businesses; and*
- *secure jobs and communities* (2022, p.18 and 19).

The "*Queensland Energy and Jobs Plan*" builds on the Queensland Government's *"Pathways to a clean growth economy, Queensland Climate Transition Strategy"* (DEHP, 2017) which provided three key climate commitments:

- *powering Queensland with 50% renewable energy by 2030;*
- *doing our fair share in the global effort to arrest damaging climate change by achieving zero net emissions by 2050;*
- *demonstrating our commitment to reducing carbon pollution by setting an interim emissions reduction target of at least 30% below 2005 levels by 2030.*"

Queensland is Australia's highest CO_2 emitting state and is "*looking to find ways to offset that pollution in another part of the economy, such as increasing carbon storage in the landscape*."…"*Queensland has also set an interim target of at least a 30% reduction in greenhouse gas emissions by 2030, contingent on continued national and global action to meet the goals of the Paris Agreement. The purpose of this target is to guide Queensland policy makers and industry in their medium-term planning and investment, while providing a clear signpost for monitoring progress towards the 2050 target*." (DEHP, p6, 2017).

The Project will assist Queensland in meeting its emissions reduction targets. There are multiple CO_2 emitters within the region of the Project that may utilise CCS to help meet emissions reduction targets. Many decarbonisation actions may also produce co-benefits in areas such as health, amenity, and the environment (DEHP, 2017).

The GHG emission targets indicate that the Australian and Queensland Governments will rely on CCS projects during the transition phase to a low carbon economy, especially in the power, industrial and manufacturing sectors.

2.3.3 Glencore's Pathway to Net Zero Emissions

Glencore's position on climate change:

- supports the global climate change goals outlined in the United National Framework Convention on Climate Change (UNFCCC) and the Paris Agreement to limit the rise in global temperature to well below 2°C by the second half of this century;
- that only through collective global action can the world achieve the goals of the Paris Agreement and limit the impact of climate change, as well as deliver the United Nations Sustainable Development Goals, including universal access to affordable energy;
- recognises its responsibility to contribute to the global effort to achieve the goals of the Paris Agreement by decarbonising the company's operational emissions footprint. Glencore's contribution should be based on a holistic approach considering the company's total emissions footprint; and

- has a well-positioned portfolio that supports the transition to a low-carbon economy, while also meeting the need for universal access to reliable energy (Glencore, 2022).

Glencore plc's climate change commitments are "*in line with the ambitions of the 1.5°C scenarios set out by the Intergovernmental Panel on Climate Change (IPCC), we target a short-term reduction target of 15% by 2026 and a medium-term 50% reduction of our total (Scope 1, 2 and 3) emissions by 2035 on 2019 levels. Post-2035, our ambition is to achieve, with a supportive policy environment, net zero total emissions by 2050.*" (Glencore, 2022)

As outlined in Glencore plc's *Pathway to Net Zero 2021 Progress Report* (Glencore, 2021, p14) and *2022 Climate Report* (Glencore, 2023), Glencore recognises the importance of abatement mechanisms such as CCS, in addition to adapting to emerging pricing mechanisms, to achieving the goals of the Paris Agreement. Development and deployment of these mechanisms requires collective action; and Glencore is supporting these efforts directly and through policy advocacy. The Project is an example of this commitment.

For Glencore plc, CTSCo's Project and CCS generally, align with its global sustainability and climate change aspirations, indicating the importance that it places on direct carbon capture technology for the transition to a low carbon future.

2.3.4 Purpose of CTSCo's Injection Testing of a GHG stream

CCS presents one of the few technologies capable of abating large volumes of CO_2. If future large-scale CCS is to be adopted, feasible storage locations are required to be developed. Feasible storge is required irrespective if CO_2 is sourced from fossil fuel emissions or extracted directly from the atmosphere using direct air capture. The primary purpose of the proposed Project, being CTSCo's injection testing of a GHG stream, is to evaluate the feasibility of GHG stream (CO_2) storage by GHG storage injection testing in the Surat Basin to allow the later assessment of the region for potential future large-scale CO_2 storage. The Project has been scaled to adequately demonstrate the monitoring and verification technologies that would be required for any future large-scale GHG stream storage, with only a relatively small volume of GHG stream to be injected as part of the injection testing. The Project also seeks to provide confidence in the GHG stream storage technology for both the community and regulators via a successful fixed duration injection testing, and monitoring and verification program. Although the Project predicts to successfully abate CO_2 emissions, the reduction in CO_2 emissions from the injection testing alone are incidental. The aim of the GHG storage injection testing is to provide sufficient information to evaluate the feasibility of future large-scale GHG storage within the Surat Basin, and to allow timely decisions for potential development of a CCS hub in the region.

2.4 Inter-related Activities outside of EPQ10

2.4.1 GHG Stream Source

The GHG stream for the Project is to be sourced from a Post Combustion Capture (PCC) plant to be constructed immediately adjacent to the existing Millmerran Power Station (MPS) on lot 4 SP260880. The MPS is located approximately 100 km west of Toowoomba near the Millmerran township in the Toowoomba Regional Council local government area.

Millmerran Power Station is owned by Millmerran Power Partners (ABN 45 651 427 855). The Millmerran Power Station is a coal-fired power station, in operation for 19 years, and has an 850 MW capacity, typically supplying 6,300 GWh annually (Genuity, 2023).

The PCC plant will be owned by Glencore Carbon Capture Pty Limited (ABN 30 646 703 933). The PCC plant design is based on the Clean Energy Research Institute's (CERI's) Shanghai Shidongkou PCC plant in China. The Shidongkou plant has been in operation since 2009, producing both food and industrial-grade CO_2 for the local Chinese market.

The PCC plant will be located in the north-west corner of the MPS, with the land leased by Glencore Carbon Capture Pty Limited from Millmerran Power Partners. Figure 2-2 shows the layout of the PCC plant in relation to MPS. Site selection for the PCC plant considered the available space on the MPS site, distance to the flue gas stack, and site access for vehicle movements. Flue gas will be sourced from the MPS generating Unit 2. The major components of PCC plant will be manufactured in China to Australian Standards, and transported in modules to MPS, to be assembled by an Australian construction contractor.

The approvals associated with the construction and operation of the PCC plant have been sought by Millmerran Power Partners, with support from Glencore Carbon Capture Pty Limited. In 1999, the MPS was approved under Community Infrastructure Designation (CID) 8779 under the now repealed *Integrated Planning Act 1997*. For the PCC plant, amendment to the MPS site Ministerial Infrastructure Designation (MID) has been progressed by Millmerran Power Partners under the *Planning Act 2016*, with a MID minor amendment process followed. A MID minor amendment application was lodged on 5 May 2022 by Millmerran Power Partners to the Department of State Development, Infrastructure, Local Government and Planning (DSDILGP). The consultation phase ran from 28 May 2022 to 11 August 2022, with clarification sort from one entity. On 3 October 2023, Deputy Premier, the Minister for State Development, Infrastructure, Local Government and Planning and Minister Assisting the Premier on Olympic and Paralympic Games Infrastructure, gave notice that under section 38 of the *Planning Act 2016*, an amendment was made to the MID, with the decision to take effect from 6 October 2023.

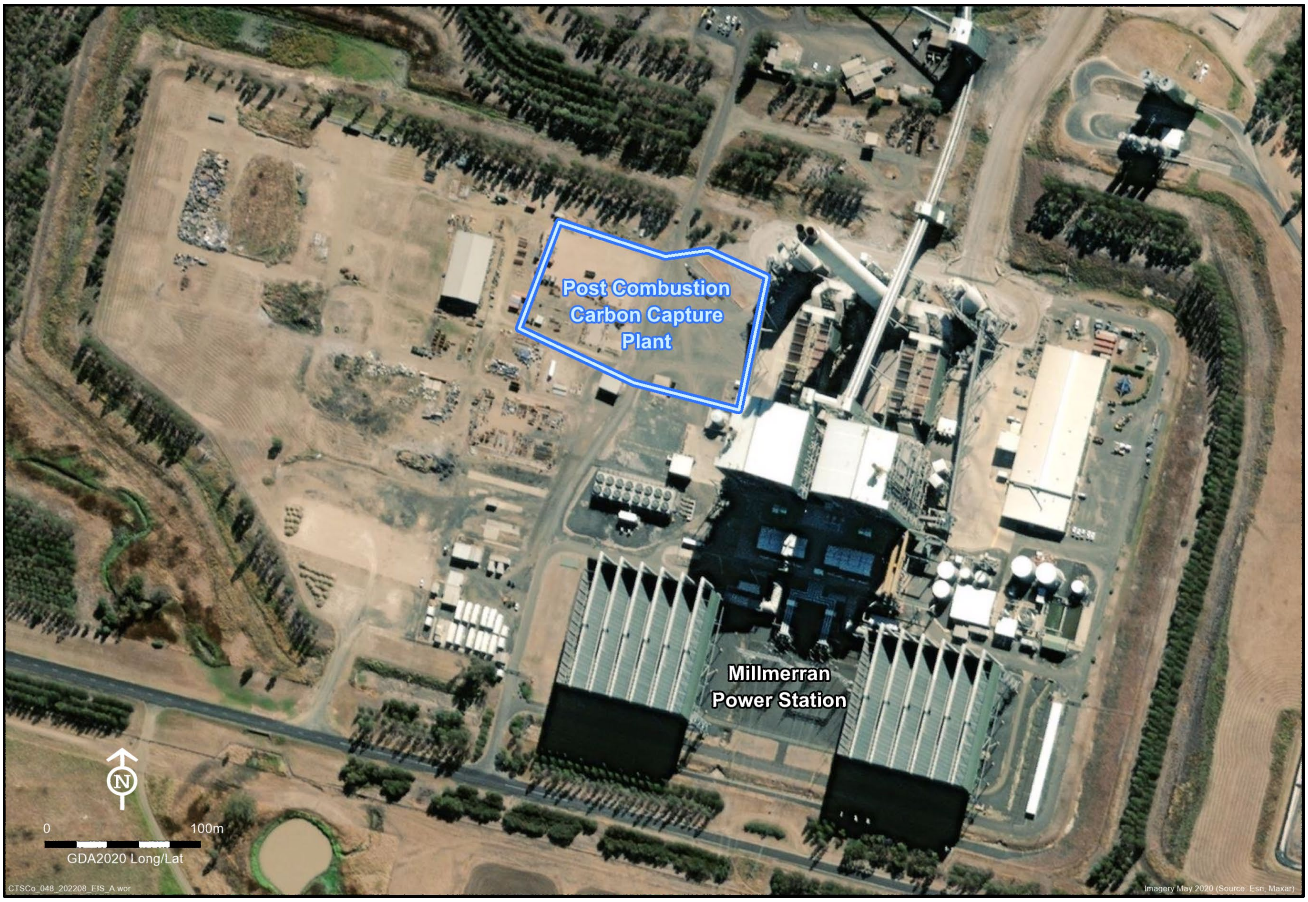

Figure 2-2 PCC Plant layout at Millmerran Power Station

Equipment manufacture for the PCC plant is anticipated to commence in 2024. Consistent with the *Greenhouse Gas Storage Act 2009* (GHG Act), s.12, the CO_2 product from the PCC plant is defined as a GHG stream for the purposes of GHG stream storage. The CO_2 will typically be more than 98% of the volume of the product stream from the PCC plant. Table 2-2 below outlines the product specifications anticipated to be available from the PCC plant. The PCC plant Guarantee Output Specification represents the worst-case GHG stream composition which would be accepted for the injection testing, while the CERI PCC plant actual operating output data is expected to be the typical composition of the GHG stream delivered for the injection testing.

Table 2-2 Proposed GHG Stream Composition

Constituent	Minimum Specification (Plant manufacturer's Guarantee Output Specification)	Expected Specification (CERI PCC Plant Actual Operating Output Data)
Carbon dioxide (CO_2)	>98 vol%	>99.5%
Water (H_2O)	<150 ppmV	<150 ppmV
Nitrogen / Argon / Hydrogen (N_2 / Ar / H_2)	<2%	<0.5%
Other Hydrocarbons	<0.1% v/v (1,000 ppmV)	0
Oxygen (O_2)	100 ppmV	~100-400 ppmV
Carbon monoxide (CO)	200 ppmV	0
Nitrogen oxides (NO_x expressed as NO_2)	33 ppmV	10~15 ppmV
Sulphur oxides (SO_x expressed as SO_2)	20 ppmV	2~5 ppmV
Particulates	10mg/m^3	<5 mg/m^3
Amines (MEA)	6 ppmV	~1 ppmV
Ethylene Glycol ($C_6H_6O_2$)	40 ppmV	0
Hydrogen Sulphide (H_2S)	15 ppmV	0
Other externalities	0	0

As per the *Guidance on Best Available Techniques and Best Environmental Practices* under Article 8 of the Minamata Convention on Mercury (UNEP, 2019), and the specification of the proposed GHG stream composition in Table 2-2, no mercury is anticipated to be present in the GHG stream.

The CO_2 product (GHG stream) will be stored at the PCC plant in two 200 tonne CO_2 Storage Tanks. The CO_2 will be held as a cryogenic liquid at 332 psi (2.29 MPa) and -20°C. Further details on the transport of CO_2 (GHG stream) to CTSCo's GHG stream storage site in EPQ10 is discussed section 2.10.1 below.

2.5 EPQ10 GHG Exploration Tenement Description

The EPQ10 GHG exploration tenement is made up of 1,200 sub-blocks, covering 3,664 km^2, located in the Surat Basin, as shown in **Error! Reference source not found.**.

EPQ10 overlaps or is adjacent to various resource tenements, as shown in **Error! Reference source not found.**. Overlapping tenements are:

- one petroleum lease (PL 1) held by Bridgeport (Surat Basin) Pty Ltd, being a subsidiary of New Hope Corporation Limited, for the purposes of production of petroleum (oil and conventional gas);
- four authorities to prospect (ATPs):
  - ATPs 2037 and 2038 held Cypress Petroleum Pty Ltd, being a subsidiary of Omega Oil and Gas Limited;
  - ATP 2044 held by Energy Capture Pty Limited, being a subsidiary of Elixir Energy Limited;
  - ATP 2045 held by Santos QNT Pty Ltd being a subsidiary of Santos Limited, and Starzap Pty Ltd, being a subsidiary of Shell plc; and
- one petroleum pipeline licence (PPL 6) being the Jackson to Moonie Pipeline for the transmission of oil held by Santos Limited.

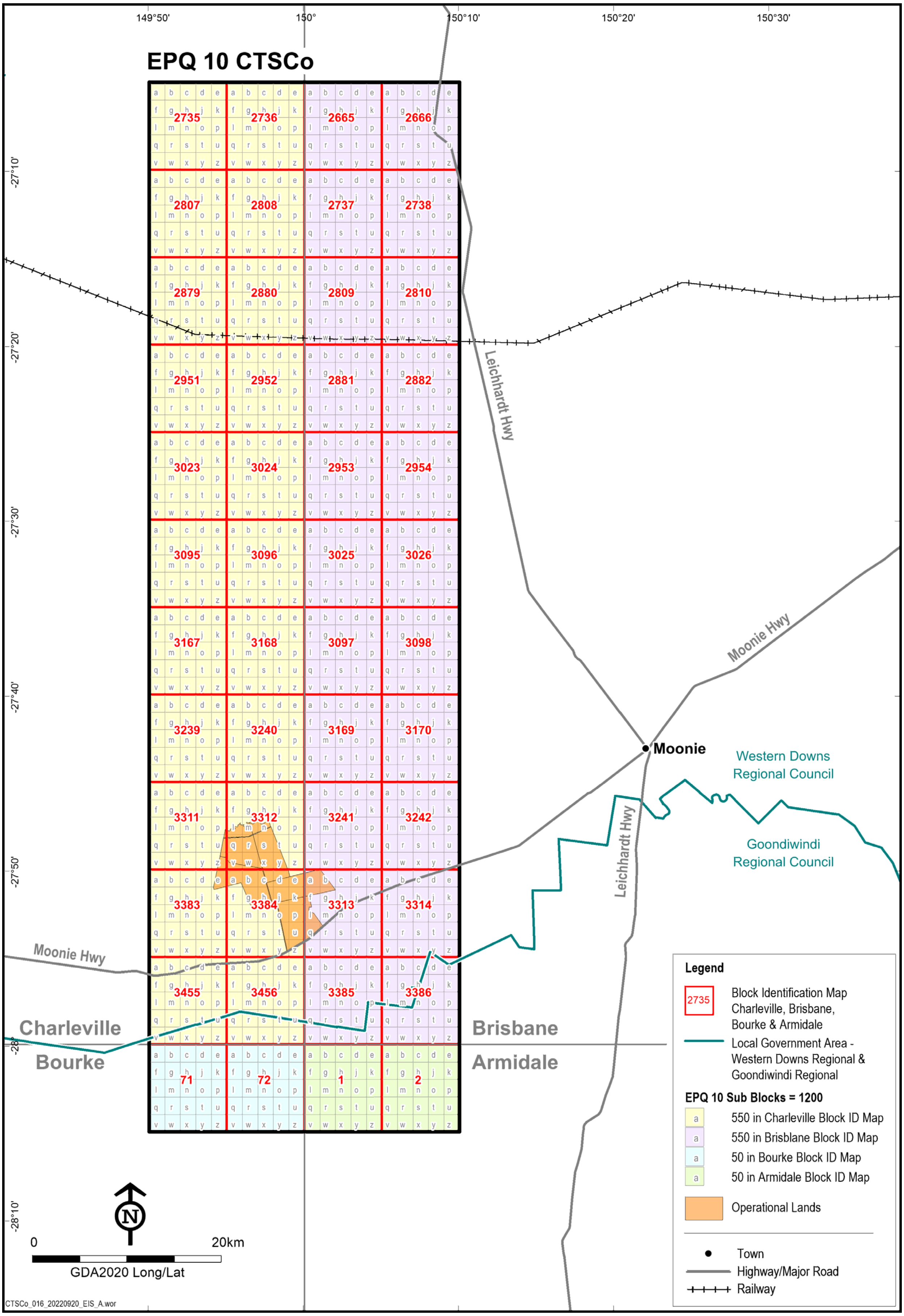

Figure 2-3 EPQ10 sub-blocks

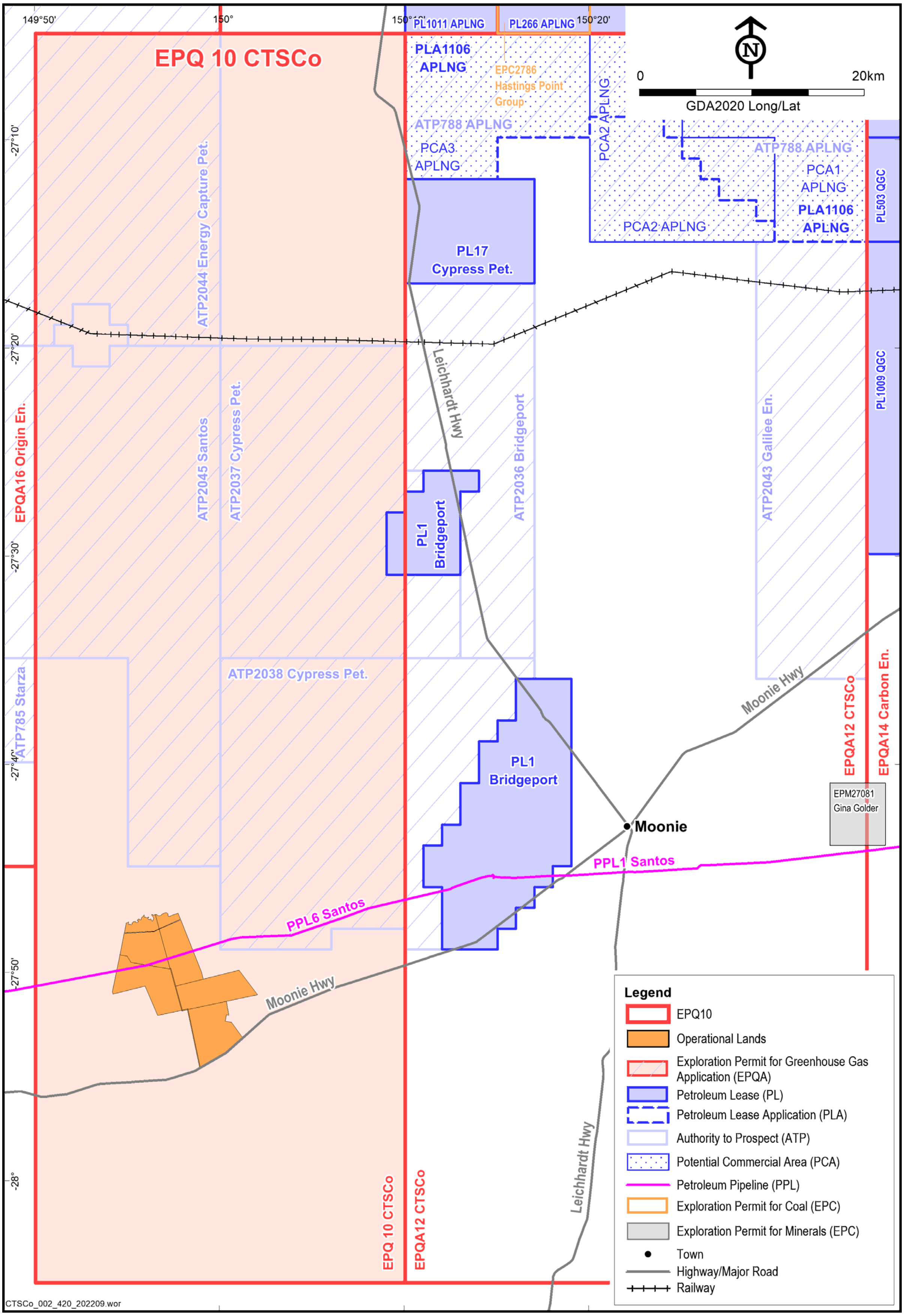

Figure 2-4 Overlapping or Adjacent Resource Authorities with EPQ10

2.6 Proposed Project Site and Locality Description

The Project is a greenfield site development located approximately 44 km south-west of Moonie township and 27 km east of Westmar township, being the closest population centres. The Harts Road entry to the GHG stream storage site for injection testing is from the Moonie Highway.

The *Environmental Protection Act 1994* (EP Act) s.39 defines operational land as "*the land on which the project is to be carried out*." In developing the Project, consideration of an affected person as defined under EP Act s.38 is required, which includes any land adjoining the operational land. Table 2-3 lists the operational lands and Table 2-4 lists the land adjoining the operational lands, while Figure 2-5 shows the operational land and land adjoining the operational land for activities within EPQ10. Note that the Moonie Highway is not considered as operational land, as it is a public road used for the transport of the GHG stream.

Table 2-3 Operational Lands

Lot on Plan	Tenure	Project Feature
27 PG462	freehold	buried seismic survey lines
30 PG222	freehold	buried seismic survey lines
32 PG223	freehold	West Moonie-1 Injection Well, West Moonie-2 Monitoring Well, West Moonie Sentinel Well, West Moonie Shallow Monitoring Bore, Gubberamunda Monitoring Bore, West Moonie-5 Soil Monitoring Bore, West Moonie-6 Soil Monitoring Bore, flowline, air quality and atmospheric monitoring, and buried seismic survey lines
33 PG223	freehold	flowline and buried seismic survey lines
60 SP199322	freehold	flowline and Transportation Facility
Harts Road	road reserve	access road to Transportation Facility from Moonie Highway

Table 2-4 Land Adjoining Operational Lands

Lot on Plan	Tenure
1 PG408	freehold
1 SP318366	freehold
5 PG192	freehold
18 PG289	freehold
29 PG223	freehold
31 PG355	freehold
41 PG463	lands lease for purposes of communications
G PG463	easement
P PG437	easement
20 PG408	lands lease (special lease with 60 FTY776)
60 FTY776	Currajong State Forest (special lease with 20 PG408)
Moonie River	-
Tarawindi Road	road reserve
Apelts Road	road reserve
Southwood Road	road reserve
Stephens Creek Road	road reserve
Moonie Highway	state-controlled road reserve
144 NPW682	Southwood National Park

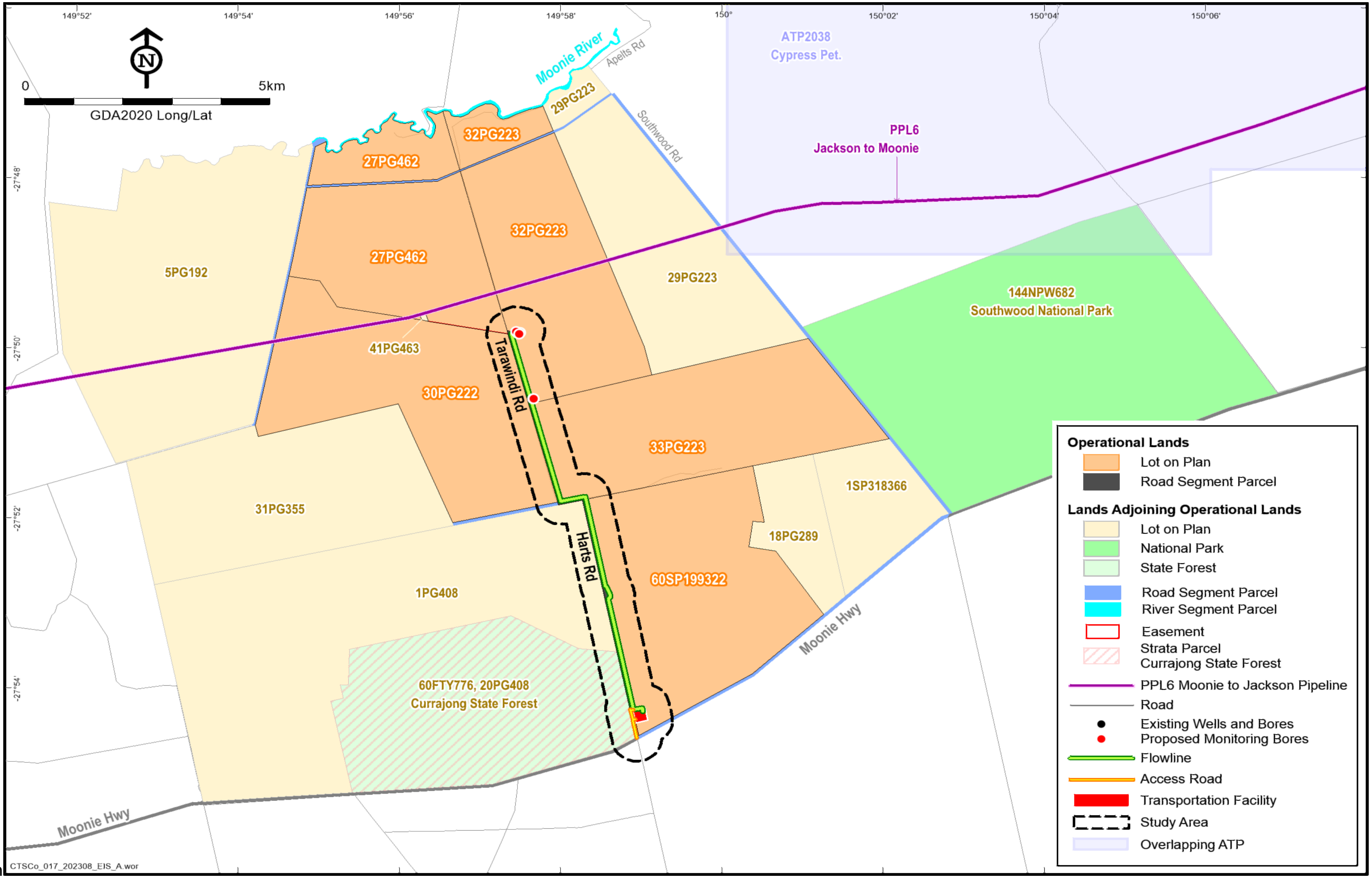

Figure 2-5 Operational Lands and Land Adjoining Operational Lands in EPQ10

The operational lands cover 7,766 ha. However, the Study Area of the Project's activities within the operational lands covers 1,079 ha, while the disturbance area is anticipated to be 14.61 ha. Figure 2-6 identifies the key features of the Project within the operational lands, including the Study Area.

The key features of the Project within EPQ10 are:

- 640 m of bitumen seal along Harts Road from the Moonie Highway intersection, as further described in section 2.9.1;
- the 7.35 ha (294 m x 250 m) Transportation Facility on lot 60 SP199322, further described in section 2.9.2;
- the 9.5 km flowline, with a 107 m section under South Branch Stephens Creek and a 380 m section under a stand of brigalow (RE 11.4.3) to be installed using horizontal directional drilling (HDD), to carry the GHG stream from the Transportation Facility to the West Moonie-1 Injection Well, further described in section 2.9.3;
- the 1 ha well pad area that includes the West Moonie-1 Injection Well, West Moonie-2 Monitoring Well, West Moonie Shallow Monitoring Bore, Gubberamunda Monitoring Bore, West Moonie-5 Soil Monitoring Bore, air quality and atmospheric monitoring, and associated telemetry equipment, further described in section 2.8.1.1 and section 2.8.1.2;
- the 1 ha well pad area that includes the West Moonie Sentinel Monitoring Well, and West Moonie-6 Soil Monitoring Bore, further described in section 2.8.1.2.3 and section 2.8.1.2.6; and
- approximately 32 km of 2D buried seismic monitoring lines, further described in section 2.8.1.3.3.

The drilling of all wells and bores, installation of air quality and atmospheric monitoring, and all seismic activities are already authorised under EPQ10 and the current EA, and are not subject to EIS processes and assessment. All other key features are subject to the EIS processes and EA amendment. Figure 2-7 highlights the key features which are already authorised, and which are subject to EIS processes and EA amendment.

The Study Area is based upon a 500 m buffer distance being applied around the disturbance area of all key features, excluding 2D buried seismic monitoring lines.

As shown in Figure 2-5, the operational lands and land adjoining the operational lands overlap with only two resource tenements:

- PPL6 – Jackson to Moonie Pipeline for the transmission of oil held by Santos Limited; and
- ATP2038 held by Cypress Petroleum Pty Ltd, being a subsidiary of Omega Oil and Gas Limited.

2.7 Project Program of Activities within EPQ10

As the commencement date for construction is dependent upon the timing of the EIS processes and EA amendment, only indicative dates are provided throughout the EIS. Table 2-5 outlines the various phases of the Project's program.

Table 2-5 Indicative Project Program Phases

Project Program Phases	Indicative Dates	Already authorised by EA	Subject to EA amendment
Exploration and Appraisal, excluding injection testing	9 December 2019 to 8 December 2031	Yes	No
Construction	January 2024 to September 2024	No	Yes
Operation (injection testing)	April 2025 to May 2028	No	Yes
Monitoring (prior to injection operation commencing) Monitoring (during injection operation) Monitoring (post-injection)*	January 2025 to April 2025 April 2025 to May 2028 June 2028 to June 2030	No	Yes
Rehabilitation	June 2028 to December 2028 June 2030 to December 2030	Partially	Yes

The monitoring (post-injection)* phase is to verify the final GHG plume position, being when the GHG plume has ceased expansion plus two seismic surveys at a 6-monthly interval after the GHG plume has ceased to expand, or 2 years, whichever is longer.

To enable the Project to inject a GHG stream (CO_2) into EPQ10 for injection testing, the following EA condition is proposed:

General Condition 1

Activities under this environmental authority must be conducted in accordance with the following:

a) This environmental authority authorises the carrying out of GHG storage exploration on EPQ10 and EPQ12.
b) This environmental authority authorises the carrying out of GHG storage injection testing on EPQ10.
c) The GHG stream is a stream of carbon dioxide or a substance that overwhelmingly consists of carbon dioxide, and may be in a gaseous or liquid state.
d) For the purpose of assessing the feasibility of GHG stream storage, the environmental authority authorises the following GHG storage activities: drilling of GHG wells, drilling of GHG wells (and bores) for monitoring purposes, water production, GHG storage exploration, GHG storage injection testing, geophysical surveys, all associated monitoring, limited GHG storage exploration activities, low impact GHG storage exploration activities, GHG exploration permit activities, principal authorised activities, and incidental activities.
e) The environmental authority authorises the release of a GHG stream to groundwater at West Moonie-1 Injection Well within the Precipice Sandstone aquifer, as a confined aquifer as defined by the Environmental Protection Regulation section 41, at a rate of up to 110,000 tonnes of GHG stream per year, up to a total of 330,000 tonnes.
f) The environmental authority authorises the release of GHG stream within the Precipice Sandstone aquifer, being the GHG storage reservoir within the GHG stream storage site, and subject to the rehabilitation requirements of Rehabilitation Condition 9, Rehabilitation Condition 10, Rehabilitation Condition 11, Rehabilitation Condition 16 and Rehabilitation Condition 17.

Figure 2-6 Key Features of the Project

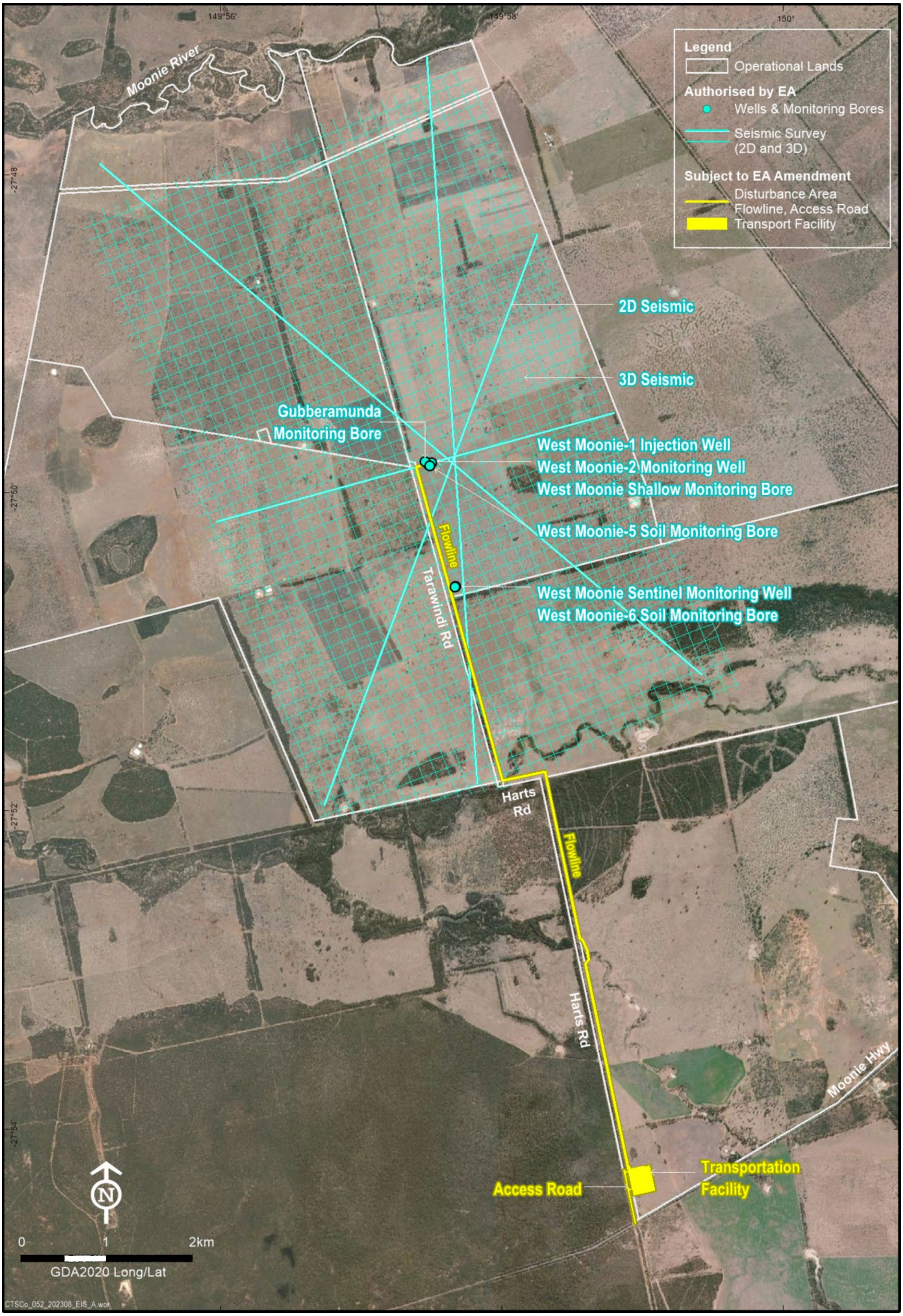

Figure 2-7 Project Key Features already authorised and those subject to EA amendment

2.8 Exploration and Appraisal Activities

Exploration and appraisal activities are not subject to EIS processes or EA amendment. All exploration and appraisal activities given below are already authorised under EPQ10 and EA EPPG00646913. The exploration and appraisal activities are provided in this chapter for context in the achievement of the overall purpose of CTSCo's activities for conducting the GHG storage injection testing, as defined by the GHG Act, s.16.

2.8.1 Exploration and Appraisal Program

In 2019, CTSCo identified that the most prospective locations for large-scale GHG storage exploration in the Surat Basin are likely to be within the area of EPQ10. Appraisal of EPQ10 included desktop studies utilising existing two dimensional (2D) seismic and regional geological data.

CTSCo's prospectivity assessment, compared to the University of Queensland's "*Regional hydrogeology of the southern Surat Basin*" project (7-0918-C316) (Rodger *et al*, ongoing 2022) for Australian National Low Emissions Coal Research & Development (ANLEC R&D), identified the Precipice Sandstone as the preferred stratigraphic interval to target for the GHG storage injection testing. Further details of the geological characteristics found during the appraisal program are given in Chapter 8 Geology, and the groundwater characteristics in Chapter 9 Groundwater.

Following discussions and negotiations with various landowners within the southern area of EPQ10, a Conduct and Compensation Agreement (CCA) was entered into with the landowners/occupiers of lot 32 PG223 that allows for:

- access tracks to the well pads;
- establishment of 2 x 100 m x 100 m well pads;
- drilling of the West Moonie-1 Injection Well, the West Moonie-2 Monitoring Well, the West Moonie Shallow Monitoring Bore, the Gubberamunda Monitoring Bore, the West Moonie Sentinel Monitoring Well, the West Moonie-5 Soil Monitoring Bore, and the West Moonie-6 Soil Monitoring Bore;
- air quality and atmospheric monitoring equipment;
- equipment telemetry;
- seismic monitoring (2D and 3D seismic programs) including installation of buried seismic monitors; and
- flowline.

To provide for an extended scale of seismic monitoring, assessment of potential flowline alignments, and location of the Transportation Facility, CCAs are in place or will be negotiated with the landowners of lots 27 PG462, 30 PG222, 33 PG223 and 60 SP199322.

Access to Harts Road to establish the access road into the Transportation Facility is discussed further in section 2.9.1.

2.8.1.1 ACCESS TRACKS AND WELL PAD

In 2020, access tracks to the well pad to West Moonie-1 Injection Well were established using 1.3 km of existing farm tracks in lot 32 PG223, with 300 m of new track established by grading of a 5 m wide track. Short sections of the existing farm tracks were improved with the addition of roadbase to provide consistent access conditions.

The 100 m x 100 m well pad was established by grading the area to remove topsoil.

Following drilling of the wells, as described in section 2.8.1.2.1, the majority of the well pad was rehabilitated with topsoil respread.

2.8.1.2 WELLS AND BORES

Three wells and four bores have been or will be established as part of the appraisal program, as summarised in Table 2-6. The Milgarra Bore was accessed and a water quality sample taken to determine the existing water quality of the Gubberamunda Sandstone aquifer.

Table 2-6 Wells and Bores of the Appraisal Program

Well or Bore Name	Target Formation	Date Drilled	Status	Latitude (GDA2020)	Longitude (GDA2020)	Maximum Deviation	Total Depth (m)
West Moonie-1 Injection Well	lower Precipice Sandstone	11/08/2020 to 14/09/2020	cased and suspended	-27.830242	149.958101	2.93 at 1,914.75 m	2,710.5
West Moonie-2 Monitoring Well	lower Precipice Sandstone	01/07/2021 to 22/07/2021	cased and suspended	-27.830186	149.957973	19.96 at 536.90 m	2,445.0
West Moonie Sentinel Monitoring Well*	lower Precipice Sandstone	(planned)	yet to be drilled	-27.842974	149.961095	-	2,450 (approximate)
West Moonie Shallow Monitoring Bore	Griman Creek Formation	25/05/2021 to 26/05/2021	cased (PVC) gravel packed and suspended	-27.830019	149.958352	-	48.0
Gubberamunda Monitoring Bore*	Gubberamunda Sandstone	(planned)	yet to be drilled	-27.829854	149.957577	-	1,400 (approximate)
West Moonie-5 Soil Monitoring Bore*	soil near surface	(planned)	yet to be drilled	-27.830332	149.958098	-	between 1 m and 3 m (approximate)
West Moonie-5 Soil Monitoring Bore*	soil near surface	(planned)	yet to be drilled	-27.842973	149.961196	-	between 1 m and 3 m (approximate)
Milgarra 1 (RN 23075)	Gubberamunda Sandstone	October 1982	producing water bore	-27.866462	150.129106	-	1,242.6

Note: * All items are planned, yet to be drilled

All wells designed, drilled, constructed and equipped by or on behalf of CTSCo comply with the relevant Australian Standards, code and guidelines, including the "*Code of Practice for the construction and abandonment of petroleum wells and associated bores in Queensland*" (DNRME, 2019).

2.8.1.2.1 West Moonie-1 Injection Well

The West Moonie-1 Injection Well is the well for GHG storage injection testing for the Project. Figure 2-8 and Figure 2-9 depict the key design features of the West Moonie-1 Injection Well, and the well head. Figure 2-10 shows West Moonie-1 Injection Well in situ.

Other design features include:

- corrosion resistant alloy casing, with metal-to-metal gas tight connections, across flow-wet zones;
- a second casing/cement barrier for regionally important aquifers, such as the Gubberamunda Sandstone;
- GHG stream resistant cement used for cementing of steel casing, with cement integrity confirmed via cement bond logging;
- perforated steel production casing to allow connection to the Precipice Sandstone for water testing between 2,313.8 m to 2,315.8 m below surface. Approximately 8 m of additional perforations will be added to the existing 2 m perforated section prior to the commencement of GHG stream injection; and
- the wellhead and adjacent injection control equipment will include remote, real-time monitoring via a telemetry system. This system will allow continuous monitoring of pressure, temperature, and leak detection sensors to facilitate remote control. The system will also include automated shut-down, alarm and notification should injection operations deviate from expected conditions, or any leak be detected.

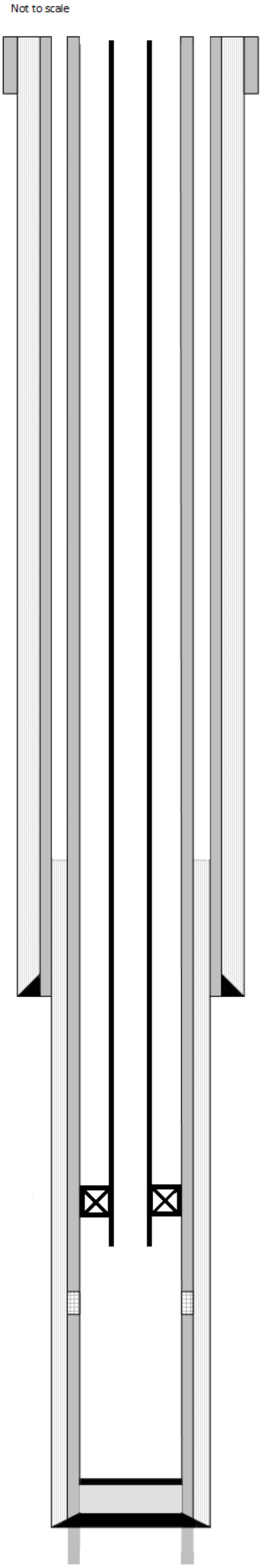

Figure 2-8 Schematic Design of West Moonie-1 Injection Well

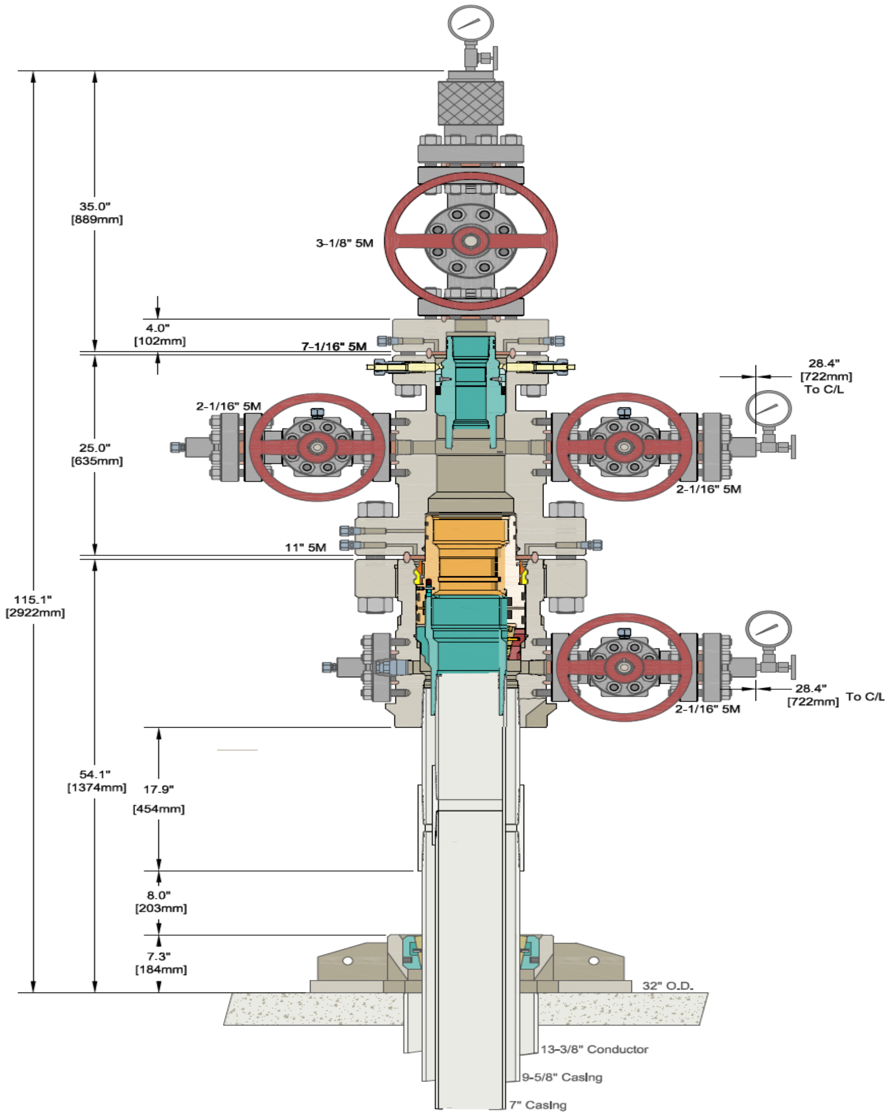

Figure 2-9 Schematic Design of the West Moonie-1 Injection Wellhead

Figure 2-10 Photo of West Moonie-1 Injection Well

Drilling and bore construction of the West Moonie-1 Injection Well was completed in August and September 2020. The main aims of the drilling of the well were to:

- assess the Precipice Sandstone formation for injection suitability, specifically porosity and permeability;
- determine the presence of suitable geological seals above and below the Precipice Sandstone;
- construct a well suitable for future GHG storage injection testing; and
- allow water quality sampling to establish the water characteristics of the Precipice Sandstone formation.

Well evaluation included the following:

- cuttings samples were taken from surface to total depth;
- core was cut from 2,234 m in the Evergreen Formation to 2,713.5 m in the Moolayember Formation;
- isoTube sampling of mud gas to allow mud gas isotope analysis;
- electric wireline logs were acquired from surface to total depth; and
- water samples were collected from the Precipice Sandstone.

Further details of the findings for various geological and groundwater assessments undertaken are provided in Chapter 8 Geology and Chapter 9 Groundwater and the associated technical reports.

2.8.1.2.2 West Moonie-2 Monitoring Well

The West Moonie-2 Monitoring Well is the primary monitoring well in the Precipice Sandstone aquifer for the Project. Figure 2-11 depicts the key design features of the West Moonie-2 Monitoring Well. The wellhead design is identical to the West Moonie-1 Injection Well. Other design features include:

- corrosion resistant alloy casing, with metal-to-metal gas tight connections, across flow-wet zones;
- a second casing/cement barrier for regionally important aquifers, such as the Gubberamunda Sandstone;
- GHG stream resistant cement used for cementing of steel casing, with cement integrity confirmed via cement bond logging;
- being directionally drilled from the West Moonie-1 well pad, with the bottom-of-hole location 170 m west of the West Moonie-1 Injection Well, and positioned to be within the predicted GHG plume;
- the wellhead and adjacent control equipment will include remote, real-time monitoring via a telemetry system. This system will allow continuous monitoring of pressure, temperature, and leak detection sensors to facilitate remote control. The system will also include automated shut-down, alarm and notification should injection operations deviate from expected conditions, or any leak be detected; and
- the well will be completed with suitable production packers and downhole flow control devices to allow selective groundwater sampling and pressure measurement from both the Precipice Sandstone aquifer and the Hutton Sandstone aquifer.

The West Moonie-2 Monitoring Well is currently suspended, ready for completion and fit-out of monitoring equipment prior to commencement of injection testing.

Drilling and bore construction of the West Moonie-2 Monitoring Well was completed in July 2021. The main aims of the drilling of the well were to:

- assess the Precipice Sandstone Formation for injection suitability, specifically porosity and permeability;
- further appraise the Precipice Sandstone and overlying sealing Evergreen Formation;
- pressure measurement of the Precipice Sandstone and the Hutton Sandstone to assess connectivity potential of these formations; and
- construct a well suitable for future GHG storage injection testing or monitoring.

Well evaluation included the following:

- cuttings samples were taken from surface to total depth;
- core was cut from 2,130 m to 2,139 m in the Evergreen Formation;
- isoTube™ sampling of mud gas to allow mud gas isotope analysis;
- electric wireline logs were acquired from surface to total depth;
- pressure logging of the Precipice Sandstone and Hutton Sandstone; and
- extended leak-off testing in the Evergreen Formation.

Further details of the findings for various geological and groundwater assessments undertaken are provided in Chapter 8 Geology and Chapter 9 Groundwater and the associated technical reports.

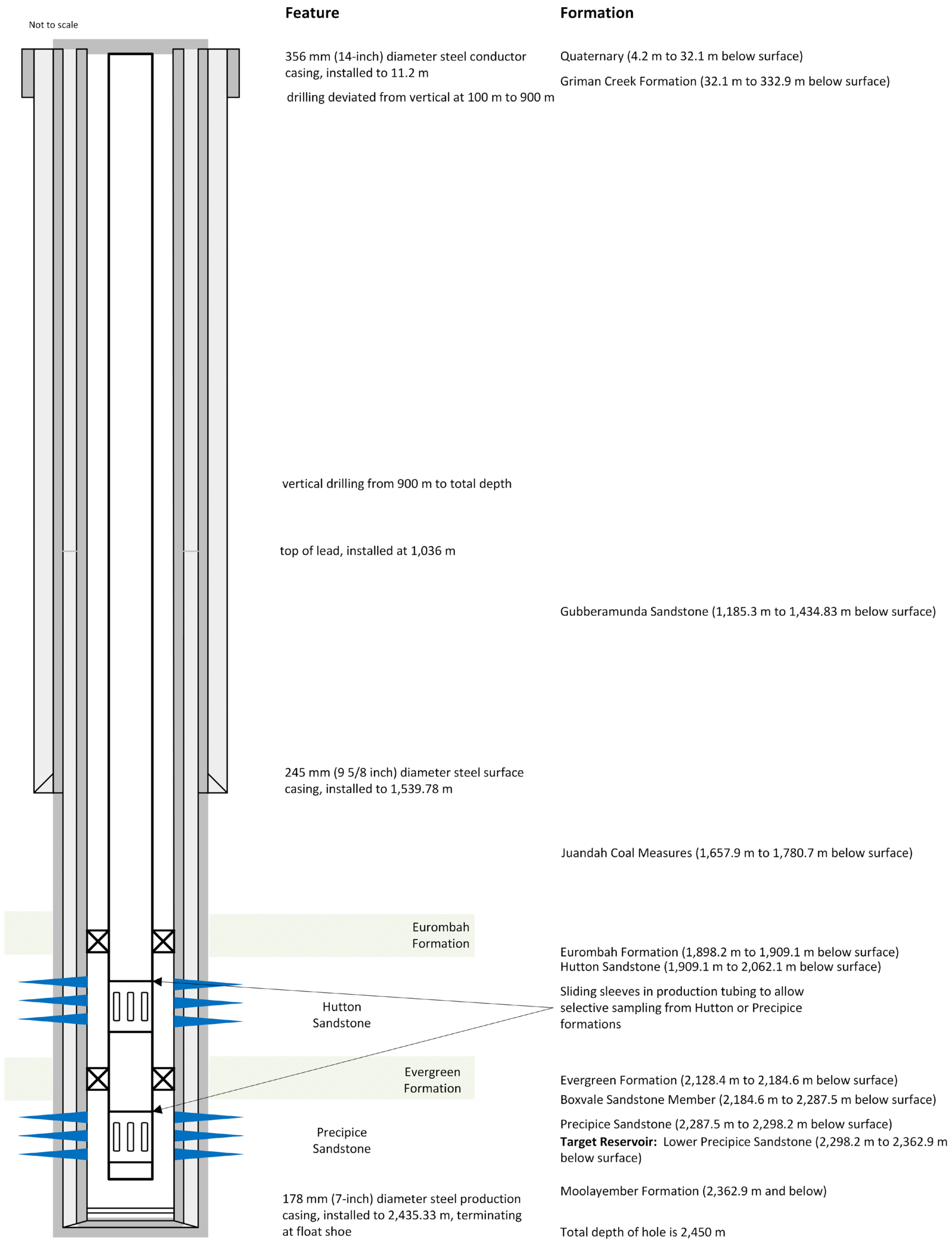

Figure 2-11 Schematic Design of West Moonie-2 Monitoring Well

2.8.1.2.3 West Moonie Sentinel Monitoring Well

The West Moonie Sentinel Monitoring Well is the secondary monitoring well in the Precipice Sandstone aquifer for the Project.

The design features and well head design of the West Moonie Sentinel Monitoring Well will be similar to the West Moonie-2 Monitoring Well.

Drilling and bore construction of the West Moonie Sentinel Monitoring Well is planned for 2024. The main aims of the drilling of the well are to:

- obtain further data on the Precipice Sandstone Formation for injection suitability, specifically porosity and permeability;
- further appraise the Precipice Sandstone and overlying sealing Evergreen Formation; and
- construct a well suitable for future GHG storage injection testing or monitoring which is located outside the predicted GHG plume extent.

Well evaluation will include the following:

- cuttings samples to be taken from surface to total depth;
- isoTube™ sampling of mud gas to allow mud gas isotope analysis;
- electric wireline logs from surface to total depth; and
- groundwater sample collection from the Precipice Sandstone aquifer.

2.8.1.2.4 West Moonie Shallow Monitoring Bore

The West Moonie Shallow Monitoring Bore monitors the water present within the Griman Creek Formation. The key design features include:

- PVC casing to the Griman Creek Formation;
- gravel packed across the Griman Creek Formation; and
- grouted from the top of the Griman Creek Formation to surface.

Drilling and bore construction of the West Moonie Shallow Monitoring Bore was completed on 26 May 2021. The main aim of the drilling of the bore was to conduct water quality monitoring and stygofauna sampling.

Further details of the findings for various geological, groundwater, and stygofauna assessments undertaken are provided in Chapter 8 Geology, Chapter 9 Groundwater, and Chapter 14B Aquatic Flora and Fauna and the associated technical reports.

2.8.1.2.5 Gubberamunda Monitoring Bore

The Gubberamunda Monitoring Bore will monitor the aquifer in the Gubberamunda Sandstone. The key design features are to include:

- steel casing from surface through to the Gubberamunda Sandstone; and
- perforations to connect the aquifer of the Gubberamunda Sandstone to the wellbore.

Drilling and bore construction of the Gubberamunda Monitoring Bore is planned for 2024. The main aims for drilling of the bore are to allow ongoing monitoring of groundwater quality and pressure in the aquifer of the Gubberamunda Sandstone, close to the West Moonie-1 Injection Well.

Further details of the findings for various geological and groundwater assessments undertaken are provided in Chapter 8 Geology and Chapter 9 Groundwater and the associated technical reports.

2.8.1.2.6 West Moonie-5 Soil Monitoring Bore, and West Moonie-6 Soil Monitoring Bore

Drilling and construction of the bores is planned for 2024. Soil monitoring bores will be installed at the West Moonie-1 Injection Well and the West Moonie Sentinel Well approximately 10 m from each well to monitor and characterise the CO_2 content of the soil using in-wellbore soil vapour monitoring.

Further details of the proposed soil monitoring are provided in Chapter 8 Geology, sections 8.7.1.2 and 8.10.4.1.

2.8.1.2.7 Milgarra Bore

The Milgarra Bore (RN 23075) is located at approximately 17 km south-east of the West Moonie-1 Injection Well on lot 5 PG217. The Milgarra Bore is an active water production bore supplying stock and domestic water to the landowner from the Gubberamunda Sandstone aquifer.

Water quality samples were taken for analysis to understand the water quality of the Gubberamunda Sandstone aquifer.

The Milgarra Bore does not form part of the Project, and will not be used for monitoring purposes during any future phase of the Project.

Further details of the groundwater findings are provided in Chapter 9 Groundwater and the associated technical reports.

Figure 2-12 shows the surface layout of the wells and bores within the operational lands.

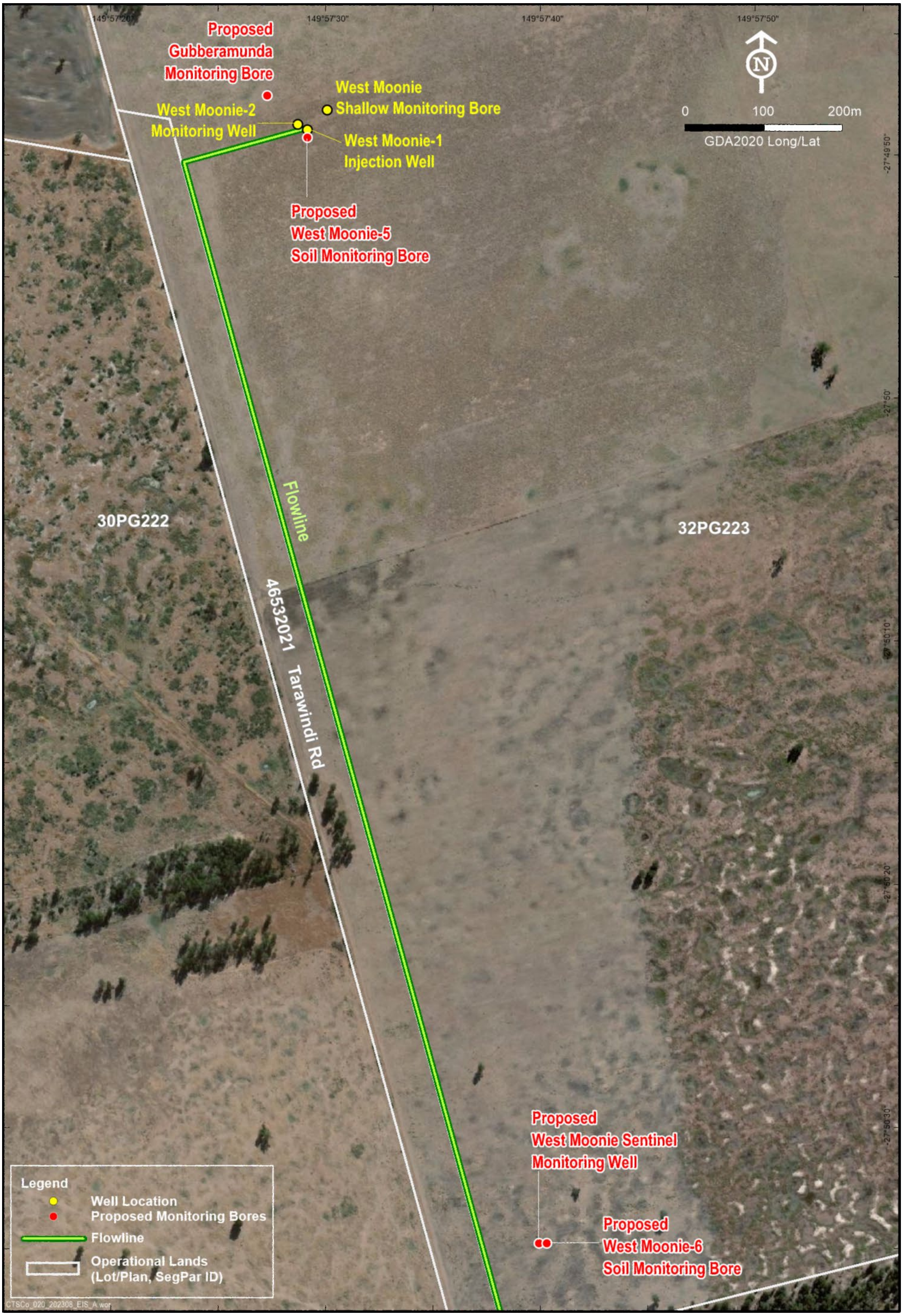

Figure 2-12 Surface Well Layout

2.8.1.3 SEISMIC PROGRAM

Seismic data has been and will be obtained from three sources as part of the exploration and appraisal program:

- legacy oil and gas exploration seismic data;
- 3D seismic program; and
- 2D seismic program.

All seismic data acquisition undertaken during the exploration and appraisal program will provide the baseline for all future seismic monitoring during the 3-year operation phase of the GHG storage injection testing and subsequent monitoring phase (approximately 2 years).

2.8.1.3.1 Legacy Oil and Gas Exploration Seismic Data

Seismic data from oil and gas exploration, and other regional geological and geophysical data held by the Queensland State Government was examined to determine the most prospective areas for geological storage of CO_2. The legacy data identified that within EPQ10 the Precipice Sandstone aquifer is deep and thick with a thick impermeable geological seal above the Precipice Sandstone, as shown in **Error! Reference source not found.**. The data indicated that the geology is stable, with no obvious faulting.

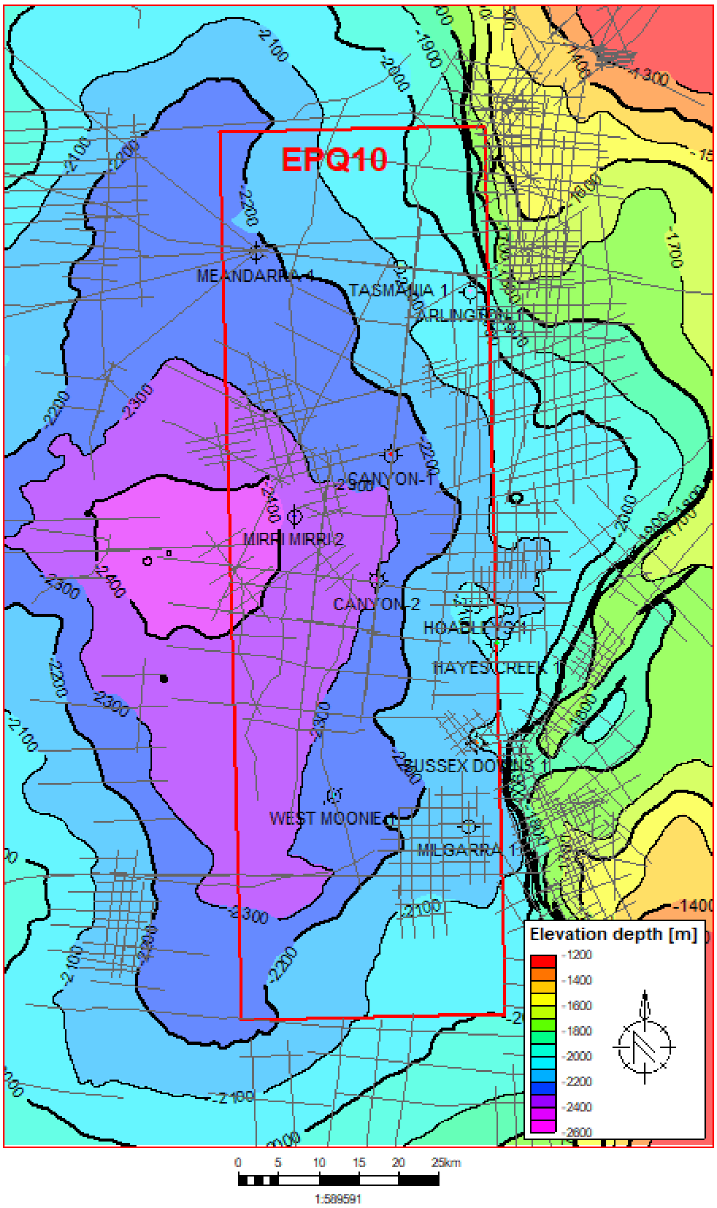

Figure 2-13 Regional lower Precipice Sandstone depth map (mbgl) showing existing wells and seismic lines in EPQ10

2.8.1.3.2 3D Seismic Program

The 3D seismic program aims to provide a high resolution of data points of geological structures from ground surface into the Moolayember Formation, being approximately 2,600 m below surface. This survey is primarily designed to determine the GHG storage reservoir properties in the Precipice Sandstone aquifer away from existing well data. Data from the 3D seismic survey will further improve the geological and hydrogeological models, and will also provide additional data on any faults, fractures, deformation, stratigraphy, and other geological or hydrogeological features across a 40 km^2 surface area (5 km x 8 km) covering four lot on plans in the operational lands. Existing seismic data interpretation has shown that no faulting is present around the West Moonie-1 Injection Well location. The data outputs from the 3D seismic survey are expected to further demonstrate an absence of faulting around the West Moonie-1 Injection Well.

In EPQ7 at the Glenhaven site, the seismic exploration methodology of Amplitude Variation with Offset (AVO) and inversion was used to predict the earth's elastic parameters and thus properties of rocks and fluid. AVO is a method that measures the variation is seismic reflection amplitude with a change in distance between the vibration source and receiver that indicates differences in lithology and fluid content in rocks above and below the reflector. At the Glenhaven site, AVO and inversion successfully characterised the lithology and porosity heterogeneity.

The geophysical workflow used for the Project is shown in Table 2-7 below, with a similar workflow used for the Glenhaven site.

Table 2-7 AVO and Inversion Workflow

Workflow Step	Step Name	Workflow Action
1	Petrophysical Evaluation	Well log quality control, depth matching, environmental correction, generate Vshl, PHIT, Permeability and SW logs
2	Rock Physics Study	Generate seismic related rock property logs, i.e. Poisson Ratio (PR), Young Modulus (I), Bulk modulus (K), Shear modulus (U), VP/VS, LamdaRho (LR), MuRho (MU), P-Impedance (P-Imp), S-Impedance (S-Imp), Elastic Impedance (El angle), at various angles
		Generate crossplot of Vshl, Gamma Ray (GR), Porosity (PHIT) and Density (DEN) against seismic property logs
3	Well and Seismic Tie	Extract a statistical wavelet, generate a zero offset synthetic seismogram and tie to West Moonie-1 Injection Well, extract a deterministic wavelet and re-tie to the well
		Welltie to angle stack at 5-15, 15-25, 25-35, 35-45, 45-55 degrees
4	Lithology Replacement	Generate 1D models with various lithology
5	Wedge model	Generate a wedge model at the Precipice Sandstone reservoir interval
6	Synthetic Gather Modelling	Generate a synthetic gather and compare to real gathers
7	Conditioning real gathers	Noise suppression and multiple attenuation
8	Post Stack Inversion	Generate Post Stack Inversion on Fullstack, Angle stacks at 5-15, 15-25, 25-35, 35-45, 45-55 degrees
9	AVO	Generate AVO modelling, intercept and gradient attributes volumes
10	Prestack Inversion	Generate VPVS, P-Imp and Density volumes
11	Generate Volumes	Generate Vshl, Porosity and Lithology (combined Vshl and Porosity) volumes
12	Convert time volume to depth volume	Generate Vshl, Porosity, Lithology two way time volumes to depth volume

One of the outputs of AVO and inversion at the Glenhaven site was a combined lithology (Vshl) and porosity (PHIT) section with 20 seismic classes. Direct seismic attributes mapping using a conventional seismic amplitude volume was not undertaken, as the upper Precipice Sandstone and Evergreen Formation rock physics properties have no correlation with the seismic amplitude attributes or its derivatives. The AVO and inversion were conducted using Hampson-Russell Software (HRS).

The 3D seismic program for the Project is scheduled to be undertaken in Quarter 2 (Q2) 2024, depending upon weather and ground conditions. Seismic lines running nominally north-south and east-west with nominal 150 m spacing between each line have been identified, as shown in **Error! Reference source not found.**. Establishment of the seismic lines will avoid tall vegetation (trees and shrubs), permanent standing waterbodies or wetlands, any cultural heritage sites, existing structures, and agricultural infrastructure, as agreed with the landowners. Where grass is long, slashing of the grass will be undertaken for safe access. Wireless geophones will be inserted into the ground, each having the ability to record data for up to three weeks. Vibro-seismic vehicles will generate vibrations of known frequency and will drive across the operational lands over a three-week period. The proposed geophone installation and a vibro-seismic vehicle are shown in Figure 2-15. All geophones will be removed following the survey, with recorded data taking approximately six months to process to create 3D imagery and a geophysical model of the 40 km^2 area around the West Moonie-1 Injection Well.

Figure 2-14 3D Seismic Program layout

Photo 1 Slashed Grass for Seismic Lines

Photo 2 Wireless Geophone

Photo 3 Geophone installed

Photo 4 Vibro-seismic vehicle

Figure 2-15 Geophone Installation for 3D Seismic Program

2.8.1.3.3 2D Seismic Monitoring Program

The 2D seismic monitoring program will commence approximately 6 months prior to the start of the operation phase to collect a baseline data set ahead of GHG storage injection testing.

The purpose of obtaining the 2D seismic data, when partnered with other monitoring techniques includes:

- obtaining additional baseline seismic data prior to commencing the injection testing;
- monitoring GHG plume movement within the Precipice Sandstone storage reservoir to assess whether the GHG stream injected has behaved or is behaving as predicted (conformance monitoring);
- detecting if there is a risk of leakage, or leakage into other geological formations (containment monitoring); and
- obtaining scientific data to demonstrate the performance of the predicted GHG plume and any associated impacts.

The 2D seismic monitoring program will involve the installation of eight (8) seismic lines extending approximately 4 km each in radius from near West Moonie-1 Injection Well, as shown in Figure 2-16, with a total of approximately 32 km of seismic lines. Seismic monitoring will occur at least every six (6) months during the operation and monitoring phases. The seismic monitoring program will utilise the MicroVibe system to obtain seismic survey data. This system involves installing fixed signal source units and signal retrieval lines (also called seismic lines). The source units will emit a short duration (approximately 8 seconds) of ground-penetrating sound waves generated by a vibrating pad when a survey is required.

Installation of the receiver lines will involve excavating a 0.1 m wide trench to a depth of 1 m to 2 m. Unlike conventional seismic survey methods, the MicroVibe system does not require any clearance tracks. Receiver lines will be placed to avoid tall vegetation (trees and shrubs), permanent standing waterbodies or wetlands, any cultural heritage sites, existing structures, and agricultural infrastructure, as agreed with the landowners. Topsoil will be immediately respread after trenching activities.

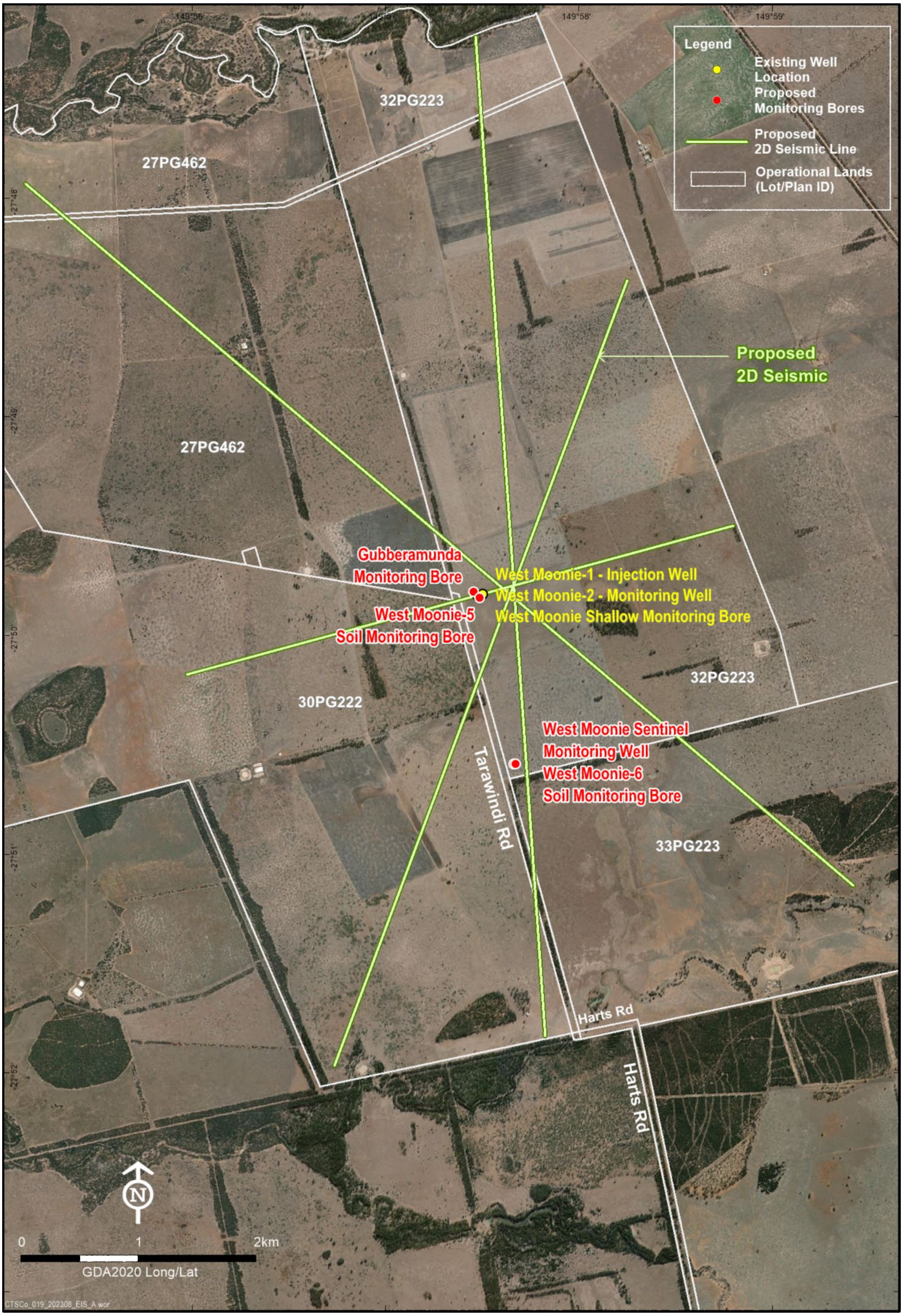

Figure 2-16 2D Seismic Monitoring Indicative Layout

2.8.2 Air Quality and Atmospheric Monitoring Equipment

At least 6 months prior to commencement of GHG storage injection testing, an air quality and atmospheric monitoring station will be installed on concrete footings within the well pad adjacent to West Moonie-1 Injection Well. The station and equipment will be approximately 10 m high. For all air quality and atmospheric monitoring equipment, data points will be recorded every 10 minutes, including temperature, barometric pressure, relative humidity, wind speed, wind direction, and rainfall (tipping bucket). CO_2 concentrations will be measured approximately 1.2 m above ground level in three locations, one on the monitoring station, one on West Moonie-1 Injection Well, and one on West Moonie-2 Monitoring Well. Figure 2-17 shows an indicative air quality and atmospheric monitoring station.

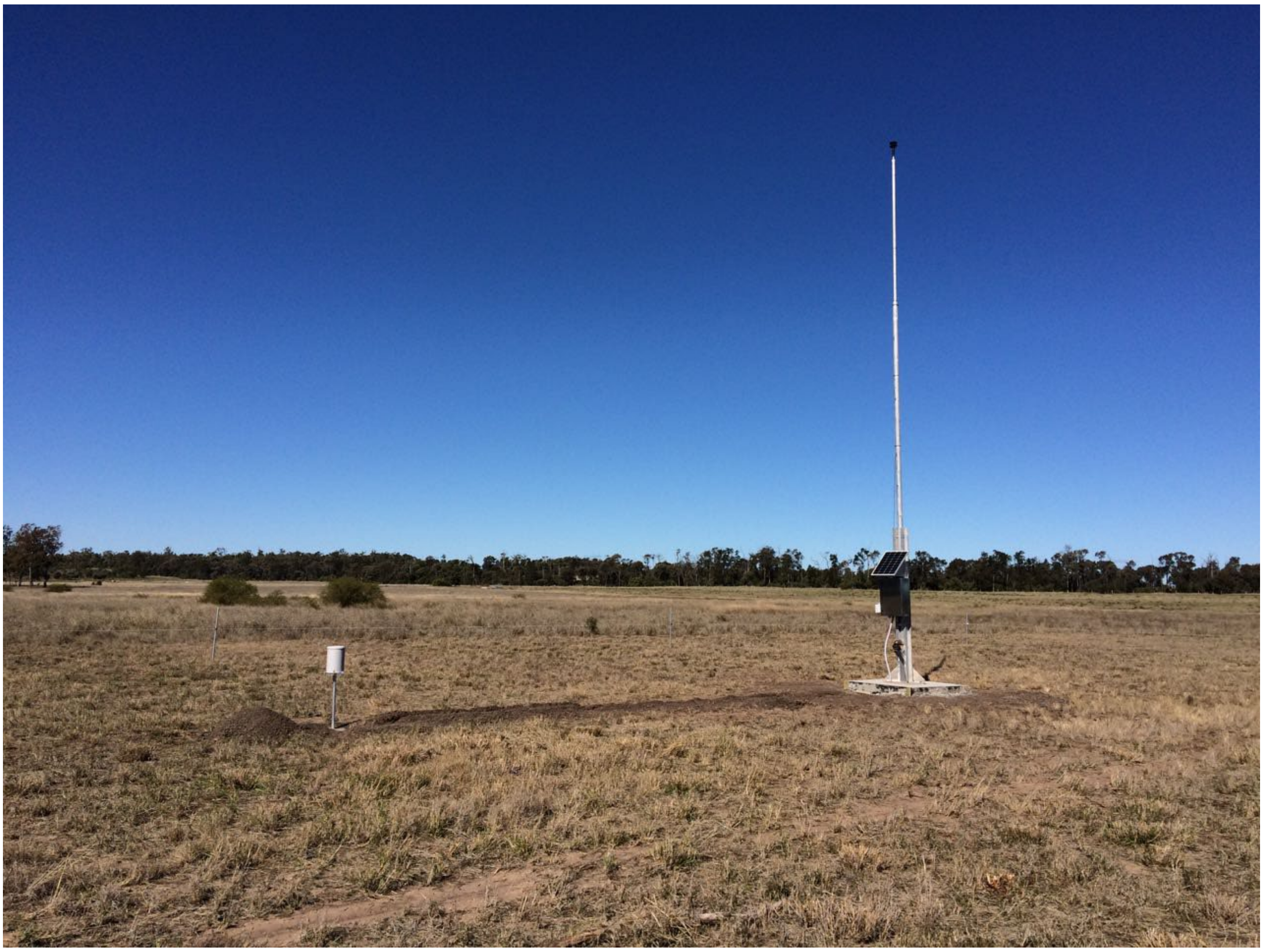

Figure 2-17 Indicative Air Quality and Atmospheric Monitoring Station (top of mast is 10 m above ground level)

2.8.3 Telemetry and Telecommunications

All equipment for the exploration and appraisal program has data recording and individual telemetry equipment installed or to be installed.

All data will be transmitted to a mobile/satellite communications relay to be installed on the well pad. The relay will boost the mobile signal in the area, sending recorded data from all monitoring equipment to a dedicated CTSCo data room in Brisbane. A satellite communications back-up system will also be installed at the Transportation Facility.

2.9 Construction

Project key features and activities that are proposed to be undertaken as part of the construction phase are considered to be advanced activities, and subject to EIS processes and where relevant, proposed EA condition amendments.

2.9.1 Access Road

Access to the Project during construction, operation and monitoring phases will be from the Moonie Highway into Harts Road, then into the one-way access and egress points of the Transportation Facility. The Moonie Highway – Harts Road intersection is 44 km west of Moonie township.

The Moonie Highway (35A) is a regional state-controlled road, featuring a fully sealed dual lane carriageway, suitable for truck types: B-triples, Type 1 Road Trains, and 23 m and 25 m B-doubles, operating at a 100 km/h speed environment.

Harts Road is a local road, featuring a gravel surface, single plus lane carriageway. As a local road, the speed limit is 50 km/h, however, is practically 30 km/h. Good sight lines onto the Moonie Highway already exist. Opposite Harts Road is the Dicks Road intersection with the Moonie Highway. Dicks Road is also a local road with gravel surface.

The traffic impact assessment is provided in Chapter 11 Transport. The traffic volumes and vehicle movements associated with the Project are below the design thresholds to modify the Moonie Highway – Harts Road intersection. CTSCo proposes to improve the existing Basic Auxiliary Right Turn (BAR) intersection of the Moonie Highway and Harts Road intersection by widening the access to Harts Road and sealing the formation or similar, as to be approved by the Department of Transport and Main Roads under the *Transport Infrastructure Act 1994* under section 33, to improve access and egress to Harts Road during construction and operation. Improvements are proposed to be based on normal design domain (NDD) requirements.

Development of Harts Road to allow access and egress to and from the Transportation Facility will require the forming, shaping and bitumen sealing of approximately 640 m of the existing carriageway into a dual lane local road suitable for B-double and low-loader trucks.

Access and egress from Harts Road into the Transportation Facility will provide a one-way traffic flow through the Transportation Facility. Access will be approximately 612 m and egress approximately 404 m from the Moonie Highway intersection, providing an approximately 7 m wide, two-lane bitumen sealed carriageway.

Road improvements of both the Moonie Highway and Harts Road will be negotiated and agreed with the Department of Transport and Main Roads for the Moonie Highway, and Western Downs Regional Council for Harts Road. All necessary permits and approvals and Infrastructure Agreement with Western Downs Regional Council will be sought by CTSCo prior to the commencement of construction. Subject to commercial negotiations, construction will be undertaken by either a local road construction contractor or council.

2.9.2 Transportation Facility

The Transportation Facility allows for the delivery of the GHG stream by B-double trucks onto operational land into a defined and secure area. The Transportation Facility will be located on lot 60 SP199322, accessed from Harts Road, and will cover 7.35 ha.

Siting of the Transportation Facility within lot 60 SP199322 has considered:

- the avoidance of clearing three large hollow bearing trees (nest sites) and one large habitat tree that are located near the south-west corner of the lot;
- minimising clearance of vegetation in the Harts Road road reserve for the access and egress points;
- locating on areas historically cleared for agricultural activities immediately adjacent to the lot boundary with Harts Road;
- locating outside the potential flood hazard area for the 1% AEP (1 in 100 year) flood event as identified in the "Western Downs Planning Scheme" (WDRC, 2019) flood overlay mapping; and
- locating away from sensitive places including areas subject to native title.

Transportation Facility construction works will include:

- erection of unmanned security gates on access and egress points, and perimeter fencing suitable to keep stock and wild dogs out of the facility;
- minor earthworks to level the site and excavate foundations for plant and equipment;
- pouring concrete foundations and footings;
- trenching and laying of the flowline (see section 2.9.3 for further details);

- shallow trenching and placement of buried electrical and telecommunications cables;
- hardstands, road and carpark with road base gravels and seal with bitumen surfacing to minimise noise and dust generation;
- hardstands with gravel base for construction equipment laydown;
- installation of prefabricated transportable building for the office, including control room, crib room and restrooms;
- excavation and trenching for plumbing, potable water, drainage and sewage for the office. Potable water to be captured rainwater and stored in water tanks. Sewage is to be treated by a septic system unit sized to be less than 21 equivalent persons (EPs), which is consistent with the existing EA condition 55;
- solar panels with battery storage on the transportable building to power the office;
- installation of:
  - sufficient LED lamps for site lighting;
  - security system and surveillance;
  - power, including back-up generator and solar panels;
  - 4 x 100 tonne cryogenic GHG stream storage tanks (each approximately 3.6 m diameter x 3.9 m high);
  - 3 x 3 tonne capacity LPG tanks (approximately 8 m long x 1.22 m diameter, sitting 1 m above ground surface);
  - 2 x water bath heaters;
  - 2 x 15 t/h capacity pumps, one in use and one as back-up;
  - flowline valves and connections from the pumps; and
  - other ancillary equipment for the offloading and handling of the GHG stream.

Topsoil and earth removed during earthworks will be retained on site for future rehabilitation, as discussed further in Chapter 19 Rehabilitation.

Any quarried materials (rock, gravel, road base) and concrete required will be sourced locally from existing licenced suppliers. No new quarries, concrete batching plants or similar will be required for construction of the Transportation Facility. A fleet profile of construction vehicles and equipment is provided in section 2.9.4 and further discussion on traffic movements and vehicles is provided in Chapter 11 Transportation. Workforce numbers associated with construction are provide in section 2.9.5.

Most of the plant, equipment and structures will be delivered to the Transportation Facility as fully prefabricated units, ready for installation. All building and construction waste and general waste generated during construction will be held on site in dedicated bins and recycled or disposed to a local licenced transfer station or waste facility. Negligible volumes of regulated waste generation are anticipated. Further details on wastes generated during construction are provided in Chapter 6 Waste.

Figure 2-18 provides a general arrangement plan of the Transportation Facility.

Figure 2-18 Transportation Facility (general arrangement plan)

2.9.3 Flowline

The flowline will be a 4-inch (100 mm) diameter Fiberspar™ LinePipe pipeline (or similar), constructed to Australian Standard (AS) 2885, and consider the requirements of the Petroleum and Gas (Safety) Regulation 2018 for gathering networks.

As shown in Figure 2-19, Fiberspar™ LinePipe is a spoolable product consisting of an inner thermoplastic pressure barrier reinforced by high-strength glass fibres embedded in an epoxy matrix. The glassfibre reinforced epoxy (GRE) matrix adhesively bonded to the high-density polyethylene (HDPE) results in a very high tolerance to pressure, and designed for corrosive-gathering and injection applications, including general and sour produced fluids and gases. Fiberspar™ LinePipe is manufactured by NOV Inc (formerly National Oilwell Varco) or similar to comply with the American Petroleum Institute's standards API 15S and API 15HR.

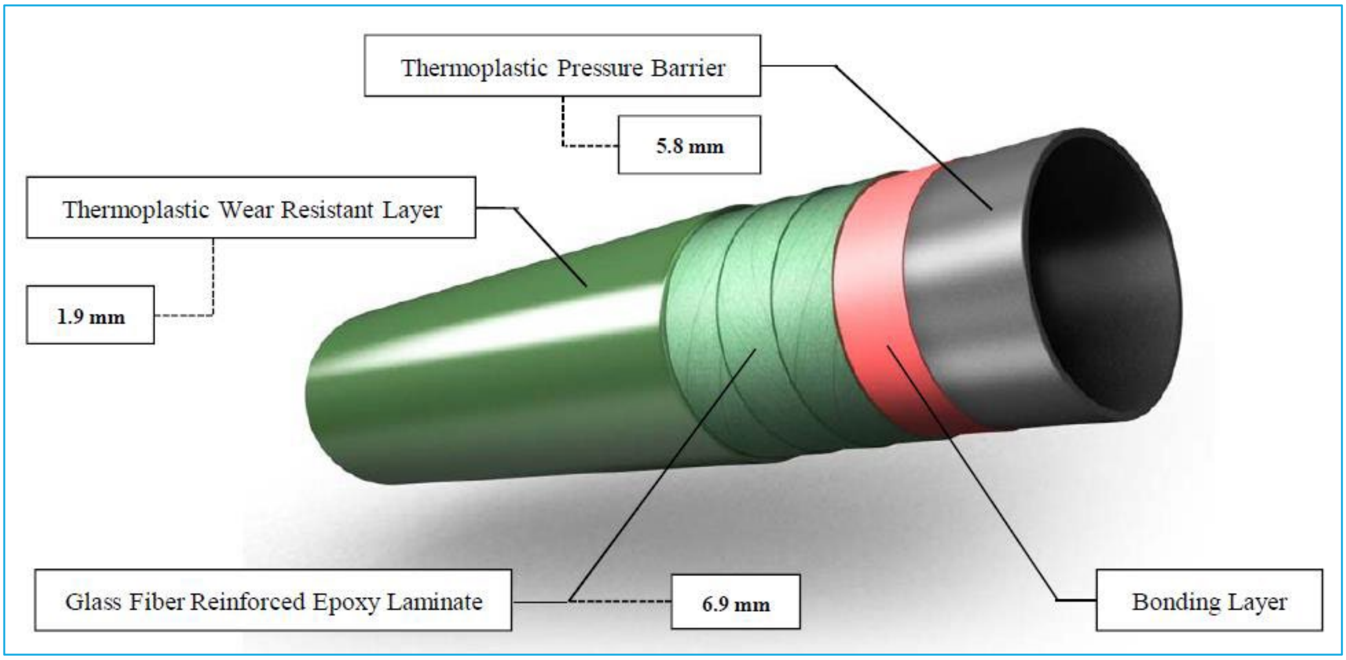

Figure 2-19 Fiberspar™ LinePipe (source: NOV, 2019)

As shown in Figure 2-6, the flowline corridor and right of way (ROW) is anticipated to be 9.5 km in length and 5 m wide, commencing at the Transportation Facility, along western boundaries of lots 60 SP199322, 33 PG223 and 32 PG223, and then turning east to the West Moonie-1 Injection Well. The western boundaries of the properties have been historically cleared due to installation of boundary fencing and firebreaks.

A 107 m section under South Branch Stephens Creek and a 380 m section under a stand of brigalow (RE 11.4.3) will be installed using horizontal directional drilling (HDD), minimising construction delays, and disturbance and impacts to the watercourse, flora, and fauna.

Otherwise, construction of the flowline will be by standard open trench and pipe laying methods for a spool and reel system.

Typical spool and reel construction configuration involves a trench excavator removing soil to 1.5 m depth in a 0.5 m wide slot, with the flowline spooled directly into the trench. The trench is then backfilled with a small excavator. One flowline spool contains 1 km of flowline. All flowline connections will be undertaken at time of laying the flowline.

Once installed, integrity testing of the flowline will be by hydrotesting, that is, filling the flowline with potable or stock/domestic quality water to detect any leaks.

Further details regarding the flowline and applicable hazard and safety considerations are provided in Chapter 15 Hazards and Safety.

2.9.4 Construction Fleet Profile

All construction vehicles and equipment will either be road registered, or transported to site on standard road registered low-loaders, B-doubles or similar. If oversized, over-mass, wide-load or similar deliveries are necessary, they will be escorted where required, and relevant permissions obtained.

Construction activities are anticipated to be undertaken with:

- daily workforce travel:
  - up to 6 x light vehicles;
- for earthworks:
  - 1 x D8 or D9 dozer;
  - 1 x 14 t excavator;
  - 2 x bobcats;
  - 1 x spool and reel trencher;
  - 1 x horizontal directional drilling rig (HDD) on prime mover;
  - 2 x dump trucks;
  - 3 x low loaders;
  - 1 x truck-mounted crane; and
  - 2 x concrete trucks.

2.9.5 Construction Workforce and Accommodation

Construction of the access road, Transportation Facility and flowline is anticipated to involve approximately 10 full-time equivalent (FTE) persons at any one time in-field, with up to 10 office-based technical persons in Brisbane.

Contracting of the local skilled workforce will be considered wherever possible.

For personnel not already living in the area, accommodation of the in-field construction workforce is anticipated to be housed in the existing local accommodation options in Moonie, Westmar, St George, Dalby, and/or Goondiwindi. No new housing, worker accommodation facilities, camps or villages are proposed to be constructed as part of the Project.

All personnel will drive in, drive out. No fly-in, fly-out workforce is anticipated.

Note that drilling of wells and bores, and installation of seismic equipment is not included in the Project's construction workforce numbers, as these activities have been or will be undertaken under the current conditions of EPQ10 and the EA.

2.9.6 Construction Phase

As outlined in section 2.7, the indicative construction phase is anticipated to be undertaken over a nine-month period, commencing January 2024 and completing by the end of September 2024. Ultimately, the actual construction phase will be dictated by when all relevant approvals have been obtained.

Workdays are nominated as Monday to Saturday inclusive, excluding any public holidays recognised for Queensland, and for Brisbane or Moonie areas. However, the majority of activities are anticipated to be conducted Monday to Friday.

Construction hours are anticipated to be 10-hour days, daylight only, typically between 7 am and 6 pm for all nominated workdays.

2.10 Operation

2.10.1 GHG Stream Transportation and Access Road

The GHG stream will be provided by MPS as a low-pressure, low-temperature cryogenic liquid at 332 psi (2.89 MPa) and -20°C, in purpose built 20-foot-long CO_2 cryogenic iso tank containers (in accordance with UN T75). Each iso tank container holds 18 tonnes of GHG stream. One B-double truck can transport two iso tank containers, totalling 36 tonnes per truck. Transportation of the GHG stream in a cryogenic state in iso tank containers is the same method used by commercial CO_2 suppliers for food and industrial applications across Australia, and meets the relevant Australian National Transport laws, regulations, codes and guidelines.

CTSCo anticipates that up to nine (9) dedicated B-double trucks for GHG stream delivery will make a total of up to nine (9) return trips per day (one return trip per truck), up to 6 days a week (Monday to Saturday). This equates up to 18 truck movements per day during daylight hours.

As depicted in Figure 1-1 of Chapter 1, trucks will transport the GHG stream on approximately 260 km of public roads, from the MPS:

- 4.2 km along Moffatt Reserve Road;
- turn right onto the Millmerran-Inglewood Road to the intersection with the Gore Highway for 13 km;
- turn left onto the Gore Highway (28B), heading west for 122 km;
- turn right onto the Leichhardt Highway (26C), heading north for 79 km;
- turn left onto the Moonie Highway (35A) at Moonie, heading west for 44 km; and
- then turn right at the Harts Road intersection.

The return journey to MPS will be via the same route.

Other deliveries and vehicle access during operations via Harts Road will include:

- LPG tanker deliveries of up to 16 tonnes of LPG on a weekly basis;
- one light vehicle once a week for cleaning of the office in the Transportation Facility; and
- one light vehicle daily for inspection of plant and equipment along the access road, in the Transportation Facility, along the flowline and at the injection testing GHG stream storage site.

Given that the access road is Harts Road, which is a local public road, no restrictions on the access to Harts Road are anticipated during Project operation.

Landowners and/or leaseholders of operational lands or land adjoining operational lands are understood to be the only current users of Harts Road. This is not anticipated to change during Project operation.

2.10.2 Transportation Facility

The Transportation Facility includes the following key features:

- office;
- one-way traffic flow;
- cryogenic GHG stream off-loading and storage tanks;
- water bath heaters and LPG tanks;
- pumps and flowline valves and connections.

2.10.2.1 OFFICE

The Transportation Facility will be remotely supervised. Monitoring data from all equipment in the Transportation Facility and at the injection testing GHG stream storage site will be collected into the data storage system in the office and transmitted to Brisbane. Remote control of infrastructure will be from both the office within the Transportation Facility and from Brisbane.

The crib room and amenities in the office will be available to all personnel permitted with access to the Transportation Facility, including delivery drivers, to allow for personal comfort and fatigue management.

Inspection of the office, car park, office power supply (solar panels and batteries), potable water supply and sewage treatment will occur every workday. Cleaning of the office will occur once a week.

2.10.2.2 ONE-WAY TRAFFIC FLOW

To minimise vehicle interactions, traffic flow through the Transportation Facility will be one-way circulation. As shown on Figure 2-16, entry into the Transportation Facility will be at the northern end of the western boundary, turning right from Harts Road. Exit from the Transportation Facility will be at the southern egress point, turning left onto Harts Road.

Carparking and overtaking areas will be provided within the Transportation Facility for trucks to safely pass each other if required.

No on-site fuelling or maintenance of vehicles is proposed for the Project. All fuelling of vehicles will be off-site.

2.10.2.3 CRYOGENIC GHG STREAM OFF-LOADING AND STORAGE TANKS

The GHG stream will arrive at the Transportation Facility as a cryogenic liquid. As outlined in section 2.10.1, each B-double delivering the GHG stream to the Transportation Facility will carry a total of 36 tonnes. Discharge of the GHG stream into the GHG stream storage tanks will take approximately 16 minutes per iso tank container, totalling approximately 32 minutes for each truck to completely discharge its load.

Four 100 t GHG stream tanks will store a total of up to 400 t of cryogenic GHG stream within the Transportation Facility. There will be two connection points to allow for discharge from the trucks into each tank. This will allow for two trucks to discharge at the same time without creating ramping of trucks awaiting to discharge loads. Couplings for connections between an iso tank container and a tank will be designed to minimise fugitive emissions of the GHG stream.

2.10.2.4 WATER BATH HEATERS, GENERATORS AND LPG TANKS

To be suitable for the injection testing process, the GHG stream as a cryogenic liquid requires that it be heated and pressured to be a supercritical fluid, being a high pressure, dense, liquid-like state of approximately 31°C and up to 1,500 psi (10 Mpa). This pressure and temperature profile assists in assimilating the GHG stream with the existing conditions of the Precipice Sandstone at injection.

The heat source for the water bath heaters will be LPG burners. The LPG will be supplied from the LPG tankers. The burners can consume up to 60 kg/h total of LPG.

The burners are fully enclosed to prevent access to the naked flame, with thermal protection provided. The following design codes will apply: API 12K, AS1170, AS1210, AS3814, ASME VIII, and B31.3.

The LPG tanks will be located in a dedicated area in accordance with AS/NZ1596, with an exclusion zone of 15 m to be established around the LPG tanks.

The water bath heaters allow for a controlled, steady, continuous and confined compression and heating of the GHG stream. The water in the water baths does not mix with the GHG stream but acts as a heat transfer medium from the LPG burners to the outside of the pressurised tanks containing the GHG stream. The water bath heaters are a closed loop system, that will only require small top-ups of water during maintenance.

After the GHG stream is heated to a supercritical fluid, it is transferred to the flowline.

Electricity for the unloading pumps of cryogenic GHG stream, and injection pumps for supercritical GHG stream will be provided by two 300 kW LPG-fired power generators (gensets) located at the Transportation Facility, with a combined consumption rate of LPG of up to around 46 kg/h.

2.10.2.5 PUMPS FOR SUPERCRITICAL FLUID GHG STREAM

Two pumps (one in use, one as back-up) will pump the supercritical fluid GHG stream into the flowline at approximately 31°C and up to 1,500 psi (10 Mpa) to transfer the fluid to the West Moonie-1 Injection Well. The flowrate will be approximately 15 t/h, with no additional pumping required along the flowline.

Pumps are to be positive displacement pumps, likely piston and plunger pumps, designed to API 674. This standard is used in mining, oil and gas, and other industrial applications, with pumps typically being robust and versatile in operation.

2.10.2.6 CORROSION

Corrosion studies have been undertaken for materials selection for the Transportation Facility pipework and equipment. The studies considered:

- process conditions;
- minimum design metal temperature;
- internal corrosion;
- external corrosion;

- erosion; and
- anti-explosive decompression (AED) for elastomers and seals.

Table 2-8 lists the components, recommended material standards and other considerations in the design of the Transportation Facility and flowline.

Table 2-8 Recommended Materials and Considerations for the Transportation Facility and Flowline Design

Component	Recommended Material Standard	Other Considerations
Facility piping	ASTM A333 Gr 3, 4 or 7	An internal corrosion allowance of 0 mm is to be adopted in the design. External corrosion protection is via painting. A maximum flow velocity of 4.5 m/s to be adopted to prevent erosion.
Other facility piping components (forged or cast)	ASTM A350-LF3 and ASTM A352-LC3	Corrosion allowance as per facility piping
Elastomers	Low temperature terpolymer FKM, such as Marco Compound # V1160 Low Temperature 90	Material to be tested to both NACE and NORSOK RGD standards. Material to be suitable for low temperatures and applicable coincident pressure.

2.10.2.7 PIPING

Pressure piping systems are to be designed to ASME B31.3, which is permitted by AS4041, clause 1.6. Pipework is sized to give velocities that reduce the likelihood of the following:

- vibration;
- noise;
- excessive pipe stresses;
- excessive pressure drop;
- flow induced corrosion or erosion; and
- Net Positive Suction Head (NPSH) problems for pumps.

The criteria given in API RP 14E for offshore piping is to be used, as it is considered conservative for clean, single phase (supercritical) CO_2 service:

$$v_{max} = C / \sqrt{\rho}$$

in customary (US / field) units, with C = 100.

2.10.3 Flowline

The flowline will convey the supercritical GHG stream from the water heater bath to the West Moonie-1 Injection Well. The flowline will be constantly charged, delivering up to 15 t/h of GHG stream to the well head. Monitoring equipment will monitor all inlets, outlets and any other connection points for temperature, pressure, flow rate and other items as required by the relevant standards.

Due to frictional and surface area losses along the 9.5 km flowline, the supercritical GHG stream will be introduced into the flowline at approximately 31°C and 1,500 psi (10 Mpa), and arrive at the well head at approximately 31°C and 1,377 psi (9.5 Mpa). The flowline is sized to give an acceptable pressure drop, with lower velocities than the Transportation Facility pipework.

2.10.4 Wells

2.10.4.1 WEST MOONIE-1 INJECTION WELL

All GHG storage injection testing activities will be in accordance with the Injection Test Plan (ITP) as required by the GHG Act s.80 and GHG Regulation s.6. Chapter 4 Approvals provides further details of the legislative requirements.

As shown in Figure 2-20, at depths below surface of 800 m (0.8 km), CO_2 naturally increases in density and becomes a supercritical fluid. Supercritical fluids take up less space by increasing in density and diffuse better than either gases or ordinary liquids through the tiny pore spaces in storage rocks, such as sandstone. The blue numbers in Figure 2-20 show the volume of CO_2 at each depth below surface, compared to a volume of 100 at the surface (CO2CRC, 21 February 2021).

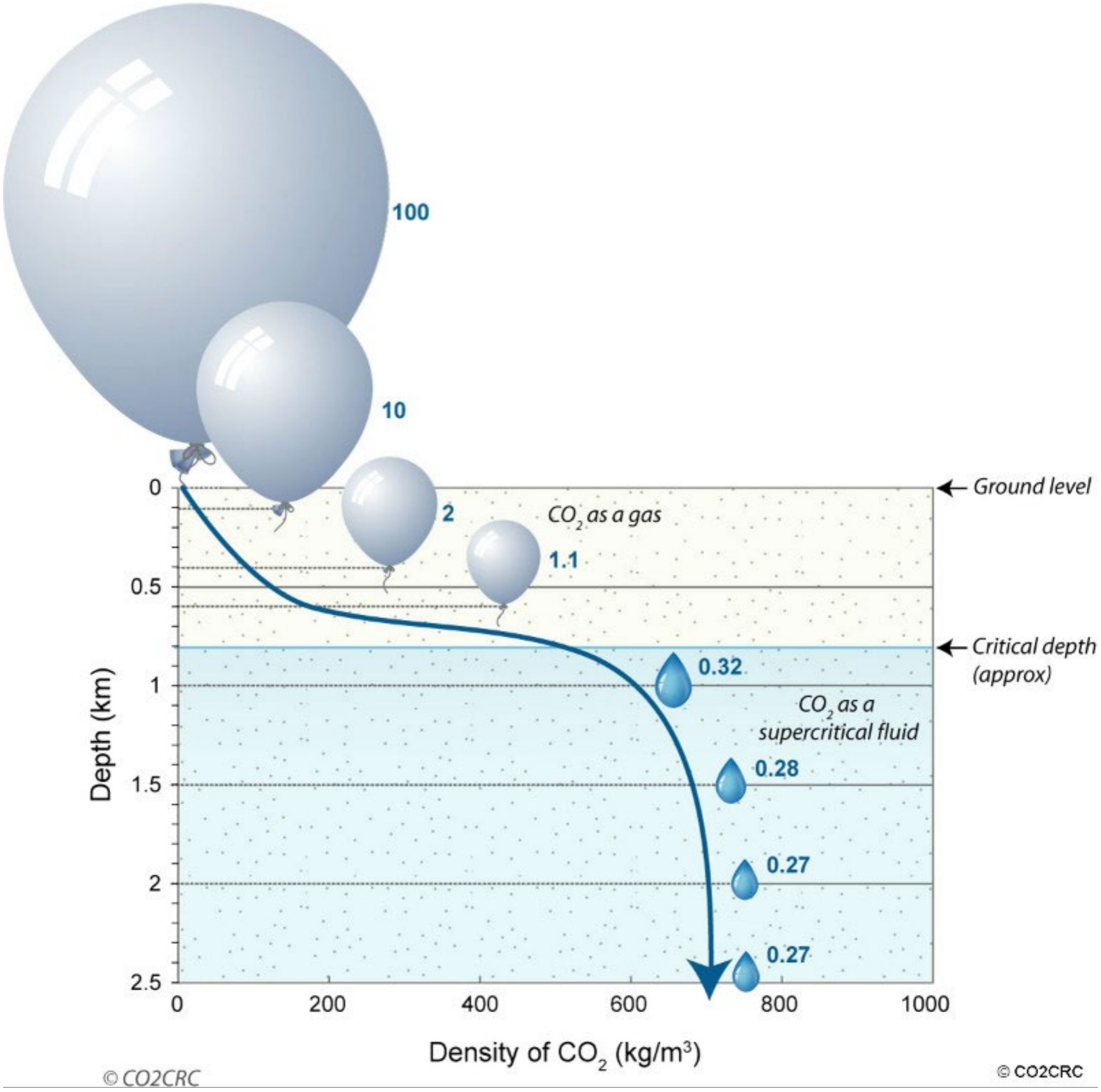

Figure 2-20 Storage Phases of GHG stream (density of CO_2 vs depth (km)) (source: CO2CRC, 21 February 2022)

Injection testing of the GHG stream supercritical fluid will be via the West Moonie-1 Injection Well. The GHG stream will be injected into the wellhead at approximately 31°C and 1,377 psi (9.5 MPa). The GHG stream will take approximately 52 minutes to travel from the wellhead to the perforated injection zone located approximately 2,300 m below ground level in the lower Precipice Sandstone. During this process, the well is expected to act as an effective heat exchanger, warming the GHG stream as it travels between the surface and the injection depth. The relatively slow transport speed of the GHG stream within the well tubing results in the GHG stream being delivered to the injection zone at a temperature of approximately 80°C and a pressure of 3,270 psi (22.54 MPa). Figure 2-21 demonstrates the expected changes in temperature, pressure and pH as the GHG stream moves through to the GHG storage reservoir. Further discussion on the behaviour of the GHG plume and its interaction with the GHG storage reservoir and surrounding geology is given in section 2.11 below and in Chapter 8 Geology and Chapter 9 Groundwater and the associated technical reports.

The injection well infrastructure will inject up to 110,000 tonnes per year of the GHG stream, injecting for a 3-year period. Injection is anticipated to be conducted continuously 24 hours a day, 7 days a week, with the site being unmanned, and the performance of all injection infrastructure remotely monitored and controlled from the control room in the Transportation Facility and from Brisbane. Injection activities will be in accordance with the Injection Test Plan (ITP) to be approved by the Department of Resources (DoR) and the proposed EA condition amendments.

Following completion of injection activities, West Moonie-1 Injection Well will be suspended, in accordance with the GHG Act, and any applicable provisions of the *Petroleum and Gas (Production and Safety) Act 2004* (P&G Act) and regulations. Monitoring of the well and GHG plume will be ongoing, as described in section 2.11.

Given that all other wells and bores are installed for the purposes of monitoring, these are discussed further in section 2.11.5.

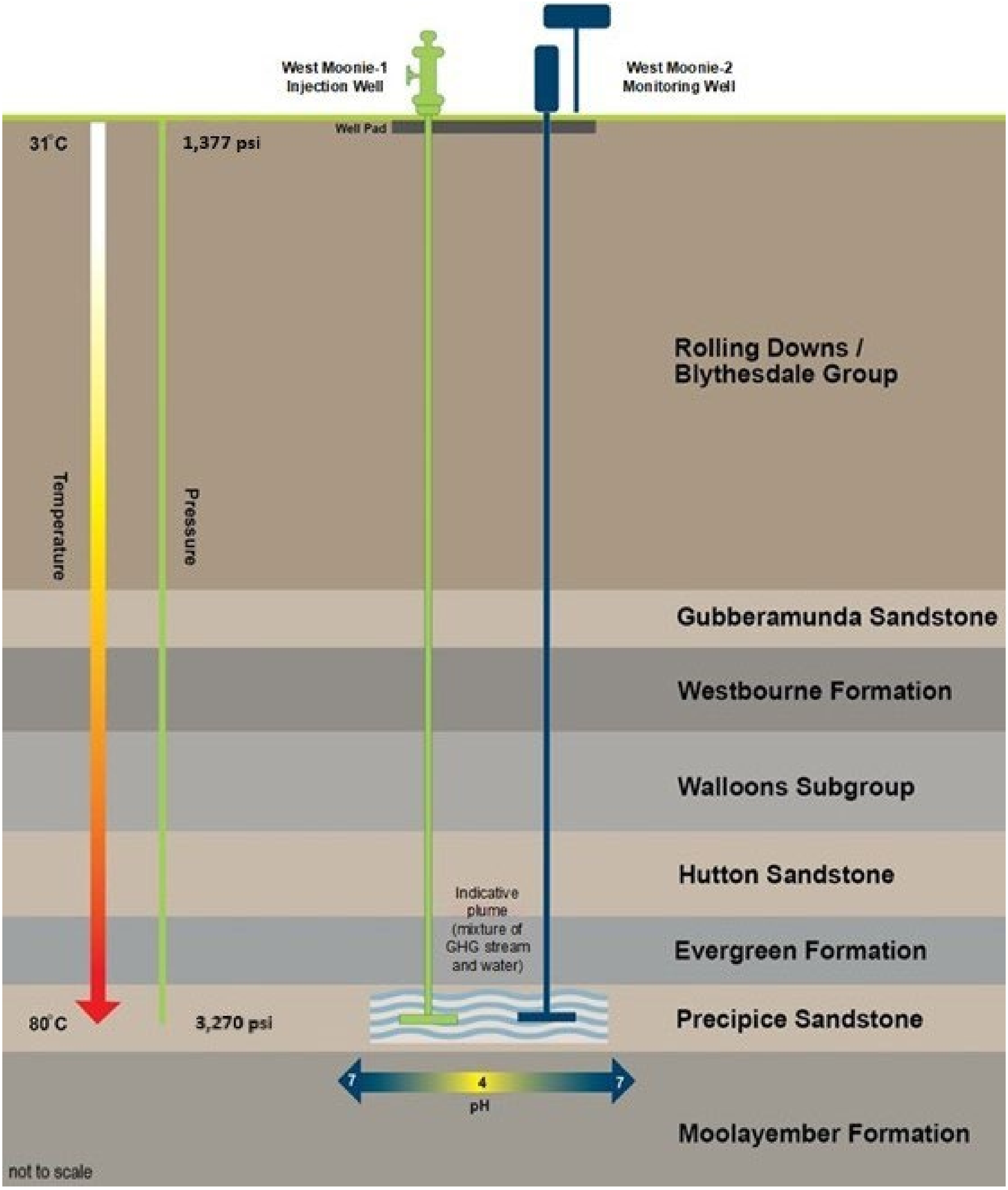

Figure 2-21 Temperature, Pressure and pH changes through GHG stream injection

2.10.5 Operation Workforce and Accommodation

Operation of the Transportation Facility and injection testing GHG stream storage site is anticipated to involve up to five full-time equivalent (FTE) persons in-field, being mostly locally based truck drivers delivering the GHG stream, LPG or other materials to the Transportation Facility. Up to four office-based technical persons are anticipated, mostly associated with the remote monitoring and operation of equipment from Brisbane.

Depending upon skills and availability, in-field personnel can be people from the local area, considered as Millmerran, Goondiwindi, Moonie, Westmar, Tara, Dalby, Yelarbon, or St George. Otherwise, accommodation of personnel travelling to the Project during operations will be in Moonie or Westmar.

2.10.6 Operation Phase

As outlined in section 2.7, the operation phase is anticipated to be undertaken over a 3-year period, commencing April 2025 with completion by end of May 2028.

Personnel workdays are nominated as Monday to Saturday inclusive, excluding any public holidays recognised for Queensland, Brisbane or Moonie areas. However, the majority of activities are anticipated to be conducted Monday to Friday.

Operation phase work hours involving personnel on-site are anticipated to be daylight only, typically 7 am to 6 pm for all nominated workdays.

Operation of the water bath heaters, pump to flowline, flowline and injection of the GHG stream into West Moonie-1 Injection Well, and all associated monitoring equipment will be 24 hours per day, 7 days a week. Deviation from these operational hours is only anticipated due to equipment servicing and maintenance, or triggering of monitoring parameters that require halting of operations until investigations are complete. Section 2.11 provides further discussion on monitoring parameters that may trigger a suspension of operational activities.

2.11 Monitoring

A range of monitoring and verification technologies will be deployed to address the key risks and consequences of the GHG storage injection testing that are specific to the different surface and subsurface domains. For the purposes of the Project, the domains are:

- surface and shallow subsurface (atmosphere, biosphere, hydrosphere and geosphere), monitored to:
  - minimise the likelihood of unauthorised environmental harm caused by leakage from Project activities; and
- deep subsurface (hydrosphere and geosphere), monitored to:
  - track GHG plume movement, extent and impact; and
  - ability to identify the presence of the GHG stream above the Precipice Sandstone in the shallower Hutton Sandstone, should it occur.

Under s.80 of the GHG Act and s.6 of the Greenhouse Gas Storage Regulation 2021 (GHG Regulation), CTSCo is to prepare and submit an Injection Test Plan (ITP) for the Project to the Minister for Resources. The proposed test plan will include the information prescribed in the GHG Regulation s.6, including information regarding the operations and techniques to be used to monitor and verify the behaviour of the substance during the proposed testing (GHG Regulation, s.6(c)). The Monitoring and Verification Plan (MVP), as part of the ITP, is required to demonstrate conformance, containment and performance of the injected GHG stream:

- **conformance**: the GHG plume remains within the GHG storage reservoir (below the Evergreen Formation seal) and behaves as predicted;
- **containment**: no GHG stream leakage or containment breaches, with the GHG plume remaining within the predicted extent; and
- **performance**: monitor pressure and quality impacts on groundwater, including changes to pH, mobilisation and fate of trace metals, and obtain scientific data to demonstrate the performance of the predicted GHG plume and any associated impacts are within limits permitted, and that the environmental values of the receiving aquifer are not deteriorated.

The MVP will use systems that are tailored to suit to the geology, groundwater chemistry, pressure and temperature conditions expected at the GHG stream storage site. Anomaly detection threshold limits (triggers) will be set for all installed monitoring systems that, if exceeded, will result in an appropriate operational response.

Although the injection operation will cease after three years, monitoring and verification activities will continue to monitor the post-injection behaviour of the GHG plume. Post-injection monitoring activities will include:

- repeat 2D seismic surveys for monitoring and verification of GHG plume movement until the GHG plume has ceased expansion plus two seismic surveys at a 6-monthly interval after the GHG plume has ceased to expand, or 2 years, whichever is longer;
- water quality testing of groundwater from the Precipice Sandstone aquifer; and
- pressure and chemistry recording of the Precipice Sandstone aquifer, and comparison with pre-injection environmental baseline characteristics.

2.11.1 Predicted GHG Plume Behaviour

Preliminary modelling using the data acquired in the West Moonie-1 and West Moonie-2 wells has been conducted to predict GHG plume, GHG plume extent, GHG plume behaviour and associated impacts. The various aspects and attributes of the modelling undertaken include:

- geophysical model: to provide a picture of the subsurface;
- static geological model: to convert the geophysical model into a 3D structure and rock properties model;
- dynamic (plume) model: a numeric finite element model using the static model to predict GHG plume movement and GHG storage reservoir pressures;
- sensitivity analysis and testing to confirm:
  - vertical versus horizontal permeability (kv:kh) to determine the maximum impact on GHG plume extent;
  - that the GHG plume stops moving vertically by the lower Precipice Sandstone / upper Precipice Sandstone interface;
- geochemical model: to predict the reaction on GHG storage reservoir water and host rock with the pH arising from the injection of the GHG stream, and includes the reactive transport modelling to predict pH and trace metal changes and potential impacts;
- hydrogeological model: to predict water pressure changes and potential impacts.

Modelling results indicate that the maximum expected increase in the lower Precipice Sandstone pressure is less than 12 psi (equating to approximately 8 m head increase) adjacent to the West Moonie-1 Injection Well, and the maximum pressure increase at the upper/lower Precipice Sandstone interface is 2 psi. These changes are modelled as highly localised and dissipate rapidly with increasing distance from the West Moonie-1 Injection Well due to the high porosity and permeability of the lower Precipice Sandstone rock at this location. Groundwater pressure changes are modelled as typically less than 1 m of head increase.

With a GHG stream injection volume of 110,000 tonnes per year for 3 years, modelling results show that the GHG plume extent will be approximately 1,200 m to 1,500 m in diameter around West Moonie-1 Injection Well. GHG plume modelling results for the Scenario 1 base case are shown in Figure 2-22. The GHG plume extent is expected to remain within the Project's operational lands. Chapter 9 Groundwater provides further details on the GHG plume and the scenarios examined.

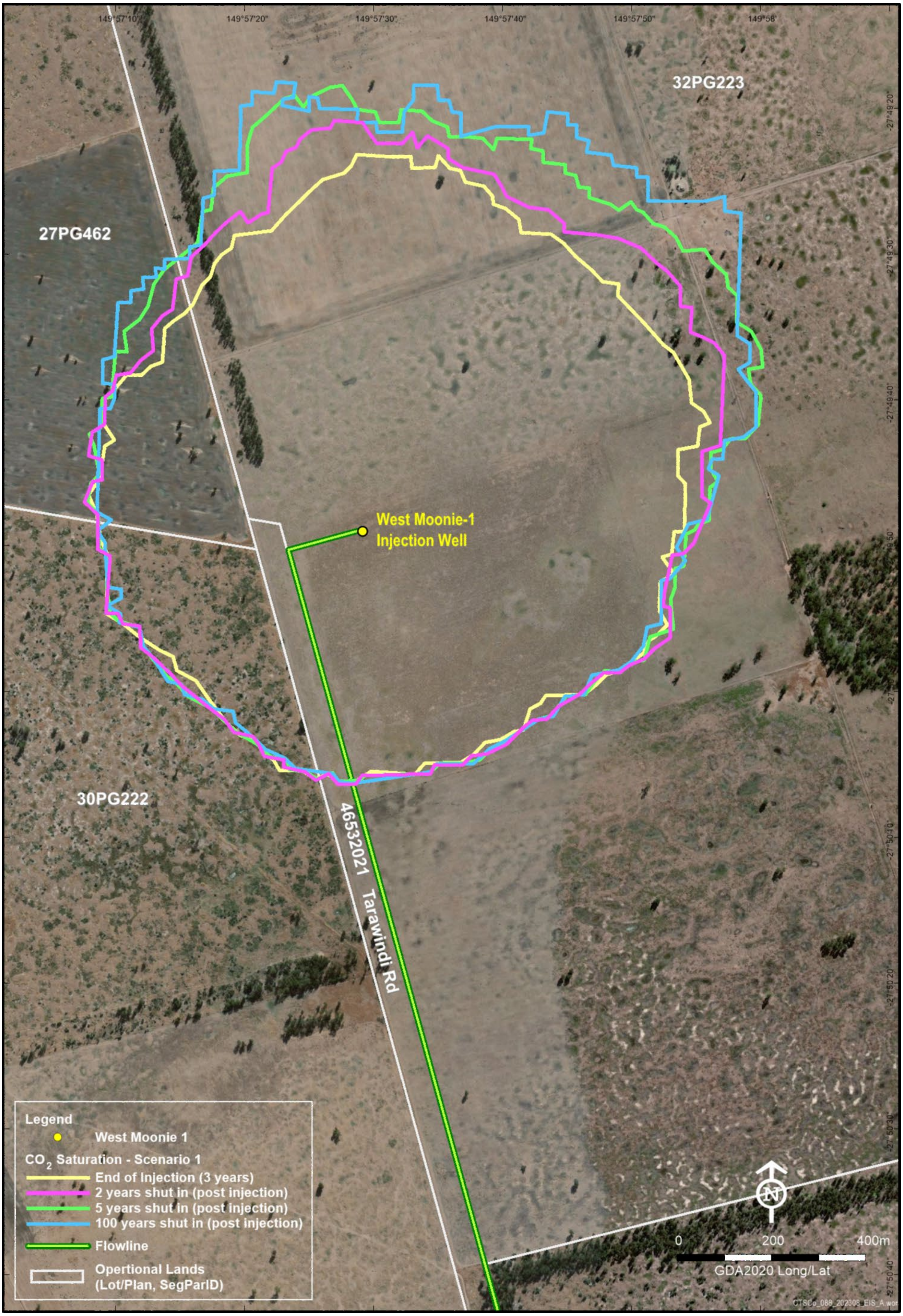

Figure 2-22 Predicted GHG plume extent (base case)

A 1 m increase in groundwater pressure was adopted to define the limit of the affected zone as it is within the range of natural seasonal groundwater pressure fluctuations and represents the reasonable limit of precision that can be inferred from groundwater modelling. The groundwater pressure changes are anticipated to dissipate in the first 5 years following cessation of injection activities. Subsequently, modelling predicts no discernible change in the Precipice Sandstone groundwater pressure or groundwater levels surrounding the injection site. The injection testing is predicted to not create a zone of increased pressure or changed groundwater levels in the overlying or underlying formations.

Geochemical modelling predicts that the GHG plume will be less dense than the Precipice Sandstone water and lower the pH of the groundwater to approximately pH 4 directly adjacent to the West Moonie-1 Injection Well. The GHG plume is predicted to rise upwards from the lower Precipice Sandstone to the upper Precipice Sandstone, reacting with calcite and feldspar minerals present within the upper Precipice Sandstone, including basic silicates (sodium and potassium), calcium, magnesium, magnesium iron carbonates, and silicates. The reactions will form bicarbonate ions that will react with salts to form solid carbonate minerals. The solid carbonate minerals will precipitate from the groundwater within the rock pores. The deposited carbonates are predicted to fill the rock pores of the upper Precipice Sandstone over time. This will reduce the porosity and permeability of the upper Precipice Sandstone, limiting the GHG plume and groundwater movement. As a result, the upper Precipice Sandstone is predicted to become an effective reservoir seal between the lower Precipice Sandstone reservoir and the main Evergreen Formation reservoir seal.

Limited mineral precipitation is predicted in the lower Precipice Sandstone. Hence, no significant changes to the porosity and permeability of the lower Precipice Sandstone are predicted. No pH or geochemical changes are predicted outside the GHG plume.

Further discussion on the predicted behaviour of the GHG plume and its interaction with the GHG storage reservoir and surrounding geology is given in Chapter 8 Geology and Chapter 9 Groundwater and associated technical reports.

2.11.2 GHG Plume Monitoring

Prior to the commencement of injection operations, a baseline data set will be collected. During the 3 years of injection, and for at least 2 years after injection ceases, monitoring of the atmosphere, wells and bores, GHG storage reservoir, and other geological features at the GHG stream storage site will be undertaken in accordance with the MVP as described in section 2.11.

The main items of monitoring equipment that have been or are to be constructed and installed in accordance with existing EPQ10 and EA conditions include:

- West Moonie-2 Monitoring Well, drilled in July 2021, as described in section 2.8.1.2.2;
- West Moonie Sentinel Well, to be drilled in 2024, as described in section 2.8.1.2.3;
- West Moonie Shallow Monitoring Bore installed in 2021 to 48 m below ground level into the shallow Griman Creek formation, as described in section 2.8.1.2.4;
- Gubberamunda Monitoring Bore to be drilled just below the base of the Gubberamunda Sandstone, as described in section 2.8.1.2.5;
- West Moonie-5 Soil Monitoring Bore and West Moonie-6 Soil Monitoring Bore, as described in section 2.8.1.2.6; and
- buried 2D seismic survey lines, scheduled for installation in 2024, as described in section 2.8.1.3.3.

Figure 2-23 shows how the MVP has been designed to capture data from the surface and deep geological formations and monitor the vertical and lateral GHG plume extent within the Precipice Sandstone reservoir.

Details of the MVP will be prepared in accordance with legislative requirements, as outlined sections 2.11.6 and 2.11.7 below, and in Chapters 4 Approvals, 8 Geology, and 9 Groundwater. The MVP will address:

- monitoring measures to be undertaken in relation to the monitoring equipment installed or to be installed at the West Moonie-1 Injection Well, West Moonie-2 Monitoring Well, West Moonie Sentinel Well, Gubberamunda Monitoring Bore, the West Moonie Shallow Monitoring Bore, and the soil monitoring bores;
- frequency of the various types of monitoring;
- sampling and analysis of parameters and methods used;
- triggers that determine whether or not injection activities are temporarily suspended, monitored in greater detail, or ceased during the scheduled 3-year injection period; and

- measures to determine the observed outcomes of the injection testing compared to model predictions and recognised statistical measures.

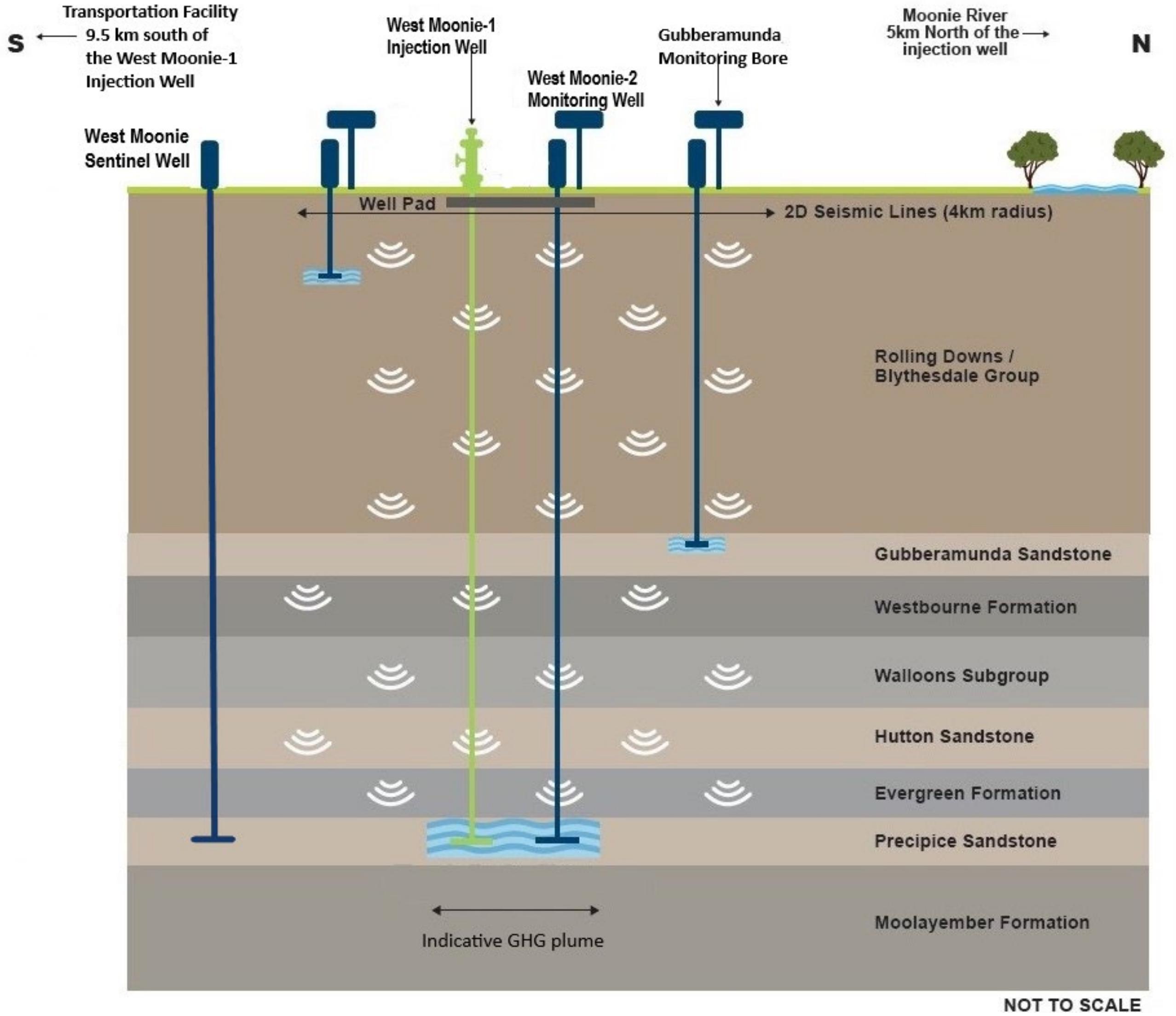

Figure 2-23 Monitoring and verification of indicative GHG plume

2.11.3 Transportation Facility

Access and egress from the Transportation Facility will be monitored via access passes for gates and closed-circuit television (CCTV).

Remote monitoring will be installed for critical equipment, including GHG stream and LPG leak detection.

2.11.4 Flowline

Remote monitoring will be installed on the inlet and outlet of the flowline to ensure flow rates, temperatures, and pressures are maintained within the flowline operating limits, as described in section 2.10.3.

2.11.5 Wells and Bores

2.11.5.1 WEST MOONIE-1 INJECTION WELL

The primary purpose of the West Moonie-1 Injection Well is to inject GHG stream into the Precipice Sandstone aquifer as the GHG storage reservoir. At the West Moonie-1 Injection Well, a suite of sensors will be installed to monitor for any GHG stream leakage or changes in well operating conditions that require intervention. Continuous atmospheric CO_2 monitoring and wellhead temperature monitoring will be installed at the injection wellhead to detect any GHG stream leaks at the wellhead. Pressure monitoring will be installed in both the tubing-production casing annulus and in the surface casing-production casing annulus to detect any leakage within the well. Downhole temperature and pressure gauges shall be installed on the production tubing to monitor injection pressures close to the Precipice Sandstone. All well monitoring will be integrated into the automated control system at the well to allow immediate shutdown of injection operations should any leak and deviation from expected operating parameters are detected. Measurements from the well monitoring system will be transmitted via a mobile telecommunication link (with satellite back-up) to allow remote monitoring, alarm notification and control (if required).

2.11.5.2 WEST MOONIE-2 MONITORING WELL

The West Moonie-2 Monitoring Well has been located to be within the predicted GHG plume extent during the injection testing phase. The primary purposes of the West Moonie-2 Monitoring Well is to allow measurement of the GHG plume position vertically within the GHG storage reservoir (using wireline logging), and to allow for groundwater sampling and subsequently water chemistry testing from within the GHG plume. The well will allow cased-hole wireline log evaluation of all formations from surface to the Moolayember Formation to detect the presence and location of any GHG stream.

At the West Moonie-2 Monitoring Well, a suite of sensors shall be installed to monitor for any GHG stream leakage or changes in well conditions requiring intervention. Continuous atmospheric CO_2 monitoring and wellhead temperature monitoring will be installed at the monitoring wellhead to detect any GHG stream leaks at the wellhead. Pressure monitoring will be installed in both the tubing-production casing annulus and in the surface casing-production casing annulus to detect any leakage within the well. Downhole temperature and pressure gauges shall be installed on the production tubing to monitor Precipice Sandstone pressure. All well monitoring will be integrated into the automated control system at the well to allow immediate shutdown of injection operations should any leak and deviation from expected monitoring parameters be detected. Measurements from the well monitoring system will be transmitted via a mobile telecommunication link (with satellite back-up) to allow remote monitoring, alarm notification and control (if required). The well will be completed with a series of production packers and downhole flow control devices to allow selective groundwater sampling from both the Precipice Sandstone and the Hutton Sandstone aquifers.

2.11.5.3 WEST MOONIE SENTINEL MONITORING WELL

The West Moonie Sentinel Monitoring Well has been located to be outside the predicted GHG plume extent during all Project phases. The primary purpose of the West Moonie Sentinel Well is to monitor for any unexpected GHG stream impacts outside the GHG plume extent. The well will allow cased-hole wireline log evaluation of all formations from surface to the Moolayember Formation to detect any presence of GHG stream. The well will be similar in design to the West Moonie-2 Monitoring Well and will allow for water sampling and pressure measurement of the Precipice Sandstone. If required, the West Moonie Sentinel Well may be completed to also allow for selective groundwater sampling of both the Hutton Sandstone and the Precipice Sandstone aquifers.

2.11.5.4 WEST MOONIE SHALLOW MONITORING BORE

The purpose of the West Moonie Shallow Monitoring Bore is primarily to allow sampling of the Griman Creek Formation to monitor for any changes in water quality.

2.11.5.5 GUBBERAMUNDA MONITORING BORE

The primary purpose of the Gubberamunda Monitoring Bore is to allow sampling of the Gubberamunda Sandstone aquifer to monitor for any changes. No impacts are expected in the Gubberamunda Sandstone aquifer as a result of the injection testing. This monitoring bore is designed to provide additional verification of the absence of any impacts on this important regional water source by the injection testing in the deeper Precipice Sandstone aquifer.

2.11.5.6 WEST MOONIE-5 SOIL MONITORING BORE, AND WEST MOONIE-6 SOIL MONITORING BORE

Further to section 2.8.1.2.6, the purpose of soil monitoring bores is to allow soil vapour monitoring immediately adjacent to the West Moonie-1 Injection Well and West Moonie Sentinel Well.

The soil monitoring bores will be used to monitor and characterise the CO_2 content of the soil using in-wellbore soil vapour monitoring.

CTSCo has selected the Romanak 'Process Based' soil gas monitoring methodology, which relies on the simple stoichiometric ratios of various gases (Romanak *et al*., 2012a). This is a powerful and baseline independent method for identifying concentrations of CO_2 that are unlikely to arise from metabolic activity in the soil.

Soil vapour monitoring will be continuous, commencing 12 months prior to injection to establish a baseline data set, and will be maintained until the end of the post-injection monitoring phase.

2.11.6 2D Seismic Monitoring Program

Further to section 2.8.1.3.3, when 2D seismic monitoring is conducted at least every 6 months, data obtained by each the geophones will be transmitted to CTSCo for processing, interpretation, and reporting. Raw survey data will be transmitted directly over a mobile telecommunications network (or back-up satellite network) to the Brisbane office data centre.

The seismic monitoring network will be used to monitor early GHG plume development and its maximum extents. Seismic surveys will be undertaken using all seismic lines on at least 6-monthly intervals. Groundwater, CO_2 and CO_2 rich water produce distinctly different seismic responses. Hence, seismic surveys are ideally suited to monitoring the GHG plume extent. Seismic surveys will be undertaken prior to commencement of injection activities to establish baseline conditions (i.e. the seismic properties of the groundwater-bearing formations in the absence of injected GHG stream). Seismic surveys will continue on at least 6-monthly intervals during and post-completion of injection activities to detect any changes in the baseline seismic conditions due to the presence of the GHG stream. Seismic surveys will continue in the post-injection monitoring phase to verify the final GHG plume position, being when the GHG plume has ceased expansion plus two seismic surveys at a 6-monthly interval after the GHG plume has ceased to expand, or 2 years, whichever is longer. The results of each seismic survey will show the vertical and lateral extent of the GHG plume along each seismic line. The results collected from each seismic line, the West Moonie-2 Monitoring Well, and the West Moonie Sentinel Well will be integrated to show the GHG plume extent in three dimensions. This form of seismic surveying enables a time-lapse view of GHG plume location and behaviour.

CTSCo has selected time-lapse seismic surveying as the primary monitoring method for the injection testing. Seismic monitoring allows for robust GHG plume position determination, both vertically and laterally, within the GHG storage reservoir. The technique also allows for detection of unanticipated GHG stream in overlying formations, both adjacent and distant to the West Moonie-1 Injection Well. Consequently, seismic monitoring offers spatial monitoring that cannot be achieved reliably using monitoring wells. Seismic monitoring of GHG plumes is also an established and proven technology, with the majority of CO_2 storage projects globally using the technology as their primary GHG plume monitoring technique. Furthermore, some international CCS projects have eliminated monitoring wells from their GHG storage reservoir surveillance programs in favour of time-lapse seismic monitoring.

2.11.7 Management of Potential Impacts from the Predicted GHG Plume

CTSCo recognises the importance of appropriate monitoring to demonstrate compliance with EP Regulation s.41, including comparison to the predicted GHG plume behaviour and observations obtained from monitoring data. The monitoring and verification program has been designed to detect movements of the GHG plume, and changes in water quality parameters of the GHG storage reserviour, being the Precipice Sandstone aquifer, and overlying aquifers. Although CTSCo does not expect these potential impacts to occur during the Project given the Precipice Sandstone is a confined aquifer, the monitoring and verification program is specifically designed for early detection of any potential impacts from the predicted GHG plume.

Based on the requirements of EP Regulation s.41, learnings from other global CCS projects, and knowledge of the geological charactieristics of the Surat Basin, CTSCo has identified the potential impacts from the predicted GHG plume behaviour include:

- if not released entirely within a confined aquifer (s.41(2)(a)):
  - the GHG plume spreading beyond its predicted spatial extent of the GHG storage reservoir;
  - the GHG plume leaking through the GHG storage reservoir geological seal into the overlying aquifer;
  - the GHG plume leaking into overlying aquifers due to failure of the West Moonie-1 Injection Well;
  - injection resulting in larger and/or more extensive pressure changes in the Precipice Sandstone aquifer than predicted;
  - changes in standing water level, pressure or water quality in the Gubberamunda Sandstone aquifer due to injection activities;
  - changes in standing water level, pressure or water quality in the Hutton Sandstone aquifer due to injection activities;
- if a surface ecological system is adversely affected or there is deterioration in the environmental values of the receiving water (s.41(2)(b) and s.41(2)(c)):

- changes in groundwater quality within the GHG plume beyond predicted levels compared to existing water quality of the Precipice Sandstone aquifer;
- changes in groundwater quality outside the GHG plume of the Precipice Sandstone aquifer;
- potential impacts on groundwater uses and users; and
- changes in CO_2 concentrations in the atmosphere immediately adjacent to the West Moonie-1 Injection Well or West Moonie-2 Monitoring Well.

Under s.80 of the GHG Act and s.6 of the Greenhouse Gas Storage Regulation 2021 (GHG Regulation), CTSCo is to prepare and submit an Injection Test Plan (ITP) for the Project to the Minister for Resources. The ITP will include the information prescribed in the GHG Regulation s.6, including information regarding the operations and techniques to be used to monitor and verify the behaviour of the substance during the proposed testing (GHG Regulations.6(c)). The Monitoring and Verification Plan (MVP), as part of the ITP, is required to demonstrate conformance, containment and performance of the injected GHG stream.

The submission of the ITP including MVP is separate to the EIS process. **Error! Reference source not found.** outlines the contents of the draft ITP/MVP, cross referencing to the relevant sections of the EIS and Chapter 22 Proposed EA condition amendments.

Table 2-9 Draft ITP/MVP contents

ITP/MVP Chapter headings	Chapter sub-headings			EIS Reference	Proposed EA condition amendment Reference
	Heading 1	**Heading 2**	**Heading 3**		
1. Executive summary				Chapter 1 Introduction	Not applicable
2. Introduction				Chapter 1 Introduction & Chapter 2 Proposed Project Description	
	2.1 Surat Basin CCS Project			Chapter 1 Introduction	General Condition 1
	2.2 Project phases and timing			Chapter 2 Proposed Project Description, section 2.7	General Condition 9
		2.2.1 Project stages			General Condition 9
			2.2.1.1 Stage 1: Pre-Injection	Chapter 2 Proposed Project Description, sections 2.9 and 2.11.2	
			2.2.1.2 Stage 2: Injection	Chapter 2 Proposed Project Description, section 2.11.2	
			2.2.1.3 Stage 3: Post Injection	Chapter 2 Proposed Project Description, sections 2.11.2 and 2.12	
3. Approvals				Chapter 4 Approvals	
	3.1 Greenhouse Gas Storage Act 2009 (GHG Act)			Chapter 4 Approvals, section 4.4.9	
	3.2 Greenhouse Gas Storage Regulation 2021			Chapter 4 Approvals, section 4.4.9	
	3.3 Environmental Protection Act 1994 (EP Act)			Chapter 4 Approvals, section 4.4.4	
		3.3.1 Environmental Authority EPPG00646913		Chapter 4 Approvals, section 4.2	
	3.4 Other approvals			Chapter 4 Approvals, section 4.4	
4. West Moonie injection testing site location				Chapter 2 Proposed Project Description Chapter 8 Geology Chapter 9 Groundwater	
	4.1 Site selection			Chapter 2 Proposed Project Description, sections 2.5 and 2.6	
	4.2 Site geological description			Chapter 8 Geology, section 8.7	
		4.2.1 Stratigraphy		Chapter 8 Geology, section 8.7.1	
		4.2.2 Geological structural elements		Chapter 8 Geology, section 8.7.1	
		4.2.1 Storage trapping mechanism		Chapter 9 Groundwater, section 9.9.4.2	
		4.2.2 Natural seismicity		Chapter 8 Geology, section 8.7.1.1.3	Water Condition 18
5. Appraisal of the injection testing site				Chapter 2 Proposed Project Description	

5.1 Appraisal wells, bores and seismic surveys		Chapter 2 Proposed Project Description, section 2.8	General Condition 4, 5, 6, 8, Cultural Heritage Condition 1
	5.1.1 West Moonie-1 Injection Well	Chapter 2 Proposed Project Description, section 2.8.1.2.1	
	5.1.2 West Moonie-2 Monitoring Well	Chapter 2 Proposed Project Description, section 2.8.1.2.2	
	5.1.3 West Moonie Sentinel Monitoring Well	Chapter 2 Proposed Project Description, section 2.8.1.2.3	
	5.1.4 Gubberamunda Monitoring Bore	Chapter 2 Proposed Project Description, section 2.8.1.2.5	
	5.1.5 West Moonie Shallow Monitoring Bore	Chapter 2 Proposed Project Description, section 2.8.1.2.4	
	5.1.6 West Moonie-5 and West Moonie-6 Soil Monitoring Bores	Chapter 2 Proposed Project Description, section 2.8.1.2.6	
	5.1.7 Milgarra Bore	Chapter 2 Proposed Project Description, section 2.8.1.2.7	
	5.1.8 West Moonie 3D Seismic Survey	Chapter 2 Proposed Project Description, section 2.8.1.3.2	General Condition 5; Vibration Condition 1, 2, 3, 4, Cultural Heritage Condition 1
	5.1.9 2D Monitoring Seismic Survey	Chapter 2 Proposed Project Description, section 2.8.1.3.3	Vibration Condition 1, 6,7
5.2 Geological characterisation of the storage complex		Chapter 8 Geology	
	5.2.1 Moolayember Formation: base seal to the storage complex	Chapter 8 Geology, section 8.7.6.7	
	5.2.2 Precipice Sandstone: storage reservoir	Chapter 8 Geology, sections 8.7.6.4 to 8.7.6.6	
	5.2.3 Evergreen Formation: top seal to the storage complex	Chapter 8 Geology, sections 8.7.6.1 to 8.7.6.3	
5.3 Geological characterisation above the storage complex		Chapter 8 Geology	
	5.3.1 Hutton Sandstone	Chapter 8 Geology, section 8.7.5.11	
	5.3.2 The Walloon Sub-Group	Chapter 8 Geology, section 8.7.5.10	
	5.3.3 The Springbok Sandstone	Chapter 8 Geology, section 8.7.5.9	

		5.3.4 Westbourne Formation		Chapter 8 Geology, section 8.7.5.8	
		5.3.5 Gubberamunda Sandstone		Chapter 8 Geology, section 8.7.5.7	
		5.3.6 Orallo Formation		Chapter 8 Geology, section 8.7.5.6	
		5.3.7 Mooga Sandstone		Chapter 8 Geology, section 8.7.5.5	
		5.3.8 Bungil Formation		Chapter 8 Geology, section 8.7.5.4	
		5.3.9 Wallumbilla Formation		Chapter 8 Geology, section 8.7.5.3	
		5.3.10 Surat Siltstone		Chapter 8 Geology, section 8.7.5.2	
		5.3.11 Griman Creek Formation		Chapter 8 Geology, section 8.7.5.1	
6. Pre-injection groundwater quality				Chapter 9 Groundwater, section 9.7.5	General Condition 13
7. Source and composition of the GHG stream				Chapter 2 Proposed Project Description, section 2.4	
	7.1 Millmerran PCC plant			Chapter 2 Proposed Project Description, section 2.4.1	Not applicable
	7.2 GHG stream composition			Chapter 2 Proposed Project Description, section 2.4.1	Water Condition 1
8. Injection testing operations					
	8.1 GHG stream injection rate and volume			Chapter 2 Proposed Project Description, section 2.10.4.1	
	8.2 Surface infrastructure				
		8.2.1 GHG stream transportation	8.2.1.1 Transport regulatory framework	Chapter 2 Proposed Project Description, section 2.10.1	
		8.2.2 Access road		Chapter 2 Proposed Project Description, section 2.10.1	
		8.2.3 Transportation Facility		Chapter 2 Proposed Project Description, section 2.10.2	Air Condition 5, 6, 7, 8
			8.2.3.1 Office	Chapter 2 Proposed Project Description, section 2.10.2.1	
			8.2.3.2 One-Way Traffic Flow	Chapter 2 Proposed Project Description, section 2.10.2.2	
			8.2.3.3 Cryogenic GHG stream Off-Loading and Storage Tanks	Chapter 2 Proposed Project Description, section 2.10.2.3	Air Condition 5, 8, Land Condition 9
			8.2.3.4 Water Bath Heater and LPG Tanks	Chapter 2 Proposed Project Description, section 2.10.2.4	Air Condition 5, 8
			8.2.3.5 Pumps	Chapter 2 Proposed Project Description, section 2.10.2.5	Air Condition 5
		8.2.4 Flowline		Chapter 2 Proposed Project Description, section 2.10.3	Air Condition 8, 11, 12, 13; Land Condition 10, 11, 12, 13
	8.3 Well operations				

		8.3.1 West Moonie-1 Injection well		Chapter 2 Proposed Project Description, section 2.10.4.1	General Condition 7, Air Condition 5, 6, 7, 8
		8.3.2 Monitoring wells and bores		Chapter 2 Proposed Project Description, section 2.11.5	
			8.3.2.1 Monitoring wells	Chapter 2 Proposed Project Description, section 2.11.4.2 Chapter 2 Proposed Project Description, section 2.11.5.3 Chapter 2 Proposed Project Description, section 2.11.5.5	General Condition 7, 9
			8.3.2.2 Monitoring bores	Chapter 2 Proposed Project Description, sections 2.11.5.4 and 2.11.5.6	Air Condition 14
9. Predicted behaviour of the injected GHG stream					
	9.1 Hydrogeological modelling				
		9.1.1 Base case hydrogeological model set-up		Chapter 9 Groundwater, section 9.6.2.1.2	
		9.1.2 Sensitivity analysis set-up for impact of hydraulic head		Chapter 9 Groundwater, section 9.6.2.1.3	
		9.1.3 Sensitivity analysis set-up for impact on groundwater movement		Chapter 9 Groundwater, section 9.6.2.1.4	
	9.2 Dynamic (plume) modelling			Chapter 9 Groundwater, section 9.6.2.2	
		9.2.1 Static parameter sensitivity analysis		Chapter 8 Geology, section 8.6.2.3.1	
		9.2.2 Dynamic parameter sensitivity analysis		Chapter 9 Groundwater, section 9.6.2.2	
	9.3 Potential impacts on plume movement from the extraction of water from the Precipice Sandstone aquifer			Chapter 9 Groundwater, section 9.6.2.1.4	
		9.3.1 Scenarios for extraction of water from the Precipice Sandstone aquifer		Chapter 9 Groundwater, section 9.6.2.1.4	
			9.3.1.1 Scenario 1 – Base Case of existing extraction from the Precipice Sandstone aquifer	Chapter 9 Groundwater, section 9.6.2.1.4.1	
			9.3.1.2 Scenario 2 – Precipice Sandstone aquifer existing water entitlements	Chapter 9 Groundwater, section 9.6.2.1.4.2	

			9.3.1.3 Scenario 3 – Hypothetical future entitlements from unallocated water	Chapter 9 Groundwater, section 9.6.2.1.4.3	
		9.3.2 Water extraction modelling results			
			9.3.2.1 Scenario 1 – Base Case of existing extraction from the Precipice Sandstone aquifer	Chapter 9 Groundwater, section 9.9.2.4.1	
			9.3.2.2 Scenario 2 – Precipice Sandstone aquifer existing water entitlements	Chapter 9 Groundwater, section 9.9.2.4.2	
			9.3.2.3 Scenario 3 – Hypothetical future entitlements from unallocated water	Chapter 9 Groundwater, section 9.9.4.3	
	9.4 Geochemical modelling				
		9.4.1 Evolution of Mineralogical Change within the GHG stream Plume		Chapter 9 Groundwater, sections 9.6.4 and 9.9.4	
		9.4.2 Evolution of Water Composition Change within the GHG stream Plume		Chapter 9 Groundwater, section 9.9.4.3	
		9.4.3 Mobilisation and Fate of Trace Elements Released in Response to GHG stream Injection		Chapter 9 Groundwater, section 9.9.4.4	
	9.5 Geomechanical modelling			Chapter 8 Geology, section 8.6.2.4	
10. West Moonie Monitoring & Verification Plan					Water Condition 22, 23, 24, 25, 26
	10.1 Containment			Chapter 8 Geology, section 8.10 Chapter 9 Groundwater, section 9.10	
	10.2 Conformance			Chapter 8 Geology, section 8.10 Chapter 9 Groundwater, section 9.10	
	10.3 Assessment of risk to public health or the environment				Water Condition 17, 18
		10.3.1 Storage risks before monitoring and verification			

		10.3.2 Risk assessment methods			
		10.3.3 Storage technical risk matrix			
		10.3.4 Technical risk assessment outcomes			
		10.3.5 Loss of containment definition			
		10.3.6 Potential consequences due to a loss of containment			
	10.4 Risk mitigation				
	10.5 Monitoring technologies				
		10.5.1 Pulsed neutron and carbon oxygen logging			
		10.5.2 Temperature and pressure			
		10.5.3 Seismic technology			
		10.5.4 Wellbore mechanical integrity			General Condition 7
		10.5.5 Groundwater sampling			General Condition 13, 14, 15
		10.5.6 Atmospheric monitoring			
	10.6 Monitoring & Verification approaches deployed by other CO_2 storage projects				
	10.7 West Moonie injection testing monitoring technologies			Chapter 9 Groundwater, section 9.10.1	
		10.7.1 Telemetry and telecommunications		Chapter 2 Proposed Project Description, section 2.8.3	
		10.7.2 West Moonie conformance monitoring			Water Condition 22
			10.7.2.1 Time lapse 2D seismic	Chapter 2 Proposed Project Description, sections 2.8.1.3.3 and 2.11.6	Vibration Condition 1, 6,7, 8, 9,10, 11, 12, 13
			10.7.2.2 Groundwater sampling	Chapter 9 Groundwater, section 9.10.1.4	General Condition 13, 14, 15, Water Condition 19, 20, 21

		10.7.3 West Moonie containment monitoring			Water Condition 22
			10.7.3.1 Transportation Facility	Chapter 2 Proposed Project Description, section 2.11.3	
			10.7.3.2 Flowline	Chapter 2 Proposed Project Description, section 2.11.4	
			10.7.3.3 Moolayember Formation	Chapter 2 Proposed Project Description, sections 2.11.5.2 and 2.11.5.3	Vibration Condition 7, 8, 9, 10, 11, 12,13
			10.7.3.4 Evergreen Formation	Chapter 2 Proposed Project Description, sections 2.11.5.2 and 2.11.5.3	Vibration Condition 7, 8, 9, 10, 11, 12,13
			10.7.3.5 Hutton Sandstone	Chapter 2 Proposed Project Description, sections 2.11.5.2 and 2.11.5.3	Vibration Condition 7, 8, 9, 10, 11, 12,13, Water Condition 19, 21
			10.7.3.6 Walloon Coal Measures		Vibration Condition 7, 8, 9, 10, 11, 12,13
			10.7.3.7 Gubberamunda Sandstone	Chapter 2 Proposed Project Description, section 2.11.5.5	Vibration Condition 7, 8, 9, 10, 11, 12,13, Water Condition 19, 21
			10.7.3.8 Shallow Groundwater Monitoring	Chapter 2 Proposed Project Description, section 2.11.5.4	General Condition 13, Water Condition 19, 21
			10.7.3.9 Soil Monitoring	Chapter 2 Proposed Project Description, section 2.11.5.6	Air Condition 14, 15, 16
			10.7.3.10 Air Quality Monitoring	Chapter 2 Proposed Project Description, section 2.11.8	Air Condition 6, 7, 8, 9, 10, 11, 12, 13, 17, 18
	10.8 Departure from predicted GHG plume behaviour				
		10.8.1 West Moonie monitoring procedures and TARP		Chapter 10 Surface Water, section 10.8.1	Water Condition 22, 23, 24
11. Site closure, decommissioning and rehabilitation				Chapter 2 Proposed Project Description, section 2.1.12	Rehabilitation Condition 1, 12, 13, 14, 15, 16, 17
	11.1 Regulatory framework process and closure requirements				
	11.2 Site closure certification				Water Condition 25, 26
		11.2.1 Transfer of monitoring infrastructure and systems			Rehabilitation Condition 11
		11.2.2 Transfer of measurement, monitoring, and verification capability			Water Condition 25
			11.2.2.1 Storage Performance Data		Water Condition 25

	11.3 Surface infrastructure decommissioning	Rehabilitation Condition 2, 3, 4, 5, 6, 7
	11.4 Well decommissioning	Rehabilitation Condition 6, 9
	11.5 Well pad reclamation	Rehabilitation Condition 13, 14, 15
	11.6 Monitoring infrastructure decommissioning	Rehabilitation Condition 8, 9
12. References		Not applicable
Appendices		Not applicable

If investigation findings show that a departure or trigger is due to Project activities, remediation measures will be implemented. Potential remediation measures are listed, but not limited to, measures in Table 2-10 .

Table 2-10 Potential Remediation Measures

Mitigation Trigger	Potential Remediation Measures
Updated modelling shows unexpected GHG plume geometry at a given timeframe (6, 12, 18, 24, 30, and 36 months) of greater than predicted by modelling for the following 6-month interval.	• Suspend injection activities. This will reduce the total volume of GHG stream in the Precipice Sandstone and minimise the potential for expansion of the GHG plume within the operational lands. • Investigate potential reasons for changes in predicted GHG plume extent, such as by undertaking additional seismic monitoring, additional groundwater quality sampling or other suitable method.
Updated modelling shows the maximum spatial GHG plume extent is predicted to increase beyond the maximum predicted GHG plume extent around the West Moonie-1 Injection Well.	• Suspend injection activities. This will reduce the total volume of GHG stream in the Precipice Sandstone and minimise the potential for expansion of the GHG plume within the operational lands. • To verify the final GHG plume extent, determined by when the GHG plume has ceased expansion plus two seismic surveys at a 6-monthly interval after the GHG plume as ceased to expand, or 2 years, whichever is longer. • Updated modelling undertaken to confirm that the maximum spatial GHG plume extent will remain within the boundary of operational lands. • Report as an incident to the administering authorities of the EA, ITP (MVP), and water licence.
An investigation confirms a leak is due to a preferential migration pathway through the GHG storage reservoir seal (and hence the leakage cannot be rectified) to the overlying Hutton Sandstone aquifer.	• Undertake additional monitoring to check if an anomalous reading or logging has occurred; • Report as an incident to the administering authority; • Undertake additional monitoring to recheck with % CO_2 saturation is triggered • Report findings to administering authority.

The proposed mitigation measures, monitoring and verification program, and potential remediation measures are considered to be sufficient to minimise the effects of any departure or trigger from the predicted GHG plume and prevent any adverse impacts on environmental values. Chapter 22 Proposed EA condition amendments further details triggers, actions and responses.

Monitoring will continue until the monitoring results confirm that the mitigation measures, monitoring and verification program, and potential remediation measures (if required) have been successfully implemented and the observed departures or triggers and their effects have been effectively mitigated. The actual duration of the post-injection monitoring will be confirmed by monitoring results but is predicted to be approximately two (2) years.

2.11.8 Air Quality and Atmospheric Monitoring Equipment

The air quality and atmospheric monitoring will continue during the monitoring phase, as described in section 2.8.2.

At CO_2 monitoring points, remediation measures that will be implemented, as per Table 2-10 above, and/or Chapter 12 Air Quality, Table 12-6 CO_2 Monitoring TARP, and Chapter 22 Proposed EA condition amendments.

2.11.9 Telemetry and Telecommunications

The telemetry and telecommunications associated with all key infrastructure and monitoring will continue during the monitoring phase, as described in section 2.8.3.

2.11.10 Monitoring Workforce and Accommodation

During the monitoring phase, there will be up to two full-time equivalent (FTE) persons in-field, being personnel inspecting the monitoring equipment. Up to four office-based technical persons are anticipated, mostly associated with the remote monitoring and operations of equipment from Brisbane.

Depending upon skills and availability, in-field personnel can be people from the local area, considered as Millmerran, Goondiwindi, Moonie, Westmar, Tara, Dalby, Yelarbon, or St George. Otherwise, accommodation of personnel travelling to the Project during monitoring will be in Moonie or Westmar.

2.11.11 Monitoring Phase

As outlined in section 2.7, the monitoring phase is anticipated to be undertaken over a total of approximately 5 years:

- January 2025 to April 2025 – prior to injection operations commencing;
- April 2025 to May 2028 – during the 3 years of injection operation; and
- June 2028 to June 2030 – post-injection period to verify the final GHG plume extent, being when the GHG plume has ceased expansion plus two seismic surveys at a 6-monthly interval after the GHG plume as ceased to expand, or 2 years, whichever is longer.

Personnel workdays are nominated as Monday to Friday inclusive, excluding any public holidays recognised for all of Queensland, and Brisbane or Moonie areas.

Work hours involving personnel on-site are anticipated to be daylight only, between 7 am to 6 pm for all nominated workdays.

Operation of all monitoring equipment will be 24 hours per day, 7 days a week. Deviation from these hours is only anticipated due to equipment servicing, maintenance, or calibration.

2.12 Rehabilitation

The findings of the Project will determine whether or not the Project:

- wells are immediately plugged, abandoned and rehabilitated following completion of the anticipated 5-year period of injection and monitoring phases; or
- wells are suspended and shut-in for future development, subject to further approvals.

Final rehabilitation will be in accordance with EPQ10 conditions, proposed EA condition amendments and legislative requirements, including but not limited to the "*Code of Practice for the construction and abandonment of petroleum wells and associated bores in Queensland*" (DNRME, 2019) or later version thereof.

Subject to negotiations and agreement with the landholder and receipt of the relevant approvals from the Department of Regional Development, Manufacturing and Water, the Gubberamunda Monitoring Bore may be converted to a water supply bore for stock and domestic or irrigation purposes during the rehabilitation phase of the Project, using an appropriately licenced water bore driller to undertake modifications to the bore construction. Otherwise, the bore will be fully plugged, abandoned and rehabilitated.

Pursuant to the GHG Act, s.31, given the temporary nature of all structures in the Transportation Facility, all structures other than the flowline will be removed from the area, with the operational lands rehabilitated to pasture consistent with the surrounding paddock.

Rehabilitation of the flowline will involve leaving the flowline in-situ, and disconnecting the flowline from the equipment in the Transportation Facility and West Moonie-1 Injection Well. The flowline will be filled with cement.

Further details of the rehabilitation measures to be undertaken are provided in Chapter 19 Rehabilitation.

2.12.1 Rehabilitation Workforce and Accommodation

Rehabilitation of the access and egress roads to the Transportation Facility, the Transportation Facility and flowline is anticipated to involve approximately 15 full-time equivalent (FTE) persons in-field, with up to four office-based technical persons in Brisbane.

Subject to negotiations with WDRC, CTSCo proposes that the section of the access road that is located on Harts Road is left for ongoing usage of landowners and leaseholders in the area.

Wherever possible, contracting of local people of the area will be considered for in-field roles, depending upon the skills available. The local area is considered to be Millmerran, Goondiwindi, Moonie, Westmar, Tara, Dalby, Yelarbon, or St George. Otherwise, accommodation of personnel travelling to the Project during rehabilitation will be in Moonie or Westmar.

All personnel will drive in, drive out. No fly-in, fly-out workforce is anticipated.

2.12.2 Rehabilitation Phase

As outlined in section 2.7, the indicative rehabilitation phases are anticipated to be undertaken over two 6-month periods:

- June 2028 to December 2028 – for the Transportation Facility and all of the flowline following the end of the operation phase, i.e. the end of injection testing of the GHG stream; and
- June 2030 to December 2030 – for the wells after the end of the monitoring phase.

Workdays are nominated as Monday to Friday inclusive, excluding any public holidays recognised for all of Queensland, and Brisbane or Moonie areas.

Work hours are anticipated to be 10-hour days, daylight only, typically between 7 am and 6 pm for all nominated workdays.

2.13 Novel and Emerging Technologies

CTSCo does not propose the use of any novel or emerging technology as part of the injection testing.

The Project's GHG storage injection testing is to allow an informed decision on the potential future development and permitting of GHG stream storage in the Surat Basin. The Project is not intended as a new technology trial. The infrastructure, technology and monitoring techniques proposed by CTSCo are established and have proven successful in CO_2 geological storage projects worldwide and within Australia. The wells and infrastructure required adopt petroleum technology that is long-established in Australia and is currently regulated within Queensland under the *Petroleum Act 1923* or the *Petroleum and Gas (Production and Safety) Act 2004* and associated regulations.

Notably, the monitoring techniques proposed by CTSCo are conventional and well established, having been successfully deployed in large-scale CO_2 storage projects in Canada and Norway in addition to the CO_2 storage project by CO2CRC in Victoria, Australia. The Australian Government has also acknowledged the standing of CCS technology as non-emerging in its "*Environmental Guidelines for Carbon Dioxide Capture and Geological Storage – 2009*" (Commonwealth of Australia, 2009).

2.14 Capital and Operational Expenditure

The expected capital expenditure (CAPEX) and operational expenditure (OPEX) across both the inter-related activities outside of EPQ10 as described in section 2.4, being the PCC plant, and the Project are summarised in Table 2-11. The total anticipated expenditure for the both the PCC plant and Project (the subject of the EIS) is $210 million (AUD).

Table 2-11 Capital and Operational Expenditures

Item	$m (AUD)	Timeframe
PCC Plant (inter-related activity)		
Capital Expenditure		
Plant manufacture (China)	81.3	20-year operating life
Shipping	5.9	20-year operating life
Plant construction (Australia)	42.0	20-year operating life
Plant commissioning (technical and professional engineering services)	3.3	20-year operating life
Professional engineering services	11.2	20-year operating life
Operating Expenditure		
Plant operating (power, utilities, etc)	11.5	3-year Project operational program phase
Labour	5.8	3-year Project operational program phase
Maintenance	4.4	3-year Project operational program phase
Project (subject of EIS)		
Capital Expenditure		
Transportation Facility	9.2	3-year Project operational program phase
Flowline	3.4	3-year Project operational program phase
Monitoring equipment	3.6	5-year Project operational and monitoring program phases
Professional engineering services	5.6	5-year Project operational and monitoring program phases
Operating Expenditure		
Transport of GHG stream	9.0	3-year Project operational program phase
Fuel (LPG)	2.0	3-year Project operational program phase
Monitoring (40% technical and professional services, 60% earth science services)	11.8	5-year Project operational and monitoring program phases
Total capital and operational expenditures	**210.0**	

2.15 Project Alternatives Considered

2.15.1 Do Nothing

If this Project does not proceed, CO_2 emissions would continue to be emitted to the atmosphere from the Millmerran Power Station, as is already permitted.

The potential for improving the understanding of the suitability and feasibility of undertaking geological storage of a GHG stream (CO_2) in the Precipice Sandstone aquifer of the Surat Basin, would not occur or be delayed for several years while other proponents develop EPQs.

Development by the administering authorities of suitable EA conditions for other EPQ EA holders and application for GHG storage leases and ultimately the EA conditions, would not occur or be delayed for several years.

The opportunity to assist the Queensland Government in driving climate action to meet its Scopes 1 and 2 emissions targets of 30% emissions reduction below 2005 level by 2030 and zero net emissions by 2050, would be potentially delayed.

2.15.2 EPQ7

CTSCo previously held EPQ7 in the northern Surat Basin. At an identified development site 16 km west of Wandoan township, CTSCo conducted extensive studies of the feasibility of GHG storage injection testing between 2009 and 2019, including the drilling of the West Wandoan-1 well to a depth of 1,293 m below surface into the Moolayember Formation, the acquisition of detailed geological and hydrogeological data from the Glenhaven 3D Seismic Survey, studies into existing CO_2 atmospheric dynamics, and various baseline studies of surface water quality, groundwater quality, air quality and the atmosphere. The characteristics of the site included:

- a freshwater source for existing community and shared bores that draw water from the Precipice Sandstone aquifer for agriculture and community use, including the drinking water supply of Wandoan township;
- water quality that meets various water quality objectives including for aquatic ecology, town water supply, and irrigation, stock and domestic use; and
- potential for community opposition to GHG storage injection testing at this location due to the community's existing use of the water drawn from the Precipice Sandstone aquifer.

Given the community concerns from users of water from the Precipice Sandstone aquifer, in close consultation with Department of Resources, CTSCo made the decision to cease activities in EPQ7, with EPQ7 fully relinquished in 2019.

The decision to investigate EPQ10 and locate the West Moonie-1 Injection Well in its current location was that the Precipice Sandstone aquifer is approximately 1,100 m deeper with fewer potential users compared to EPQ7.

2.15.3 Transmission of GHG stream from MPS

Construction of a pipeline containing supercritical GHG stream was considered between MPS and the West Moonie-1 Injection Well. However, pipeline construction was assessed as cost prohibitive, given the short duration of the Project and pipeline use, small volume of GHG stream (being up to 330,000 tonnes total), and extent of land disturbance for pipeline construction which would result in community and social impacts, and impacts on existing private and public infrastructure.

For an industrial-scale GHG stream storage, use of a pipeline to move a GHG stream from a source to an injection well becomes feasible, and would not have B-double trucks delivering a GHG stream to an injection well, thereby reducing impacts on road users and road infrastructure, and minimising greenhouse gas emissions from truck transportation.

2.15.4 Siting of Transportation Facility

As outlined in section 2.9.2, the siting of the Transportation Facility considered:

- locating on freehold land to enable negotiation of a CCA with the landowner/occupier, rather than adjacent Currajong State Forest;
- the avoidance of clearing three large hollow bearing trees (nest sites) and one large habitat tree that are located near the south-west corner of the property, thereby maintaining terrestrial flora and fauna habitat features in the landscape;
- locating on areas historically cleared for agricultural activities immediately adjacent to the lot boundary with Harts Road, thereby minimising disruption to the landowner, and minimising potential impacts on terrestrial or aquatic flora and fauna;
- minimising clearance of vegetation in the Harts Road road reserve for the access and egress points;
- minimising air quality and noise impacts on and traffic disruption to users of Harts Road and Tarawindi Road by locating the Transportation Facility close to the Moonie Highway;
- minimising potential erosion and sediment, water quality and flooding impacts by locating the Transportation Facility outside the potential flood hazard area for the 1% AEP (1 in 100 year) flood event as identified in the "*Western Downs Planning Scheme*" (WDRC, 2019) flood overlay mapping;
- locating away from sensitive places, particularly habitable dwellings; and
- locating away for sites of known cultural heritage and outside areas subject to native title.

2.15.5 Siting of Flowline

As outlined in section 2.9.3, the siting of the flowline is proposed along the western boundaries of lots 60 SP199322, 33 PG223 and 32 PG223, and then turning east to the West Moonie-1 Injection Well. The western boundaries of the properties have been historically cleared due to installation of boundary fencing and firebreaks, thereby minimising potential impacts on terrestrial and aquatic flora and fauna, and disruption to agricultural activities of the landowners.

Using horizontal directional drilling (HDD) to install a 107 m section under South Branch Stephens Creek and a 380 m section under a stand of brigalow (RE 11.4.3), will minimise construction delays and avoids potential disturbance and impacts to terrestrial and aquatic flora and fauna, and the watercourse including fish passage, flow regimes, and erosion and sediment generation.

2.15.6 Use of Photovoltaic (PV) System (solar panels) as alternative to LPG

As outlined in sections 2.9.2 and 2.10.2.4 above, and Chapter 5 Climate, section 5.2.2.2.2, the Project proposes to use liquefied petroleum gas (LPG) to heat the GHG stream from a cryogenic liquid to a supercritical fluid in two water bath heaters (WBHs) that use LPG burners, and provide electrical power for the Transportation Facility via LPG fired generators.

As an alternative to using LPG, the use of a photovoltaic (PV) system (solar panels) as a heat source and electrical source have been examined, as well as a Battery Energy Storage System (BESS).

The Transportation Facility is estimated to use approximately 16 tonnes of LPG each week, with approximately 9.9 tonnes for the WBHs and remaining 6 tonnes of LPG for electrical plant and equipment. Further details are provided in Chapter 5 Climate, section 5.2.2.2.2.

To examine the potential feasibility to use a PV system compared to the Project's Transportation Facility requirements, a corresponding day time load is estimated to consume 8,300 kWh/week or 430,000 kWh/y applicable to the potential direct offsetting via a photovoltaic (PV) system. Using the PV Watts open-source calculator with the open rack option selected (which is appropriate for a ground-mounted system as applicable to this Project), in order to meet expected site demand at lowest winter minimum output occurring in June, an indicative 275 kW PV system would be required (NREL, 2023).

Alternatively, as the injection of supercritical fluid occurs 24 hours a day, 7 days a week, outside of these hours the Transportation Facility would require a Battery Energy Storage System (BESS) and additional solar generated energy to be stored in the BESS. However, the Transportation Facility would still need to maintain the 200 kW LPG generator for emergency backup functions. If the total site demand is to be covered (excluding alternative heating options for the WBHs), assuming additional 10% round trip losses for AC-DC conversions of BESS, total site generation is estimated at 790,000 kWh and would require a nominal 450 kW ground mount PV system integrated with BESS. It is also important to note that PV panel output typically degrades in the first year by a nominal 1.5% to 2% and then between 0.5% to 0.75% per year, thereafter. The estimated land area required for a 450 kW ground mounted PV system is in the order of 5,000 m^2 (Solar Farms 2022).

The typical economic payback periods for roof mounted solar systems are in the order of 4 to 7 years (Solar Choice, 2020). This increases for ground mounted options excluding BESS. Given the sizeable land requirements for installing a ground mounted system, the very short duration of the Project (3-year operation phase), and economic payback times greater than the Project life, the significant additional electrical, engineering and infrastructure works required and the necessity to maintain LPG generation for emergency function, it is not feasible to consider an off-grid whole-of-site PV system for the Transportation Facility.

Nuheat was consulted to confirm the expected sizing envelope for thermal solar hot water generation to supplement the two WBHs (Nuheat, 2023). The two standard design strategies can be summarised as:

- optimal coverage: this use case finds the optimal balance between sizing, energy yield, and specific cost. In this case, a quick calculation gives a 4 MWth (about 1 ha) peak solar thermal field that will produce about 70% of the annual energy requirement for the two WBHs; or
- highest coverage: maximise the solar thermal production (usually do not aim to cover 100% as the last 10% is very expensive to produce). In this case, a quick calculation gives a 6 MW peak solar thermal field (<2 ha) that will produce about 90% of the annual energy requirement for the two WBHs.

Details on a recent life cycle assessment (LCA) commissioned by Nuheat identified that for a 2.8 MWth solar district heating plant commissioned in 2021, the 25-year cradle-to-grave life cycle will generate a total carbon footprint of 730 tonnes of CO_2-e or 0.12 kgCO_2-e per kilowatt hour of solar heat produced (Inuk, 2022). The feasibility of using solar hot water (whether by concentrated thermal solar or via heat pumps) combined with additional buffering requirements of thermally insulated storage tanks is deemed not commercially feasible to cover the short 3-year operation phase of the Project.

2.15.7 Use of Deeper Formations (Below the Precipice Sandstone) for Storage

The potential use of formations located deeper than the Precipice Sandstone formation was considered. These deeper formations were evaluated during the drilling of the West Moonie-1 Injection Well. West Moonie-1 Injection Well was drilled to a depth of 2,710 m and included core and wireline log evaluation of all formations to well total depth. At West Moonie-1 Injection Well, these deeper formations were found to have very low permeability and were consequently assessed as unsuitable for GHG stream injection and storage. Appendix 8A Geology, Well Completion Reports for West Moonie-1 Injection Well and West Moonie-2 Monitoring Well, provides evidence with the wireline log evaluations of the unsuitability of formations below the Precipice Sandstone aquifer for GHG storage.

2.16 Summary of Commitments

Table 2-12 provides a summary of commitments that CTSCo will undertake during the relevant phases of the Project against the proposed EA EPPG00646913 condition amendments given in Chapter 22.

Table 2-12 Summary of Commitments

Chapter section	Commitment	EA conditions or other requirements
2.4.1, 2.7	Conduct GHG storage injection testing, as defined by the GHG Act, s.16	To enable the Project to inject a GHG stream into EPQ10 for injection testing, the proposed EA condition is General Condition 1 as detailed in Chapter 22.
2.8	Exploration and appraisal activities, including drilling of GHG appraisal wells, water production, and geophysical survey.	Consistent with the proposed EA condition - General Condition 1 as detailed in Chapter 22.
2.8.1	CCAs are in place or will be negotiated with the landowners of all operational lands, prior to advanced activities commencing on the respective lot on plans, and remain in place until rehabilitation is considered successful.	Consistent with the *Mineral and Energy Resources (Common Provisions) Act 2014*, *Regional Planning Interests Act 2014*, proposed EA condition - Rehabilitation Condition 13, and proposed EA condition - Rehabilitation Condition 6 as detailed in Chapter 22.
2.9.1	Construction of the Access Road and access and egress tracks, being the upgrade of Harts Road section to Transportation Facility	Consistent with proposed EA condition – Land Conditions 14 and 15 as detailed in Chapter 22.
2.9.1	Prior to construction of the Access Road, enter into an Infrastructure Agreement with Western Downs Regional Council.	Consistent with the *Planning Act 2016*, Chapter 4, Part 4, and proposed EA condition – Land Condition 15.
2.9.1	Prior to construction of the Access Road, obtain approval/s from relevant administering authority.	Consistent with Department of Transport and Main Roads industry standards, proposed EA conditions – Land Conditions 14 and 15, Biodiversity Condition 5, Noise Condition 1, and Rehabilitation Condition 6 as detailed in Chapter 22.
2.9.1	Construction of the Access Road	Consistent with Department of Transport and Main Roads industry standards, proposed EA conditions – Land Conditions 14 and 15, Biodiversity Condition 5, Noise Condition 1, and Rehabilitation Condition 6 as detailed in Chapter 22.

Chapter section	Commitment	EA conditions or other requirements
2.9.2	Construction of the Transportation Facility	Consistent with the *Mineral and Energy Resources (Common Provisions) Act 2014*, the *Petroleum and Gas (Production and Safety Act) 2004* and regulations, industry standards, proposed EA condition – Cultural Heritage Condition 1, proposed EA condition – Biodiversity Condition 4, 5, 6 and 7, proposed EA condition - Land Condition 2, proposed EA condition – Waste Condition 1, 9 and 10 as detailed in Chapter 22.
2.9.3	Construction of the flowline	Consistent with proposed EA condition – Biodiversity Condition 1, 2 and 3, and proposed EA condition – Biodiversity Condition 4, 5, 6, 7, 8, 9 and 10, proposed EA condition - Water Condition 5, 6, and 9, and proposed EA condition – Land Condition 10, 11 and 12 as detailed in Chapter 22.
2.9.6	Construction work hours and workdays	Consistent with proposed EA condition – Noise Condition 1 as detailed in Chapter 22.
2.10.2.2	Operation of the Transportation Facility will have vehicular traffic enter and exit via a one-way traffic layout.	Not applicable to EA condition, but is considered to improve traffic safety
2.10.2.2	No on-site fuelling or maintenance of vehicles is proposed. All fuelling of vehicles will be off-site.	Consistent with the *Petroleum and Gas (Production and Safety Act) 2004* and regulations, industry standards and practices, proposed EA condition Water Condition 22, proposed EA condition – Waste Condition 5, proposed EA condition – Land Condition 9, proposed EA condition – Land Condition 2, 4, 5 and 6 as detailed in Chapter 22.
2.10.6	Operation work hours and workdays	Consistent with proposed EA condition – Noise Condition 1 as detailed in Chapter 22.
2.11	Develop an Injection Test Plan (ITP) and Monitoring and Verification Plan (MVP), with copies to be submitted to the administering authority.	Consistent with *Greenhouse Gas Storage Act 2009*, s.80 and Greenhouse Gas Storage Regulation 2021, s.6, proposed EA condition - General Condition 3, and proposed EA – Air Condition 3, 6, 9, 12 and 15 and proposed EA condition – Water Condition 22 a detailed in Chapter 22.
2.11	CTSCo will undertake a monitoring and verification program for the GHG stream storage, and implement mitigate measures, and where required, report to the administering authority.	Consistent with *Greenhouse Gas Storage Act 2009* s.80 and Greenhouse Gas Storage Regulation 2021 s.6, Environmental Protection Regulation s.41, proposed EA condition Water Condition 22, and proposed EA – Air Condition 6, 7, 8, 9, 10, 15, 16, 17 and 18 as detailed in Chapter 22.
2.12	Final rehabilitation will be in accordance with EPQ10 conditions, EA conditions and legislative requirements, including the "*Code of Practice for the construction and abandonment of petroleum wells and associated bores in Queensland*" (DNRME, 2019) or later version thereof.	Consistent with proposed EA condition – Rehabilitation Condition 5, 12 and 13 as detailed in Chapter 22.
2.12	Subject to negotiations and agreement with the landholder and receipt of the relevant approvals from the Department of Regional Development, Manufacturing and Water, the Gubberamunda Monitoring Bore may be converted to a water supply bore for stock and domestic or irrigation purposes during the rehabilitation phase of the Project, using an appropriately licenced water bore driller to undertake modifications to the bore construction. Otherwise, the bore will be fully plugged, abandoned and rehabilitated.	Consistent with proposed EA condition – Rehabilitation Condition 11 as detailed in Chapter 22.

Chapter section	Commitment	EA conditions or other requirements
2.12	Pursuant to the GHG Act, s.31, given the temporary nature of all structures in the Transportation Facility, all structures other than the flowline will be removed from the area, with the operational lands rehabilitated to pasture consistent with the surrounding paddock.	Consistent with *Greenhouse Gas Storage Act 2009*, s.31, proposed EA condition – Rehabilitation Condition 5, 6, 12 and 13 as detailed in Chapter 22.
2.12	Rehabilitation of the flowline will involve leaving the flowline in-situ, and disconnecting the flowline from the equipment in the Transportation Facility and West Moonie-1 Injection Well. The flowline will be filled with cement.	Consistent with proposed EA condition – Land Condition 4, EA condition – Rehabilitation Condition 5 and 6 as detailed in Chapter 22.
2.12.2	Rehabilitation work hours and workdays	Consistent with proposed EA condition – Noise Condition 1 as detailed in Chapter 22.

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