

Onshore Petroleum Activity – NT EPA Advice

IMPERIAL OIL & GAS PTY LTD ENVIRONMENT MANAGEMENT PLAN 2021 WORK PROGRAM EXPLORATION PERMIT (EP) 187 (IMP3-4)

BACKGROUND

The Minister for Environment and Natural Resources has formally requested under section 29B of the *Northern Territory Environment Protection Authority Act 2012* (NT EPA Act) that the Northern Territory Environment Protection Authority (NT EPA) provide advice on all Environment Management Plans (EMPs) received under the Petroleum (Environment) Regulations 2016 (the Regulations).

That advice must include a recommendation on whether the EMP should be approved or not, supported by a detailed justification that considers:

- whether the EMP is appropriate for the nature and scale of the regulated activity to which the EMP relates (regulation 9(1)(b))
- the principles of ecologically sustainable development sustainable development set out in sections 18 to 24 of the *Environment Protection Act 2019*
- whether the EMP demonstrates that the activity will be carried out in a manner by which the environmental impacts and environmental risks of the activity will be reduced to a level that is as low as reasonably practicable and acceptable (regulation 9(1)(c)), and
- any relevant matters raised through the public submission process

In providing that advice, the NT EPA Act provides that the NT EPA may also have regard to any other matters it considers relevant.

Subject	Description
Interest Holder	Imperial Oil & Gas Pty Ltd
Petroleum interest	Exploration Permit 187 (EP187)
Environment Management Plan (EMP) title	2021 Work Program EP187 Environment Management Plan
EMP document reference	IMP3-4
Regulated activity	<p>The activities under the EMP cover the actions required to enable the interest holder to conduct hydraulic fracturing and well production testing on the existing Carpentaria-1 well in 2021. The activities include:</p> <ul style="list-style-type: none"> • clearing of up to 10.5 hectares (ha) for Carpentaria-1 wellpad extension to accommodate wastewater tanks, firebreaks and access tracks • establishing bunded tanks pads and tanks fitted with leak detection at the well site

	<ul style="list-style-type: none"> • hydraulic fracture stimulation of the existing Carpentaria-1 vertical exploration well • completion and workover maintenance of the vertical exploration well • extended Production Testing (EPT) of the vertical exploration well, with EPT estimated to take up to 90 days • well suspension of the exploration well • volume reduction of hydraulic fracturing wastewater by evaporation and removal to authorised treatment facility • routine maintenance and monitoring activities at the Carpentaria-1 well site • any other minor works ancillary of the above • site decommissioning and rehabilitation. <p>This activity is an extension of the drilling activity addressed in an earlier EMP (IMP2-06.1).</p>
Public consultation	<p>Public consultation on the revision to the EMP was required under 8A(1)(b) of the Petroleum (Environment) Regulations as the EMP proposes the hydraulic fracturing of a well. The EMP was made available for public comment for 28 days from 23 November to 21 December 2020.</p>

NT EPA ADVICE

The 2021 Work Program EP187 Environment Management Plan (IMP3-4) (the EMP) proposes the hydraulic fracturing and production testing of the existing Carpentaria-1 exploration and appraisal well located on EP187 and constructed under the previously approved Imperial 2020 Drilling Program EMP (IMP2-4).

1. Is the EMP appropriate for the nature and scale of the regulated activity (regulation 9(1)(b))

Information relating to the location, nature and scale of the regulated activity is provided in a satisfactory format. The existing environment has been adequately described through baseline surveys and is suitably understood. Table 1 summarises the scope and duration of the regulated activity at each location.

Table 1: Summary of the scope and duration of the regulated activity

Phase	Activity	Estimated Duration
Civil Works	<ul style="list-style-type: none"> Additional land disturbance of up to 10.5 ha at the Carpentaria-1 well site for a civil works program to establish a well site firebreak, a hydraulic fracturing flowback wastewater storage tank pad and evaporative volume reduction treatment system for wastewater prior to offsite disposal 	Two weeks Q2 2021
Hydraulic Fracturing	<ul style="list-style-type: none"> Perforation of the Production casing in the target Velkerri shale; undertaking a DFIT and subsequent modelling of reservoir properties for hydraulic fracturing Hydraulic fracture stimulation of the target Velkerri shale in the existing Carpentaria-1 well in 5 separate stages at different depths in the Velkerri formation 	Two weeks Q2 2021
Completion and Flowback	<ul style="list-style-type: none"> Completion of the well including flowback of pumped HF fluid from the Velkerri shale formation 	One week Q2 2021
Extended Production Test	<ul style="list-style-type: none"> Extended production testing (EPT) of the existing Carpentaria-1 well with up to 90 days of gas flaring 	Twelve weeks Q2 2021
Volume Reduction of Wastewater	<ul style="list-style-type: none"> Evaporation in bunded open water tanks with freeboard of 1.1 m during the wet season and 0.5 m during the dry season. 	Fifty weeks Q2 2021 to Q3 2022
Decommissioning	<ul style="list-style-type: none"> Well suspension and/or Plugging and Abandonment Maintenance and/or Rehabilitation of the well site 	Four weeks To be determined
Other key activities	<ul style="list-style-type: none"> Operation of a 30 person accommodation camp at existing highway campsite Cumulative groundwater extracted to date by the interest holder under water license GRF10316 is 3.013 ML Estimated groundwater use approximately 7.5 ML (based on 5 hydraulic fracturing stages) on the vertical well targeting the Velkerri shale formation Total greenhouse gas emissions (GHG) for the approved activity estimated at approximately 10,000 tCO₂-e assuming 90-days EPT of the well Estimate of average traffic movements of ~10–30/week for the first three months and ~1-10/week for the remaining duration of the activity 	

1.1 Sub-surface geology

The stratigraphic formations intersected by the Carpentaria-1 petroleum well has been adequately described in the EMP, informed by 2D seismic data acquired in 2019 on EP187 and used to screen for large scale, regional faults or structures. This information together with the information gathered during the drilling of Carpentaria-1 well provides adequate information to assess potential sub-surface geohazards and formation depths. Isolation and protection of aquifers intersected by the well has been confirmed in the Carpentaria-1 well.

The existing groundwater monitoring bores at the Carpentaria-1 well site are installed to the base of the regional Cambrian Limestone Aquifer (CLA) system, in compliance with the *Code of Practice: Onshore Petroleum Activities in the Northern Territory* (the Code).

1.2 Activity scope and duration

The EMP describes the scope of the activity and its duration. The duration of the hydraulic fracture stimulation and testing activities is expected to be approximately 6 months (indicative), subject to approval of the regulated activity and seasonal access. On completion of the hydraulic fracturing and technical evaluation, the exploration well will either be suspended for future re-entry, or in a non-success case, a decision made to decommission the exploration well with permanent cement plugs in accordance with the Code.

Estimations of consumables (e.g. water, sand and chemical additives) discussed in the EMP are based on a maximum 5-stage hydraulic fracturing program. Water and sand make up the bulk of the materials of the hydraulic fracturing fluids per stage. Chemicals either biodegrade, are inorganic and dissociate (e.g. chloride salts and acids) or are inert. The preliminary hydraulic fracturing design will involve pumping approximately 1.5 ML of fluids and 180 – 250 tonnes of proppant per stage. The final designs will be determined after the Diagnostic Fracture Injection Test (DFIT) is performed. Total volume of flowback fluid wastewater from hydraulic fracturing required for offsite disposal is estimated to be 2.5 ML (after evaporation).

The existing campsite will be used for the activity. A smaller crew will be required during the longer well completion and testing stage. Peak projected vehicle movements is 30 vehicles per day during the demobilisation of equipment from site.

There are no areas of high conservation value or cultural significance in close proximity of the regulated activity. The EMP includes an impact and risk assessment based on information gathered during environmental baseline surveys and experience drilling the Carpentaria-1 petroleum well. The potential impacts and risks of the regulated activity have been identified and relevant environmental outcomes, performance standards and measurement criteria have been provided in the EMP.

1.3 General compliance with Code

The EMP demonstrates how the interest holder will comply with relevant requirements of the Code in undertaking this regulated activity. The risk assessment provided in the EMP (Appendix 4) cross-references relevant sections of the Code that apply to the mitigation and management measures to enable the reviewer to identify and confirm that the hydraulic fracturing and well testing activities comply with the Code. The EMP also provides the following plans, which are compliant with the Code:

- Chemical Risk Assessment of chemicals to be used in the hydraulic fracturing activity
- Wastewater Management Plan – including management of flowback wastewater
- Spill Management Plan – including spill risk assessment and response strategy
- Methane Emissions Management Plan
- Weed Management Plan
- Bushfire Management Plan
- Stakeholder Engagement Plan
- Rehabilitation Management Plan.

All groundwater monitoring data is (or will be soon after a sampling event) available from the DEPWS website.¹ Water is sampled on a quarterly basis and analysed at a NATA accredited laboratory for an array of analytes, including Total Dissolved Solids, chloride, electrical conductivity, boron,

¹ <https://denr.nt.gov.au/onshore-gas/onshore-gas-in-the-northern-territory/industry-compliance-and-reporting/groundwater-monitoring-results>

strontium, barium, naturally occurring radioactive material (NORM) and dissolved methane. As required in the Code and the *Preliminary Guideline: Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-basin*, the interest holder must undertake ongoing groundwater monitoring for three years from the approval date of the EMP, to demonstrate 'no change' to groundwater quality.

The level of detail and quality of information provided in the EMP is sufficient to inform the evaluation and assessment of potential environmental impacts and risks, and meets the EMP approval criteria under Regulation 9(1)(b). As a further precautionary step, the NT EPA has provided advice relating to approval conditions for this EMP contained at the end of this document.

2. Principles of ecologically sustainable development

2.1 Decision-making principle (s 18 Environment Protection Act 2019)

The EMP adequately assesses the environmental impacts and risks associated with the regulated activity and outlines appropriate avoidance and mitigation measures. The regulated activity for Carpentaria-1 hydraulic fracturing operations phase in this pilot testing operation is low impact, small scale and of short duration (up to 30 days). The well testing phase will use an EPT to measure gas flow and quality for a period up to 90 days. The gas will be flared in a flare stack at the Carpentaria-1 well site, if flow permits. The activities proposed will inform longer-term decision making on development of a petroleum resource on EP187.

The risks and control measures associated with the previous approval for drilling the Carpentaria-1 petroleum well have been assessed and the NT EPA has provided advice to the Minister². The Carpentaria-1 well has since been constructed and the well barriers confirmed³, thus ensuring aquifer and potential aquifers present at the well site have been isolated and protected behind a minimum of two barriers, in compliance with the Code. Among the various formations intersected during drilling, the Gum Ridge aquifer (shallowest) was encountered from 50 to 115 mRT and the deepest potential aquifer being the Bukalara Sandstone was encountered from 115 m to 244 mRT. Therefore, a minimum offset of 851 m is present between the base of the deepest aquifer and the top of the shallowest primary target of the well (Velkeri - Amungee C Shale formation). This separation distance complies with the minimum offset of 600 m between the top target zone and the base aquifer as mandated by the Code. All encountered aquifers were isolated behind cemented casing.

The EMP includes additional Tier 2 toxicity screening of the cumulative risks to workers from chemicals of potential concern through exposure pathways such as aboveground storage and handling of flowback water. The information in the EMP confirms that chemicals of potential concern in the hydraulic fracturing fluid are all, at potential maximum concentrations in the whole fluid system (potential exposure levels), much lower than their published toxicity dose values for fauna. In addition all the chemicals either readily biodegrade, are inorganic and dissociate (e.g. chloride salt and acids) or are inert. The hydraulic fracturing service provider and list of hydraulic fracturing chemicals is the same as those used previously by interest holders in the Beetaloo. The residual chemicals that may be contained in the hydraulic fracturing flowback wastewater are not considered to pose a risk to the environment.⁴

The risks are therefore considered low and acceptable. The information in the EMP further indicates there is minimal risk of an exposure pathway for hydraulic fracturing chemicals to impact potable groundwater sources in proximity to the regulated activity. Environmental impact mitigation measures include:

- physical vertical separation distances between the aquifer and target formation to prevent any migration of stimulation fluid to aquifers (approximately 850 m)

² https://depws.nt.gov.au/_data/assets/pdf_file/0010/937504/NT-EPA-advice.pdf

³ https://nt.gov.au/_data/assets/pdf_file/0004/963832/carpentaria-1-post-drilling-well-suspension-wbiv.pdf

⁴ https://denr.nt.gov.au/_data/assets/pdf_file/0005/821912/ep161-santos-waste-water-risk-assessment-report.pdf

- more than 3 km horizontal separation distance between the exploration well and the closest third-party groundwater extraction bores
- appropriate bunding in use for storage of chemicals and where required adherence to standards and with bunded containment for the storage of chemical materials
- hydraulic fracturing fluid system mixed, contained and monitored in engineered fluid storage tanks.
- spill management kits located onsite for response to any small-scale spills
- tankpad to be constructed to engineering design specifics of tank manufacturer requirements
- bunded tank pad will accommodate 110% of the volume of the largest storage tank
- use of double lined enclosed wastewater tanks for storage of wastewater fitted with leak detection
- use of open double lined wastewater treatment tanks for volume reduction fitted with leak detection with specified minimum wet and dry season freeboard
- implementation of the spill management plan, which includes mandatory secondary containment
- wellpad activities to cease if minimum freeboard is not maintained in wastewater tanks and freshwater ponds
- wastewater tanks and ponds will be inspected weekly to check integrity during periods of site inactivity
- as per the Code, open-topped tanks may be used for treatment, and while operational over the wet season during periods of site inactivity, will be fitted with level monitoring telemetry that reports back to the operations team and will be actively managed to ensure minimum freeboard is maintained while maximising volume reduction by evaporation
- in the unlikely event it is required, wastewater will be transferred back to the enclosed waste water storage tank to ensure minimum freeboard is maintained in the open top treatment tanks.

The EMP meets the requirements of the Code, including tracking of water use and wastewater generation and movement. The NT EPA has assessed the potential for spills from chemicals and hydrocarbons (e.g. diesel) stored in designated bunded areas at the well site location. The mitigations described in the EMP include bunding around chemical storage areas, containment of hydrocarbons in double-lined diesel storage tanks and spill prevention and response procedures for hazardous spill prevention, monitoring, assessment, response and clean-up. To ensure the interest holder complies with the EMP commitments in regards to containment of hydraulic fracturing chemicals and flowback wastewater, the NT EPA has provided advice relating to an approval condition for an independent site audit prior to commencement of hydraulic fracturing operations.

Should the risk eventuate, the interest holder must notify DEPWS under the Regulations and has committed in the Spill Management Plan to remediating any spill area in accordance with the National Environment Protection Measure (NEPM) standards protective of ecological resources⁵. The NT EPA has recommended the interest holder provide DEPWS with a written report of any incident relating to release of a contaminant exceeding 200 litres, within 24 hours of the incident being detected.

The proposed environmental outcomes are expected to be achieved based on the best available information on the nature and scale of the activity, and the environment in which the regulated activity will be conducted. The studies undertaken by the interest holder to inform the EMP has provided the interest holder with detailed knowledge of the potential environmental impacts and risks and the most appropriate measures for management and mitigation of those impacts and risks.

⁵ NEPM 2011. Guideline on Investigation Levels for Soil and Groundwater. National Environment Protection (Assessment of Site Contamination) Measure April 2011

The interest holder has demonstrated ongoing stakeholder engagement in the EMP as required by the Regulations with landholders and land managers, traditional owners, the Northern Land Council (NLC) and NT Government Agencies. The EMP was made available for public comment as required under the Regulations from 23 November to 21 December 2020. A specific concern regarding the possible use of toluene in hydraulic fracturing fluid raised by a stakeholder was clarified. Toluene is not intended to be used and is not included in the list of disclosed chemicals (Appendix 6.01) to potentially be used in the HF fluid.

2.2 Precautionary principle (s 19 *Environment Protection Act 2019*)

The NT EPA considers there is a very low risk of serious or irreversible damage from the activities proposed in the EMP. The risks associated with undertaking hydraulic fracturing activities and well testing are well understood. The hydraulic fracturing operations and wastewater management detailed in the EMP demonstrates adherence to the Code which establishes best practice management measures for these operations.

A previously approved seismic survey has been conducted by the interest holder on EP187. This information, together with the information gathered during the drilling of Carpentaria-1 well, provides adequate information to assess potential sub-surface geohazards and formation depths at the well site. The chemicals that may be used in hydraulic fracturing operations and their maximum concentrations in the hydraulic fracturing fluid are the same as those assessed and approved in other hydraulic fracturing EMP for the Beetaloo sub-basin.^{6 7}

The risk assessment classifies the hierarchy of controls for the mitigations applied to each risk (e.g. eliminate, substitute, engineering, administrative, personal protective equipment). Uncertainty in relation to the environmental features was assessed, with no areas of significant environmental uncertainty identified. The EMP outlines the interest holder's investigations into the physical, biological and cultural environment and demonstrates a sound understanding of the environment at the location, providing a satisfactory scientific basis to assess potential environmental impacts and risks for the activity, and to identify measures to avoid or minimise those impacts and risks. These investigations are informed by data for the drilling of the Carpentaria-1 petroleum exploration well.

The EMP includes the assessment of impacts and risks for operations and management strategies to manage rainfall during operations, including measures such as halting activities and regular inspection of the site, including water and chemical storages, erosion and sediment control measures and access roads.

There are internationally recognised standards and established management measures in well design, operation and well integrity monitoring to ensure aquifer protection; these are reflected in the mandatory requirements of the Code.

The NT EPA is of the view that the precautionary principle has been considered in assessing the regulated activity and has not been triggered due to the low risk of serious or irreversible damage existing and a satisfactory scientific basis for assessing potential impacts and risks. In addition, the environmental monitoring commitments contained in the EMP are compliant with the Code and will provide measurable performance measures to ensure that the environmental outcomes are met.

2.3 Principle of evidence-based decision-making (s 20 *Environment Protection Act 2019*)

The EMP demonstrates a good understanding of the environment in which the regulated activity will be undertaken, and considers all relevant aspects of the environment that has potential to be affected.

⁶ https://depws.nt.gov.au/data/assets/pdf_file/0005/747779/ep161-santos-mcarthur-basin-hydraulic-fracturing-program-an-sor.pdf

⁷ https://depws.nt.gov.au/data/assets/pdf_file/0003/722514/Approval-notice-and-SoR.pdf

A traffic management plan approved by the Department of Infrastructure, Planning and Logistics (DIPL) was included in the previously approved Drilling EMP and the Carpentaria-1 well site access track turnoff to the Carpentaria highway has been sealed to mitigate highway traffic risks.

An archaeological survey has been carried out over the project area to identify and avoid areas of cultural heritage in the planning stages and is provided in the EMP.

A certified erosion and sediment control plan (CESCP) contains specific design and management controls for the well site access track and expanded Carpentaria-1 well site to mitigate potential erosion under sheet flow conditions. Detailed elevation plans and layout for the well site is provided in the CESCP. Bunding will be constructed around the wastewater tank pad.

Geotechnical assessment of the soil at the well sites has been completed and assessed by DEPWS in compliance with a Ministerial Approval Condition of the approved Drilling EMP. The geotechnical assessment provides load-bearing assessment of the well site and recommends removal of <50 mm of topsoil at the well site to be stockpiled on the well site under cover, for future use in rehabilitation of the well site. The subsurface is assessed as suitable for compaction rolling to provide a hard low permeability, low dust hardstand area for the hydraulic fracturing operations.

More than six months of baseline groundwater monitoring data is provided in the EMP. The suite of analytes measured in the groundwater is compliant with the Code. Well site-specific proposed reporting thresholds (triggers) for all analytes have been derived by use of statistically derived outliers from baseline measurements. These are provided in the EMP. The interest holder commits to report any water sampling results that exceed these thresholds.

The location of the impact monitoring bore (IMB) is approximately 20 m down-gradient from the Carpentaria-1 exploration well in compliance with the Code. Groundwater quality reporting from the impact monitoring bore (IMB) to DEPWS will continue in compliance with the Code. In addition, the interest holder will install a continuous pressure/water level logger in the IMB prior to, during and after the hydraulic fracturing pumping operations, to detect any pressure anomalies in the groundwater, in the unlikely circumstance of a well barrier failure during hydraulic fracturing pumping operations. The time-series log will be downloaded and provided to DEPWS. This monitoring is to further demonstrate that the Carpentaria-1 petroleum well has isolated and protected the Gum Ridge aquifer and to confirm that no impact to groundwater is occurring as a result of the regulated activities.

The EMP includes additional Tier 2 toxicity screening of the cumulative risks to workers from chemicals of potential concern through exposure pathways such as aboveground storage and handling of flowback water. The information in the EMP confirms that the calculated risks associated with chemicals of potential concern in hydraulic fracturing fluid is low and acceptable. Maximum concentrations of chemicals of potential concern are well below the harmful dose to fauna. Chemicals either biodegrade, or are inorganic and dissociate, or are inert. The information in the EMP further indicates there are no exposure pathways from hydraulic fracturing chemicals to potable groundwater sources in proximity to the regulated activity. A risk analysis of hydraulic fracturing flowback-produced water sequestered from the same target Velkerri shale formation at the nearby Santos Tanumbirini-1 well site did not identify elevated concentrations of any analytes specified in the Code that may be of potential concern to fauna such as birds⁸

Environmental impact mitigation measures to be implemented include:

- vertical separation distance between the aquifer and target formation to prevent any migration of stimulation fluid to aquifers (approximately 850 m)
- more than 3 km distance between the exploration well and the closest groundwater extraction bores
- use of banded enclosed double-lined wastewater storage tanks with leak detection
- use of banded double-lined open wastewater tanks with leak detection with wet and dry season minimum freeboard for treatment of wastewater by volume reduction
- spill management plan

⁸ https://denr.nt.gov.au/data/assets/pdf_file/0005/821912/ep161-santos-waste-water-risk-assessment-report.pdf

- mandatory secondary containment.

The NT EPA is of the view that the evidence-based decision-making principle has been considered in assessing the regulated activity and that in the circumstances, decisions can be based on best available evidence that is relevant and reliable.

2.4 Principle of intergenerational and intra-generational equity (s 21 *Environment Protection Act 2019*)

The potential environmental impacts and risks associated with the regulated activity can be adequately avoided or managed through the management measures and ongoing monitoring programs proposed in the EMP.

Groundwater extraction is managed under a groundwater extraction license (GRF10316), which permits extraction of groundwater from the Gum Ridge aquifer of 22 ML per year. Water extraction for this activity is estimated to be 7.5 ML (based on 5 hydraulic fracturing stages).

Cumulative GHG emissions generated by the regulated activity are not considered significant when considering the regulated activity will result in an increase in total NT GHG emissions of approximately 0.06% (10,000 tCO₂-e), based on three (3) months flaring, land clearing and diesel combustion. Flaring makes up approximately 80% of total potential GHG emissions from the activity with an assumed flare tip efficiency of 96%.

The EMP includes an assessment of the maximum combined cumulative greenhouse gas emissions from the regulated activity and previously approved regulated activities. The total cumulative emissions are approximately 20,000 tCO₂-e over a 2 to 3 year period. This represents an approximately 0.12% increase in annual Northern Territory emissions reported for 2018-19.⁹

Under these circumstances of preliminary exploration activity, the NT EPA considers that cumulative emissions are not significant when considered in context of 2018 NT and Australian emissions, which were approximately 16.5 million tonnes and 535 million tonnes respectively¹⁰.

Protection of cultural interests is achieved through compliance with the requirements of Authority Certificates issued by the Aboriginal Areas Protection Authority under the *Northern Territory Aboriginal Sacred Sites Act 1989* (NT) and the previously completed archaeological assessment at the site to avoid archaeological heritage impacts. The regulated activity is subject to requirements of Authority Certificate C2020/012. Appropriate measures are in place for the management of items of heritage value should they be discovered through implementation of the "unexpected heritage finds procedure".

Proactive measures included in the EMP, such as site-specific bushfire protection, weed management and rehabilitation plans have been provided in the EMP.

The previously approved Drilling EMP commits the interest holder to progressive rehabilitation throughout the life of the exploration program which, combined with the Code requirements, is considered to reduce the risk of soil contamination to a level that is ALARP and acceptable. A rehabilitation management plan is provided in the EMP.

The NT EPA considers that environmental values will be protected in the short and long term from the activities outlined in the EMP and that the health, diversity and productivity of the environment will be maintained for the benefit of future generations.

2.5 Principle of sustainable use (s 22 *Environment Protection Act 2019*)

Exploration activities are necessary to enable commercial appraisal of resources, in order to assess the viability of the resource and its potential for production. The regulated activity forms one

⁹ DISER 2020. State Greenhouse Gas Inventory. <https://ageis.climatechange.gov.au/SGGI.aspx>.

¹⁰ NT and Australian GHG emissions in 2017 were approximately 16.5 million tonnes and 535 million tonnes, respectively, as reported in the DOEE (2019) State and Territory Greenhouse Gas Inventories 2017. <http://www.environment.gov.au/system/files/resources/917a98ab-85cd-45e4-ae7abcd1b914cfb2/files/state-territory-inventories-2017.pdf>

component of a broader exploration program to inform the potential for commercial petroleum production on EP187.

The interest holder has considered the use of recycled water for hydraulic fracturing operations, but the volume required and the remoteness of the location does not make it reasonably practical. The interest holder will consider utilising hydraulic fracturing flowback fluid in future EP187 operations.

Cumulative impacts of groundwater extraction have been assessed. The interest holder has a groundwater extraction licence (GRF10316) with a maximum water entitlement of 22 ML per annum from the Gum Ridge aquifer. The anticipated water demand for this regulated activity is 7.5 ML (based on 5 hydraulic fracturing stages), which is less than the interest holder's maximum water entitlement. The total volume of groundwater extracted during 2020 under this license is approximately 3 ML. Annual cumulative groundwater extraction from the Gum Ridge Formation from all licenced bores (approximately 850 ML) is currently well below the storage ranges of 1,766,000 to 3,532,000 GL.¹¹

The total estimated greenhouse gas emissions of approximately 10,000 tCO₂-e for the activity will result in an overall increase in NT GHG emissions of approximately 0.06%.

Flaring operations will include the following controls:

- use of flaring rather than venting, using a flare with nominal 96 % combustion efficiency
- incorporation of an appropriate buffer around the flare, with barriers to prevent access by wildlife, in addition to a perimeter fence surrounding the well site
- locating the flare at least 20 m from vegetation to ensure safe operations during fire danger periods
- positioning the flare pit and flare stack as per a hazardous area classification
- establishment of a fire protection zone surrounding the well pad and flare, that will be devoid of trees
- establishment of firebreaks around the well pad, with minimum setbacks to infrastructure based on flaring design
- equipping the flare with an auto-ignition system that provides electrical impulses to generate a spark every 1.3 seconds to ensure that the flare is always operational
- monitoring of the flare stack during flaring
- implementation of the Fire Management Plan
- implementation of the WOMP Emergency Response Plan.
- no flaring on Fire Ban days
- design, preparation and operation of the flare and flare stack in accordance with industry standards.

The NT EPA notes that the Government has committed to implementing all recommendations of the Hydraulic Fracturing Inquiry, including that the NT Government seeks to ensure there is no net increase in the lifecycle GHG emissions emitted in Australia from any onshore petroleum produced in the NT. To support the NT Government's commitment, the NT EPA has provided advice that the interest holder provide an annual summary report to DEPWS of actual scope 1 and scope 2 greenhouse gas emissions reported under the National Greenhouse Energy Reporting Scheme (NGERS) versus predicted emissions in the EMP.

The NT EPA is of the view that the sustainable use principle has been considered in assessing the regulated activity.

¹¹ Tickell, SJ & Q Bruwer, 2019. Georgina Basin Groundwater Assessment: Daly Waters to Tennant Creek. Water Resources Division, Report 17/2017 (Version 2, April 2019).

2.6 Principle of conservation of biological diversity and ecological integrity (s 23 Environment Protection Act 2019)

Site selection for conduct of the regulated activity was informed by a previous detailed ecological and heritage assessment, which covered a much larger area than that required to be cleared of vegetation, thereby enabling the interest holder to expand the lease pad to support hydraulic fracturing operations and minimise impacts from additional land clearing.

Additional land disturbance of up to 10.5 ha at the Carpentaria-1 well site is proposed in a civil works program to establish a well site firebreak, a hydraulic fracturing flowback and wastewater storage tank pad and evaporative volume reduction treatment system for wastewater prior to offsite disposal. The EMP describes land clearing controls for the additional clearing. Cumulative impacts to flora and fauna from the regulated activity and the approved seismic and drilling activities are not considered to be significant, given the relatively small area of impact (total cleared area) and amount of similar habitat within the region. The NT EPA has previously advised of its view that the conservation of biological diversity and ecological integrity on EP187 would not be impacted by the approved drilling activity.

The regulated activity poses a low risk to the ecosystem within the Sturt Plateau bioregion. Given the relatively small area of impact due to additional clearing (10.5 ha), and the very large area of similar habitat within the region, the regulated activity does not pose a significant risk to any regional populations of threatened species. The DEPWS Flora and Fauna Division is satisfied the proposed activities do not pose a significant risk to threatened species or significant habitats and vegetation types. Further, avoidance and mitigation measures identified in the EMP are adequate to reduce risks from, for example, vehicle-strike, dust, erosion and/or spills, to as low as reasonably practicable and acceptable levels, in relation to potential impacts on biodiversity. Based on a search of DEPWS flora and fauna databases, the environmental description in the EMP area and expert knowledge of species' habitat requirements, six threatened species may occur within EP187:

- Red Goshawk
- Mertens' Water Monitor
- Grey Falcon
- Northern Shrike-tit
- Ghost Bat
- Gouldian Finch.

It is considered that there is a low to medium likelihood of these species occurring in the EMP footprint. Surveys previously confirmed that Mertens' water monitor (*Varanus mertensi*) occurs within EP187, but it has a very low likelihood of occurring within the vicinity of the Carpentaria-1 well site.

The proposed location for the regulated activity does not include groundwater dependent ecosystems; nor is it within proximity to a declared ecological community under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

Due to the management strategies outlined in the EMP and the relatively small area of impact, it is unlikely that the regulated activity will pose a risk to the identified threatened species. Impacts and risks to flora, fauna, and ecosystems are considered to have been mitigated to an acceptable level. The relevant biodiversity values associated with the proposal have been adequately identified by the interest holder.

The EMP outlines measures to minimise impacts on affected environmental values, including the management of threatening processes such as erosion, weeds and fire through implementation of existing management plans, monitoring and corrective actions. Where relevant, management measures for the aforementioned threatening process are consistent with the requirements of the Code, the *NT Land Clearing Guidelines*, the *Weed Management Planning Guideline: Onshore Petroleum Projects* and Commonwealth threat abatement plans and advice. Specific precautions to ensure interaction with wildlife is avoided are included in the EMP, including installation of fencing around the well site, appropriate storage of waste, implementation of a fauna interaction log, ongoing

remote camera monitoring around the well/lease pad and use of speed limits and avoidance of driving on unsealed roads after significant rainfall. There are no flare pits associated with this activity.

As a further precaution, the NT EPA recommends that the interest holder should provide to DEPWS, within 6 weeks of completion of flowback operations at the Carpentaria-1 well site, a laboratory analysis and risk assessment of hydraulic fracturing flowback wastewater that is stored in tanks at the Carpentaria-1 well site. The laboratory analysis must comply with the Code.

The NT EPA considers that implementation of, and compliance with, the EMP will ensure the conservation of biological diversity and ecological integrity is not impacted by the regulated activity.

2.7 Principle of improved valuation, pricing and incentive mechanisms (s 24 *Environment Protection Act 2019*)

The interest holder will be required to prevent, manage, mitigate and make good any contamination or pollution arising from the regulated activity, including contamination of soils, groundwater and surface waters through accidental spills.

All stages of the regulated activity, including progressive rehabilitation of all disturbed areas to an acceptable standard, will be at the cost of the interest holder.

The interest holder is required to provide an adequate environmental rehabilitation security bond to indemnify the NT Government. This is based on an assessment by DEPWS of the estimated rehabilitation cost submitted by the interest holder. The rehabilitation costs for the regulated activity is supported by independent contractor quotes.

The NT EPA is of the view principle of improved valuation, pricing and incentive mechanisms has been considered in assessing the regulated activity and is based on the interest holder bearing any environmental costs for the activity.

3. Environmental impacts and risks reduced to a level that is as low as reasonably practicable (ALARP) and acceptable (regulation 9(1)(c))

The interest holder has identified measures to avoid impacts on environmental values, informed by a baseline studies, surveys and data derived from the drilling of Carpentaria-1 exploration well.

The EMP demonstrates a systematic identification and assessment of environmental impacts and risks associated with the regulated activity. The key potential environmental impacts and risks considered in the EMP are:

- loss in long-term soil productivity and viability from cleared areas (e.g. access tracks, lease pads and camp pads) from contamination or physical disturbance of soils
- impacts to surface waterways causing changes in water quality and decline in ecological function from failure of a flowback storage tank, uncontrolled gas pressure, overtopping of waste storage facilities or a transportation accident resulting in a release of contaminants
- groundwater contamination and over-extraction from exploration activities degrading environmental values (including groundwater dependent ecosystems) and impacts on pastoralist water extraction
- impacts to high value habitats and threatened flora and fauna from, for example, contamination, vehicle strikes and wildlife entrapment
- impact on local air quality, predominantly from dust and particulate matter generated from accidental fires
- environmental nuisance and impacts to communities and pastoralists, from, for example, noise, light pollution, the introduction and spread of weeds in the area, or particulate matter and loss of pasture generated from accidental fires
- decline in environmental values and disturbance of sacred sites, from, for example, unauthorised access to sacred sites, accidental fires, or structural failure of a flowback tank.

The EMP also considers cumulative impacts to groundwater, flora and fauna, and greenhouse gases and concludes the cumulative impacts are not significant.

The EMP has considered the hierarchy of controls (elimination, substitution, engineering, administration) and provided demonstration of why the controls to be implemented are considered ALARP and acceptable. Of the 68 environmental risks identified by the interest holder, 63 are considered 'low' risk, and therefore are ALARP and acceptable. The remaining five potential risks are considered 'medium' and the interest holder has included mitigations that can/will be implemented such that the risks will therefore be managed at levels that are ALARP and acceptable.

Specifically:

1. *Groundwater over-extraction*: the Carpentaria-1 well site is greater than 1 km mandatory separation between exploration wells and water extraction bores; and continuous flow meters to monitor take and water balance implemented to ensure compliance with water extraction licence. Water levels in the monitoring bores will also be reported quarterly.
2. *Exploration activities may cause impacts to high value habitats and threatened flora and fauna*: The Carpentaria-1 well site location has been selected to avoid impacts to conservation areas. Buffer distances from riparian vegetation, waterways and drainage lines has been applied in accordance to *Recommended Widths for Riparian Buffers of the Land Clearing Guidelines* (2019). Large trees will be avoided as much as reasonably practical in the proposed additional clearing at the well site. The interest holder has committed to daily monitoring of bushfires in the region during periods of high fire danger; no flaring during periods of total fire ban; more than 20 m separation between flares and surrounding vegetation; ongoing remote camera monitoring of the well/lease pad and reporting of results to DEPWS; controlling vehicle movements to avoid driving at night; storage and disposal of camp wastes to prevent scavenging by fauna; progressive rehabilitation in those areas not required for future use, inclusive of deep ripping to reduce the effects of compaction and preservation of topsoil and cleared vegetation for respreading; monitoring of rehabilitation progress; and equipment and vehicles are to be washed-down and to have a Biosecurity Declaration Certificate prior to access to site. The 'medium' risk ranking is based on the likelihood being considered 'unlikely', but the consequence of the event occurring being considered 'serious'.
3. *Impact on local air quality*: the interest holder has committed to, for example, using flares designed and operated in compliance with the US EPA 40 CFR § 63.18 to achieve a volatile organic carbon combustion efficiency of 96%; reporting all greenhouse gas emissions from flaring under the NGRS; preferential offsite transport of condensate; installation of multiple barriers during well suspension/operation, including downhole suspension plugs, suspension fluid and surface valves; weekly inspection of flares to avoid excessive smoke production; preparation of annual fire frequency mapping using the Northern Australia Fire Information fire history database; and dust suppression using water carts. The 'medium' risk ranking is twofold based on a) the likelihood from fire being considered 'unlikely', but the consequence of the event occurring being considered 'serious'; and b) the likelihood from dust being considered 'likely', but the consequence of the event occurring being considered 'minor'.
4. *Decline in environmental values and disturbance of sacred sites*: the interest holder has committed to ignition sources being placed outside hazardous areas; firebreaks will be constructed around the lease pad; wastewater tanks will be designed and engineered to AS3990, AS 1170.1 and AS1170.2; enclosed tanks will have vents and ignition exclusion zones to eliminate the risk of explosive gases; all wastewater tanks will have no return valves to prevent multiple tanks draining in the case that one tank fails; weekly tank and sump integrity inspections will be conducted; and inductions will be provided for all personnel highlighting the need to avoid unauthorised access to sacred sites. The 'medium' risk ranking is based predominantly on the outcome of a fire event. Although likelihood is considered 'highly unlikely', the consequence of the event occurring is considered 'serious'.
5. *Bushfire risk*: The Bushfire Management Plan, together with a revised well site design in the expanded footprint, includes a firebreak established as a ring-road round the well site, providing an additional level of fire protection. All fallen timber will be removed from the firebreak and cleared areas and stockpiled away from the well site. Flaring will not be carried out on Fire Ban days. The 'medium' risk ranking is based on a) the likelihood from fire - considered 'unlikely' as

a result of operations, but with the consequence of the event occurring being considered 'serious'; and b) the likelihood bushfire may impact the well site from a bushfire arising in the site from an external source.

The NT EPA considers that all reasonably practicable measures will be used to control the environmental impacts and risks, considering the level of consequence and the resources needed to mitigate them, and the nature, scale and location of the regulated activity. The NT EPA considers that the environmental impacts and risks will be reduced to a level that is ALARP and acceptable, considering the sensitivity of the local environment, relevant standards and compliance with the Code.

4. Relevant matters raised through public submissions

Public consultation on the revision to the EMP was required under the Petroleum (Environment) Regulations 2016, as the EMP proposes hydraulic fracturing activities. The EMP was made available for public comment for 28 days from 23 November to 21 December 2020, during which 166 submissions were received, with 165 of these comprising a campaign form letter.

A total of 166 submissions were received:

- 165 (>99%) of the public submissions originated from the advocacy website – Do Gooder, and were a campaign form letter that canvassed five issues: open tanks during wet season, disposal of wastewater, threatened species, impact to groundwater and impact to air quality, which are similar issues to the previous campaign form letter for the Imperial Drilling EMP
- the remaining submission was from one individual, and raised many of the same issues previously addressed in the approved Drilling EMP
- approximately 55% of submissions came from outside the NT.

Table 2 provides a summary of the issues raised in public submissions. Consideration of the issues raised follow Table 2.

Table 2: Issues raised in public submissions

Theme	Overview of issue raised
Flora and fauna (environment)	<ul style="list-style-type: none"> • toxicity of hydraulic fracturing chemicals to aquatic life • ingestion of contaminated wastewater/materials impacting, for example, reptiles, birdlife in general and threatened species – e.g. Gouldian Finch • birds may be impacted by potential interaction with hydraulic fracturing flowback wastewater • impact to birds by bathing in flowback water containing chemicals • stygofauna impacted by chemicals • potential ignition sources and flaring on total fire ban days
Water	<ul style="list-style-type: none"> • potential impacts to downstream catchment from spills and/or loss of containment, particularly during the wet season resulting in contamination of soils • contamination of groundwater caused by well corrosion • impacts from the Moroak Sandstone
Waste	<ul style="list-style-type: none"> • use of open tank wastewater storages • transportation of toxic waste interstate, as opposed to treatment options in the NT
Air Quality	<ul style="list-style-type: none"> • impacts to air quality due to venting of methane or the use of a combustion device creates a fire or safety hazard
Social and cultural	<ul style="list-style-type: none"> • concerns as to the lack of stakeholder engagement
Chemical Disclosure for Hydraulic Fracturing fluid	<ul style="list-style-type: none"> • hydraulic fracturing chemicals not disclosed in the EMP • chemical use is too vague and not transparent

1. *Flora and fauna*: Submissions raised concerns with animal welfare, increased bushfire risk and interactions with various aspects of the regulated activity, including for example, contaminated water, open tanks and flaring. The EMP appropriately identifies the risks and potential impacts raised in these submissions. The interest holder has implemented routine remote camera monitoring and physical surveillance to log fauna interactions with wastewater tanks and the drill cuttings sump, and is committed to implementing additional controls if required. The EMP has considered the threat that open wastewater facilities pose to general and listed threatened fauna species. The EMP appropriately identifies the risks and potential impacts in relation to interactions between the regulated activity and fauna and flora, including an assessment of listed species and threatened ecological communities within a 10 km radius of the location of the regulated activity. The assessment of risk from the regulated activity was based on both field-based and desktop assessments, giving a high level of data certainty. No long-term impacts to populations of general or listed threatened species are expected.

The NT government is currently working with independent experts, research agencies such as CSIRO, and industry to undertake a comprehensive Strategic Regional Environmental and Baseline Assessment (SREBA) in prospective onshore petroleum basins prior to granting any production approvals. These studies are expected to address potential impacts to stygofauna. However, given that the aquifers are isolated and protected, and no change in natural variation of water quality is expected due to project attributable operations, the risk is considered very low.

The chemical risk assessment found potential impacts to birds potentially ingesting the hydraulic fracturing wastewater containing hydraulic fracturing chemicals was negligible. The maximum concentrations of chemicals of potential concern in the fluid system are well below toxicity values

as cited in the Chemical Risk Assessment and are also readily biodegradable. No negative interactions have been identified at Santos Tanumbirini well site where hydraulic fracturing wastewater was stored in open tanks throughout 2020.⁶

Potential pathways that would lead to an increase in the number of feral pest species, such as access to food and semi-permanent open water sources have been assessed in the EMP as 'low' based on the mitigation controls currently implemented on site and discussed previously in item 3 below.

2. *Water:* Public submissions raised concerns about potential impacts to soils, aquatic ecosystems (e.g. Macarthur River catchment) from spills and/or loss of containment, particularly during the wet season, and contamination of groundwater. Impacts to soil and surface waters have been identified and existing mitigations and controls are in place to prevent downstream impacts to in the Macarthur River catchment through loss of containment or spills, including bunding around the well/lease pad that has a holding capacity of 110% of the largest wastewater storage tank. Primary and secondary containment is in place on the site for all chemical, hydrocarbon and wastewater storage/containment. The Carpentaria-1 wellsite location is an elevated area that is not prone to flooding. The site specific Erosion and Sediment Control Plan specifies hydrological design controls for the well site during the wet season and is compliant with the Code. The risk of overflow is considered very low as the open tanks' operational freeboard will be maintained during the wet season to conservatively accommodate a 90-day 1 in 1000 year wet season rainfall event. The minimum freeboard of 1100 mm in the wet season and 500 mm during the dry season will be monitored electronically by telemetry and maintained.

Development of the Carpentaria-1 well at EP187 has verified the vertical distances between the base of the closest aquifer and hydraulic fracturing is greater than 600 m as required in the Code minimising any potential groundwater pathways/contamination via this pathway.

The well design and construction method described in the approved drilling EMP surpasses the requirements of the Code for protection of aquifers. The interest holder has installed control and impact groundwater monitoring bores in the vicinity of the exploration well, with monitoring results made public. A Well Operations Management Plan (WOMP) is provided separately to this EMP and sent to DITT for review and acceptance prior to works commencing. The WOMP will only be accepted if it complies with the requirements detailed in the Code. As per the Code, the interest holder has demonstrated it has a system for managing well integrity throughout the whole well life cycle that complies with ISO 165301:2017 Well integrity - Part 1: Life cycle governance.

In accordance with clause B.4 of the Code, all onshore shale gas wells (including exploration wells constructed for the purposes of production testing) have mandatory requirements for well construction. The top of cement in each casing string must comply with barrier requirements set out in section B.4.3 of the Code. This has been confirmed in the Well Barrier Integrity Verification report for Carpentaria-1 well¹². The interest holder must implement the accepted WOMP for the hydraulic fracturing program to ensure isolation of the Gum Ridge aquifer and overall petroleum well integrity continues to be achieved. The measures to be implemented, as specified in the Code, include:

- development of critical controls and hold points throughout the well construction process that have verification by a competent person prior to proceeding to the next operation
- barrier verifications and monitoring throughout well construction, maintaining primary and secondary well control measures
- a maximum allowable operating pressure in the Carpentaria-1 well for hydraulic fracturing pumping operations
- multiple strings of steel casing with surface casing string cement grouted to the surface and multiple engineered and system mitigations to adequately detect water quality threats to the Cambrian Limestone Aquifer.

¹² https://nt.gov.au/data/assets/pdf_file/0004/963832/carpentaria-1-post-drilling-well-suspension-wbiv.pdf

Increasing salinity and temperature with depth below surface is a general feature of all sedimentary basins including the Beetaloo Sub-basin. In conventional petroleum reservoirs a salt “top seal” is a common feature of the stratigraphic trap that causes hydrocarbons to accumulate. The risk of corrosion as a result of increased salinity and temperature is therefore not unique to unconventional (e.g. shale) petroleum exploration and production. However, petroleum wells are designed with multiple barriers, as required by the Code, so that a single barrier failure will not lead to a loss of containment or in this case aquifer contamination. As such, petroleum wells are highly engineered underground “pressure vessels”. Complete well integrity failure where all well barriers fail is an extremely rare occurrence in contemporary petroleum wells, including shale wells. International failure rate is estimated at less than 1 in 10,000 wells.¹³ Moreover, a recent study on well integrity of coal seam gas wells in Queensland, Australia, covering the period 2010-2015 concluded that the risk of a subsurface breach of a well integrity was assessed to be “very low to near zero”.¹⁴ The 2019 document cited in the submission in relation to coal seam gas wells in Queensland dates back to 2016 and is not a new issue arising since the NT Hydraulic Fracturing Inquiry.

The necessary ingredients for upward flow are an upward head gradient (pressure) or driving force and a leakage pathway. In order for upward flow to occur, the head gradient must be large enough to overcome density gradients associated with increasing salinity with depth and these upward head gradients would need to be sustained over thick sequences (typically >1000 m) to drive a significant amount of brine from the Moroak into shallow fresh groundwater. The source formation (Moroak) must also have sufficient fluid that exists in the pore space (porosity) and is also permeable enough to provide a driving force in a potential leakage pathway. Rate of progress (ROP) during drilling through the Moroak formation at Carpentaria-1 well was extremely low, as reported elsewhere in the Beetaloo, indicating a very high degree of cementation in the Moroak and this supports the fact that it has acted as a barrier to any upward migration of hydrocarbons from the target Velkerri shale over millions of years and also prevents any potential hydraulic fracture upward growth from the target Velkerri formation. The high degree of cementation (extremely low porosity) evident in the Moroak due to difficulty in drilling through it, also precludes the likelihood of any significant water production from the Moroak. In addition, there was no evidence of over-pressure during drilling through the Moroak sandstone at Carpentaria-1 well, as evidenced by the drilling and mud logs for the Carpentaria-1 well. Overpressure is necessary for upward flow. The likelihood that pollutants will be moved to other aquifers is therefore considered remote.

Regardless of the driving mechanism, flow rates are low and timescales for transport are long (often >10⁶ years). The effective hydraulic isolation of these formations is demonstrated by the fact that fluids have been trapped at depth for tens to hundreds of millions of years.¹⁵

3. **Waste:** Concerns were raised about use of open tanks for wastewater and interstate transport of wastewater for disposal. The interest holder is required to ensure all waste is classified and that all listed waste is only disposed of through licensed waste contractors, under the *Waste Management and Pollution Control Act 1998* (NT). The Code mandates that all backflow be recycled and re-used to maximum potential and the off-site transport and disposal of fluids should be minimised. Offsite (interstate) treatment is an interim solution while the NT Government works with industry to implement a long term solution to water management including recycling and disposal. With regard to the use of open tanks, the outcome intended by the Inquiry’s recommendation (7.12) was that enclosed tanks prevent the risk of open wastewater ponds overflowing during significant rainfall events. This outcome has been maintained in the Code. Water will be allowed into evaporation ponds (open above ground tanks) to reduce the amount of water stored in tanks and to reduce the potential impacts of transporting large volumes of

¹³ King, G. E., & King, D. E. 2013. Environmental Risk Arising From Well Construction Failure: Differences between Barrier Failure and Well Failure, and Estimates of Failure Frequency Across Common Well Types, Locations and Well Age. *Society of Petroleum Engineers*. doi:10.2118/166142-MS.

¹⁴ Wu B, R Doble, C Turnadge and D Mallants (CSIRO) (2016) *Well Failure Mechanisms and Conceptualisation of Reservoir-Aquifer Failure Pathways*. SPE Asia Pacific Oil & Gas Conference and Exhibition, 25-27 October, Perth, Australia.

¹⁵ Flewelling S and M Sharma, ‘Constraints on upward migration of hydraulic fracturing fluid and brine’ (2014) 52(4) *Groundwater* 492-4.

wastewater offsite for subsequent treatment and disposal. This is necessary during the early stages of exploration when on-site treatment and recycling is unfeasible. The EMP does not propose to dispose of hydraulic fracturing flowback wastewater in-situ.

Volume reduction of the wastewater and trucking to an authorised facility in Queensland by a listed waste transporter is proposed at this pilot exploration stage. As noted in Section 2.3 above, a risk analysis of hydraulic fracturing flowback produced water sequestered from the same target Velkerri shale formation at the nearby Santos' Tanumbirini-1 well did not identify elevated concentrations of any analytes specified in the Code that may be of potential concern to fauna, such as birds, or to potential soil contamination above published trigger level standards¹⁶ in the event of a spill.

The NT EPA has recommended the interest holder provide to DEPWS a laboratory analysis and risk assessment report of hydraulic fracturing wastewater contained in wastewater tanks following flowback from the well.

4. *Air:* Concerns were raised about impacts to air quality due to venting of methane or the use of a combustion device that creates a fire or safety hazard. During the well completion phase, low levels of methane may be entrained in the early stages of flowback wastewater that is insufficient to combust in automatic flare ignition, resulting in direct methane emissions to atmosphere. This has been conservatively estimated to be approximately 25 tonnes of methane or 625 tonnes CO₂-e which is negligible (refer to Section 2.5 above). As noted previously, the flare is equipped with an auto-ignition system that provides electrical impulses to generate a spark every 1.3 seconds to ensure that the flare is always operational. Flowback from the well and flaring during regional fire ban days will stop. Gas detection monitoring will be conducted during all phases of the hydraulic fracturing operations.
5. *Social and Cultural:* The public submissions assert there has been inadequate stakeholder engagement. The Stakeholder Engagement Plan (Appendix 11 of the EMP) is compliant with the Code and Regulations, and correctly identifies stakeholders as per the definition of a stakeholder in the Regulations. In addition the interest holder also consults more broadly with local community members and businesses in the area. A current (through to end of 2020) Stakeholder Communication log is provided in the Plan in relation to the proposed regulated activity. The communication log includes details of stakeholders, dates of communication, responses/objections raised by stakeholders and outcomes/responses from the interest holder. The plan also includes details of ongoing communications with stakeholders regarding monitoring and other matters during the proposed regulated activity. The public consultation of the EMP resulted in 165 submissions from the community.
6. *Chemical Disclosure:* Concerns were raised about the EMP not disclosing hydraulic fracturing chemicals and a lack of transparency. Appendix A of Appendix 6 – Chemical Risk Assessment - provides the full list of chemicals and conservative maximum concentrations that may be used in the hydraulic fracturing operation. The list is the same as previously approved hydraulic fracturing chemicals listed by other interest holders in the Beetaloo. During the shale gas exploration stage it is not possible to provide an exact composition of the hydraulic fracturing fluid. Many factors contribute to the composition including in-field real time adjustments during hydraulic fracturing pumping operations. The selection of chemicals from the list provided is determined as a result of logs and modelling undertaken prior to hydraulic fracturing (including DFIT) and in-field real time adjustments. The information in the EMP confirms that all chemicals of potential concern in the hydraulic fracturing fluid are, at potential maximum concentrations in the whole fluid system (potential exposure levels), much lower than their published toxicity dose values for fauna. In addition all the chemicals either readily biodegrade, are inorganic and dissociate (e.g. chloride salt and acids) or are inert. The residual chemicals that may be contained in the hydraulic fracturing flowback wastewater are not considered to pose a risk to the environment.¹⁷

¹⁶ NEPM 2011. Guideline on Investigation Levels for Soil and Groundwater. National Environment Protection (Assessment of Site Contamination) Measure April 2011 National Environment Protection (Assessment of Site Contamination)

¹⁷ https://denr.nt.gov.au/data/assets/pdf_file/0005/821912/ep161-santos-waste-water-risk-assessment-report.pdf

The EMP demonstrates how the interest holder will comply with relevant requirements of the Code in undertaking the regulated activity. This includes reference to applicable Australian and international standards that have been adopted for the regulated activity, as applicable. The EMP cross references relevant sections of the Code that apply to the mitigation and management measures to enable the reviewer to identify and confirm that the proposed regulated activity complies with the Code, as applicable. The EMP includes management plans that meet the requirements of the Code.

5. Other relevant matters

Regulation 9 requires that an EMP provides a comprehensive description of the regulated activity, including provision of a detailed timetable for the activity. To meet this requirement, the NT EPA recommends the interest holder be required to submit a register of the key service providers that will be engaged for the regulated activity – prior to undertaking the relevant scope of work; and a detailed timetable for the regulated activity, including reporting on approval conditions to DEPWS.

CONCLUSION

The NT EPA has reviewed the public and NT Government agency submissions as part of its decision-making and when making recommendations to the Minister. This NT EPA advice to the Minister for Environment considers and provides a response to any relevant matters raised in public submissions.

The NT EPA considers that, subject to the recommended EMP approval conditions, the EMP:

- is appropriate for the nature and scale of the regulated activity
- demonstrates that the regulated activity can be carried out in a manner that potential environmental impacts and environmental risks of the activity will be reduced to a level that is as low as reasonably practicable and acceptable.

In providing this advice the NT EPA has considered the principles of ecologically sustainable development.

RECOMMENDATION

The NT EPA recommends that should the IMP3-4 EMP for Imperial Oil & Gas Pty Ltd be approved, the following conditions be considered:

Condition 1: The interest holder must submit to the Department of Environment, Parks and Water Security (DEPWS) via Onshoregas.DEPWS@nt.gov.au:

- i. notification of the commencement of hydraulic fracturing activities one week prior to planned commencement;
- ii. a timetable for the regulated activity that is to be provided one week prior to the commencement of the activity and each quarter thereafter, or more frequently should other constraints, such as seasonal weather forecasts or travel restrictions emerge, and including:
 - time-bound commitments in the EMP;
 - due dates for satisfaction of Ministerial approval conditions;
 - due dates for regulatory reporting;
- iii. daily on-site reports indicating the status and progress of vegetation clearing and hydraulic fracturing, and the freeboard available in open wastewater tanks;
- iv. a seven-day activity forecast for the duration of the activity during the wet season (1 October – 30 April each year);

- v. written notification of any halt to the activity due to wet season conditions, within 24 hours of the halt;
- vi. immediate written notification of any fires potentially threatening the activity from external or internal sources; and
- vii. weekly reports that detail the outcome of site inspections, and corrective actions taken, and inclusive of all commitments in the approved EMP, from the commencement of the regulated activity and continuing while the EMP remains in force.

Condition 2: In the event of any accidental release of contaminants¹⁸ that exceeds 200 litres (for liquids), the interest holder must provide a written report to DEPWS, via Onshoregas.DEPWS@nt.gov.au, within 24 hours of the incident being detected. The report must include:

- i. details of the incident specifying material facts, actions taken to avoid or mitigate environmental harm;
- ii. the corrective actions taken including the volume and depth of impacted soil removed for appropriate disposal if required; and
- iii. any corrective actions proposed to be taken to prevent recurrence of an incident of a similar nature.

Condition 3: The interest holder must provide to DEPWS within 6 weeks of completion of well flowback operations at the Carpentaria-1 well site on EP187 a report on the risk assessment of flowback wastewater from the hydraulic fracturing phase, via Onshoregas.DEPWS@nt.gov.au. The risk assessment must be:

- i. prepared by a suitably qualified person;¹⁹ and
- ii. prepared in accordance with the monitoring wastewater analytes specified in Section C.3 of the *Code of Practice: Onshore Petroleum Activities in the Northern Territory*.

Condition 4: In support of schedule 1, item 11 of the Petroleum (Environment) Regulations 2016 (NT) and clause A.3.5 of the Code, the interest holder must provide geospatial files of the land disturbance footprint(s) to DEPWS, via Onshoregas.DEPWS@nt.gov.au, within 2 months of completion of each land clearing activity or within 6 months of approval of this EMP, whichever occurs first.

Condition 5: The interest holder must provide an annual report to DEPWS, via Onshoregas.DEPWS@nt.gov.au, on its environmental performance, in accordance with item 11(1)(b) in schedule 1 of the Petroleum (Environment) Regulations 2016 (NT). The first report must cover the 12 month period from the date of the approval, and be provided within three calendar months of the end of the reporting period. The annual environmental performance report must align with the template prepared by DEPWS for this purpose.

Condition 6: An emissions report must be provided to DEPWS by 30 September each year, via Onshoregas.DEPWS@nt.gov.au, which summarises actual annual greenhouse gas emissions

¹⁸ 'Contaminant' is defined in section 117AAB(1) of the Petroleum Act 1984 (NT).

¹⁹ Defined in the Code as: A person who has professional qualifications, training or skills or experience relevant to the nominated subject matters or tasks and can give authoritative assessment, advice and analysis about performance relevant to the subject matters using relevant protocols, standards, methods or literature or conduct tasks in accordance with requirements.

reported under the Commonwealth *National Greenhouse and Energy Reporting Act 2007* versus predicted emissions in the EMP.²⁰

Condition 7: Audits of compliance must be undertaken by a suitably qualified and independent person, to be approved by DEPWS, and the audit report provided to DEPWS via Onshoregas.DEPWS@nt.gov.au, no later than two weeks after the completion of the audits, with the focus of the audits as follows:

- i. Conduct a readiness audit prior to commencement of hydraulic fracturing to confirm that EMP commitments have been met and that facilities are suitable to manage all foreseen risks that could occur during hydraulic fracturing; and
- ii. Conduct an operational audit during extended production testing to confirm that EMP commitments in relation to wastewater and spill management have been met.

Condition 8: In support of clause 16 of the *Water Act 1992* (NT) and clause B.4.2 of the Code, the interest holder must undertake groundwater level/pressure monitoring at the Carpentaria-1 impact monitoring bore using a logger to record water level for 4 weeks prior to, during, and 4 weeks after completion of hydraulic fracturing operations on Carpentaria-1 well. Data logging should be recorded at a minimum of every 4 minutes for the duration of the recording period. The logging data should be provided to DEPWS via Onshoregas.DEPWS@nt.gov.au within 2 weeks of completion of groundwater level monitoring in the Carpentaria-1 impact monitoring bore.

Condition 9: A register must be provided to DEPWS via Onshoregas.DEPWS@nt.gov.au, of the key service providers that will be engaged for the regulated activity, prior to undertaking the relevant scope of work.

Condition 10: In support of clause B.4.17.2 of the Code, the interest holder must provide to DEPWS, via Onshoregas.depws@nt.gov.au, groundwater monitoring data and an interpretative report of groundwater quality based on the groundwater monitoring required to be conducted at the well site(s) in accordance with Table 6 of the Code. Groundwater data must be provided within one month of collection and be provided quarterly, in a format to be determined by DEPWS. The interpretative report must be provided annually within three months of the anniversary of the approval date of the EMP and include:

- i. demonstration that there is no change to groundwater quality or level attributable to conduct of the regulated activity at the well site(s);
- ii. interpretation of any statistical outliers observed from baseline measured values for each of the analytes;
- iii. discussion of any trends observed; and
- iv. a summary of the results inclusive of descriptive statistics.



DR PAUL VOGEL AM
CHAIRPERSON

NORTHERN TERRITORY ENVIRONMENT PROTECTION AUTHORITY
5 FEBRUARY 2021

²⁰ Clause D.6.2(b) of the Code requires actual annual greenhouse gas emissions to be provided even where emissions are below the NGERs threshold of 25 ktCO₂-e for scope 1 and scope 2 emissions reporting.