LOCK THE GATE ALLIANCE
AUSTRALIANS WORKING TOGETHER TO PROTECT OUR LAND, WATER, AND FUTURE

Reply to: Georgina Woods
Head of Research and Investigations
george@lockthegate.org.au

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Northern Territory
Environmental Protection Authority

Submission: Carpentaria pilot EPA referral

Thank you for the opportunity to make a submission on this referral.

The Lock the Gate Alliance is a national collection of grassroots organisations made up of over 120,000 supporters and over 100 local groups concerned about risky coal mining, coal seam gas and fracking. Several of these groups are located in Darwin, Katherine and Alice Springs, as well as rural and remote areas around the NT. Our members include farmers, traditional custodians, conservationists and urban residents. Together, we have a vision of healthy, empowered communities that have fair, democratic processes available to them to care for land and water.

This project would have a significant impact on the environment if it were allowed to proceed and requires a full Environmental Impact Statement, or a Supplementary Environment Report at the very least. The material provided by the proponent is incomplete and inaccurate. It downplays the impacts of the project by omitting information and failing to investigate and describe its major environmental impacts.

The environmental harms from this project, particularly regarding impacts on groundwater and its contribution to climate change will last for generations and the EPA must ensure that it undergoes comprehensive assessment and should, ultimately, prevent it from proceeding.

Summary

The EPA must determine whether the referred action or strategic proposal has the potential to have "a significant impact on the environment." The Carpentaria pilot *will* have significant impacts on the environment that require full environmental impact assessment but the information provided to the EPA claims otherwise, largely because the proponent hasn't considered some impacts at all, and has addressed others in a cursory manner.

The information provided by the proponent has considerable gaps and omissions and cannot be relied upon by the EPA in deciding there will not be a significant impact.

The EPA is required to consider "The context and intensity of the impact" the project will have. The most severe and most lasting direct, indirect and cumulative impacts of this project are its contribution to climate change and the alteration it will cause to groundwater values. The

information provided by the proponent about its climate change impact relies on an assumption that the project will avoid flaring gas altogether. This assumption has multiple problems:

1. It omits any mention of the downstream emissions caused by the use of the gas that is sold on an appraisal basis;
2. It omits to mention that the pipeline to McArthur River does not have sufficient capacity to transport 25TJ a day of gas, so some flaring will have to take place regardless if that amount of gas is produced;
3. It fails to provide any information about the indirect and cumulative environmental impacts of warming over 1.5 degrees and the role of the direct and downstream emissions from this project will play in breaching that threshold;

The EPA cannot rely on the proponent's assumption that it will avoid triggering the 100,000 tonne per year threshold of the large emitters policy. It also cannot accept an environmental assessment that does not quantify and assess the impact of downstream emissions.

Since the proponent is relying for this referral in part on its draft EMP, we attach the submission we made to DEPWS in response to that EMP (**Appendix A**). We also attach reviews of the EMP by Professor Matthew Currell, Head of Civil and Environmental Engineering, School of Engineering and Built Environment, Griffith University (**Attachment 1**), Dr Ryan Vogwill and Director and Principal Hydrogeologist and Rachel Hamilton, Senior Hydrogeologist, Hydro Geo Enviro Pty Ltd (**Attachment 2**) and Professor Neil McIntyre, Sustainable Minerals Institute, School of Civil Engineering, University of Queensland (**Attachment 3**).

We provide more detail below and make the following key points:

- EPA must accept the referral for assessment due to the potential for the Project to have a significant impact on climate change and water.
- Imperial has referred the Project to the EPA due to its potential to have a significant impact on Atmospheric Processes. It submits these impacts will be reduced or completely removed by sale of appraisal gas. This cannot be true. Selling, rather than venting appraisal gas does not remove emissions, it merely shifts them from being emitted during extraction of the gas (also known as scope 1 emissions) to their being emitted when the energy is used by consumers (also known as scope 3 emissions). Regardless of where and when emissions are emitted, those emissions will contribute to climate change.
- The Referral Documents and EMP fail to both identify the environmental risks and impacts of those emissions, or apply the mitigation hierarchy to them by discussing how Imperial plans to avoid, mitigate or offset those emissions. It is also unclear from the Referral Documents where the appraisal gas, if sold, would be emitted. This information is critical for the NT EPA to understand whether the Project will contribute to the NT's goal of net zero emissions by 2050, an environmental objective identified in the NT EPA's Environmental Factors and Objectives.
- The referral documents provided by Imperial demonstrate the potential of the project to have a significant impact on climate change due to the total emissions from the project being likely to be at least 3,040,381 tCO_2-e greenhouse gas emissions over the life of the

project. However, there is key information missing on emissions from the Referral Document, including scope 3 emissions calculations if appraisal gas is sold and not vented. Therefore, the EPA must set the level of assessment as, at least, supplementary environmental report, to ensure Imperial must provide further information in relation to the Project to enable the NT EPA to understand the acceptability of these impacts.

- Imperial fails to identify that there are additional potential significant impacts related to the extraction of groundwater, use of water in hydraulic fracturing and the wastewater management system proposed in the EMP. The use and management of water and wastewater has the potential to have a significant impact on terrestrial environmental quality and inland water environmental quality due to the likelihood of aboveground contamination in hydraulic fracturing. Inter-aquifer leakage additionally has the potential to have a significant impact on groundwater through contamination into surface aquifers and groundwater. Please see the attached expert reports which provide relevant information.
- The referral documents and EMP provide insufficient information to fully assess the potential environmental risks associated with the Project. These will be required for the NT EPA to be satisfied about the acceptability of the environmental risks the Project poses. Missing water-related data includes groundwater testing and drawdown modelling, an understanding of geological structures, rock properties and biogeochemical environment, surface water hydrology and detailed plans for the wastewater management system. Further information on these issues is vital for the NT EPA to undertake any environmental impact assessment.
- Consequently, Lock the Gate submits that the EPA must accept the referral of the Project for an environmental impact assessment and the level of assessment required is an Environmental Impact Statement or, at the very least, a supplementary environmental report. This level of assessment is appropriate for the nature and scale of the project, which represents a major escalation of fracking activities and infrastructure in the Beetaloo Basin, and given the lack of information provided in the referral and in the EMP.

Climate change

The contribution of this project to climate change is a direct impact of the project. The environmental consequences of that climate change are indirect impacts. In our view, the Carpentaria Pilot is a substantial cause of climate change within the terms of the *Environment Protection Act 2019*. Climate change is a direct environmental impact and the flow-on impacts of climate change are indirect impacts with a large number of substantial causes. We note that the EP Act doesn't require the action under consideration to be "the" sole substantial cause of indirect impacts, but simply "a" substantial cause - one of many. The Act makes clear that an impact may be cumulative and may occur over time and this clause aids in interpreting the "substantial cause" requirement of indirect impacts.

To prevent 1.5 degrees of average global warming global greenhouse gas emissions need to fall substantially annually. Prima facie, any additional greenhouse gas emissions are contrary to this effort and will have a significant impact. Any additional greenhouse gas emissions created by one

new activity increase the burden of effort required to reduce emissions overall. None of these matters are described or explored by the proponent in the referral material.

Principles of ESD

The referral information provides no assessment or discussion of the principles of ecologically sustainable development.

A brief mention of ESD was included in the draft EMP that was recently exhibited by DEPWS, but the only mention of ESD in the EPA referral is three instances where the proponent claims that siting multiple wells on one well pad is consistent with the principles of ESD because it is "minimising disturbance."

The material provided to EPA and the draft EMP, fail to identify where the activity comes into conflict with these principles. Specifically,

- There is no discussion of the intergenerational inequity of large-scale groundwater removal by this activity, cumulative with other activities, which have the potential, given low recharge rates and interconnectivity of the Cambrian Limestone System to deplete resources to the detriment of future generations and to have indirect impacts on other water users and on groundwater dependent ecology and culture;
- There is no discussion of the impacts of climate change on future generations or the carbon budget context of the direct, indirect and downstream emissions that would result from this activity;
- There is no discussion about the wise and sustainable use of either the groundwater that will be extracted for this project or the gas that will be produced;
- There is no discussion of the proponent's proposed application to use or sell the gas "on an appraisal basis" and how the proponent will value the downstream emissions that will result from this activity.

Groundwater

The direct and cumulative impacts of groundwater drawdown have not been described or assessed at all in the material by the proponent. This includes the potential impact on groundwater dependent ecosystems in the vicinity, as well as on other water users. In NSW and Queensland it is routine for the effects of drawdown caused by groundwater removal to be modelled but no such modelling has been undertaken for this referral. As a result, the proponent is entirely unaware of the scale, duration and intensity of the impacts that will be caused by its water use, and indeed seems unaware that such impacts are likely to occur.

The referral information identifies that "Significant alluvial groundwater dependent ecosystem (GDE) vegetation (riparian woodland and Melaleuca Forest) associated with sandstones ranges and escarpments where the Sturt Plateau and Gulf Fall and Uplands bioregions converge, was identified in the SREBA [DEPWS, 2022b]. However, most of this habitat is to the east and north of the CPP Area at lower ground elevations, with comparatively little in the CPP area." But no attempt has been

made to understand the impact on these GDEs of the removal of nearly a gigalitre of groundwater for the project.

Groundwater use is described only in terms of the system-wide cap in the Georgina-Wiso water allocation plan, but the local and regional impact of any drawdown caused by this removal is not mentioned at all by the proponent. This has the potential to cause a significant and lasting environmental harm and requires full environmental impact assessment.

Cultural and heritage

We are concerned about the release of the draft EMP and the referral to the EPA asserting "no significant impact" have both occurred prior to the follow-up meeting with Traditional Owners in Daly Waters, Eliot and Borroloola that were scheduled in the late months of 2023 but had to be postponed. The draft EMP indicates that meetings of this kind have not taken place since August last year.

Biodiversity

The EPA is also required to consider "The sensitivity, value and quality of the environment impacted on and the duration, magnitude and geographic extent of the impact." The area to be impacted by this activity is relatively intact and poorly understood by Western science. We note that Traditional Owners from Daly Waters, Borroloola and Eliot have not yet had the promised follow-up meeting with the proponent. Only one meet has so far been held, in August 2023. It does not appear that Traditional Owners have been involved with the biodiversity or water impact assessments.

The conclusion that this activity will not pose a significant impact to nationally threatened and migratory species is not supported by evidence, and the material provided to the EPA demonstrates serious deficiencies in the survey effort and assessment of these species.

The documentation provided to the EPA with this referral claims "No MNES mammals, reptiles, threatened invertebrates or threatened flora were found during desktop searches or field surveys within the study area that may potentially be impacted by the Activity." This is a reflection of the deficiency of data in the area, and the failure of the proponent to adhere to survey methods required by guidelines for nationally threatened birds and reptiles.

However, as the material concedes,"Subsequent to the environmental assessments associated with the Environmental Assessment Report (Appendix 01) (which was finalised in October 2023), the Northern Blue-tongued skink has been uplisted to Critically Endangered in December 2023." Despite this, there is no mention in the material provided of the presence or otherwise in the area of habitat described in the conservation advice for this species as critical for its survival. Targeted survey guidelines for nationally threatened reptile species are outlined in *Survey guidelines for Australia's threatened reptiles* (Commonwealth of Australia 2011).[1] Without adequate targeted surveys, there is

[1] Department of Sustainability Environment Water Population and Communities, 2011. "Survey guidelines for Australia's threatened reptiles" https://www.dcceew.gov.au/sites/default/files/documents/survey-guidelines-reptiles.pdf

a high risk that habitat for the Northern blue tongue skink will be impacted by the proposed development and that unacceptable impacts will occur. As suitable habitat has been identified and the species has been previously recorded within the study area, it can be considered to be habitat critical to its survival according to Conservation Advice (DCCEEW 2023).[2] In addition, any non-vegetated areas that provide shelter from thermal extremes, fire and predators are also habitat critical to the survival of the species.

Similarly, the assessment for EPBC-listed bird species Gouldian Finch, Painted Honeyeater and Grey Falcon concluded that there were no significant impacts on these species as they have not been (opportunistically) recorded within the study area since 2021. These species require targeted surveys to be undertaken as outlined in *Survey guidelines for Australia's threatened birds* (Commonwealth of Australia 2010) in order to confirm their likelihood of occurrence within the project area.[3]

The assertion that there will be no significant impact on biodiversity values is based on inadequate survey effort and unreliable methods, is reliant on SREBA surveys which, far from being comprehensive, represent only an initial and incomplete snapshot of biodiversity in the Beetaloo Basin and is overly reliant on database records and previous surveys, rather than targeted surveys, for flora, fauna and ecological communities to determine likelihood of occurrence. This demonstrates the necessity of a full environmental impact assessment.

Wastewater management and spills

Professor Currell's advice indicates that, "The likelihood of spills and leaks of fracking wastewater has likely been under-estimated" in the draft EMP citing studies of spill and incident rates in shale gas developments elsewhere.

We note that a wastewater leak incident was reported by Imperial Oil and Gas at the Carpentaria 1 site in September 2023. Carpentaria 1 is quite close to Relief Creek and it is not clear from the preliminary report available publicly what volume of liquid was lost before the leak was detected. That preliminary report indicates that the corrective actions taken by the proponent would be to "temporarily cease evaporation in the Carpentaria 1 tank and the second above ground treatment tank at Carpentaria 2 until investigation complete" and "create an action plan for fluids contained in the Carpentaria 1 tank." The available information is not sufficient to understand whether the source of the leak has been detected and can be fixed.

[2] DCCEEW 2023. "Conservation Advice for *Tiliqua scincoides intermedia* (northern blue-tongue skink)" https://environment.gov.au/biodiversity/threatened/species/pubs/89838-conservation-advice-21122023.pdf

[3] Department of Environment Water, Heritage and the Arts, 2010. "Survey Guidelines for Australia's Threatened Birds" https://www.dcceew.gov.au/sites/default/files/documents/survey-guidelines-birds-april-2017.pdf

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Reply to: Georgina Woods
Head of Research and Investigations
george@lockthegate.org.au

18 April 2024

Department of Environment, Parks and Water Security
Petroleum Operations Unit
By email: imperial.ep187@nt.gov.au

Objection: Carpentaria pilot Environmental Management Plan EP187

Thank you for the opportunity to comment on this draft EMP.

The Lock the Gate Alliance is a national collection of grassroots organisations made up of over 120,000 supporters and hundreds of local groups concerned about risky coal mining, coal seam gas and fracking. Several of these groups are located in Darwin, Katherine and Alice Springs, as well as rural and remote areas around the NT. Our members include farmers, traditional custodians, conservationists and urban residents. Together, we have a vision of healthy, empowered communities that have fair, democratic processes available to them to care for land and water.

Lock the Gate objects to this EMP and urges the Department to reject it, on the basis of its unacceptable environmental and social impacts. Despite manifest failures in the adequacy of the information provided with the EMP, it is clear that risks from the project are neither as low as reasonably practicable, nor acceptable.

The proponent's EMP has failed to meet the approval criteria in section 9 of the *Petroleum (Environment) Regulation 2016* (*PER*). The EMP as exhibited does not, under criteria s 9(1)(c) "demonstrate 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 (i) as low as reasonably practicable or (ii) acceptable." Specifically, the EMP fails to meet approval criteria to reduce risks to as low as reasonably practicable (ALARP) or to a level that is acceptable in, for example, the management of fracking wastewater and the management of greenhouse gas emissions, as detailed in the submission.

The draft EMP fails to address "*all the environmental impacts and environmental risks arising directly or indirectly*" from all aspects of the activity and likewise fails to assess "*the cumulative effects of those impacts and risks* when considered with each other and in conjunction with any other activities or events that occurred or may occur in or near the permit area for the regulated activity."[1] Specifically, with regard to these requirements, the EMP:

[1] *Petroleum (Environment) Regulations 2016*, Schedule 1 Part 1 regulation 3(2)(b).

- Fails to engage with the principles of Ecologically Sustainable Development as spelled out in Part 2 Division 1 of the Environment Protection Act 2019, and, indeed, appears unaware that these principles have been articulated in Territory law.
- Provides incomplete and inaccurate information about its emissions of greenhouse gases and no assessment of the indirect climate change impacts of the release of that pollution;
- Provides incomplete information on the water resources in the area and the impact of the activity on that water and the values it supports, including no discussion of the presence or potential impacts of faults in the areas where drilling is to occur and the likelihood of these to provide transmission pathways for fracking fluids;
- Undertakes no modelling of local effects of groundwater removal and provides no discussion of the impacts of groundwater drawdown as a result of abstraction from the Gum Ridge Formation on local shallow aquifers and groundwater dependent ecosystems;
- Fails to detail how it will meet the requirement in the *Code of Practice: Onshore Petroleum Activities in the Northern Territory* (the Code of Practice) for "an auditable chain of custody system" for wastewater tracking;
- Proposes the use of open storages for contaminated wastewater, contrary to the Code of Practice;
- Fails to describe the method of disposal for contaminated drill-cuttings;
- Fails to satisfy Clause 2(c) of Schedule 1 of the PER as it does not describe "*details of any uncertainties or lack of understanding in relation to [the] environment*" particularly for water resources and biodiversity.
- The draft EMP also makes concerning revelations about previous failures to appropriately identify and assess the significance of heritage sites, which requires action.

We attach reviews of the EMP by Professor Matthew Currell, Head of Civil and Environmental Engineering, School of Engineering and Built Environment, Griffith University (**Attachment 1**), Dr Ryan Vogwill and Director and Principal Hydrogeologist and Rachel Hamilton, Senior Hydrogeologist, Hydro Geo Enviro Pty Ltd (**Attachment 2**) and Professor Neil McIntyre, Sustainable Minerals Institute, School of Civil Engineering, University of Queensland (**Attachment 3**).

Principles of Ecologically Sustainable Development

The principles of Ecologically Sustainable Development (ESD) are relevant to the approval decision for a petroleum EMP. The EMP as exhibited fails to consider the principles of ESD as set out in Part 2 Division 1 of the *Environment Protection Act 2019*, which include:

- Decision-making principle: Decision-making processes should effectively integrate both long-term and short-term environmental and equitable considerations;
- The precautionary principle: If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;
- Intergenerational equity: The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of present and future generations;

- Principle of sustainable use: Natural resources should be used in a manner that is sustainable, prudent, rational, wise and appropriate.
- Principle of improved valuation: Persons who generate pollution and waste should bear the cost of containment, avoidance and abatement.

The proponent seems unaware that Territory law has inscribed these specific principles and instead claims "there is no universally accepted definition" of the principles and cites a statement from Australia's ESD Steering Committee dated 1992. In the very short treatment of ESD principles conceptually in the EMP it is stated that "Further assessment of the consideration of ESD, the environmental values of the CPP Area and the potential impacts and environmental performance standards are presented in Section 6" but no further consideration is made.

As a result, the EMP fails to identify where the activity comes into conflict with these principles. Specifically,

- There is no discussion of the intergenerational inequity of large-scale groundwater removal by this activity, cumulative with other activities, which have the potential, given low recharge rates and interconnectivity of the Cambrian Limestone System to deplete resources to the detriment of future generations and to have indirect impacts on other water users and on groundwater dependent ecology and culture;
- There is no discussion of the impacts of climate change on future generations or the carbon budget context of the direct, indirect and downstream emissions that would result from this activity;
- There is no discussion about the wise and sustainable use of either the groundwater that will be extracted for this project or the gas that will be produced;
- There is no discussion of the proponent's proposed application to use or sell the gas "on an appraisal basis" and how the proponent will value the downstream emissions that will result from this activity.

Ground and surface water

The EMP provides no assessment of the impact of large-scale groundwater removal anticipated for this project, particularly the consequences of groundwater drawdown as a result of this removal. As Professor Matthew Currell outlines in the attached advice, stating the overall volume of water in an aquifer and comparing it to the volume to be removed does not describe the effects of that removal on local and regional water resources, flows and availability. Professor Currell indicates that:

> "This analysis is insufficient for a robust assessment of groundwater impact and risk. The Georgina Basin is a huge aquifer system, covering hundreds of thousands of square kilometers, of which the Petroleum Lease is only a tiny fraction. Understanding the local impacts of extraction from individual projects involving groundwater extraction in the basin requires detailed analysis of aquifer properties, water extraction scenarios and drawdown, rather than a 'whole of basin' approach that only compares extraction to basin-wide estimates of volume and/or sustainable yield."

Water removal by extractive activities in NSW and Queensland are routinely required to undertake modelling to understand the drawdown effects of groundwater removal. Dr Ryan Vogwill and Rachel Hamilton likewise identify the absence of any assessment of groundwater drawdown impacts on environmental receptors as a result of groundwater abstraction as a major gap in the EMP, including the impact this would have on shallow aquifers that must be present given the presence of groundwater dependent ecosystems (GDEs), but are not identified mapped or discussed in the draft EMP. Specifically, larger pools along the creek that persist during the dry season are likely groundwater dependent and support a higher fauna diversity than surrounding areas. The impact of localised groundwater drawdown following removal of water from the Gum Ridge Formation for this project needs to be modelled and analysed as it could lead to unacceptable impacts.

Professor Currell advises that to fully assess groundwater risks from the proposal, further analysis is required to understand the following effects of groundwater removal, including:

- An assessment of the potential for drawdown to spread to productive bores within 5, 10 and 15km of the activity;
- An assessment of the potential impacts on springs including the extent of drawdown associated with water extraction, and the changes to water balance (including any reduction in groundwater discharge from aquifer units which may sustain springs);
- An assessment of the impact of the magnitude and extent of groundwater drawdown caused by the project's groundwater extraction on groundwater dependent vegetation.

Dr Vogwill identifies that the EMP similarly provides no discussion of the potential impacts arising from permeable underground pathways, including production wells themselves (if there is loss of well integrity or a poor well seal), natural fractures (faults etc) and newly-created fractures. All of these could allow hydraulic fracturing fluids, other fluids (such as saline groundwater) and gases to reach underground drinking water resources. In other parts of the Beetaloo Basin, fracking companies have encountered fractures in the Cambrian Limestone Aquifer system, introducing the risk that drilling and fracking fluid may enter that system.

Regarding well integrity, Dr Vogwill's advice also identifies that the "vuggy and cavernous" units of the Cambrian Limestone Aquifer presents particular risks not described or acknowledged in the EMP because "Cementing the annulus of vuggy and cavernous units can be notoriously hard as cement runs into the porous/vugs in the formation and doesn't seal the annulus where it is placed. This has large implications for well integrity and commonly leads to sections of the annulus not being sealed, potentially providing a conduit for groundwater flow."

Dr Vogwill similarly highlights the lack of any mention of stygofauna or troglofauna, noting that the Cambrian Limestone aquifer is likely suitable habitat for these species, so this is clearly a potential impact that requires assessment.

The project is in the headwaters of two catchments, the Limmen Bight River catchment to the north and McArthur River to the east. The pilot project crosses Relief Creek and the area around it that floods. Wells will be located just outside the 1 in 100 year flood zone, which means they are likely to flood in more extreme events. Dr Vogwill's advice uses publicly available data to show examples of

relatively persistent surface water features in the area of the proposed Carpentaria Pilot not included in the EMP, highlighting the insufficiency of the assessment for understanding the risks and impacts of the project on surface water resources. The conclusion of Dr Vogwill is that the EMP does not provide an adequate assessment of the risks and impacts of this project on ground and surface water resources.

Cultural heritage

We are concerned about the release of this EMP for public comment prior to the follow-up meeting with Traditional Owners in Daly Waters, Eliot and Borroloola that were scheduled in the late months of 2023 but had to be postponed. The draft EMP indicates that meetings of this kind have not taken place since August last year.

The draft EMP also makes concerning revelations about previous failures to appropriately identify and protect heritage sites. Archaeological survey results from December indicate that the cultural heritage artefacts found in 2022 and previously considered "isolated artefacts" are in fact part of a medium density artefact scatter, "the most significant site yet found south of the Carpentaria Highway in EP 187." The site is referred to in the study as Balbirini 3. It is next to the existing Carpentaria 4 well, just east of Relief Creek, which was drilled over the new year in 2022/23. It appears that this drilling took place on the basis of the archaeological finds being "isolated," prior to their true significance being revealed nearly a year later in surveys conducted for this project. As a result of this, the Archaeology report recommends the Carpentaria 4 horizontal well development (C4-H) push east into the forested area - away from Relief Creek. This is the first part of the project planned for construction, in July, according to the schedule in the draft EMP.

The re-evaluation of the importance of cultural heritage artefacts found at the site in 2022 and previously considered "isolated artefacts" indicates the inadequacy of the assessments being conducted for Environmental Management Plans for fracking activities. The absence of follow up meetings with Traditional Owners and this evidence of lax or inaccurate previous assessments demonstrates inattention to these values and calls into question the conclusions of the draft EMP that risk of harm has been addressed.

Wastewater management

The environmental risks from management of contaminated wastewater from fracking have not been reduced to as low as reasonably practicable, and are unacceptable. Professor Currell's advice indicates that, "The likelihood of spills and leaks of fracking wastewater has likely been under-estimated" citing studies of spill and incident rates in shale gas developments elsewhere.

The EMP indicates in its risk assessment that in order to prevent the risk of wastewater harming the environment in the event of extreme rainfall, the proponent will rely on forecasts of significant rainfall events and a calculation of whether there is sufficient freeboard to contain such an event, at which point further control measures, in the form of "engineered tank covers" will be installed on "open-top treatment tanks" with eight hours notice. This does not reduce the risk of contamination and spills to "as low as reasonably practicable" given the proponent does not appear to have

considered covering all storages of contaminated water, not even during the wet season. The presence of fracking chemicals and other contaminants presents an unacceptable risk of spills and accidents, given unpredictable wet season conditions and difficulties of access during those periods.

The EMP Wastewater Management Plan cites a report created for the proponent by Kleinfelder in 2021, reviewing the contaminants present in flowback water at the Carpentaria 1 well. That report states:

> *The calculated annual dose for the combined alpha and beta activity exceeded the 1 mSv/year screening criteria in four of the seven treatment tank samples (2.5 to 10.4 mSv/year). It is noted that the three initial samples were below the screening criteria, with the later samples above the screening criteria, which could suggest NORM build-up of radioactive material within the treatment tank.*

The report also found that, "The evaporation treatment process is anticipated to increase the TDS concentrations and that of other contaminants of concern." This finding underscores why the proposal to hold large volumes of flowback water on site for unspecified periods, in storages that will not always be enclosed, even in the wet season, does not reduce impacts to an "as low as reasonably practicable" or an acceptable level. The longer water is held on site, particularly in open tanks, the greater the risk that spills and leaks will cause environmental harm. Yet the EMP does not discuss the length of time the proponent intends to hold such water on site. The length of time wastewater will be held on site is crucial to understanding the risk presented by that water. We note that a wastewater leak incident was reported by Imperial Oil and Gas at the Carpentaria 1 site in September 2023. Carpentaria 1 is quite close to Relief Creek and it is not clear from the preliminary report available publicly what volume of liquid was lost before the leak was detected. That preliminary report indicates that the corrective actions taken by the proponent would be to "temporarily cease evaporation in the Carpentaria 1 tank and the second above ground treatment tank at Carpentaria 2 until investigation complete" and "create an action plan for fluids contained in the Carpentaria 1 tank." The available information is not sufficient to understand whether the source of the leak has been detected and can be fixed.

The method by which the proponent has estimated the holding capacity necessary to withstand extreme rainfall events requires interrogation. It is stated in the EMP that although the usual approach would be to utilise the BOM's Revised Generalised Tropical Storm Method, the maximum duration considered in this method is 120 hours in the coastal zone and to extend it to the required 90 day period "introduces considerable statistical uncertainty in predicting extreme rainfall." A prudent risk-based approach would present the range of this uncertainty, particularly if it indicates the possibility of low-likelihood but high consequence extreme rainfall events. Instead, the EMP states that "utilising probability methods that leverage historical daily rainfall datasets emerges as a viable approach to reasonably forecast a 0.1% [probable maximum precipitation] estimate for 90 days." The proponent uses this method to calculate "the minimum required reserved space to handle a 1 in 1,000-year rainfall event." We note that advice from Professor Neil McIntyre from the University of Queensland about the information provided with the EMP is that, "The estimation of design extreme rainfall is fundamental to the assessment of risks from accidental spills. Without a

precise explanation of the method of estimating design extreme rainfall I cannot conclude that the assessment is adequate."

We note that BOM rainfall data for Tanumbirini, which is not included in the EMP, recorded 1,200mm in the first 90 days of 2024, greater than the 1 in 1000 year wet season 90 cumulative rainfall maximum given for Daly Waters in the EMP, but less than the 90 day cumulative maximum at McArthur River mine (1,400mm). Given this, the proponent's freeboard calculation seems reasonable based on historical data, but there is no discussion in the EMP of the influence of climate change on precipitation extremes. We note in this regard, Professor McIntyre's advice that "the statistical methods employed in the EMP integrate any effects of climate change in recent decades" This is reassuring, but discussion of this context should be provided with the EMP and Professor McIntyre's advice provides some guidance in this regard. In our view, a complete risk assessment would consider and plan for the possibility that the envelope of possible extreme conditions may already have altered. Finally, the assessment is based on the need to hold water over a 90 day period, but it is not clear from the EMP and the waste water management plan how long water may be expected to remain on site.

We provide at **Attachment 3** advice from Professor Neil McIntyre who asserts that while the risks from a project of this nature can be manageable with the application of good practice in planning, design and operation, "*the reviewed EMP documents do not provide the level of information required to confidently conclude that risks are acceptably low or that an adequate assessment has been conducted."*

Drill-cuttings waste management

The project will produce 600 cubic metres of drill cuttings per well and the destiny of these materials is not clearly articulated in the draft EMP. The proponent cites a study it commissioned to examine the analytes likely to be present in these cuttings, but that report is not made available with this EMP and, unlike the flowback water report, has not otherwise been made public.

Greenhouse gas emissions

The EMP indicates that the company plans to apply to "use the gas on an appraisal basis" instead of flaring it onsite. To do this, the company will need to secure a connection and usage agreement for the McArthur River mine gas pipeline, secure approval from the NT Government and necessary approval under the Native Title and Land Rights Acts. While there is a rough estimate given of the annual emissions that would result should this proposal *not* be successful (~475,000 tonnes per year) there is no assessment provided of this scenario, or discussion of how the company intends to meet the Safeguard Mechanism's zero emissions baseline for shale gas which would apply if emissions from the pilot were greater than 100,000 tonnes in any of the years of operation.

The ability of the company to avoid flaring by securing approval to supply appraisal gas to the McArthur River mine power station is uncertain. The company claims it will produce 25 terajoules (TJ) of gas a day, but the McArthur River Pipeline only has capacity for 15TJ a day, some of which is presumably already contracted. There's no mention or explanation of this difference in the draft

EMP and no estimation of emissions from flaring any excess gas not able to be transported via that pipeline, or the downstream emissions from burning any transported gas. Given that the Pepper Inquiry made clear that shale gas operations in the NT need to be net zero from the outset, including their downstream emissions in Australia, then this is an omission that must be rectified. We note that there were 141,369 tonnes of greenhouse emissions reported from McArthur River mine power station in the most recent reporting year.

Furthermore, the EMP does not explain or describe how emissions calculations have been made and appears to contain errors in this regard. The estimates of fugitive emissions, for example, has the number "18" in the column labelled "total" for emissions estimates and no number in the column for total gas throughput. The number "787" appears out of place in another cell, but is not the total of the emissions numbers provided for each year. The presence of such basic errors indicates that neither the company nor the Department has attended to the accuracy of the greenhouse emissions assessment.

The EMP therefore has not provided sufficient information to meet the relevant regulatory requirements to consider the full direct, indirect cumulative impacts, and the principles of ecologically sustainable development.

The "cumulative impact assessment" in the EMP tallies the expected emissions from other shale gas fracking activities in the area, but it does not contextualise the direct and downstream emissions from these activities within Australia and the Territory's climate change commitments and emissions reduction trajectories required to achieve the goals of the Paris climate agreement.

Biodiversity

The assertion in the Environmental Assessment Report (Appendix 1) that impacts to biodiversity from proposed activities are considered to be low is not supported by the methodology or impact assessment. The Carpentaria Pilot Project should be refused because it is not consistent with the principles of ecologically sustainable development and it fails to meet approval criteria to reduce risks to biodiversity to as low as reasonably practicable or to a level that is acceptable.

The EMP provides only a superficial overview of the ecological values of the lease area, relies on deficient records and does not offer any effective mitigation measures other than avoidance of some habitat features. Furthermore, the EMP:

- Does not demonstrate alignment with the principles of Environmentally Sustainable Development, specifically the conservation of biological diversity and ecological integrity;
- Is based on inadequate survey effort and unreliable methods;
- Is reliant on SREBA surveys which, far from being comprehensive, represent only an initial and incomplete snapshot of biodiversity in the Beetaloo Basin;
- Is overly reliant on database records and previous surveys, rather than targeted surveys, for flora, fauna and ecological communities to determine likelihood of

occurrence;
- Fails to quantify or qualify potential direct and indirect impacts on ecological values;
- Fails to assess cumulative impacts in the context of current and future gas development.

Further basic errors in the EMP indicate the lack of care taken in this assessment. EPBC listed migratory birds, Glossy Ibis, Cattle Egret, Whistling Kite and Rainbow bee-eater are repeatedly labelled as "marine" species, for example.

These are discussed further below.

Inadequate survey effort

The environmental assessment fails to satisfy Clause 2(a) of Schedule 1 of the PER because it does not adequately describe "*the existing environment that may be affected by the regulated activity*," in particular, the likely occurrence and distribution of threatened flora and fauna species in the study area. The field survey is based solely on opportunistic observations that are almost certainly unable to detect rare species. It also fails to meet Clause 2(b) as it does not provide "*details of any particular values and sensitivities of that environment relevant to the activity*."

The environmental assessment conducted as part of the EMP consists of a desktop survey and "targeted" field surveys undertaken on foot and via helicopter and all-terrain vehicle (Section 2.3). The only information describing the methodology indicates that surveys were undertaken in October 2023 during optimal dry season conditions. There are no details regarding survey timing, effort, coverage or limitations. Elsewhere in the report, the field survey is more accurately described as a combination of "opportunistic observations" and "ecological information." Such limited efforts are inadequate and seek only to broadly describe environmental features with no attempt to confirm the presence of threatened flora or fauna. The fact that only doves, pigeons, a Whistling Kite and several Spectacled hare-wallabies were observed opportunistically in October 2023 confirms that this methodology cannot be relied upon to adequately describe the flora and fauna assemblages in the study area, let alone threatened species.

The report's conclusion on page 21 actually spells out that the aim of field surveys was to identify weeds and to describe "key ecological characteristics" and potential constraints. Knowledge of threatened species occurrence is therefore overly reliant on database records, which are widely recognised as being depauperate in the NT and are more likely to indicate absence of survey effort rather than species' occurrence. The environmental assessment also relies on previous surveys that are not appended or referenced, but are only vaguely referred to as "*field surveys undertaken over a 2-year period between 2021-2023*" (pp. 10, 11 and 13, Appendix C). Review of environmental reports undertaken as part of the EP187 seismic and

drilling programs in May 2019[2] and March 2021[3] confirm that those assessments were also based on opportunistic surveys. There has been no attempt in the EMP to address the considerable gaps in the SREBA surveys.

There is confusion around the identification and conservation status of the Common blue tongue lizard (*Tiliqua scincoides*) which is labelled as Data Deficient under the *Territory Parks and Wildlife Conservation Act* (TPWC Act) on page 6 and records for which are mapped in Figures 4 and 5. However, an addendum to Appendix 1 of the environmental report provides EPBC Significant Impact Criteria (SIC) assessment for the Northern blue tongue skink (*Tiliqua scincoides intermedia*) and Merten's Water Skink (*Varanus mertensi*). It can therefore be assumed that the species referred to throughout the report as the "Common" blue tongue is actually the critically endangered Northern blue tongue skink that has been previously recorded within the study area (Section 2.1.1, Addendum to Appendix 1) and Table 8 (Appendix B). Targeted survey guidelines for nationally threatened reptile species are outlined in *Survey guidelines for Australia's threatened reptiles* (Commonwealth of Australia 2011).[4] Without adequate targeted surveys, there is a high risk that habitat for the Northern blue tongue skink will be impacted by the proposed development and that unacceptable impacts will occur. As suitable habitat has been identified and the species has been previously recorded within the study area, it can be considered to be habitat critical to its survival according to Conservation Advice (DCCEEW 2023).[5] In addition, any non-vegetated areas that provide shelter from thermal extremes, fire and predators are also habitat critical to the survival of the species.

The environmental assessment considers the Sharp-tailed Sandpiper as a migratory species only and does not acknowledge that this species was listed as Vulnerable under the EPBC Act in January 2024. As it is likely to occur in the study area (Table 4), it also requires an SIC assessment to be undertaken.

SIC assessments conducted for EPBC-listed bird species Gouldian Finch, Painted Honeyeater and Grey Falcon concluded that there were no significant impacts on these species as they have not been (opportunistically) recorded within the study area since 2021. These species require targeted surveys to be undertaken as outlined in *Survey guidelines for Australia's threatened birds* (Commonwealth of Australia 2010) in order to confirm their likelihood of occurrence within the project area.[6] Another EPBC-listed species, the Northern shrike-tit, that has moderate potential to occur in the study area, requires targeted survey using the *Survey*

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[2] EMP IMP3-4 Carpentaria 1 program, Appendices, 2021. https://depws.nt.gov.au/__data/assets/pdf_file/0009/977355/emp-imp-3-4-imperial-o-and-g-2021-carpentaria-1-program-appendices-01.02-to-05.pdf

[3] EMP IMP4-3 Appendices 1-4 https://depws.nt.gov.au/__data/assets/pdf_file/0003/1048134/emp-imp4-3-appendices-01-to-04.pdf

[4] Department of Sustainability Environment Water Population and Communities, 2011. "Survey guidelines for Australia's threatened reptiles" https://www.dcceew.gov.au/sites/default/files/documents/survey-guidelines-reptiles.pdf

[5] DCCEEW 2023. "Conservation Advice for *Tiliqua scincoides intermedia* (northern blue-tongue skink)" https://environment.gov.au/biodiversity/threatened/species/pubs/89838-conservation-advice-21122023.pdf

[6] Department of Environment Water, Heritage and the Arts, 2010. "Survey Guidelines for Australia's Threatened Birds" https://www.dcceew.gov.au/sites/default/files/documents/survey-guidelines-birds-april-2017.pdf

protocol for the Northern Shrike-tit (Ward et al. 2019).[7]

The fact that 21 plant species previously recorded within the study area (2) or with high (11) or moderate (8) potential to occur are classified as either Near Threatened or Data Deficient, demonstrates that the NT listing process is deficient and cannot be relied upon to accurately quantify or assess ecological values. However, as all of these plants are considered to be significant species under the *TPWC Act* (p 6), they should have been subject to targeted surveys according to the *Northern Territory guidelines for targeted surveys of threatened and significant plant species* (DEPWS 2020).[8] There is a significant risk that some or all of them will be unknowingly impacted by the proposed activities.

The report does not describe or map any significant or sensitive vegetation within the study area although it does highlight that the ephemeral waterway and riparian vegetation associated with Relief Creek provides "significantly higher fauna diversity than surrounding areas." Hollow-bearing trees and ephemeral soaks were identified as potential constraints to development which would be avoided. No details or mapping are provided to demonstrate how significant or sensitive vegetation will be avoided or how closely these areas will be encroached by infrastructure.

The use of opportunistic observations and unreliable databases to determine the presence of threatened flora and fauna species when widely used targeted survey methods are readily available is unacceptable. There is a significant risk that the proposed development will lead to unacceptable cumulative loss of biodiversity in the short-, medium- and long-term because ecological values, including threatened flora and fauna species, have not been adequately surveyed, described or mapped.

Inadequate SREBA surveys

The environmental assessment fails to satisfy Clause 2(c) of Schedule 1 of the PER as it does not describe "*details of any uncertainties or lack of understanding in relation to that environment*." It does not describe any limitations associated with survey methods used or deficiencies in the databases upon which the assessment relied. The biodiversity studies in the SREBA represent a preliminary and incomplete assessment of the conservation values of the Beetaloo Basin. The paucity of ecological data collected in the NT prior to 2018 was noted in the Pepper Inquiry report and in the SREBA and surveys undertaken to date only scratch the surface. Significant additional work is required in order to deliver a confident assessment of the impact of any specific gas development in the Beetaloo Basin, and certainly for this application. There is therefore still considerable uncertainty around the species/communities present, their distributions, their conservation status and their reservation status.

Justice Pepper estimated that, for the Beetaloo Basin, assessment of terrestrial and aquatic biodiversity would take in the order of three to five years to undertake. However, SREBA

[7] Ward et al. 2019. Survey protocol for the Northern Shrike-tit (*Falnunculus frontatus whitei*) https://nt.gov.au/__data/assets/pdf_file/0006/678390/northern-shrike-tit-survey-protocol-2009.pdf

[8] https://depws.nt.gov.au/__data/assets/pdf_file/0008/1294658/northern-territory-survey-guidelines.pdf

surveys were undertaken between June 2020 and May 2022 and included only two wet seasons. They were plagued with limitations including:

- Covid restricted access to some survey sites to a single visit, making seasonal comparisons impossible;
- Fauna surveys were restricted to a single four-night stay and six weeks of camera trapping (five cameras deployed) at each site;
- The survey period included poor wet seasons with no opportunities to extend time frames to include the good wet season of 2022/23;
- Migratory bird surveys were not undertaken;
- Only a limited range of fauna groups was surveyed;
- Aquatic field work was restricted to single visits during two dry seasons.

The SREBA guidelines noted that established sampling methods should be applied that:

- provide sufficiently high detection probability for robust analysis of geographic patterns and detection of change in community composition over time, and
- must not have access or resource constraints (cost, personnel or time) that prevent them from being effectively applied over a large number of sites within the scope of a SREBA.

However, this was not the case for the SREBA, where access constraints associated with Covid restrictions did not result in extended timelines, but instead, ended surveys prematurely, thereby missing important seasonal variation and preventing survey replication. The high number of new species records and apparent range extensions found in the SREBA indicate the lack of previous survey work and systematic monitoring. Of the three targeted threatened species considered in the SREBA, the Northern Shrike-tit was recorded at 37 new sites, Gouldian Finch was detected at 52 new sites and the Yellow Spotted Monitor at 22 new sites. As habitat for these species has been identified in the Carpentaria study area, it is apparent that targeted surveys provide the best opportunity to detect threatened species, augment existing databases and to minimise the risk of significant impacts. The EMP should not rely on SREBA survey data or existing databases and must undertake targeted surveys in order to reduce risks to biodiversity, and particularly threatened species, to as low as reasonably practicable or to a level that is acceptable.

Missing impact assessment

The environmental assessment does not satisfy Clause 3(1)(a)(b) of Schedule 1 of the PER. It does not provide any details regarding the potential direct, indirect and/or cumulative impacts of the proposed activities on threatened species or their habitat. It does not describe any processes used to assess impacts but simply states repeatedly that there will be no environmental impacts. The report does not quantify the total amount of vegetation to be cleared or estimate the area of each vegetation community/habitat type to be removed or how that might impact flora or fauna species. It does not quantify or qualify the habitat loss for those species that have been recorded or that are highly or moderately likely to occur in the

study area. It does not describe or assess potential indirect impacts associated with alterations to groundwater and surface water, habitat fragmentation, road mortality, changed fire regimes, predation or increased noise and lighting.

The report states that "production facility areas" have been sited in order to avoid waterways and drainage lines and that well pads have been moved to avoid ephemeral areas and large landscape trees with "significant" hollows, but this has not been demonstrated. Significant hollows have not been defined. Even if sensitive or significant habitats have been avoided, there is still the risk of significant indirect impacts if infrastructure is located in adjacent areas or affected areas.

Habitat fragmentation is dismissed as an impact risk by repeating throughout the environmental assessment that it will not occur. However the proposed linear development, with its associated pipelines and access roads, will by its very nature fragment what presently appears to be a relatively intact environment. Its intactness is supported by the fact that it is relatively weed-free with only one weed species being detected in October 2023. The species most at risk from fragmentation are sedentary ground-dwelling birds and small mammals such as the Spectacled hare-wallaby, which will be more exposed to the risk of predation. Predation by introduced cats, dogs and foxes has been implicated in the extinction of 16 species of small mammals in the NT. The EMP offers no mitigation measures to control this major threat to NT ground-dwelling fauna.

The EMP has not demonstrated that nationally threatened species will not be significantly impacted nor even confirmed the presence or absence of threatened species. The risk to threatened species has therefore not been reduced to as low as reasonably practicable or to a level that is acceptable.

Cumulative impacts

The environmental assessment does not satisfy Clause 2(b) of Schedule 1 of the PER because it does not consider the incremental loss of vegetation communities/habitat types with respect to their conservation status in reserves or in the face of ongoing development.

Section 3.10 of the main EMP report estimates the total amount of vegetation to be cleared for EP187 and EPs within a 50-km radius to be 969.6 ha. As with all the EMPs prepared to date, the Carpentaria EMP seeks to minimise the amount of clearing by presenting it as 0.01% of the 9,419,700 ha "cumulative study area." This percentage is meaningless in an ecological sense and is highly misleading. It is based on the assumption that all habitats are equally suitable for all species and ignores the fact that these areas will be subject to ongoing clearing for future gas development and other activities given the very poor reservation status in the NT.

From an ecological perspective, cumulative impact assessment needs to take into consideration the conservation status of vegetation communities, which is extremely poor in the NT. Less than

1% of the Sturt Bioregion is protected in reserves (Woinarski et al. 2014).[9] Many of the broad vegetation groups within the Sturt Plateau are poorly represented in conservation reserves including eucalypt forest and woodlands with tussock understorey (0.09%), eucalypt low woodland with tussock grass understorey (0.02%), and Acacia woodland including Mulga (0.48%) (Baker et al. 1995).[10] Of even more concern are the groups that are not reserved at all, including eucalypt woodland with hummock grass understorey, mixed species low open woodland, hummock grassland, tussock grassland and chenopod shrublands.

It is apparent from the EMPs that have been approved or are undergoing assessment that they are impacting particular threatened species disproportionately, including, but not limited to, Gouldian finch, Northern shrike-tit, Yellow-spotted monitor, Painted honeyeater and Spectacled hare-wallaby. The latter species was found to be closely associated with the Lancewood-Bullwaddy vegetation community in Tamboran's ecological assessment of EPs 98 and 117[11] and several individuals were observed in a Lancewood-dominated community in EP 187. This species is listed as Near Threatened and is declining in the NT and is a Critical Weight Range mammal most vulnerable to predation by introduced predators. It is also rare in the Kimberley and Pilbara regions Western Australia and was recommended for listing as Vulnerable in the NT by Ingleby in 1991.[12] Nine species of hare-wallabies are listed on the EPBC Act, demonstrating that this fauna group is particularly susceptible to population decline and range contractions. The primary threats identified for the closely related Barrow Island Spectacled hare-wallaby (*Lagorchestes conspicillatus conspicillatus*) are identified as habitat degradation from commercial infrastructure development and predation by cats and foxes.[13] The Spectacled hare-wallaby is likely to be at high risk of extinction from the cumulative impacts of gas development in the Beetaloo Basin, but is routinely dismissed from consideration as it is not currently listed as threatened in the NT. A conservative approach is therefore recommended when assessing impacts on this species.

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[9] Woinarski J., Traill B. & Booth C. (2014). The modern outback: Nature, people and the future of remote Australia. Report prepared as part of the 'Outback Papers' & co-ordinated by The Pew Charitable Trusts.

[10] Baker B., Price O., Woinarski J., Gold S., Connors G., Fisher A. & C. Hempel (2005). *Northern Territory Bioregions – assessment of key biodiversity values and threats.* Report prepared to accompany the Northern Territory Parks & Conservation Masterplan.

[11] These documents are no longer publicly available as this EMP is still under assessment

[12] Ingleby S (1991). Distribution and status of the spectacled hare-wallaby *Lagorchestes conspicillatus*. *Wildl. Res.* 18(5): 501-519.
https://www.publish.csiro.au/wr/WR9910501

[13] Commonwealth of Australia 2008. Approved Conservation Advice for *Lagorchestes conspicillatus conspicillatus* (Spectacled Hare-wallaby (Barrow Island) https://www.environment.gov.au/biodiversity/threatened/species/pubs/66661-conservation-advice.pdf

REVIEW OF THE HYDROGEOLOGICAL AND HYDROLOGICAL IMPACT ASSESSMENT IN THE ENVIRONMENTAL MANAGEMENT PLAN FOR THE CARPENTARIA PILOT PROJECT

PREPARED FOR | Environmental Defenders Office

PREPARED BY | Hydro Geo Enviro Pty Ltd

ABN | 92 624 961 360

CONTACT | Dr Ryan Vogwill, Director

TELEPHONE | M: +61 427 427 269

EMAIL | ryanv@hydrogeoenviro.com.au

DATE | 18/04/2024

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Contents

Introduction

The Carpentaria Pilot Project (CPP) is an unconventional shale gas project located in the Barkly region of the Northern Territory, 640km south-east of Darwin. The area is located within the Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust. The project's environmental outcomes in relation to water are to have no significant impacts on groundwater or surface water quality or quantity (as stated in the EMP on page 15).

The CCP area is located on the divide between the Limmen Bight River and Macarthur River catchments, several streams transect the project area. The Cambrian Limestone Aquifer (CLA) is the recognised aquifer system in the CPP Area for water supply. It is comprised of near flat-lying layers of mainly carbonate rocks with an estimated age of 500-510 million years. It comprises two main layers: an upper siltstone-dominated layer (Anthony Lagoon) and a lower limestone/dolostone-dominated layer (Gum Ridge). The groundwater source in the CPP Area is the Gum Ridge Formation (GRF) aquifer which occurs as a vast vuggy limestone aquifer, which can often be cavernous. Up to nine groundwater production bores are planned for construction during the project.

As part of this the following documents have been reviewed in detail with a focus on impacts to surface water and groundwater dependant environmental receptors:

- Environmental Management Plan Carpentaria Pilot Project March 2024 – Imperial Oil and Gas EP187 and
- Appendix 1 – Environmental Assessment Report December 2023 (Environmental Management Plan Carpentaria Pilot Project)

Other references have been reviewed when identified as relevant but not comprehensively.

Initially some background context is provided on the mechanisms by which environmental impacts occur in hydraulic stimulation projects. This is followed by an overall review summary, answers to questions posed by the EDO as part of the expert brief followed by a point by point review of key documents. Note that all page numbers referred to herein are the PDF file's page numbers, not the EMP and appendices page numbering.

The questions posed as part of this expert brief are included below in the relevant section. We have read and agree to be bound by the Expert Code of Conduct. The Environmental Defenders Office briefed us on behalf of the Lock the Gate Alliance.

Hydraulic Stimulation Environmental Impacts - Context and Background

According to the United States Environmental Protection Agency (US EPA 2016), there are five stages to a hydraulic stimulation project and the potential areas of impact to groundwater and surface waters are highlighted:

1. Water Acquisition - the withdrawal of groundwater or surface water to make hydraulic fracturing fluids. Groundwater and surface water resources that provide water for hydraulic fracturing fluids can also support groundwater dependant ecosystems. This is a key issue in arid areas and areas of limited water resources.

2. Chemical Mixing - the mixing of a base fluid to create hydraulic fracturing fluids. Spills of additives and hydraulic fracturing fluids can result in large volumes or high concentrations of chemicals reaching groundwater potentially impacting groundwater and surface water, with the potential to also impact dependant ecosystems where a pathway from source to receptor is present.

3. Well Injection - the injection and movement of hydraulic fracturing fluids through the production well and in the targeted rock formation. Belowground pathways, including the production well itself

if there is an integrity breach, natural fractures (faults etc) and newly-created fractures, can allow hydraulic fracturing fluids, other fluids and gases to reach underground drinking water resources. Given groundwater can also support surface water resources (Winter et al. 1998) this can potentially impact on surface and groundwater resources and dependant ecosystems (Entrekin et al. 2015).

4. Produced Water Handling - the onsite collection and handling of water that returns to the surface after hydraulic fracturing and the transportation of that water for disposal or reuse. Spills of produced water can impact groundwater and surface water.

5. Wastewater Disposal and/or Reuse - the disposal and reuse of hydraulic fracturing wastewater. Disposal practices (such as in unlined or poorly lined pits) can release inadequately treated or untreated hydraulic fracturing wastewater to groundwater and surface water resources, agricultural water quality and subsequently the wider environment.

With regards to shallow groundwater or environmental impact from deep target formation and shallow aquifer connectivity, Reagan et al. (2015) identified five plausible failure scenarios which are:

(1) Extensive vertical fracturing of the formations bounding the reservoir because of inadequate design or implementation of the hydraulic stimulation operation, with the resulting fractures reaching shallow aquifers or even permeable formations connected to these formations.

(2) Sealed/dormant fractures and faults that can be reactivated by the hydraulic stimulation creating pathways for upward migration of gas, hydrocarbons and other contaminants.

(3) Induced fractures/faults that reach groundwater resources after intercepting conventional hydrocarbon reservoirs, which may create an additional pollutant source.

(4) Hydraulic stimulation creates fractures that intercept older, abandoned unplugged wells (or wells with integrity failure) in their vicinity. This can be caused by lack of information about the location and installation specifics of the abandoned wells, or because of inadequate design or implementation of the stimulation operation resulting in excessively long fractures. These aging wells can intersect and communicate with freshwater aquifers, and inadequate or failing completions/cement can create pathways for contaminants to reach the potable groundwater resources.

(5) Failure of the well completion during stimulation because of inadequate/inappropriate design, installation and/or weak cement. In this case, the well itself is the weak link, and it either includes open voids, or is fractured during the stimulation process, or both. Thus, improper cementing and well completion can result in continuous, high-permeability pathways connecting the reservoir with the shallow aquifer, through which contaminants can be discharged towards the surface. Note that the overlying formations may or may not be fractured in this case.

The likelihood of these impact scenarios manifesting will vary on a site by site and case by case basis but Reagan et al. (2015) conclude they are all possible.

Overall Review Summary

Currently the EMP is generic and lacking specifics on the risk to the area's groundwater dependant ecosystems (GDE) and inflow dependant ecosystems (IDE). Once the hydrogeology and surface water hydrology (including environmental features and pathways for contamination) have been rigorously documented then risks can be assessed including determining appropriate responses to

worst case scenarios. The main knowledge gaps and impact assessment shortcomings which are needed to understand the risks to groundwater and surface water (including the environment) are discussed by subject area below:

1. Shallow Aquifer Mapping - Any shallow 'surface' aquifers in the project area have not been discussed. The identification of GDEs in the project area means there must be a water source shallower than the Cambrian Limestone. This water source may not be productive from a water supply context and may not 'produce' water during drilling operations but vegetation will be accessing a shallower system than the Cambrian Limestone which occurs at approximately 60mbgl. The Anthony Lagoon Formation and the Gum Ridge Formation of the Cambrian Limestone aquifer appear to be hydraulically connected (ELA, 2022).

   > *"a conservative and precautionary conceptualisation is recommended, and it should be assumed that there is a high degree of connectivity throughout the CLA and its sub-units. This is especially the case given its karstic nature and potential to be highly connected."* ELA (2022).

   A major knowledge gap is the surficial hydrogeological units that overlie the CLA and how they are hydraulically connected. Water table and potentiometric surface maps need to be developed for all aquifers. Essentially, will water abstraction from the CLA affect water levels or quality in overlying aquifers closer to the surface which could impact on GDE's?

2. Groundwater Abstraction Drawdown – Following on from above the groundwater drawdown impacts on environmental receptors as a result of groundwater abstraction have not been addressed. Groundwater resources that provide water for hydraulic fracturing fluids can also support groundwater dependant ecosystems. This is a key issue in arid areas and areas where there are prolonged periods without rainfall, as at the project site.

3. Geological Structures and Hydrogeological Pathways - Hydraulic fracturing can impact aquifers by activating fracture pathways for groundwater/hydraulic stimulation fluids to propagate. Permeable underground pathways, including the production well itself (if there is loss of well integrity or a poor well seal), natural fractures (faults etc) and newly-created fractures, can all allow hydraulic fracturing fluids, other fluids (such as saline groundwater) and gases to reach underground drinking water resources. Structural geological controls, particularly those that might be reactivated are unclear and need to be mapped.

   There also needs to be mapping of the water table and other potentiometric surfaces for the aquifers to be drilled/hydraulically stimulated to allow for correct siting of monitoring bores upgradient (for background levels) and downgradient (to detect leakage).

   > *"the faulting that is responsible for the orientation of surface drainage as well as the springs at Hot Spring Valley (not part of the CLA) is likely to be deep-rooted and may provide a connection between the Beetaloo Sub-basin to the surface."* ELA (2022).

4. Well Integrity – The integrity of the wells annular seals are of particular importance in this setting. The CLA is described as vast vuggy limestone aquifer, which can often be cavernous. This type of geology provides difficult conditions for drilling, cementing and installing annular seals, heightening well completion and failure risk.

5. Chemical Spills - During operation high volumes of hydraulic fracturing flowback fluid and wastewater will be transferred between the well pads and water handling system using

buried high-density polyethylene flowlines (up to 60km of flowlines). Flowlines will also be used to transfer water to well pads for use as make-up water for hydraulic fracturing operations. Spills of additives and hydraulic fracturing fluids can result in large volumes or high concentrations of chemicals reaching groundwater and/or surface water, with the potential to also impact dependant ecosystems. Disposal practices (such as in unlined or poorly lined pits) can release inadequately treated or untreated hydraulic fracturing wastewater to groundwater and surface water resources and subsequently the wider environment. The susceptibility of the area to bushfires and flooding means chemicals need to be handled accordingly but the location of environmental receptors (including but not limited to IDEs and GDEs) has not been definitively assessed.

6. Environmental Receptors for Surface Water and Shallow Groundwater Contamination - These have not been adequately identified. Maps showing the location IDEs and GDEs need to be presented. This should be backed up by an assessment of groundwater travel times to the closest downgradient GDE receptors. IDEs and GDEs are shown on the Bureau of Meteorology GDE Atlas but should be refined with local scale analysis which should include remote sensing to identify areas of high plant water use, such as normalized difference vegetation index (NDVI) or Normalized Difference Water Index (NDWI), to help identify these areas. Water table mapping (see point 1 above) will also help identify areas of shallow groundwater. Water Observations from Space data could also help identify IDEs and GDEs, it is out of scope for this to be completed as part of this review but a scan of these data on Geoscience Australia's National Map web portal indicates a number of surface water features that are inundated 20% of the time are present with some features inundated 50% of the time. These type of hydrological features (wetlands) are relatively common in the braided fluvial system that runs through the middle of the project area, in particular Relief Creek and its immediate tributaries. Examples of these features are provided in Figure 1 noting this is not an exhaustive assessment. Currently risk to the environment are only explored in a generic sense, but need to be addressed for individual features in the context of both surface water and groundwater. The NT Government's strategic regional environmental and baseline assessment' (or SREBA) for this area (ELA, 2022) provides a good high-level regional assessment of the hydrology and hydrogeology but this project needs to develop the local scale equivalent, i.e. with greater detail.

7. Stygofauna or Troglofauna - There is no mention of stygofauna or troglofauna. The CLA is likely suitable habitat for these species and they could be impacted.

   > *"The common occurrence of stygofauna across the region and between different sub-units also supports the conceptualisation of a high degree of connectivity of the CLA system." ELA (2022).*

8. Flood risk - The risk of flooding causing the sites of above ground activities (including pipelines) to be compromised needs to be more holistically and robustly assessed. The predicted extent of flooding has been provided but insufficient detail on the modelling is presented (Figure 4.9 in main EMP referral page 198). No assessment of water velocities (that can cause erosion which could compromise ponds and other surface infrastructure) has been provided. A sensitivity analysis for this modelling is required to assess its applicability. The digital elevation model used in the flood modelling appears to be from the Shuttle Radar Topography Mission which is known to have accuracy issues at a local scale. A local scale Light Detection and Ranging (LiDAR) dataset should be used in areas where flooding could interact with all of the surface activities and infrastructure.

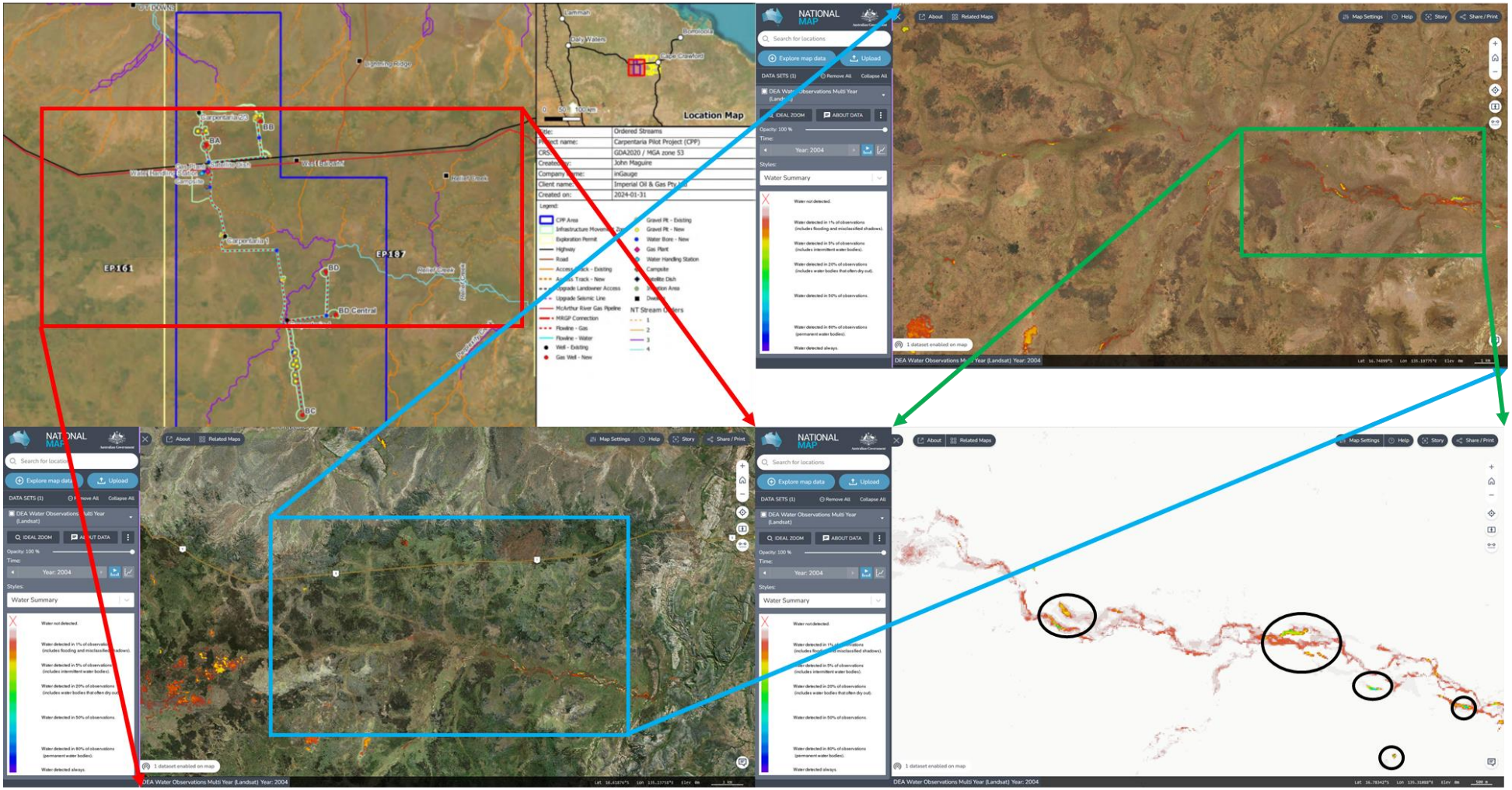

Figure 1 - Examples of surface water features identified using the Water Observations from Space data. Top left image is 4.9-2 from the EMP page 194. Other panels show approximate areas of progressive magnification. The black circles in the bottom right show examples of relatively persistent surface water features.

Answers to Questions Posed in the Brief

a. Describe the sensitivity and quality of the groundwater, surface water and soil resources that may be potentially impacted by the Project.

Answer - The area has abundant sensitive groundwater resources that could be impacted by this project. The CLA and the shallow (unnamed) aquifers are of greatest concern from surface activities, well failure and shallow deep connectivity due to hydraulic stimulation. Although not an area of extensive surface water resources per se there are ephemeral creeks (including persistent but ephemeral pools) that become active after heavy rainfall and are likely important sites hoisting biological and cultural values. These areas will be sensitive to contamination but the risks are currently unclear (discussed more below). Any area of soil that receives contamination (via either surface or groundwater processes) could be negatively impacted but this is area is not seen as having high value agricultural soils. The natural environment will however be sensitive to soil contamination from spills or leakage. This risk is greatest near the well pads.

b. Whether, in your opinion, the EMP provides an adequate assessment of the environmental impacts and/or environmental risks of the Project to:

i. groundwater;
ii. surface water; and
iii. soil.

Answer - No the EMP is predominantly generic regarding environmental impacts and needs considerable expansion as detailed herein. A lack of impact potential needs to be demonstrated, not merely assumed with a generic risk assessment.

c. If applicable, describe any environmental impacts and/or environmental risks of the Project, which are not addressed in the EMP, to:

i. groundwater;
ii. surface water; and
iii. soil.

Answer - This is unclear as the EMP is too generic and lacking specifics on the area's GDE and IDE features. Once the hydrogeology and surface water hydrology (including environmental features and pathways for contamination) have been rigorously documented then risks can be assessed including determining the response to worst case scenarios.

d. Whether, in your opinion, any mitigation measures proposed in the EMP in relation to the environmental impacts and/or environmental risks of the Project to groundwater, surface water, and/or soil are adequate. If not, please describe what other or further mitigation measures you consider necessary.

Answer - Similar to the answer to question (c) above, this is unclear as the EMP is generic and lacking specifics on the area's GDE and IDE features. Until the hydrogeology and surface water hydrology (including environmental features and pathways for contamination) have been rigorously documented and impacts assessed (including worst case scenarios, such as well integrity failure) determining mitigation measures is premature. Further mitigation measures will be required but they cannot be determined until the EMP is substantially revised.

Specific Document Review

Environmental Management Plan - March 2024

Itemised Comments

Page 3 – "… Such work includes 388 km of 2D seismic acquisition, the drilling of four petroleum wells (two horizontal and two vertical), and the hydraulic fracturing (HF) of three of those wells."

> Comment – What monitoring was done on these previous wells in regard to groundwater, hydraulic fracturing fluid migration, well integrity and structural controls? There should be data that could be incorporated into the next stage of the project.

Page 6 – "Multiple wells may be drilled off each well pad. The well's true vertical depth (TVD) to the target shale is approximately 1,600 m; the lateral length of the horizontal section can reach up to 5 km, although are typically 3 km."

And

Figure 3.4 -3

> Comment – Since the development and reduced cost of horizontal drilling techniques lower well densities are more typical, with multiple wells starting from the same drilling site or pad, as is planned at CCP. Although this reduces pad and well density in the landscape, this potentially puts greater pressure on the sites in terms of likelihood of impact due to the increased failure potential in the vertical portion of the well hole. This increased well density increases the risk of impact as greater numbers of wells are present to potentially fail and requires increased industrial activity (vehicle movement, spills, pipelines etc) during construction and operation of these well fields. This increases the potential spatial scale and magnitude of impact when compared to conventional oil/gas wells. Can wells on the same well pad be hydraulically fractured safely simultaneously or does this increases risk of well integrity failure? The extent of these drilling and hydraulic stimulation operations needs to be combined with an understanding of the structural geology of the area.

Page 11 – Table 3: "The CPP Area is located within the Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust (NT Portion 5706). There are no settlements within the CPP Area. The closest dwelling is West Balbarini, which is 1.3 km east of the CPP Area."

> Comment – Are there any other environmental features which are of importance to the First Nations people? Creek lines and rivers on either side of the project support numerous GDEs. Impacts to groundwater and surface will likely impact cultural values and the social surrounds of the native people. Stakeholder engagement is well documented but have the direct and indirect effects of the project (e.g. groundwater drawdown affecting riparian vegetation or permanently drying ephermal/permanent pools) been communicated and investigated?

Page 14 – "Based on an assessment including the persistent, bioaccumulative, and toxic (PBT) nature of the chemicals, a hazard quotient (HQ) of less than one was determined for all considered chemicals. On this basis, no further management controls are deemed necessary…."

And

"… This risk assessment is conducted using a quantitative evaluation of the risks based on the potential complete exposure pathways…"

Comment – Hazard quotients are designed for quantifying risks to human health. The risks to ecosystems and the ecological toxicity to the environment also need to be considered. For example, copper sulphate can be highly toxic to aquatic species and can bioaccumulate in the food chain. Given the potential adverse effects of some of these Tier 2 chemicals on surface and groundwater the risk assessment, quantitative evaluation and potential complete exposure pathways should be scrutinised further.

Page 85 – "The new location for BD still appears to be within the modelled flood zone, but the ground assessment (as per above points) verified that the modelling in this location is not reflective of the site conditions."

Comment – This raises questions about the modelled flood zone and the accuracy of this modelling. How accurate is the digital elevation model etc? During ground-truthing assessments were on ground conditions typically inline with the model or not? What is the model's sensitivity/uncertainty for flooding predictions?

Figure 3.3-6 to 3.3-10

Comment – This flood modelling needs further exploration. Map 4 of this series has significant flooding (0.5-1m) on the BD well pad. All other maps have flooding mapped adjacent to pads (within 500m). Flooding controls and shutdown/evacuation procedures will need to be well planned to avoid adverse environmental and infrastructure incidents. Some questions that need more exploration are: Can operations be paused? If hydraulic fracturing has begun, can it be shut down during the process if a natural disaster occurs? Can flowlines (pipelines) be flooded safely and not exposed/compromised? Is there telemetry data to check underground flowlines pressure data to detect leaks while offsite. If a major leak is detected during a flood, how will this be dealt with?

Also, by mid-century extreme rain events in the Northern Territory are projected to become more intense and recent trends show increased rainfall between December to February (Climate Change in Australia 2024 - https://www.climatechangeinaustralia.gov.au/en/changing-climate/state-climate-statements/northern-territory/). Have these climate change trends been accounted for in current flood modelling? Insufficient detail on flood modelling is presented to evaluate how robust it is.

Figure 3.3-16 to 3.3-20

Comment – SREBA Type 2 and Type 3 GDE's are mapped within a 1km radius of several water bores and streams. These are also potential receptors for shallow contamination. The effects of groundwater abstraction on these ecosystems requires better evaluation. Groundwater drawdown contours, aquifer testing, hydrostratigraphy and groundwater modelling (that has been calibrated and undergone a sensitivity analysis) are needed.

Page 122 – "Hydraulic fracturing…. typically involves injecting a viscous slurry of water and sand under high pressure into a target formation via the well. This process is intended to create new fractures in the rock and increase the size, extent, and connectivity of existing natural fractures."

Comment – Creating new fractures and increasing the size, extent and connectivity of the natural fractures has large implications for groundwater flow and conduits underground. A high-level understanding of these structural connections and controls needs to be obtained to enable a robust risk assessment to be undertaken. Flow pathways can be created during

fracturing and can lead to contamination of aquifers with fracturing fluid or other contaminants e.g. deep saline groundwater mixing with fresh groundwater. These shallow deep connectivity issues are essentially not explored in this EMP.

Page 123 – "Groundwater monitoring at each existing well pad has been conducted in accordance with relevant regulations since 2019 (see Section 4.10). There has been no detectable change in groundwater quality or the level of the Gum Ridge Aquifer on EP 187 at any of the groundwater bore monitoring bores since operations began in 2019. The Gum Ridge Aquifer is part of the larger Cambrian Limestone Aquifer."

Comment – The groundwater monitoring network is not sufficient. A network of nested piezometers or a set of monitoring bores (targeting different aquifer units at each site) should be established. Connections between the formations above and below the CLA need to be better established. A hydrograph of groundwater levels at each current monitoring site would be a helpful inclusion.

Page 124 – "…a sub-surface aquifer protection zone sits below the CLA aquifer basement at the CPP Area and the target Velkerri formation. This aquifer protection zone comprises rock greater than 900 m thick, which is 150% of the Code's protection zone requirement of 600 m [clause B.4.13.2 (l)]. This protection zone ensures there is no potential for a connection between the much deeper shale hydraulic fracture operation and the base of the overlying CLA aquifer."

Comment – What geological unit/s make up this protection zone? Figure 3.5-1 shows a basic geological cross-section, little information about these geological units is provided. In relation to this review structural features are very relevant e.g. faults or fractures that could create flow pathways during hydraulic fracturing. More information about this protection zone is required and it should be noted that a connection between the deeper shale and the CLA aquifer could also be created by a well that leaks due to a failure of well integrity or poor construction. The cavernous and vuggy nature of the CLA magnifies these risks as aquifer hydraulic conductivities will be relatively high for this unit and cementing operations will be challenging, especially obtaining an annular seal across the CLA.

Page 134 – "Assessment of HF chemicals that may be used downhole during the activity did not identify any Persistent-Bio-accumulative-Toxic (PBT) chemicals in terms of measured PBT criteria that may pose a risk to human health. In addition, the concentration of CoPC in the HF fluid system is extremely low (mg/L or ppm) and any potential toxicity effects to local fauna are therefore negligible."

Comment – The PBT criteria has been used in relation to human health risks. Even though chemicals of potential concern are extremely low in concentration this does not necessarily mean effects on fauna are negligible. If large quantities of fluid end up in surface water or groundwater systems this could equate to a toxic amount, particularly if we consider bioaccumulation effects and long-term timeframes.

Page 135 – "The GRF occurs as a vast vuggy limestone aquifer across the Beetaloo, which can often be cavernous."

Comment – Well integrity during installation and operation in this GRF unit will need particular care. Cementing the annulus of a vuggy and cavernous units can be notoriously hard as cement runs into the porous/vugs in the formation and doesn't seal the annulus where it is placed. This has large implications for well integrity and can lead to sections of

the annulus not being sealed, potentially providing a conduit for groundwater flow. An assessment of the extent of any possible contamination from well failure or surface activities is required.

Page 136 – Figure 3.9-1 and "This maximum potential increased groundwater extraction (0.75 GL/year) by Imperial is not considered to have a significant impact on available groundwater in the GRF aquifer"

Comment – Imperial's proportion of the Georgina Groundwater Allocation is relatively small and should therefore have minimal impact on the available groundwater across the Basin. However, availability of groundwater, i.e. groundwater depths, at identified environmental receptors (e.g. GDE's) could have larger impacts near the site. Important riparian vegetation along ephermal creek lines, rooting depths, vegetation health surveys and wet and dry season water levels need to be understood so water abstraction can be undertaken responsibility. Essentially impacts at a local scale could be significant and need to be assessed.

Page 137 – Table 3.9-2

Comment – Annual potential extraction is substantially below the groundwater licence volume applied for (i.e. 750ML/a). Why is a 750ML/a licence being applied for, when the highest estimated potential groundwater extraction in a year is 414ML?

Page 138 – "a significant impediment to the recycling of HF flowback in several major shale developments in North America has been the extremely high level of chlorides in the flowback, more than ten times seawater concentrations. This project will test recycled fluids and expects to be able to extend this capability as the project develops."

Comment – It is our understanding that that four wells have already been drilled with three undergoing hydraulic fracturing. Onsite information regarding the chemical nature of the flowback fluid and subsequent potential recycling of this fluid should be available and analysed. These wells should have been monitored to assess leakage etc.

Page 174 – Figure 4.3-2

Comment – There are a lot of waterholes east of ''Carpentaria 1' along the Relief Creekline. No information is provided on these waterholes and if or which aquifer they are connected to. Are they permanent and are they groundwater dependant? See Figure 1 above.

Page 177 – "As surface water diminishes throughout the dry season, many seasonal waterholes become dry season water refuges, thus putting additional pressure on riparian vegetation…. In the prolonged absence of rain, the availability of green leaf matter is very low. Under these conditions, animal condition declines as animal growth is dependent on plant growth. In the absence of rain, herbivores attempt to survive through complex strategies"

Comment – During the dry season groundwater and these waterholes are of particular importance to native fringing flora as well as resident and transient fauna. Potential drawdown from groundwater extraction at the project needs to be quantified and modelled to allow a thorough assessment of impacts in these GDE areas along with spill and shallow contamination risks.

Page 178 – “This protection zone ensures there is no potential for a connection between the much deeper shale hydraulic fracture operation and the base of the overlying CLA aquifer.”

> Comment – The use of the word ensure here is very definitive language in the context of the impact assessment provided. Natural connections could exist. Connections could be created during fracturing within the protection zone. The fracturing process is intended to create new fractures in the target rock and increase the size, extent, and connectivity of existing natural fractures. Given this is the aim of fracturing, connections being created in the protection zone is not unlikely. Also note that no structural mapping of existing fractures and faults have been presented.

Page 198 - Figure 4.9—5 Flood Modelling Within the CPP Area, Draining to the North and South from the Crest of Favenc Range on Carpentaria Highway

> Comment - More detail on and more outputs of this flood mapping are required. What is the digital elevation model that has been used? If it is the SRTM (Shuttle Radar Topography Mission) dataset it has substantial inaccuracies and low resolution in the context of site-specific flooding assessments. The use of a high-resolution LiDAR dataset is recommended. With respect to other model parameters (surface roughness, climate scenarios etc) what was used and were any sensitivity analyses conducted to assess the uncertainty of this modelling? There also needs to be an assessment of flood water velocities in the context of all infrastructure (including pipelines) to ensure that erosion and subsequent failure (with release of contaminates) cannot occur.

Page 201 – “The Bukalara sandstone formation lies directly below the Gum Ridge formation at CPP. The formation is characterised by intergranular spaces that are mainly filled with white kaolinitic clay, but minor sections have moderately good intergranular porosity. Porosities range from poor to fair (6 to 18%), and permeability is commonly low at less than a few millidarcies (md). Bore logs indicate the strata consists of a firm to hard, white, fine to medium grained quartz sandstone. The only relatively deep water bore to intersect the Bukalara Sandstone beneath the CLA in the eastern Beetaloo region is RN041679 at the Carpentaria 1 well site, constructed by Imperial for monitoring the Bukalara at the request of DEPWS. The formation was encountered between 108 and 178 m and only yielded 0.5 L/s. The drill cuttings and gamma log indicated that the sandstone is interbedded with numerous shale beds at that site [S TICKELL, 2022B]

> Comment – The hydraulic connection of the Bukalara Sandstone and the CLA need to be quantified and the request of DEPWS to construct this monitoring bore could predominantly be for this purpose. What information has been gathered during existing monitoring and what does it imply regarding groundwater/aquifer connections?

Page 202 – ‘’Only a small number of inter-aquifer pumping tests have been undertaken to help establish the degree of connection between the Anthony Lagoon and Gum Ridge Formations”

> Comment – Water quality and water level observations from these two aquifers imply they are potentially hydraulically connected at Carpentaria 2/3. Additional aquifer tests to investigate connectivity were scheduled for 2023. Were these tests carried out? What did the results conclude?

Page 212 – ". None of the existing non-Imperial bores are within 1 km of potential well pads as required by the Code."

> Comment – Imperial owned bores within a 1km radius need to be considered also for monitoring. Hydraulic stimulation creates fractures that intercept older, abandoned unplugged wells (or wells with integrity failure) or their vicinity. These aging wells can intersect and communicate with freshwater aquifers, and inadequate or failing completions/cement can create pathways for contaminants to reach the potable groundwater resources. This needs to be considered for these risks to be managed.

Page 231 – "The water table at CPP well pads has consistently been measured to be >50m BGL, dependent on topography. Generally, where groundwater is within 20m of the land surface, some native plants may access and use groundwater"

> Comment – The CPP well pad groundwater bores have targeted the Cambrian Limestone Aquifer. Shallower or 'perched' surface aquifers and aquifers along creeklines, have not been addressed adequately regarding GDE impact assessment. These need to be assessed and groundwater levels mapped.

Page 231 - These will not be impacted as CPP site selection has complied with LCG buffer areas associated with waterways and drainage lines."

> Comment – This statement implies that because a land clearing guideline buffer has been put in place for waterways and drainage lines that no impacts will occur. This statement does not consider groundwater drawdown from operations propagating into these buffer zones or chemical spills/leaks. This needs considerably more work.

Page 256 – Table 6.2-2

> Comment – Risks #7 and #8 only mention risks to surface water, if this surface water infiltrates the surface it becomes groundwater. Groundwater should probably be included here for completeness. Also, groundwater abstraction and resulting drawdown should be included as it presents a risk to GDEs. This risk assessment is generic.

Page 287 – "Should wet season weather monitoring indicate floodwater inundation is possible, a window of opportunity exists to ensure freeboard is in place, the transfer of fluids has been completed if required and the safe shutdown of ancillary equipment has been completed."

> Comment – Does this window of opportunity provide adequate time to shutdown operations and store fluids safely? How long can fluids be stored safely if no site access occurs for a prolonged period?

Page 300 – Table 6.3 -5

> Comment – No significant groundwater drawdown that affect GDE's should be added to this groundwater environmental quality table.

Page 304 – Table 7.1 – 1

> Comment – Is there a water licence operating strategy/plan or the like? A plan to manage groundwater?

Page 332 – Table 8.2-2

> Comment – Groundwater monitoring is listed as quarterly. Groundwater level data should be collected more frequently. This will allow a more proactive approach if levels start trending down due to groundwater abstraction or start mounding due to hydraulic fracturing operations. A minimum four to six weekly frequency is recommended with preferably daily logger data at least initially.

Page 333 – Table 8.2-2

> Comment – The Rehabilitation Management Plan mentions vegetation ground cover and canopy height surveys. These should be conducted annually to assess vegetation condition temporally and spatially and be combined with vegetation density/persistence remote sensing. This table only states these surveys will be done prior to construction. Ideally these vegetation survey should measure vegetation 'health' across the area. Remote sensing is required to understand to understand where GDEs and IDEs are.

Appendix 1 – Environmental Assessment Report - December 2023

General Comments

Within the CPP project area the waterways and riparian areas offer potential habitat for a range of conservation significant species. There has been a large focus on buffer zones for clearing around creek lines and riparian areas, however other impacts such as groundwater drawdown, have not been mentioned. This needs substantial expansion as per comments herein.

Itemised Comments

Page 27 – "Provides water (in wet season) and larger pools in the dry season."

> Comment – These larger pools are likely groundwater dependant and support a higher fauna diversity than surrounding areas. Groundwater drawdown and potential for contamination in these areas needs to be managed to prevent impacts to these important riparian areas. Known permanent and ephermal pools should be monitored. The groundwater hydraulics and aquifer connectivity of these riparian areas and pools needs to be understood to enable potential impacts to be managed. Potential surface water contamination pathways also need to be assessed across a range of surface water flow events, not just for floods.

Page 27 – "These will not be impacted as the exploration will adhere to the LCG buffer areas associated with waterways and drainage lines"

> Comment – These will not be impacted by clearing but could be impacted by groundwater drawdown, hydraulic fracturing leaks and fracturing fluid or wastewater spills (either via surface water pathways or by groundwater contamination).

References

ELA, 2022, Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin: Water Quality and Quantity Baseline Summary Report. Technical Report 24/2022. Report prepared for the Northern Territory Department of Environment, Parks and Water Security by Eco Logical Australia (ELA) and Tetra Tech Coffey.

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US EPA, 2016, Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States. Executive Summary. Office of Research and Development, Washington, DC. EPA/600/R-16/236ES.

Winter T. C., Harvey J. W., Franke O. L., Alley W. M., Reston V. A., 1998, Ground Water and Surface Water A Single Resource, Circular 1139, United States Geological Survey (USGS).

Comments on groundwater risk assessment for Carpentaria Pilot Project Environmental Management Plan: Imperial Oil & Gas EP187

Professor Matthew Currell
Head of Civil & Environmental Engineering
School of Engineering & Built Environment / Australian Rivers Institute
Griffith University
Nathan, Qld 4111

15th April 2024

Summary

This proposed shale gas exploration project, involving the drilling and hydraulic fracturing of ten new gas wells and associated extraction of up to 950 GL of groundwater for drilling and fracking operations, is located in the eastern Beetaloo Basin, where it is overlain by the Cambrian Limestone Aquifer (CLA).

Key potential risks of the proposed activities include:

1. **Depletion of groundwater** through freshwater extraction from the CLA to support hydraulic fracturing of the wells, and associated impacts on groundwater dependent ecosystems (GDEs) and other water users;
2. **Contamination of soil and groundwater** through:
   - Inter-aquifer leakage of contaminating fluids (including fugitive hydrocarbon migration), through either natural features, such as faults and fractures, or through well integrity breaches;
   - Surface spills and leaks of fracking chemicals, drilling fluids, flowback water and/or hydrocarbons produced by the wells;
   - Leaching and release of contaminants from waste brines produced during treatment of flowback water and other solid wastes generated on site.
3. **Seismicity** - e.g., fault activation that occurs during fracking, triggering increased seismic activity

At present, the EMP is missing important hydrogeological data and other information required to properly analyse these risks (as described below in more detail). As such, the current risk and scientific certainty ratings summarised in Table 6.2-3 are overly optimistic in many cases, and fail to acknowledge significant uncertainties and data gaps.

My analysis – conducted under timing and resource constraints – is not fully in-depth on all of the above matters (e.g., the seismicity risk was beyond the scope of my review). Subjecting the proposal to a more robust assessment - e.g., through referring the matter to the Commonwealth Department of Climate Change, Energy the Environment and Water and IESC would be advisable, to ensure the full array of water risks is properly independently assessed and considered.

Groundwater extraction and potential depletion

The EMP outlines plans to extract approximately 950 ML of groundwater, under a 750 ML/year groundwater extraction licence. This is a considerable quantity of water, comprising approximately 10% of the total allocation set aside for Petroleum activities within the Georgina Basin, under the Georgina-Wiso Water Allocation Plan 2023 (Northern Territory Government, 2023).

Given the substantial quantities of water extraction involved, an important part of the groundwater impact assessment is to estimate the likely extent of the area affected by groundwater drawdown within the target aquifer. This is required so that any other potential water users in the area – including existing water supply bores and groundwater dependent ecosystems – can be identified, and risk(s) to these assessed. This would normally be undertaken using analytical and/or numerical modelling, to calculate and map the anticipated drawdown resulting from extracting at different rates and locations, taking into account the aquifer hydraulic properties. These hydraulic properties are broadly known for the Cambrian Limestone Aquifer (see Tickell, 2022) and depending on the level of accuracy required, they can be estimated at a site-specific scale, using appropriate aquifer testing methods (e.g., pumping tests).

In the EMP, such testing and drawdown modelling is not included. There is instead only a very general assessment of the quantity of water proposed to be extracted (up to 750 ML/year), compared against the total estimated sustainable yield for the entire Georgina Basin (Figure 3.9-1). This analysis is insufficient for a robust assessment of groundwater impact and risk. The Georgina Basin is a huge aquifer system, covering hundreds of thousands of square kilometers, of which the Petroleum Lease is only a tiny fraction. Understanding the local impacts of extraction from individual projects involving groundwater extraction in the basin requires detailed analysis of aquifer properties, water extraction scenarios and drawdown, rather than a 'whole of basin' approach that only compares extraction to basin-wide estimates of volume and/or sustainable yield.

It is plausible that extraction at the proposed rates could lead to direct impacts to groundwater levels in existing bores, reductions in flow to groundwater dependent ecosystems, and/or induced inter-aquifer leakage, which may result in water quality changes (e.g., due to contrasting salinities between the different units). These issues require careful analysis based on local bore drilling, aquifer testing, drawdown estimation and spatial analysis of water quality.

Potentially impacted receptors

There are a number of receptors that could potentially be impacted by extraction of groundwater at the rate(s) put forward in the EMP. These broadly fall into the two categories of

a) Existing bores utilised by groundwater users (e.g. pastoral stations)
b) Groundwater dependent ecosystems.

A search of the NT Government's bore database shows that there are multiple groundwater bores located within a radius of 10 to 15 km from the proposed activities (Including some within 5 km). This includes multiple bores whose purpose is listed as 'production' (i.e., water supply), mostly occurring to the north and west of the PL boundary (e.g., RN035503, RN038188, RN03189, RN040617, RN041009 and RN041273). An assessment of the potential for drawdown to spread to these locations is needed to fully assess groundwater risks from the proposal.

Springs – which are by definition groundwater dependent ecosystems, also occur to the east of the PL, just beyond the eastern edge of the Georgina Basin (Figure 1). For example, Cockatoo Spring, Little Spring and Wee-ak spring are mapped occurring approximately 25 km from the PL eastern boundary. These springs were (according to NT government metadata) identified in the 2009 Gulf water study, by U. Zaar. To assess potential impacts to springs, the extent of drawdown associated with water extraction, and the changes to water balance (including any reduction in groundwater discharge from aquifer units which may sustain springs), must be analysed. A short section of the EMP discusses possible impacts on GDEs, but this does not mention springs. This section identifies that River red gum vegetation along ephemeral waterways is likely to be a GDE, but it is concluded that such vegetation is unlikely to be impacted by the project activities, due to 'buffer areas associated with waterways and drainage lines'. As discussed above, without any assessment or estimation of the magnitude of groundwater drawdown caused by the project's groundwater extraction, it is not possible to assess the full risk to groundwater dependent vegetation (such as the Red gum communities in these drainage lines), which may be sensitive to changes in groundwater levels.

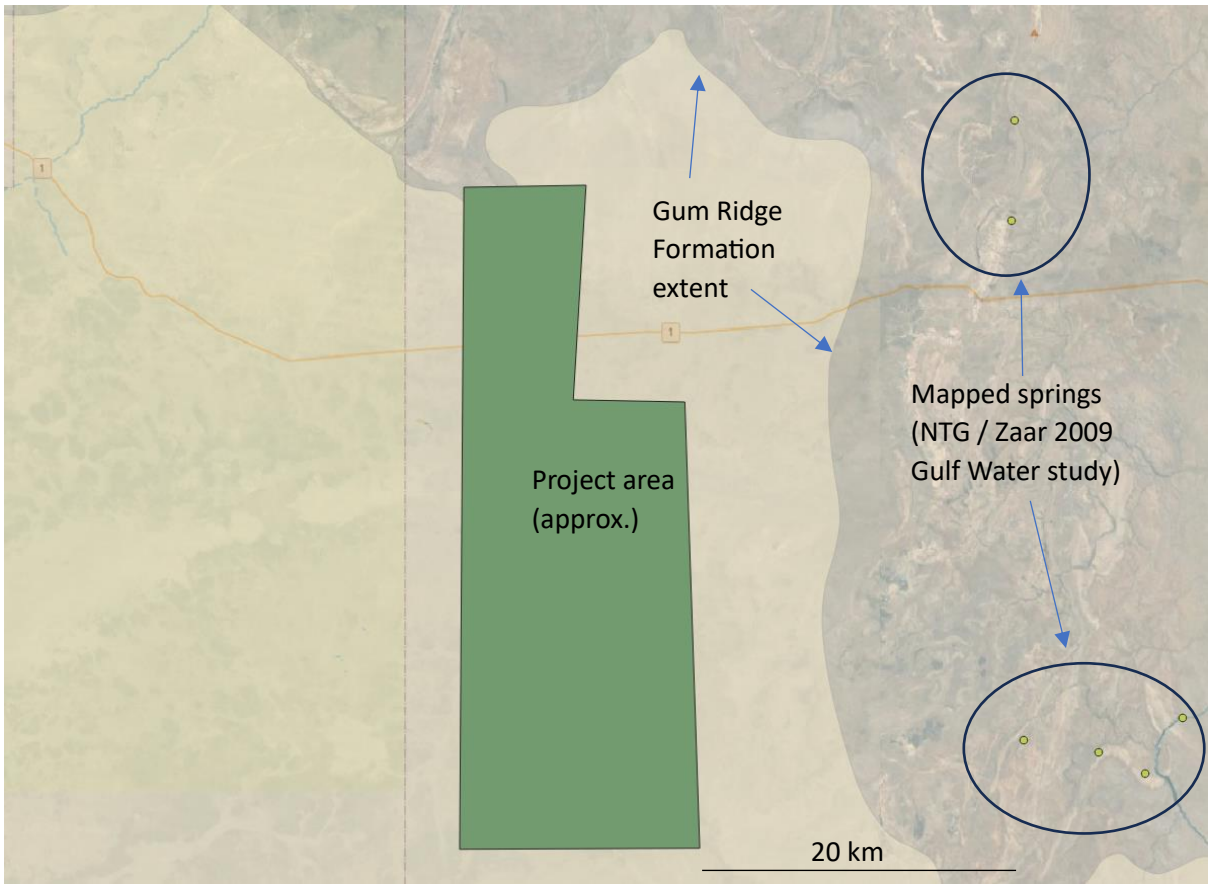

Figure 1 – approximate location of the Petroleum Lease, within which project activities are proposed, the location of mapped springs (from Northern Territory Government's ntspr 2M dataset) and the extent of the Gum Ridge Formation.

Groundwater quality

Section 4.10 of the EMP analyses groundwater chemistry data from the region and includes summarised results of groundwater quality monitoring, for a series of control/impact monitoring bores across the site. While these data are valid to some degree as a description of current groundwater quality (and could potentially serves as a baseline against which to assess any future

changes in groundwater quality relating to project activities), there are limitations in the data and their presentation, which leave ambiguity as to the spatial and temporal variability in groundwater chemistry/quality, and its main controlling processes.

While bore codes and names for the monitoring network are shown in figures (e.g. Fig 4.10-5), full bore construction details including the unit(s) monitored, bore construction type and screen interval depths are not apparent (as far as I could tell from the EMP documents). This means that attribution of the groundwater quality data to the different aquifers and areas within the PL is ambiguous, and the spatial variability in chemistry unclear. Figures 4.10-6 to 10 provide summarised box-plots of water quality parameters. These are fine as an overall summary of parameter ranges, but time-series plots are needed to show the level of variability in different parameters at each bore site over time. The above limitations mean there is limited information regarding the spatial distribution (both laterally, and with depth in different aquifer units and lithologies) and long-term variability of key water quality parameters.

Processes controlling the groundwater chemistry – e.g., evapotranspiration, water-rock interaction, and inter-aquifer leakage, and their relationship to measured water quality variables, are also not analysed in any significant detail in the report. Baseline measurements of groundwater quality must be assessed within the context of understanding of these processes to ensure robust interpretations.

Further important water quality parameters, which are critical for assessing unconventional gas impacts, are also not present in the data. Specifically, dissolved methane and other hydrocarbons, which are present within the target gas reserves and which may in future be potential contaminants of concern due to well-integrity issues, or spills and leaks of flow-back water during hydraulic fracturing are not reported – a significant gap with respect to baseline groundwater quality (e.g., Jackson et al., 2013).

Other key indicators (e.g. metals and radio-nuclides) are presented in section 4-10 only as aggregated totals (e.g. Fig. 4.10-9), meaning it isn't possible for the reader to examine or understand the distribution of individual contaminants within the aquifer system, or their degree of temporal variability through time. Overall, these limitations mean that a robust assessment of groundwater quality risks from the proposed activities is not possible.

Groundwater, soil and surface water contamination risk

Further issues which create uncertainty with respect to risk of groundwater, soil and surface contamination include:

- There is currently a relatively limited understanding of geological structures, rock properties and the biogeochemical environment in which the proposed fracking activities would take place - all of which are critical to a full assessment of well integrity risks. The EMP does not include detailed site-specific analysis of likely permeability and other rock properties of the different units, or analysis of biogeochemical conditions. As noted by Currell and Ndehedehe, 2023, there remains a general lack of understanding of inter-aquifer connectivity between the Beetaloo basin sedimentary rocks, and shallow, high-value Cambrian Limestone Aquifer throughout Beetaloo region. This is a significant issue as these properties and the level of connectivity affect the potential for hydrocarbons to migrate from the target shale resources into shallower aquifers, particularly in the event of well

integrity breaches. Davies et al., (2014) found that, according to global databases, well integrity failures occur in approximately 2 to 75% of oil and gas wells over their lifetime, meaning this risk is relevant to the activity, even if the number of wells is relatively small. Examples of where well integrity issues have led to methane contamination of high-value shallow groundwater resources in areas of shale gas development include Osborn et al., 2011; Darrah et al., 2014, Llewellyn et al., 2015 and Whyte et al., 2021.

- The likelihood of spills and leaks of fracking wastewater has likely been under-estimated. A review by Patterson et al. (2017) of tens of thousands of shale gas wells across four US states indicated that spills of potentially contaminating fluids from unconventional gas (particularly flowback water) occur at rates of between 2 and 16% of active wells per year, with the majority occurring in the first three years of a well's life. Spills are associated with equipment failure, human error and environmental conditions (e.g. extreme weather). Approximately half of spills documented by Patterson et al. were associated with storage and transport of fluids through flow-lines. While the risk assessment (Table 6.2-3) acknowledges a medium level of risk from leakage from wastewater flowlines following control measures, other risk rankings (e.g. risk of fluid or chemical spill during operation or drilling of petroleum wells) appear to be overly optimistic (i.e., under-state the true potential likelihood of incidents) in light of the global data. The use of open-topped storage tanks for hydraulic fracturing flowback fluid also appears risky, even with the proposed measures outlined in Table 6.2-3. This is in part acknowledged in the 'medium' residual risk rating for TE-17. If further changes to project design are not feasible to control the risk of soil and water contamination from uncontrolled leaks and spills of hydraulic fracturing fluids and flow-back, then the overall environmental sustainability of the proposed activities should be carefully considered.

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THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

CREATE CHANGE

18 April 2024

Emma Buckley Lennox
Solicitor
Environmental Defenders Office

Dear Emma,

Carpentaria Pilot Production EMP and EPA referral

This letter follows your request for my independent expert advice on the above matter.

I confirm that I have read the Northern Territory Supreme Court's Practice Direction No 6 of 2015: Expert Reports (PD 6) and the Code of Conduct and I agree to be bound by it.

The documents that I have referred to during preparation of this advice are (file names as provided):

- Referral form
- Referral-report-imperial-part1
- Referral-report-imperial-part2
- Referral-report-imperial-part3
- EMP-IMP5-1-reduced-redacted-resubmitted-070324
- 01-Appendix-01-Environmental-Assessment-Report(compressed)-Redacted
- 06-Appendix-Imperial-Wastewater-Management-Plan
- Code of Practice: Onshore Petroleum Activities in the Northern Territory, 31 May 2019
- EPBCA Significant Impact Guidelines 1.3

Due to the short time-frame for preparing this advice I have not been able to undertake a site visit or request supplementary information.

My advice is provided below in three parts: Summary of findings; Responses to questions raised in the Expert Brief; and Other matters.

My consideration of soil is limited only to the potential for contamination of soil from spills of wastewater (not land clearance and other activities).

Summary of findings

The surface water and soil-related risks from the proposed Carpentaria Pilot Project (CPP) are principally associated with potential accidental releases, leaks and spills of chemicals and flowback water, and potential flooding of facilities. These risks are manageable by application of good practice in planning, design and operation of the CPP. The proposed approach to design and operation of wastewater and water storages and other infrastructure is likely to be adequately conservative with respect to preventing weather-related spills. However, the reviewed EMP documents do not provide the level of information required to confidently conclude that risks are acceptably low or that an adequate assessment has been conducted.

Due to the relatively short timeframe of the proposed CPP (2025-2029), and hence the limited potential effect of climate change relative to historical variability, it is not necessary to explicitly consider climate change in assessing impacts. This may change if an extension to the CPP is proposed.

The University of Queensland
Brisbane QLD 4072 Australia
E n.mcintyre@uq.edu.au
W uq.edu.au
ABN: 63 942 912 684
CRICOS Provider 00025B
TEQSA PRV12080

The scope in the Expert Brief did not include groundwater and I have not reviewed risks to groundwater in detail; however, there are omissions from the reviewed EMP documents related to groundwater management that may be a concern.

Responses to questions raised in the Expert Brief

a) Whether, in your opinion, the EMP provides an adequate assessment of the environmental impacts and/or environmental risks of the Project to:

i. surface water; and

ii. soil.

The EMP has identified and assessed the relevant impacts that could arise through accidental releases, leaks and spills of chemicals and flowback water, including the potential sources, pathways and receptors of contaminants.

Due to time constraints, I have not examined in detail the methods or evidence relied upon for all elements of the surface water and soil risk assessments, in particular the local hydrological and soil characteristics of the project area and how they may affect pathways of contaminants. My review has focussed on the assessment of potential spills from water storage tanks and flooding of infrastructure, which I regard as the key sources of risk to surface water and soils. I cannot conclude that the assessment of these risks is adequate due to lack of information provided in the documents, specifically:

The EMP lacks a clear description and illustration of the proposed water management system. A reasonable understanding of water management system is important to understand the risks of spills from wastewater storages. The Water and Wastewater Management Plan (WWMP) should include a node-link water system diagram that describes: the type of storage (freshwater, wastewater untreated, wastewater treated, greywater, cover, uncovered, floating cover); flow rates between storages under design conditions; water sources, locations and type of treatment; and references to the relevant wet weather triggers. At present, it is too difficult for the reader to understand the flows of water and wastewater that affect storage levels, too difficult to relate terms in the reports to locations and roles of tanks (for instance “treated water storage tanks” are referred on page 18 of the WWMP but it is unclear where they are and whether they have a role in wet weather contingencies), and too difficult to follow which tanks will be covered and which will not. Without this information I cannot conclude that spill risks have been adequately assessed.

The EMP says “However, for compliance with this EMP, regulatory standards require operators employ a 0.1% Probable Maximum Precipitation (PMP) estimate over a 90-day period” (page 29 of the WWMP). The reason for using a 90-day period and how the 0.1% annual exceedance probability rainfall total has been estimated has not been presented, nor is there clarity as to whether and how the PMP has been used – contrary to what is implied in the WWMP, the PMP is not the same as the 0.1% annual exceedance probability rainfall. The reference to BOM (2023) on page 30 of the WWMP is not helpful in this regard because the rainfall estimation tools on that website do not cover 90-day periods. The estimation of design extreme rainfall is fundamental to the assessment of risks from accidental spills. Without a precise explanation of the method of estimating design extreme rainfall I cannot conclude that the assessment is adequate.

Flooding due to catchment runoff is a potentially significant environmental risk due to potential erosion of the bund and potential ingress of water into the well pad. Page 87 of the Referral Report Part 2 shows well pad “BD” to be within the predicted 100-year ARI flood; however, according to that report, on-ground inspection proved “the modelling in this location is not reflective of the site conditions”. Detailed justification is not provided. The potential for flooding of the well pads is critical to understanding potential surface water impacts of the CPP as well as understanding risks to CPP operations. Therefore, more evidence should be provided that the proposed location of well pad BD is not exposed to the 100-year ARI flood. This might consist of an extended description of why the on-ground survey concluded that the flood modelling results were inaccurate and photographs. Without further evidence, I cannot conclude that the assessment is adequate.

b) If applicable, describe any environmental impacts and/or environmental risks of the Project, which are not addressed in the EMP, to:

i. surface water; and

ii. soil.

The EMP has not omitted any environmental impacts and/or environmental risks to surface water or soils that I consider to be material.

c) Whether, in your opinion, any mitigation measures proposed in the EMP in relation to the environmental impacts and/or environmental risks of the Project to surface water and/or soil are adequate. If not, please describe what other or further mitigation measures you consider necessary.

The EMP generally proposes adequate risk mitigation measures.

An exception is that no information is provided about surface water monitoring. Water quality monitoring is normal good practice where there is a risk of contamination from project activities. Such monitoring allows the impacts of the project to be determined relative to baseline water quality, especially following a spill or accidental release of wastewater. The Referral Report Part 3 p106 includes “Baseline and ongoing seasonal surface water quality monitoring of selected perennial waterholes near CPP area will be conducted as part of monitoring overall isolation, containment, and integrity in the CPP Activity (Section 6.2 of the EMP – Environmental Performance Standards)”. However, no information about proposed locations, frequencies and water quality parameters is provided. A map showing monitoring locations plus a table listing parameters and monitoring frequencies, including a baseline period, should be included.

Page 33 of the WWMP explains the trigger action response plan for drawing down water levels in open tanks if significant rainfall is forecasted: If the Bureau of Meteorology (BOM) 7-day forecast predicts a “significant rainfall event" exceeding 300 mm over four days for the CPP Area, Imperial plans to ensure that freeboard will be maintained as follows…”. Due to the limitations of relying on rainfall forecasts, which are not always accurate, this should be supplemented by a trigger related to measured water levels.

Also, referring still to page 33 of the WWMP, it is unclear what is meant by “If no tank at the WHS has sufficient freeboard, tanks on the well pads may be used”. It is unclear what well pad tanks are being referred to and the basis for assuming that they will have capacity to store excess water. Without this information I cannot conclude that the measures for controlling excess water are adequate.

d) Whether, in your opinion, the EMP provides an adequate assessment of how climate change may affect:

i. the management of wastewater produced by the Project; or

ii. any other environmental risk or environmental impact of the Project relevant to your area of expertise.

The EMP does not provide an assessment of how climate change may affect wastewater management or environmental impacts, which is appropriate. Although climate change is expected to increase rainfall extremes (e.g. Fig 1 below from Moise et al. 2015), within the timeframe of the proposed CPP (2025-2029 as indicated on p57-58 of the EMP) these increases will be small compared to historical variability. Not adjusting for climate change over this short project period is in line with guidance in Part 1, Section 6 of the Australian Rainfall and Runoff Guide (Ball et al. 2019), which is the relevant guidance. Climate change may already be producing wetter weather in this region, as shown in Figure 10 of Heidemann et al. (2023) (not reproduced here due to copyright, but the link is provided below). However, the statistical methods employed in the EMP integrate any effects of climate change in recent decades. Instead of considering 140 years of historical rainfall at the Daly Waters Gauge (as in page 31 of the WWMP), including only the last 60 years would weight the design rainfall to more recent decades, which would more conservatively allow for historical climate change. However, general best practice is to use the full available historical record.

If a CPP project extension is proposed, climate change may need to be explicitly considered.

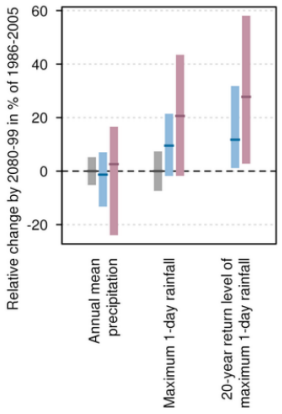

FIGURE 4.3.7: PROJECTED CHANGES IN MEAN RAINFALL, INTENSITY OF ANNUAL MAXIMUM 1-DAY RAINFALL AND INTENSITY OF THE 20-YEAR RETURN VALUE FOR THE 1-DAY RAINFALL FOR THE SOUTHERN SLOPES CLUSTER (SEE TEXT FOR DEFINITION OF VARIABLES). CHANGES ARE GIVEN IN % WITH RESPECT TO THE 1986-2005 MEAN FOR RCP4.5 (BLUE) AND RCP8.5 (PURPLE). NATURAL CLIMATE VARIABILITY IS REPRESENTED BY THE GREY BAR. BAR PLOTS ARE EXPLAINED IN BOX 4.2.

Figure 1. Projected percentage change in mean rainfall in northern Australia (Moise et al. 2015)

e) If applicable, describe any additional environmental impacts and/or environmental risks of the Project, which are not addressed in the EMP, resulting from the effects of climate change on:

i. the management of wastewater produced by the Project; or

ii. any other environmental risk or environmental impact of the Project relevant to your area of expertise.

This is addressed by the answer to (d).

f) Whether, in your opinion, any relevant mitigation measures proposed in the EMP are adequate having regard to the effects of climate change, if any, on:

i. the management of wastewater produced by the Project; or

ii. any other environmental risk or environmental impact of the Project relevant to your area of expertise.

If not, please describe what other or further mitigation measures you consider necessary.

This is addressed by the answer to (d).

g) In your responses to paragraphs (d) to (f) above, please consider:

i. any current effects of climate change in the Northern Territory; and

ii. projections of any future effects of climate change in the Northern Territory during the life of the Project, or during the life of any relevant environmental impact or environmental risk of the Project (if such may persist beyond the operational period of the Project).

This is addressed by the references to Moise et al. (2015) and Heidemann et al. (2023). For additional context, Figure 2 below shows large uncertainty about whether wet season rainfall total, which is most relevant in terms of the EMP's 90-day criterion for fixing freeboard, will increase or decrease under future climate.

Recent climate data sets exist that can be used to update the data shown in Figures 1 and 2; however, this requires extracting and processing data and the time constraints of providing this advice did not permit this to be done.

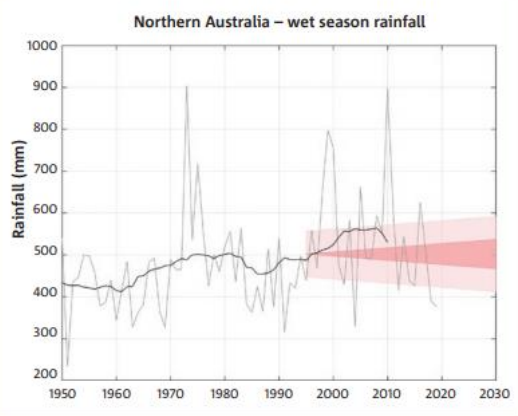

Figure 2.11. Total wet season rainfall in northern Australia as a whole (north of 26°S) for each year since 1950 (thin line) and the underlying trend (thick line) with the projected range of change for 1986–2005 to 2020–2039 under any emissions scenario from Climate Change in Australia added as a pink range. The decadal variability is shown as a feint pink band. (The trend uses a 20-year moving average (Hawkins et al. 2020), observations are from AWAP.)

Figure 2. Historical and projected wet season rainfall totals in northern Australia (NESP ESCC 2020)

Other matters

The scope in the Exert Brief excluded groundwater and so my advice does not address potential groundwater impacts in any detail; however various issues may be worth noting:

- The reviewed EMP documents do not address the potential for cumulative impacts to water levels in groundwater bores on neighbouring properties due to the proposed CPP and other gas projects, except noting that they are more than 1 km from the activity.
- The reviewed EMP documents exclude a conceptual hydrogeological model showing the main hydrogeological units, their relation to the CPP wells/bores, and flow pathways. This may be regarded as an essential requirement in an environmental assessment of unconventional gas projects.
- The reviewed EMP documents exclude lithological details from the existing boreholes in the project area, while noting the requirement of the code that “A key requirement of the Code in relation to groundwater monitoring in the Beetaloo is the guideline requirement for an accurate lithological log of rock from the water supply bore at a well pad”.
- The reviewed EMP documents show baseline groundwater quality data from 10 samples from four bores, with no information about the period over which the samples were taken. Samples should be taken over at least one year, ideally two years, to capture any effects of hydrological variability. Baseline data will need to be collected from proposed bores with an adequate baseline period.

If these issues are of concern, I recommend that a groundwater expert is consulted.

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Yours sincerely

Professor Neil McIntyre PhD, CEng, MICE
Sustainable Minerals Institute | School of Civil Engineering | The University of Queensland
Brisbane Qld 4072 Australia
M +61 7 419 339 700
E n.mcintyre@uq.edu.au smi.uq.edu.au
CRICOS code: 00025B . TEQSA PRV12080