



BENNETT RESOURCES

Bennett Resources Pty Ltd

Valhalla Exploration Drilling Response to Public Submissions – EPA Assessment No. 2281

BNR_HSE_MP_016

VERSION HISTORY				
Ver. No.	Ver. Date	Author	Reviewer	Revision
A	10 October 2024	AES	ML	Issued for Review
B	10 January 2025	AES	ML/SM	Issued for Review
0	7 February 2025	AES	ML	Issued to EPA
1	10 June 2025	AES	ML	Issued to EPA

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Terms / acronyms

Terms / acronym	Definition / expansion
AHIS	Aboriginal Heritage Inquiry System
APPEA	Australian Petroleum Production and Exploration Association
BACI	Before-After-Control-Impact
BME	Black Mountain Exploration Pty Ltd
BNR	Bennett Resources Pty Ltd
BC Act	(WA) <i>Biodiversity Conservation Act 2016</i>
DAWE	(Commonwealth) Department of Agriculture, Water and the Environment
DE	Development Envelope
DMAs	decision-making authorities
DEMIRS	Department of Energy, Mines, Industry Regulation and Safety
DoH	Department of Health
DRF	Declared Rare Flora
DWER	Department of Water and Environmental Regulation
EP	Environment Plan
EPA	Environmental Protection Authority
EP 371	Exploration Permit 371
EP Act	(WA) <i>Environmental Protection Act 1986</i>
EPBC Act	(Commonwealth) Environment Protection and Biodiversity Conservation Act 1999
ERD	Environmental Review Document
ESD	Environmental Scoping Document
GWMP	Groundwater Management Plan
HHRA	Human Health Risk Assessment
HSE	Health, Safety and Environment
IESC	Independent Expert Scientific Committee
LOWC	Loss of Well Control
NORMS	naturally occurring radioactive material
OSCP	Oil Spill Contingency Plan
PER	Public Environmental Review
PGER(E)R	Petroleum and Geothermal Energy Resources (Environment) Regulations 2012
REC	Reduced Emissions Completion
RTS	Response to Submissions
SA	South Australia
SDS	Safety Data Sheet
TDS	Total Dissolved Solids
TEC	Threatened Ecological Community
WA	Western Australia
WAC	Warlanguuru Aboriginal Corporation
YAC	Yungngora Aboriginal Corporation

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1 Introduction

1.1 Overview

This Response to Submissions (RTS) has been prepared to inform and accompany the Environmental Review Document (ERD) (Bennett Resources, 2024) for the Valhalla Project (the Proposal) by the proponent, Bennet Resources Pty Ltd (BNR).

The Proposal is to complete an unconventional exploration and appraisal drilling and hydraulic fracture stimulation (HFS) program on Petroleum Exploration Permit 371 (EP 371) in the Canning Basin, within the Shire of Derby / West Kimberley (SDWK) in Western Australia (WA). The intent of the Proposal is to evaluate the large tight gas resource in the region, which has the potential to offer long-term energy security to Australia. The onshore Canning Basin is an early Ordovician to early Cretaceous aged geological basin that covers ~430,000 km² in the West Kimberley region. The Proposal is targeting hydrocarbons present from the Laurel through to the Devonian Formations, at depths ranging from 2,000 m to 5,000 m below ground level. The main target is the Laurel Formation, with hydrocarbons present at depths between 2,000 m and 4,000 m below ground level.

Note, this Proposal does not cover gas production. It is an exploration and appraisal program only, to be undertaken in two phases, being exploration then field appraisal (field appraisal being dependant on successful outcomes from exploration). Should a commercially viable resource be identified, BNR will seek additional approvals as required under both Federal and State Government legislation. To note, all distances in the ERD and this RTS are presented as straight-line geographic distances, unless otherwise stated. The Development Envelope is ~123 km southeast of the town of Derby (Figure 1-1 and Figure 1-2).

The Proposal involves constructing up to 20 wells in a region of the Canning Basin that has previously been surveyed and explored for petroleum purposes. Following well construction, HFS will be undertaken, if required, to appraise the hydrocarbon flow rates.

The Proposal includes these activities:

- site preparation
- drilling
- HFS
- site reinstatement (including ongoing management of the wells).

These activities are proposed to be undertaken in two stages over seven years. The overall expected disturbance footprint within the Development Envelope is ~112 hectares (ha).

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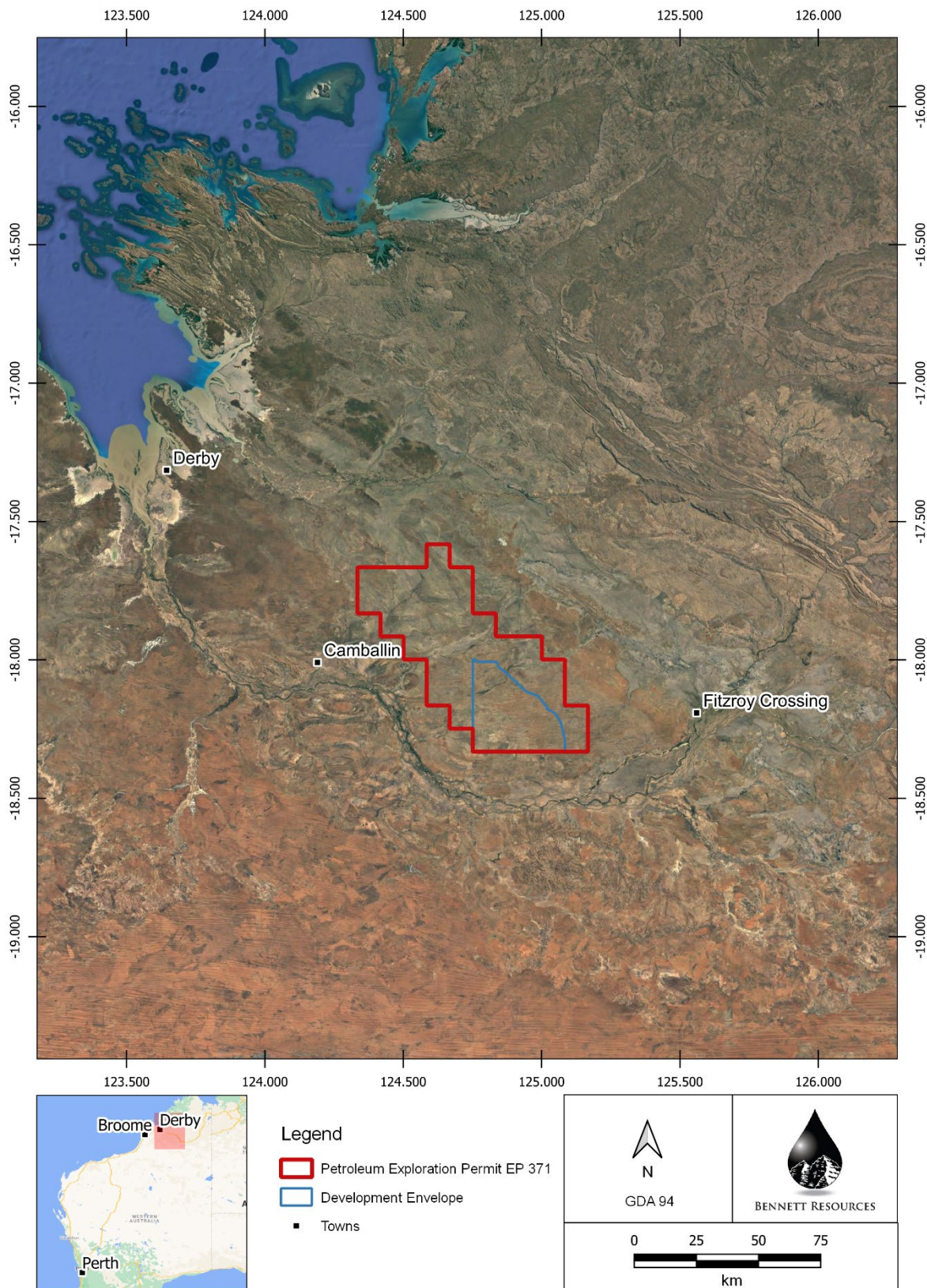


Figure 1-1: Regional context and the Development Envelope associated with the Proposal

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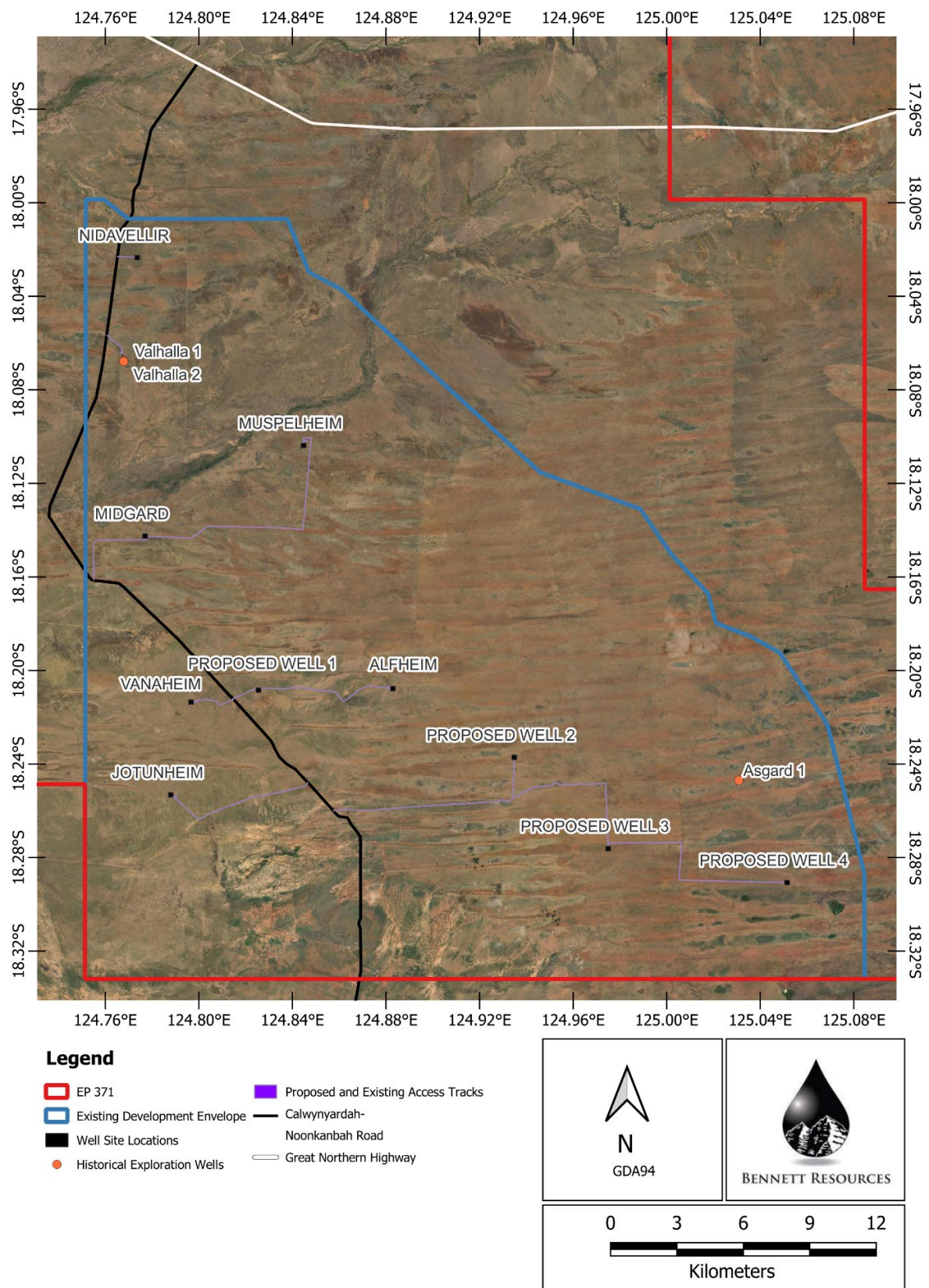


Figure 1-2: Well locations and Disturbance Footprint

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Themes of submissions were collated according to the environmental factor it was relevant to, these included:

- flora and vegetation
- landforms
- subterranean fauna
- terrestrial environmental quality
- terrestrial fauna
- inland waters
- air quality
- greenhouse gas emissions
- social surroundings
- human health
- general statements or comments on the proposal.

BNR's response to these submissions are addressed in Section 2 of this report. Each comment has been responded to with the proponent's response, either with a full response or a reference to a response in Appendix 2. Each Environmental Factor has been coded accordingly as per below and then numbered e.g. FV-001, FV-002:

- FV flora and vegetation
- SF subterranean fauna
- TEQ terrestrial environmental quality
- TF terrestrial fauna
- IW inland waters
- AQ air quality
- GG greenhouse gas emissions
- SS social surroundings
- HH human health
- GS general statements or comments on the proposal.

When reading the response to each comment please also read the response in Appendix 2 that matches the stated code.

1.2 Assessment Process of the Proposal

BNR referred the Proposal to the WA Environmental Protection Authority (EPA) under under Section 38 of the *Environmental Protection Act 1986* (EP Act) on 24 December 2020. On 3 February 2021, the EPA determined that the Proposal should be assessed under section 39a of the EP Act at the level of assessment of Public Environmental Review (PER).

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On 4 August 2021, the EPA issued the Environmental Scoping Document (ESD) for public review, which contained the requirements that should be included in this ERD. The ERD was prepared to meet the requirements of the final ESD, which was issued by the EPA on 8 November 2021. In preparing this ERD, BNR completed engagements and studies to address the key environmental factors determined by the EPA, including:

- flora and vegetation
- terrestrial environmental quality
- terrestrial fauna
- inland waters
- social surroundings
- air quality
- greenhouse gas emissions
- human health
- Other environmental factors or matters
- subterranean fauna.

BNR updated the ERD following comment from DWER and resubmitted this in June 2024, in accordance with the EPAs Environmental Impact Assessment (Part IV Divisions 1 and 2) Procedures Manual. The ERD was available for a public review for a period of 8 weeks from 12 August 2024, closing on Monday, 7 October 2024. On 9 December 2024, EPA Services at the Department of Water and Environmental Regulation (DWER) provided BNR with a summary of public submissions received during the public review period.

BNR has addressed these comments in this RTS document as well as responding to further actions requested in the EPA Letter (16 April 2025) requesting further information to the RTS submitted on the 7th February 2025. This document will constitute part of the assessment documentation for the Proposal.

Once BNR submit the RTS the EPA will then prepare its report and recommendations and submit this to the WA Minister for Environment for consideration as part of the Minister's decision process on Proposal approval or otherwise.

The Proposal was also referred to the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCCEW) on 16 September 2024 (EPBC identification number 2024/10006 EPBC application number 02593).

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2 Submissions Received

2.1 Summary of Submissions Received (EPA Services)

EPA Services comment	Proponent response
Inland Waters 1. EPA Services noted in its advice of 17 April 2024 that the conceptual hydrogeology of wetlands and waterways in the development envelope (DE) should be presented in the ERD, and that a comparison of wetland locations with groundwater drawdown contours could provide justification for not completing further hydrogeological investigations. The proponent's response included an updated figure (5-36) depicting various water bodies within the DE. The proponent noted that Mount Hardman Creek is the only waterbody located in or within close proximity of the (fixed) disturbance footprint. Groundwater modelling indicates drawdown to be limited to 1 mm at 700 m from abstraction points (located at the wellsite). Clarification, including a figure, should be provided around the location of mapped water features within the 700 m drawdown zone of each abstraction point. From this analysis, provide further comment as required on any potential indirect impacts to surface water features resulting from groundwater drawdown.	The figure below shows that at 700 m from all proposed well sites, there are no intersections with known permanent water features associated with the proposed abstraction points. Specifically, Mount Hardman Creek does not intersect with the nearest 700 m abstraction point associated with the proposed Muspelheim well. This indicates that the rate of drawdown (<1 mm) from the abstraction point associated with the wellsite to Mount Hardman Creek would be negligible and would not result in any impact to the surface water hydrology.

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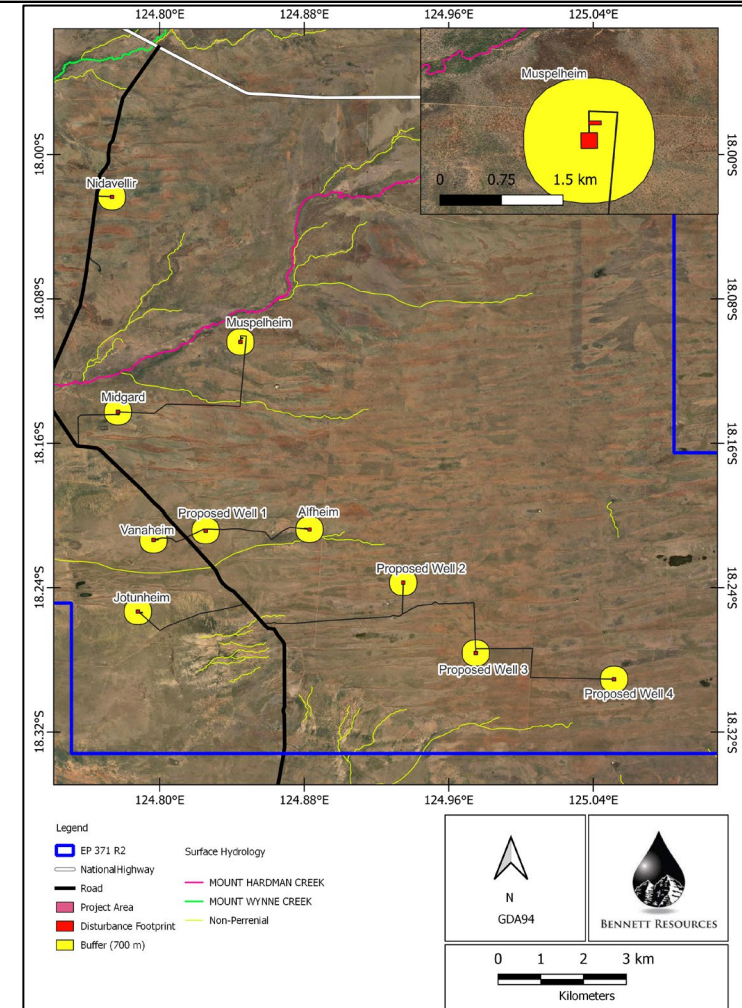
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EPA Services comment

Proponent response



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EPA Services comment	Proponent response
2. In its advice of 17 April 2024, EPA Services highlighted that threshold contingency actions in the Groundwater Management Plan (GWMP) should include response actions that are quick and decisive in order to bring the impact below the threshold criteria and trigger criteria. EPA Services also recommended that the GWMP should detail whether the contingency actions relate to groundwater level or quality. EPA Services recommends that the response actions should be separated into different sections for groundwater level and groundwater quality. Trigger levels should be guided by baseline data and will need further review and refinement in consultation with the Department of Water and Environmental Regulation (DWER) and the Department of Energy, Mines, Industry Regulation and Safety once an appropriate baseline data set is available.	BNR updated Rev 5 of the GWMP to clearly state either quality or levels in each of the threshold and trigger criteria (Appendix 7). BNR also included commitments to engage with DWER and DEMIRS regarding amendments to thresholds following collection of baseline data in Section 4.2. Although no changes are required to be made as they have already been made, BNR updated the GWMP to split Table 3-1 into groundwater quality and groundwater level per EPA request.
3. EPA Services notes the additional information included in the ERD regarding the fluctuations in methane concentrations. EPA Services considers that there remains uncertainty as to the origin and cause of the increasing methane concentrations recorded, and there is insufficient contemporary data available to demonstrate that there has been a return to 'baseline' conditions. The proponent's response to EPA Services' comments (dated 7 April 2024) noted that a detailed investigation will be provided but is not appropriate for inclusion in the ERD. This investigation should be provided with the Response to Submissions to support the EPA's assessment. EPA Services notes that any outstanding uncertainty will be a consideration for the EPA's assessment of the proposal, including the consideration of requirements for baseline groundwater monitoring prior to drilling/fracturing.	The outcomes of the investigation are provided below. Baseline samples were collected from AB1S and VNB1S for 18 months starting in 2014 and completing in August 2015. Over this time a number of methane readings above the LOR (being 0.005) were recorded across Valhalla and Asgard aquifers indicating that methane may naturally fluctuate in the Liveringa aquifer. These readings were between 0.005 (LOR) and 0.015. HFS commenced in August 2015. During this period and the years that followed (2018) methane readings were stable hovering at or below 0.02 which was determined to be not inconsistent with the baseline readings. Between 2018 and 2019 all bores sampled onsite experienced an increase in methane levels. The operator at the time reviewed their field notes (reviewed by BNR) which suggested no additional outside activities could have contaminated the source, the samples were collected by the same people from 2017 and the only "petroleum activities to occur over this period" were relatively non-invasive down hole activities for Asgard completed in 2019 (not in 2018 when the increases were first identified). All other activities on site were limited to maintenance of existing hardstands ruling out potential contamination sources attributable to petroleum activities. BNR sampled VNB4S and AB1S in 2021 for methane with both bores returning methane levels that were below the methane LoR (0.001mg/L). the methodology involved low-flow sampling to reduce purging volumes completed by the previous operator and to minimize disruption of the samples as much as possible.

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EPA Services comment	Proponent response
	Given that that VNB4S and AB1S are up the hydraulic gradient from the well and the fracking activities, if methane would have been released from the wellbore, it is extremely unlikely that it would have been recorded upgradient (and thus in these bores). These bores were specifically located in consultation with DWER to ensure they were upgradient of the wellbore in a location that would enable the operator to differentiate between activity related and natural occurring events. Given all bores spiked over this period of time (not just the baseline/environmental bore), this indicates there may have been a broader change to groundwater across the canning basin (not restricted to Valhalla and Asgard locations). Given that the data doesn't indicate an increase in Total Dissolved Solids (TDS), Barium, Boron, or other highly concentrated Trace Metals (which would be expected in correlate with an increase in methane if it was attributed to the petroleum activity) BME expects that these results may be attributable to other naturally occurring events experienced in the Canning Basin at this time. In 2018, the region experienced a large drought, with significant heatwaves and then subsequent flooding events resulting in mass reported cattle death across the Noonkanbah Station. It is possible that these events could explain an increase in methane over this period of time (i.e., decomposition of organic material) and infiltrating the surficial aquifer. The only other explanation available to BNR is operator error which seems unlikely given the person responsible for sampling during 2017 was responsible for sampling in 2018 and 2019.
Item 4 In its advice of 7 April 2024, EPA Services requested additional information to verify the validity of the groundwater monitoring data presented in the ERD. This information was not provided in the revised ERD, and should be provided with the Response to Submissions to support the EPA's assessment. This information should include: When monitoring wells were drilled and purged and who was responsible for undertaking sampling and analysis for each monitoring event. A review and discussion of the sampling and analysis methodologies and evaluation of any differences in procedures between the pre 2020 monitoring and the post 2021 monitoring, including changes to the limit of reporting. This may include a review of field sheets, chain of custody and laboratory documentation relating to the monitoring events.	Please refer to Appendix 6. Attachments A to C added to Appendix 6 It should be noted that given the EPA's requirement to conduct baseline sampling on each wellsite, the value that this data provides is to support BNR's understanding that the aquifer is geochemically stable, and that the proposed monitoring program will be the most effective data in identifying fluctuations in Constituents of Potential Concern.

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EPA Services comment	Proponent response
Item 5a In its advice of 7 April 2024, EPA Services requested that the ERD and GWMP be revised to reflect a commitment to finalising Liveringa and Grant aquifer monitoring bore locations in consultation with DWER and DEMIRS. EPA Services also requested a commitment to collect two years of baseline data from the Grant and Liveringa aquifer at each wellsite, prior to onsite activities. Consistent with the Groundwater monitoring in the onshore petroleum and geothermal industry guideline (DMP & DoW 2016) and the approved Environmental Scoping Document (ESD).	Revision 5 of the GWMP included commitments for BME to finalise bore monitoring locations in consultation with DWER and DEMIRS. “the location of the bores will be identified in consultation with DWER and DEMIRS” BNR’s understands that many other drilling operations occur in WA. These projects have actively engaged with both DWER hydrogeologists and DEMIRS indicating with many exploration drilling programs gaining approval for a minimum groundwater baseline sampling requirement that comprises three samples over a three-month period to provide a trend which could be subject to further analysis. BNR understands that DWER accepts a reduced timeframe for when hydrogeology is well known and sufficient data exists to inform local geochemistry. BNR agrees that there is local groundwater variation across some constituents within the project area (consistent with DWER comments). This is validated through the extensive data set BNR has at Asgard and Valhalla. However, DWER have not acknowledged that this data also shows that there is limited local variation in constituents over this period of time indicating that locally (at each bore location [Figure 5-17 – Figure 5-27 in the ERD]), there is limited variability in constituents suggesting that a shortened baseline collection program is sufficient because the aquifer is mature and geochemically stable. This approach is consistent with other areas of WA. This approach was discussed with Paul Vogel (the previous EPA Chair and Current EPA Chair of the NT) who stated that: “The proponent has access to 8 years’ of groundwater monitoring data from the previous tenement holders as well as community and stock bores and has adopted a risk-based and conservative approach to protecting groundwater quality. These data in my opinion would provide an adequate baseline for water quality in the local vicinity, especially considering the absence of any significant polluting activity in the region.” The groundwater guideline may suggest that 24 months’ worth of data should be collected – but how this data is collected is nonspecific. BNR propose to install a bore adjacent to the wellsite and positioned in a manner that would not risk impact from the activity (hydraulically upgradient with the position of the bore being confirmed with DWER prior to installation [per existing commitments in the GWMP]). For an example of what this could look like please refer to the Baseline Bore in Figure 3-1 in the GWMP. This would allow sufficient data to be “collected” whilst concurrently allowing the activity to commence providing DWER confidence that local constituent variability is stable. Further given the installation of a monitoring bore downgradient of the well it will enable analysis to validate that the upgradient bore is not affected by the activity. This is standard BACI monitoring design and given the extensive data collected in the region would provide the ability to get the data DWER are looking for in a practical yet scientifically robust manner that would enable operational efficiency to be managed. Given the overarching concern about baseline is understanding natural variation and fluctuations of

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EPA Services comment	Proponent response
	constituents this can be easily alleviated through a pragmatic monitoring program design as proposed by BNR. The GWMP (Rev 4 Appendix 7) has been updated to reflect this approach. The constituents that would be utilized to indicate a release event would cause a peak of either chlorides (from drilling fluids) or BTEX/TPH from produced water. Given the regional data indicates that there is limited variability for these constituents, any unplanned release event would cause an immediate spike of these constituents that would far outweigh the natural variability. As per the GWMP this would then require BNR to implement additional monitoring actions to be implemented. One of these may include installation of additional upgradient bores and increased sampling intensity thus enabling a BACI monitoring design to be implemented (regardless of an existing bore being present or not). This would enable BNR to show how the aquifer responds to seasonal and natural influences at each location. Although not clearly written into Rev 3 GWMP this is a standard action that would be implemented and was inherently considered part of the plan (BNR has updated the GWMP to detail this in Rev 5 Appendix 7). Outlined below is the baseline monitoring and surveillance monitoring for the Liveringa aquifer and the Grant Group aquifer. <u>Liveringa aquifer</u> <u>Baseline monitoring</u> The GWMP has been updated to reflect that BNR will gather sufficient baseline groundwater data from the up-hydraulic gradient control monitoring bore to ensure seasonal variation is captured over the course of a single a year (i.e. captures seasonal groundwater high post wet season, and seasonal groundwater low post dry season, which may be less than 12 months). The GWMP has been updated to reflect that each well site will have three (3) monitoring bores: • One (1) control monitoring bore that will be located up-hydraulic gradient of the well to collect baseline pre-activity data. • Two (2) impact monitoring bores will be installed down-hydraulic gradient of the well and wastewater pond upon completion of installation of the well cellar and wastewater pond to enable the impact monitoring bores to be suitably positioned to monitoring infrastructure integrity with the locations of all bores subject to DWER confirmation [per existing commitments in the GWMP]. There are a number of reasons that down gradient impact (surveillance) bores may not be able to be installed pre activity; the major reason being operational constraints. The location of the wells and the ponds on the wellsite are subject to detailed wellsite design and engineering. To inform the wellsite design and engineering, the drilling rig that will be utilised needs to be contracted given the rig will determine the layout of infrastructure to ensure that everything is positioned to enable the rig to operate

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EPA Services comment	Proponent response
	safely. The Rig will not be contracted until all approvals are in place (resulting in multiple dependencies that will cause significant time constraints). If the impact bores are installed too early, there is the potential for them to be: • damaged given well cellar and pond construction requires heavy civil / earthmoving machinery, and • mispositioned resulting in them not being optimally placed for identifying contamination events arising from the activity. To summarise, the local siting of monitoring bores is usually completed in consultation with DWER Hydrogeologists during the development of an Environment Plan under the PGER Act to enable specific requirements for each site to be bespoke such that the environmental outcomes are achieved. <u>Control monitoring bore location</u> The GWMP has been updated to reflect that BNR will locate the control monitoring bore for each wellsite up-hydraulic gradient and as far as practically possible (acknowledging the EPA's recommendation for a minimum of 100 m from the potential sources of contamination). However, the location of the control monitoring bore and its distance from the potential sources of contamination are subject to final well site design (which is subject to rig contractor availability). Although the control bore location will require the wellsite design to be near final, it does not require the wellsite or infrastructure such as the production water pond to be constructed and utilisation of access roads. To ensure suitability BNR will ensure that the position of each control monitoring bore is confirmed with DWER prior to installation [as per existing commitments in the GWMP]. BNR notes that provisions can be made to allow disturbance required for installation and access of the control monitoring bore outside of the disturbance footprint. The local siting of monitoring bores is usually completed in consultation with DWER Hydrogeologists during the development of an Environment Plan under the PGER Act to enable specific requirements for each site to be bespoke such that the environmental outcomes are achieved. These provisions will be managed by DEMIRS. <u>Impact monitoring bore location</u> Two (2) impact monitoring bores will be installed on each well pad, each impact monitoring bore will be installed down hydraulic gradient and as close as possible to the production well and the wastewater pond (without creating any obstacles for safe operating practices on the site) to ensure impacts are detected. As detailed above, the installation of impact monitoring bores is subject to a number of operational constraints. Their placement and appropriate installation are more important than the collection of baseline data given the up-gradient control monitoring bore will be collecting sufficient baseline data for

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	each wellsite. Given the operational constraints, it may not be possible to gather 12 months of baseline monitoring data from these bores prior to HFS activities beginning. However, this is not required given the control bore will provide sufficient baseline data to inform local geochemical conditions. The final detailed well design for each well pad will only be completed after receiving State and Commonwealth environmental approval. The final well pad designs will inform the monitoring bore locations which will be agreed through consultation with DWER. BNR has updated the GWMP to reflect the requirement to install surveillance bores down-hydraulic gradient of potential contamination sources. In the event a second well is to be drilled on each wellsite, BNR will engage with DWER regarding bore placement (per existing commitments in the GWMP) given it is possible that one surveillance bore could cover both wells suitably depending on their positioning. <u>Sampling frequencies</u> It should be noted that HFS activities occur after drilling activities. These may occur immediately after drilling (subject to meeting the recommendations associated with the HFS Scientific Inquiry that are already detailed in the ERD) or be delayed by a number of weeks or days (subject to contractor availability and mobilising constraints). Baseline sampling will be considered complete once the drilling activity commences given the sampling will be monitoring for well and pond integrity failure from this point on. During HFS activities BNR acknowledges that an increased frequency of sampling may be required which is why the GWMP has been updated to provide optionality of approach. The specific approach is required to be discussed with DWER to ensure the expected environmental outcome can be sufficiently measured to demonstrate if the outcome has been achieved (or not). Consequently, the GWMP has been updated to provide the following options: <u>Baseline</u> - Quarterly in field sampling during baseline AND <u>Surveillance</u> - Quarterly in field sampling during petroleum activities. - Monthly in field sampling during HFS activities (noting provisions to increase monitoring frequency per updated trigger and threshold criteria).

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	- Daily sampling of adequate screening parameters (i.e. PH, EC, TDS and groundwater depth) of all wells. - Following completion of HFS activities, samples will revert to quarterly and where no significant variation from baseline is identified, the sampling frequency will drop to a single down gradient Livinga bore twice a year and continue until the termination criteria is achieved (noting provisions to increase monitoring frequency when triggered or threshold criteria are not met). OR <u>Surveillance</u> - Quarterly in field sampling until telemeter units are installed in all monitoring bores. - Continuous telemetered monitoring of all monitoring bores for PH, EC, TDS and ground water depth. - Annual in field sampling event of all monitoring bores once telemetry is no longer utilised in the field. - Following completion of HFS where no significant variation from baseline is identified (and where telemetry is no longer utilised), the sampling frequency will drop to a single down gradient Livinga bore twice a year and continue until the termination criteria is achieved (noting provisions to increase monitoring frequency when triggered or threshold criteria are not met). The reason for providing multiple options for surveillance sampling during HFS activities is that regular full sampling suite is not required where bores have telemetered gauges in place to continuously sample for PH, EC, TDS. These will pick up any changes in water quality (potentially associated with the Proposal) which will then trigger the requirement for a full suite analysis to be conducted. Given mobilisation timeframes, BNR expects that sampling could be conducted within a week where a spike of constituents occurs which would occur in most cases quicker than implementing a frequent full suite monitoring station. This detail is usually discussed with DWER hydrogeologists during Environment Plan development under the PGER Act. Providing multiple options at this stage of the Proposal (during EPA Assessment) enables BNR to maintain operational flexibility subject to finalising wellsite design and equipment availability. BNR believes that a robust adaptive management framework for increasing and/or reducing monitoring frequency based upon actual monitoring results is the most scientifically robust, enabling environmental outcomes to be more clearly and transparently assessed. All groundwater monitoring information is shared with DEMIRS and DWER transparently through annual reporting to demonstrate the compliance with identified environmental outcomes.

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EPA Services comment	Proponent response
	Grant Group aquifer <u>Bore location</u> BNR has updated the GWMP to read: Two (2) monitoring bores will be installed at the base of the Poole Aquifer for this Proposal within the Development Envelope: • one up-hydraulic gradient from the production well, located as far as possible from potential contamination sources (noting the EPA's preference for a separation distance of at least 100 m which will be considered during wellsite design). BNR notes that provisions can be made to allow disturbance required for installation and access of the control bore outside of the 'locked' disturbance footprint. These provisions will be managed by DEMIRS. • one located down-hydraulic gradient from either the first or second exploration well, as close as possible to the well and no further than the edge of the lease. <u>Screening</u> The GWMP (Appendix 7) has been updated to read: • both Poole bores will be screened at the base of the Poole aquifer and appropriately constructed to mitigate risks of a hydraulic short circuit. <u>Baseline and Surveillance</u> The GWMP has been updated to read. • baseline samples from the two (2) Poole bores installed for the Proposal will be collected at least 6 months prior to drilling activities commencing, at either the first or second exploration well. • baseline samples from the two (2) Poole bores installed for the Proposal will be collected at least 6 months prior to drilling the first or second exploration well. • this monitoring program (including bore location, frequency and methodology) can be reviewed by BNR and DWER post implementation, in accordance with Section 4.2 of this GWMP. BNR notes that the monitoring framework for future activities is likely to look different given the extensive data collection and monitoring framework enacted for this Proposal. This will be addressed should any future activities be proposed.

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EPA Services comment	Proponent response
	BNR notes that the monitoring framework for future activities is likely to look different given the extensive data collection and monitoring framework enacted for this Proposal. This will be addressed should any future activities be proposed.
Item 5b In its response, the proponent outlined an alternative process involving comparing variance from regional baseline data to six months of local baseline data to evaluate whether sufficient baseline data is available from each aquifer prior to implementation of drilling. EPA Services advises that this approach may not be appropriate because: Variance analysis on six months of data does not provide sufficient water quality and quantity data to understand how the aquifer responds to seasonal and natural influences at each location.	BNR acknowledges that there is local groundwater variation across some constituents within the project area (consistent with DWER comments). This is validated through the extensive data set BNR have at Asgard and Valhalla. However, EPA Services have not acknowledged that this data also shows that there is limited local variation in constituents over this period of time indicating that locally (at each bore location [Figure 5-17 – Figure 5-27 in the ERD]), there is limited variability in constituents suggesting that a shortened baseline collection program is sufficient because the aquifer is mature and geochemically stable. This approach was discussed with Paul Vogel (the previous EPA Chair and Current EPA Chair of the Northern Territory) who stated that: “The proponent has access to 8 years’ of groundwater monitoring data from the previous tenement holders as well as community and stock bores and has adopted a risk-based and conservative approach to protecting groundwater quality. These data in my opinion would provide an adequate baseline for water quality in the local vicinity, especially considering the absence of any significant polluting activity in the region.” The groundwater guideline may suggest that 24 months’ worth of data should be collected – but how this data is collected is nonspecific. BNR plan to install an upgradient bore adjacent to the wellsite and positioned in a manner that would not risk impact from the activity (hydraulically upgradient with the position of the bore being confirmed with DWER prior to installation [per existing commitments in the GWMP]. For an example of what this could look like please refer to the location description of the Control Monitoring Bore in the GWMP. This would allow sufficient data to be collected whilst concurrently allowing the activity to commence providing DWER confidence that local constituent variability is stable. Further the installation of a monitoring bore downgradient will enable analysis to validate that the bore is not affected by the activity. This is standard BACI monitoring design and given the extensive data collected in the region would provide the ability to get the data DWER are looking for in a practical yet scientifically robust manner that would enable operational efficiency to be managed.
Item 5c Six months of data does not provide a sufficiently robust data set upon which surveillance and decommissioning monitoring data can be compared to provide confidence that the environmental outcomes are consistent with the EPA’s objectives.	Refer to 5a.

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EPA Services comment	Proponent response
Item 5d Water quality parameters from the Poole Sandstone bores do not include all parameters that are required to be monitored (E.g. TPH and methane).	BNR has never agreed with sampling the Poole because: • There are no surface spill scenarios that could result in an unplanned release to the Poole Sandstone. And a subsurface release is not credible (this was recently validated by the IESC report into deep unconventional resources (IESC, 2024). Historically, engagements with DWER and DEMIRS have wanted bores to focus on surface polluting infrastructure to ensure any surface release and potential contamination event could be identified. This is also consistent with IESC (IESC, 2024). • The Poole sandstone is not used in the Project Area. • Vertical migration from the Laurel is not credible given the mitigations required to be implemented arising from the HFS inquiry such as ○ The Poole sandstone is geologically separated from the targeted hydrocarbon reservoir (laurel) by a shale aquitard layer ○ Geotechnical risk assessment (identification and avoidance of any local migration / faulting paths) prior to stimulation ○ Separation distances of the stimulation zones and the pool ○ The physical properties (such as pressure) that limit the extent to which any fracture length can be achieved. BNR understands that DWER is focused on baseline data collection from the Poole sandstone, however it is as yet, not clear to BNR how this data will be used to support compliance / assessment of the project. As such BNR believes provision of publicly available Poole sandstone data would be suitable for the purposes of understanding the aquifers seasonal and natural influences. Although BNR believe that the data provided is sufficient for background purposes, BNR has suggested that additional data be collected from the Poole (i.e. Poole Sandstone) aquifer (per Rev 5 of the GWMP) – please refer to Section 3.1 and Table 3-2 of the GWMP. However, the lack of engagement with DWER and EPA on BNR's updates to the GWMP, validate why BNR's approach to baseline data (i.e. not collecting prior to getting a Ministerial Statement and subsequent GWMP approved by the EPA) is the right approach. BNR will collect data that is consistent with an DWER approved monitoring framework to ensure the data collected is legally (and environmentally) robust.
Item 5e Data presented from the Asgard and Valhalla wellsites demonstrates variation in water quality across the project area.	BNR acknowledges that there is local groundwater variation across some constituents within the project area (consistent with DWER comments). This is validated through the extensive data set BNR have at Asgard and Valhalla. However, EPA Services have not acknowledged that this data also shows that there is limited local variation in constituents over this period of time indicating that locally (at each bore location [Figure 5-17 – Figure 5-27 in the ERD]), there is limited variability in constituents suggesting that a shortened baseline collection program is sufficient because the aquifer is mature

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EPA Services comment	Proponent response
	and geochemically stable. This approach was discussed with Paul Vogel (the previous EPA Chair and Current EPA Chair of the NT) who stated that: “The proponent has access to 8 years’ of groundwater monitoring data from the previous tenement holders as well as community and stock bores and has adopted a risk-based and conservative approach to protecting groundwater quality. These data in my opinion would provide an adequate baseline for water quality in the local vicinity, especially considering the absence of any significant polluting activity in the region.” The groundwater guideline may suggest that 24 months’ worth of data should be collected – but how this data is collected is nonspecific. BNR plan to install a baseline bore adjacent to the wellsite and positioned in a manner that would not risk impact from the activity (hydraulically upgradient with the position of the bore being confirmed with DWER prior to installation [per existing commitments in the GWMP]). For an example of what this could look like please refer to the Baseline Bore in Figure 3-1 in the GWMP. This would allow sufficient data to be collected whilst concurrently allowing the activity to commence providing DWER confidence that local constituent variability is stable. Further given the installation of a monitoring bore downgradient of the well will enable analysis to validate that the bore is not affected by the activity. This is standard BACI monitoring design and given the extensive data collected in the region would provide the ability to get the data DWER are looking for in a practical yet scientifically robust manner that would enable operational efficiency to be managed.
Item 5f No evidence is available to demonstrate why two years of baseline monitoring is not practical in this instance, noting the time that has elapsed since the proposal was referred, and the ESD approved.	The baseline data of groundwater does not inform the environmental risk assessment - thus it is not needed to be collected now to inform project approvals. Although BNR experienced continual pushback on this point – DWER acknowledged that approach made practical sense prior to the release of the ERD. Further to this, advice from the previous EPA Chair (Paul Vogel) indicated that on review, existing data should be considered sufficient for baseline for a HFS activity. “The proponent has access to 8 years’ of groundwater monitoring data from the previous tenement holders as well as community and stock bores and has adopted a risk-based and conservative approach to protecting groundwater quality. These data in my opinion would provide an adequate baseline for water quality in the local vicinity, especially considering the absence of any significant polluting activity in the region. Notwithstanding, the proponent has committed and can be conditioned to construct additional groundwater monitoring bores prior to well construction to monitor any impacts of drilling and fracturing. These would, in all likelihood, be conditioned by DMIRS as part of the Well Management Plan (WMP) and EPs required by petroleum legislation for onshore gas exploration and appraisal.” Reasons why the data has not yet been collected: Currently, there is no access to the proposed well sites and approximately 25-30 hectares of vegetation (directly adjacent to the proposed wellsite) would need to be cleared to access the

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	proposed wells in order to provide local baseline groundwater data. This equates to approximately 22 % of the total project disturbance footprint. Given the regulatory uncertainty associated with the project due to the lack of regulatory framework post moratorium, clearing this area to implement a baseline program for a proposal that may or may not be approved by government (given the lack of policy support) does not seem like a reasonable environmental endeavour. Further to this, BNR considered it unlikely that any of the subsequent required approvals could be sought as other decision makers would likely be constrained from making a decision subject to final EPA approval. So why not sample closer in areas that you can access? Sampling at locations that are adjacent to existing access roads or on existing hardstands was considered unlikely to be sufficient as baseline given the EPA were not willing to accept data from Asgard and Valhalla (and broader community bore data) as <u>local baseline</u> data (Figure 5-30 in the ERD). Although BNR disagree with this position, BNR did not believe that the EPA would accept data from locations that were located away from the proposed well sites. BNR does not believe that collecting data that may be considered insufficient and risk project execution is appropriate. The specific constituents, aquifers and sampling requirements and frequencies are not clear in the ESD / HFS recommendations or industry guidelines. As the monitoring requirements were not clear, BNR developed a Groundwater Management Plan to ensure these requirements are clear. Although BNR has proposed what is believed to be an appropriate monitoring plan, this approach has not yet been endorsed or authorized. BNR hoped the GWMP would form a framework for robust discussion and engagement with DWER and EPA. However, this has yet to be realized. Given BNR's experience with sampling in the Canning Basin (within EP371) and following engagement with other operators in WA, BNR understands that there are differing expectations between governmental Departments regarding groundwater monitoring requirements (both from a baseline and surveillance perspective). Further BNR does not believe that referring to the guideline is appropriate given the guideline is nonspecific and is openly interpreted differently between departmental agencies, proponents and SME contractors. From day 1, BNR has been actively lobbying to collect baseline post Ministerial Statement to enable clear conditions such as "implement the Groundwater Management Plan" to be put on BNR. We believe that this "de-risks" both the project execution but also environmental uncertainty as a clear framework (in lieu of clear governmental guidance) could be followed. The problem we have had is that it wasn't until recently that DWER agreed that collection of baseline data post Ministerial statement would be reasonable (in 2023). Since referring the project, there have been multiple years of discussion (and delays) whilst BNR have tried engaging with the EPA and DWER to confirm that: • baseline could be collected post Ministerial Statement, and • that the Groundwater Monitoring Plan developed and proposed was scientifically robust and consistent with DWERs objectives.

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EPA Services comment	Proponent response
	Unfortunately, it feels like there has been a disconnect between BNR and the EPA / DWER regarding the importance of these engagements (given similar comments are being received post multiple updates to management plan with limited ability to discuss with DWER). Now we are 5 years into an approval process with the potential requirement to collect 2 years of baseline data (which in reality if we were already through the process, we could be well on the way to collecting this data).
Item 5g EPA Services advises that a reduced baseline monitoring program from the Grant aquifer may be justified given the deep, confined nature of the Grant Group aquifer and likely slow rates of water quality change.	BNR contends that based upon the most recent IESC report (IESC, 2024) that there should be no requirement to sample within the Grant group. However, BNR has agreed to collect Poole aquifer data from a single location within the Project Area. Please refer to Section 3.1 of the GWMP.
Item 6. EPA Services supports the proponent's commitment to maintain a 600 m separation distance between the top of the HFS fracture zone and the base of the deepest aquifer. In a local context, the base of the Reeves Formation should be considered the base of the deepest/nearest aquifer, noting the hydraulic connectivity between this formation and the Grant Formation. Where the Anderson Formation (confining layer) is less than 600 m thick it is expected the remaining distance at the top of the Laurel Formation would be excluded from any HFS zones. For example at the location of the Asgard 1 well, the Anderson Formation is approximately 200 m in thickness. The depth of horizontal well sections, and related HFS zones, will need to be determined based on predicted geology (including from drilling data) along the horizontal section to ensure that the 600 m separation is maintained.	Regardless of the separation distances, the risk assessment as detailed in the ERD remains the same in that the risk of vertical migration is non-plausible. BNR maintains that separation requirements should be limited and calculated relative to the bottom of the Poole aquifer. However, for reference the bottom of the Grant formation is estimated to be between 1200 m and 1400 m deep (Figure 5-16 of the ERD) indicating that at least 450 m separation between the base of the Grant formation can be achieved. Should the distance be less than this, BNR has evaluated the risks of vertical migration (exposing or impacting overbearing aquifers) in Section 5.4.5.4. The separation distances are only a small part of the equation, all of which indicate the potential for exposure remains non-plausible. The proposed vertical extent of the fracture envelope is expected to be ~150 m. As such, even if the separation distance is 400 m to the bottom of the Grant formation, BNR does not believe it is plausible for induced fractures to create a hydraulic connection between the deep back shales and other tight formations and overlying potable aquifers such as the Grant formation and Poole aquifer. This is determined based upon limitations to fracture height growth and potential fault slip, as discussed in the HFS Scientific Inquiry (Buru Energy, 2018). In summary, BNR has committed to at least 600 m separation distance from the base of the nearest useable aquifer (defined as the Poole aquifer) and anticipates that at least 600 m separation between the base of the Grant formation will be achieved. However, BNR will commit to a separation of the 450 m from the HFS Zone to the base of the Grant Formation for this Proposal. The risk of exposing the Grant formation to vertical migration of fluids remains non-plausible (as per the full assessment completed in the ERD). In summary: the fracture envelope is expected to 150 m, above which is the Anderson Shale / Sandstone which acts as a confining geological seal.

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	- the Laurel formation is predominately self-sealing (due to well depth and associated pressure) indicating that the geology is pre-disposed to self-seal any fractures. - all faults are closed and no geo-mechanical hazard for upward propagation could occur as the activation energy required to dilate faults or fractures in tension is higher than overburden (meaning fracture growth would rotate to horizontal before opening such faults in tension).
Item 7a The flood risk assessments provided in the ERD are not considered to be consistent with current industry standards and guidelines. EPA Services previously noted that available data indicates that the proposal area is unlikely to be impacted by flooding in the Fitzroy River. However, flood risk from Mount Hardman Creek has not been assessed. Based on available survey information, the proposed well locations (midgard and muspelheim) are approximately 1 m above the level of the creek and would be likely to flood based on knowledge for the adjacent catchment (Mount Wynne Creek). Furthermore, the general area could be subject to shallow sheetflow (<0.3 m deep) over the ground surface during major rainfall events.	BNR only completed a desktop assessment given the civil wellsite and pond engineering is not yet complete and the modelling requires the site design to validate that flood risks have been sufficiently mitigated. Completing quantitative modelling at this point of the Proposal would require duplication of modelling effort following design commencement. The desktop analysis indicates that the flood height of (Fitzroy River) waters from extreme events are unlikely to significant influence the Proposal engineering design, however BNR agrees that detailed analysis on a per well basis is required (this is an existing requirement under the Petroleum and Geothermal Energy Act 1967 thus was planned to be completed post Ministerial Approval). It is in BNR's interest to ensure flood risks are mitigated given the potential economic impacts (associated with asset integrity events). BNR understands that given the location of EP 371 that inundation from rainfall events and localised flooding would be expected. Given the proximity to Mount Hardman Creek BNR expects that in the event of intense weather systems there is the potential for the area to flood consistent with EPA services comment. However, BNR commit to completing quantitative flood modelling during the design phase of the Proposal to ensure that infrastructure design can be complete in a manner that eliminates the risk of pond inundation during a flood event. BNR will not construct ponds where modelling indicates that those ponds are at risk of inundation during extreme flood events. BNR can either then provide this design on a per well basis to the EPA to validate their suitability (as a Ministerial Condition) or these designs can be provided to DEMIRS via the well planning approval requirements under the <i>Petroleum and Geothermal Energy Resources Act 1967</i> consistent with all other drilling programs in the Kimberley.
Item 7b The final well pad and storage pond designs, and operational procedures should consider this information, along with major rainfall predictions.	Well pad, storage pond designs and operational procedures will consider flood risk assessment. This is standard practice and required under the <i>Petroleum and Geothermal Energy Resources Act 1967</i>. That is why commitments have been written the way they have in the ERD to ensure that the specific details are captured when the engineering design is completed and when the drilling contractor is selected.

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2.2 Proponent Response to Summary of Submissions

2.2.1 The Proposal – General Comments

No.	Submitter	Submission and/or issue	Response to comment
1.	Group 1 (See Appendix 1) Proforma 1 Proforma 4	A high number of submissions expressed general opposition to the proposal, with key issues raised including:	Many industries currently coexist within the Kimberley Region, for example Iron ore, diamond exploration, mineral sands, O&G, ports, etc. Further noting that the Proposal footprint, in comparison to these industries is relatively small.
		the lack of consideration of the global significance of the Kimberley environment, including the heritage and ecological values of the Martuwarra Fitzroy River	BNR evaluated the exposure mechanisms by which the proposal could directly or indirectly impact any surface water bodies (both within the Development envelope and outside of the Development Envelope). Refer to: IW-004
		disturbance of pristine and relatively undisturbed landscapes	BNR has evaluated the potential impacts to flora and vegetation (Section 5.1), terrestrial environmental quality (Section 5.2) and inland water quality (Section 5.4) and subsequent potential impacts arising from the proposal within the ERD and believes that the quality of the land along with existing land uses has been suitably represented.
		the scale and associated risks of the proposal in the Kimberley that could lead to further industrialisation of the Canning Basin	The proposal is limited to an exploration and appraisal project. Any further activities will be subject to separate assessment and approvals (including cumulative consideration of this proposal). Refer to: GS-004
2.	ANON-6RBT-RUET-X	The ERD failed to meet the requirements of the approved Environmental Scoping Document (ESD).	Refer to: GS-034

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No.	Submitter	Submission and/or issue	Response to comment
3.	ANON-6RBT-RU1B-R ANON-6RBT-RUGC-F	Submissions expressed concerns about the timing of the EPA's assessment given the Implementation Plan's Progress indicates that almost half of the actions (encompassing 30 of the 44 recommendations arising from the HFS Inquiry) have still not been implemented. A Code of Practice (Action 11) that aims to develop an enforceable Code of Practice and implement the intent of the recommendations for a code that defines and prescribes minimum standards for onshore exploration and production proposals involving hydraulic fracturing have not yet been drafted.	BNR acknowledges the comment, however all recommendations from the Scientific enquiry have been incorporated into the ERD. Refer to: GS-028
		One submission noted that although the ERD outlines that the proponent will comply with a Code of Practice once developed, this is considered unsatisfactory as the Implementation Progress states: "Proponents will not be permitted to commence hydraulic fracturing exploration until the WA Code of Practice has been developed, and hydraulic fracturing production will not be approved until Traditional Owner and private landowner consent requirements have been implemented".	BNR must comply with all legislation and approval under the EP Act is not the only approval required before BNR can commence activities. However as detailed in the ERD BNR has traditional owner consents in place for the project.
4.	ANON-6RBT-RUET-X	The proponent's statements and claims are not reliable due to: Black Mountain Energy was issued with three Infringement Notices by ASIC (Section 12GX of the Australian Securities and Investments Commission Act 2001) in 2022 for making false or misleading claims in relation to its 'Valhalla' EP371 activities, specifically in relation to greenhouse gas emissions. Black Mountain Energy has made other incorrect claims in relation to its project, for example in relation to the granting of an onshore gas export exemption and the native title status of its lease.	BNR has engaged independent consultants to support the delivery of the environmental studies, modelling and impact assessments for the project. No previous infringements are related to the company's environmental management or on-ground performance.
5.	ANON-6RBT-RUET-X	The proponent contacts details (Level 4, 225 St George Terrace) included in Table 1-1 of the ERD document is false, as visits to that address could not locate an office representing the proponent (either Bennett Resources or Black Mountain). Additionally, it is possibly illegal to provide false address to the EPA. The information is misleading as public has been advised that it was possible to collect a copy of the ERD from the proponent's office.	The address provided is correct. However, given work from home restrictions arising from COVID and a reduced office staff that are scattered around the world, the office is manned infrequently.
6.	ANON-6RBT-RUET-X ANON-6RBT-RU17-D ANON-6RBT-RUE2-V	A cumulative impact assessment of foreseeable future expansions has not been undertaken. If the exploration and appraisal program is approved and	The proposal is limited to an exploration and appraisal project. As detailed in the ERD it is possible that only Phase 1 activities will be completed with a clear decision required to progress additional activities. Understanding of future prospectivity or development is not clear at this stage (and will rely on data

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		successful, a petroleum production industry will be established in the area involving: - hundreds or thousands of wells to be drilled and fractured - a total clearing footprint up to or over 10,000 ha - using over 10,000 ML of groundwater - releasing over 200 million tonnes of CO₂-e - constructing over 1000 km of pipeline to the Burrup Peninsula for LNG export. These future cumulative impacts should be considered reasonably foreseeable since the proponent itself has promoted these outcomes. Companies in the Kimberley, including the proponent) often compare the scale of the hydrocarbon resource in the Canning basin to the Eagle Ford and Piceance basins the US, therefore the foreseeable future impacts arising from the successful implementation of the Valhalla exploration project should be considered.	gathered from this proposal to make an informed decision). As such any further activities will be subject to separate assessments (including cumulative consideration of this proposal). Refer to: GS-004
7.	ANON-6RBT-RUET-X	An assessment of the significant, direct, indirect and cumulative impacts associated with 'frack sand' (proppant) has not been undertaken. It is estimated that approximately 47,000 tonnes of sand will be used for 20 wells (Note calculation is done based on the sand requirements for the similar Shenandoah Pilot Project). The ERD does not provide information about the sourcing, washing (including water sources) and transport of the large quantities of proppant for the proposal. Additional greenhouse gas emissions will be generated for the mining and transport of proppant. It is not clear whether table 5-49 of the ERD includes the GHG emissions associated with the mining and transport of proppant.	BNR will acquire the quantities of proppant from a third party. Similar to sourcing any materials for a project – the sourcing washing and transport of the required proppant will be conducted by a third-party activity and subject to separate consideration and assessment. This is not dissimilar to all other material equipment mobilisations required. BNR does not yet have a known source or agreements in place for this material so inclusion of this (along with inclusion of other materials that are required to be purchased and used in support of the project) is not appropriate.
8.	ANON-6RBT-RUET-X ANON-6RBT-RUE6-Z	The appendices to the ERD do not provide a reliable basis for impact and risk assessment as they are outdated, irrelevant, misleading and poor-quality documents and studies.	Once approvals are received and prior to project execution further data will be collected and used along with historical information to inform the projects potential impacts, this represents best practice. Currently, there is no cleared access to the proposed well sites and approximately 25-30 hectares of vegetation (directly adjacent to the proposed wellsite) would need to be cleared to access the proposed wells in order to provide local baseline groundwater data. This equates to approximately 22 % of the total project disturbance footprint. Given the regulatory uncertainty associated with the project

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			due to the lack of regulatory framework post moratorium, clearing this area to implement a baseline program for a proposal that may or may not be approved by government (given the lack of policy support) does not seem like a reasonable environmental endeavour. Further to this, BNR considered it unlikely that any of the subsequent required approvals could be sought as other decision makers would likely be constrained from making a decision subject to final EPA approval. However, BNR has included many commitments and management plans that identify the information that is required to be collected, how the data will be utilized and how this will inform on ground management and decision making. BNR believes that this is the most appropriate way to balance environmental impact
9.	ANON-6RBT-RU7B-X ANON-6RBT-RUFZ-5	The proposal should be declared a 'controlled action' for its impacts on threatened species and water resources and undergo an assessment under the EPBC Act.	BNR has referred the Proposal under the EPBC Act [2024/10006] which addresses Matters of National Environmental Significance. A Referral Decision/Assessment approach is due from DCCEEW by the end of January 2025.
10.	ANON-6RBT-RU7Z-P ANON-6RBT-RUF6-1 ANON-6RBT-RUFA-C ANON-6RBT-RU8H-5 ANON-6RBT-RU93-H ANON-6RBT-RU6Z-N ANON-6RBT-RUBE-C	Renewable energy sources are a safe alternative and the proponent should invest in renewable energy to mitigate environmental and health impacts associated with the implementation of the proposal.	Renewable energy was considered in the GHG Management Plan (Table 2-4) but was not considered suitable given the nature of the proposal (being limited to a temporary exploration activity)
11.	ANON-6RBT-RU94-J	Hydraulic fracturing activities are harmful in ways that cannot be mitigated through regulation. The submitter provided the following points based on the Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking and Associated Gas and Oil Infrastructure (9th edition, October 19, 2023): Fracking activities have detrimental impacts on public health, climate stability, water and air quality, farming and livestock, property values, economic vitality, and quality of life. Fracking is an unpredictable process with innate engineering problems that include uncontrolled fracturing, induced earthquakes, and well casing failure that worsen with age. Intractable problems also include radiation releases,	BNR has completed a human health assessment in the ERD which was peer reviewed and validated through consultation with Department of Health. Refer to: HH-001 A recent independent advice report on unconventional gas completed by the (IESC, 2024) confirmed that a key risks from deep unconventional gas projects arise from standard storage and handling practices which can be suitably mitigated with standard operational management. BNR has considered local seismic changes. Refer to:

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		abandoned wells that are pathways for contamination, and venting, flaring, and blowdowns that result in methane releases.	TEQ-008 BNR has sufficiently discussed groundwater contamination in the ERD. Refer to: IW-003 BNR has assessed the presence of naturally occurring radioactive material (NORMS) in produced water within the ERD. Refer to IW-001 IW-012 BNR has considered and assessed flare emissions in the ERD. Refer to: AQ-001 Blowdowns are associated with production. The proposal is limited to exploration and appraisal activities. BNR has discussed and assessed greenhouse gas emissions (including methane emissions) in the ERD Refer to: GG-002 Well decommissioning BNR will manage its wells throughout their lifecycle under a well integrity management system, which includes meeting or exceeding all requirements set forth in the Petroleum and Geothermal Energy Resources (Resource Management and Administration) Regulations 2015, as required by DEMIRS. Under the Regulations, a Well Management Plan (WMP) that describes the history of all well activities relating to the planning, design, construction, integrity, and management of a well throughout its life cycle (including decommissioning) must be approved by DEMIRS. A preliminary well decommissioning plan will be included in the WMP, with the final plan approved by DEMIRS under the Petroleum and Geothermal Energy Resources (Resource Management and Administration) Regulations 2015 based on the actual geology / stratigraphy and results of the drilled well prior to commencement of the well decommissioning process.

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Approver:

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			While this Proposal covers exploration and appraisal only, should a commercially viable resource be found, it is recognised that any of these wells may form part of a production program in the future. ISO Standard 16530-1:2017 will be adhered to throughout the planning, construction, testing and decommissioning phases to effectively manage well integrity during the well life cycle. Please also refer to ERD Section 2.4.6 Site reinstatement/decommissioning and Section 2.5.1.6 Well decommissioning.

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2.2.2 Flora and Vegetation

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12.	ANON-6RBT-RUEQ-U ANON-6RBT-RUET-X ANON-6RBT-RU7X-M ANON-6RBT-RU77-K ANON-6RBT-RU1Q-7 ANON-6RBT-RUYA-Y ANON-6RBT-RUB4-U ANON-6RBT-RUBG-E ANON-6RBT-RUE8-2 ANON-6RBT-RU1B-R	Submitters noted that the proposal would result in clearing of native vegetation that will impact 3 land systems and 4 vegetation associations that consist of 235 flora species and 13 vegetation communities mostly in excellent to very good condition. Submitters stated that due to the data deficiencies, there is an uncertainty about the actual impacts and risks to flora and vegetation. The following deficiencies were noted: Vegetation and habitat mapping is inadequate (Appendix C). It does not give an indication of the extent, configuration or connectivity of vegetation communities/fauna habitats within the wider landscape. Vegetation mapping in low resolution (1:1,000,000) does not clearly show disturbance areas in the context of natural features in the landscape including waterways and vegetation cover. The ERD claims that the flora and vegetation of the development envelope is well understood (page 83). However, the discovery of 112 individuals of Priority 3 species <i>Nymphoides beaglensis</i> from eight locations within an "additional survey area" of 15.69 ha is further evidence that the vegetation is not well understood. Flora surveys undertaken for the proposal did not meet the requirements for targeted surveys.	BNR does not believe flora and vegetation will be significantly impacted. Refer to: FV-001 BNR has used vegetation mapping to understand the extent of broadscale vegetation communities in the region. Refer to: FV-003 As per the EPA guidelines, the flora and vegetation survey has identified its limitations. The limitations identified are largely associated with access due to the lack of cleared access. Refer to: FV-004 The Valhalla Flora and Fauna Survey states <i>"Eco Logical Australia (ELA) was commissioned by Bennett Resources to undertake a Detailed and Targeted flora and vegetation survey and a Basic fauna survey of the Project Area, which consists of access tracks, camp locations of proposed well pads (the Disturbance Footprint; 112.46 hectares), and an additional 15.69 hectares of alternative tracks (Additional Survey Area; 128.15 hectares total)." (ERD Appendix C).</i> As per the EPA guidelines, the flora and vegetation survey has identified its limitations. The limitations identified are largely associated with access due to the lack of cleared access. Refer to: FV-004

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		No targeted surveys have been undertaken to gather sufficient information on flora and/or vegetation. Targeted surveys would likely to reveal new populations and confirm significant direct, indirect and cumulative impacts and risks to flora and vegetation.	The Valhalla Flora and Fauna Survey states <i>"Eco Logical Australia (ELA) was commissioned by Bennett Resources to undertake a Detailed and Targeted flora and vegetation survey and a Basic fauna survey of the Project Area, which consists of access tracks, camp locations of proposed well pads (the Disturbance Footprint; 112.46 hectares), and an additional 15.69 hectares of alternative tracks (Additional Survey Area; 128.15 hectares total)."</i> (ERD Appendix C) As per the EPA guidelines, the flora and vegetation survey has identified its limitations. The limitations identified are largely associated with access due to the lack of cleared roads and vegetation type. Refer to: FV-004
13.	ANON-6RBT-RU1B-R	It is noted that survey and assessment has been restricted to access tracks and well pads only. The location of ancillary activities (installation of gathering networks, drilling waste and flowback wastewater management, chemical and fuel handling, groundwater extraction and monitoring, sand extraction) that likely to result in direct and indirect impacts to the surrounding environment have not been mapped. No information is provided about the impacts associated with clearing for firebreaks and construction of waterway crossings.	BNR do not propose to place any infrastructure associated with the Project in areas of native vegetation that are outside of the Disturbance Footprint. As such BNR surveyed 100% of the native vegetation areas that are proposed to be disturbed. . Certain activities (such as sand extraction) are considered outside the scope of this proposal. BNR will acquire the quantities of proppant from a third party. Similar to sourcing any materials for a project – the sourcing washing and transport of the required proppant will be a third-party activity and subject to separate consideration and assessment. BNR does not yet have a known source or agreements in place for this material so inclusion of this (along with inclusion of other materials that are required to be purchased and used in support of the project) is not appropriate. BNR has not completed detailed design of the well pads. Once the Proposal is approved, a detailed design of each well pad will be completed including the location of all ancillary infrastructure and equipment. Well pad designs will be approved by DWER and DEMIRS prior to construction. Well pad design is dependent on which a drilling rig is to be selected for use and subsequent placement of the wells on each well pad. Location of the impact monitoring bores having regard to the known wells and wastewater pond will be discussed with and approved by DWER.

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			However, BNR can confirm that all the activities and infrastructure associated with the Proposal will be located within the approved disturbance footprint, either on the well pads or on the access tracks. Fire breaks will be placed in accordance with the Shire of Derby/West Kimberly and be within the disturbance footprint. The Proposal will also have appropriate fire response equipment on site. As the disturbance footprint does not overlap any waterways (with the s43a requested early in the process to realign an access track to avoid crossing waterways), there will be no clearing or disturbance of waterway crossings in the disturbance footprint. All direct and indirect impacts arising from the proposal have been accounted for and BNR does not believe flora and vegetation will be significantly impacted. Refer to: FV-001

2.2.3 Landforms

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14.	ANON-6RBT-RUE6-Z	One submitter considered that 'landforms' should always be a key environmental factor. The submitter noted that consideration of landforms will help to understand and evaluate the environmental risks of the proposal and risks to groundwater reservoirs by studying the behaviour of runoff. There are nine land systems within the area of influence of the proposal: Alexander, Calwynyardah, Camelgooda, Chestnut, Djada, Luluigui, Mamilu, Myroodah and Yeeda land systems (See Figure 1). The proposal will interact with some land systems to a greater extent and with some to a lesser extent. For instance, the Yeeda land system contributes overland flow across the landscape encompassed by the proposal. Increasing the through flow of water also increases the risk of contaminants being carried to the Martuwarra Fitzroy River. The Alexander land system is a possible, but unlikely transit area for runoff and contaminants from the proposal area to the river. Parts of the remaining systems are in a direct line of flow from the proposal area and the	The assessment of potential environmental impacts focuses on the key environmental factors identified in the ESD, which are further discussed in the ERD Sections 5.1 to 5.9. Landforms was not deemed by the EPA to be a key environmental factor for the proposal Refer to the approved ESD. Soil landscape systems are discussed in the ERD Section 5.2.3.1. Also see Figure 5-8. Soil quality characteristics are discussed in the ERD Section 5.2.3.2. Including Soil physical analysis. Soil mapping profiles are discussed in the ERD in Section 5.2.3.3 Potential impacts to soil and terrestrial quality are discussed in the ERD in Section 5.2.4.

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		Martuwarra Fitzroy River, Mt Hardman Creek and My Wynne Creek (Payne, A. and Schoknecht, N., 2011). The submitter also describes the importance of the soil systems within the project area which helps to understand the movement of contaminants and assess the associated risks to the surrounding environment, particularly the Martuwarra Fitzroy River. Figure 1. Location of the Kimberley land systems within the area of the proposal and approximate direction of overland flow across the systems	BNR has developed an environmental monitoring program to be implemented. Refer to: IW-017 BNR has also considered impacts from constructing access tracks and hardstand in the ERD. Section 5.4.5.3 Changes to surface water flow due to the construction of well sites and access tracks also discusses localised surface water flow.

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2.2.4 Subterranean Fauna

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15.	ANON-6RBT-RUET-X ANON-6RBT-RU97-N ANON-6RBT-RU17-D ANON-6RBT-RUY5-K ANON-6RBT-RU1B-R ANON-6RBT-RU1F-V	Submissions raised concerns regarding potential impacts to subterranean fauna, and the lack of detailed information on subterranean fauna values within the proposal area. Specific issues raised in the submissions included: The proponent failed to undertake any actual on-ground survey to identify the presence and significance of subterranean fauna within the project area. The ERD acknowledges that subterranean fauna in the region is recognised as being “globally significant” due to its “extraordinarily high species richness and high levels of endemism,” but no dedicated survey and impact assessment has been undertaken. Local sampling within the geological and hydrogeological units should be undertaken to be able to determine whether subterranean fauna species or communities of concern occur. Given there are no site-specific data on subterranean species diversity or habitat requirements, the desktop review is not sufficient to assess the impact to subterranean fauna. The proposal has the potential to impact stygofauna as poor management strategies have been formulated in the absence of adequate data. Given the current state of knowledge of subterranean fauna in the region is limited, the magnitude of impacts to subterranean fauna could be greater than predicted in the ERD. The submitter references the EPA’s Technical Guidance on Sampling methods for Subterranean fauna that states: “The Kimberley is poorly surveyed... It is likely significant troglofaunal communities occur in the Kimberley”. Rockwater (2016) and Bennelongia (2023) desktop studies fail to address the issue of groundwater quality adequately. The reports do not provide discussion on dissolved oxygen, which is a critical parameter where there is variable permeability throughout the aquifer depth profile. Submitters raised concerns about the large volume of groundwater abstraction for the proposal, and groundwater contamination as potential impacts to subterranean fauna.	BNR believe that sufficient information exists to inform the risk assessment and detail that risks are unlikely to be significant. The desktop assessment completed by Bennelongia (2023) (ERD Appendix S) found that: While the likelihood of stygofauna occurrence and the nature of any stygofauna community remains unclear, this has little relevance to an assessment of potential impacts of groundwater abstraction on stygofauna in the Project area because the maximum drawdown experienced at each bore is modelled to be only 1.2 m and to decline to 1 m at 56 m from the bore. The level of drawdown interpreted as having potential impact on stygoofauna is usually taken to be 2 m (EPA, 2016). Both the very small spatial extent of drawdown, and the minimal drawdown itself at the Project, indicate the there is little likelihood of impact on stygofauna, irrespective of whether a stygofauna community is present. Subterranean fauna impact assessments were undertaken in ERD Section 5.9.5.1 Groundwater drawdown of surficial aquifers associated with water extraction and ERD Section 5.9.5.2 Potential contamination of surficial aquifers from an accidental release (of drilling fluids, HFS chemicals, liquid hydrocarbons, or produced formation water) at the surface. The outcome of the assessment that should any indirect impacts to potential subterranean fauna habitat occur it would be highly localised in extent and duration with impacts to potential habitat returning rapidly recovering following completion of water abstraction activities. Further mitigations relevant to subterranean fauna can be found in ERD Section 5.9.6 Mitigations.

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			Further to this, the GWMP lists the requirement to sample Dissolved Oxygen and as such these parameters will be monitored.

2.2.5 Terrestrial Environmental Quality

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16.	ANON-6RBT-RUY5-K ANON-6RBT-RUE6-Z	Submitters stated that the proponent inadequately considered the risks from the chemicals used for the proposal and insufficient information has been provided to properly evaluate the risks to the environment. The following specific concerns were raised in the submissions: Appendix A 'Chemical Inventory' provides Safety Data Sheet documents for chemicals intended to be used; however no ecological risks assessment information is available for some chemical products.	BNR has provided the required information consistent with the ESD. During the ESD process BNR discussed chemical management including the assessment and approval process under the <i>Petroleum and Geothermal Energy Resources Act 1967</i>. BNR has provided all relevant information as required by the ESD noting that not all Safety Data Sheets (SDS's) have ecotoxicological information and it is standard practice to utilize other sources to inform the assessment of these chemicals. Refer to: TEQ-003
		The National Toxic Network Australia (NTN) Submission to the Inquiry into Unconventional Gas (Fracking) in South Australia (2015) concluded that the regulatory controls for the chemical and mixtures of chemicals that are typically required in hydraulic fracturing activities were inadequate to protect against environmental impacts. The NTN also highlighted the problem of safe disposal of waste drilling muds and fluids, and other products used in the process.	The design and formation of fluid systems are done in conjunction with well engineering practices. BNR has discussed chemical management multiple times with DWER including how chemicals are considered, selected and approved under the Petroleum and Geothermal Energy Resources Act 1967. <u>Produced Wastewater Pond</u> Once evaporation is complete, the ponds will only have a thin coating of residue and not will not comprise a sludge. This residue is then cleaned from the pond liner (scrubbed, contained and removed offsite via small tanks or vacuum trucks given small volumes of residue) and disposed of at an appropriate waste disposal facility. When the infrastructure is no longer required, liners are then pulled and also disposed of at an appropriate waste disposal facility. As detailed in Table 2-8 of the ERD, management of these wastes will be managed in accordance with the requirements of the Radiological Council and the Radiation Safety (General) Regulations 1983.

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			<u>Drilling Fluid and Cutting Sump</u> Drilling fluids will be stored in the Drilling Fluid and cuttings sump. Once the pond is no longer required, BNR will allow excess fluids to evaporate from the pond. BNR will then collect a number of samples from within the mud sump (consistent with decommissioning requirements under the Petroleum and Geothermal Energy Resources (Environment) Act 1967) and analyse the remnant solid waste for the various characteristics to determine the classification and landfill type that accepts this material. The solids will be removed from the mud sump and where not suitable to be buried in situ (consistent with DWER Assessment and management of contaminated sites guidelines (DWER, 2021) requirements), be removed to an appropriate waste disposal facility. The plastic sump liner will then be removed when the infrastructure is no longer required and sent for disposal at an appropriate waste disposal facility. On removal of the plastic sump liner, the soil beneath the liner will be sampled and analysed for potential contaminants. In the event the soil beneath the sump liner is determined as being not suitable to remain in situ, the contaminated soil will be removed to an appropriate waste disposal facility. The mud sump will then be backfilled using fill remaining from site construction or sourced from deconstruction of the well location as well as the previously removed and tested mud sump solid waste if determined suitable for burial in situ. It should be noted that the regulatory environment in South Australia (SA) is different to that in WA and SA are considering moving towards that provided in WA.
		The International Pollution Elimination Network (IPEN) recognised the risks from the many chemical additives used during the HFS process due to the use of hazardous substances. Appendix A 'Chemical Inventory' lists 187 solutions to be used for fracking process, but the proponent did not address the toxicity or incompatibilities between the chemicals and its safety, as the use of chemicals pose a high risk of contamination. The submission provides an assessment of the potential contamination using KLA-STOP as an example.	BNR has provided a list of all chemicals to be introduced into the environment in the ERD consistent with the ESD requirements. Ecotoxicity testing of the combined fluid system planned to be used for the proposal has been undertaken by the previous operator and demonstrated that the fluid system is of very low toxicity (Buru Energy, 2018) Refer to: TEQ-003

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		Comprehensive consideration of the landscape of the proposal area and the understanding of the potential impacts are crucial. Extensive distribution of sandy soils suggests that chemicals will be transferred via the soil profile to the alluvial aquifer underlying the proposal area and into the Martuwarra Fitzroy River.	BNR has considered the physical properties of the environment with regards to potential project impacts and risks. Section 5.2.3 Receiving environment of the ERD details the overall landform and geography of the Project Area in Depth, whilst the water resources are discussed within Section 5.4 Inland waters of the ERD. The exposure pathways to surface waterbodies including those outside of the Development Envelope are also addressed in the ERD and clarified in: IW-004.
		Interactions between contaminants, soil and groundwater are very complex. Considering the climate and based on the Fitzroy River Groundwater review (Harrington G.A. and Harrington N.M., 2015), it is understood that annual potential evapotranspiration greatly exceeds rainfall. This means that if the activities are taken during dry season, there will be little transfer of contaminants. However, during the wet season contaminants will be transferred into the Martuwarra Fitzroy River and into the groundwater system.	BNR evaluated the exposure mechanisms by which the proposal could directly or indirectly impact groundwater and any surface water bodies (both within the Development envelope and outside of the Development Envelope). Refer to: IW-004 IW-003

2.2.6 Terrestrial Fauna

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17.	Group 2 (see Appendix 1) Proforma 1 Proforma 2 Proforma 3 Proforma 4	A large number of submissions raised concerns about impacts of the proposal on terrestrial fauna. Specific issues raised included: Significant direct and cumulative impacts on terrestrial fauna due to habitat loss and fragmentation. The project has the potential to contribute to population decline, disease dynamics and disruption of migratory pathways.	BNR does not believe the project will significantly impact fauna habitat / destruction or result in the population decline of significant fauna species. Refer to: TF-001 TF-008 An assessment of migratory species specifically protected under the EPBC Act has been included along with the referral to DCCEEW. It should be noted that in the EPBC Referral [2024/10006] although migratory species were considered (assessed) by BNR, the outcome was that these species were deemed not present in the proposal area and /or will not be significantly impacted.

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			Population decline arising from direct and indirect impacts from the proposal has been considered in Section 5.3.5. Although disease dynamics have not explicitly been assessed in the ERD, BNR considered habitat destruction, fragmentation and loss in Section 5.3.5. given the Disturbance Footprint is located on an active pastoral station, BNR does not believe that installation of additional access tracks will significantly increase the disease dynamics given the limited impacts of fragmentation on the key fauna species.
		Habitat fragmentation will increase access for invasive species such as foxes and cats. The cumulative impacts of habitat fragmentation and fox predation are not adequately discussed or considered in the ERD.	BNR assessed the potential impacts associated with fragmentation (and associated fauna impacts including introduced pathways for introduced species) in the ERD (refer to Section 5.3.5.4). in summary The ERD stated: <i>Although there is the potential for indirect impacts arising from opening up habitat to predators, there is no evidence to indicate any overall increase in predation because there is limited temporal overlap between the Greater Bilby and its predators</i> (Dawson, S, 2017) Further to this, mitigations detailing the requirement to implement introduced predator management (consistent with the request from DWER) is included in Table 5-18 of the ERD indicating sufficient controls are in place for this risk. Also refer to: TF-005.
		The impacts of noise and light pollution to terrestrial fauna need to be considered.	BNR acknowledges that light emissions were not clearly considered in the ERD. This has been addressed in: TF-004 The well sites are situated within two pastoral stations, where pastoral, petroleum activities, and vehicle movements associated with the local community are common. As such fauna are likely to be accustomed to noise and traffic movement and any noise would be restricted to short periods of loud activities. Historical monitoring of similar activities indicates that HFS activities typically produce noise levels <65 dB(A) 800 m away from the source indicating a highly localised impact. Given the nature of the activity (being an exploration activity) noise and vibration emissions will be limited to the duration of the activity and immediately return to ambient levels once activities are complete indicating the proposed action will only result in a localised and short-term increase in noise and vibration levels. Further

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			detailed assessment (including a description of modelling and monitoring) is provided in Section 5.5.5.2 of the ERD. Item 17.1 Noise and light impacts to terrestrial fauna Initial assessment of fauna impact was limited to fauna strike, noise and vibration. As it is exploration only and the well sites are spread out over a large distance (and as detailed by the sound modelling), exposure areas are not anticipated to overlap, indicating that only temporary localised impacts would be expected (consistent with exploration activities). It should be noted that testing of multiple wells at the same time is highly unlikely given multiple crews and equipment would need to be mobilised. Noise Refer to ERD Section 5.3.5.1 The temporary increase in impacts such as noise and vibration resulting from the Proposal were also considered. Such impacts may have the potential to displace fauna species. As the Development Envelope is situated within two pastoral stations, where pastoral, petroleum activities, and vehicle movements associated with the local community are common, fauna are likely to be accustomed to noise and traffic movement. Additionally, noise impacts are restricted to short periods of loud activities, including mobilisation and demobilisation of people and equipment. Therefore, it is expected that fauna would avoid the area during these times. The death or displacement of native fauna species as a result of the Proposal remains possible; however, the Development Envelope has similar habitat throughout, and any displacement would be limited to the activity, causing only short-term and temporary impacts. Light As with noise and vibration, light impacts to fauna are expected to be minimal as placement of wells are spread out around the Development Envelope and not concentrated in one location. Only a single well at a time will be worked on, and drilling activities will result in localised impacts only (due to the emissions associated with generators, and temporary light towers that are no different to any other civil activity). During HFS and well testing activities, light emissions may increase due to the requirement for multiple pumps and subsequent flaring operations. However, these too are limited in duration. The activity is a non-

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			permanent / non-production activity thus once the activity ceases, ambient light levels, noise levels and vibration levels will immediately return to ambient. BNR notes that light emissions may not have been explicitly addressed, and thus provides information below that is consistent with the recent EPBC Referral: The Proposal is situated within two pastoral stations, where vehicle movements associated with the local community are common. As such fauna are likely to be accustomed to traffic movement and artificial lighting used for drilling and HFS activities. Subsequently no changes to fauna behaviour are expected to arise from these sources. The largest change to ambient light levels will be associated with well testing / flaring activities that will be 24-hour operations for no more than 90 days per well. Light from flaring will be visible from a distance further than the wellsite. Due to the temporary nature of the activity, considering flare heights, natural terrain and vegetation within the Proposal Area, changes to ambient light levels are not expected to be significant. As well testing is for no more than 90 days, ambient light levels will only be altered for a short period of time and will immediately return to ambient levels following completion of the activities. Although flaring may result in an increased change to ambient light levels adjacent to the wellsite, as flaring will occur at differing well sites in a series (not in parallel) impacts will be spread throughout the Proposal area and are not expected to result in any cumulative impacts to any species that are present within or adjacent to the Proposal Area. As such, BNR does not believe that the Proposed Action will result in a significant impact to fauna from this cause. Further to this, targeted fauna surveys indicate light sensitive species (such as Ghost Bats) are highly unlikely to be present given the lack of suitable habitat within the Proposal. Other impacts to fauna from increased light may include attraction of introduced or invasive species such as the cane toad (<i>Rhinella marina</i>). No cane toads were identified in the 2021 Ecological Survey or 2024 Ecologia Survey. Although the Proposal is not located in the known distribution of cane toads, the Proposal area is in the predicted distribution area. Additional management and mitigation measures will be implemented if cane toads are detected in the vicinity of the Proposal area. Additional management and mitigation measures for noise, vibration and light will be considered where behavioural disturbances, displacement of species or introduction of invasive species are observed. By having these contingency mitigations, BNR can implement an appropriate adaptive environmental

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			management program that will inform future program design. This is considered appropriate and commensurate to the level of potential impact identified.
		The adverse impacts of noise from gas flaring on terrestrial fauna is well established (Shannon G. et al., 2015).	The well sites are situated within two pastoral stations, where pastoral, petroleum activities, and vehicle movements associated with the local community are common. As such fauna are likely to be accustomed to noise and traffic movement and any noise would be restricted to short periods of loud activities. Historical monitoring of similar activities indicates that HFS activities typically produce noise levels <65 dB(A) 800 m away from the source indicating a highly localised impact. Given the nature of the activity (being an exploration activity) noise and vibration emissions will be limited to the duration of the activity and immediately return to ambient levels once activities are complete indicating the proposed action will only result in a localised and short-term increase in noise and vibration levels. Further detailed assessment (including a description of modelling and monitoring) is provided in Section 5.5.5.2 of the ERD.
		The project will likely have a significant impact on threatened species, in particularly the greater bilby that is listed as Vulnerable.	BNR does not believe the project will significantly impact fauna habitat / destruction or result in the population decline of significant fauna species. Refer to: TF-001
		The project is likely to have a significant impact on terrestrial fauna which could include their consumption of contaminated water from fracking chemicals especially during the wet season	<u>17.2 – Wastewater ponds - Mitigation</u> Effective and humane bird control methods such as physical barriers (netting) or bird deterrents will be considered on a well-by-well basis subject to routine inspections indicating the ponds start to act as an attractant. These mitigations will be evaluated and implemented following a robust analysis where the outcome indicates the mitigations provide a net environmental benefit and not cause an overarching disproportionate impact to identified species (such as resulting in entrapment). As detailed in ERD Section 5.3.6 Mitigation. BNR will conduct routine inspections of areas considered to be potential fauna traps. These include open excavations or well cellars, if they need to be left open. Egress paths from ponds will also be regularly inspected to ensure their useability. In addition, wastewater ponds will be inspected daily to ensure no fauna (including birds) are trapped or adversely affected by contact with wastewater.

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			BNR has detailed mitigation measures in the ERD to manage impacts to fauna in relation to wastewater ponds. Table 5-18 (Proposed mitigation measures – terrestrial fauna) of the ERD lists mitigation measures such as fauna exclusion and egress requirements for wastewater ponds along with other mitigations to prevent release into the surrounding environment. These controls are standard across the onshore petroleum industry, including other operating facilities and produced water storage ponds. Additional controls (such as pond netting / bird diverters) were considered but as these controls also pose potential risks to bird species (including entrapment and behavioural change) and as the risk was considered to be low, they have not been selected for use. However, these controls can be retroactively added (as they are not critical design elements) to the infrastructure if the ponds are found as a bird attractant. Mitigation controls are evaluated on a case-by-case basis to provide a net environmental benefit.
18.	ANON-6RBT-RUET-X ANON-6RBT-RU8T-H ANON-6RBT-RU1B-R	Submitters raised concerns about the adequacy of fauna surveys: No detailed targeted fauna surveys have been undertaken for the project area to accurately understand species presence, significance and threats. Although the ERD indicates that the fauna presence within the project area is well understood given the numerous surveys that have been conducted for previous petroleum activities within exploration permit EP371 (ERD page 118), the proponent has not demonstrated that the terrestrial fauna of the project area is well understood. The proponent presents conflicting, incomplete and sub-standard reports and commentary about terrestrial fauna. For instance, page 122 in the ERD states that the greater bilby habitat likely to be available within the development envelope. However, the proponent considers that additional surveys are not required given the mitigations presented in Section 5.3.6. The proponent plans to complete a targeted survey at least six months prior to commencing the proposal to ensure no active burrows are present within the disturbance footprint. Given appropriate surveys have not been undertaken, the proponent cannot claim that the proposal will not impact conservation listed fauna species populations, or cause significant degradation or fragmentation of habitat surrounding the development envelope (ERD page 132).	BNR has completed targeted surveys since completion of the ERD to support referral of the project under the EPBC Act which validate BNR's understanding of the project area (Appendix 3). After considerable survey effort in the vicinity of the potential diggings, no additional distinctive secondary or primary signs were recorded to confirm the presence of bilby within the project area. In addition to this, the traditional custodian who accompanied Ecologia during the survey indicated that bilbies are generally seen south of the Fitzroy River in the sandy country and not regularly encountered within the vicinity of the project area. Refer to: TF-001 BNR does not believe the project will significantly impact fauna habitat / destruction or result in the population decline of significant fauna species.

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19.	Department of Biodiversity Conservation and Attractions (DBCA)	Given the presence of suitable habitat and potential for <i>Magrotis lagotis</i> (bilbies, ranked vulnerable) to be present within the development envelope, the surveys supporting the ERD are not considered to be sufficient. Although the ERD specifies that a targeted survey will be undertaken for the disturbance footprint at least 6 months prior to clearing activities and mitigation measures will be applied to minimise the potential impacts to bilbies, the targeted surveys across suitable habitat should be undertaken in line with the current guidelines (DBCA, 2017 and Southgate et al., 2018).	BNR has completed targeted surveys since completion of the ERD to support referral of the project under the EPBC Act which validate BNR's understanding of the project area (Appendix 3). After considerable survey effort in the vicinity of the potential diggings, no additional distinctive secondary or primary signs were recorded to confirm the presence of bilby within the project area. In addition to this, the traditional custodian who accompanied Ecologia during the survey indicated that bilbies are generally seen south of the Fitzroy River in the sandy country and not regularly encountered within the vicinity of the project area. Refer to: TF-001
		Due to species mobility, DBCA recommends undertaking pre-disturbance targeted survey within the 14 days prior to disturbance, as a timeframe of six months is not considered appropriate.	BNR has recently completed targeted fauna surveys (refer to TF-001 / Appendix 3). BNR will complete pre-clearance surveys within 14 days prior to disturbance per DBCA recommendation.
		DBCA advised that the current mitigation measures included in the ERD are insufficient to minimise the risk of introduced predators to terrestrial fauna, specifically bilby. DBCA recommends the development of a bilby management plan. The plan should include avoidance and management measures, including introduced predator mitigation measures and vehicle speed limits to ensure the risks and impacts on bilby are appropriately managed.	BNR notes DBCA's requirements to develop a management plan. However, management measures consistent with management plan requirements have already been presented in the ERD and will form the control measures of subsequent Environment Plans. These mitigations are consistent with other management plans known to be implemented in the region and are consistent with previous feedback from DBCA. The mitigations to avoid and minimize impacts as detailed in Table 5-18 of the ERD include the following mitigations: • Fauna exclusion and egress • Targeted Bilby Survey • Specific bilby management measures • Speed limits • Fire breaks • Site inspections of fauna traps • Weed management measures • Introduced predator management. Refer to the ERD for details on these measures.

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			BNR does not believe that development of another management plan is required as the mitigations are consistent with industry standard management plans.
20.	DBCA	<i>Trichosurus vulpecula arnhemensis</i> (northern brushtail possum, ranked vulnerable) has the potential to occur within the disturbance envelope. DBCA advised that the species had been identified within 50 kilometres of the project area in 2019 and 2022. DBCA recommends conducting targeted surveys to identify the presence of northern brushtail possum within the development envelope, to clarify direct, indirect and cumulative impacts of the proposal to species if suitable habitat is identified.	According to the Valhalla Flora and Fauna Survey (Ecological 2021 ERD Appendix C) the Post-survey likelihood justification states “<i>No habitat for this species is present within the Project Area.</i>” BNR will complete pre-clearance surveys prior to clearing. The <i>Trichosurus vulpecula arnhemensis</i> (northern brushtail possum, will be considered in these surveys as per DBCA recommendation.
21.	DBCA	Pre-clearance targeted surveys should be undertaken to identify, avoid and relocate <i>Tiliqua scincoides intermedia</i> (northern blue-tongue skink) individuals, as it is listed as critically endangered under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> (EPBC Act). Northern blue-tongue skink may shelter under shrubs and thick grasses, in leaf litter and within burrows and rock crevices and most of their movements throughout the day are limited to 20 meters (DCCEEW, 2023).	BNR will complete pre-clearance surveys prior to clearing. The <i>Tiliqua scincoides intermedia</i> (northern blue-tongue skink) will be considered in these surveys as per DBCA recommendation. BNR will liaise with DBCA in the event that the Northern blue-tongued skink (<i>Tiliqua scincoides</i>) is recorded during pre-clearance survey.
22.	DBCA	Given the proposal may require Ministerial authorisation under the Biodiversity Conservation Act 2016 (BC Act), DBCA recommends the proponent to contact DBCA's Species and Communities Program to discuss requirements under section 40 of the BC Act.	BNR acknowledges compliance with all environmental legislation is required as detailed in Section 1.4. In the event that authorisations are required under the <i>Biodiversity Conservation Act 2016</i> BNR will seek to have these in place prior to completing the required activities.
23.	ANON-6RBT-RUET-X	The proponent failed to adequately demonstrate that threatened fauna species are not present within the project area and/or will not be significantly impacted by the project. There are discrepancies in threatened and migratory species information provided in the ERD and in the referral documents to Department of Climate Change, Energy, the Environment and Water (DCCEEW) under the Environment Protection and Biodiversity Act 1999 (EPBC Act). For example, table 5-15 in the ERD excludes listed threatened and migratory species which the proponent included in its referral information to DCCEEW. Those species are: Northern quoll (<i>Dasyurus hallucatus</i>) Ghost bat (<i>Macroderma gigas</i>) Greater bilby (<i>Macrotis lagotis</i>)	It should be noted that the inconsistency in fauna species are due to the requirements from DCCEEW to evaluate these species (even if these are then ruled out). The approval processes are separate, and the required information is provided in the required form to enable government departments to follow their administrative processes. It should be noted that in the EPBC Referral [2024/10006] although these species were considered (assessed) by BNR, the outcome was that these species were deemed not present in the proposal area and /or will not be significantly impacted. BNR assessed the impacts to the freshwater sawfish but due to the lack of credible exposure mechanisms does not believe impacts will occur. Refer to TF-007

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		Northern brushtail possum (<i>Trichosurus vulpecula arnhemensis</i>) Gouldian finch (<i>Erythura hallucatus</i>) Grey falcon (<i>Falco hypoleucos</i>) The ERD does not mention the Freshwater (largetooth) sawfish (<i>Pristis pristis</i>), a listed threatened migratory species. Whereas the species is discussed in the EPBC referral documents, claiming that it is not present in the project area and will not be impacted by the project. The submitter notes that the EPBC Attachment 4 (Flora and fauna assessment. Odin 2D and 3D seismic survey, Fitzroy Basin, WA prepared by Low Ecological Services P/L (2020) for Bennett Resources) states that given largetooth sawfish are known from the Fitzroy River and associated tributaries, the species will likely be present in the project area (page 36).	
		Similarly, the ERD Appendix C (EcoLogical Australia survey) states that purple-crowned fairy wrens were observed within the project area, but the attachments 11 and 12 provided to DCCEEW indicate that no habitat for this species is present within the project area and the species is unlikely to occur.	It should be noted that approval under the EPBC act is a separate process. It should be noted that in the EPBC Referral [2024/10006] These species were considered (assessed) by BNR. although the survey (ERD Appendix C EcoLogical Australia survey Appendix K) states that it was directly observed, the outcome for presence on habitat in ERD Appendix C EcoLogical Australia survey Appendix D Fauna likelihood of assessment (Post survey likelihood justification) regarding the purple- crowned fairy wren was that <i>"No habitat for this species is present within the Project Area. Several historical records (1920 - 2000) 25 km east of the Project Area."</i> As such any presence of this species is expected to be transient with exposure to large numbers of individuals not expected.
24.	ANON-6RBT-RUE2-V	The submitter states that the following species are likely to be directly and indirectly impacted by the proposal due to habitat loss and fragmentation and water contamination of groundwater dependent ecosystems: Critically endangered: Curlew Sandpiper (<i>Calidris ferruginea</i>), Endangered: Northern Quoll (<i>Dasyurus hallucatus</i>), Gouldian finch (<i>Erythrura gouldiae</i>) Purple Crowned Fairy-Wren (<i>Malurus coronatus</i>) endangered and rare Night Parrot (<i>Pezoporus occidentalis</i>), Princess parrot (<i>Polytelis alexandrae</i>), Australian Painted Snipe (<i>Rostratula australis</i>).	These species were assessed in the EPBC Referral [2024/10006]. Please also refer to: TF-008 IW-003 IW-004

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		Vulnerable: Greater Bilby (<i>Macrotis lagotis</i>), Ghost Bat (<i>Macroderma gigas</i>), Black-footed rock-wallaby (West Kimberly Race) (<i>Petrogale lateralis</i>), Freshwater sawfish (<i>Pristis pristis</i>).	
25.	ANON-6RBT-RUET-X ANON-6RBT-RUYV-M ANON-6RBT-RUEQ-U ANON-6RBT-RU9V-M ANON-6RBT-RUY5-K ANON-6RBT-RU1F-V	The proposal has the potential to impact freshwater sawfish at Mount Hardman Creek via groundwater drawdown and/or surface water contamination or in the Fitzroy River due to surface water contamination from flooding events. The proponent failed to properly consider the implications of major flooding events and potential impacts to threatened species such the freshwater sawfish.	BNR evaluated the exposure mechanisms by which the proposal could directly or indirectly impact any surface water bodies (both within the Development envelope and outside of the Development Envelope). Refer to: IW-004 BNR has engaged a freshwater sawfish specialist (Dean Thorburn from Indopacific) who confirms that species habitat is highly unlikely to be present in the Proposal area or in Mount Hardman Creek. Although the final report is not yet complete, this report will support BNR's DCCEEW assessment process. BNR has assessed that no direct or indirect impacts to the Freshwater Sawfish will occur Refer to: TF-007
26.	ANON-6RBT-RUY5-K ANON-6RBT-RU4P-9 ANON-6RBT-RU1B-R	Submitters state that the proposal has the potential to impact the greater bilby. Submissions highlighted the following points: The proposal does not include baseline or ongoing monitoring for impacts to greater bilby populations from the proposal. Greater bilby could be at risk from increase predation, including by feral cats, due to clearing from seismic lines and vehicle trails and the loss off protective habitat. The mean home range of female bilbies is 0.182 km (DCCEEW conservation advice, p2), which is less than the 22 ha (0.222 km) disturbance footprint. It is feasible that disturbance of this size for the proposal could have an impact on the foraging behaviours of female bilbies, produce further environmental fragmentation and edge effects, and create barriers to dispersal and gene flow. The project will fragment vegetation and will increase access opportunities for foxes, cats and other feral pets. Fox predation has been identified as a major threat to bilbies (Conservation Advice 2016).	BNR has completed targeted surveys since completion of the ERD to support referral of the project under the EPBC Act which validate BNR's understanding of the project area (Appendix 3). After considerable survey effort in the vicinity of the potential diggings, no additional distinctive secondary or primary signs were recorded to confirm the presence of bilby within the project area. In addition to this, traditional custodian Tyrone Skinner indicated that bilbies are generally seen south of the Fitzroy River in the sandy country and not regularly encountered within the vicinity of the project area.Refer to: TF-001 BNR assessed the potential impacts associated with fragmentation (and associated fauna impacts including introduced pathways for introduced species) in the ERD (refer to Section 5.3.5.4). in summary The ERD stated <i>..Although there is the potential for indirect impacts arising from opening up habitat to predators, there is no evidence to indicate any overall increase in predation because there is limited temporal overlap between the Greater Bilby and its predators</i> (Dawson, S, 2017).

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			Further to this, mitigations detailing the requirement to implement introduced predator management (consistent with the request from DWER) is included in Table 5-18 of the ERD indicating sufficient controls are in place for this risk. Refer to TF-005 TF-008
		As drainage lines are prime bilby habitat, contamination of surface waters could result in additional impacts to the greater bilby.	Contamination of surface waters is addressed in the ERD. Refer to IW-004
		Progressive rehabilitation of cleared areas may be insufficient to address the residual impacts for short-lived species. The greater bilby has a typical maximum lifespan of 6-7 years and could be severely impacted by vegetation clearing that has not been sufficiently rehabilitated within a short time frame.	Duration of rehabilitation completion in the Kimberley is more rapid than in other areas of the state due to rainfall availability. BNR does not believe that progressive rehabilitation of cleared areas are insufficient to address the residual impacts for short-lived species given it is expected that cleared areas would be expected to recover within 5-7 years. Further to this, areas proposed to be cleared are within an existing pastoral station that comprise a network of existing access tracks and hardstands (of which BNR has designed the proposal to utilize as much as possible to reduce direct impacts to flora and vegetation).
		It has not been substantiated that the proposed mitigation measures, such as buffers for identified burrows, are adequate.	DBCA have provided comment on proposed buffers and distances and BNR amended the ERD accordingly Section 5.3.6.
27..	ANON-6RBT-RUY5-K	Documents submitted to DCCEEW (<i>Assessment to potential impacts to MNES</i> (Rev B)) indicate that there is no suitable habitat for the ghost bat in the proposal area, but foraging habitat may be present. Appropriate mitigation strategies such as the use of fencing, enclosure of wastewater sources and protection of foraging habitat should be in place to protect ghost bats from the impacts of the proposal.	Subsequent targeted fauna surveys that are now reflected in Appendix 3 indicate no rocky habitats considered as critical habitat (roosting or denning) for the ghost bat and northern quoll were identified and no major drainage lines considered as dispersal habitat were identified. It is considered unlikely that northern quolls and ghost bats will utilise any of the habitats found within the disturbance footprint. Refer to: TF-001
28.	ANON-6RBT-RU1F-V	Wastewater ponds present a risk to threatened species. Bats are known to utilise wastewater treatment ponds. Stock-proof fencing does not prevent access to waste ponds by small species such as ghost bats, quolls and numbats (Korine C. et al.,2016). The submitter states that all waste fluids should be required to be stored in rigid, closed-loop tanks to mitigate impacts to fauna.	Mitigation measures are detailed in ERD Section 5.3.6 Mitigation Table 5-18 discusses fauna exclusion and egress from water retention ponds including fencing. These will be included in an Environment Plan (EP) for assessment and acceptance by DEMIRS under the PGER(E)R before activities commence.

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			Whilst BNR acknowledges closed loop systems (and the use of sealed tanks) can mitigate exposure of pond waste to fauna species, this creates additional impacts which BNR considered in the design of the project. The use of sealed tanks is not considered an ALARP control measure as the impacts outweigh the benefits as: BNR will require additional space and the “tank farm” would require a significant higher amount of clearing to support the volumes required The waste (trucked to an associated facility) will require a significant amount of trucking and associated risks (emissions, fauna strike risk, traffic etc) and result in utilizing a large part of liquid waste facility capacity (rather than evaporate off the water and dispose of the remnants residue only).
29.	ANON-6RBT-RUY5-K	Mitigation strategies to identify key habitat requirements or protection of EPBC listed migratory bird species from the proposed hydraulic fracking activities have not been addressed.	BNR has detailed mitigation measures in the ERD to manage impacts to fauna in relation to wastewater ponds. Table 5-18 (Proposed mitigation measures – terrestrial fauna) of the ERD lists mitigation measures such as fauna exclusion and egress requirements for wastewater ponds along with other mitigations to prevent release into the surrounding environment. These controls are standard across the onshore petroleum industry, including other operating facilities and produced water storage ponds. Additional controls (such as pond netting / bird diverters) were considered but as these controls also pose potential risks to bird species (including entrapment and behavioural change) and as the risk was considered to be low, they have not been selected for use. However, these controls can be retroactively added (as they are not critical design elements) to the infrastructure if the ponds are found as a bird attractant. Mitigation controls are evaluated on a case-by-case basis to provide a net environmental benefit. BNR has also referred also the Proposal under the EPBC Act [2024/10006] which addresses Matters of National Environmental Significance. Decision/Assessment approach is due from DCCEEW Q2 2025.

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30.	ANON-6RBT-RU1B-R	One submission noted that aquatic habitats have not been mapped and assessed in the ERD. The ERD did not consider the presence of ephemeral wetlands in the vicinity of the development envelope. Nor did the ERD adequately consider the likely impacts to the Fitzroy River or Mount Hardman Creek which provide habitat for freshwater sawfish.	BNR has discussed and mapped where relevant aquatic habitats in the ERD were present. This included updating the ERD with figures based upon feedback on the ERD from DWER. BNR evaluated the exposure mechanisms by which the proposal could directly or indirectly impact any surface water bodies (both within the Development envelope and outside of it. this ensures that a conservative approach is applied for ephemeral surface water features that are not mapped but present within the Development Envelope and the broader region. The impact pathways have been appropriately assessed for all surface water features. Refer to IW-004 IW-008

2.2.7 Inland Waters

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31.	ANON-6RBT-RUET-X	The ERD fails to adequately identify, map and assess the extent and significance of permanent and ephemeral wetlands, springs marshlands and other water-dependent ecosystems within or adjacent to the project area that are likely to be directly, indirectly or cumulatively impacted by the proposed hydraulic fracture activities. The ERD does not document and consider numerous ephemeral wetlands within the exploration petroleum licence EP 371 that are likely having high conservation significance.	BNR has discussed and mapped relevant aquatic habitats in consultation with DWER in the ERD. Refer to IW-008 As surface water features are outside of the Disturbance footprint they will not be directly impacted by the proposal. Indirect impact exposure mechanisms were evaluated to all surface water bodies. Refer to IW-004 for more information on these mechanism and assessments.

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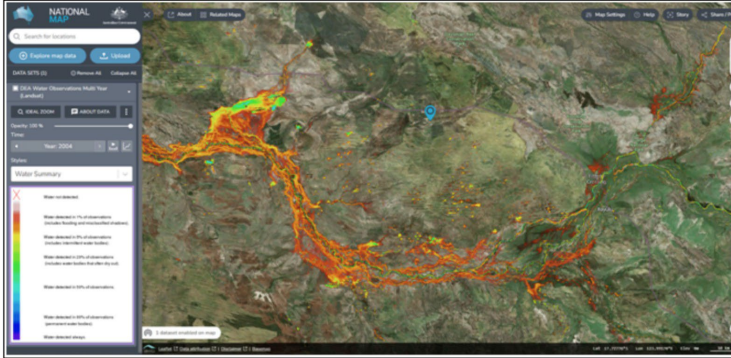
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		 Figure 2. Surface Water Feature Persistence Mapping (source: https://www.nationalmap.gov.au/#share=s-aKwJUX0i2AQzLMQVzwikbF1zuo6) Figure 5-36 in the ERD shows the existing 'lakes' and 'swamps' in proximity to proposed well #4. However, the ERD does not provide information about the nature of significance of these surface water features or potential impacts to them.	
32.	ANON-6RBT-RU1B-R ANON-6RBT-RU1F-V ANON-6RBT-RUET-X ANON-6RBT-RUYE-3	Submitters raised concerns that potential impacts of the proposal to surface waters have not been considered or assessed appropriately. Submissions highlighted the following points: Given the lack of site-specific surveys and baseline data and reliance on management plans that are yet to be developed, there is a high risk that surface waters will be impacted. The ERD refers to the outdated Guidelines for the protection of surface and groundwater resources during exploration drilling (DMPR 2002) but does not refer to Environmental Factor Guideline for Inland Waters (EPA 2018).	BNR does not believe there is a "high risk" that surface waters will be impacted. For further information please refer to: IW-004 ERD Section 5.4.2 Policy and Guidance states that Environmental Key Factor Guideline – Inland Waters (EPA, 2018) was used as a guidance document. The Guidelines for the protection of surface and groundwater resources during exploration drilling (DMPR, 2002) details a key mitigation for protecting useable aquifers. This document was referenced as a source for a standard industry control measures that is in place (and has been since 2002) to protect groundwater sources from hydrocarbon drilling activities.

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		No recent site-specific investigations of surface waters or hydrogeology have been undertaken as part of the referral and included in the ERD. The proponent relies on an outdated Fitzroy River integrated ground and surface water hydrology assessment that was conducted between 2008 and 2014 and includes some records from 2005.	No direct impacts to surface waters are planned. Indirect impacts (or risks) to surface waters have been assessed informed by various data sources. No additional data collection was required under the ESD or deemed to be required by BNR to support the assessment. Please refer to: IW-004 BNR has discussed and assessed hydrogeology in a regional context and aquifer connectivity in the ERD. Please refer to IW-011
		DWER (2023a) describes weather change projections near the Fitzroy River to include increases in the magnitude of flooding as well as the severity and duration of droughts or both. These changes may impact river pools and their ability to sustain water over the dry season without groundwater interaction. The ERD fails to assess how the proposal will impact on groundwater discharge to seasonal baseflow and whether ephemeral pools in the Fitzroy River and Mount Hardman creek, with the associated dependent aquatic fauna, will be affected.	Groundwater drawdown and potential impacts on GDEs are assessed in the ERD. Please refer to: IW-004 The proposal is associated with a one-off exploration activity over a seven-year window not a permanent activity that will continually use water each year. BNR does not believe that, given the nature of the –exploration project, it will result in prolonged and increased impacts over a longer time frame. If the appraisal is successful further approvals will be applied for.
33.	ANON-6RBT-RUET-X	The proponent failed to conduct adequate and required baseline groundwater level and water quality monitoring. ESD Required work #2 required the proponent to undertake baseline monitoring of geogenic chemicals, radon and methane concentrations for a minimum of 24 months prior to commencing the proposal.	ERD Appendix E Valhalla Environmental Monitoring Program is a comprehensive Monitoring Plan for Soil quality, Air Quality, Methane Emissions and NORMs. Refer to: IW-017 BNR has developed a GWMP and will implement this following the approval of the project. For additional justification regarding this approach, please refer to: IW-025 IW-026 IW-027 GS-034

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34.	Group 4 (see Appendix 1)	A large number of submissions raised concerns about the volume of groundwater to be abstracted for the proposal and potential impacts to other groundwater users. Submissions highlighted the following points:	The proposal is limited to an exploration and appraisal project. Any further activities will be subject to separate assessment (including cumulative consideration of this proposal).
	Proforma 1	The use of 2 billion litres of groundwater for the exploration and appraisal program for 20 wells is significant. The volume of groundwater to be abstracted will be multiplied if the further expansion of the proposal occurs.	BNR have discussed groundwater drawdown impacts on pastoral bores in the ERD Refer to: IW-002 Consideration of groundwater allocation is detailed in Section 5.4.3.3.4 Local and regional use of the ERD. Refer to: IW-005
	Proforma 2		
	Proforma 3		
	Proforma 4	The nearest groundwater user is the Yungngora community, located approximately 18 km south. The ERD does not disclose whether the Yungngora community is reliant on the Liveringa aquifer.	The nearest Grant group aquifer bore (including the Poole aquifer) is the Yungngora Community bore (YG2/18) which is located within the Yungngora community. Section 5.4.3.4.3 acknowledges that the Yungngora bore is associated with the Poole aquifer. Please note that “the Yungngora Community – located ~28 km from the nearest proposed well site”
		Given the reliance of nearby residents and pastoral users on groundwater bores, and the serious consequences of changes in groundwater levels to those users, the EPA should adopt a precautionary principle in its assessment.	Potential impacts to pastoral station water use is detailed in Section 5.4.5.1 Changes to groundwater levels (groundwater drawdown) associated with water extraction of the ERD. In summary drawdown modelling indicates that for a single wellsite a 10cm drawdown is expected 400 m from the pumping bore reducing to 2 cm at 500 m and 1 mm drawdown at 700 m (Intera Geosciences Pty Ltd, 2023). As detailed in Section 7.1 (Cumulative impacts) Inland Waters no pastoral bores are known to be within 1.5 km of the well sites; therefore, there should be no overlap in groundwater depressions associated with pastoral and Proposal use. BNR have discussed groundwater drawdown impacts on pastoral bores in the ERD Refer to: IW-002
		The proponent holds a licence pursuant to s5C of the <i>Rights in Water and Irrigations Act 1914</i> (WA) (RIWI Act) to take 103,800 KL water per annum for the maintenance of three existing exploration wells. This suggests that approximately 34,000 KL water is required annually for maintenance purposes per well for the life of the well. For the proposed 20 wells, assuming well lives of 10 years, this equates to an additional 6,800 ML of water the project may require	At the time of the ERD BNR held three separate licences which were then amalgamated into a single licence for ease of administrative burden. Each of these licences were acknowledged in the existing use (Section 5.4.3.3.4 and Table 5-23 of the ERD).

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		for maintenance purposes that has not been included in analysis of impacts to water resources.	The assumption is incorrect (30kL required annually per well). Water allocation is required in the event that a well workover is required, however this is not an annual activity and only required when maintenance or intervention efforts are needed to be undertaken. Currently this has not been required for BNR's existing assets and annual water use is very low (next to zero). However, if it were required, BNR have approval to enable the safe and efficient management of its assets without the need to reactively seek approval from the government. Consideration of groundwater allocation is detailed in Section 5.4.3.3.4 Local and regional use of the ERD - indicating that: In accordance with the RIWI Act 1914, DWER allocates water use via groundwater licences within the sustainable volume available for a groundwater resource. DWER has determined that the Canning-Kimberley groundwater area has an allocated limit of >300,000 ML / year (DoW, 2014), of which only 0.9 GL (4.3 %) is licensed within the Liveringa Aquifer (Harrington & Harrington, 2015). As detailed in Section 5.4.5.1 Changes to groundwater levels (groundwater drawdown) associated with water extraction, BNR's water use for the Proposal per well represents a negligible portion (<0.034 %) of the Canning Basin allocation limit and is far less than water extracted for other uses in the region such as by communities and pastoralists.
35.	Proforma 2 ANON-6RBT-RUYE-3 ANON-6RBT-RUF3-X ANON-6RBT-RU8S-G ANON-6RBT-RU14-A ANON-6RBT-RUB6-W ANON-6RBT-RU7H-4 ANON-6RBT-RU9W-N ANON-6RBT-RU1J-Z ANON-6RBT-RU15-B ANON-6RBT-RUYD-2 ANON-6RBT-RU4U-E ANON-6RBT-RUG7-3 ANON-6RBT-RUUW-H ANON-6RBT-RUUJ-4 ANON-6RBT-RUU5-F	Groundwater extraction will cause drawdown of pastoral bores, which is a significant impact and needs independent expert review from the Independent Expert Scientific Committee (IESC).	BNR cannot advise EPA on the assessment process and use of an Independent Expert Scientific Committee (IESC) other than to state that governmental experts within the water branch of DWER have been engaged with over the course of the Proposal. Potential impacts to pastoral station water use is detailed in the ERD Section 5.4.5.1 Changes to groundwater levels (groundwater drawdown) associated with water extraction of the ERD. In summary drawdown modelling indicates that for a single wellsite a 10 cm drawdown is expected 400 m from the pumping bore reducing to 2 cm at 500 m and 1 mm drawdown at 700 m (Intera Geosciences Pty Ltd, 2023). As detailed in Section 7.1 (Cumulative impacts) Inland Waters no pastoral bores are known to be within 1.5 km of the well sites; therefore, there should be no overlap in groundwater depressions associated with pastoral and Proposal use. Please refer to: IW-002

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36.	ANON-6RBT-RUE6-Z ANON-6RBT-RUYE-3 ANON-6RBT-RUET-X	The hydrogeological assessment (Rockwater 2016) is outdated and has very limited value for the purposes of assessing the proposal. Hydrogeological assessment was based on one proposed frack well. The report cannot be considered an adequate assessment of the hydrogeology of the area or the associated groundwater impacts and risks of the proposed 20 wells.	The only direct hydrogeological impacts that will arise from the Proposal is related to groundwater drawdown. The Proposal will only extract water from the Liveringa. There is no connectivity between the Liveringa and the Poole (Item 5) and as such it is irrelevant to review drawdown from the Poole. The hydrogeological assessment and EIA are sufficient to understand groundwater drawdown impacts from the Liveringa. This is consistent with in-field monitoring completed by the previous operator monitoring drawdown during abstraction. Further to this, groundwater abstraction (for the purposes of HFS) is no different to groundwater abstraction for other activities such as pastoral and mining activities in the region. <u>Modelling</u> The system was modelled with individual one-layer models for each aquifer system rather than an integrated multi-layer model with some limitations on vertical inter-formational flows (e.g. an aquiclude or vertical anisotropy). Using individual one-layer models and applying all expected pumping to each model results in a more conservative model as any intraformational flows would likely result in additional water moving into the abstraction formation, which in turn will reduce modelled drawdowns. This approach is therefore considered to be a conservative approach that will overstate actual aquifer drawdowns. Additional local data will be collected following the drilling of the well (including local faulting information) which will inform the geotechnical risk assessment in accordance with the HFS Scientific inquiry recommendations. Please refer to: GS-026: BNR does not agree with this statement The report cannot be considered an adequate assessment of the hydrogeology of the area or the associated groundwater impacts and risks of the proposal.

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			The EIA is based upon a magnitude of high-quality regional proponent and publicly available data. All drawdown modelling was based upon operating multiple wells at the same time. BNR re-engaged Intera to validate model inputs and assumptions including completion of sensitivity analysis and extraction rates. Please refer to: IW-028
		The hydrogeological assessment focusses on impacts associated with groundwater abstraction and the development of a groundwater drawdown cone around point of abstraction. The assessment does not analyse and provide explanations on the risks to groundwater associated with hydraulic fracturing activity which could generate fractures and faults in overlying and surrounding structures, including aquifers. The separation zone of 700 m between the base of the Grant aquifer and the proposed fracking target does not guarantee that fractures and faults will not happen. These fractures and faults could permanently alter the upper aquifer and reduce water quality and quantity for other users. Therefore, the impacts on hydraulic fracturing on upper aquifers should be the focus in hydrogeological assessment.	BNR have considered and assessed the risk of HFS activities causing faults in the ERD. Refer to: IW-010 BNR has discussed and assessed hydrogeology in a regional context and aquifer connectivity in the ERD. IW-011
		The hydrogeological assessment undertaken does not provide sufficient information on vertical groundwater flow. Given there are strong vertical hydraulic gradients in other parts of the Canning Basin, the hydrogeological assessment should present conceptual models for local groundwater at individual bore holes that considers vertical groundwater flow too. Given the <u>Independent Scientific Panel Inquiry into Hydraulic Fracture Stimulation in Western Australia Final Report</u> outlines that fracking is likely to have a moderate impact on shallow aquifer, there is a potential for connectivity.	Geological profiles and regional data indicate that the Liveringa and Poole aquifers within the Development Envelope are separated from each other (and from the targeted Laurel formation) via aquiclude's and impermeable geological formations (Table 5-20 in the ERD). BNR will validate this <u>at each</u> of the well sites as the petroleum well will be hydrostatically logged (in accordance with the mitigations detailed in Table 5-33 of the ERD). Water will only be abstracted from the Liveringa and as detailed in Section 5.4.3.3.1 of the ERD BNR has acknowledged that monitoring of the Liveringa Aquifer and surface alluvial waters associated with the Fitzroy River indicated a strong connection between the river and the aquifer. Modelling has considered groundwater drawdown (given potential connectivity with surface waters). For further information please refer to IW-004 BNR has discussed and assessed hydrogeology in a regional context and aquifer connectivity in the ERD. IW-011

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Document No: BNR_HSE_MP_016

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			In accordance with ESD Item 12, a comprehensive geotechnical risk analysis has been conducted and is attached in Appendix B Geotechnical Risk Assessment of the ERD. Multiple comments regarding the accuracy of desktop data has been received and in response to this BNR agrees that additional localised information is required to inform the risk assessment. This has always been BNR's position. This is why as detailed in Table 5 33: Proposed mitigation measures – inland waters, and as required following the outcomes of the Scientific Inquiry into fracking, that BNR has also including commitments to complete a site-specific geotechnical risk assessment will be completed after each well has been constructed and prior to any HFS taking place. This will enable site-specific geological information (including the identification of potential localised faulting) to be identified. in addition to identification of local faults this will enable BNR to validate that each HFS treatment will have more than 600 m vertical separation to the nearest useable aquifer. For further information regarding groundwater monitoring please refer to: IW-025 IW-026
		Recommendation 7 of the Independent Scientific Panel Inquiry into Hydraulic Fracture Stimulation in Western Australia indicated that all hydraulic fracture stimulation operations should be preceded by a comprehensive geomechanical risk analysis according to an enforceable Code of Practice. The hydrogeological assessment, particularly in relation to the potential for aquifer connectivity, should be reviewed in the context of the geomechanical risk analysis for the proposal.	Currently there is no legislation for fracking of HFS in Western Australia, however, BNR have addressed the 20 Actions outlined in the WA Government's Implementation Plan which arose from the 2018 Independent Scientific Panel Inquiry into Hydraulic Fracture Stimulation in Western Australia. Refer to: GS-028 Multiple comments regarding the accuracy of desktop data has been received and in response to this BNR agrees that additional localised information is required to inform the risk assessment. This has always been BNR's position. This is why as detailed in Table 5 33: Proposed mitigation measures – inland waters, and as required following the outcomes of the Scientific Inquiry into fracking, that BNR has also including commitments to complete a site specific geomechanical risk assessment will be completed after each well has been constructed and prior to any HFS taking place. This will enable site-specific geological information (including the identification of potential localised faulting) to be identified. in addition to identification of local faults this will enable BNR to validate that each

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			HFS treatment will have more than 600 m vertical separation to the nearest useable aquifer.
37.	ANON-6RBT-RUET-X ANON-6RBT-RU1B-R ANON-6RBT-RUEQ-U ANON-6RBT-RUEM-Q	There is a lack of information and uncertainty about groundwater in the Canning Basin. A full cumulative impact assessment that considered all impacts of groundwater abstraction and use has not been undertaken. The groundwater modelling (Appendix L) cannot be relied upon to accurately predict impacts to groundwater due to the following issues: Groundwater modelling for the proposal (INTERA Geosciences Pty Ltd, 2023) does not accurately predict impacts to groundwater. The model is highly simplified and is based on incorrect criteria and assumptions and therefore produces unreliable results and should be disregarded. The modelling assumed that the aquifers were unconnected. Harrington et al. (2011) indicated that there could be vertical upward flow of groundwater between the two systems and between the aquifer and the Fitzroy River. Taylor et al. (2021) concluded that there was insufficient information to determine if there are vertical interactions between the aquifers or even to develop aquifer parameters to model vertical flows. The vertical connectivity has not been included in the impact modelling which limits the ability of the modelling-based impact assessment to predict impacts appropriately (HydroGeoEnviro, 2024a). Groundwater modelling has considered the pumping of 33,400 kL/well whereas the conservative maximum amount of groundwater abstraction was increased up to 100 ML per well. The modelling is based upon a single bore at each well site and not two bores per well as proposed. Given the proposed activities are planned to be suspended during the wet season, there could be four wells drilled and fracked within any given 6-8 months, each requiring up to 100 ML of water. The ERD did not consider cumulative impacts to groundwater from likely abstraction and use of 400 ML during the driest 6-8 months.	BNR re-engaged Interra to validate model inputs and assumptions including completion of sensitivity analysis and extraction rates. Please refer to: IW-028 BNR re-engaged Interra to validate model inputs and assumptions including completion of sensitivity analysis and extraction rates. Please refer to: IW-028 BNR re-engaged Interra to validate model inputs and assumptions including completion of sensitivity analysis and extraction rates. Please refer to: IW-028 BNR re-engaged Interra to validate model inputs and assumptions including completion of sensitivity analysis and extraction rates. Please refer to: IW-028 Cumulative assessment and overlap of bore drawdown (assuming all bores are pumping at the same time) is provided in Section 7.1 of the ERD. Given there is no overlap in exposure areas (and as the aquifer will quickly recover on completion of abstraction) no cumulative impacts are expected.

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		The validity of the modelling results needs to be examined by considering larger pumping volumes for groundwater (100 ML) for each well.	BNR re-engaged Interra to validate model inputs and assumptions including completion of sensitivity analysis and extraction rates. Please refer to: IW-028
		Despite the claimed “conservative” approach to modelling and a water extraction rate lower than predicted, sensitivity analysis of aquifer simulations indicated that the Liveringa formation may not be able to sustain 100% of the required pumping rates.	BNR re-engaged Interra to validate model inputs and assumptions including completion of sensitivity analysis and extraction rates. Please refer to: IW-028 If insufficient water abstraction rates are achieved, BNR would review its approach which may include slower pumping over a prolonged period of time to achieve the same volumes, or installation of the bore deeper into the Liveringa.
		Given the information on the hydrogeology of the Canning basin is scarce and there is little understanding about the complexity of inter-aquifer and between groundwater and surface water connectivity and water quality parameters, the level of risks and impacts associated with the implementation of the project is uncertain. Submissions state that the EPA should apply the precautionary principle in its assessment.	Whilst BNR cannot respond to how the EPA should assess the project, sufficient modelling data (including sensitivity analysis) has been used to validate BNRs expectation (based upon previous projects) that sufficient information exists to demonstrate that the impacts and risks are low. Further, all commitments in the ERD to gather site specific local data along with management / mitigations commitments provided in the ERD and GWMP have been developed to ensure a robust management framework is in place to manage potential impacts and risks to inland waters.
38.	ANON-6RBT-RU1B-R ANON-6RBT-RUET-X	The ERD did not consider the potential impacts of the proposal to Mount Wynne hot spring and methane gas seep. The connectivity between the water and gas emerging at the Mount Wynne site and the deep aquifers and gas reserves that are planned to be targeted by the proponent has not been considered and discussed. Based on gas isotope studies conducted by Geoscience Australia, a review of available data has identified the likelihood of connectivity between the water and gas emerging at the Mount Wynne site and the deep aquifers and targeted gas reserves (Currell 2022). The review concluded: “Isotopes of methane from the seep are very similar to those in the methane sampled from the gas wells. This overlap suggests a common origin of the gas and is consistent with the gas at the seep being from the same primary source as gas being targeted and extracted by the gas wells. The methane may reach the seep from the deep shale layers in the basin either through migration as dissolved gas in groundwater circulating through the Canning Basin (which discharges at the seep, and/or movement as free phase gas, e.g., migrating	The only pathway for the targeted reservoir (laurel formation) to contaminate the Liveringa or surface waters (such as Mount Hardman creek or Mount Wynne Site) Appendix 8 is for hydrocarbons to migrate over 1800 m vertically through the impermeable Noonkanbah shale formation (~200 m thick) and the Anderson aquitard (~200 m thick). In this regard BNR does not believe that vertical migration in the Development Envelope is credible. Whilst BNR acknowledges that faults can create natural pathways for vertical migration (which may provide an explanation for Currell, 2022), BNR also understands that the geology is different depending on location with many formations at different depths making it more (or less) likely for communication with the surface depending on location. The best visual representation is Figure 5-31 in the ERD (Bennett Resources, 2024). BNR evaluated the exposure mechanisms by which the proposal could directly or indirectly impact environmental and social receptors both within and outside of the Development Envelope and as such consideration of environmental receptors outside of the Development Envelope include Mount Wynne Creek. Those exposure mechanisms include vertical migration as detailed in the ERD,

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		from deep in the basin to the surface via a geological structure. Further geological and geochemical information would need to be examined to further constrain the gas transport mechanism with more confidence." "Based on the isotope data analysed above, it appears that there is a likelihood of connection between shale gas resource targeted in the onshore Canning Basin, and the Mount Wynne seep at the surface. Gas and/or groundwater may therefore have one or more pathways of reaching the surface from deep in the basin. Shale gas extraction and hydraulic fracturing may therefore have potential to cause impacts such as drying up of the seep or, in the long-term, contamination of the seep and any other similar connected surface features in the region that are similarly connected to deep parts of the basin."	Section 5.4.5.4 - Potential contamination of aquifers through unplanned fracture heights. The outcome of this analysis is that BNR does not believe that the proposed vertical extent of the fracture envelope, which is expected to be ~150 m, is physically plausible for induced fractures to create a hydraulic connection between the deep back shales and other tight formations and overlying aquifers. BNR acknowledges that Mount Wynne Creek may well have communication between a deep formation and surface waters, and this is unable to be explained by BNR given a detailed subsurface geological / hydrogeological assessment for Mount Wynne Creek has not been completed as this is outside of the Development Envelope and not the focus of our Proposal (Appendix 8). However, the occurrence can be explained through either: 1. natural fault pathways, or 2. previous activities being undertaken directly below known naturally occurring faults and the induced fractures connecting to the natural faults. Regardless of the pathway, the Scientific Inquiry into hydraulic fracture stimulation is clear in its requirements for geomechanical assessments to ensure that activities do not commence before clear subsurface risks are analysed and mitigated. This is why (consistent with mitigations included in the original ERD) BNR has committed to building a specific local geological model based upon hydrostatically logged petroleum wells which will validate the required separation distances from faults, the pressure (and subsequent fracture lengths) and have these all independently verified before commencing any HFS activities. This will ensure that the connection to, or reactivation of any faults will arise. Given the distance from Mount Wynne Creek and other sensitive receptors outside of the Development Envelope, BNR does not believe that the Proposal poses a credible risk to these sensitivities with the highly conservative mitigations set out by the Scientific Inquiry and committed to by BNR. Following comments from DMAs, BNR updated the ERD to reflect known surface water features from governmental databases. As Mount Wynne is located outside of the Development Envelope (Appendix 8), and as no exposure mechanism exist that would result in any impact to this area. This is consistent with recent IESC

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			studies that confirmed a subsurface release from deep unconventional gas projects resulting in aquifer contamination is unlikely (IESC, 2024). Please refer to: IW-008 As can be seen in In the ERD Figure 5-31, within some areas of the Canning basin, the Grant-group (including the Poole aquifer) are located much closer to the grounds surface. This is reflected in the depth to Pool sandstone at Yungnogra (identified on Figure 5-31 in the ERD) - south of the Development Envelope and of Mount Wynne (west of the Development Envelope). These indicate that the Noonkanbah formation (regional aquitard) may not be present to provide a natural geological barrier. Mount Wynne is outside of the Development Envelope and presents a different subsurface geology than that known within the Development Envelope BNR is unable to comment on features that are not connected to this proposal nor consider hydrocarbon connectivity in this area. BNR has detailed at length the process which will be completed post drilling the well (which will include) building a specific local geological model based upon hydrostatically logged petroleum wells which will validate the required separation distances from faults, the pressure (and subsequent fracture lengths) and get this all independently verified before commencing any HFS activities.
		The review recommended further research be undertaken to understand: The hydrogeology of the region, including information on any geological features that may provide pathway(s) for fluids and gases from deep in the basin and any surface features, including the Mount Wynne seep and any additional similar features in the region. Groundwater and gas geochemistry from a wider array of monitoring sites, including groundwater monitoring bores at multiple depths installed between the target gas resources and the surface (including near the Mount WynneSeep)".	BNR has developed a suitable suite of mitigations (ERD Table 5-33 Proposed mitigation measures – Inland waters) and monitoring requirements (including the detailed Ground Water Management Plan) to ensure local baseline, and surveillance monitoring is completed in accordance with industry standards and the outcomes of the Scientific enquiry. Following comments from DMAs, BNR updated the ERD to reflect known surface water features from governmental databases. As Mount Wynne is located outside of the Development Envelope, and as no exposure mechanism exist that would result in any impact to this area, it has not been mapped or discussed. This is consistent with recent IESC studies that confirmed a <i>subsurface release from deep unconventional gas projects resulting in aquifer contamination is unlikely</i> (IESC, 2024)

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39.	ANON-6RBT-RU1B-R ANON-6RBT-RU9V-M ANON-6RBT-RUE6-Z ANON-6RBT-RUYE-3 ANON-6RBT-RUEQ-U	The ERD provides minimal information about the management of drilling fluids and produced formation water. Inadequate management of drilling fluids and produced formation water can result in contamination to groundwater and surface water as a result of surface spills and leaks of drilling fluids, flowback water and produced fluids. Insufficient mitigation measures are adopted to prevent and minimise contamination of surface waters and groundwater from release of drilling fluids and formation water, specifically during significant rainfall events. The submitter notes that the ERD has undertaken a desktop flood risk assessment that relies on untested assumptions, anecdotal observations and historical average annual rainfall data. Designing wastewater ponds to manage rainfall from a 90th percentile wet season is inadequate in a rapidly changing climate. It can be expected that heavy rainfall will exceed the 90th percentile more frequently which is likely to cause wastewater ponds to overflow.	BNR has detailed the management of drilling fluids and produced water throughout the various relevant sections of the ERD. Risks associated with a surface release of drilling fluids or Produced water is provided in Section 5.4.5.5 and subsequent mitigations included in Section 5.4.6 of the ERD. For further information refer to: IW-001 IW-003 TEQ-001 BNR acknowledge that design considerations be present for all ponds (that include factoring fluid type and environmental conditions) which is why the detailed design of these ponds are completed prior to submitting plans for assessment and approval under the <i>Petroleum and Geothermal Energy Resources Act 1967</i>. Please refer to: TEQ-004 BNR only completed a desktop assessment given the civil wellsite and pond engineering is not yet complete and the modelling requires the site design to validate that flood risks have been sufficiently mitigated. Completing quantitative modelling at this point of the Proposal would require duplication of modelling effort following design commencement. The desktop analysis indicates that the flood height of (Fitzroy River) waters from extreme events are unlikely to significant influence the Proposal engineering design, however BNR agrees that detailed analysis on a per well basis is required (this is an existing requirement under the <i>Petroleum and Geothermal Energy Act 1967</i> thus was planned to be completed post Ministerial Approval). It is in BNR's interest to ensure flood risks are mitigated given the potential economic impacts (associated with asset integrity events). BNR understands that given the location of EP371 that inundation from rainfall events and localised flooding would be expected. Given the proximity to Mount Hardman Creek BNR expects that in the event of intense weather systems there is the potential for the area to flood consistent with the aforementioned EPA services comment. BNR is committed to completing quantitative flood modelling during the design phase of the Proposal to ensure that infrastructure design can be complete in a manner that eliminates the risk of pond inundation during a flood event. BNR will

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			construct ponds where modelling indicates that those ponds are at risk of inundation during extreme flood events. BNR can either then provide this design on a per well basis to the EPA to validate their suitability (as a Ministerial Condition) or these designs can be provided to DEMIRS via the well planning approval requirements under the Petroleum and Geothermal Energy Resources Act 1967 consistent with all other drilling programs in the Kimberley.
		The ERD claims that the risk to the environment is minimised as all water storage ponds will be designed to meet the <u>Water Quality Protection Note 26</u> (WQPN26) (DoW, 2013) requirements to prevent unintended overflow of water from storm. Given the wastewater produced by fracking is known to contain radioactive substances (Elliot et al., 2016), the submitter notes that the WQPN26 is broad and excludes tanks to be used for storage of radioactive materials and persistent soluble toxins. Therefore, the adopted recommendations from WQPN26 are not appropriate for the storage of highly toxic fracking wastewater. To avoid contamination from the spill to the surrounding environment, the wastewater should be stored in rigid, closed-loop tanks and flowback and wastewater should be disposed of at licensed hazardous waste facilities.	Please note that naturally occurring radioactive material (NORM), were well below the exposure concentrations identified by the Australian and New Zealand guidelines for fresh and marine water quality and the Australian Drinking Water Guidelines. As such PW is not considered highly toxic, nor incompatible with HFS wastewater. Further to this, the use of sealed tanks is not considered an ALARP control measure as the impacts outweigh the benefits as: BNR will require additional space and the “tank farm” would require a significant higher amount of clearing to support the volumes required The waste (trucked to an associated facility) will require a significant amount of trucking and associated risks (emissions, faun strike risk, traffic etc.) and result in utilizing a large part of liquid waste facility capacity (rather than evaporate off the water and dispose of the liners only)
40.	ANON-6RBT-RU1B-R	Cumulative impact assessment should be undertaken by considering future activities of the wells or the future gas development that will surely follow the Odin 2 seismic survey. The cumulative impact assessment should consider potential impacts to aquifers, wetlands and waterways.	The proposal is limited to an exploration and appraisal project. Any further activities will be subject to separate assessment (including cumulative consideration of this proposal). Refer to: GS-004
		Whilst the proposal claims that a conservative approach was adopted to assess the likely impacts to groundwater by stating that the proposed 20 wells will not be operating at the same time and extracting from the same aquifer, it does not consider the impact on hydrology of hundreds of wells operating in a future fully developed gas field.	This Proposal is only seeking an exploration permit. Future works, if gas is found will be submitted and assessed if and when it occurs as a new Proposal. Please refer to: GS-004 GS-031
		The ERD considered the cumulative impact of groundwater extraction on nearby bores only. It did not consider or assess impacts on water dependent ecosystems, subterranean fauna, springs and soaks or the cultural values of the West Kimberley National Heritage Place and Mount Wynne Seep.	The proposal is limited to an exploration and appraisal project. Any further activities will be subject to separate assessment (including cumulative consideration of this proposal). Refer to: IW-004

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			Following comments from DMAs, BNR updated the ERD to reflect known surface water features from governmental databases. As Mount Wynne is located outside of the Development Envelope, and as no exposure mechanism exist that would result in any impact to this area, it has not been mapped or discussed in the ERD. However in response, BNR has attached a map showing Mount Wynne Creek and Mount Wynne Seep (Appendix 8). IW-008 A desktop study, as required by the ESD, was undertaken and included as ERD Appendix S Subterranean Desktop Survey. Refer to: SF-001
41.	ANON-6RBT-RUET-X	One submission noted that additional studies, data and knowledge are needed, specifically in relation to groundwater and hydrogeology, in order to provide a sound basis for decision making for the proposal. The submission included the following recommendations: Further information and data on the hydrogeology of the region, including information on any geological features that may provide pathway(s) for fluids and gases from deep in the basin and any surface features, including the Mount Wynne seep and any additional similar features in the region. This would involve drilling and bore logging plus seismic and other geophysical techniques to identify and characterize structures such as faults, fractures and geological unit boundaries. Groundwater and gas geochemistry data from a wider array of monitoring sites, including groundwater monitoring bores at multiple depths installed between the target gas resources and the surface (including near the Mount Wynne Seep). To achieve this, monitoring bores would be sampled for the same geochemical/isotopic characteristics as the wells and seep as reported in the Geoscience Australia report, plus additional hydrochemical and isotope data from the groundwater (e.g. major ions, stable isotopes of water and carbon, radiocarbon and tritium activities).	BNR does not agree with this statement. The EIA is based upon a magnitude of high-quality regional proponent and publicly available data. Refer to: GS-026 Following comments from DMAs, BNR updated the ERD to reflect known surface water features from governmental databases. As Mount Wynne is located outside of the Development Envelope, and as no exposure mechanism exist that would result in any impact to this area, it has not been mapped or discussed. This is consistent with recent IESC studies that confirmed <i>a subsurface release from deep unconventional gas projects resulting in aquifer contamination is unlikely</i> (IESC, 2024) (BNR is unable to comment on features that are not connected to this proposal nor consider hydrocarbon connectivity in this area. The groundwater monitoring program detailed in the GWMP has been reviewed multiple times by DWER with updates made through each iteration. BNR aims to implement the GWMP following ministerial approval. Refer to: IW-026 IW-029

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		Detailed seismic survey across the area to identify the locations of 'minor' fractures and faults that may be activated or act as existing conduits.	Until a well is drilled and site specific geological and hydrogeological information gathered, previous studies in the Canning Basin and other HSF activity information available has been used to assess the potential impacts. Once drilled, local geological information will be present to enable specific models to be completed and detailed geotechnical risk assessments to be completed. BNR has made these commitments since referring the proposal on day 1 consistent with the Scientific Enquiry recommendations.
		Baseline surface gas survey in all existing bores and oil gas wells, the latter of which need to be also evaluated for current well seal status.	Until a well is drilled and site specific geological and hydrogeological information gathered, previous studies in the Canning Basin and other HSF activity information available has been used to assess the potential impacts. BNR propose to continue sampling for methane - for detailed monitoring plans refer to Valhalla Environmental Monitoring Plan.
		Installation of water exploration bores in the target aquifers, including aquifer testing.	BNR plan to sample local groundwater quality. Please refer to GWMP.
		Bore census for water quality and gas at all pre-existing bores and in exploration/monitoring bores that should be installed before any approval is given to better understand the current hydrogeological conditions.	Hydrogeological conditions are best understood locally. BNR plan to sample local groundwater quality prior to commencing HFS activities. Please refer to GWMP.
		A comprehensive survey for receptors such as springs and seeps (i.e., Mount Wynne) and the Fitzroy River (including sampling groundwater tracers and gas) in the area that is proposed to be hydraulically stimulated. This needs to include a buffer for hydraulic stimulation fault/fracture activation/propagation and the maximum extent of possible drawdown from the sensitivity analysis.	BNR evaluated the exposure mechanisms by which the proposal could directly or indirectly impact any surface water bodies (both within the Development envelope and outside of the Development Envelope). Please refer to: IW-004 Following comments from DMAs, BNR updated the ERD to reflect known surface water features from governmental databases. As Mount Wynne is located outside of the Development Envelope (Appendix 8), and as no exposure mechanism exist that would result in any impact to this area, it has not been mapped or discussed in the ERD. This is consistent with recent IESC studies that confirmed <i>a subsurface release from deep unconventional gas projects resulting in aquifer contamination is unlikely</i> (IESC, 2024) BNR is unable to comment on features that are not connected to this proposal nor consider hydrocarbon connectivity in this area.

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		The groundwater modelling needs to be redone based on additional data, incorporating the conceptual mechanism (i.e. fault/fracture water and gas transport) by which any impacts will manifest, which is currently not included in the modelling. Once this is completed and a more robust impact assessment presented, the potential impact area may increase, in which case the receptor survey may need to be increased.	Discussions with DWER identified the need for additional modelling, therefore, additional modelling was commissioned from Intera Geosciences Pty Ltd. Based upon modelling predictions (Section 5.4.5.1 Changes to groundwater levels (groundwater drawdown) associated with water extraction and Appendix L Groundwater modelling) from Intera Geosciences (2023), BNR does not believe that the potential drawdown associated with the Proposal pose a significant impact to the Mount Hardman Creek GDE or associated vegetation communities based upon 1 1 cm drawdown within 700 m of the abstraction bore (or the wellsite) that recharges rapidly once pumping ceases.
		The submission made the following recommendations to be addressed in the context of the fault seal analysis: Gas logging during all drilling both for water bores and hydrocarbon wells.	As detailed in the GWMP dissolved gases will be sampled locally.
		Water quality needs to be evaluated in deep aquifers prior to HFS, the area has unexplored water resources that could be impacted. Pressure monitoring in bores screened in the deep aquifer (i.e. the proposed groundwater monitoring bores) with real time pressure monitoring during hydraulic stimulation to be considered. This type of monitoring is a more reliable way of assessing how the transient pressure during hydraulic fracture stimulation propagates and impacts on deep aquifers located in critical areas, particularly near faults and fractures.	BNR has developed a GWMP (Appendix 7) that detailed the required monitoring requirements which has been updated multiple times in response to reviews by DWER.
		Monitoring of breakouts and drilling induced tensile fractures during drilling.	BNR has detailed a number of mitigations in (Table 5-33) that include: BNR will hydro-stratigraphically log the petroleum well during drilling activities and collect a geophysical interpretation of groundwater aquifers Early warning system for detecting Geomechanical event Well Management Plan These mitigations will ensure that any breakouts or unexpected geological conditions are monitored and utilized to inform subsequent Geomechanical risk assessment.

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		Fracture stability assessment should be conducted. Maximum bounds for stimulation pressure require site specific thresholds based on a consideration of both the stress state and reservoir type.	BNR has detailed a number of mitigations in (Table 5-33). Of relevance to this comment is the Geomechanical risks assessment that will be updated with local data following drilling of the well. Once drilled, local geological information will be present to enable specific models to be completed. BNR has made these commitments since referring the proposal on day 1 consistent with the Scientific Enquiry recommendations.
		Fracture propagation modelling, G Function analysis and interpretation, stress barriers assessment. Stress barriers, not just geomechanical contrasts, are required for fractures to be contained within the hydraulic stimulation zone. There needs to be more detailed consideration of minimum horizontal stress in the cap rock and this needs to be completed for all areas where hydraulic stimulation is proposed.	BNR has detailed a number of mitigations in (Table 5-33). Of relevance to this comment is the Geomechanical risks assessment that will be updated with local data following drilling of the well. Once drilled, local geological information will be present to enable specific models to be completed. BNR has made these commitments since referring the proposal on day 1 consistent with the Scientific Enquiry recommendations.
42.	ANON-6RBT-RUET-X ANON-6RBT-RU9V-M ANON-6RBT-RUYE-3 ANON-6RBT-RUE2-V ANON-6RBT-RU1B-R	Submissions raised concerns that the ERD failed to appropriately assess the potential impact of hydraulic fracture activities on water-dependent ecosystems. Specific issues raised included: No targeted assessment for groundwater-dependant ecosystems (GDEs) has been completed for the development area. Considering the potential risks to overlying aquifer structures, a targeted GDE assessment should be undertaken by utilisation of normalised difference vegetation index (NDVI) datasets and conceptual models and informed by Traditional Owners and community knowledge. Mount Harding Creek supports riparian vegetation dominated by <i>Eucalyptus camaldulensis</i>, a facultative phreatophyte. Has the reliance (or otherwise) of the <i>E. camaldulensis</i> vegetation community on groundwater been established quantitatively?	BNR completed the assessment in line with the ESD requirements. Desktop analysis was sufficient (for the purposes of a temporary exploration project) to identify potential GDE's given historical evidence from monitoring previous water abstraction events were that groundwater levels return rapidly following completion of abstraction activities. Modelling was completed to understand drawdown potential and discussions with DWER identified the need for additional modelling, therefore, additional modelling was commissioned from Intera Geosciences Pty Ltd. Based upon modelling predictions (Section 5.4.5.1 Changes to groundwater levels (groundwater drawdown) associated with water extraction and Appendix L Groundwater modelling) from Intera Geosciences (2023), BNR does not believe that the potential drawdown associated with the Proposal pose a significant impact to any potential GDEs or associated vegetation communities based upon 1 mm drawdown within 700 m of the abstraction bore (or the wellsite) that recharges rapidly once pumping ceases. Please refer to: IW-004 SS-011 BNR believes the ERD has addressed impacts to vegetation communities through groundwater drawdown in the ERD. Refer to FV-006

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		The Independent Expert Scientific Committee's (IESC) report (Doody at al., 2019) outlines the field survey requirements for GDEs.	No question raised.
		The Mount Wynne Seep and other springs of conservation and cultural significance have not been mapped or assessed in relation to the proposal. Even relatively minor groundwater drawdown has the potential to cause significant impacts to GDEs, such as the ecologically and culturally significant Mount Wynne Seep that occurs just outside the WKNHA.	BNR evaluated the exposure mechanisms by which the proposal could directly or indirectly impact any surface water bodies (both within the Development envelope and outside of the Development Envelope). Please refer to: IW-004 The only pathway for the targeted reservoir (laurel formation) to contaminate the Livinga or surface waters (such as Mount Hardman creek or Mount Hardman Seep) Appendix 8 is for hydrocarbons to migrate over 1800 m vertically through the impermeable Noonkanbah shale formation (~200m thick) and the Anderson aquitard (~200 m thick). In this regard BNR does not believe that vertical migration in the Development Envelope is credible. Whilst BNR acknowledges that faults can create natural pathways for vertical migration (which may provide an explanation for Currell, 2022), BNR also understands that the geology is different depending on location with many formations at different depths making it more (or less) likely for communication with the surface depending on location. The best visual representation is Figure 5-31 in the ERD. BNR evaluated the exposure mechanisms by which the proposal could directly or indirectly impact environmental and social receptors both within and outside of the Development Envelope and as such consideration of environmental receptors outside of the Development Envelope include Mount Wynne Creek. Those exposure mechanisms include vertical migration as detailed in the ERD, Section 5.4.5.4 - Potential contamination of aquifers through unplanned fracture heights. The outcome of this analysis is that BNR does not believe that the proposed vertical extent of the fracture envelope, which is expected to be ~150 m, is physically plausible for induced fractures to create a hydraulic connection between the deep back shales and other tight formations and overlying aquifers. BNR acknowledges that Mount Wynne Creek may well have communication between a deep formation and surface waters, and this is unable to be explained by BNR given a detailed subsurface geological / hydrogeological assessment for Mount Wynne Creek has not been completed as this is outside of the Development Envelope and not the focus of our Proposal. However, the occurrence can be explained through either:

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			1. natural fault pathways, or 2. previous activities being undertaken directly below known naturally occurring faults and the induced fractures connecting to the natural faults. Regardless of the pathway, the Scientific Inquiry into hydraulic fracture stimulation is clear in its requirements for geomechanical assessments to ensure that activities do not commence before clear subsurface risks are analysed and mitigated. This is why (consistent with mitigations included in the original ERD) BNR has committed to building a specific local geological model based upon hydrostatically logged petroleum wells which will validate the required separation distances from faults, the pressure (and subsequent fracture lengths) and have these all independently verified before commencing any HFS activities. This will ensure that the connection to, or reactivation of any faults will arise. Given the distance from Mount Wynne Creek and other sensitive receptors outside of the Development Envelope, BNR does not believe that the Proposal poses a credible risk to these sensitivities with the highly conservative mitigations set out by the Scientific Inquiry and committed to by BNR. This is consistent with recent IESC studies that confirmed <i>a subsurface release from deep unconventional gas projects resulting in aquifer contamination is unlikely</i> (IESC, 2024) (
		The impacts and risks to Mount Hardman Creek have not been adequately assessed. Two of the proposed well sites, such as Midgard and Muspelheim are within 2.5 km of the stream bed. HydroGeoEnviro report (HydroGeoEnviro, 2024b) concluded that Mount Hardman Creek could be seasonally highly dependent on groundwater discharge in some areas. Considering the proposal involves horizontal drilling of wells up to 3 to 5 kilometres long, this would easily take them up to or beyond Mount Hardman Creek.	Water abstraction will only occur from the wellsite using an abstraction bore that is different to the petroleum well. As such the drawdown exposure will be limited to within 700 m of the abstraction point (or the wellsite). Please refer to: IW004 In addition, the only pathway for the targeted reservoir (laurel formation) to contaminate the Liveringa or surface waters (such as Mount Hardman creek) is for hydrocarbons to migrate over 1800 m vertically through the impermeable Noonkanbah shale formation (~200m thick) and the Anderson aquitard (~200 m thick). In this regard BNR does not believe that vertical migration in the Development Envelope is credible. Whilst BNR acknowledges that faults can create natural pathways for vertical migration (which may provide an explanation for Currell, 2022), BNR also understands that the geology is different depending on location with many formations at different depths making it more (or less) likely

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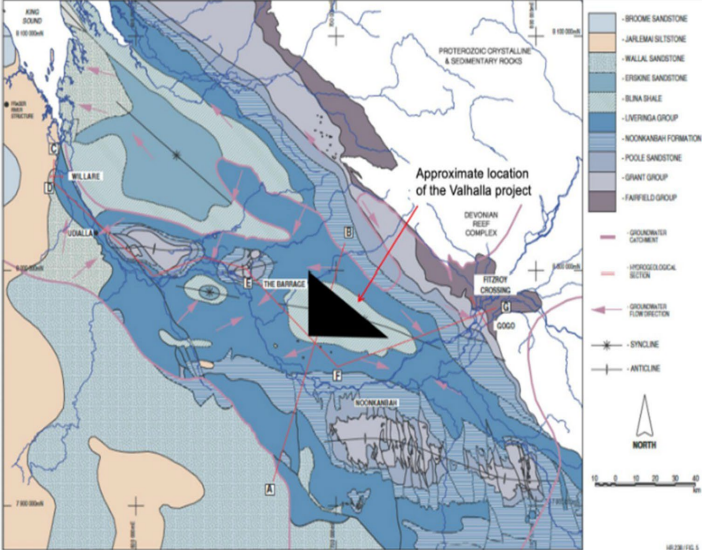
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			for communication with the surface depending on location. The best visual representation is Figure 5-31 in the ERD (Bennett Resources, 2024). BNR evaluated the exposure mechanisms by which the proposal could directly or indirectly impact environmental and social receptors both within and outside of the Development Envelope and as such consideration of environmental receptors outside of the Development Envelope include Mount Wynne Creek. Those exposure mechanisms include vertical migration as detailed in the ERD, Section 5.4.5.4 - Potential contamination of aquifers through unplanned fracture heights. The outcome of this analysis is that BNR does not believe that the proposed vertical extent of the fracture envelope, which is expected to be ~150 m, is physically plausible for induced fractures to create a hydraulic connection between the deep back shales and other tight formations and overlying aquifers.
		The ERD and the attached appendices provide misleading information on the impacts to the Mount Hardman Creek GDE due to the groundwater drawdown. The INTERA modelling was done based on the lowest possible level of groundwater use for just one well over the shortest possible period. The modelling did not include impacts of drilling and fracking up to four wells, each using up to 100 ML across the two sites on one year as a possible scenario.	As detailed in Figure 5-16 and Figure 5-31 in the ERD, BNR has acknowledged that the subsurface geology is not consistent throughout the entire canning basin. Please refer to: IW-029 Further to this, BNR re-engaged Intera to validate model inputs and assumptions including completion of sensitivity analysis and extraction rates. Refer to: IW028 Given the well sites are spatially distant from each other and the modeling indicated there is no overlap of drawdown potential the number of wells drilled per year will not impact on drawdown potential.
43.	ANON-6RBT-RUET-X ANON-6RBT-RU1B-R	Submissions stated that the proponent did not adequately assess the risks to the Martuwarra Fitzroy River, the aquifers underlying the river and the associated environment. Key issues raised included: The proponent's EPBC referral document noted that the project area is hydrologically connected to the West Kimberley National heritage Area (WKNHA) via surface waters of Mount Hardman Creek and the Fitzroy River and shared groundwater from the Canning Basin aquifer (Bennett Resources P/L, 2024). There is a risk that the WKNHA would be significantly impacted by contamination and/or groundwater drawdown due to lack of knowledge about	BNR does not believe the WKNHA will be impacted. Refer to: SS-002 BNR evaluated the exposure mechanisms by which the proposal could directly or indirectly impact any surface water bodies (both within the Development envelope and outside of the Development Envelope). Refer to: IW-004

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		potential connectivity underlying the project area and the river system. The risk of contamination is expected to be higher during floods. The proposal is likely to impact the Fitzroy River based on: Studies have indicated surface water and groundwater interactions in the lower Martuwarra Fitzroy River (Loomes R. and La Sina K., 2023; Harrington et al., 2011) The presumed direction of flow of alluvial groundwater is from the project area towards to Martuwarra Fitzroy River (Lindsay, R.P. and Commander, D.P., 2005). See Figure 3.  Figure 3. Direction of flow of alluvial groundwater underlying the approximate location of the Valhalla project	

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		The proposal poses a serious risk because: There is a lack of fundamental data and scientific knowledge about the groundwater systems, including recharge and discharge processes and the nature of surface water – groundwater interactions along the Fitzroy River. The project will be implemented during the dry season when human and environmental dependence on groundwater is high. The landscape funnels overland rainwater flows across the proposal area to the Martuwarra Fitzroy River and into the groundwater system.	BNR evaluated the exposure mechanisms by which the proposal could directly or indirectly impact any surface water bodies (both within the Development envelope and outside of the Development Envelope). Refer to: IW-004 IW-001 The EIA is based upon a magnitude of high-quality regional proponent and publicly available data. Refer to GS-026
		Submissions noted that the proposal has the potential to cause significant impacts to the Martuwarra River due to: Contamination via surface water inflows from frack sites, especially under flood conditions. Contamination via polluted groundwater inflow through the springs that provide water to the river system during the dry season. Contamination via polluted groundwater transmitted to the river through existing or fracking-generated deep fissures and fractures. Drawdown of groundwater affecting springs providing water to the river in the dry season. Toxic air emissions from fracking and flaring operations drifting over and depositing on the WKNHP.	BNR evaluated the exposure mechanisms by which the proposal could directly or indirectly impact any surface water bodies (both within the Development envelope and outside of the Development Envelope). Refer to: IW-004 BNR evaluated the exposure mechanisms by which the Proposal could directly or indirectly impact environmental and social receptors both within and outside of the Development Envelope. As detailed in Section 5.6.5.1, similar activities occur around the State, and flaring dispersion modelling conducted for much larger projects show ground-level concentrations in isolation and cumulatively are well below the corresponding ambient air quality and workplace exposure standard criteria (Ramboll, 2019). Given that air quality impacts are well below ambient air quality and workplace exposure standard criteria on the wellsite itself, BNR does not believe that air quality impacts will result in any exposure to the WKNHP located ~10 km away from any wellsite. Section 5.6.5 of the ERD discusses the assessment of impacts and Section 5.6.6 discusses mitigation measures with the environmental outcome stating that: "Based on the predicted outcomes for the Proposal as shown in the information above, BNR does not believe that the Proposal will result in a significant impact to air quality. The environmental mitigation measures believes that the EPA's objective to 'maintain air quality and minimise emissions so that environmental values are protected' can be met." BNR maintains its position with regards to the WKNHP.

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44.	ANON-6RBT-RUET-X	Given the proponent has failed to provide adequate studies and information in relation to issues around groundwater, including groundwater-surface water interaction, an independent peer review of the proponent's groundwater assessment and the relevant supporting appendices should be undertaken. Relevant appendices include: Appendix B - Geotechnical risk analysis Appendix I - Rockwater (2016) hydrogeological assessment Appendix J - Local groundwater characterisation Appendix L - Groundwater modelling Appendix M - Groundwater management plan Appendix N - Human health risk assessment	BNR does not agree with this statement. The EIA is based upon a magnitude of high-quality regional proponent and publicly available data. Refer to GS-026

2.2.8 Air Quality

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45.	ANON-6RBT-RU1F-V	The submitter stated that the proponent's Human Health Risk Assessment provided as appendix N does not adequately disclose or address the risks from the use of silica as a proppant or VOCs associated with flaring and fugitive emissions. The submitter also noted potential impacts to air quality and human health associated with the mixing of fracking chemicals, and the storage of returned fracking fluids.	BNR has completed a human health assessment in the ERD which was peer reviewed and validated to be appropriate through consultation with Department of Health. The Human health risk assessment included consideration of: • Dust from proppant (fine sand) storage on site • VOCs and products of incomplete combustion (PICs) from flaring during well testing activities on site • VOCs as fugitive emissions from the well following completion of HFS activities. • VOCs as fugitive emissions from the well following completion of HFS activities. Refer to: HH-001

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			Specific risk assessment and management measures regarding silica are included in the Human Health Risk Assessment (HHRA) Appendix for the Valhalla Gas Exploration and Appraisal Program was prepared in accordance with the Health Risk Assessment (Scoping) Guidelines Appendix 9, as well as peer reviewed by Geosyntech Consultants (Geosyntech). The HHRA identifies silica as part of the human health assessment, concluding no exposure to fixed receptors is expected to arise from dust emissions associated with the Proposal. Refer to ERD Section 4.1.2 which states: Constituents of Potential Concern (CoPC) were identified as posing a human health risk: <u>Silica</u> Typically, proppant is comprised of naturally occurring sand grains, resin coated sand (RCS) or high-strength ceramic materials that range in size from 106 um to 1180 um. Based upon the typical size of proppant, silica can be measured onsite through monitoring of particulate matter (PM) given that the presence of proppant (or RCS) would show up during monitoring for fine particulates. Baseline studies identified a range of environmental concentrations for PM2.5 and PM10 onsite dependant on various environmental conditions. The Valhalla Monitoring Plan (VMP) (Appendix E of the Valhalla ERD [BNR_HSE_MP_016]) details 24-hour average Health indicators for PM2.5 and PM10. BNR will monitor for these over the course of the Proposal. Table 3-4 of the VMP details air quality monitoring location and frequency. Table 3-6 of the VMP components-air quality discusses trigger levels actions and threshold contingency actions. As detailed in Section 5.5.3.1 of the ERD, the closest public (Aboriginal) communities are located 20 km and 28 km from the closest proposed well sites within the Development Envelope. No other fixed sensitive human receptors are known to occur within the Development Envelope. Consequently, no exposure to fixed receptors is expected to arise from dust emissions associated with the Proposal. <u>Monitoring and Management</u> As per the ERD Section 3.1.2 Silica can be measured onsite through monitoring of particulate matter (PM). Baseline studies identified a range of environmental concentrations for PM2.5 and

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			PM10 onsite dependant on various environmental conditions. The Valhalla Monitoring Plan (Appendix E of the Valhalla Environmental Review Document [BNR_HSE_MP_016] Section 3.2.3) details the 24-hour average health indicators for PM2.5 and PM10. BNR will monitor for these over the course of the Proposal. BNR has developed an environmental monitoring program to be implemented. Refer to: IW-017
46.	ANON-6RBT-RU1V-C	The submitter noted that fracking will increase the release of radon gas and uranium progeny and increase the distribution of radioactive and carcinogenic materials in the biosphere and food chain. The submitter also stated that 'radon daughters' are solids that adhere to surfaces, such as dust particles in the air, posing a further risk to air quality and human health. In support of their concerns, the submitter referred to a previous submission to the Western Australian Inquiry into Hydraulic Fracture Stimulation.	BNR has assessed all of the direct and indirect impact associated with the proposal within the requirements of the <i>Environmental Protection Act 1986</i>. To impact any stakeholders / the food industry outside of the Development Envelope would require exposure through an indirect pathway. With the low concentration of NORMS expected in the Laurel Formation and the mitigation measures in place, BNR does not believe the amount of radioactive and carcinogenic materials that may be released will impact the biosphere or food chain any more than other industries in the area. The release of materials into the biosphere arising from the Proposal can only arise from two pathways being: 1) a release to atmosphere (from flaring) or 2) a release to ground / groundwater from an accidental release of produced formation fluids. The release to atmosphere is limited to flaring of hydrocarbon gas given produced fluids are passed through a separator (preventing water from being run through the flare eliminating potential for non-combusted water and contaminants being spread outside of the lease area). Although opportunities to prevent and minimise flaring are standard practice for hydrocarbon developments, well testing is required (and is standard practice) for exploration activities. Releases to ground/groundwater can only arise from an unplanned event (or accidental release). These pathways are identical to conventional drilling activities and subsequently are well understood with effective mitigations in place to prevent a release and contingencies in place to limit any potential impacts should prevention controls fail.

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			Given the information provided from wells targeting the same formation in the region, BNR is not aware of any other information that would indicate the Proposal would significantly deviate from the limited presence of radioactive and carcinogenic materials previously provided. Given the pathways for introducing radioactive and carcinogenic materials into the biosphere are the same for any conventional development projects (like the Midwest), BNR does not believe the Proposal which is limited to a temporary exploration and appraisal program will increase the distribution of radioactive and carcinogenic materials in the biosphere and food chain. Assessment of all the exposure mechanisms associated with the proposal indicate that based upon the nature of the activity, subsurface geology and proposed mitigations and exposures outside of the Development Envelope would be highly unlikely / non-credible.

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2.2.9 Greenhouse Gas Emissions

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47.	ANON-6RBT-RUET-X ANON-6RBT-RU6F-1 ANON-6RBT-RUY5-K ANON-6RBT-RUYE-3 ANON-6RBT-RUYV-M ANON-6RBT-RU94-J ANON-6RBT-RUA3-S ANON-6RBT-RU4P-9 ANON-6RBT-RU8T-H ANON-6RBT-RU1B-R ANON-6RBT-RU1F-V	Several submitters raised concerns regarding the greenhouse gas emissions (GHG) associated with the proposal. Submissions highlighted the following points: GHG emissions along with the purpose of the project are inconsistent with state, national and global efforts to reduce greenhouse gas emissions, adhere to the Paris Agreement and limit the impacts to global warming.	Whilst BNR acknowledges concerns about future GHG emitting activities, the Valhalla asset comprises methane with a very low carbon dioxide concentration when compared to other assets / fields. BNR understands that whilst gas is a potential energy transition fuel, it is also critical for supporting various industries and its development is supported by the Government. Refer to: GG-006
		The cumulative greenhouse gas emissions (GHG) impact of full-scale production involving hundreds of frack wells at full production will result in lifecycle emissions of national and local significance. This is inconsistent with WA and Australia's commitment to decarbonise and prevent catastrophic global warming.	Approval is being sought for exploration only; any additional activity will be subject to further approvals. The scope of the proposal is an exploration project. On completion of well testing, no further gas flaring or production is planned under this proposal and as such the project life is limited to 7 years. Refer to: GG-006
		Due to the release of GHG emissions of 1.6 Mt CO ₂ -e per annum, the proposal is considered as an exceptionally intensive carbon-emitting proposal which does not align with majority expectations regarding the urgent decarbonisation of the economy and poses a high risk to climate change.	To quantify the resource, well testing and flaring is required to understand flow capabilities of the reservoir and cannot be compared to a producing or production project. Whilst BNR acknowledges concerns about future GHG emitting activities, the Valhalla asset comprises methane with a very low carbon dioxide concentration when compared to other assets / fields. BNR understands that whilst gas is a potential energy transition fuel, it is also critical for supporting various industries and its development is supported by the Government.
48.	ANON-6RBT-RUY5-K	One submission noted that monitoring and regulating fugitive emissions in the Canning Basin will be costly and difficult due to remote location.	BNR has discussed and assessed greenhouse gas emissions in the ERD Section 5.6 Air quality and Section 5.7 Greenhouse gas assess the levels of methane gathered from baseline monitoring. As stated in Appendix E Valhalla Monitoring Plan, Section 3.3. To understand if the Proposal and associated emissions have had any short of long-term adverse impacts to air quality, BNR plans to continue surveilling for the presence of methane. Any fugitive emissions will be limited to the wellhead as there is no additional infrastructure proposed. As such fugitive emission monitoring is not complex.

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49.	ANON-6RBT-RUET-X	Submissions raised concerns regarding the GHG emissions estimates presented by the proponent: There is a huge, unexplained discrepancy in maximum emissions that could be generated by the project. Based on Figure 3-1 (Timeline for overall scope 1 GHG emissions of the Valhalla E&P Program) in the GHGEMP, the total project emissions would be approximately 2.64 Mt CO ₂ e, rather than 1.6 Mt.	BNR has updated the Greenhouse Gas Environmental Management Plan (GHGEMP) refer to Appendix 5 to reflect the correct figure, now Figure 3-1.
		The assessment should be based upon flaring for 90 days rather than 60 days, consistent with the proponent's statements (including in the s43A document) that only a 90 day flaring option is being considered.	The assessment is based upon maximum predicted emission levels. All considerations are based upon flaring for 90 days.
		One submission raised concern about the use of creative accounting tricks or concoct its own self-serving 'targets' to avoid GHG obligations. The submitter stat that the proponent's attempted use of fake measures like 'exceeding 43% of estimated baseline emissions by the end of the 5th year' and accounting for emissions on a 'per well' basis, must be rejected.	BNR engaged with DWER multiple times through the assessment process to discuss the use of GHG emission targets for exploration projects. These targets can only be suitably designed for ongoing projects with continuing GHG emission footprint. Targets have been set consistent with EPA guidelines and in accordance with feedback from DWER even though BNR does not believe that demonstrating that meeting net zero targets by 2050 (for a 7 year project) is appropriate, nor demonstrating reduced GHG emission footprint consistent with state policies (for a seven year project) are appropriate.
		The proponent did not undertake site-specific investigations to inform impact assessment. A major assumption and uncertainty associated with the estimation of the project's GHG emissions is that the quantity of emissions is based on a historic understanding of the Laurel Formation in EP371 and may not reflect reality.	BNR utilized historic data regarding CO ₂ composition of gas present within the Valhalla Formation to inform GHG emissions estimates. The nature of exploration and appraisal projects are to validate resource estimates and assumptions. This proposal will provide additional information to inform decisions including future activities. The collection of this data will de risk any future activities however the proposal is to collect data (explore and appraise the Valhalla Formation) to understand if any economic prospects are available.
50.	ANON-6RBT-RUET-X	The proponent does not provide details on how net zero emissions from commencement will be achieved, consistent with the Safeguard Mechanism (DCCEEW, May 2024, pages 1,3) which states: "The Safeguard Mechanism applies to facilities that emit more than 100,000 tonnes of carbon dioxide (CO ₂) equivalent in a year...Projects extracting or exploring a shale [or tight] gas formation covered by the scheme, including projects within the Beetaloo Basin, are required to have net zero scope 1 emissions."	BNR has updated the GHG Environmental Management Plan (Appendix 5). The scope of the Proposal is limited to exploration activities. Development of a production facility is not within the scope of this Proposal, however if the program is executed in accordance with the plan detailed in the ERD, the Proposal will emit more than 100,000 tonnes of carbon dioxide (CO ₂) equivalent in a year and subsequently be subject to the safeguard mechanism. For further information refer to: GG-008

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51.	ANON-6RBT-RUY5-K	The Greenhouse gas management plan should be reviewed to include an emission reduction strategy that meets the EPA objective. Capture of gas for sale or use in other applications are not considered as actual mitigations for greenhouse gas emissions.	The GHG management plan (Table 2-4) (ERD Appendix R) considered the following mitigations • Condensate capture for sale or other use • Gas capture for sale or other use • Compressed Natural Gas. Noting that the proposal is for an early exploration and appraisal project these options were not considered further. These options were subject to peer review by an independent consultant who validated BNR's outcomes of the assessment and applicability of mitigation outcomes.
52.	ANON-6RBT-RU1B-R ANON-6RBT-RUET-X	Submissions noted that the GHG emissions per well are greater than projects of a similar nature. One submission also noted that GHG emissions for the project are high when benchmarking with other similar projects, such as Muja and Collie coal-fired power stations that generate 2.8 Mt CO ₂ e and 778,000 t CO ₂ e per annum.	The project is an exploration and appraisal project thus are not "similar" to assets such as Muja and Collie coal-fired power stations given there is no production. This is a short program to validate production potential. BNR understands that benchmarking future production / operation phases may be suitable against coal fired power stations and given the low carbon nature of the reservoir (and the economic incentives to flare as little as possible) would likely clearly show that emission intensity is well below that of coal (consistent with other gas projects). However, The Greenhouse Gas Management plan (Appendix 5) Section 3 provides GHG Emissions Benchmarking.
53.	ANON-6RBT-RUYE-3	Submissions raised concerns regarding the reliance on the use of carbon offsets for carbon reductions and the lack of action to reduce GHG emissions. The ERD raises many potential avoidance measures to which the proponent has not committed. For example, the use of compressed gas for power generation. The 'avoid and reduce' options that the proponent has committed to are likely to reduce emissions by 37,300 t CO₂-e, which is an insignificant amount compared to 1.6 Mt million tonnes of greenhouse gas emissions. The reliance on carbon offsets is not aligned with accurate carbon reduction and sustainability and is inconsistent with the EPA's view that there should be deep, substantial and sustained reductions in WA's emissions this decade (Environmental Factor Guideline Greenhouse Gas Emissions. EPA 2023).	The proposal is associated with a short-term exploration and appraisal project. BNR engaged a technical expert to complete benchmarking and consider GHG mitigation options (Table 2-4) including: • Condensate capture for sale or other use • Gas capture for sale or other use • Compressed Natural Gas. Noting that the proposal is for an early exploration and appraisal project these options were not considered further due to various factors including lack of infrastructure, limited duration of the activity and economic implications. These options were subject to review by an independent consultant who validated BNR's outcomes of the assessment.

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			Further, the project is subject to other GHG regulations. Refer to: GHG-008
54.	ANON-6RBT-RUFR-W	One submission provided commentary on the ERD and the GHG EMP (Appendix R) and related Peer Review document (Appendix R addendum) and concluded that the project does not exhibit or meet the intent of best practice. Specific comments included: The documents do not provide evidence for selecting best practice design.	BNR engaged an independent expert who has completed multiple reviews of GHG Environmental Management Plan under the EP Act that is consistent with DWER guidelines. Please note the project is limited to a short-term exploration and appraisal activity.
		Table 3-3 of the GHGEMP provides a list of emissions avoidance and reduction measures considered and the outcomes, but no justifications of the claims are provided.	The proposal is associated with a short-term exploration and appraisal project. BNR engaged a technical expert to complete benchmarking and consider GHG mitigation options (Table 2-4) including: • Condensate capture for sale or other use • Gas capture for sale or other use • Compressed Natural Gas. Noting that the proposal is for an early exploration and appraisal project these options were not considered further due to various factors including lack of infrastructure, limited duration of the activity and economic implications. These options were subject to review by an independent consultant who validated BNR's outcomes of the assessment.
		Each well for the phase 1 is estimated to emit 29,747 tonnes CO2-e via flaring from the reservoir gas component, but it is unclear why a potential reduction for the proposal can achieve only a reduction of 10,000 tonnes of CO2-e compared to venting, where methane has a greenhouse gas potential of 28.	All calculations are based upon the baseline expectation that flaring will be undertaken (not venting) given that is not suitable practice from either an environmental or safety perspective.
		The Peer Review report does not provide a commentary on the substantial volume of diesel required for each well (over 120,000 litres per well) or on alternatives considered that may be able to utilise the reservoir gas and condensate for useful work. It is not evident that best available technologies were considered. Equipment that can run on a high percentage of filed gas as a dual fuel system as a practicable alternative was not considered. Given the citation of the US EPA Tier 4 regulations, it was expected that the dual fuel engines would be the base case for the project.	BNR engaged a technical expert to complete a peer review of the GHG management plan. This included review of mitigations and stated that: Three emission reduction opportunities were identified but not progressed due to commercial or technical feasibility. These were: • Renewables for power generation • Compressed Natural Gas • Micro Liquefied Natural Gas.

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			Conclusion The emission reduction opportunities proposed within the GHG EMP for exploration and appraisal activities align with national and international industry best practices when considering the project-specific context Regarding dual fuel engines – refer to: GG-005
		Page 43 of the GHGEMP states that “Reduced Emissions Completions (RECs) will be used, and no cold venting will occur during well completions and negligible amount of fugitive emissions are expected from well completions activities”. This statement is contradictory to the conclusions provided in the Peer Review report that flaring of condensate was considered best practice, noting that, REC is related to the practice of capturing gas and condensate produced to reduce flaring emissions.	The documents are not inconsistent. Running completions is a different stage to well testing (i.e. flaring). You must run the completion prior to being in a position to test the well (flare). During this period BNR will implement RECs to reduce emissions during this stage of the project. Following this BNR will then flare to reduce GHG potential from cold venting.
		The preferred design case for the work scope is unclear and it is not possible to build the best practice design base case for which further emissions reduction measures will be considered.	BNR has clearly stated that the design phase of the wells (well engineering) is not yet complete. However, all information used in the proposal assessment is conservative including number of wells, length of flaring and maximum emission volumes. It is possible that over the course of the proposal, well completion and flaring designs can be optimized to gather the required information over a reduced period of time resulting in reduced emission quantities. However, given the nature of the project (being a temporary exploration and appraisal project) BNR has opted to include maximum worst case emission estimates to support the EIA process.
		The “NetZero 2050” target stated in the GHGEMP related to the WA EPA Greenhouse Gas environmental factor guidelines. The 100,000 tonnes stated in the guideline is not a baseline value but rather a threshold. Section 5.1, figure 5-1 (pg. 59) of the GHGEMP states: “...provides a quantitative estimate of maximum GHG emissions and the reductions/offsets that could be mandated by EPA under the NetZero 2050 trajectory for the Valhalla E & A program under each of the two timelines considered. Depending on how EPA would assess a shale gas exploration project, BNR may or may not be required to offset part of the GHG emissions associated with the Valhalla E & A program beyond the annual EPA NetZero targets.”	BNR has discussed the application of the guidelines to exploration projects with DWER in detail. The GHGMP has been developed in line with the requirements of the time and updated consistently as policy has changed since it was first developed. BNR has committed to thresholds and targets consistent with the EPA requirements for GHG Management plans. However, it should be noted the faster works are completed the greater the emissions per year and the greater the application of safeguard. Thus, sufficient regulation exists either through the application of the GHGEMP and BNRs commitment to meet the identified targets OR through application of Safeguard Mechanism. For further information regarding the safeguard, refer to: GG-008

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		Corollary to this, the Peer Reviewer agreed that a baseline of 100,00 tonnes CO₂-e is provided by the WA EPA, with the emissions trajectory given in Figure 5-1 (pg. 59); pg. 19 of the GHGEMP crystallises the offset requirements calculated by the proponent where <i>"the expected maximum carbon offsets needed after the fifth year of operations would be 22,763 tCO₂e/well in phase one, and 39,588 tCO₂e/well in phase two."</i> The statement on pg. 59 of the GHGEMP, "hence, it would be beneficial for BNR to commit to a faster overall development timeline in a NetZero carbon environment" is highly concerning." This implies that the quicker the project is completed, the less offset / emissions reduction is required and is part of the GHG reduction strategy – this is not aligned to the intent of best practice.	
		The GHGEMP recognised the Safeguard Mechanism baseline for the project, but it does not describe it. Page 38 of the GHGEMP states that <i>"the safeguard mechanisms applies to facilities with direct emissions (scope 1) in exceed of 100,0000 tonnes CO₂- e per annum"</i>.	Oil and gas exploration activities are reportable under the National Greenhouse and Reporting (NGER) scheme and can be covered by the Safeguard Mechanism if those activities form part of a facility that triggers the Safeguard Mechanism threshold. BNR acknowledge that the threshold for application of the safeguard is exceedance of <i>100,0000 tonnes CO₂- e per annum</i>. Two of the key project assumptions for the project is that multiple wells will be drilled and tested each year and that well testing may be undertaken for up to 90 days. If multiple wells are drilled and tested each year and the flaring duration is close to 90 days then the 100,0000 tonnes CO₂- e per annum threshold will be exceed and BNR will be subject to safeguard requirements. Where this is the case than EPA state GHG emission requirements are unlikely to be applicable given the recent policy decisions and updated EPA GHG emission factor guidance.

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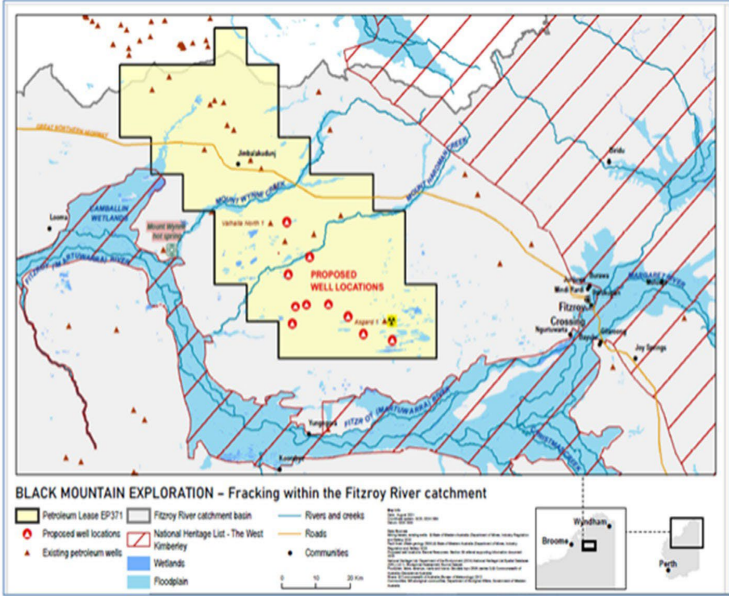
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2.2.10 Social Surroundings

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55.	Group 3 Proforma 1 Proforma 2 Proforma 3 Proforma 4	A high number of submitters noted the significant risk that the proposal would pose to the Martuwarra Fitzroy River, which is recognised as a key component of the West Kimberley National Heritage Place (WKNHP) and is registered as an Aboriginal heritage cultural place (Place ID 12687). The proposal is located on a petroleum tenement that extends to within approximately 10 km of the boundary of the WKNHP (Figure 1).  Figure 1: The location of Valhalla Gas Exploration and Appraisal Program in relation to Mount Wynne hot spring (highlighted, ~15 km west of EP371) and West Kimberley National Heritage Place (~10 km south of EP 371)	BNR does not believe the West Kimberley National Heritage Area (WKNHA) will be impacted. Refer to SS-002

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56.	ANON-6RBT-RU1F-V	Insufficient information is provided in the ERD regarding impacts to the WKNHA from noise and light pollution or unpleasant odours from flaring.	The WKNHA is located ~12 km south, ~24 km west and ~19 km East from the Development Envelope and even further away from the Development Envelope. For a detailed response refer to: SS-002 All potential impacts have been detailed within the ERD as being localised in both extent and duration and given the proximity to the WKNHA are not considered credible. Refer to: AQ-003
57.	ANON-6RBT-RUET-X	The social and cultural risks of the proposal, and associated impacts to Social Surroundings, including cumulative impacts, from large scale onshore gas development have not been addressed in the ERD. More details on likely cumulative impacts of a similar development has been identified and considered in the Northern Territory (see Beetaloo SREBA Regional Report).	The proposal is limited to an exploration and appraisal project. Any further activities will be subject to separate assessment (including cumulative consideration of this proposal). BNR has considered all known developments within the Development Envelope (Section 7 of the ERD).
58.	ANON-6RBT-RUYV-M ANON-6RBT-RUEQ-U	The proposal has the potential to impact Aboriginal communities through: • water and air pollution. • restricting access to bush food and medicine. • clearing and significant impacts on two species of flora and fauna recognised as bush food. • An influx of workers to the region, and resultant social and health impacts.	Human Health impacts have been evaluated in accordance with Department of Health (DoH) guidelines to complete a Human Health Risk Assessment (HHRA) that considers all human health impacts (including those to indigenous communities). Relevant Native Title Groups have been identified in Section 3.2.3 Native title groups of the ERD, with the continuous consultation and identification of economic development opportunities included in Section 3.2.3.1 Native title group engagement of the ERD. Section 5.5 considers direct impacts to indigenous communities arising from noise, traffic, dust, disruptions to existing land users, amenity and aesthetics to name a few). Indirect impacts have also been considered including potential impacts to (but not limited to) water (Section 5.4), air (Section 5.6) flora and vegetation impacts (Section 5.1) and human health (Section 5.8). In all cases, the proposal was not deemed to result in significant impacts to these communities. The Valhalla Environmental Monitoring Plan (Appendix E to the ERD) includes a range of trigger and threshold criteria to ensure that relevant environmental emissions are monitored within proximity of communities to enable correct actions to be implemented in the highly unlikely event that they are triggered.

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			BNR and the Yungngora Traditional Owners met with the EPA Chair on 20/11/2024. The purpose of the meeting was for the Traditional Owners to communicate their ongoing support for the Valhalla Project to be endorsed. The Traditional owners voiced that the Valhalla Project, if endorsed, will enable social and economic benefits for the communities in EP371.
59.	ANON-6RBT-RUYV-M	Traditional owners are concerned about the risk of damage and loss of cultural heritage from fracking (Hirsch et.al., 2018). There is concern about loss of access to land for cultural learning for current and future generations (Poelina et a., 2023).	Engagement with the traditional owners (including during a meeting with the EPA Chair) indicated that no impacts are expected to cultural heritage given surveys have been completed, and they intend to work with BNR during the project execution. The EPA Chair asked if the group had concerns about cultural heritage. In response TO's responded that they have worked with BNR to complete heritage surveys to ensure no impacts will occur. The Traditional owners of land associated within the Development Envelope are supportive of the project.
60.	ANON-6RBT-RUGC-F	The ERD did not identify all proposal activities that may impact on the aesthetic, cultural and other social surroundings values, including the cultural traditions related to the manifestation of the Rainbow Serpent in the proposal area and surroundings. Those activities include groundwater abstraction, clearing of native vegetation and fauna habitat, drilling and hydraulic fracture stimulation activities.	BNR has evaluated all exposure mechanisms by which the project could impact on environmental, social and cultural sensitivities the outputs of which are included in the ERD including <u>but not limited</u> to, groundwater drawdown (Section 5.4.5.1), groundwater contamination (Sections 5.1.5.2-5.4.5.6), native vegetation clearing (Section 5.1.5.1) flaring activities (Section 5.6.5), aesthetics (Section 5.5.5.8). The consideration of impacts to cultural heritage culminates in the review of heritage areas, and mitigations to prevent both direct and indirect impacts. These are detailed in ERD Section 5.5.5). Engagement with the traditional owners (including during a meeting with the EPA Chair) indicated that no impacts are expected to cultural heritage given surveys have been completed, and they intend to work with BNR during the project execution.
61.	ANON-6RBT-RU1B-R	The proponent's <u>Interim Report</u> dated 30 June 2023 reported that flooding along the Fitzroy River impacted 16 known Aboriginal heritage sites and potentially exposing new ones. Given the ERD states that cultural heritage surveys were undertaken in 2021, the cultural heritage report should be updated as part of the referral.	BNR's cultural heritage report has been withheld from the public due to information sensitivity. However, engagement with the traditional owners (including during a meeting with the EPA Chair) indicated that no impacts are expected to cultural heritage given surveys have been completed, and they intend to work with BNR during the project execution including preclearing (or clearance) surveys

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2.2.11 Human Health

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62.	ANON-6RBT-RUUQ-B	The submitter considers that the proposal poses multiple direct and indirect health and wellbeing risks and provided the following report in support of the concerns raised in their submission (Haswell, M., Hegedus, J. and Shearman, D., 2023). The report combines extensive evidence demonstrating health and wellbeing risks from oil and gas developments. Studies reported health effects among children and adults living in proximity to oil and gas operations that may result from both chemical exposures and chronic distress, including symptoms and markers for diseases, higher hospitalisation rates among adults, asthma exacerbations and hospitalisations among children, increased deaths and reduced life expectancy, more frequent traffic and pedestrian injuries and fatalities and higher incidence of mental health conditions.	BNR has completed a HHRA in the ERD which was peer reviewed and validated through consultation with Department of Health. Refer to: HH-001 In addition to this, the proposal is located on a remote pastoral station away from existing communities so people will not be living in close proximity to oil and gas developments. The distances are not dissimilar to oil and gas operations in the mid-west of Australia noting that there are residents that are in fact located much closer to production facilities in the mid-west that are permanent. The Proposal is for an exploration project that is located away from existing communities.
63.	ANON-6RBT-RUYV-M	The submitter raised concerns about the safety of chemicals/additives to be used for hydraulic fracturing processes and its potential impact to human health via water contamination. The submission is supported through Hansard references (<u>Extract from Hansard</u> - Council dated 11 August 2015, and <u>Extract from Hansard</u> dated 20 March 2014) that relate to gas well leaks and overflow from a retention pond in the Kimberley region.	The formation of fluid systems are done in conjunction with well designing practices. BNR has discussed chemical management multiple times with DWER including how chemicals are considered, selected and approved under the Petroleum and <i>Geothermal Energy Resources Act 1967</i>. Refer to: TEQ-003 Ecotoxicity testing of the combined fluid system planned to be used for the proposal has been undertaken by the previous operator and demonstrated that the fluid system is of very low toxicity (Buru Energy, 2018). Exposure pathways from chemical use were considered in the HHRA which was peer reviewed and validated by the Department of Health. Refer to: HH-001 The HHRA was recently validated by a recent independent advice report on unconventional gas completed by the IESC confirmed that <i>a subsurface release from deep unconventional gas projects resulting in aquifer contamination is unlikely</i> (IESC, 2024)

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64.	ANON-6RBT-RUYV-M	The submitter noted research concerning the mental health and psychological well-being of fracking communities (Hirsch et al., 2018).	The existing community has lived experienced with fracking projects previously undertaken safely on their land and are in favour of the project. No mental health and psychological well-being of the community arising from these activities has been raised with BNR during engagements stretching as far back as 2012.
65.	ANON-6RBT-RUYV-M	The submitter raised concerns about the faults and fracture that can occur during hydraulic fracture activities and cause contamination of aquifer due to dispersal of toxic chemicals and have a subsequent impact to humans (CSIRO, 2009).	BNR have considered and assessed the risk of HFS activities causing faults in the ERD. Refer to: IW-010 This was recently validated by a recent independent advice report on unconventional gas completed by the IESC confirmed that <i>a subsurface release from deep unconventional gas projects resulting in aquifer contamination is unlikely</i> (IESC, 2024)
66.	ANON-6RBT-RUYV-M	The submitter raised concerns about the impacts of climate change due to increasing heat on the health and wellbeing of Aboriginal people and their communities because of implementation of the project. Given the already existing health disparities faced by local communities, the implementation of the project will exacerbate the water and food insecurity, health sector workforce stress, housing issues especially during extreme weather events in the Kimberley region (AHCWA., 2019).	BNR is unable to comment on the impacts of climate change due to increasing heat on the health and wellbeing of Aboriginal people and their communities. BNR does not believe that the project will exacerbate the water and food insecurity, health sector workforce stress, housing issues given the proposal is located away from local communities, will not impact on known water sources (both on pastoral land and used by the communities). BNR has a strong relationship with the Traditional Owners, who actively support BNR. The Traditional Owners are made aware of all BNR presence and activities on site, and discussions are ongoing regarding the participation and employment of community members in the Proposal's activities. The community supports current and future work opportunities on EP 371 and the opportunities the project brings to provide self-sufficient solutions to housing, infrastructure and health deficiencies in the region due to lack of governmental support. This information was relayed directly from the Traditional owners during a meeting between the EPA Chair, the Traditional Owners and BNR on 20/11/2024
67.	ANON-6RBT-RU8S-G ANON-6RBT-RU6J-5 ANON-6RBT-RU1F-V ANON-6RBT-RUYV-M ANON-6RBT-RU94-J	Submissions raised potential impacts to human health from airborne pollutants, including volatile organic compounds (VOC), particulate matter (PM2.5), endocrine disrupting chemicals (EDC), secondary organic aerosols and ground level ozone. Airborne pollutants can affect human body systems such as respiratory, endocrine, cardiovascular, reproductive and nervous systems and cause asthma, cancer and adverse birth outcomes. Residential proximity to oil and gas	BNR has completed a HHRA in the ERD which was peer reviewed and included review of exposure mechanisms and distance to sensitive receptors. Any airbourne pollutants are expected to be present only locally to the release point which are away from communities and residential populations as detailed in the HHRA.

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		development has been associated with increased risk of non-hematologic cancer in children (McKenzie et al., 2017) and with adverse birth outcomes in pregnant women (Tran et al., 2021). Submissions cited the following publications: Hays, Jake & Seth B.C. ShonkoT, Towards an Understanding of the Environmental and Public Health Impacts of Unconventional Natural Gas Development: A Categorical Assessment of the Peer-Reviewed Scientific Literature, 11 PLoS ONE e0154164 (2016). ShonkoT 2014; Webb, Ellen et al., Developmental and reproductive effects of chemicals associated with unconventional oil and natural gas operations, 29 Rev Environ Health 307 (2014). McKenzie 2012; Clean Air Task Force, Fossil Fumes: A Public Health Analysis of Toxic Air Pollution from the Oil and Gas Industry, June 2016 available at http://www.catf.us/resources/publications/files/FossilFumes.pdf One submitter noted that Research (Compendium of Scientific, Medical and Media Findings Demonstrating Risks and Harms of Fracking and Associated Gas and Oil Infrastructure, 9th edition, October 2023) shows that fracking related air pollutants (potent carcinogens benzene, formaldehyde, diesel exhaust, fine particles, hydrogen sulphide gas, nitrogen oxides, chlorine and other chemicals can cause serious health issues by damaging respiratory, cardiovascular and nervous systems. Studies from across the United States shows that public health harms linked with drilling, fracking and associated infrastructure are well established. Submitters drew attention to the principles of the <i>Public Health Act WA 2016</i> and the <i>Environmental Protection Act 1986</i>, including principles relating to: • Sustainability • Precautionary principle • Intergenerational equity.	Review by Department of Health validated the exposure assessment. Refer to HH-001 The exposure assessment (and identified potential impacts and risks) is consistent with permanent oil and gas operations in Australia that are located closer to existing residential premises. Given the nature of the proposal (exploration project) the assessment and outcomes are considered consistent with existing projects in WA.
68.	ANON-6RBT-RUET-X	Longer-term, larger-scale and cumulative health and social impacts and risks of the proposal are not adequately addressed in the ERD.	BNR has completed a HHRA in the ERD consistent with the DoH Human Health guidelines. The guidelines require the assessment be undertaken in two stages, with the first being hazard assessment and exposure pathway analysis.

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		ESD requirement no. 52 for the environmental factor Social Surroundings: Health required a peer-reviewed, site-specific human health risk assessment, addressing potential short and long-term health impacts of the proposal. The human health risk assessment (BNR, 2022) includes unsubstantiated comment: "The closest relevant human receptor, an Indigenous Community, is aware and supportive of the Proposal. They are currently knowledgeable of the risks to the environment and of the chemical sources arising from the Proposal given in the past they have supported and worked for a similar unconventional project, now part of Bennett Resources' existing assets. Community members and associated workers such as pastoralists travelling within the Proposal's area understand that they are not considered susceptible or vulnerable populations likely to be exposed by the Proposal's activities." The proponent's discussion of contaminants of potential concern in the human health risk assessment is inadequate and incomplete. The proponent did not consider any studies or scholarly articles that are relevant to the human health risks and impacts from fracking, including those referenced in the report by the Australian National Toxics Network (NTN, 2016). The submitter provides a sample of 'studies of regional community impacts of fracking' in an appendix to their submission.	Where exposure assessment results in a <i>pathway by which human health may be affected</i> additional assessment is required. The outcomes of the hazard and pathway assessment consistent with the guidelines is that: This HHRA has presented plausible evidence of the exposure pathways linking the source of contamination and the exposed receptors. With the exception of air emissions (associated with dust generation), all exposure mechanisms are based upon unplanned events that are well understood in the industry with suitable management and consequence mitigation measures in place. All risks were deemed to be very low according to characterisation in accordance with the DoH risk matrix, which determined that no further risk characterisation is required. The outcomes were peer reviewed and validated through consultation with Department of Health. Refer to: HH-001
69.	ANON-6RBT-RUET-X	The Chemical Inventory (Appendix A) provides limited and confusing information from companies that hold proprietary rights over fracking fluids. The inventory is not possible for lay-persons to understand. Furthermore, many of the listed chemicals have not been tested for human and ecological toxicity risks.	BNR has provided the required information consistent with the ESD. During the ESD process BNR discussed chemical management including the assessment and approval process under the <i>Petroleum and Geothermal Energy Resources Act 1967</i>. BNR has provided all relevant information as required by the ESD noting that not all SDS's have ecotoxicological information and it is standard practice to utilize other sources to inform the assessment of these chemicals. Refer to: TEQ-003
70.	ANON-6RBT-RUET-X	The ERD does not address the results of a WA Health Department assessment of the impacts of fracking that found 28 suspected carcinogens in the 96 substances found in flowback fluids/produced formation water that were not used in the initial hydraulic fracturing fluid. The submitter also questions if this report was made available to the 'receptor communities' relevant to the proposal.	Impacts arising from an unplanned release of produced water (flowback water) have been considered in Section 5.4.5.5 of the ERD. Given the sites are non-accessible to the public with specific exclusionary barriers the only risk of exposure is through a release. Mitigations detailed in ERD Section 5.4.6 detail engineering design controls to avoid and minimize the risk of potential impact through pond design and management. These are known standard industry

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			controls. On this basis BNR believes that sufficient assessment of potential indirect impacts has been considered. BNR acknowledges that minerals and chemicals present at depth are likely to be present in produced water at varying concentrations, which upon return to surface will also be present regardless of the chemicals used in the hydraulic fluid. This is no different to any other resource project. However, BNR has made commitments to complete ecotoxicity testing of flowback water to confirm constituents (and toxicology) of specific formation water and subsequent chemical interactions.
71.	ANON-6RBT-RUET-X	The proponent's assessment identified only four chemicals of possible concern (silica, nitrilotriacetic acid, trisodium salt monohydrate and sulfuric acid). However, the Strategic Regional Environmental and Baseline Assessment (SREBA) for the Beetaloo Sub-basin undertaken following the recommendation of the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory (SREBA 2022), considered 41 chemicals of potential concern and 33 chemicals of potentially high concern. It is likely that many of these chemicals of concern identified in the Northern Territory assessment could be used for the proposal.	The assessment and exposure assessment was based upon the specific chemicals proposed to be used (Appendix A) not other chemicals that may be used elsewhere in the country.
72.	ANON-6RBT-RUET-X	The human health risk assessment report does not adequately address the impacts and risks to human health associated with toxic contaminants such as heavy minerals, VOCs, high concentrated salts, BTEX (benzene, toluene, ethylbenzene and xylene), fracking and/or drilling chemicals and naturally occurring radioactive materials (NORMs, such as radium and radon) that are usually found in produced water from fracking operations and are known to be toxic to humans and animals. Furthermore, the health risk assessment does not address 'radionuclides' despite recent experience of elevated levels of these potentially toxic and long-lasting materials (i.e., Radium-228) in produced formation water recovered at frack well sites within EP371 (Buru Energy, 2018).	BNR has completed a human health assessment in the ERD which was peer reviewed and validated through consultation with Department of Health. In accordance with the Human Health Factor, the assessment for the proposal is focused on radioactive substances. Refer to: HH-001 Assessment of impacts that result in a build-up and release of radioactive substance or emissions are assessed in ERD Section 5.4.5.5 Potential contamination of surficial aquifers from an accidental release at the surface of drilling fluids, HFS chemicals, liquid hydrocarbons, or produced formation water. The previous operator (Buru Energy) took multiple water samples and had them analysed at a NATA-accredited laboratory. The produced formation water from the water retention ponds has naturally occurring radioactive material (NORM), the concentrations were well below the exposure concentrations identified by the Australian and New Zealand guidelines for fresh and marine water quality and the Australian Drinking Water Guidelines.

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73.	ANON-6RBT-RUET-X	No detailed studies were conducted to understand the local community use of water bodies such as Hardman Creek, despite the proximity of the proposal to the creek.	As detailed in Section 3.1.1 of the HHRA, land uses were reviewed and documented to a suitable level to complete an exposure assessment consistent with DoH Guidelines. The updated Human Health Risk Assessment (HHRA) (Appendix 9) now includes contamination of surface from surface spills. Contamination of surface water may occur from a large unplanned surface spill event such as loss of containment from the most northern produced water pond. Standard construction, petroleum storage, and petroleum use mitigation measures (ERD Table 5-11) will be applied to this activity; therefore, the likelihood of such a spill event occurring is extremely low. Containment and recovery measures will ensure that any impact would be minimised and exposure to Mount Hardman Creek (~1 km away) avoided and therefore is not considered to have the potential to result in a significant impact. In addition to pastoral activities, the Traditional Owners (TOs) of the land and members of the Yungngora Community, including some Warlangurru People residing at the Jimbalakudunj Community, use the land within and surrounding the Development Envelope for cultural practices, such as hunting and gathering of traditional foods, initiations and education. The land in this region is also used for recreational purposes such as swimming and fishing. Mount Hardman Creek is a non-perennial water body and only flows during the wet season. The only exposure pathway for surrounding surface waters would be surface contamination from loss of containment of the pond during a flood event. Consequently, an unplanned release event would need to occur during the wet season (given any release during the dry season would not reach the surface water feature and would be cleaned up prior to the wet season) and as such the only potential spill event that could occur in these circumstances is a flooding event. Furthermore, the mitigations that are in place to prevent a release mean that even a significant flooding event would not result in a release (due to pond design flood analysis informing berm height design along with freeboard requirements). ERD Section 5.4.3.5 FitzCAM—a community group comprising representatives from the key Traditional Owner groups of the Fitzroy River Catchment, pastoralists, irrigators, recreational fishers and catchment residents—developed a draft table of assets known to be

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			water-dependent features (Harrington & Harrington, 2015). These assets included: • Lake Gladstone, the largest permanent freshwater wetland in the Central Kimberley bioregion, providing a refuge for vulnerable species. • Freshwater springs such as Udialla Springs and Honeymoon Springs. • Mallallah Swamp and Sandhill Swamp, which are potentially important waterbird habitats. Refer to the undated Human Health Risk Assessment (HHRA) (Appendix) to include contamination of surface from surface spills.
74.	ANON-6RBT-RUET-X	The submitter highlighted potential risks to human health due to exposure to groundwater contamination via pastoral bores as a result of hydraulic fracturing activities. Additionally, the submitter notes that proponent's peer review of the human health risk assessment (Appendix X) identified the lack of discussion regarding surface water bodies within the proposal area, despite the risk assessment listing swimming and fishing as relevant considerations. The submitter also raised concerns regarding the peer review of the human health risk assessment being initially withheld from the public review period, and only released when the submitter raised the matter with the EPA.	BNR has completed a human health assessment in the ERD which was peer reviewed and validated through consultation with Department of Health. In accordance with the Human Health Factor. The assessment (in accordance with DoH guidelines) considered the initial exposure pathways (rather than identified sensitivities). The outcome of the assessment is that sub-surface exposure pathways are not credible thus impacts to human health is not credible This was recently validated by a recent independent advice report on unconventional gas completed by the IESC confirmed that <i>a subsurface release from deep unconventional gas projects resulting in aquifer contamination is unlikely</i> (IESC, 2024) BNR apologises for the administrative error of not attaching the peer review. This was oversight on our part during the compilation of the large ERD and many supporting studies and reports. This was immediately rectified (the same day) on request from DWER.
75.	ANON-6RBT-RU1Y-F	One submitter raised concerns that the proposal will have a detrimental impact to the health of Western Australian residents, leading to increased incidence of cancer. Scientists have been concerned about polycyclic aromatic hydrocarbons (PAHs) being released into water supplies and air during undoes this conventional gas mining. <u>Recent studies</u> have shown that unconventional gas mining has resulted in an increase in cancer incidence in the USA and in Queensland. Regular resting of produced water for PAHs is needed to assess the health risks of the proposal.	In accordance with the Human Health Factor, the assessment for the proposal is focused on radioactive substances. Refer to: HH-001 Credibility of subsurface release was recently validated by a recent independent advice report on unconventional gas completed by the IESC confirmed that <i>"a subsurface release from deep unconventional gas projects resulting in aquifer contamination is unlikely"</i> (IESC, 2024). Surface releases are considered with sufficient mitigation included in the ERD.

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2.2.12 Consultation

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76.	ANON-6RBT-RU8D-1 ANON-6RBT-RU1T-A ANON-6RBT-RUY1-F ANON-6RBT-RU16-C	Submitters raised concerns about the lack of consultation undertaken with the Native Title Parties. Specific concerns raised in the submissions include: - Lack of consultation with Native Title Parties, and impacts to Aboriginal heritage sites. - Traditional Owners have not been involved appropriately or sufficiently powerfully in discussions about their land, and they need to have the right to say "no" to such proposals. - No permission has been granted by First Nations People. - This country belongs to its Traditional Owners, and it is they who need not only to be consulted, but also listened to, with their decisions respected and implemented.	Traditional Owners of the land and members of the Yungngora Community, Warlangurru Community and Jimbalakudunj Community use the land within and surrounding the Development Envelope for cultural and recreational reasons, such as education, hunting, gathering, fishing and swimming. Over the past 10 years, BNR and the previous operator have proved that oil and gas activities can exist with cultural activities. BNR has a strong relationship with the Traditional Owners, who actively support BNR. The Traditional Owners are made aware of all BNR presence and activities on site, and discussions are ongoing regarding the participation and employment of community members in the Proposal's activities. The community supports current and future work opportunities on EP 371 as evidenced during a meeting between the EPA Chair, the Traditional Owners and BNR on 20/11/2024.
77.	ANON-6RBT-RUGC-F ANON-6RBT-RUE6-Z	Submissions stated that not all relevant Traditional Owner groups have been identified and consulted. Several key stakeholders, including but not limited to Walalakoo Aboriginal Corporation RNTBC (Walalakoo) and Yanunijarra Aboriginal Corporation RNTBC (Yanunijarra) that are likely to be affected by the proposal were not identified and consulted. The connectivity of these Traditional Owner groups to the proposal area is discussed in the <u>Special Gazette - Inclusion of a place in the National Heritage List: The West Kimberley</u>, which states: "The Fitzroy River and a number of its tributaries, together with their floodplains and the jila sites of Kurrpurrngu, Mangunampi, Paliyarra and Kurungal, demonstrate four distinct expressions of the Rainbow Serpent tradition associated with Indigenous interpretations of the different ways in which water flows within the catchment and are of outstanding heritage value to the nation under criterion (d) for their exceptional ability to convey the diversity of the Rainbow Serpent tradition within a single freshwater hydrological system". One submission notes that the Bunuba Dawangarri and Nyikina Mangala communities may also be impacted through increased transport movements across their lands	BNR has consulted with all key stakeholders through consultation regarding the Traditional Owner groups identified as overlapping the Development Envelope. ERD Section 3.2 Key Stakeholders details BNR key stakeholders as <i>"any person or organisation whose functions, interests or activities may be affected by the proposed activities"</i>. Through consultation the Traditional Owner groups identified as overlapping the Development Envelope are Yungngora Aboriginal Corporation, Warlangurru Aboriginal Corporation. As detailed in the impact and risk assessment, the potential impacts and risks associated with the proposal are limited to the Development Envelope with no indirect impacts expected outside of this area. As such BNR believes consultation has been undertaken with all traditional owner groups potentially impacted by the proposal. All access outside of the disturbance footprint will be via dedicated public roads so any increased transport movements would be limited to public roads. BNR's cultural heritage report has been withheld from the public due to information sensitivity. However, engagement with the traditional owners (including during a meeting with the EPA Chair) indicated that no impacts are expected to cultural heritage given surveys have been completed, and they intend to work with BNR during the project execution including preclearing (or clearance) surveys.

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		The proponent has failed to adequately identify Aboriginal cultural heritage in order to meet "required work" requirements identified in the ESD for the 'social surroundings' factor.	
78.	ANON-6RBT-RU9N-C	One submitter outlined that the Noonkanbah community is well informed about the risks of hydraulic fracturing. Sufficient information was provided to Noonkanbah community by Buru Energy between 2012 and 2020. The submission refers to more details being included in Buru Energy Submission to the Scientific Inquiry into Hydraulic Fracture Stimulation in Western Australia. The Noonkanbah community provided consent for the 2015 hydraulic fracturing activities to commence via a community vote held in June 2014. The submitter also refers to Noonkanbah – Proper Way, a short documentary made by Buru Energy in partnership with Yungngora (Noonkanbah) community in the Kimberley region.	BNR agrees with this submission. This statement is consistent with outcomes from engagement completed by BNR to date.
79.	ANON-6RBT-RUE6-Z	One submitter noted that insufficient detail was provided regarding the cultural, ethnographic and archaeological heritage surveys conducted in 2021 by Deep Wood Surveys, and noted that it is therefore not possible to assess the potential limitations of the survey.	BNR's cultural heritage report has been withheld from the public due to information sensitivity. However, engagement with the traditional owners (including during a meeting with the EPA Chair) indicated that no impacts are expected to cultural heritage given surveys have been completed, and they intend to work with BNR during the project execution including preclearing (or clearance) surveys.

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**2.2.13 Other**

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80.	ANON-6RBT-RU7Z-P ANON-6RBT-RU8C-Z ANON-6RBT-RUET-X	Seismicity The submitters raised concerns regarding the consequences of hydraulic fracturing activities that can induce seismicity and cause earthquakes. The submissions noted: The injection of wastewater into deep wells has been linked to increased seismic activity, including small earthquakes. While these are typically minor, they can still pose risks to infrastructure and safety. In Texas fracking fields, millions of litres of polluted wastewater are injected into the ground. Problems caused include groundwater pollution, blowouts from disused oil wells (https://www.texastribune.org/2024/08/07/texas-oil-fracking-wastewater-injection-blowouts-permian-basin/), and earthquakes, a phenomenon new to that part of the world (https://www.nytimes.com/2023/01/28/us/texas-earthquakes-fracking.html). Hydraulic fracturing can induce earthquakes exceeding magnitude 4, resembling natural earthquakes in source characteristics, ground motions and hazard – with the potential to greatly exceed natural earthquake hazard in regions of low to moderate seismicity (Atkinson et al., 2020).	BNR has considered local seismic changes which are considered in the Geotechnical Risk Assessment documented included as Appendix B of the ERD. BNR does not believe that HFS activities in the Kimberley would result in increased seismic activity. Refer to: TEQ-Q08 BNR does not plan to reinject wastewater into the ground and will design the HFS program and monitor it closely to ensure that pressures applied are consistent and limited to designed threshold levels.
81.	ANON-6RBT-RU7D-Z ANON-6RBT-RUF8-3 ANON-6RBT-RU9H-6 ANON-6RBT-RU1T-A ANON-6RBT-RU66-H ANON-6RBT-RUEU-Y ANON-6RBT-RUUW-H	Tourism Several submissions noted the tourism values of the region, and the potential impacts of the proposal on tourism. Key points raised include: The Kimberley is a national and international tourism icon for its intact landscapes and vibrant living First Nations cultures. The Kimberley has a \$600m tourism industry that is at risk if fracking was to go ahead. Tourism has the potential to give long-term employment and growth to the region. The Kimberley's economy is largely based on tourism, agriculture, and Indigenous-owned businesses, all of which rely on the region's pristine environment. Industrializing the landscape with fracking operations would not only deter tourists but could also harm the long-term viability of these industries, leading to job losses and economic instability over time.	BNR has discussed the impacts of the proposal to the tourism industry in the ERD and does not believe that these will be significant. As road usage is limited to travelling community members, pastoralists and other occasional workers from the region, and as no tourism is currently present within this area nor within the Project Area, tourism activities should not be affected. The traffic assessment completed in Section 5.5.5.4 of the ERD indicates that although the proposal could increase road use significantly, this increased traffic attributable to the Proposal is not likely to significantly impact local road users as the road is of suitable quality to allow two directions of travel. Section 5.5.5.8 Amenity and aesthetics of the ERD discusses overall impacts to amenities and aesthetics in the project Area surrounds and discusses Project impacts on tourism. Mitigation measures and their hierarchy are detailed in Section 5.5.6 Mitigation.

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		Tourism, including cultural tourism led by First Nations tour companies, is huge in the Kimberley. It represents an economy of approximately \$600million annually and employs many people. It also looks after and preserves the environment, as the marvellous environment and the culture bound up in it is at the centre of cultural tourism. Fracking projects and pipeline projects are not compatible with Cultural Tourism. Putting Culture and the environment at risk by allowing pipelines, fracking and extractive industries, would seriously damage, if not destroy, the popular First Nations cultural tourism businesses.	
82.	ANON-6RBT-RUET-X	Hydraulic fracturing infrastructure One submitter stated that the proponent relies on outdated, non-fit-for-purpose and substandard fracking infrastructure and processes that pose a high risk to the environment and surrounding communities.	The rig and HFS infrastructure, well and stimulation design is not yet complete. Once BNR has received approval under the EP Act, BNR will start to engage partners to support the detailed design and execution of the activity and this will involve completing detailed well engineering, civil engineering and reviewing available materials and equipment. Only after the approvals are de-risked, will BNR invest significant capital in these areas.
83.	Group 5 (see Appendix 1) Proforma 1 Proforma 4	Regulation by Department of Energy, Mines, Industry Regulation and Safety Numerous submissions raised concerns about the ability of the Department of Energy, Mines, Industry Regulation and Safety (DEMIRS) to appropriately regulate the onshore hydraulic fracturing industry. Submissions made reference to previous incidents involving leaks at the Yulleroo 2 wellhead and wastewater ponds overflow at other sites in the Kimberley.	BNR understands that the assessment of this Proposal is limited to the scope of the Proposal and not the broader industry. However, as detailed in the ERD, BNR acknowledges that the oil and gas industry has experienced some release events in the past, in particular Yulleroo 2. However, the events from past projects under different operatorship does not equate to certainty that these events will arise for this Proposal. That said, BNR has incorporated the learnings from such historical events into the mitigations clearly detailed in the ERD. BNR will manage its wells throughout their lifecycle implementing a well integrity management system, which includes meeting or exceeding all requirements set forth in the Petroleum and Geothermal Energy Resources (Resource Management and Administration) Regulations 2015, as required by DEMIRS. Under the Regulations, a Well Management Plan (WMP) that describes the history of all well activities relating to the planning, design, construction, integrity, and management of a well throughout its life cycle must be approved by DEMIRS. Well integrity impacts have been assessed in the ERD Section 5.4 and mitigation measures have been detailed in Table 5-33. BNR will ensure that the wastewater retention pond design will meet WQPN 26 (DoW, 2013) and all lined storage compounds should have sufficient freeboard (at least 500 mm) maintained to prevent unintended overflow of water from storms with an average return frequency of at least 20 years, plus capacity to store rainfall resulting from a 90th percentile wet season, after allowance for any evaporative water loss and the effects of any water re-use recovery system.

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84.	ANON-6RBT-RU7Y-N ANON-6RBT-RUYP-E	Submissions raised concerns around well integrity and noted that three wells have been fracked in the Kimberley over the past 14 years and all have had problems, including documented well-integrity failures.	Well integrity is managed in accordance with a DEMIRS approved well management plan under the <i>Petroleum and Geothermal Energy Resources Act 1967</i> . These plans require management of well integrity incidents to be documented to the satisfaction of DEMIRS. BNR will develop these plans and implement them as detailed in Section 1.4.3 of the ERD.
85.	Group 6 (see Appendix 1) Proforma 1 Proforma 2 Proforma 3 Proforma 4	Wastewater management Several submissions raised concerns relating to potential impacts from the management of wastewater produced during fracking. Key points raised included: Insufficient information has been provided on the management of wastewater generated by hydraulic fracturing operations. Produced wastewater is likely to contain radioactive and carcinogenic substances due to the movement (flow) of the produced water and chemicals added during the drilling and fracking process. Wastewater from test fracking in the Kimberley has been found to be radioactive. The volume and management of produced wastewater is not well documented in the ERD. A similar activity in the Kimberley region has resulted in overflow of ponds during the wet season that were designed to contain and hold produced wastewater.	BNR has assessed the risks associated with produced water management in the ERD. Refer to: IW-001 Following queries from DMAs on the flowback water volumes, BNR ERD included Table 2-5: Site total water balance (per well), Table 2-6: Site total water balance (per wellsite x 2) and Table 2-7: Site total water balance (entire program x 20). It should be noted that these numbers are estimates and indicative only and are subject to a number of local geological details (such as success of stimulations, the number of stimulations and duration of flowback). Estimations in these tables have utilised conservative estimates (i.e. the longest durations, highest success and maximum number of stimulations per well). BNR notes the discrepancy of produced water volumes between ERD Section 2.4.5 Water balance and Table 5-49 this is an administrative error. The volumes provided in Section 2.4.5 are more contemporary and used as the basis for the impact assessment. BNR has assessed the risks associated with produced water management in the ERD. Estimated volumes are clearly documented within the ERD. Refer to: IW-001

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		Several submitters noted that the produced water will be disposed by evaporation while stored in lined tanks, however there is no information provided about the transport and disposal of highly toxic sludge that will remain after evaporation.	Once evaporation is complete, the ponds will only have a thin coating of residue and not will not comprise a sludge. This residue is then cleaned from the pond liner (scrubbed, contained and removed offsite via small tanks or vacuum trucks given small volumes of residue). Liners are then pulled and disposed of at a relevant waste disposal facility. As detailed in Table 2-8 of the ERD - management of these wastes will be managed in accordance with the requirements of the Radiological Council and the Radiation Safety (General) Regulations 1983.
		Two submissions raised concerns that the ERD does not provide sufficient information about the risks of potential chemical contamination of the environment associated with incidents involving spillage of drilling waste and flowback wastewater during wastewater transfer, overflow of evaporation ponds, explosion of toxic chemicals, flooding of well pads and waste pits.	The risks of potential groundwater impacts arising from a surface release is detailed in Section 5.4.5.5 Potential contamination of surficial aquifers from an accidental release at the surface of drilling fluids, HFS chemicals, liquid hydrocarbons, or produced formation water. The risks of potential terrestrial quality impacts arising from a surface release is detailed in Section 5.2.5.2 Contamination of land and soils from surface spills. Section 5.2.5.2 specifically identifies the following scenarios and provides a summary of the magnitude of the event. • Loss of diesel during refueling • Loss of diesel from onsite diesel storage tank • Loss of minor volumes of hydrocarbon or chemicals during storage and handling around the well site • Loss of drilling fluids due to circulation issues or well integrity failure • Loss of HFS fluid at the surface during HFS operations • Loss of well control • Loss of formation water produced during well testing BNR has assessed the risks associated with produced water management in the ERD. Estimated volumes are clearly documented within the ERD. Refer to: IW-001
		One submission stated that misinformation was spread about radioactive flowback water in relation to the 2015 hydraulic fracturing program in the Kimberley region. The results of the flowback water analysis during the program were included in Section 3.4.6.2 of the Buru Energy Submission to the WA	BNR has not misrepresented the data. BNR included information in the ERD from samples collected within the pond (not all samples collected) to provide a realistic representation of water quality associated with the produced water once collected in the pond.

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		<u>Scientific Inquiry</u>, which showed that radionuclides in flowback water were above the Australian Drinking Water Guideline levels in two samples.	BNR acknowledges that two individual samples from Asgard were above the drinking water guidelines, however as detailed in Buru's <u>Buru Energy Submission to the WA Scientific Inquiry</u>, the composite sample collected from the flowback pond was well below the guideline level and a more realistic representation from an unplanned release scenario (arising from a spill from a pond). BNR has assessed radioactive waste impacts in the ERD.
		Several submitters consider that the effects of climate change on the proposal have not been adequately considered. The Kimberley region experienced an extreme flooding event in January 2023, which indicates there is an increased risk for an accidental fracking wastewater spill. Spilled produced wastewater can eventually make its way to surface water and groundwater and cause contamination.	BNR has sufficiently addressed flooding risks to Project infrastructure in the ERD. The key considerations are the subsequent engineering design considerations including hardstand and pond design to ensure that asset integrity and risk of pond overflow is managed. These are suitably captured. Refer to: TEQ-004 IW-001 IW-004
		The proponent relies on outdated 2013 guidelines from the former Department of Water when designing its storage ponds. The ERD (page 38) refers to Water Quality Protection Note 26 (DoW, 2013) for the construction of surface ponds of using dual liners. In comparison, sumps with a Coletanche® liner, which is a composite liner consisting of five different layers, have been used recently by Tamboran Resources for its proposed 15 well fracking operation in the Beetaloo. It is noted that even stricter requirements are set out in the Northern Territory's <u>Code of Practice: Onshore Petroleum Activities in the Northern Territory (2019)</u> which requires the mandatory use of above-ground enclosed tanks to contain all produced water and flowback fluid.	BNR has applied standard Western Australian Controls for the management of produced water that are consistent with permanent operating oil and gas facilities in WA. These controls have recently been approved by DWER and other agencies thus were considered suitable for a temporary short-term use.
		The proponent does not have a good understanding on how much produced formation water is likely to be created despite of having two frack wells o EP371. The ERD indicated that formation water produced from well is estimated to be of 8 ML per well during the testing phase up to 57 ML per well. The produced water will be left in retention ponds to evaporate.	Following queries from DMAs on the flowback water volumes, BNR included Table 2-5: Site total water balance (per well), Table 2-6: Site total water balance (per wellsite x 2) and Table 2-7: Site total water balance (entire program x 20). It should be noted that these numbers are estimates and indicative only and are subject to a number of local geological details (such as success of stimulations, the number of stimulations and duration of flowback). Estimations in these tables have utilised conservative estimates (i.e. the longest durations, highest success and maximum number of stimulations per well). BNR notes the discrepancy of produced water volumes between Section 2.4.5 Water balance and Table 5-49 this is an administrative error. The volumes provided in Section 2.4.5 are more contemporary and used as the basis for the impact assessment.

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			Given BNR may not drill the maximum number of wells applied for or complete the maximum number of stimulations the volume of wastewater is based upon a conservative estimate of all wells and all stimulations.
		It is predicted that a total of 1140 ML of wastewater will be produced over the life of the project. The ERD does not provide information on how much final waste will be produced and how the concentrated toxic waste, potentially including radioactive materials will be disposed safely.	Volume of produced water was provided in the ERD and updated in relation to DMA queries. Refer to: IW-023 Waste management is detailed within Table 2-8 of the ERD and includes produced water and radioactive wastes.
		The proponent failed to discuss and address the risks and impacts associated with the management of flowback water such as estimating the total volume of produced water, estimating the risks to groundwater and surface water resources due to leaky pit membranes or other pond failures, providing details on re-injection if proposed, providing details on storage and disposal of drilling and hydraulic fracturing flowback fluids, sufficient information on potential impacts from radiation being brought to the surface in flowback water from the proposed operations.	Reinjection of Produced water is not proposed. BNR has assessed the risks associated with produced water management in the ERD including storage, management and mitigation. Refer to: IW-001 IW-004 Volume of produced water was provided in the ERD and updated in relation to DMA queries. Refer to: IW-023
		Improved management of wastewater is necessary to avoid impacts to surface water, groundwater and fauna habitat.	BNR has assessed the risks associated with produced water management in the ERD and included sufficient design mitigation to avoid and minimize this risk from occurring. Refer to: IW-001
		Toxic wastewater ponds may appear as a rest stop for passing flock of birds and therefore may cause harm to fauna.	BNR has detailed mitigation measures in the ERD to manage impacts to fauna in relation to wastewater ponds. Table 5-18 Proposed mitigation measures – terrestrial fauna of the ERD lists mitigation measures such as fauna exclusion and egress requirements for wastewater ponds along with other mitigations to prevent release into the surrounding environment. These controls are standard across the onshore petroleum industry including for other operating facilities and produced water storage ponds. Additional controls (such as bird diverters) were considered but as the risk is low were not selected

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			for use. These controls can be added (as they are not design elements) to the proposal in the future if the presence of birds are realized BNR has detailed mitigation measures in the ERD to manage impacts to fauna in relation to wastewater ponds. Refer to: TEQ-002 BNR has assessed the risks associated with produced water management in the ERD. Refer to: IW-001 IW-004
		There is a high risk of wastewater pond overflow during wet season.	BNR has assessed the risks associated with produced water management in the ERD and included sufficient design mitigation to avoid and minimize this risk from occurring. Refer to: IW-001
86.	ANON-6RBT-RUF7-2	One submitter questioned the availability of independent scientific knowledge to support the EPA's assessment. Specific questions posed included: • What independent research and scientific knowledge does the EPA possess? • What independently corroborated research has the company provided to the EPA? • If the EPA has such research, is the EPA willing to put that research on public display? • Is the EPA actually qualified to approve such a project on its own environmental credentials?	BNR cannot advise EPA on the assessment process and use of an Independent Expert Scientific Committee (IESC) other than to state that governmental experts within the water branch of DWER have been engaged with over the course of the project.

***Uncontrolled in Hardcopy Format* Printed: 10-Jun-25 Use Latest Revision**

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Approver:

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***Uncontrolled in Hardcopy Format* Printed: 10-Jun-25 Use Latest Revision**

Author / Reviewer:

AES

Approver:

Michael Laurent

Review Frequency: Extreme/High=1yr; Medium=2yr; Low=3yr

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***Uncontrolled in Hardcopy Format* Printed: 10-Jun-25 Use Latest Revision**

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ANON-6RBT-RU8S-G	ANON-6RBT-RU8S-G	ANON-6RBT-RU1W-D	ANON-6RBT-RU9K-9	ANON-6RBT-RUYX-P	ANON-6RBT-RU6W-J
ANON-6RBT-RU8K-8	ANON-6RBT-RU8K-8	ANON-6RBT-RU1C-S	ANON-6RBT-RU9Q-F	ANON-6RBT-RUY8-P	ANON-6RBT-RU68-K
ANON-6RBT-RU8U-J	ANON-6RBT-RU8U-J	ANON-6RBT-RU15-B	ANON-6RBT-RU9H-6	ANON-6RBT-RUYW-N	ANON-6RBT-RU6C-X
ANON-6RBT-RU82-F	ANON-6RBT-RU8Q-E	ANON-6RBT-RU1A-Q	ANON-6RBT-RU9D-2	ANON-6RBT-RUYP-E	ANON-6RBT-RU6V-H
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***Uncontrolled in Hardcopy Format* Printed: 10-Jun-25 Use Latest Revision**

Author / Reviewer:

AES

Approver:

Michael Laurent

Review Frequency: Extreme/High=1yr; Medium=2yr; Low=3yr

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Date Review Due:

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ANON-6RBT-RU63-E	ANON-6RBT-RU6B-W	ANON-6RBT-RU61-C	ANON-6RBT-RU8U-J	ANON-6RBT-RU41-A	ANON-6RBT-RUYP-E
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ANON-6RBT-RU67-J	ANON-6RBT-RU67-J	ANON-6RBT-RUYZ-R	ANON-6RBT-RU1C-S	ANON-6RBT-RU4H-1	ANON-6RBT-RU6F-1

***Uncontrolled in Hardcopy Format* Printed: 10-Jun-25 Use Latest Revision**

Author / Reviewer:

AES

Approver:

Michael Laurent

Review Frequency: Extreme/High=1yr; Medium=2yr; Low=3yr

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Date Review Due:

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ANON-6RBT-RUYG-5	ANON-6RBT-RUYG-5	ANON-6RBT-RU45-E	ANON-6RBT-RU67-J	ANON-6RBT-RUBT-U	

***Uncontrolled in Hardcopy Format* Printed: 10-Jun-25 Use Latest Revision**

Author / Reviewer:

AES

Approver:

Michael Laurent

Review Frequency: Extreme/High=1yr; Medium=2yr; Low=3yr

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Date Review Due:

TBC

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***Uncontrolled in Hardcopy Format* Printed: 10-Jun-25 Use Latest Revision**

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AES

Approver:

Michael Laurent

Review Frequency: Extreme/High=1yr; Medium=2yr; Low=3yr

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Review Frequency: Extreme/High=1yr; Medium=2yr; Low=3yr

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ANON-6RBT-RUBH-F	ANON-6RBT-RUBM-M	ANON-6RBT-RUEE-F	ANON-6RBT-RU4D-W		
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ANON-6RBT-RUEV-Z	ANON-6RBT-RUE7-1	ANON-6RBT-RUG8-4	ANON-6RBT-RUBY-Z		

***Uncontrolled in Hardcopy Format* Printed: 10-Jun-25 Use Latest Revision**

Author / Reviewer:

AES

Approver:

Michael Laurent

Review Frequency: Extreme/High=1yr; Medium=2yr; Low=3yr

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Author / Reviewer:	AES		Approver:	Michael Laurent		
Review Frequency: Extreme/High=1yr; Medium=2yr; Low=3yr		2	Date Review Due:	TBC	Page:	110 of 139



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Author / Reviewer:

AES

Approver:

Michael Laurent

Review Frequency: Extreme/High=1yr; Medium=2yr; Low=3yr

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ANON-6RBT-RUUJ-4	ANON-6RBT-RUU1-B		ANON-6RBT-RUG7-3		
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ANON-6RBT-RUUN-8			ANON-6RBT-RUGF-J		
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***Uncontrolled in Hardcopy Format* Printed: 10-Jun-25 Use Latest Revision**

Author / Reviewer:

AES

Approver:

Michael Laurent

Review Frequency: Extreme/High=1yr; Medium=2yr; Low=3yr

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Appendix 2. BNR Supplemental information (long-form answers)

CODE	RESPONSE
FV-001	BNR does not believe flora and vegetation will be significantly impacted. ERD Section 5.1 Flora and Vegetation describes the flora and vegetation within the Development Envelope in detail. To date, flora and vegetation surveys undertaken within the Development Envelope have not identified the presence of any Threatened Flora or Priority Ecological Communities (PECs). The potential direct and indirect impacts to flora and vegetation (loss and fragmentation of native vegetation from clearing, introduction of non-indigenous species, unplanned fire events and dust emissions) are discussed in the ERD Section 5.1.4 Potential Impacts The Proposal will require an overall disturbance footprint of ~112 ha, with a clearing footprint of <110 ha. BNR have intentionally used previously cleared roads to reduce the impact to local vegetation. Mitigation measure to avoid, and minimise these impacts are detailed in Section 5.1.6 Mitigation. BNR believes that as detailed in the ERD, the proposal can be implemented in a manner that allows the EPA's objective 'Protect flora and vegetation so that biological diversity and ecological integrity are maintained' to be met.
FV-002	BNR believes the introduction and spread of weeds has been sufficiently addressed. The ERD identifies the introduction and/or spread of non-indigenous species (weeds) as a potential indirect impact. Eco Logical 2021 (ERD Appendix 3) states there were nine (9) weed species found in the Project Area. Given the Proposal is located within a pastoral station, significant pressures exist regarding the transfer of weeds within the site regardless of implementing the proposal. Subsequently, the introduction of a new species is considered the highest risk to the Proposal given the potential for this to be spread through existing pastoral activities. These impacts are discussed in detail within Section 5.1.5.2 Degradation or loss of vegetation ecology and biodiversity as a result of the introduction of non-indigenous species (weeds). Further to this, the indirect impacts to fauna species associated with the introduction of weed species is detailed within Section 5.3.5.4 Habitat degradation as a result of the introduction and/or spread of non-indigenous species (weeds). Mitigation measures to avoid, and minimise these impacts are detailed in Section 5.1.6 Mitigation. With these mitigation measures in place, it is not expected the Proposal will introduce further species or contribute to the current populations of introduced weeds or disease. BNR believes that as detailed in the ERD, the proposal can be implemented in a manner that allows the EPA's objective 'Protect flora and vegetation so that biological diversity and ecological integrity are maintained' to be met.
FV-003	BNR has used vegetation mapping to understand the extent of broadscale vegetation communities in the region. Whilst it has not been used to inform the local potential impacts, it has been used to understand the potential impacts in a broader regional scale context. This is a standard approach in lieu of spending significant efforts on scientific characterisation of vegetation units outside of the area that will potentially be directly or indirectly impacted by the proposal.
FV-004	As per the EPA guidelines, the flora and vegetation survey has identified its limitations. The limitations identified are largely associated with access due to the lack of cleared roads and vegetation type. However as detailed by Eco logical (2021) or Appendix C of the ERD, the survey was considered sufficient (based on the desktop assessment (database searches and literature review) and a detailed post-survey flora likelihood of occurrence assessment) to inform the outcome that, no Threatened flora species are considered as being likely or having the potential to occur within the Project Area. This is consistent with previous surveys in the area indicating that the information gathered during the scientific surveys is adequate to inform the impact assessment.
FV-005	BNR has assessed impacts to Aboriginal significant Bush Food In Section 5.5.3.4 Culturally significant flora species the ERD discusses that during the Flora and Vegetation survey conducted by Eco logical (2021) Appendix C of the ERD that two Aboriginal significant bush food (flora) species were recorded within the Project Area, namely <i>Adansonia gregorii</i> (Boab) and <i>Carissa lanceolata</i> (Conkerberry). As Boabs and Conkerberries occur extensively throughout the area, and because ground-disturbing activities will avoid any significant Boabs, BNR does not believe that the Proposal's activities will result in a significant impact to culturally significant flora species.
FV-006	BNR believes the ERD has addressed impacts to vegetation communities through groundwater drawdown in the ERD.

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CODE	RESPONSE
	The ERD does not quantitatively determine the reliance (or otherwise) of the E. camaldulensis vegetation community on groundwater. However, the groundwater drawdown was from the proposal activities has been assessed in Section 5.4.5.1 Changes to groundwater levels (groundwater drawdown) associated with water extraction. This section assesses in detail the previous groundwater drawdown was monitoring undertaken during water extraction activities by Buru Energy in 2012, in summary, short-term drawdown is expected to remain within the extent of natural variability, and therefore would be indistinguishable from normal seasonal fluctuations. Discussions with DWER identified the need for additional modelling, therefore, additional modelling was commissioned from Intera Geosciences Pty Ltd. Based upon modelling predictions (Section 5.4.5.1 Changes to groundwater levels (groundwater drawdown) associated with water extraction and Appendix L Groundwater modelling) from (Intera Geosciences Pty Ltd, 2023), BNR does not believe that the potential drawdown associated with the Proposal pose a significant impact to the Mount Hardman Creek GDE or associated vegetation communities based upon 1 mm drawdown within 700 m of the abstraction bore (or the wellsite) that recharges rapidly once pumping ceases.
TEQ-001	BNR has sufficiently evaluated HFS wastewaters spills in the ERD. Management of unplanned HSF wastewater spills is discussed Section 5.4.5.5 Potential contamination of surficial aquifers from an accidental release at the surface of drilling fluids, HFS chemicals, liquid hydrocarbons, or produced formation water. BNR plans to use water retention ponds used to store formation water produced during well testing. BNR plans to install multiple liners for the produced water pond and mud sump, thus the most credible scenario is a small leak from a pond versus a catastrophic failure of both liners. Further to this, pond design mitigations (such as increased capacity for storm events and freeboard requirements) will ensure that the risk of the pond overflowing is mitigated. On this basis, the volume of any accidental release, should it occur, would be small. Mitigation measures to avoid and minimise unplanned releases of HSF wastewater are discussed in Section 5.4.6 Mitigation. These will be included in an EP for assessment and acceptance by DEMIRS under the PGER(E)R before activities commence.
TEQ-003	BNR has provided clarification on all chemicals to be introduced into the environment in the ERD. All chemicals that may be used as ingredients in drilling and hydraulic fracture is included in ERD Appendix A Chemical Inventory. Ecotoxicity testing of the combined fluid system planned to be used for the proposal has been undertaken by the previous operator and demonstrated that the fluid system is of very low toxicity (Buru Energy, 2018). All of the chemicals proposed to be used have been evaluated in accordance with the requirements of the ESD and are attached as Appendix A Chemical Inventory of the ERD. As per Table 5-33: Proposed mitigation measures – inland waters, BNR has also committed to assessing the ecotoxicity of the flowback water that will also comprise the HFS fluid system. In addition to this, per the requirements of Regulation 9 of PGER(E)R 2012, chemicals or substances must be disclosed for acceptance by DEMIRS before commencing activities where they are: • in, or added to, any treatment fluids to be used for drilling or hydraulic fracturing undertaken in the course of the activity, • otherwise introduced into a well, reservoir, or subsurface formation in the course of the activity. The proposed mitigation measures the Proposal chemicals are discussed in Table 5-13 and Table 5-33 of the ERD.
TEQ-004	BNR has sufficiently addressed flooding risks to Project infrastructure in the ERD. ERD Figure 5.39 Rainfall Intensity Chart – Fitzroy Crossing charts the rainfall intensity for the Fitzroy Crossing between 1997 and 2023. Section 5.4.5.6 Potential risk to site activities and infrastructure due to extreme rainfall events reviews rainfall and conditions in the Kimberly. This includes detailed analysis of 100 year storm events. As well as the recent 2023 floods which were greater than the 100 year storm level. Although ponds have not yet been designed, more detailed analysis will be used by the engineers in the design to ensure that the ponds can withstand a 100 year storm event and not spill into the environment. The requirements to present finalised pond design for approval by DEMIRS is a requirement under the PGER Act. Mitigations measures associated with inland waters are summarised in Table 5-33 of the ERD.

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Author / Reviewer:

AES

Approver:

Michael Laurent

Review Frequency: Extreme/High=1yr; Medium=2yr; Low=3yr

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CODE	RESPONSE
TEQ-005	BNR has described Project waste management in the ERD. Section 2.4.6 Site reinstatement/decommissioning of the ERD discusses waste management of evaporation ponds. During decommissioning/reinstatement, any soil, drilling fluid solid waste, drill cutting subsoils, etc. that do not meet landfill guidelines will be removed and disposed of at an appropriate waste disposal facility. Before liners are removed, fluid contained within water retention ponds, sumps, and pits will be left to naturally evaporate with any remaining residue removed and disposed of at an appropriate water disposal facility.
TEQ-008	BNR has considered local seismic changes which are considered in the Geotechnical Risk Assessment documented included as Appendix B of the ERD. Further to this, the US Geological Survey (USGS) (2017) state that not all well injection activities induce earthquakes. BNR note that comparing the Australian Landscape to the US is difficult given that there are approximately 35,000 active wastewater disposal well, 80,000 active enhanced oil-recovery wells, and tens of thousands of wells that are hydraulically fractured every year in the United States. Even with all of this activity, only a few dozen of these wells are known to have induced felt earthquakes (Rubinstein and Mahani 201517). As described by the USGS, BNR understands that a combination of many factors is necessary for injection to induce felt earthquakes. These include: • The injection rate and total volume injected; • The presence of faults that are large enough to produce felt earthquakes; • Stresses that are large enough to produce earthquakes; and • The presence of pathways for the fluid pressure to travel from the injection point to faults (USGS 201718). On the basis that: • the initial geotechnical risk assessment has not identified any critically stressed or reactive faults present, and • following completion of the well a local geotechnical risk assessment will be completed (using local geological data) that will include separation distances to be demonstrated and well integrity validated by an independent certified expert prior to HFS activities being complete (ERD Table 5 33: Proposed mitigation measures – inland waters), and that • an early warning seismic monitoring mechanism will be present to provide real time data to inform pressure management responses. • historic HFS activities in the canning basin (that also implemented an early warning seismic monitoring mechanism) have not resulted in any known local seismic changes. BNR does not believe that HFS activities in the Kimberley would result in increased seismic activity.
TEQ-009	BNR has assessed disposal of sewage and wastewater in the ERD. Sewage handling and treatment is discussed in Section 2.4.3 Drilling activities, Table 2-8 Well waste characterisation, and Table 1-3 Other statutory decision-making processes which can mitigate potential impacts on the environment of the ERD.
TF-001	BNR does not believe the project will significantly impact fauna habitat / destruction or result in the population decline of significant fauna species. Direct and indirect impacts (through habitat destruction / habitat fragmentation or habitat degradation associated with weeds, or fire event) to fauna habitat have been assessed in Section 5.3.4 Potential Impacts. As stated in the ERD Section 5.2.3.1, Section 5.3.3.1 Fauna Habitat, Section 5.3.5.2 Habitat destruction and Section 5.11.1.7 Habitat for fauna, the vegetation and fauna habitat to be impacted is ubiquitous; and the landscape systems are represented in the broader landscape; therefore, the fauna habitats identified are not considered locally restricted. To better understand the presence of sensitive fauna species BNR engaged Ecologia to undertake a targeted fauna survey for the Threatened bilby (<i>Macropus lagotis</i>), northern quoll (<i>Dasyurus hallucatus</i>) and ghost bat (<i>Macrodermas gigas</i>) from July 22-29 2024 (which has been included as Appendix 3 to this response to comments document). Results of the targeted survey concluded: • No rocky habitats suitable for roosting were recorded and no calls indicating social interaction or echolocation were recorded within the surveyed areas. It is considered highly unlikely that ghost bats will utilise any habitats within the survey area.

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	- No habitats considered critical for the northern quoll were identified within the survey area and no dispersal habitat was recorded. It is considered highly unlikely that this species will be recorded within the project area with the nearest known records are greater than 100 km to the north in the Devonian Reef rocky habitats. - Traditional custodian attending the survey indicated that northern quolls have never been observed on Yungngora country or in the vicinity of the project area. - Old Bilby diggings were found at Well location 3 and 4. According to (Dziminski, M. A., & Carpenter, FM, 2018) only three types of signs provide definitive evidence of the presence of bilbies: - Tracks - Scats - Multiple diggings into the base of Acacia shrubs where grubs are accessed. After considerable survey effort in the vicinity of the potential diggings, no additional distinctive secondary or primary signs were recorded to confirm the presence of bilby within the project area. In addition to this, traditional custodian attending the survey r indicated that bilbies are generally seen south of the Fitzroy River in the sandy country and not regularly encountered within the vicinity of the project area. Following completion of the assessment in Section 5.3 Terrestrial fauna and the results of the targeted survey BNR believes that the proposal can be undertaken in a manner that is consistent with the EPA Objectives. Mitigation measures are detailed in ERD Section 5.3.6 Mitigation. These will be included in an EP for assessment and acceptance by DEMIRS under the PGER(E)R before activities commence.
TF-004	BNR believes that the impact to terrestrial fauna from light will be minimal. BNR believes that the level of impact to fauna will be minimal on the basis that only a single well at a time will be worked on, and drilling activities will result only in localised impacts (due to the emissions associated with generators, and temporary light towers that are no different to any other civil activity). During HFS and well testing activities, emissions may increase (due to the requirement for multiple pumps and subsequent flaring operations) however these too are limited in duration. The activity is a non-permanent / non-production activity thus once the activity ceases, ambient light levels, noise levels and vibration levels will immediately return to ambient. BNR notes that light emissions may not have been explicitly addressed thus provides an assessment that is consistent with recent EPBC Referral: The Project Area is situated within two pastoral stations, where vehicle movements associated with the local community are common. As such fauna are likely to be accustomed to traffic movement and artificial lighting used for drilling and HFS activities and subsequently no changes to behaviour are expected to arise from these sources. The largest change to ambient light levels will be associated with well testing / flaring activities that will be 24-hour operations for no more than 90 days per well. Light from flaring will be visible from a further distance than the wellsite but is due to the temporary nature of the activity, the flare heights and natural terrain and vegetation within the Project Area, the changes to ambient light levels are not expected to be significant. As well testing is for no more than 90 days, ambient light levels will only be altered for a short period of time and will immediately return to ambient levels following completion of the activities. Although flaring may result in an increased change to ambient light levels adjacent to the wellsite, as flaring will occur at differing well sites in a series (not in parallel) impacts will be spread throughout the Project area and are not expected to result in any cumulative impacts to any species that are present within or adjacent to the Project Area. As such, BNR does not believe that the Proposed Action will result in a significant impact to fauna from this cause. Further to this, targeted fauna surveys indicate light sensitive species (such as the Ghost Bat) are highly unlikely to be present given the lack of suitable habitat within the proposal area (Appendix 3 to this response to comments document). The significance of potential impacts to fauna species associated with these emissions are assessed in Section 5.3.5.1 Death or displacement of native fauna species.
TF-005	BNR assessed the potential impacts on flora and fauna associated with the introduction of non-indigenous species in the ERD as required by the ESD. Section 5.1.5.2 Degradation or loss of vegetation ecology and biodiversity as a result of the introduction of non-indigenous species (weeds) and Section 5.3.5.4 Habitat degradation as a result of the introduction and/or spread of non-indigenous species (weeds) discusses the potential impacts associated with the introduction of invasive species of flora and fauna (respectively).

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Issue Date:	10/06/2025

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	The incidences of spreading weed species around and introducing new weed species to the Development Envelope can be managed through standard mitigation measures and hygiene procedures. As weed and hygiene management are part of a standard suite of measures that can be effectively applied to the Proposal, BNR does not expect these indirect impacts to cause a significant environmental impact. Mitigation measures and their hierarchy are detailed in Section 5.1.6 Mitigation and are suitable to prevent the introduction of introduced or invasive species (weeds and fauna) to the Development Envelope. These will be included in an EP for assessment and acceptance by DEMIRS under the PGER(E)R before activities commence. BNR assessed the potential impacts associated with fragmentation (and associated fauna impacts including introduced pathways for introduced species) in the ERD (refer to Section 5.3.5.4). in summary The ERD stated <i>Although there is the potential for indirect impacts arising from opening up habitat to predators, there is no evidence to indicate any overall increase in predation because there is limited temporal overlap between the Greater Bilby and its predators</i> (Dawson, S, 2017). Further to this, mitigations detailing the requirement to implement introduced predator management (consistent with the request from DWER) is included in Table 5-9 of the ERD indicating sufficient controls are in place for this risk.
TF-007	BNR has assessed that no direct or indirect impacts to the Freshwater Sawfish will occur As per section and 5.11.1.4 Wetlands and Waterways and 5.1.5.1.3 Conservation Significant flora of the Proposal, the Proposal has been designed to avoid interactions with damp lands. Further to this, potential impacts to groundwater resulting in impacts to surface water bodies and subsequent indirect impacts to fauna species were considered in Section 5.4.5.2 Potential contamination of surficial formations due to lost circulation or well integrity issues, including casing failure, were addressed in Section 5.4.5.4 Potential contamination of aquifers through unplanned fracture heights is addressed in Section 5.4.5.5 and potential contamination of surficial aquifers from an accidental release at the surface of drilling fluids, HFS chemicals, liquid hydrocarbons, or produced formation water. These assessments determine that the proposal is not expected to impact habitat of freshwater sawfish.
TF-008	BNR has discussed habitat fragmentation and predation in the ERD Habitat fragmentation is discussed in Section 5.1.5.1 Loss and fragmentation of native vegetation from clearing and Section 5.3.5.3 Habitat fragmentation in the immediate area of clearing (in relation to Bilbies). As the well sites are geographically separated, habitat fragmentation is not expected on a regional scale. Fragmentation impacts (if any) would only be highly localised to each well and not significantly different to that experienced within the Development Envelope due to the presence of pastoral access tracks. BNR believes that with the mitigations in place, the proposal can meet the EPA's objective to: 'protect terrestrial fauna so that biological diversity and ecological integrity are maintained.'
IW-001	BNR has assessed the risks associated with produced water management in the ERD. BNR has provided a detailed quantification of HFS produced water management in Section 2.4 Activity Overview of the ERD. Further to this, a list of detailed mitigation and management strategies for preventing loss of containment events is included in Section 5.4.6 Mitigation of the ERD. These controls have been developed in accordance with industry standard guidelines that are also detailed in the ERD. In summary, produced formation water from the water retention ponds is very high in salt at three to five times the salt concentration of sea water, not toxic to fauna or humans and has very low levels of heavy metals. In addition, although naturally occurring radioactive material (NORM) has been previously detected, the concentrations were well below the exposure concentrations identified by the Australian and New Zealand guidelines for fresh and marine water quality. Further detail can be found in the ERD Section 5.4.5.5 Potential contamination of surficial aquifers from an accidental release at the surface of drilling fluids, HFS chemicals, liquid hydrocarbons, or produced formation water and specific characterisation, chemicals and concentrations are detailed in Table 5-30 Produced formation water – Laurel Formation characterisation. ERD Figure 5.39 Rainfall Intensity Chart – Fitzroy Crossing charts the rainfall intensity for the Fitzroy Crossing between 1997 and 2023. Section 5.4.5.6 of the ERD discusses potential risk to site activities and infrastructure due to extreme rainfall events reviews rainfall and conditions in the Kimberly. This includes detailed analysis of 100 year storm events. As well as the recent 2023 floods which were greater than the 100 year storm level. Although ponds have not yet been designed, this analysis will be used in the design to ensure that the ponds can withstand a 100 year storm event and not spill into the environment. BNR is not aware of previous incidents but can confirm that the mitigations presented in the ERD are there to prevent these incidents occurring.

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	Mitigation measures having regard to rainfall risks are detailed in ERD Section 5.4.6 Mitigation.
IW-002	BNR has discussed groundwater drawdown impacts on pastoral bores in the ERD Potential impacts to pastoral station water use are detailed in Section 5.4.5.1 Changes to groundwater levels (groundwater drawdown) associated with water extraction of the ERD. In summary drawdown modelling indicates that for a single wellsite a 10cm drawdown is expected 400 m from the pumping bore reducing to 2 cm at 500 m and 1 mm drawdown at 700 m (Intera Geosciences Pty Ltd, 2023). As detailed in Section 7.1 (Cumulative impacts) Inland Waters, no pastoral bores are known to be within 1.5 km of the well sites; therefore, there should be no overlap in groundwater depressions associated with pastoral and Proposal use.
IW-003	BNR has sufficiently discussed groundwater contamination in the ERD. Potential impacts associated with groundwater contamination have been evaluated in the ERD. Specifically, - Section 5.4.5.2 Potential contamination of surficial formations due to lost circulation or well integrity issues, including casing failure. - Section 5.4.5.4 Potential contamination of aquifers through unplanned fracture heights, and - Section 5.4.5.5 Potential contamination of surficial aquifers from an accidental release at the surface of drilling fluids, HFS chemicals, liquid hydrocarbons, or produced formation water. Mitigation measure to avoid, and minimise these impacts are detailed in Section 5.4.6 Mitigation.
IW-004	BNR evaluated the exposure mechanisms by which the proposal could directly or indirectly impact any surface water bodies (both within the Development envelope and outside of the Development Envelope). As no surface water impacts are present within the disturbance footprint, the indirect exposure mechanism will be through contamination of surface water features arising from groundwater contamination: - Section 5.4.5.1 Changes to groundwater levels (groundwater drawdown) associated with water extraction. - Section 5.4.5.2 Potential contamination of surficial formations due to lost circulation or well integrity issues, including casing failure. - Section 5.4.5.4 Potential contamination of aquifers through unplanned fracture heights. - Section 5.4.5.5 Potential contamination of surficial aquifers from an accidental release at the surface of drilling fluids, HFS chemicals, liquid hydrocarbons, or produced formation water. Or via extreme rainfall events These include: - Section 5.4.5.6 Potential risk to site activities and infrastructure due to extreme rainfall events. In all of these assessments, the outcomes is that BNR does not believe that based upon the subsurface geology and proposed mitigations in place, that the Proposal could impact any surface water feature. Based upon this assessment, further consideration to specific surface water values and sensitivities outside the Development Envelope is not required as exposure to these sensitivities is not deemed credible. Groundwater drawdown has the potential to impact the surface waters and GDE's. The groundwater drawdown was from the proposal activities has been assessed in Section 5.4.5.1 Changes to groundwater levels (groundwater drawdown) associated with water extraction. This section assesses in detail the previous groundwater drawdown was monitoring undertaken during water extraction activities by Buru Energy in 2012, in summary, short-term drawdown is expected to remain within the extent of natural variability, and therefore would be indistinguishable from normal seasonal fluctuations. Discussions with DWER identified the need for additional modelling, therefore, additional modelling was commissioned from Intera Geosciences Pty Ltd. Based upon modelling predictions (Section 5.4.5.1 Changes to groundwater levels (groundwater drawdown) associated with water extraction and Appendix L Groundwater modelling) from Intera Geosciences (2023), BNR does not believe that the potential drawdown associated with the Proposal pose a significant impact to the Mount Hardman Creek GDE or existing pastoral bores. Mitigation measure to avoid, and minimise these impacts are detailed in Section 5.4.6 Mitigation. These will be included in an EP for assessment and acceptance by DEMIRS under the PGER(E)R before activities commence. In addition, a Part IV Groundwater Management Plan (GWMP) (Appendix M) has been prepared to support this ERD. The GWMP describes the proposed groundwater monitoring program as well as trigger and threshold criteria that will be implemented to minimise impacts associated with the Proposal. The GWMP will be implemented to demonstrate that residual impacts are not greater than predicted.

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IW-005	Consideration of groundwater allocation is detailed in Section 5.4.3.3.4 Local and regional use of the ERD - indicating that: In accordance with the RIWI Act 1914, DWER allocates water use via groundwater licences within the sustainable volume available for a groundwater resource. DWER has determined that the Canning–Kimberley groundwater area has an allocated limit of >300,000 ML/year (DoW, 2014), of which only 0.9 GL (4.3%) is licensed within the Liveringa Aquifer (Harrington, G., & Harrington, N, 2015) As detailed in Section 5.4.5.1 Changes to groundwater levels (groundwater drawdown) associated with water extraction, BNR's water use for the Proposal per well represents a negligible portion (<0.034%) of the Canning Basin allocation limit and is far less than water extracted for other uses in the region such as by communities and pastoralists.
IW-008	Following comments from DMAs, BNR updated the ERD to reflect known surface water features from governmental databases. As Mount Wynne is located outside of the Development Envelope, and as no exposure mechanism exist that would result in any impact to this area, it has not been mapped or discussed. This is consistent with recent IESC studies that confirmed <i>a subsurface release from deep unconventional gas projects resulting in aquifer contamination is unlikely</i> (IESC, 2024). BNR is unable to comment on features that are not connected to this proposal nor consider hydrocarbon connectivity in this area.
IW-010	BNR has considered and assessed the risk of HFS activities causing faults in the ERD. In accordance with ESD Item 12, a comprehensive geotechnical risk analysis has been conducted and is attached in Appendix B Geotechnical Risk Assessment of the ERD. Multiple comments regarding the accuracy of desktop data has been received and in response to this BNR agrees that additional localised information is required to inform the risk assessment. This has always been BNR's position. This is why as detailed in Table 5 33: Proposed mitigation measures – inland waters, and as required following the outcomes of the Scientific Inquiry into fracking, that BNR has also including commitments to complete a site specific geotechnical risk assessment will be completed after each well has been constructed and prior to any HFS taking place. This will enable site-specific geological information (including the identification of localised faulting) to be identified. In addition to identification of local faults this will enable BNR to validate that each HFS treatment will have more than 600 m vertical separation to the nearest useable aquifer.
IW-011	BNR has discussed and assessed hydrogeology in a regional context and aquifer connectivity in the ERD. BNR has described the receiving environment using publicly available and credible data from previous studies in the area. Section 5.4.3 .1 Groundwater systems – regional context discusses Groundwater systems in a regional context. In particular Section 5.4.3.3.2 Aquifer connectivity (surface water/groundwater interaction) discusses aquifer connectivity. BNR acknowledges that the subsurface geology and subsequent knowledge of hydrogeology is limited to wells and other shallower bores that have been drilled throughout the region and accepts the requirement to collect localised data to inform the model. BNR believes that this information provided within the ERD is sufficient to inform the impact assessment, noting that commitments to collect additional local data through installation of local groundwater bores, and following completion of the drilling activity have been made in Table 5 33: Proposed mitigation measures – inland waters. Once the groundwater bores and well is drilled, BNR can validate that the hydrogeological model regarding existing aquifer structures (as detailed in Section 5.4.3.2 Groundwater systems – localised context) are consistent (mainly that aquifers are separated by an aquiclude shale formations (Noonkanbah Formation) and the aquitard of the Anderson Formation.
IW-012	BNR has assessed radioactive waste impacts in the ERD The assessment of impacts in relation to human health regarding radioactive substances is detailed in Section 5.8.5.1 Industrial processes that result in the build-up and release of radioactive substances or emissions. The risk of release to the environment (following production and storage within the wastewater pond) is limited to failure of liner integrity or flooding. These exposure mechanisms are assessed and detailed in Section 5.4.5.5 Potential contamination of surficial aquifers from an accidental release at the surface of drilling fluids, HFS chemicals, liquid hydrocarbons, or produced formation water and Section 5.4.5.6 Potential risk to site activities and infrastructure due to extreme rainfall events respectively. Mitigations relevant to management of produced water management are detailed in both Section 5.4.6 Mitigation and Section 5.8.6 Mitigation

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IW-017	BNR has developed an environmental monitoring program to be implemented. ERD Appendix E Valhalla Environmental Monitoring Program is a comprehensive Monitoring Plan for Soil quality, Air Quality, Methane Emissions and NORMs. The VMP is intended to be dynamic and may be updated to reflect changes in management practices and the natural environment over time. Consequently, BNR will implement an adaptive management framework that allows BNR to adapt and implement improvements as a result of monitoring against trigger and threshold criteria tailed in this document. This will ensure that impacts and risks are reduced to as low as reasonably practicable as well as ensuring the environmental outcomes of this VMP are achieved.
IW-018	BNR has discussed and mapped where relevant aquatic habitats in the ERD were present. This included updating the ERD with figures based upon feedback on the ERD from DWER. BNR evaluated the exposure mechanisms by which the proposal could directly or indirectly impact any surface water bodies (both within the Development Envelope and outside of it. this ensures that a conservative approach is applied for ephemeral surface water features that are not mapped but present within the Development Envelope and the broader region.
IW-023	Following queries from DMAs on the flowback water volumes, BNR included Table 2-5: Site total water balance (per well), Table 2-6: Site total water balance (per wellsite x 2) and Table 2-7: Site total water balance (entire program x 20). It should be noted that these numbers are estimates and indicative only and are subject to a number of local geological details (such as success of stimulations, the number of stimulations and duration of flowback). Estimations in these tables have utilised conservative estimates (i.e. the longest durations, highest success and maximum number of stimulations per well). BNR notes the discrepancy of produced water volumes between Section 2.4.5 Water balance and Table 5-49 this is an administrative error. The volumes provided in Section 2.4.5 are more contemporary and used as the basis for the impact assessment. Given BNR may not drill the total number of wells or complete the maximum number of stimulations the volume of wastewater is based upon a conservative estimate.
IW-025	Why BNR believe 6-months of data is sufficient. - What purpose does the baseline serve? BNR understands that many other drilling operations occur in WA. These projects have actively engaged with both DWER hydrogeologists and DEMIRS indicating with many exploration drilling programs gaining approval for a minimum groundwater baseline sampling requirement that comprises three samples over a three-month period to provide a trend which could be subject to further analysis. BNR GWEMP proposes to collect 6 months of data which is more than sufficient to provide data to enable trend identification and post activity analysis to be completed. - BNR agrees that there is local groundwater variation across some constituents within the project area (consistent with DWER comments). This is validated through the extensive data set BNR have at Asgard and Valhalla. However, DWER have not acknowledged that this data also shows that there is limited local variation in constituents over this period of time indicating that locally (at each bore location [Figure 5-17 – Figure 5-27 in the ERD]), there is limited variability in constituents suggesting that a shortened baseline collection program is sufficient because the aquifer is mature and geochemically stable. This approach was discussed with Paul Vogel (the previous EPA Chair and Current EPA Chair of the NT) who stated that: “The proponent has access to 8 years’ of groundwater monitoring data from the previous tenement holders as well as community and stock bores and has adopted a risk-based and conservative approach to protecting groundwater quality. These data in my opinion would provide an adequate baseline for water quality in the local vicinity, especially considering the absence of any significant polluting activity in the region.” - The groundwater guideline may require 24 months’ worth of data to be collected – but how this data is collected is nonspecific. BNR plan to install a baseline bore adjacent to the wellsite and positioned in a manner that would not risk impact from the activity (hydraulically upgradient with the position of the bore being confirmed with DWER prior to installation [per existing commitments in the GWMP]). This would allow 24 months data to be “collected” whilst concurrently allowing the activity to commence providing DWER confidence that local constituent variability is stable. Further given the installation of a monitoring bore downgradient of the well it will enable analysis to validate that the bore is not affected by the activity. This is standard BACI monitoring design and given the extensive data collected in the region would provide the ability to get the data DWER are looking for in a practical yet scientifically robust manner that would enable operational efficiency to be managed. - The constituents that would be utilized to indicate a release event would cause a peak of either chlorides (from drilling fluids) or BTEX/TPH from produced water. Given the regional data indicates that there is limited variability for these constituents, any unplanned release event would see an immediate spike of these constituents that would far outweigh the natural variability. As per the GWMP this would then require BNR to implement additional monitoring actions to be implemented. One of these may include installation of additional upgradient bores and increased sampling intensity thus enabling a BACI monitoring design to be implemented (regardless of an existing bore being present or not). This would enable BNR to show how the aquifer responds to seasonal and natural influences at each location. Although not clearly written into the GWMP this is a standard action that would be implemented and was inherently considered part of the plan (BNR has updated the GWMP to reflect this).

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IW-026	- Why has BNR not completed local baseline groundwater data collection to date? The baseline data of groundwater does not inform the environmental risk assessment - thus it is not needed to be collected now to inform project approvals. Although BNR experienced continual pushback on this point – DWER acknowledged that this approach made practical sense prior to the release of the ERD. Further to this, advice from the previous EPA Chair (Paul Vogel) indicated that on review, existing data should be considered sufficient for baseline for a HFS activity. <i>“The proponent has access to 8 years’ of groundwater monitoring data from the previous tenement holders as well as community and stock bores and has adopted a risk-based and conservative approach to protecting groundwater quality. These data in my opinion would provide an adequate baseline for water quality in the local vicinity, especially considering the absence of any significant polluting activity in the region. Notwithstanding, the proponent has committed and can be conditioned to construct additional groundwater monitoring bores prior to well construction to monitor any impacts of drilling and fracturing. These would, in all likelihood, be conditioned by DMIRS as part of the Well Management Plan (WMP) and EPs required by petroleum legislation for onshore gas exploration and appraisal.”</i> Currently, there is no access to the proposed well sites and approximately 25-30 hectares of vegetation (directly adjacent to the proposed wellsite) would need to be cleared to access the proposed wells in order to provide local baseline groundwater data. This equates to approximately 22% of the total project disturbance footprint. Given the regulatory uncertainty associated with the project due to the lack of regulatory framework post moratorium, clearing this area to implement a baseline program for a proposal that may or may not be approved by government (given the lack of policy support) does not seem like a reasonable environmental endeavour. Further to this, BNR considered it unlikely that any of the subsequent required approvals could be sought as other decision makers would likely be constrained from making a decision subject to final EPA approval. - So why not sample closer in areas that you can access? Sampling at locations that are adjacent to existing access roads or on existing hardstands was considered unlikely to be sufficient as baseline given the EPA were not willing to accept data from Asgard and Valhalla (and broader community bore data) as <u>local baseline</u> data (Figure 5-30 in the ERD). Although BNR disagree with this position, BNR did not believe that the EPA would accept data from locations that were located away from the proposed well sites. BNR does not believe that collecting data that may be considered insufficient and risk project execution is appropriate. - Why don't you know what data needs to be collected? The specific constituents, aquifers and sampling requirements and frequencies are not clear in the ESD / HFS recommendations or industry guidelines. As the monitoring requirements were not clear, BNR developed a Groundwater Management Plan to ensure these requirements are clear. Although BNR has proposed what is believed to be an appropriate monitoring plan, this approach has not yet been endorsed or authorized. BNR hoped the GWMP would form a framework for robust discussion and engagement with DWER and EPA. However, this has yet to be realized. Given BNR's experience with sampling in the Canning Basin (within EP371) and following engagement with other operators in WA, BNR understands that there are differing expectations between governmental Departments regarding groundwater monitoring requirements (both from a baseline and surveillance perspective). Further BNR does not believe that referring to the guideline is appropriate given the guideline is nonspecific and is openly interpreted differently between departmental agencies, proponents and SME contractors. Why don't you just start collecting the data now? From day 1, BNR has been actively lobbying to collect baseline post Ministerial Statement to enable clear conditions such as “implement the Groundwater Management Plan” to be put on BNR. We believe that this “de-risks” both the project execution but also environmental uncertainty as a clear framework (in lieu of clear governmental guidance) could be followed. The problem we have had is that it wasn't until recently that DWER agreed that collection of baseline data post Ministerial statement would be reasonable (in 2023). Since referring the project, there have been multiple years of discussion (and delays) whilst BNR have tried engaging with the EPA and DWER to confirm that: i. baseline could be collected post Ministerial Statement and ii. that the Groundwater Monitoring Plan developed and proposed was scientifically robust and consistent with DWERS objectives. Unfortunately, it feels like there has been a disconnect between BNR and the EPA / DWER regarding the importance of these engagements (given similar comments are being received post multiple updates to management plan with limited ability to discuss with DWER). Now we are 5 years into an approval process with the potential requirement to collect 2 years of baseline data (which in reality if we were already through the process, we could be well on the way to collecting this data).

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IW-027	Data provided for the Poole is not complete (i.e. it lacks some constituents). Why not collect the Poole Sandstone data (now)? 1. BNR has never believed that sampling of the Poole should occur because: a) There are no surface spill scenarios that could result in an unplanned release to the Poole Sandstone. Historically, engagements with DWER and DEMIRS have wanted bores to focus on surface polluting infrastructure to ensure any surface release and potential contamination event could be identified. b) The Poole sandstone is not used in the Project Area. c) Vertical migration from the laurel is not credible given the mitigations required to be implemented arising from the HFS inquiry such as i. the Poole sandstone is geologically separated from the targeted hydrocarbon reservoir (laurel) by a shale aquitard layer ii. geotechnical risk assessment (identification and avoidance of any local migration / faulting paths) prior to stimulation iii. separation distances of the stimulation zones and the pool iv. the physical properties (such as pressure) that limit the extent to which any fracture length can be achieved. 2. BNR understands that DWER are focused on baseline data collection from the Poole sandstone, however it is as yet not clear to BNR how this data will be used to support compliance / assessment of the project. As such BNR believes provision of publicly available Poole sandstone data would be suitable for the purposes of understanding the aquifers seasonal and natural influences. Although BNR believe that the data provided is sufficient for background purposes, BNR has suggested that additional data be collected from the Grant group (i.e. Poole Sandstone aquifer) (per Rev 4 of the GWMP Appendix 7) – please refer to Section 3.1 and Table 3-2 of the GWMP. However, the lack of engagement with DWER and EPA on BNR's updates to the GWMP, validate why BNR's approach to baseline data (i.e. not collecting prior to getting a Ministerial Statement and subsequent GWMP approved by the EPA) is the right approach. BNR will collect data that is consistent with an DWER approved monitoring framework to ensure the data collected is legally (and environmentally) robust.
IW028	BNR re-engaged Interra to validate model inputs and assumptions including completion of sensitivity analysis and extraction rates. <i>"The sensitivity analysis uses a variety of extraction rates that range from 50% to 300% of the expected extraction rates, with the overall pumping time (182 days) held constant."</i> <i>"For all 36 simulations the modelled drawdowns at each existing bore (see Figure 5-1 for existing bore locations) were 0.01 m or less, which is considered to be less than the resolvable precision of the model and is interpreted to indicate no impact from pumping on existing bores. This suggests that, even with the most conservative conditions, pumping from the proposed bores completed in the unconfined system will not result in any observable impacts to existing bores."</i> Please refer to Appendix 4. For completeness BNR considered a number of assumptions including abstraction targets within the model, to understand potential for vertical migration. However, BNR have only ever planned to abstract water from the Liveringa. On this basis the modelling indicated that there is very little risk of pumping from the Liveringa affecting any existing bores noting that the likely limiting factor would be that the aquifer may be unlikely to support production at higher pumping rates.
IW029	As detailed in Figure 5-16 and Figure 5-31 in the ERD, BNR has acknowledged that the subsurface geology is not consistent throughout the entire Canning Basin. As can be seen in Figure 5-31, within some areas of the Canning Basin, the grant-group (including the Poole aquifer) are located much closer to the grounds surface. This is reflected in the depth to Poole sandstone at Yungnogra (identified on Figure 5-31) - south of the Development Envelope and of Mount Wynne (West of the Development Envelope). These indicate that the Noonkanbah formation (regional aquitard) may not be present to provide a natural geological barrier, and Mount Wynne is outside of the Development Envelope and presents a different subsurface geology than that known within the Development Envelope BNR is unable to comment on features that are not connected to this proposal nor consider hydrocarbon connectivity in this area.



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	BNR has detailed at length the process which will be completed post drilling the well (which will include) building a specific local geological model based upon hydrostatically logged petroleum wells which will validate the required separation distances from faults, the pressure (and subsequent fracture lengths) and get this all independently verified before commencing any HFS activities.
AQ-001	BNR has considered and assessed flare emissions in the ERD Environmental impacts arising from flaring are considered in Section 5.6.5.1 Reduction in air quality causing impacts to sensitive social receptors of the ERD. Appendix E Valhalla Environmental Monitoring Plan considers impacts arising from air quality and this will be implemented over the course of the Proposal. Section 5.7.5 Assessment of impacts the ERD considers that flaring emissions will constitute the majority of scope 1 greenhouse gas emissions. A Greenhouse Gas Environmental Management Plan (ERD, Appendix R) will also be implemented to develop management measures that minimise impacts associated with implementing this Proposal. Mitigation measures and their hierarchy are detailed in Section 5.7.6 Mitigation.
AQ-003	The WKNHA is located ~12 km south, ~24 km west and ~19 km East from the Development Envelope. All potential impacts have been detailed within the ERD as being localised in both extent and duration. The extent of noise impacts are detailed in the ERD Figure 5 58: Worst-case noise level contour plot (and in ERD Appendix P). Light impacts will be localised and limited to the use of lighting towers for the majority of activities associated with the proposal. These impacts will be no different to any other civil activity. Light emissions would, however, be highest during flaring activities which are limited to no more than 90 days per well. Modelling was not completed for light emissions given it was expected to have localised impacts. Noise and light emissions in relation to the WKNHA from flaring have not been considered in the ERD. However, due to the distance of the nearest well to the WKNHA noise, light and odour emissions from the flare are unlikely to be visible or detectable from the WKNHA. Specifically, BNR believes that visual amenity impacts will be limited to a few months during the drilling activity.
GG-002	BNR has discussed and assessed greenhouse gas emissions (including methane emissions) in the ERD. ERD Section 5.6 Air quality and Section 5.7 Greenhouse gas assess the levels of methane gathered from baseline monitoring. As stated in Appendix E Valhalla Monitoring Plan, Section 3.3. To understand if the Proposal and associated emissions have had any short of long-term adverse impacts to air quality, BNR plans to collect air quality samples and analyse for presence of methane. Mitigation measures and their hierarchy are detailed in Section 5.7.6 Mitigation. This includes Appendix E of the ERD detailing the Greenhouse Gas and Air Quality Monitoring requirements as well as implementation of a Greenhouse Gas Environmental Management Plan (ERD Appendix R).
GG-005	The Greenhouse Gas Management Plan (Appendix R of the ERD, specifically Table 2-4: Emission avoidance and reduction) provides a summary of all alternatives considered. As detailed in Table 2-4 of the Greenhouse Gas Management plan (Appendix R) the use of gas as a fuel was considered under the following options [Gas capture for sale or other use, Compressed Natural Gas, Micro LNG,]. As detailed in the table, "CNG could also be used in dual-fuel engines for the drilling and HFS within the Valhalla Gas Exploration and Appraisal Program if equipment with suitable engine specifications is available locally". Currently equipment availability is unknown, and this will be subject to further consideration following approval of the proposal and subsequent project design. However, CNG was not selected for use on the basis that equipment will unlikely be available. BNR acknowledges the status of this option should change to Under consideration.
GG-006	The Greenhouse Gas Management Plan (Appendix R Greenhouse gas Management Plan Section 3.3 discusses the trajectory of emissions in relation to achieving 'Net Aero by 2050. It should however be noted that the proposal is not associated with a long-life production asset. The scope of the proposal is an exploration project. On completion of well testing, no further gas flaring or production is planned under this proposal and as such the project life is limited to 7 years. BNR engaged with DWER multiple times through the assessment process to discuss the use of GHG emission targets for exploration projects. These targets can only be suitably designed for ongoing projects with continuing GHG emission footprint. Targets have been set consistent with EPA guidelines and in accordance with feedback from DWER even though BNR does not believe that demonstrating that meeting net zero targets by 2050 (for a 7 year project) is appropriate, nor demonstrating reduced GHG emission footprint consistent with state policies (for a seven year project) are appropriate.

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Review Frequency: Extreme/High=1yr; Medium=2yr; Low=3yr

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GG-008	Oil and gas exploration activities are reportable under the National Greenhouse and Energy Reporting Scheme (NGERS) and can be covered by the Safeguard Mechanism if those activities form part of a facility that triggers the threshold. BNR acknowledges that the threshold for application of the Safeguard Mechanism is in exceedance of 100,000 tonnes of carbon dioxide equivalent (tCO₂ e) per annum. BNR has planned the drilling program to drill and test multiple wells in a single year. Based upon the specification in the ERD this will result in more than 100,000 tCO₂ e in a year being produced. Given that the Proposal is also being assessed under the EPBC Act (and will likely be approved under the Act), and as the emission threshold is likely to be exceeded, the Proposal will be subject to the Safeguard Mechanism. The information regarding baseline (or initial prediction and subsequent actual emission profiles are included in the GHGEMP. The GHGEMP also discusses best practice mitigations, an assessment of alternative mitigations considered to avoid and minimize emissions, as well as an emission intensity analysis comparing previous programs to the proposal.
SS-001	BNR has assessed cultural impacts to heritage sites and determined that there is no impact to known and registered cultural heritage sites. As described in Section 5.5.3.5.1 Native title, the Development Envelope is situated within two native title areas. Two registered heritage sites and two other heritage sites are present near the project area. No wells are located within any known heritage sites. Consideration of heritage sites outside of the Development Envelope were not considered relevant under the EP Act (please refer to SS-002 for further detail) Traditional Owners of the land and members of the Yungngora Community and Jimbalakudunj Community use the land within and surrounding the Development Envelope for cultural and recreational reasons, such as education, hunting, gathering, fishing and swimming. Over the past 10 years, BNR and the previous operator have proved that oil and gas activities can exist with cultural activities. BNR has a strong relationship with the Traditional Owners, who actively support BNR. The Traditional Owners are made aware of all BNR presence and activities on site, and discussions are ongoing regarding the participation and employment of community members in the Proposal's activities. The community supports current and future work opportunities on EP 371. Impacts to social surroundings, including cultural heritage are discussed in ERD Section 5.5 Social surroundings. As outlined in ERD Section 3 Social engagement, close consultation and engagement has occurred with the Yungngora and Warlangurru Peoples regarding petroleum activities on their native title areas. This has occurred over many years and includes the proposed activities. The Aboriginal communities support the Proposal. Section 5.5.3.5.2 Heritage sites discusses the relevant heritage surveys and studies within EP 371. Section 5.5.5.7 Potential impacts to heritage sites discusses potential impacts to heritage sites. In summary with the current understanding of local heritage, the Proposal is not expected to have a significant impact on the cultural heritage sites of the region. BNR has already revised the proposed disturbance footprint in response to requests from the Traditional Owners and, as shown in ERD Table 5.42 Proposed mitigation measures – social surroundings. Mitigation measures are detailed in Section 5.5.6 Mitigation. Section 5.5.5.5 Social and economic benefits discusses social and economic benefits of the Proposal and Table 5.4.1 Letters of support for HFS during the HFS scientific inquiry lists over 20 letters of support from the Yungngora People and Warlangurru People. Stakeholder engagement, including Native title groups is also clearly outlined in ERD Section 3.3 interested stakeholders and Section 3.2.3.1 Engagement throughout the ESD process.
SS-002	BNR does not believe the WKNHA will be impacted. Given the geographical distance of the proposal area to the WKNHA the only exposure mechanism to the West Kimberly National Heritage Area (WKNHA) is through hydrological connectivity. SURFACE WATER Impacts to the WKNHA are not discussed in the ERD as BNR do not believe there is the potential for impacts to arise. DCCEEW requested that the impacts to the WKNHA were assessed in the EPBC referral 2024/09889. The following information is a summary of that content.



CODE	RESPONSE
	Surface waters from the Project Area to the WKNHA are connected via Mt Hardman Creek which flows into the Fitzroy River, a main river system that flows through to the WKNHA. As there is no credible impact to the Mount Hardman Creek or surrounding surface waters or any significant groundwater impacts at the project site (ERD Section 5.4.5 Assessment of impacts) the Proposal is not expected to result in any direct or indirect impacts to the WKNHA. The Fitzroy River near Noonkanbah is likely recharged by the Liveringa Group, a Canning Basin aquifer shared by the Project Area. Given the Liveringa group aquifer underlies the Project Area, and on the conservative assumption that the aquifer is ubiquitous in the area, the project area can be considered hydrologically connected. However, assuming conservative hydraulic connectivity properties (ERD Appendix I – Hydrogeological Assessment of Paradise-Valhalla-Asgard Project Areas, Page 9-10), it would take approximately 7,300 years for groundwater to move from the project area to the Fitzroy River, indicating that whilst connected in geological terms any groundwater impacts at the project site are highly unlikely to result in any impacts to the Fitzroy River, and subsequently, the WKNHA. Further to this, geological separation of the Grant group (and the overlying Poole aquifer) arising from the Noonkanbah shale, suggest that even if an impact was to arise from a subsurface release to the Poole aquifer (which is highly unlikely due to the underlying geological separation from the Laurel Formation by the Anderson formation), the Liveringa is not expected to be impacted thus indirect impacts to Mount Harman Creek then Fitzroy River than the WKNHA is not expected. GROUND WATER Two primary models were developed to assess potential groundwater drawdown associated with groundwater abstraction: one simulating abstraction from the unconfined Liveringa aquifer (Model 1) and one simulating abstraction from the confined Grant Group system (Model 2). The modelled drawdown at the end of the six-month pumping period (for 20 wells) for the Liveringa Aquifer showed potential for a 0.2 m drawdown within 500 m of each bore, assuming that all well sites were abstracting water at the same time (ERD Appendix L Valhalla Project Groundwater Modelling, Section 5, pp 5). The modelled drawdown at the end of the six-month pumping period (for 20 wells) for the Grant Group system showed potential for a 0.2 m drawdown within the Project Area, including four existing pastoral bores (ERD Appendix L, Valhalla Project Groundwater Modelling, Figure 5-2). The potential minor short-term drawdown associated with the groundwater abstraction required to support the exploration program is predicted to be limited to the Project Area and is not expected to have any impact on the WKNHA. No changes to the water quality within the surface or 'useable' aquifers are expected as a result of the Proposed Action, and as such presents no potential exposure (therefore impact) to the WKNHA.
SS-004	BNR believes the social implications to indigenous communities have been assessed, BNR has also committed to continued consultation with indigenous communities throughout the Proposal. Relevant Native Title Groups have been identified in Section 3.2.3 Native title groups of the ERD, with the continuous consultation and identification of economic development opportunities included in Section 3.2.3.1 Native title group engagement of the ERD. Section 5.5 considers impacts to indigenous communities arising from noise, traffic, dust, disruptions to existing land users, amenity and aesthetics to name a few). In all cases, the proposal was not deemed to result in significant impacts to these communities. The Valhalla Environmental Monitoring Plan (Appendix E to the ERD) includes a range of trigger and threshold criteria to ensure that relevant environmental emissions are monitored within proximity of communities to enable correct actions to be implemented in the highly unlikely event that they are triggered. BNR and the Yungngora Traditional Owners met with EPA and the EPA chair on 20/11/2024. The purpose of the meeting was for the Traditional Owners to communicate their ongoing support for the Valhalla Project to be endorsed. The Traditional owners voiced that the Valhalla Project, if endorsed, will enable social and economic benefits for the communities in EP 371.
SS-011	In gathering information to inform the ERD, BNR completed ethnographic, ethnobotanic, and archaeological surveys in consultation with the Traditional Owners. As per Section 5.5.3.5.2 Heritage sites BNR conducted ethnographic, ethnobotanic, and archaeological surveys in consultation with the Traditional Owners, to determine the significance of potential impacts (direct, indirect and cumulative) to social surroundings. The survey was undertaken by Deep Woods Surveys in September and October 2021 in consultation with the Yungngora and Warlangurru Traditional Owners.

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CODE	RESPONSE
	Apart from the diversions for the track, camp, and well site mentioned above, all other proposed disturbance footprint areas do not contain any significant cultural material, places, or sites, and BNR has the permission of the Yungngora Aboriginal Corporation and Warlangurru Aboriginal Corporation to proceed with the Proposal. Mitigation measures and their hierarchy are detailed in Section 5.5.6 Mitigation this includes clear demarcation of clearing areas and Heritage monitors being present during disturbance of the topsoil.
HH-001	BNR has completed a human health assessment in the ERD which was peer reviewed and validated through consultation with Department of Health. An administrative error initially omitted the Peer Review, but BNR rectified this as soon as the EPA made BNR aware of this omission. ERD Section 5.8 Human health discusses human health risks from the project and Appendix N details the Public Health Risk Assessment developed for the proposal which involved a health risk assessment of Air, Groundwater and Soil. In developing this risk assessment, the Department of Health was consulted, and it was peer reviewed by Geosyntec Consultants in 2022. Once peer reviewed it was submitted to the Department of Health for comment. The Department of Health approved the Public Risk Assessment in 2022 and concluded no further HHRA is required. In accordance with the Human Health Factor, the assessment for the proposal focused on radioactive substances. As such detailed analysis of human health impacts arising from silica and multiple carcinogens was not completed. Further to this, multiple queries regarding worker health was received. BNR engaged with the EPA to understand the extent to which the EP Act provides for the assessment and protection of worker health. EPA Services confirmed that worker health is not covered under the Act (Table 3-1 Recent engagements with various stakeholders). BNR can confirm that worker health is to be assessed and regulated under the new Work Health and Safety Act 2020 (WA), which will replace the Occupational Safety and Health Act 1984 (WA) and elements of the PGER Act that relate to work health and safety (Section 5.5.5.6 Impacts to workers health). Given worker health is not within the remit of the Environmental Protection Act 1986, no further evaluation has been provided. Within the ERD Section 5.6 Air quality discusses Air Quality. As requested by the ESD baseline air quality monitoring for volatile organic compounds and particulate matter for a minimum of 12 months prior to commencing the Proposal. this was used to inform the impact and risk assessment, as well as the surveillance monitoring plan (Appendix E of the ERD) specifically, Table 3 6: VMP components – air quality that includes trigger and threshold for managing potential air quality impacts. ERD Section 5.6.4 Assessment of impact assesses potential impacts such as Section 5.6.5.1 Reduction in air quality causing impacts to sensitive social receptors. Mitigation measures and their hierarchy are detailed in Section 5.6.6 Mitigation (Air quality) and 5.8.6 Mitigation (Human health).
SF-001	A desktop study, as required by the ESD, was undertaken and included as ERD Appendix S Subterranean Desktop Survey. Subterranean fauna impact assessments were undertaken in Section 5.9.5.1 Groundwater drawdown of surficial aquifers associated with water extraction and 5.9.5.2 Potential contamination of surficial aquifers from an accidental release (of drilling fluids, HFS chemicals, liquid hydrocarbons, or produced formation water) at the surface. The outcome of the assessment that should any indirect impacts to potential subterranean fauna habitat occur it would be highly localised in extent and duration with impacts to potential habitat returning rapidly recovering following completion of water abstraction activities. Further mitigations relevant to subterranean fauna can be found in ERD Section 5.9.6 Mitigations.
GS-004	The proposal is limited to an exploration and appraisal project. As detailed in the ERD it is possible that only Phase 1 activities will be completed with a clear decision required to progress additional activities. Understanding of future prospectivity or development is not clear at this stage (and will rely on data gathered from this proposal to make an informed decision). Any further activities (including development and production should sufficient resources be identified to support such a project) will be subject to separate assessment (including cumulative consideration of this proposal).
GS-026	BNR does not agree with this statement. The EIA is based upon a magnitude of high-quality regional proponent and publicly available data. DWER have acknowledged that the site-specific groundwater baseline data is not required to support the EIA given this is based upon exposure mechanisms and known hazards. BNR acknowledge that site specific data is required to be collected with commitments made in the ERD (including Appendix M - Groundwater management plan) with these outcomes subject to review with DWER prior to the activity commencing.

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CODE	RESPONSE
	However, until authorisation to clear for access tracks and well installation (both monitoring bores and the petroleum well) is received through the Ministerial Statement that will then provide for the collection of robust, site specific geological, groundwater and hydrogeological information, previous studies in the Canning Basin (including Appendix I - Rockwater (2016) hydrogeological assessment, Appendix J - Local groundwater characterisation Appendix L - Groundwater modelling and other HSF activity information available has been used to assess the potential impacts. In accordance with ESD Item 12, a comprehensive geotechnical risk analysis has been conducted and is attached in Appendix B Geotechnical risk assessment. Further geotechnical risk assessment will be completed after each well has been constructed and prior to any HFS taking place. The site-specific geotechnical risk assessment will also utilise information gathered during the installation of the groundwater monitoring bores.
GS-028	Currently there is no legislation for fracking of HFS in Western Australia, however, BNR have addressed the 20 Actions outlined in the WA Government's Implementation Plan which arose from the 2018 Independent Scientific Panel Inquiry into Hydraulic Fracture Stimulation in Western Australia. A concordance table was provided for these in the original referral documentation – these recommendations were then included in the ESD and captured in the ERD.
GS-031	This Proposal is only seeking an exploration permit. Future works, if gas is found will be submitted and assessed if and when it occurs as a new Proposal.
GS-33	BNR agrees with this statement, however, until a well is drilled in the area of the proposal to gather robust, site specific geological and hydrogeological information, previous studies in the Canning Basin and other HSF activity information available has been used to assess the potential impacts. However, in accordance with ESD Item 12, a comprehensive geotechnical risk analysis has been conducted and is attached in Appendix B Geotechnical risk assessment. Further geotechnical risk assessment will be completed after each well has been constructed and prior to any HFS taking place. The site-specific geotechnical risk assessment will also utilise information gathered during the installation of the groundwater monitoring bores.
GS-034	BNR acknowledges the comment, however the EPA has deemed the ESD meets the relevant requirements. Please refer to Table Environmental Scoping Document (ESD) checklist (Pg. 3) which clearly maps how each of the ESD requirements have been met in the ERD. Further to this, multiple engagements with DWER has occurred over the course of the project to clarify these requirements and provide the required information.

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Appendix 3. Targeted Fauna Survey

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**BENNETT RESOURCES
VALHALLA PROJECT
TARGETED GREATER BILBY SURVEY**

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Document Status						
<i>ecologia</i> project number: 2011						
Rev .	Author(s)	Reviewer	Date	Approved for Issue		
				Name	Distributed To	Date
0	C. Buters, T. McCabe, S. Plant	S.Grein	30/10/2024	S. Grein	M. Leybourne	5/11/2024
1	T. McCabe	S.Grein	2/12/2024	S.Grein	M. Leybourne	2/12/2024

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ecologia Environment
463 Scarborough Beach Rd
OSBORNE PARK WA 6017
Phone: 08 6168 7200
Email: admin@ecologia.com.au

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EXECUTIVE SUMMARY

Ecologia Environment (*ecologia*) was commissioned by Bennett Resources to undertake a targeted significant fauna survey at the Valhalla Project. The surveys were undertaken over a period of eight days between July 22 - 29, 2024. Survey methods utilised accorded with the Environmental Protection Authority's (EPA) guidance documents in addition to relevant state and Commonwealth guidance and technical documents and coincided with the appropriate survey timing for all target species.

Survey Effort

All areas within the development envelope including the 10 proposed well sites and associated infrastructure (roads) were traversed at 20 m intervals searching for primary or secondary evidence of significant fauna taxa. A cumulative total of 72 hours were spent walking transects. Ten motion camera trapping sites (49 recording nights) and 10 ultrasonic recording sites (49 recording nights) were deployed (one at each proposed pad during the targeted surveys).

Fauna Habitat

Three fauna habitat types were recorded, all which are considered widespread at local and regional scales with no habitats restricted to the development envelope. Mixed open woodland over tussock grasses on dune slopes and crests and is considered suitable for the greater bilby. The habitat in the south-east between Proposed Well 3 and Proposed Well 4 is considered the most suitable for bilbies.

No rocky habitats considered critical for northern quolls or ghost bats was recorded.

Significant fauna

Potential old greater bilby diggings at the base of shrubs at Proposed Well 4 and Proposed Well 3. These potential old diggings suggest that bilbies may have previously foraged within the area. According to the guidelines, old diggings on their own do not confirm presence and are considered as "potential greater bilby activity, presence not confirmed". To confirm presence, we would need to find scats, active burrows or tracks (fresh, very distinctive). After considerable survey effort in the vicinity of the diggings, none of those were found.

No secondary evidence of the northern quoll or ghost bat was recorded, and it is considered highly unlikely that either of these species will utilise any habitats within the development envelope.

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1 INTRODUCTION

1.1 PROJECT BACKGROUND

The Bennett Resources (the client) is proposing to undertake an unconventional exploration and appraisal drilling program within Petroleum Exploration Permit EP 371, located in the Canning Basin, West Kimberley of Western Australia. The project will require clearing of approximately 110 hectares.

The greater bilby (*Macrotis lagotis*) and the ghost bat (*Macroderma gigas*) are listed as Vulnerable, and the northern quoll (*Dasyurus hallucatus*) is listed as Endangered, under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and *Biodiversity Conservation Act 2016*.

Bennett Resources engaged Ecologia Environment (*ecologia*) to undertake a targeted significant fauna survey to validate the presence or absence of significant species and within the proposed clearing areas.

1.2 SURVEY OBJECTIVES

The Environmental Protection Authority's (EPAs) environmental objectives for the factor *Terrestrial Fauna* (EPA, 2016) are: "to protect terrestrial fauna so that biological diversity and ecological integrity are maintained". In this context, 'ecological integrity' refers to the composition, structure, function and processes of ecosystems, and the natural range of variation of these elements.

The following activities were undertaken as part of the scope of works for this project:

1. Review previously completed desktop surveys and previously undertaken surveys.
2. Conduct targeted surveys for significant fauna, with a focus on the greater bilby, northern quoll and ghost bat. Methods used included, but were not limited to;
 - Motion cameras;
 - Autonomous recording units (ARUs);
 - Search transects; and
 - Active searches.

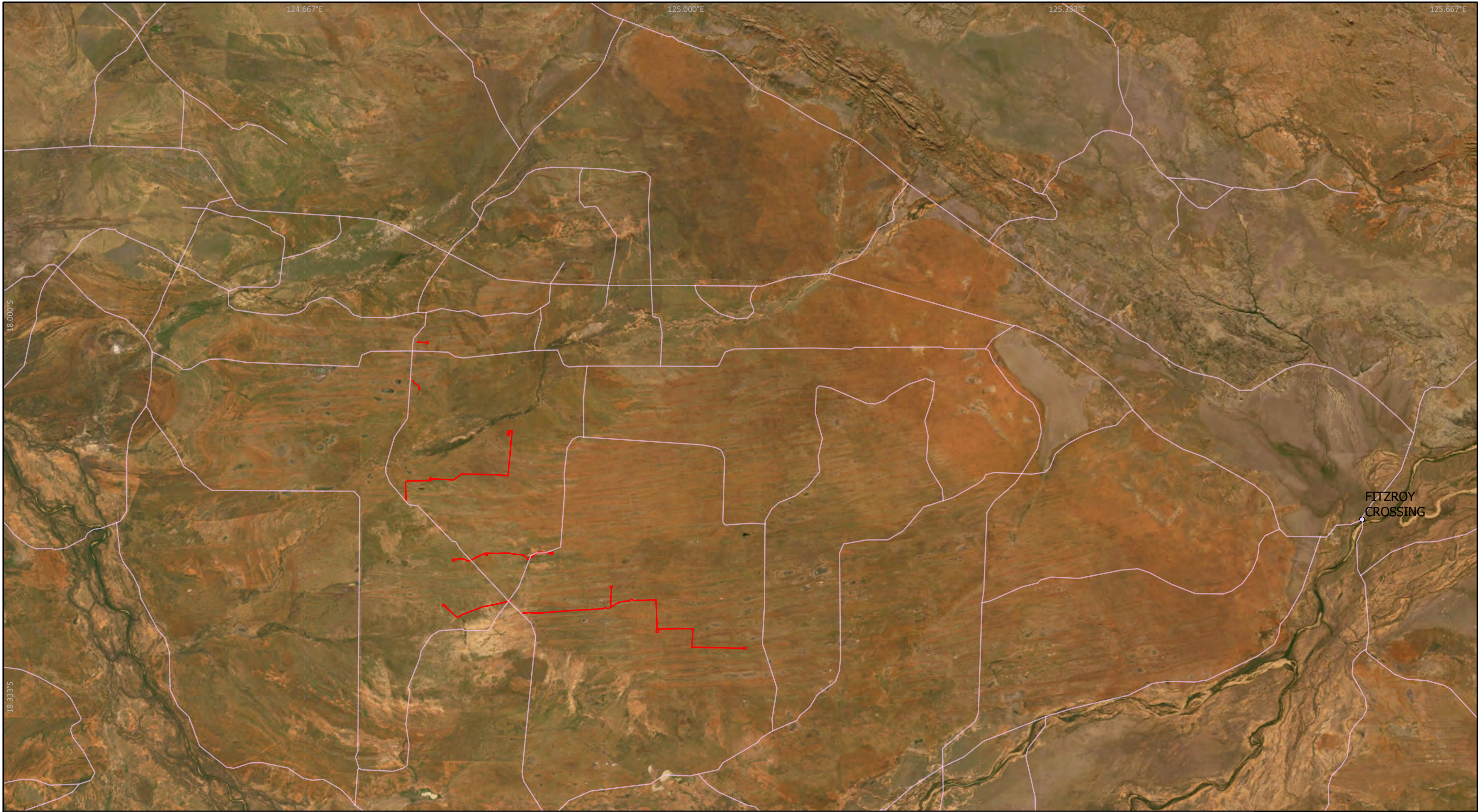
1.3 LEGISLATIVE AND REGULATORY FRAMEWORK

The survey was designed and undertaken to comply with the following statutory legislation and policies (definitions can be seen in Appendix A):

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- *Biodiversity Conservation Act 2016* (BC Act); and
- *Environmental Protection Act 1986* (EP Act).

The assessments complied with all necessary State and Commonwealth guidelines, including but not limited to:

- Technical Guidance – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA, 2020);
- EPBC Act Referral Guideline for the Endangered Northern Quoll (Commonwealth of Australia, 2016);
- Guidelines for Surveys to Detect the Presence of Bilbies, and Assess the Importance of Habitat in Western Australia (DBCA, 2017);
- Survey Guidelines for Australia's Threatened Mammals (DSEWPac, 2011); and
- Survey Guidelines for Australia's Threatened Bats (DSEWPac, 2010).



Roads

o

Town

Disturbance footprint



1.4 DESKTOP SURVEY

A total of 11 surveys have previously been undertaken within the Valhalla project area (Table 1). The most recent survey undertaken by Eco Logical Australia (ELA) in 2021 included a detailed and targeted flora and vegetation survey and a basic fauna survey.

Eco Logical Australia (2021) outlined three broad fauna habitat types present within the project area including mixed open woodland over grassland on sandy clay flats and slopes; mixed open woodland over tussock grasses on dune slopes and crests; eucalypt open woodland and mixed shrubland on closed depression and creekline.

Eco Logical Australia (2021) recorded unconfirmed signs of the bilby (*Macrotis lagotis*) at four locations in the south-east of the project area within the mixed open woodland over tussock grasses on dune slopes and crests fauna habitat type.

Unconfirmed secondary evidence (scat) of the northern quoll was recorded by Low Ecological Services (2020). This unconfirmed record is outside the known distribution of the northern quoll in the Kimberley.

Table 1: Literature review and consolidation of previous results.

Author	Report	Distance to Project Area	Significant flora	Significant ecological communities	Significant fauna	Declared Pests / WoNS
ELA (2021)	Valhalla Flora and Fauna Survey	Overlapping	<i>Nymphoides beaglensis</i> (P3)	Nil	Unconfirmed signs of the greater bilby (<i>Macrotis lagotis</i>) were observed.	* <i>Calotropis procera</i>
Low Ecological Services (2020)	Flora and Fauna Assessment Odin 2D and 3D seismic survey, Fitzroy Basin, Western Australia	Similar if not overlapping.	Nil	Nil	Unconfirmed signs of the northern quoll (<i>Dasyurus hallucatus</i>) and greater bilby (<i>Macrotis lagotis</i>) were observed.	* <i>Calotropis procera</i>
ELA (2018)	Valhalla Central 4 Flora and Fauna Survey	Within Development Envelope along creek line track.	Nil	Nil	Nil	Nil
ELA (2016)	Level 1 Vegetation, Flora and Fauna Survey of Kurrajong, Yakka Munga and Valhalla Central Well Sites	Valhalla Central A is the only site relevant, located within Development Envelope near marsh reroute.	<i>Pterocaulon intermedium</i> (no longer listed)	Nil at Valhalla Central A	Rainbow bee-eater (<i>Merops ornatus</i>); listed as Marine only	Nil
Murdoch University (2016)	Targeted bilby survey of proposed well site 'Valhalla Central', and immediate area	Within Development Envelope, central.	Nil	Nil	Nil	Nil
Buru Energy and Outback Ecology (2014)	Ophir, Paradise, Valhalla, Eden and Ellendale Flora, Vegetation and Fauna Survey Report	Adjacent to the west.	Nil	Nil	<i>Ardea modesta</i> (not currently listed), <i>Ardeotis australis</i> (not currently listed), <i>Burhinus grallarius</i> (not currently listed), <i>Merops ornatus</i> (listed as Marine only), <i>Tringa nebularia</i> (IA), <i>Tringa stagnatilis</i> (IA)	Nil
Low Ecological Services (2012a)	Asgard-1 Exploration Well: Flora, Vegetation and Fauna Survey	33 km north-northwest of Development Envelope.	Nil	Nil	Nil	Nil

Author	Report	Distance to Project Area	Significant flora	Significant ecological communities	Significant fauna	Declared Pests / WoNS
Low Ecological Services (2012b)	Asgard 2D Seismic Survey: Flora, Vegetation and Fauna Survey	Similar if not overlapping.	<i>Trianthema kimberleyi</i> (P1), <i>Goodenia virgata</i> (P2)	Nil	Australian bustard (<i>Ardeotis australis</i> ; not currently listed) and rainbow bee-eater (<i>Merops ornatus</i> ; not currently listed). Unconfirmed greater bilby burrow.	Nil
Low Ecological Services (2011a)	Flora and Vegetation Survey: Valhalla North	73 km north northwest of Development Envelope.	Nil	Nil	Rainbow bee-eater (<i>Merops ornatus</i> ; not currently listed)	* <i>Calotropis procera</i>
Low Ecological Services (2011b)	Valhalla East-1 Exploration Well: Flora and Fauna Survey	Within Development Envelope centre north about 5 km south from northern extent.	Nil	Nil	Australian bustard (<i>Ardeotis australis</i> ; not currently listed)	Nil
Woodman Environmental Consulting (2007)	Valhalla 01 Well Site Flora and Vegetation Survey	Within Development Envelope to northwest.	<i>Goodenia byrnesii</i> (P1), <i>Triodia acutispicula</i> (P3), <i>Goodenia sepulosa</i> var. <i>glandulosa</i> (P3)	Nil	Nil	Nil

2 SURVEY METHODOLOGY

2.1 SURVEY TIMING AND EFFORT

The targeted significant fauna survey was conducted by two *ecologia* zoologists from July 22-29, 2024. The survey methods implemented accord with the *Technical Guidance – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA, 2020) and were undertaken in accordance with survey timing requirements for significant fauna likely to occur within the survey area. Targeted significant fauna survey effort is outlined in Table 2 - Table 3. Survey locations and transect track effort can be seen in Appendix B.

Table 2: Motion camera and survey effort.

Site	ARU Device ID	Camera Device ID	Date Deployed	Date retrieved	Nights
Alfheim	TC39	Eco015	23/07/2024	28/07/2024	5
Jotunheim	SM4-08	Eco003	23/07/2024	28/07/2024	5
Midgard	SM4-03	Eco005	23/07/2024	28/07/2024	5
Muspelhiem	SM4-07	Eco007	23/07/2024	28/07/2024	5
Nidavellir	SM4-05	Eco001	23/07/2024	28/07/2024	5
Vanaheim	SM4-01	Eco014	23/07/2024	28/07/2024	5
Proposed well 1	SM4-06	Eco012	23/07/2024	28/07/2024	5
Proposed well 2	TC88	RC13	23/07/2024	28/07/2024	5
Proposed well 4	TC40	B15	23/07/2024	28/07/2024	5
Proposed well 3	TC36	B05	24/07/2024	28/07/2024	4
Total					49

Table 3: Targeted search effort.

Site/Transect ID	Active search (mins)
Targeted searches (bilby)	4,320
Total	4, 320 (72 hours)

2.2 SITE SELECTION

Habitat features known to provide shelter and foraging opportunities for significant fauna species were preferentially targeted during the current survey. An overview of survey effort is provided in Appendix B.

2.3 SAMPLING METHODS

The survey was undertaken using a variety of sampling techniques in accordance with *Technical Guidance – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA, 2020).

2.3.1 Habitat Descriptions

A fauna habitat type broadly describes an area of habitat that is distinguished by its vegetation, soil characteristics and land features, and is likely to support a different fauna assemblage to that found in other fauna habitats.

Habitat assessments were undertaken within each of the 10 proposed pads to identify habitats considered suitable for greater bilbies, ghost bats and northern quolls. For each fauna survey site, the following parameters were recorded:

- broad habitat type;
- digital photographs;
- landform type;
- soil colour, type and characteristics;
- type and extent of non-vegetative surface cover;
- type of vegetation in lower, middle and upper strata;
- observable fire history and evidence of any disturbance;
- presence and extent of leaf litter and coarse woody debris;
- presence of, or distance to, water sources;
- presence of significant microhabitats such as tree hollows and rocky outcrops; and
- notes on suitability for hosting significant fauna.

A habitat condition rating was assigned to each habitat assessment site, delineated according to the habitat condition criteria described in Table 4. Habitat assessment sheets are provided in Appendix C.

Table 4: Habitat condition assessment criteria.

Habitat Condition	Criteria
Excellent	Pristine or nearly so, no obvious sign of damage caused by human activity since European settlement or introduced fauna and/or flora. No signs of recent, extensive fires.
Very Good	Some relatively slight signs of damage caused by human activity since European settlement e.g., damage to tree trunks by repeated fires, no significant signs of introduced fauna and/or flora or occasional vehicle tracks.
Good	More obvious signs of damage caused by human activity since European settlement, including some obvious impact to vegetation structure such as that caused by low levels of grazing, weed introduction or by selective logging. Some tracks or secondary evidence of introduced fauna. Some signs of recent fires.
Poor	Still retains basic vegetation structure or ability to regenerate it after obvious impacts of human activity since European settlement such as partial clearing or very frequent fires. Presence of introduced fauna and/or flora.
Very Poor	Severely impacted by grazing, introduced fauna and/or flora, fire, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management.
Completely Degraded	Areas that are completely or almost completely without vegetation communities and are heavily impacted by extensive fires and/or introduced species e.g., cow paddock.

2.3.2 Greater Bilby Surveys

Targeted surveys for the greater bilby were undertaken in accordance with the *Guidelines for Surveys to Detect the Presence of Bilbies and Assess the Importance of Habitat in Western Australia* (DBCA, 2017). Given the size of the survey area (125 ha), linear search transects were traversed at intervals of 20 m to detect potential evidence of bilby occupancy or transient presence within the survey area (scat, diggings, burrows and tracks). Any evidence of greater bilby activity was documented and categorised in accordance with methodologies outlined in Dziminski and Carpenter (2018).

2.3.3 Ultrasonic Recorders

Song Meter 4 (SM4) ultrasonic ARUs and Titley Chorus ARUs have a high sampling frequency and enable the full spectrum of bat echolocation calls to be recorded without transformation, allowing greater accuracy and sensitivity. ARUs were deployed at each of the 10 pads within the survey area with microphones facing towards the sky at a height of at least 1 m above the ground, to record bat echolocation calls in the vicinity of the device.

Echolocation calls recorded were analysed by bat specialist Dr Kyle Armstrong to investigate potential usage of the survey area by the ghost bat (*Macroderma gigas* [VU]) (Appendix B) (Specialised Zoological, 2024).

2.3.4 Motion Camera Traps

Un-baited Browning Patriot Trail and X-Trail 3CR motion cameras were used to supplement baseline fauna assemblage data and provide information regarding the presence of introduced predators within the survey area. Ten motion cameras were deployed on fence lines around the boundary of the survey site to detect animals utilising the site. Each camera was set to record five images concurrently with no minimum time delay between triggers. All cameras were able to be triggered by movement using highly sensitive, passive infra-red motion sensors that function during the day and night.

2.3.5 Active Searches and Opportunistic Fauna Sightings

All proposed impact areas including pads and access tracks were traversed utilised included searching under and around old logs, stumps, and dead free-standing trees, investigating burrows and over-turning logs and stones. Supplementary search effort was undertaken in habitats likely to support significant fauna.

Tracks, burrows, scats, nests, feeding debris and diggings encountered during targeted searches and trap deployment were included in the species inventory for the survey area. Any fauna incidentally encountered while travelling between sites were incorporated into the opportunistic species list for the survey area. Targeted searches were conducted in rocky habitats for secondary evidence of significant fauna (sloughs and scats) and cave floors were inspected for northern quoll and bat scats as well as feeding debris from ghost bats.

2.4 STUDY TEAM AND LICENCES

The fauna assessment was planned, coordinated, executed, and reported by those summarised below in Table 5.

Table 5: Study team and licences.

Project staff				
Name	Qualification	Experience	Position	Project role
Shaun Grein	B. Sc. Biol.; Grad. Dip. Nat. Resources; MBA	>30 yrs	Managing Director/Senior Principal Scientist	Project management, reporting, QA
Tim McCabe	B.Sc. Env. Biol, Dip Proj Mngment, Cert III Vert Pest Mngment	>15 yrs	Principal Zoologist	Project management, field assessment, reporting, GIS
Thomas Burley	B.Sc. Cons. Biol. & Zool.; MWildlifeHth	>5 yrs	Zoologist	Field assessment

2.5 LIMITATIONS AND CONSTRAINTS

An assessment of survey-specific issues and limitations is detailed in Table 6.

Table 6: Fauna survey limitations.

Aspect	Limitation?	Comment
Competency/experience of the consultant carrying out the survey.	Nil	The principal zoologist has 15+ years of experience conducting terrestrial vertebrate fauna and avifauna surveys in Western Australia. All other zoologists involved in the fauna survey have 5+ years of experience conducting fauna surveys.
Scope (what faunal groups were sampled and were some sampling methods not able to be employed because of constraints such as weather conditions).	Nil	The fauna survey focussed on collecting evidence for significant fauna species that may have the potential to occur in the survey area. The scope was well defined. Fauna and their habitats were surveyed using standardised and well-established techniques.
Proportion of fauna identified, recorded and/or collected.	Nil	The targeted fauna surveys focussed on significant fauna species that may have the potential to occur in the survey area. All fauna taxa observed were identified.
Sources of information (previously available information as distinct from new data).	Nil	Previous surveys conducted were reviewed were available for the area and considered adequate in providing appropriate contextual information for the study.
The proportion of the task achieved and further work which might be needed.	Nil	Planned survey works were conducted and completed. No further work is required to complete the survey scope.
Timing/weather/season/cycle.	Nil	The surveys were conducted during an appropriate time/season.
Disturbances which affected results of the survey (e.g. fire, flood, accidental human intervention).	Nil	The surveys were conducted without disturbance and survey effort was not adversely affected by weather events, natural disasters or accidental human intervention.
Intensity (in retrospect was the intensity adequate).	Nil	The survey intensity is considered adequate, and all habitat types were surveyed systematically or opportunistically.
Completeness (e.g. was relevant area fully surveyed).	Nil	All sections of the survey area were accessible during the surveys.
Resources (e.g. degree of expertise available in animal identification to taxon level).	Nil	Resources were adequate to carry out the survey and survey participants were competent in the identification of species. There were no resource issues encountered.
Remoteness and/or access problems.	Nil	There were no issues resulting from remoteness or access.
Availability of contextual (e.g. biogeographic) information on the region.	Nil	Sufficient contextual information was available on the region and the study area.
Efficacy of sampling methods (i.e. any groups not sampled by survey methods).	Nil	Sampling methods are considered adequate for basic and targeted vertebrate fauna surveys.

3 RESULTS AND DISCUSSION

3.1 FAUNA HABITAT

Fauna habitat assessments were undertaken at all 10 sites within the survey area to describe the fauna habitat types with the potential to support significant fauna species. Three main habitat types were recognised and align with those outlined by Eco Logical Australia (2021) including:

- Mixed open woodland over grassland on sandy clay flats and slopes;
- Mixed open woodland over tussock grasses on dune slopes and crests; and
- Eucalypt open woodland and mixed shrubland on closed depression and creek line.

The habitat types found within the proposed pads and associated access roads are considered common at a local and regional scale and none are restricted to the project area. Fauna habitat assessment sheets for each of the 10 pads are provided in Appendix C.

Mixed open woodland over tussock grasses on dune slopes and crests habitat type provides suitable substrates for burrowing and suitable foraging opportunities for the greater bilby. The remaining habitat types are not considered critical for significant fauna.

Rocky habitats known to provide shelter, denning and roosting habitat for northern quoll and ghost bat and considered critical for their survival are not present within the project area. Additionally, major drainage lines considered as dispersal habitat were not recorded.

3.2 SIGNIFICANT FAUNA ASSESSMENT

3.2.1 Bilby (*Macrotis lagotis*) – Vulnerable EPBC Act and BC Act

Distribution and habitat

Once common over 70% of mainland Australia's arid and semiarid regions, the bilby is now patchily distributed through the Tanami, Great Sandy and Gibson Deserts (Maxwell, Burbidge, & Morris, 1996). Isolated populations also occur in south-west Queensland and to the north-east of Alice Springs. The species experienced a sudden and widespread population reduction in the early 1900s, and the distribution is believed to still be contracting northwards (Threatened Species Scientific Committee, 2016a). Since the 1800s, the bilby has experienced dramatic population reductions to the extent that it now occupies less than 20% of its former range (Threatened Species Scientific Committee, 2016a). The bilby occupies a variety of habitats, including open tussock grasslands, Acacia (mulga) shrubland and woodlands, hummock grasslands on plains and alluvial areas and cracking clays (Johnson, 2008; Maxwell et al., 1996; Threatened Species Scientific Committee, 2016a).

The bilby is a medium-sized nocturnal marsupial with soft, silky fur (Pavey, 2006). Bilbies are solitary animals which are predominantly nocturnal and shelter in burrows during the day (Threatened Species Scientific Committee, 2016a). This species has strong forelimbs and claws which are used to construct extensive tunnel systems up to 3 m long and 1.8 m deep. The diet of this species is highly specialised and it uses its long tongue to feed on seeds, insects, bulbs, fruit and fungi (Johnson, 2008). Reproduction is dependent on seasonal conditions and resource availability and litters consist of one to three offspring (Threatened Species Scientific Committee, 2016a). Females reach reproductive maturity at five months and males mature three months later (Threatened Species Scientific Committee, 2016a).

Reasons for historical decline included predation by feral predators on both young and adult bilbies, competition from rabbits and livestock, reduced food as a result of changed fire regimes, and drought (Johnson, 2008; Maxwell et al., 1996; O'Malley, 2006). Current threats impacting

bilby population numbers are identical to historical threats, with the addition of habitat loss and fragmentation due to land clearing and development.

Occurrence within the project area

ecologia recorded potential old bilby diggings at the base of shrubs at Proposed Well 4 and Proposed Well 3 (Map 2). These potential old diggings suggest that bilbies have previously foraging within the area. According to the guidelines, old diggings on their own does not confirm presence and are considered as “potential bilby activity, presence not confirmed”. According to Dziminski and Carpenter (2018) only three types of sign provide definitive evidence of the presence of bilbies:

- Tracks
- Scats
- Multiple diggings into the base of Acacia shrubs where grubs are accessed.

After considerable survey effort in the vicinity of the potential diggings, no additional distinctive secondary or primary signs were recorded to confirm the presence of bilby within the project area.

Traditional custodian Tyrone Skinner indicated that bilbies are generally seen south of the Fitzroy River in the sandy country and not regularly encountered within the vicinity of the project area.

3.2.2 Northern Quoll (*Dasyurus hallucatus*) – Vulnerable EPBC Act and BC Act

Distribution and habitat

The northern quoll once ranged contiguously across the north of Australia but is now restricted to six separate land units including the Pilbara (Department of the Environment, 2019). A 75% reduction of available habitat occurred during the 20th century and the species is now restricted to the Pilbara and northern Kimberley in Western Australia, with a few discrete populations across the Northern Territory and eastern Queensland (Braithwaite & Griffiths, 1994). The Pilbara is regarded as the stronghold population for the species given that the cane toad is not expected to make its way across the desert into parts of the Pilbara (Woinarski, Burbidge, & Harrison, 2014).

Preferred habitat for the northern quoll is rocky escarpments, but it also inhabits riverine habitats (Woinarski et al., 2014). Rocky habitats with rock crevices and caves support higher densities of northern quoll (S. van Dyck & R. Strahan, 2008; Woinarski et al., 2014). Predominantly inhabiting dissected rocky escarpments, a male quoll can have a home range of more than 100 ha while a female occupies territories of up to 35 ha (Steve Van Dyck & Ronald Strahan, 2008). This species exhibits both arboreal and terrestrial tendencies and utilises den sites in rock crevices, tree hollows, logs, termite mounds and goanna burrows (Oakwood, 2008).

Northern quoll populations considered important for the long-term survival of this species are outlined by the (Commonwealth of Australia, 2016) in the EPBC referral guidelines for the northern quoll. Populations important for the long-term survival of this species include:

- high density populations, which occur in refuge-rich habitat critical to the survival of the species, including where cane toads are present;
- occurring in habitat that is free of cane toads and unlikely to support cane toads upon arrival i.e granite habitats in WA, populations surrounded by desert and without permanent water; and
- subject to ongoing conservation or research actions i.e. populations being monitored by government agencies or universities or subject to reintroductions or translocation.

The EPBC referral guidelines define a high-density population as being characterised by numerous camera triggers by multiple individuals at multiple sites and or traps (Commonwealth of Australia, 2016). A low density population is defined as on which is characterised by infrequent captures of one or two individuals which are confined to one or two sites or where no individuals have been trapped but latrine evidence is present (Commonwealth of Australia, 2016).

The EPBC referral guidelines for the northern quoll also outline habitat critical to the survival of the species (Commonwealth of Australia, 2016). Critical habitat for this species is outlined below:

- offshore islands where the northern quoll is known to exist;
- rocky habitats such as ranges, escarpments, mesas, gorges, breakaways, boulder fields, major drainage lines or treed creek lines; and
- structurally diverse woodland or forest areas containing large diameter trees, termite mounds or hollow logs.

Dispersal and foraging habitat which is associated with or connects populations important for long-term survival of the species are also considered critical habitat for the northern quoll (Commonwealth of Australia, 2016).

Occurrence within the project area

No habitats considered critical for the northern quoll were identified within the survey area and no dispersal habitat was recorded. It is considered highly unlikely that this species will be recorded within the project area with the nearest known records are greater than 100 km to the north in the Devonian Reef rocky habitats.

Traditional custodian Tyrone Skinner indicated that northern quolls have never been observed on Yungngora country or in the vicinity of the project area.

3.2.3 Ghost Bat (*Macrotis lagotis*) – Vulnerable EPBC Act and BC Act

Distribution and habitat

The ghost bat was historically distributed across much of Australia but now has a patchy but widespread distribution restricted to northern Australia (Threatened Species Scientific Committee, 2016b). Following European settlement, the distribution of this species contracted northward with arid zone populations undergoing the greatest contractions (Threatened Species Scientific Committee, 2016b). Ghost bat populations are highly structured and are considered to be genetically distinct at both local and regional scales (Threatened Species Scientific Committee, 2016b).

Ghost bats are known to move between a number of caves seasonally or as dictated by weather conditions (Hutson, Mickleburgh, & Racey, 2001) and disperse widely when not breeding but concentrate in a relatively few roost sites when breeding (Threatened Species Scientific Committee, 2016b).

The ghost bat is the largest microchiropteran bat in Australia, is strictly carnivorous and captures its prey mainly on the ground before returning to an established feeding site to devour its catch (Steve Van Dyck & Ronald Strahan, 2008). The diet of this species includes amphibians, reptiles, birds, small terrestrial mammals, insects and other bats (Steve Van Dyck & Ronald Strahan, 2008). Unlike other microchiropteran bat species, the ghost bat does not continuously call whilst in flight and instead uses its eyes and ears to scan for prey (Steve Van Dyck & Ronald Strahan, 2008). Females reach reproductive maturity between two and three years of age (Hoyle, Pople, & Toop, 2001).

Occurrence within the project area

No rocky habitats suitable for roosting were recorded and no calls indicating social interaction or echolocation were recorded within the surveyed areas. It is considered highly unlikely that ghost bats will utilise any habitats within the survey area.



Disturbance footprint

Bilby digging

Project No.: 2011

Author: SP

Created Date: 3 September 2024

Coordinate System: GCS GDA 1994

Scale: 1:22,500 @A3

Map 2: Location of significant fauna evidence within the survey area.

Earthstar Geographics

0

0.3

0.6

0.8

2

Kilometers

4 CONCLUSIONS

The key conclusions from the terrestrial vertebrate fauna assessment of the survey area are as follows:

- Three fauna habitat types were identified within the survey area.
- The habitat in the south-east between Proposed Well 3 and Proposed Well 4 is considered the most suitable for bilbies. Potential old bilby diggings were recorded at the base of shrubs at Proposed Well 4 and Proposed Well 3. These potential old diggings suggest that bilbies may have previously foraged within the area. According to the guidelines, on their own old diggings do not confirm presence and are considered as “potential bilby activity, presence not confirmed”. To confirm presence, there would need to find scats, active burrows or tracks (fresh, very distinctive). After considerable survey effort in the vicinity of the diggings, none of those were found.
- The remaining eight pads did not provide suitable habitat for bilbies.
- No rocky habitats considered as critical habitat (roosting or denning) for the ghost bat and northern quoll were identified and no major drainage lines considered as dispersal habitat were identified. It is considered unlikely that northern quolls and ghost bats will utilise any of the habitats found within the disturbance footprint.
- Motion cameras did not record any northern quolls.
- Analysis of autonomous recordings indicated that no significant bat species were recorded within the proposed well pads.

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6 APPENDICES

Appendix A Definitions.

SIGNIFICANT FAUNA

According to the *EPA Factor Guideline: Terrestrial Fauna* (EPA, 2016) animal taxa (or records) may be considered significant for a number of reasons including, but not restricted to, the following:

A taxon listed as 'Threatened' under the Biodiversity Conservation Act 2016 (WA) or the Environment Protection and Biodiversity Conservation Act 1999 (Cwlth);

- A taxon on the Department of Biodiversity, Conservation and Attractions (DBCA) Priority Fauna List;
- Species with restricted distributions;
- Degree of historical impact from threatening processes;
- Providing an important function required to maintain the ecological integrity of a significant ecosystem.

Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (Cwlth)

At a Commonwealth level, Threatened species are protected under the EPBC Act, which lists species in accordance with the criteria of the International Union for Conservation of Nature (International Union for Conservation of Nature, 2014), that is, 'Critically Endangered', 'Endangered', 'Vulnerable', 'Conservation Dependant', 'Extinct', or 'Extinct in the Wild' (see <http://www.environment.gov.au/cgi-bin/sprat/public/publicthreatenedlist.pl?wanted=flora> and <http://www.environment.gov.au/cgi-bin/sprat/public/publicthreatenedlist.pl?wanted=fauna>).

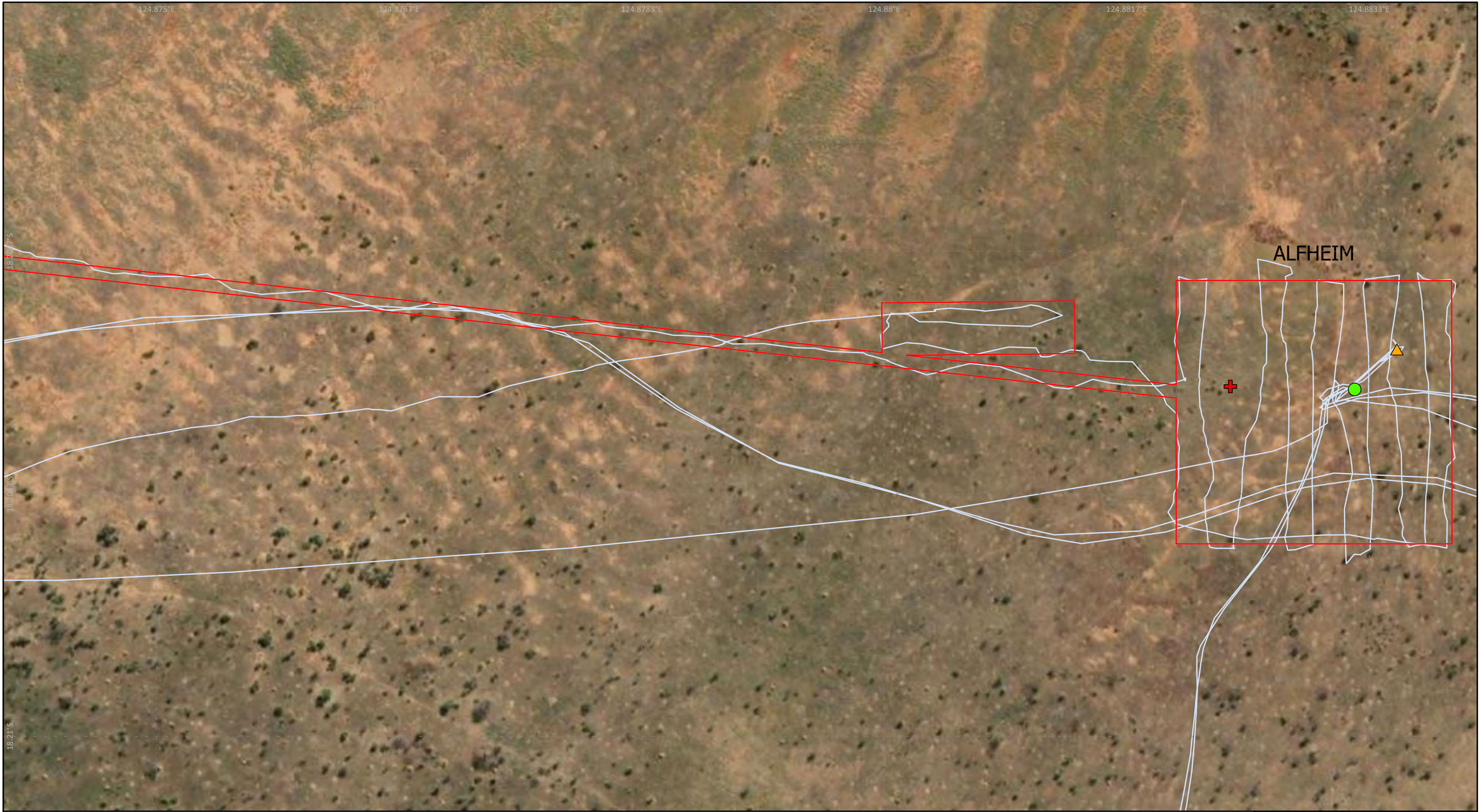
Biodiversity Conservation Act 2016 (Western Australia)

At a State level, Threatened species are protected under the BC Act. These are taxa which have been adequately surveyed and are deemed to be either rare, in danger of extinction, or otherwise in need of special protection in the wild and are gazetted as Threatened (Declared Rare) Flora. Threatened species are further categorised by the Department of Biodiversity, Conservation and Attractions (DBCA) according to their level of threat using the International Union for Conservation of Nature (IUCN) red list criteria ((International Union for Conservation of Nature, 2014) (see <https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities> for definitions).

Priority Fauna (DBCA)

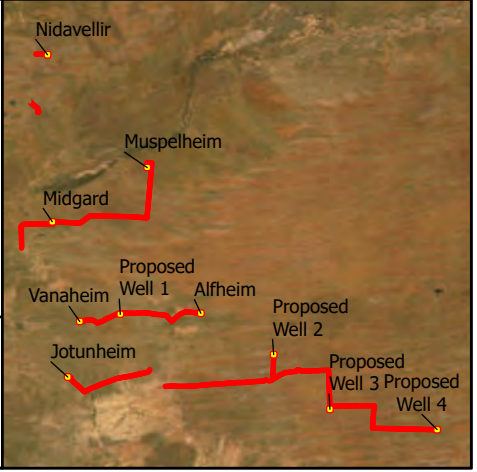
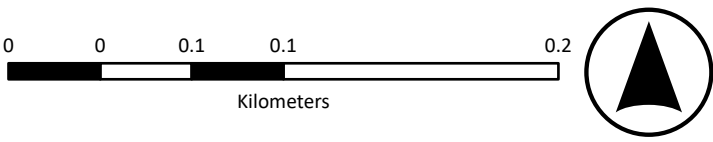
The DBCA maintains a list of Priority species, which are considered poorly known, uncommon or under threat but for which there is insufficient justification to be listed as Threatened, based on known distribution and population sizes. Priority species are assigned to one of four categories, described below. DBCA listed Priority species do not have any statutory protection (see <https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants> for definitions.)

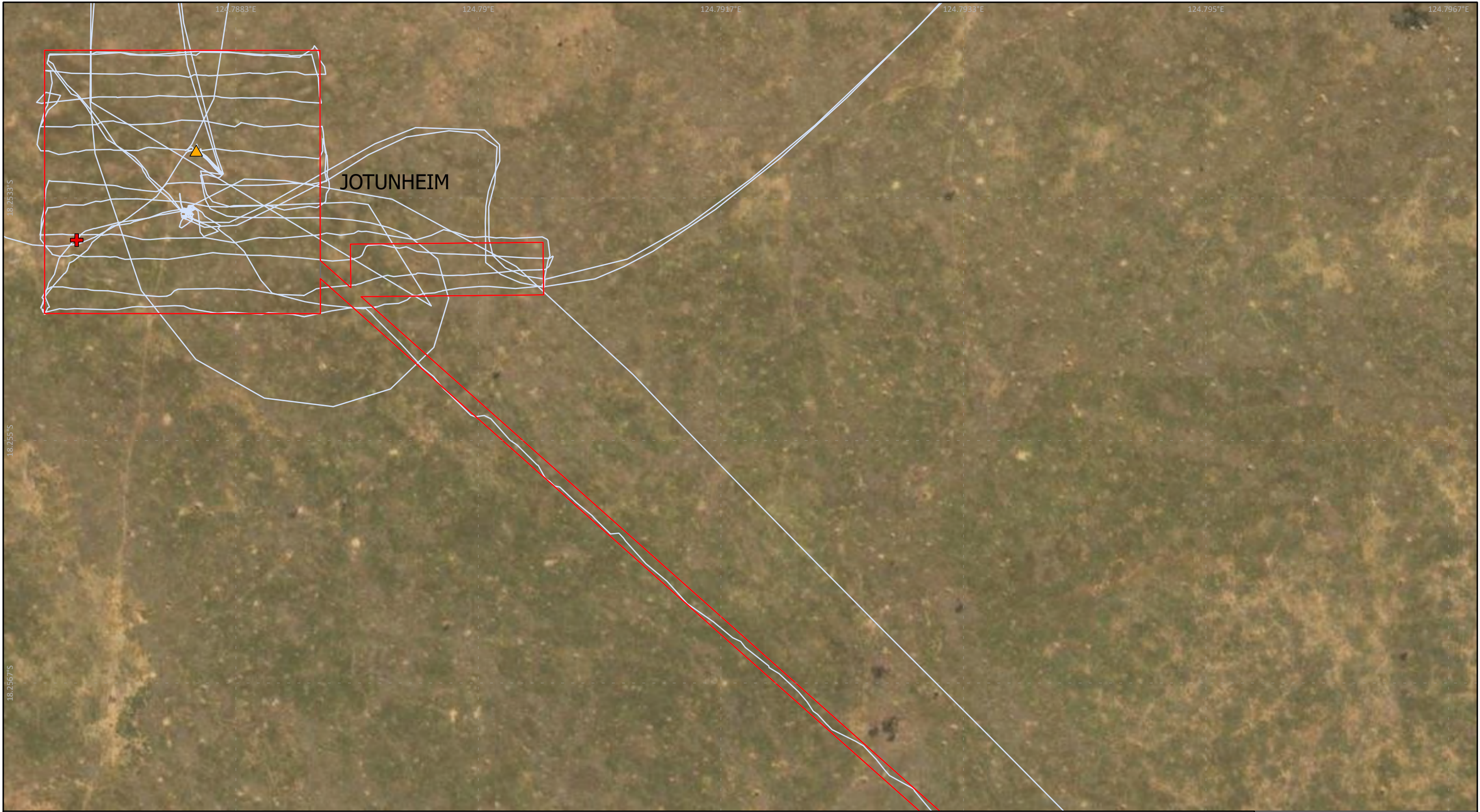
Appendix B Location of all survey sites and search transects.



- Disturbance footprint
- Motion camera
- ARU
- Habitat assessment
- Survey effort tracks

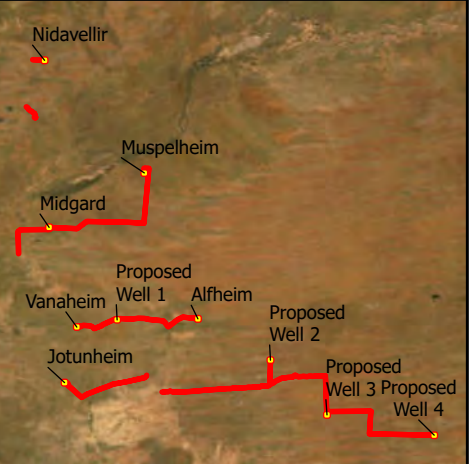
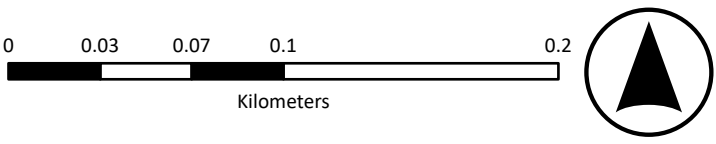
Map 4: Location of all survey sites and search transects.

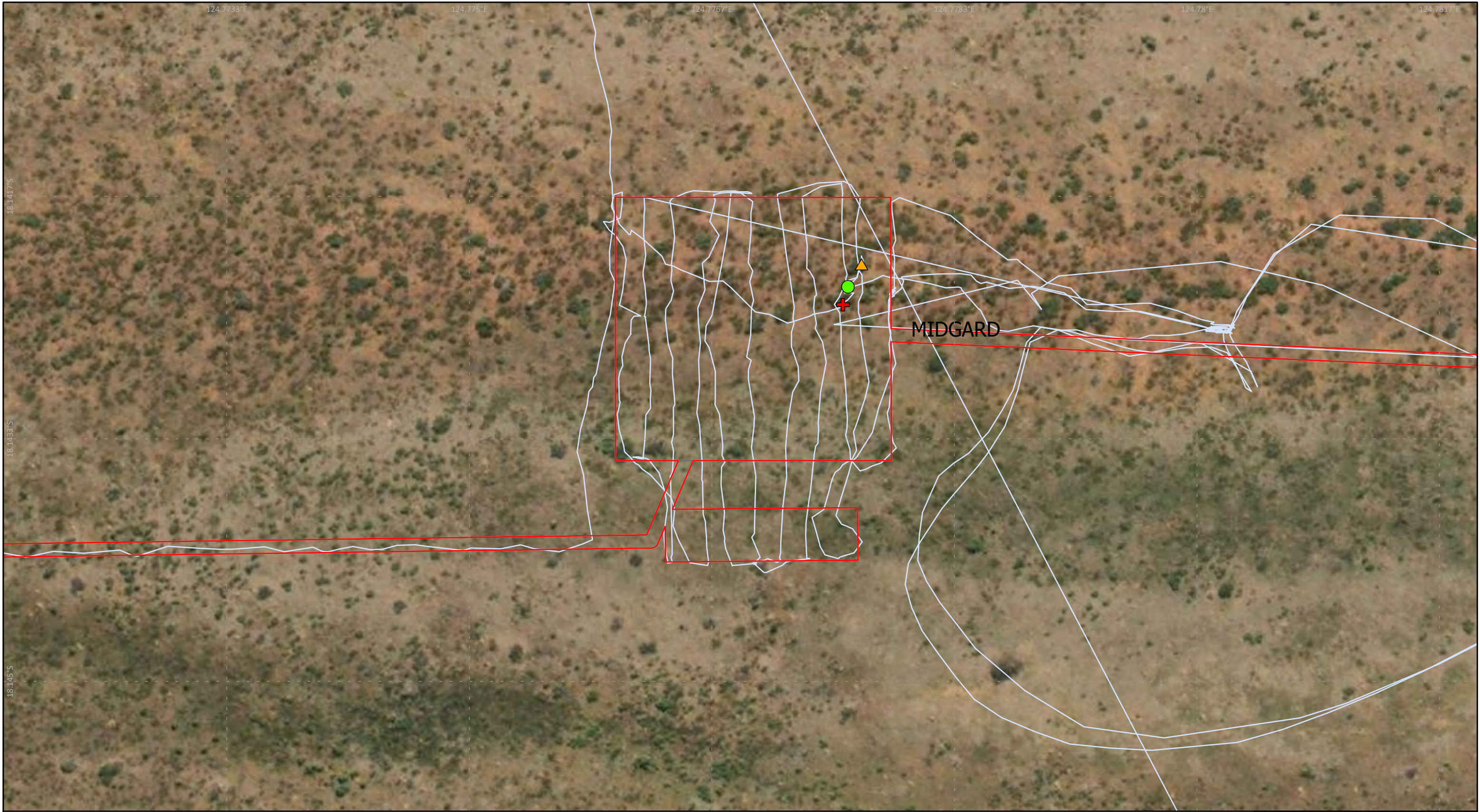




- Disturbance footprint
- Motion camera
- ARU
- Habitat assessment
- Survey effort tracks

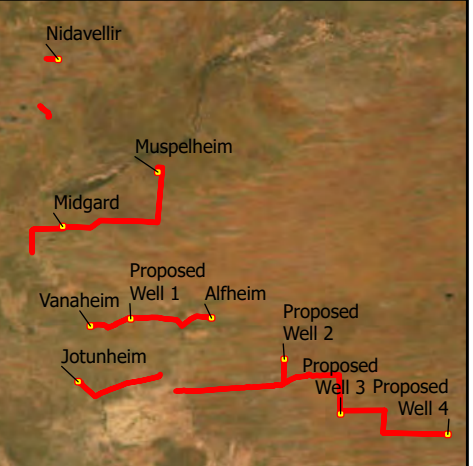
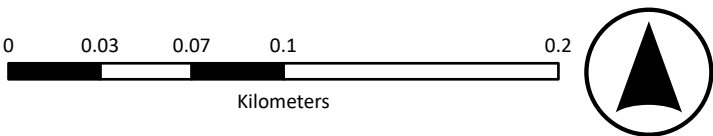
Map 4: Location of all survey sites and search transects.

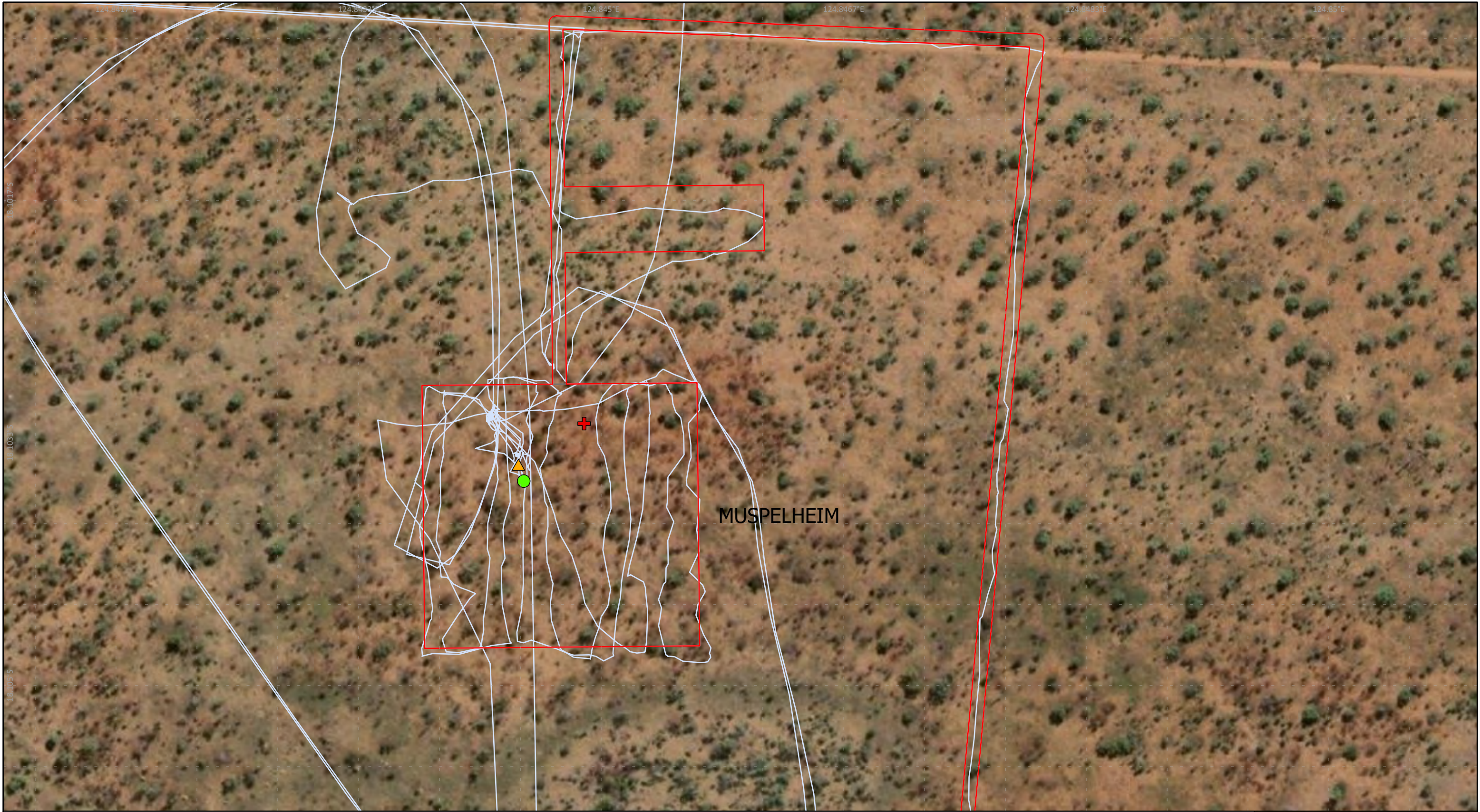




- Disturbance footprint
- Motion camera
- ARU
- Habitat assessment
- Survey effort tracks

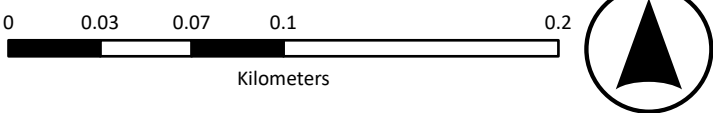
Map 4: Location of all survey sites and search transects.





- Disturbance footprint
- Motion camera
- ARU
- Habitat assessment
- Survey effort tracks

Map 4: Location of all survey sites and search transects.





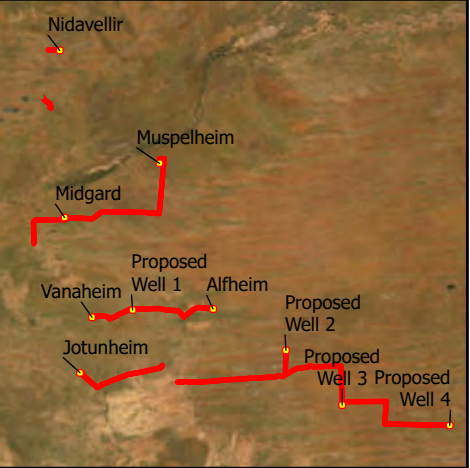
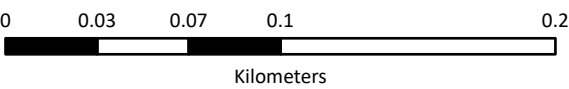
- Disturbance footprint
- Motion camera
- ARU
- Habitat assessment
- Survey effort tracks

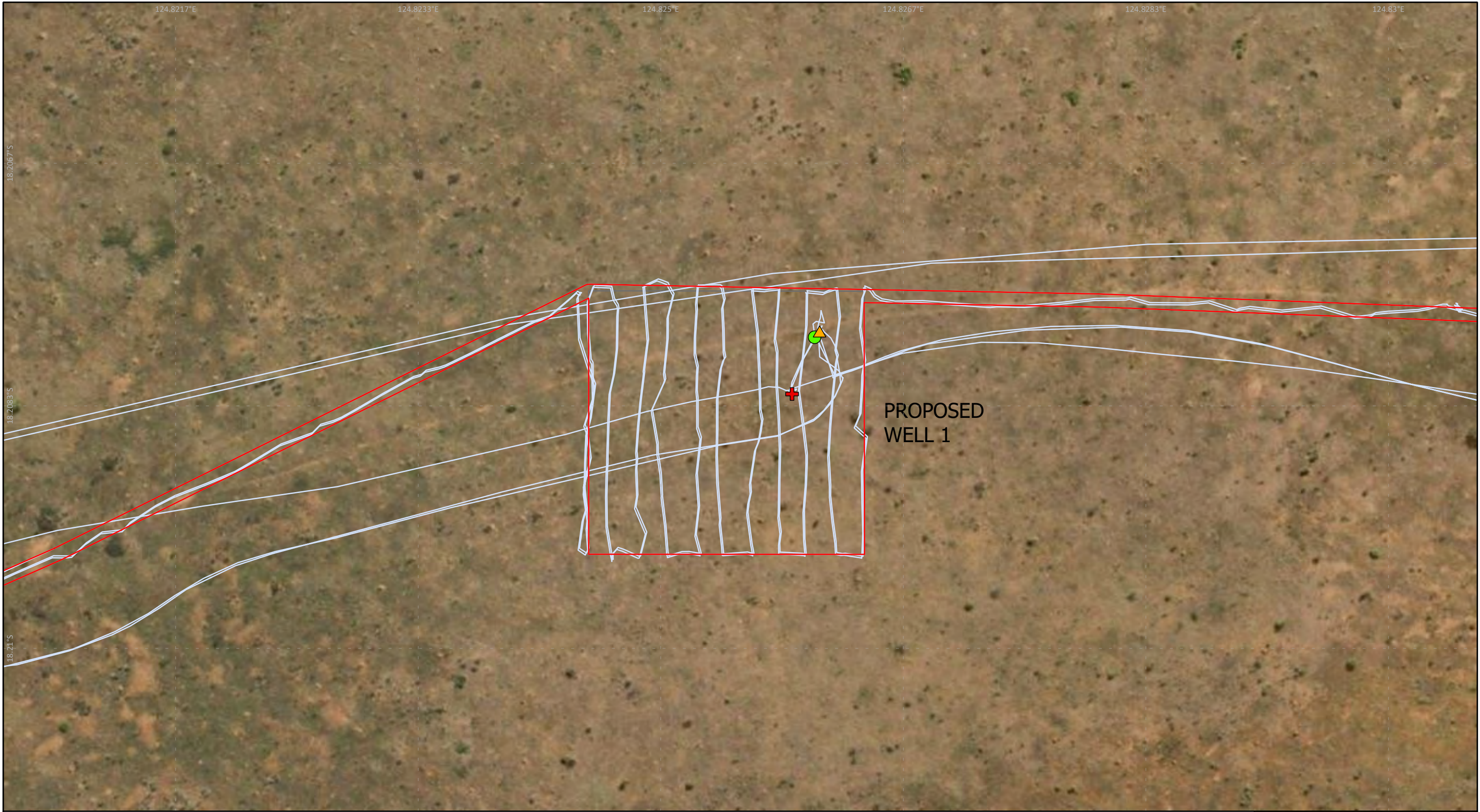
Map 4: Location of all survey sites and search transects.



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Author: SP
Created Date: 29 August 2023
Coordinate System: GCS GDA 1994
Scale: 1:2,750 @A3

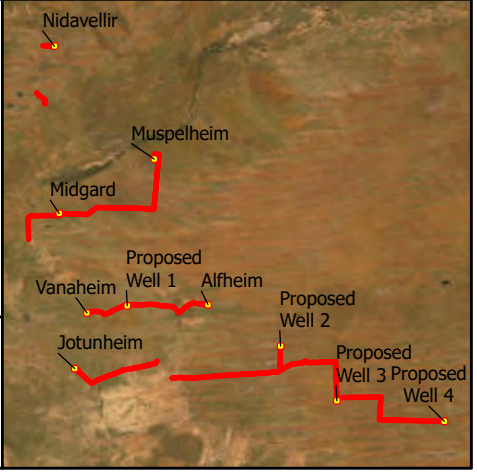
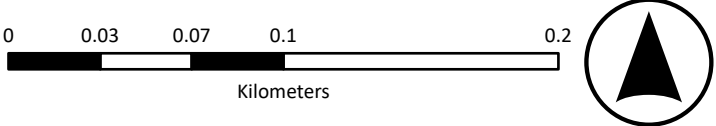
Earthstar Geographics, Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

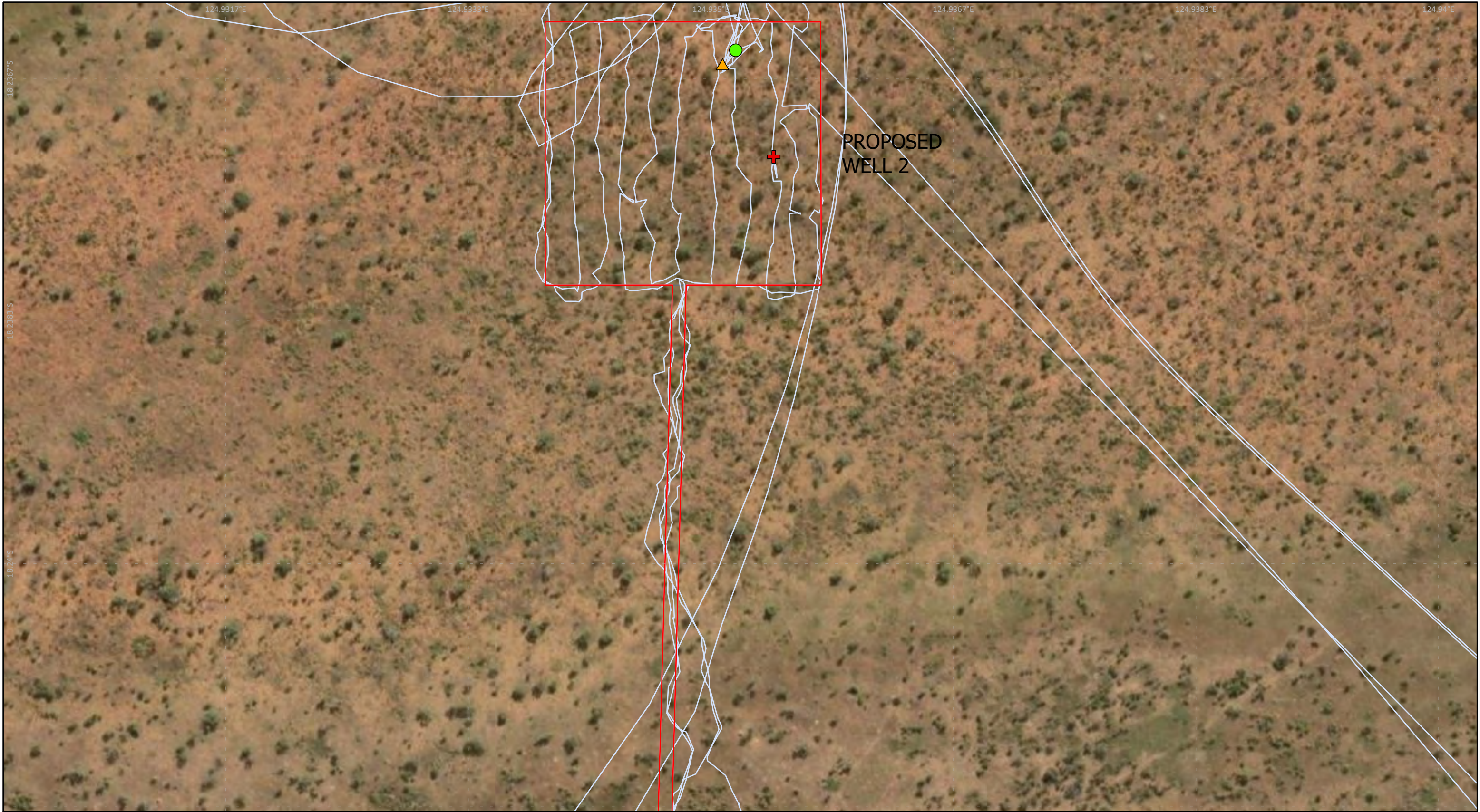




-  Disturbance footprint
-  Motion camera
-  ARU
-  Habitat assessment
-  Survey effort tracks

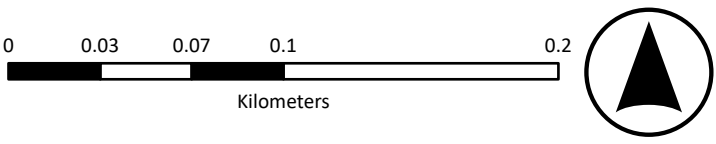
Map 4: Location of all survey sites and search transects.





-  Disturbance footprint
-  Motion camera
-  ARU
-  Habitat assessment
-  Survey effort tracks

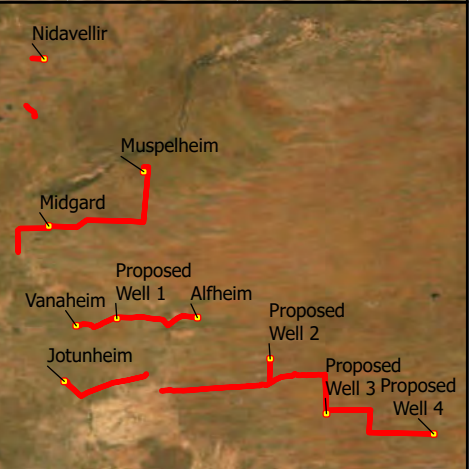
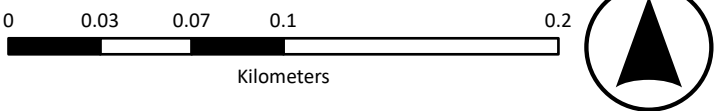
Map 4: Location of all survey sites and search transects.





-  Disturbance footprint
-  Motion camera
-  ARU
-  Habitat assessment
-  Survey effort tracks

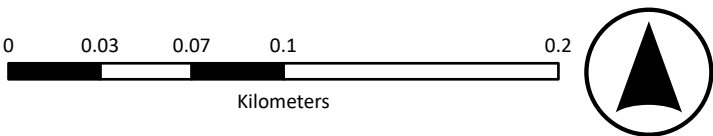
Map 4: Location of all survey sites and search transects.

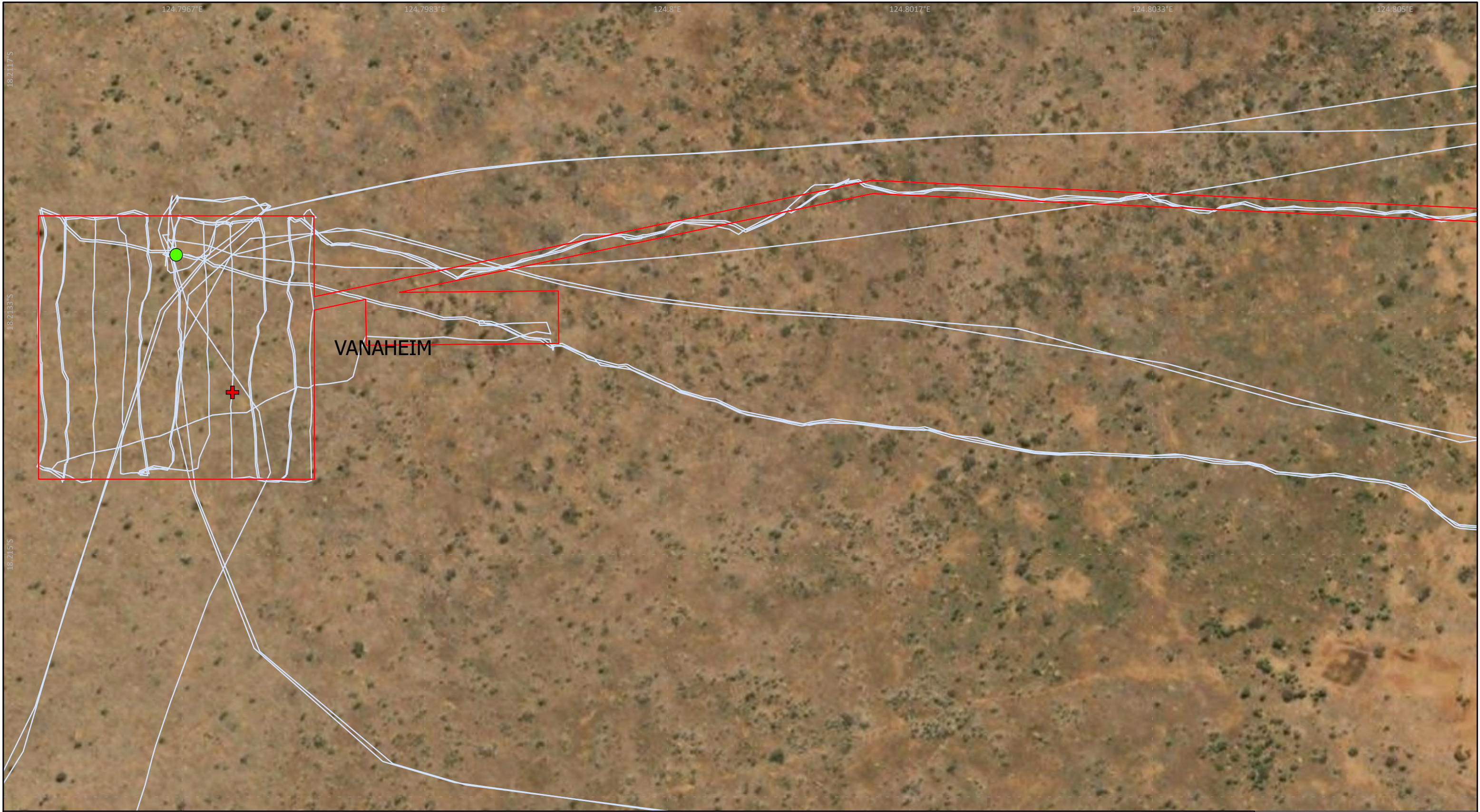




- Disturbance footprint
- Motion camera
- ARU
- Habitat assessment
- Survey effort tracks

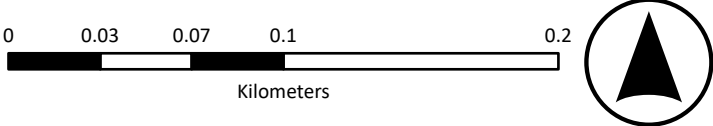
Map 4: Location of all survey sites and search transects.





- Disturbance footprint
- Motion camera
- ARU
- Habitat assessment
- Survey effort tracks

Map 4: Location of all survey sites and search transects.



Appendix C Fauna habitat assessment sheets

Nidaviller

Date	23/07/2024		
Site type	Habitat assessment		
Coordinate	124.7734°E -18.0235°S		
Habitat type	Open woodland		
Habitat description	Open eucalypt woodland over scattered shrubs over spinifex on sandy substrates. Termite mounds are main habitat feature.		
Habitat condition	Very Good		
Suitability for significant species	No		
Evidence of significant species	No		
Disturbance	Evidence of longterm cattle use		
Time since fire	1 – 2 yrs		
Leaf litter cover	< 10		
Woody debris	< 10		
Rocky crevices/caves	NA		
Large trees	No		
Tree hollows	No		
Landform	Plain	Landform (other)	
Slope	Negligible	Aspect	NA
Soil colour	Light brown	Soil texture	Sand
Bare soil	10 – 30	Drainage	NA
Rock type	NA	Rock size	NA
Rock abundance	NA		
Upper stratum	Open woodland		
Middle stratum	Scattered shrubs		
Lower stratum	Open hummock grassland		



Midgard

Date	23/07/2024		
Site type	Habitat assessment		
Coordinate	124.7775°E -18.1424°S		
Habitat type	Open shrubland		
Habitat description	Scattered trees and boats over open shrubland over hummock grassland on sandy loam substrates.		
Habitat condition	Good		
Suitability for significant species	No		
Evidence of significant species	No		
Disturbance	Evidence of longterm cattle use		
Time since fire	1 – 2 yrs		
Leaf litter cover	< 10		
Woody debris	< 10		
Rocky crevices/caves	NA		
Large trees	Yes		
Tree hollows	Small hollows		
Landform	Undulating plain	Landform (other)	
Slope	Negligible	Aspect	NA
Soil colour	Orange	Soil texture	Sandy loam
Bare soil	30 – 70	Drainage	NA
Rock type	NA	Rock size	NA
Rock abundance	NA		
Upper stratum	Scattered trees		
Middle stratum	Tall open shrubland		
Lower stratum	Open hummock grassland		



Jotunheim

Date	24/07/2024		
Site type	Habitat assessment		
Coordinate	124.7872°E -18.2536°S		
Habitat type	Hummock/Tussock Grassland		
Habitat description	Hummock grassland with scattered boabs on clay loams with an abundance of termite mounds.		
Habitat condition	Good		
Suitability for significant species	No		
Evidence of significant species	No		
Disturbance	Evidence of longterm cattle use		
Time since fire	2 – 5 yrs		
Leaf litter cover	< 10		
Woody debris	< 10		
Rocky crevices/caves	NA		
Large trees	No		
Tree hollows	No		
Landform	Plain		
Slope	Negligible		
Soil colour	Light brown		
Bare soil	30 – 70		
Rock type	NA		
Rock abundance	NA		
Upper stratum	Scattered trees		
Middle stratum	Scattered shrubs		
Lower stratum	Hummock and tussock grassland		
		Landform (other)	
		Aspect	NA
		Soil texture	Sandy clay loam
		Drainage	NA
		Rock size	NA



Alfheim

Date	26/07/2024		
Site type	Habitat assessment		
Coordinate	124.8823°E -18.2075°S		
Habitat type	Hummock/Tussock Grassland		
Habitat description	Hummock grassland with on clay loams with an abundance of termite mounds.		
Habitat condition	Good		
Suitability for significant species	No		
Evidence of significant species	No		
Disturbance	Evidence of longterm cattle use		
Time since fire	2 – 5 yrs		
Leaf litter cover	< 10		
Woody debris	< 10		
Rocky crevices/caves	NA		
Large trees	No		
Tree hollows	No		
Landform	Plain	Landform (other)	
Slope	Negligible	Aspect	NA
Soil colour	Light brown	Soil texture	Sandy clay loam
Bare soil	30 – 70	Drainage	NA
Rock type	NA	Rock size	NA
Rock abundance	NA		
Upper stratum			
Middle stratum	Scattered shrubs		
Lower stratum	Hummock and tussock grassland		



Vanaheim

Date	26/07/2024		
Site type	Habitat assessment		
Coordinate	124.797°E -18.2138°S		
Habitat type	Grassland		
Habitat description	Hummock and tussock grassland with on clay loams with an abundance of termite mounds.		
Habitat condition	Good		
Suitability for significant species	No		
Evidence of significant species	No		
Disturbance	Evidence of longterm cattle use		
Time since fire	2 – 5 yrs		
Leaf litter cover	< 10		
Woody debris	< 10		
Rocky crevices/caves	NA		
Large trees	No		
Tree hollows	No		
Landform	Plain	Landform (other)	
Slope	Negligible	Aspect	NA
Soil colour	Light brown	Soil texture	Sandy clay loam
Bare soil	30 – 70	Drainage	NA
Rock type	NA	Rock size	NA
Rock abundance	NA		
Upper stratum			
Middle stratum	Scattered shrubs		
Lower stratum	Hummock and tussock grassland		



Muspelheim

Date	27/07/2024		
Site type	Habitat assessment		
Coordinate	124.8448°E -18.1032°S		
Habitat type	Open woodland		
Habitat description	Open eucalypt woodland and baobs over scattered shrubs over spinifex on sandy substrates. Termite mounds present.		
Habitat condition	Very Good		
Suitability for significant species	No		
Evidence of significant species	No		
Disturbance	Evidence of longterm cattle use		
Time since fire	1 – 2 yrs		
Leaf litter cover	< 10		
Woody debris	< 10		
Rocky crevices/caves	NA		
Large trees	No		
Tree hollows	No		
Landform	Plain	Landform (other)	
Slope	Negligible	Aspect	NA
Soil colour	Light brown	Soil texture	Sand
Bare soil	10 – 30	Drainage	NA
Rock type	NA	Rock size	NA
Rock abundance	NA		
Upper stratum	Open woodland		
Middle stratum	Scattered shrubs		
Lower stratum	Tussock grass land / sedgeland / herbland		



Proposed Well 1

Date	28/07/2024		
Site type	Habitat assessment		
Coordinate	124.8259°E -18.2082°S		
Habitat type	Grassland		
Habitat description	Scattered trees over open shrubland over tussock and hummock grasses with an abundance of termite mounds.		
Habitat condition	Good		
Suitability for significant species	No		
Evidence of significant species	No		
Disturbance	Evidence of longterm cattle use		
Time since fire	1 – 2 yrs		
Leaf litter cover	< 10		
Woody debris	< 10		
Rocky crevices/caves	NA		
Large trees	No		
Tree hollows	No		
Landform	Plain	Landform (other)	
Slope	Negligible	Aspect	NA
Soil colour	Light brown	Soil texture	Sandy clay loam
Bare soil	30 – 70	Drainage	NA
Rock type	NA	Rock size	NA
Rock abundance	NA		
Upper stratum	Scattered low trees		
Middle stratum	Open shrubland		
Lower stratum	Open tussock grassland / sedgeland / herbland		



Proposed Well 2

Date	24/07/2024		
Site type	Habitat assessment		
Coordinate	124.9354°E -18.2372°S		
Habitat type	Open shrubland		
Habitat description	Scattered trees over open shrubland over tussock and hummock grasses.		
Habitat condition	Good		
Suitability for significant species	No		
Evidence of significant species	No		
Disturbance	Evidence of longterm cattle use		
Time since fire	1 – 2 yrs		
Leaf litter cover	10 – 40		
Woody debris	< 10		
Rocky crevices/caves	NA		
Large trees	Yes		
Tree hollows	Small hollows		
Landform	Plain	Landform (other)	
Slope	Negligible	Aspect	NA
Soil colour	Light brown	Soil texture	Sandy loam
Bare soil	10 – 30	Drainage	NA
Rock type	NA	Rock size	NA
Rock abundance	NA		
Upper stratum	Scattered trees		
Middle stratum	Tall open shrubland		
Lower stratum	Hummock grassland		



Proposed Well 3

Date	24/07/2024		
Site type	Habitat assessment		
Coordinate	124.9747°E -18.276°S		
Habitat type	Open shrubland		
Habitat description	Scattered eucalypts over tall acacia tumida shrubland in sandy loam soils.		
Habitat condition	Very Good		
Suitability for significant species	Yes		
Evidence of significant species	Old bilby diggings		
Disturbance	Evidence of longterm cattle use		
Time since fire	2 – 5 yrs		
Leaf litter cover	< 10		
Woody debris	< 10		
Rocky crevices/caves	NA		
Large trees	No		
Tree hollows	No		
Landform	Plain	Landform (other)	
Slope	Negligible	Aspect	NA
Soil colour	Orange	Soil texture	Sandy loam
Bare soil	10 – 30	Drainage	NA
Rock type	NA	Rock size	NA
Rock abundance	NA		
Upper stratum	Scattered trees		
Middle stratum	Tall open shrubland		
Lower stratum	Hummock grassland		



Proposed Well 4

Date	23/07/2024		
Site type	Habitat assessment		
Coordinate	124.8733°E -18.2081°S		
Habitat type	Open shrubland		
Habitat description	Scattered trees and boats over open Acacia tumida shrubland over hummock grassland on sandy loam substrates.		
Habitat condition	Very Good		
Suitability for significant species	Yes		
Evidence of significant species	Old bilby diggings		
Disturbance	Evidence of longterm cattle use		
Time since fire	1 – 2 yrs		
Leaf litter cover	< 10		
Woody debris	< 10		
Rocky crevices/caves	NA		
Large trees	Yes		
Tree hollows	Small hollows		
Landform	Undulating plain		
Slope	Negligible		
Soil colour	Orange		
Bare soil	30 – 70		
Rock type	NA		
Rock abundance	NA		
Upper stratum	Scattered trees		
Middle stratum	Tall open shrubland		
Lower stratum	Open hummock grassland		
		Landform (other)	
		Aspect	NA
		Soil texture	Sand
		Drainage	NA
		Rock size	NA



Appendix D Bat Call Analysis Report



Acoustic analysis and bat call identification from Valhalla, Western Australia

Prepared for **Ecologia Environment Pty Ltd**

Version **29 October 2024**

SZ project reference **SZ747**

Specialised Zoological ABN 92 265 437 422
Dr Kyle Armstrong and Yuki Konishi
Tel +61 (0)404 423 264
kyle.n.armstrong@gmail.com

This report should be included as an appendix in any larger submission to Government, and cited as:

Specialised Zoological (2024). Acoustic analysis and bat call identification from Valhalla, Western Australia. Unpublished report by Specialised Zoological for Ecologia Environment Pty Ltd, 29 October 2024, project reference SZ747.

Version history

Date	Version	Note
2024-10-29	2024-10-29	Final version

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Summary

Bat identifications from bioacoustic recordings are provided for the Valhalla project area, c. 55 km west of Fitzroy Crossing, in the Kimberley region of Western Australia. The identification of bat species from full spectrum WAV-format recordings of their echolocation calls was based on measurements of characteristic frequency, observation of pulse shape, and the pattern of harmonics.

The scope of the analysis was limited to identifying several bat species of conservation significance, and those of particular interest given their vulnerability to the disturbance of their cave roosts.

- Ghost Bat *Macroderma gigas* (Megadermatidae)
- Dusky Leaf-nosed Bat *Hipposideros ater* (Hipposideridae)
- Northern Leaf-nosed Bat *Hipposideros stenotis* (Hipposideridae)
- Orange Diamond-faced Bat *Rhinonycteris aurantia* (Rhinonycteridae)
- Bare-rumped Sheath-tailed Bat *Saccolaimus saccolaimus* (Emballonuridae)

The dataset consisted of 50 recording nights from ten recording sites (**Table 1**).

Analysis targeted the distinctive echolocation calls of these species.

No example of any of these species was observed.

Table 1. Summary of recordings made on the survey.

Site	Serial	Latitude	Longitude	First night	Last night	No. nights
	SM4BAT					
.	SM4-01	-18.14295	124.77647	23/07/2024	27/07/2024	5
.	SM4-03	-18.17731	124.86775	23/07/2024	27/07/2024	5
.	SM4-05	-18.02306	124.77339	23/07/2024	27/07/2024	5
.	SM4-06	-18.16355	124.79235	23/07/2024	27/07/2024	5
.	SM4-07	-18.10308	124.844	23/07/2024	27/07/2024	5
.	SM4-08	-18.16358	124.79205	23/07/2024	27/07/2024	5
	Chorus					
TC36	644436	-18.20998	125.5833	23/07/2024	27/07/2024	5
TC39	644439	-18.20762	124.88323	23/07/2024	27/07/2024	5
TC40	644440	-18.29056	125.05232	23/07/2024	27/07/2024	5
TC88	636488	-18.23644	124.93535	23/07/2024	27/07/2024	5

Methods

The data provided were recorded in full spectrum WAV format with Wildlife Acoustics Song Meter SM4BAT bat detectors (sampling rate 384 kHz, set to turn on automatically at sunset and off at sunrise) and Titley Scientific Anabat Chorus bat detectors (sampling rate 500 kHz).

A multi-step acoustic analysis procedure developed to process large full spectrum echolocation recording datasets from insectivorous bats (Armstrong et al. 2021a,b) was applied to the recordings made on the survey. Firstly, the WAV files were scanned for bat echolocation calls using several parameter sets in the software SCAN'R version 1.8.3 (Binary Acoustic Technology), which also provides measurements (SCAN'R parameters) from each putative bat pulse. The outputs were then used to determine if putative bat pulses measured in SCAN'R could be identified to species. This was done using a custom [R] language application that performed three tasks:

1. undertook a Discriminant Function Analysis on training data from representative calls in from northern Australia;
2. from the measurements of each putative bat pulse from SCAN'R, calculated values for the first two Discriminant Functions that could separate the echolocation call types derived from the analysis of training data, and plotted these resulting coordinates over ellipses representing one standard deviation of the variation for the defined call types; and
3. facilitated an inspection in a spectrogram of multiple examples of each call type for each recording night by opening the original WAV files containing pulses of interest in Adobe Audition version 23.1.

Species were identified based on information in Churchill (2008), Armstrong et al. (2021a) and the author's own unpublished information.

References

- Armstrong K.N., Broken-Brow J., Hoyer G., Ford G., Thomas M. and Corben C. (2021a). Effective detection and identification of sheath-tailed bats of Australian forests and woodlands. *Australian Journal of Zoology* 68:346–363. <https://doi.org/10.1071/ZO20044>
- Armstrong K.N., Clarke S., Linke A., Scanlon A., Roetman P., Hitch, A.T. and Donnellan S.C. (2021b). Citizen science implements the first intensive acoustics-based survey of insectivorous bat species across the Murray-Darling Basin of South Australia. *Australian Journal of Zoology* 68: 364–381. <https://doi.org/10.1071/ZO20051>
- Churchill, S.K. (2008). *Australian bats*. 2nd ed. Allen and Unwin, Crows Nest, NSW.

Limitations

The identifications presented in this report have been made within the following context:

1. The identifications made herein were based on the ultrasonic acoustic data recorded and provided by a 'third party' (the client named on the front of this report).
2. The scope of this report extended to providing information on the identification of several key echolocating bat species in bulk ultrasonic recordings. Further comment on these species was not part of the scope.
3. In the case of the present report, the recording equipment was not set up and supplied by Specialised Zoological. The equipment was operated by the third party during the survey.
4. Other than the general location of the study area, Specialised Zoological has not been provided with detailed information of the survey area, has not made a visit to observe the habitats available for bats, nor have we visited the specific project areas on a previous occasion.
5. Specialised Zoological has had no input into the overall design and timing of this bat survey, recording site placement, nor the degree of recording site replication.
6. While identifications have been made to the best of our ability given the available materials, and reserves the right to re-examine the data and revise any identification following a query, it is the client's and / or proponent's responsibility to provide supporting evidence for any identification, which might require follow-up trapping effort or non-invasive methods such as video recordings. Specialised Zoological bears no liability for any follow-up work that may be required to support an identification based initially on the analysis of acoustic recordings undertaken and reported on here.
7. There are a variety of factors that affect the 'detectability' of each bat species, given the frequency, power and shape characteristics of their calls. Further information on the analysis and the various factors that can impinge on the reliability of identifications can be provided upon request.
8. The analysis of ultrasonic recordings is one of several methods that can be used to survey for bats, and comprehensive surveys typically employ more than one method. If an identification in the present report is ambiguous or in question, a trapping programme would help to resolve the presence of the possibilities in the project area.
9. This version of the document supersedes any previous version. Previous drafts are not authorised by us for submission to the regulator or the public domain.



Document No:	BNR_HSE_MP_016
Revision:	1
Issue Date:	10/06/2025

Appendix 4. Intera modelling assumption review and sensitivity analysis (updated report)

***Uncontrolled in Hardcopy Format* Printed: 10-Jun-25 Use Latest Revision**

Author / Reviewer:	AES		Approver:	Michael Laurent		
Review Frequency: Extreme/High=1yr; Medium=2yr; Low=3yr		2	Date Review Due:	TBC	Page:	130 of 139



16 May 2024

Ashley Fertch
Director
Australasian Environmental Solutions
Perth, WA 6000

RE: Response to comments on the 3 October 2023 technical memorandum titled “Modelling of drawdown impacts from proposed rig supply bores in the Bennett Resources Valhalla Gas Development Project”

Dear Mr. Fertch,

In October of 2023 INTERA Geosciences Pty Ltd (INTERA) submitted the above-referenced memo (the “original memo”) to Australasian Environmental Solutions (AES). In March of 2024 INTERA received a set of comments generated by an independent review of the memo by an external reviewer. The specific comments received are as follows:

1. *The model has several parameter assumptions and many limitations.*
 - a. *Can the parameters and assumptions be clearly stated. Specifically, can a sensitivity analysis be conducted for these parameters [aquifer/aquitard thickness, hydraulic conductivity, aquifer thickness, storage] (i.e. increase/decrease the values and run multiple options through the model to understand the impact of these assumptions)*
 - b. *Can a number of extraction rates be studied to understand impacts of varied extraction rates.*
 - c. *Can the limitations be described and justified why they are suitable for the purpose of this analysis.*
 - d. *Justify why only single model layers are suitable (rather than multiple layers) and validate this against the vertical stratigraphy.*
2. *AES has been informed that MODFLOW 2005 may be outdated and have been informed other software is available (MODFLOW version includes MODFLOW-6, MODFLOW-USG, MODFLOW-SURFACT). Is it possible to provide a justification as to the software suitability for the scope?*

The attached memo titled “Revised modelling of drawdown impacts from proposed rig supply bores in the Bennett Resources Valhalla Gas Development Project” (the “revised memo”) contains an updated modeling evaluation prepared in response to the review comments. This letter summarizes the updated modeling and analysis done to address those comments.

Model Software Update

Comment 2 noted that the model was prepared using MODFLOW-2005 rather than one of the later editions of the modeling software. MODFLOW-2005 was chosen because it is an appropriate model for the scope of the problem (i.e., simulating drawdowns in an aquifer for a specific pumping scenario for both confined and unconfined conditions). The subsequent versions of the modeling software, including the latest MODFLOW version (MODFLOW 6), include the same basic modeling techniques used to simulate drawdown and contain significant modeling capabilities that are not specifically applicable to the problem addressed in the memo, therefore, the use of MODFLOW 6 or any of the other software packages listed were not considered.

In response to this comment, the model developed for the original memo was ported to the MODFLOW 6 software environment and the original models simulations were performed. Updated drawdown maps and a discussion of the results are presented in Section 5 of the revised memo. In summary, all model results are essentially equivalent to the previous results. For the Liveringa simulation the modeled drawdowns at all existing bores were less than <0.01 m and the production wells were capable of producing the required amounts with drawdowns that are much less than the available saturated thickness. For the Grant/Poole simulation, the modeled drawdowns at all existing bores were less than 0.4 m and the production wells experienced drawdowns of less than a meter.

Model Input Parameter Justification

Comment 1 discusses input parameter assumptions and requests justifications for the assumptions and parameters used in the model. The requested discussions are included in the revised memo in a new section called **Section 6.0 Modeling Limitations and Sensitivity Analysis**. This section includes a discussion of model limitations and the appropriateness of using single layer models rather than multi-layer models.

Model Sensitivity Analysis

Comment 1 also includes a request for a model sensitivity analysis to evaluate model sensitivity to reasonable ranges of input parameters as well as various extraction rates. A sensitivity analysis was performed using the revised MODFLOW 6 version of the models. The sensitivity analysis uses a variety of extraction rates that range from 50% to 300% of the expected extraction rates, with the overall pumping time (182 days) held constant. For the Liveringa unconfined model the sensitivity to variations in hydraulic conductivity and specific yield were investigated. Hydraulic conductivity values were varied over 5 orders of magnitude (0.00001 to 0.1 m/d) to match the reported range of values presented in the original memo. The results from the original simulations were included in the analysis for comparison. The approach and results are also presented in Section 6 of the revised memo.

Summary of Results for Revised Memo

Model simulations with the updated model software successfully reproduced the results from the original memo. The sensitivity analysis indicates that some of the unconfined aquifer simulations with the most restrictive input parameters indicate that the Liveringa formation may not be able to sustain 100% of the required pumping rates; however, these simulations assume a conservative pumping approach (i.e., all wells pumping at the same time and at maximum rates rather than pumping staggered throughout the gas production well development period) so these simulations

are not interpreted to indicate that the proposed well production from the shallow unconfined system is not viable. All simulations for the confined Grant/Poole system indicate that the aquifer is capable of supplying the required volume of water, and most simulations other than the lowest ranges of T and S with pumping rates greater than 100% of the required volume indicate minimal impact to existing bores.

If you have any questions or require further information, please contact me at muliana@intera.com or 0450 971 620.

Sincerely,

INTERA Incorporated

A handwritten signature in black ink, appearing to read 'Matthew Uliana', with a stylized flourish at the end.

Matthew Uliana, Ph.D., P.G.
Principal Hydrogeologist

Enclosure

TECHNICAL MEMORANDUM

To: Ashley Fertch
Marnie Leybourne
Australasian Environmental Solutions

From: Matthew Uliana, PhD, PG
Principal Hydrogeologist

Date: 16 May 2024

Re: Revised modelling of drawdown impacts from proposed rig supply bores in the Bennett Resources Valhalla Gas Development Project

1.0 Introduction

As requested, INTERA has prepared the following groundwater model-based evaluation of potential aquifer drawdowns and well interference at the proposed Valhalla site near Fitzroy Crossing, WA. It is our understanding that 20 hydrocarbon exploration wells across 10 well sites are proposed (**Figure 1-1**) with two water production bores installed at each wellsite for rig supply. The overall extent of the development is indicated on Figure 1-1 as the Development Envelope (also referred to in this report as the “project site”). Bennett Resources is proposing to undertake an unconventional exploration drilling and hydraulic fracture stimulation program within the study area targeting hydrocarbons in the Laurel Formation at depths ranging from 2,000 meters (m) to 4,000 m below ground level (bgl). The rig supply bores will provide water for hydraulic fracturing and well construction.

The expected total demand from the rig supply bores at any at each well site is 33,400 kiloliters (kL) produced over a 6-month (182-day) period, which equates to a consistent pumping rate of 183.52 cubic meters per day (m^3/d) for 182 days. It is also assumed that the rig supply bores will not represent an on-going demand upon the system, therefore, the groundwater models developed here only simulate a 182-day pumping period with an additional 270-day post-pumping recovery period. The models also assume that all ten sets of rig supply bores will operate concurrently. This is assumed to be a somewhat conservative approach as the wells will likely be installed in stages and there could be times when some rig supply bores are decommissioned before others are brought on-line.

The specific objective of the modelling is to estimate aquifer drawdowns induced by the rig supply bores and determine if there is a risk of groundwater production from the rig supply bores impacting existing bores in the area, creating excessive bore interference, or causing environmental impact to local groundwater dependent ecosystems (GDE).

2.0 Site Hydrogeology and Conceptual Model

The site sits near the northeast flank of the Fitzroy Trough within the Canning Basin geological region (**Figure 2-1**). The surface geology for the Canning Basin (**Figure 2-2**) indicates that the middle-to-late Permian Liveringa Group aquifer system is exposed at the surface at and around the project site. The Liveringa Group is comprised mostly of siltstone and limestone but also contains minor sandstone and thin coal beds (Lindsay and Commander, 2005). The Liveringa group is considered unconfined with some localized semi-confining units. The Liveringa is underlain by a regional aquitard called the Noonkanbah Formation, which overlays the Poole

Sandstone, which in turn overlays the Grant Group. The Grant Group and Poole Sandstone are both considered to be regional aquifer systems that are generally confined by the Noonkanbah Formation. For this evaluation, they are grouped together as a single aquifer unit. A block diagram showing the relationship between the aquifer formations within the Fitzroy Trough are shown on **Figure 2-3**, with a general location of the section line for the edge of the diagram on Figure 2-2. The Liveringa Group and the Grant/Poole aquifer systems are considered for this study in the event that both aquifers could supply water for the rig supply bores.

The potentiometric surface for the Grant/Poole aquifer system (**Figure 2-4**) indicates that hydraulic heads in the Development Envelope are 75-100 mAHD with a regional gradient from southeast to northwest. Ground surface elevations within the Development Envelope range from about 80 mAHD in the southwest corner to 145 mAHD along the northeast boundary; therefore, typical depths to groundwater in the Grant/Poole aquifer system are 5 to 45 m below ground surface (bgs). The potentiometric contours also suggest that groundwater is discharging to the mainstem and some tributaries of the Fitzroy River. A detailed study of groundwater-surface water interactions in an approximately 100-km reach of The Fitzroy River running to the south of the project site was presented in Harrington et al. (2011). Harrington et al. (2011) determined that The Fitzroy River is a gaining stream system that receives about 102 ML/day of groundwater inflow, with most of this flow (98.3 ML/d) derived from local sources representing recent recharge and shallow flow system. Harrington et al. (2011) also determined that fault zones in the system are providing preferential pathways for discharge from the deeper Grant/Poole system into the surface waters, which confirms that discharge is occurring from the Grant/Poole into the surface waters.

A regional potentiometric surface for the Liveringa is not available. Harrington et al. (2011) indicate that groundwater flow in the Liveringa is likely controlled locally by flow to surface waters in the Fitzroy River catchment with regional westward gradients like those in the Grant/Poole system.

Water quality data presented in Taylor et al. (2021) is relatively sparse for the aquifers near the project site, and there is insufficient data or information to determine if there are vertical interactions between the two formations or to develop aquifer parameters to model any vertical flows between the aquifers. For the evaluation described here, the two formations are assessed separately, and it is assumed that any vertical flows induced by pumping on one aquifer will not result in long-term impacts to the other aquifer.

The primary GDEs that could potentially be impacted by pumping from the proposed rig supply bores are associated with the main stem and tributaries of The Fitzroy River, with specific focus on Mount Hardman Creek given its proximity to the proposed rig sites. The proposed rig sites are all greater than 20 km from The Fitzroy River, and it is unlikely that temporary groundwater production from those bores will have any significant impact on GDEs associated with the Fitzroy River. Mount Hardman Creek is located approximately 1km away from the Muspelheim rig site and as such this well will be evaluated using the models described in subsequent sections.

3.0 Modelling Approach

A set of numerical groundwater models were developed using MODFLOW 6¹. The Groundwater Vistas (ESI) modeling software was used to develop the input files and process model output. Two primary models were developed, one simulating the unconfined Liveringa Group (Mod 1) and one simulating the confined Grant/Poole aquifer system (Mod 2). Each model included a single

¹ <https://www.usgs.gov/software/modflow-6-usgs-modular-hydrologic-model>

model layer, with Mod 1 assigned an unconfined layer condition and Mod 2 assigned a confined layer condition. Each model grid shared the same footprint, with a 1000 x 1000-meter row and column spacing that was refined to about 62 x 62 m spacing within the development envelope using quadtree mesh refinement (**Figure 3-1**). Grid refinement within the development envelope was used to allow for more precise representation of the modeled impacts from the proposed rig supply bores.

The south and west boundaries in each model were assigned CH model cells (Figure 3-1) with heads designed to develop a similar hydraulic gradient as presented in Figure 2-4. Since the actual drawdown impacts presented in Section 5 below are very small and localized, it is assumed that the regional hydraulic gradients won't have a significant effect on drawdowns around the project site; therefore, the model is not expected to be particularly sensitive to the regional gradient. For Mod 1, a set of boundaries simulating Fitzroy Creek (Figure 3-1) were included with elevations based on the typical stage elevations obtained from Google Earth. These cells were not included in Mod 2. The model assumes that the northeast and southwest boundaries of the model domain are no-flow boundaries which are determined by the extent of active model cells (Figure 3-1).

The Liveringa Group aquifer is unconfined; therefore, the

saturated thickness of the Liveringa is the difference between the water table elevations and the elevations of the base of the aquifer. Water levels for the Liveringa are not available. Taylor et al. (2021) indicate that groundwater in the Liveringa is generally flowing in a westerly direction with discharge to the Fitzroy River. Pre-development water levels in the aquifer were based on Fitzroy River stage elevations and a general westerly hydraulic gradient. Static water levels for Mod 1 were estimated based on a steady-state model simulation dependent upon Fitzroy River stage elevations, which results in Liveringa water levels ranging from about 70 to 85 mAHD at the project site. These values are slightly lower than the values of 75 to 100 mAHD for the Grant/Poole system presented in Taylor et al. (2021; see Figure 2-4), which is consistent with upward hydraulic gradients in the system identified by Taylor et al. (2021).

The elevation of the base of the Liveringa within the Fitzroy Trough ranges from -84 to -171 mAHD (Rockwater, 2016). A representative value of -100 mAHD was therefore assigned to Mod 1. This indicates that the initial saturated thickness of the Liveringa within the development envelope is about 170 to 185 meters.

The Grant/Poole aquifer system is assumed to be confined throughout majority of the model domain and is therefore simulated in Mod 2 using a single model layer assigned a confined layer condition. The thickness and elevations of the aquifer system are variable and are not known at the project site; therefore, the aquifer is simulated assuming a constant transmissivity rather than a hydraulic conductivity and thickness. Transmissivity is defined as the product of the hydraulic conductivity and the saturated thickness. Transmissivity estimates were based on ranges of values presented in Taylor et al. (2021) as discussed below in Section 4.

An attempt was made to incorporate recharge into Mod 1 using the mean recharge estimate of 1.8 mm/yr presented in Taylor et al. (2021) calibrated to estimated groundwater discharge to the Fitzroy River (~100 ML/d over a 100 km reach) by varying hydraulic conductivity in a steady-state version of the model. The results indicate that, given the assumed geometry of the system, the regional hydraulic conductivity of the Liveringa would need to be unrealistically high to match the expected groundwater discharge rate and produce a reasonable water table in the model. Recharge was therefore not included in the final predictive model. This is considered acceptable

as it provides a more conservative estimate of the potential impacts from the proposed pumping bores.

4.0 Model Inputs

4.1 Aquifer parameters for the Liveringa (Mod 1)

Hydraulic conductivity (K) values for the Liveringa Group formations as presented in Taylor et al. (2021) range from 3.25×10^{-5} to 0.0913 m/d. Rockwater (2016) used model calibration to drawdown data from nearby pumping bores to determine a representative K of 0.05 m/d for the Liveringa. This value is at the higher end of the range presented in Taylor et al. (2021), which is consistent with the high K values suggested by our attempted calibration to recharge and discharge estimates for the aquifer. A K of 0.05 m/d was therefore assumed for Mod 1.

Taylor et al. (2021) present porosity estimates for various formations in the Fitzroy Trough and assume a representative porosity of 0.05 for the Liveringa Group. This is equal to the value for specific yield (Sy) used by Rockwater (2016) for their Liveringa drawdown model. A Sy of 0.05 was therefore assumed for Mod 1.

4.2 Aquifer parameters for the Grant Group/Poole (Mod 2)

Thickness variations are uncertain in the Grant/Poole aquifer system; therefore, the Grant/Poole system was modeled assuming a homogeneous transmissivity (T) rather than hydraulic conductivity and thickness. Taylor et al. (2021) indicates T values from aquifer tests ranging from 6 to 525 m²/d. A representative regional transmissivity for the aquifer is likely in the middle to upper part of this range of values; therefore, an intermediate value of 265 m²/d was applied to the predictive model.

Mod 2 assumes a fully confined aquifer condition for the active model layer; therefore, the relevant aquifer storage coefficient is the storativity (S), which is defined as the product of the saturated thickness and the specific storage (Ss). Taylor et al. (2021) states that, for the Poole sandstone, “...specific storage has been derived for one location and is 0.001.” This statement is assumed to be a typographical error as a) specific storage should have units of 1/length (e.g., 1/m) and b) a value of 0.001 is reasonable for S (which is a dimensionless quantity) for a sandstone aquifer but is 2 to 4 orders of magnitude too high for a reasonable specific storage value in a confined sandstone. This value is therefore assumed to represent the measured value for storativity and was therefore assigned to the Grant/Pool aquifer system model.

4.3 Predictive Simulations

The predictive models were set up with a ~6-month (182-day) stress period with active pumping and a ~9-month (270-day) recovery period with no pumping. Pumping was applied to each of the rig site locations shown in Figure 1-1 at 183.516 m³/d, which is the rate required to produce a total of 33,400 kL over a 182-day period.

5.0 Model Results

Model results are presented as mapped drawdown contours with a minimum contour of 0.2 meters and a 0.2-m contour interval. Drawdown is defined as the change in water levels within the aquifers (i.e., below ground surface) that results from pumping of the proposed production wells. The value of 0.2 was chosen for the minimum because normal seasonal fluctuations are likely on the order of 0.2 to 1 m; therefore, any values less than 0.2 m are likely not significant

relative to natural variations. Locations of known existing bores within and near the project site are also shown on the maps of model results to determine potential impact to existing bores.

Figure 5-1 shows modeled drawdowns at the end of the 6-month pumping period for Mod 1. Modeled drawdowns at the pumping bores range from 7.3 m to just under 8 m. The radius of the 0.2-m drawdown contour for each bore is within 500 m of each pumping bore. All 0.2-m drawdown contours are greater than a kilometer from any existing bores in the project area. Mod 1 indicates that production of the required volumes of water should not result in any observable impacts to existing bores.

Figure 5-2 shows modeled drawdowns at the end of the 6-month pumping period for Mod 2. The 0.2 m contour interval extends throughout much of the project site and encompasses two of the known existing bores in the project area. Model-predicted drawdowns at those bores range from 0.2 to 0.3 m, which is smaller than the normal seasonal variations in water levels and which represents a very small percentage of the available water column in each bore. Drawdowns in the bores that exceed 0.2 m recover to residual drawdowns between 0.08 and 0.16 m within nine months of the end of pumping.

An additional set of predictive model simulations for both Mod 1 and Mod 2 were performed with pumping only applied to the Muspelheim well location (labeled “Mus” on Figure 1-1). These simulations were performed to determine the radius of impact from an individual bore for each model. Model results are presented as distance-drawdown plots showing modeled drawdown after 6 months of continuous pumping at 183.516 m³/d. Model results are presented in **Figure 5-3**. As indicated by **Figure 5-3A**, modeled drawdowns for Mod 1 (Liveringa aquifer) are 0.2 m at about 350 m from the pumping well, less than 0.1 m at just over 400 m from the pumping well, and less than 3E-06 m at 1,000 m from the pumping well. Model-calculated drawdowns in the Liveringa within 1-km of the Mus well for the single pumping well simulation are identical to the drawdowns from the simulation with all well locations pumping, which indicates that production from the rig supply bores at the expected rates will not result in inter-well drawdown interference. As indicated by **Figure 5-3B**, modeled drawdowns for Mod 2 (Grant/Poole aquifer) are 0.2 m at 3.25 km from the pumping well and 0.1 m at just over 10 km from the pumping well (Figure 5-3B).

The model results presented in Figures 5-1 through 5-3 suggest that the Liveringa aquifer should experience greater drawdowns at each well but with a much more limited extent of drawdown impact in the aquifer as compared to the Grant/Poole aquifer. This is consistent with the assumptions built into the model, as the Grant/Poole aquifer is expected to have a much higher hydraulic conductivity (which would result in less impact at the pumping wells) with a much lower storage coefficient associated with confined condition (which would result in a greater areal extent to drawdown impacts). In general, this result is expected as drawdowns in an unconfined aquifer (like Mod 1) are related to the production wells temporarily draining water out of the aquifer pore space right next to the well while production wells in a confined aquifer (like Mod 2) are temporarily depressurizing the aquifer, which will affect a larger area but result in smaller drawdowns at the actual wells.

6.0 Modeling Limitations and Sensitivity Analysis

The objective of the modelling presented here is to simulate pumping-induced drawdowns in an aquifer given a relatively short-term pumping period (~6 months) and general assumptions about the aquifer input parameters. The modelling software used for the simulations (MODFLOW) is an industry standard program that has been developed over 4 decades and that has been verified as an appropriate tool for simulating aquifer drawdowns in response to pumping.

A review of available literature and other data on the geology and hydrogeology of the study area indicates that there are two potential target aquifers at the site – the unconfined Liveringa and the underlying confined Grant/Poole. There is a considerable amount of uncertainty about groundwater conditions, boundary conditions, and aquifer parameters and parameter variability at the site, which in turn creates predictive uncertainty in the models. The uncertainty associated with critical aspects of the model and the approaches used for dealing with that uncertainty are discussed here.

6.1 General Modelling Approach

The total pumping demand built into the model assumes ten (10) rig supply bores each producing a given amount (33,400 kL) over a time period intended to represent the time required to install the associated hydrocarbon exploration bores (6 months) at each wellsite. For all simulations the modelling assumes that all 10 rig supply wells start pumping at the same time and operate concurrently for the same 6-month period. This is considered to be a conservative approach that results in a “worst-case” pumping application scenario as the actual exploration bores will likely be installed in stages over a multi-year period, which in turn would mean that rig supply bores will come on- and off-line over an extended period. This conservative approach helps to mitigate the uncertainty associated with other model inputs as the simulations are applying a much greater stress to the aquifer than what it will actually experience.

The system was modelled with individual one-layer models for each aquifer system rather than an integrated multi-layer model with some limitations on vertical inter-formational flows (e.g., an aquiclude or vertical anisotropy). The primary reason for this is because there is not enough available information in the literature and existing data to characterize inter-formational flows and verify that a modelling approach is adequately simulating reality. Using individual one-layer models and applying all expected pumping to each model results in a more conservative model as any interformational flows would likely result in additional water moving into the pumped formation, which in turn will reduce modelled drawdowns. This approach is therefore considered to be a conservative approach that will overstate actual aquifer drawdowns.

6.2 Boundary Conditions

Estimates of aquifer recharge to the unconfined system are available for the study area (see Section 3); however, there is considerable uncertainty associated with those estimates. Since applying recharge to the unconfined model would result in reductions to the modelled drawdowns, recharge was not included in the final modelling to create a more conservative estimate of predictive drawdowns.

Other model boundary conditions, such as the constant head cells to the south and west and the lateral no-flow boundaries to the northeast and southwest are positioned far enough from the Development Envelope that they do not have any notable impact on drawdowns within the study area.

6.3 Aquifer Parameters

Mod 1 assumes unconfined aquifer conditions; therefore, the hydraulic conductivity (K) and the specific yield (Sy) are the key aquifer parameters for that model. Mod 2 assumes confined aquifer conditions; therefore, the transmissivity (T) – which is the product of the hydraulic conductivity and the saturated thickness – and the storativity (S) – which is the product of the elastic storage coefficient and the saturated thickness – are the key aquifer parameters for that model. Estimates of appropriate values for these parameters, as derived from the available literature, are presented in Section 4.

The estimates presented for K and T in each aquifer system are broad ranges of values that cover several orders of magnitude. For the storage parameters there are very few estimates that generally cover typical values for the aquifer conditions and lithologies present at the site. The uncertainty associated with aquifer parameters is addressed through a model sensitivity analysis that involves a large number of simulations with variations in permeability, storage parameters, and pumping rates, with results presented as drawdown statistics for the proposed production bores and existing off-site bores.

6.3.1 Sensitivity Analysis – Mod 1

Table 6-1 shows a summary of the input values for the sensitivity analysis simulations for Mod 1. The input parameters varied include the total pumping rates, with four sets of pumping rates equivalent to 50%, 100%, 150%, and 300% of the expected rates described in Section 1 (183.52 m³/d per well over 6 months); three sets of K values ranging from 1.0E-05 to 1.0E-01 m/d; and three sets of Sy values ranging from 0.01 to 0.3.

Sensitivity analysis results for Mod 1 are presented in Table 6-1. The column “Avg at Pumping Bores” in Table 6-1 contains the average modelled drawdowns at the actual pumping bores at the end of the pumping period in each simulation. As indicated on Table 6-1, drawdowns at the pumping wells are sensitive to variations in K with significantly larger drawdowns at the lower K values. For the simulations at 50% or 100% of expected pumping, the lower K models result in relatively large (~20-60 m) drawdowns at the pumping wells, however, these values are still less than the assumed initial saturated thickness (~170-185 m). There is some uncertainty in the actual saturated thickness at the site; however, even if it is half of the assume thickness (85-90 m) the modelled drawdowns from the models with 50-100% of expected pumping will not exceed the available.

At the highest pumping rates, the modeled drawdowns can be a significant fraction of available saturated thickness; therefore, greater pumping rates will only be sustainable if the K values are similar to those assumed for the models presented in Section 4 and 5.

For all 36 simulations the modeled drawdowns at each existing bore (see Figure 5-1 for existing bore locations) were 0.01 m or less, which is considered to be less than the resolvable precision of the model and is interpreted to indicate no impact from pumping on existing bores. This suggests that, even with the most conservative conditions, pumping from the proposed bores completed in the unconfined system will not result in any observable impacts to existing bores.

6.3.2 Sensitivity Analysis Results – Mod 2

Table 6-2 shows a summary of the input values for the sensitivity analysis simulations for Mod 2. The input parameters varied include the same ranges of total pumping rates; three sets of T values ranging from 10 to 1,000 m²/d, and three sets of S values ranging from 1.0E-04 to 1.0E-02.

Sensitivity analysis results for Mod 2 are presented in Table 6-2. The column “Avg at Pumping Bores” in Table 6-2 contains the average modelled drawdowns at the actual pumping bores at the end of the pumping period in each simulation. As indicated on Table 6-2, drawdowns at the pumping wells are sensitive to variations in both T and S, though the differences in drawdowns at the lower values are not as significant as those indicated in Mod 1. Overall drawdowns at the pumping bores are not as extreme as those observed in Mod 1 and given that the expected completion depths for production bores in the Grant/Poole aquifer will be much deeper than those in the Liveringa (likely >200 m below ground level), the model simulations indicate that there will be sufficient available water column in the production bores for even the lowest expected aquifer parameters.

The columns containing “... at Existing Bores” in Table 6-2 contain general statistics for the modelled drawdowns at the existing bores shown in Figure 5-2. Drawdowns at existing bores are less than 4.5 m for all simulations at 50-100% of expected pumping, with all models but the lowest S values resulting in drawdowns less than 1 meter. The models indicate that the greatest sensitivity is to storativity, with the lowest S values generally resulting in drawdowns greater than a meter throughout the Development Envelope. These results indicate that there could be some risk of impact to existing bores if the actual aquifer parameters in the Grant/Poole are much lower than expected; however, those impacts will certainly be minimized if pumping from the production bores is distributed over time as expected.

7.0 Conclusions and Proposed Future Work

The results of Mod 1 indicate that production of the required water volumes from the Liveringa Group will not result in any noticeable impact to existing bores at the project site. The nearest GDE (Mt. Hardman Creek) is also too far from the nearest proposed rig site to experience any significant impacts from the proposed project.

The results from Mod 2 indicated that production of the required water volumes from the Grant/Poole aquifer system would potentially induce temporary drawdowns between 0.2 and 0.4 m on a small number of existing bores at the project site. These drawdowns will likely recover within a year after the end of the pumping period. The impacts represent a very small percentage of the available water column in each bore and would likely not induce any practical impact on the operation of the existing bores.

Hydraulic heads in the Grant/Poole system are higher than those in the overlying Liveringa, which suggests that there could be vertical upward flow of groundwater between the two systems. The evaluations presented by Harrington et al. (2011) also indicate that there is some flow moving up along fault zones and discharging into the Fitzroy River. There is insufficient data to adequately model any interactions between the two aquifer systems; therefore, this was not included in the modeling analysis. Due to the short-term nature of the proposed pumping and the relatively small impacts on each aquifer from pumping within each aquifer, it is unlikely that there would be significant cross-formational impacts from pumping in either aquifer.

Sensitivity analysis of the critical input parameters for Mod 1 indicates that there is very little risk of pumping from the Liveringa affecting any existing bores; however, the aquifer may not be able to support production at higher pumping rates. All Mod 1 sensitivity analysis simulations resulted in modeled drawdowns at the existing bores that are so small they are likely beyond the reasonable resolution of the modelling.

The Mod 2 (Grant/Poole aquifer) sensitivity analysis indicates that the aquifer should not have any problem supplying the required water even at 3 times the expected rates; however, the Grant/Poole aquifer model is sensitive to variations in model storativity and lower than expected storativity in the actual aquifer could result in existing bores temporarily experiencing 1 to 15 m of drawdown by the end of the 6-month pumping period. Drawdown contours were not generated for each of the sensitivity analysis simulations; however, the drawdown statistics presented in Section 6 indicate that typical drawdowns at existing wells for the 100% demand simulations are much less than 1 meter for all but the most restrictive input parameters.

Groundwater levels at each site are generally within 5-45 m of ground surface and each aquifer should have well over 100 m of saturated thickness (i.e., water level in wells above the base of the aquifer) available for drawdown. The modeled drawdowns for all sensitivity analysis

simulations, therefore, are expected to be a small percentage of the available drawdowns, which in turn indicates that the modelled impacts are relatively small.

The analysis presented here is conservative for several reasons:

- The modeling approach assumes that to all rig supply bores pumping concurrently, which will likely not happen as construction of the wells will likely be staged over time.
- The required pumping involves producing a finite volume of water over a relatively short period of time. Any observed impacts at existing pumping bores should recover to pre-pumping rates within a year of the end of pumping.
- Recharge is not included in any of the model simulations. Adding recharge to the system would reduce modeled impacts from pumping.
- The models assume that all pumping is applied to either the Liveringa or the Grant/Poole. If the required pumping is distributed between the two formations, the overall impacts to each formation will be reduced.

The modeling presented here was developed using data and information from the literature with no site-specific testing or investigations. Aquifer testing, including step-drawdown and constant rate pumping tests, should be performed on each of the groundwater extraction bores shortly after installation and development are completed. If possible, at least one monitoring bore should be installed close enough to a production bore to allow for at least one multi-bore aquifer test to establish storage parameters at the site. The results of site-specific testing should then be used to refine the model calculations and develop more reliable estimates of future impacts at the site.

8.0 References

- Harrington, G.A., Stelfox, L., Gardner, W.P., Davies, P., Doble, R. and Cook, P.G. 2011. Surface water – groundwater interactions in the lower Fitzroy River, Western Australia. CSIRO: Water for a Healthy Country National Research Flagship. 54 pp.
- Lindsay, R.P. and Commander, D.P., 2005. Hydrogeological Assessment of the Fitzroy Alluvium, Western Australia, Department of Water, Hydrogeological Record Series HG 16., https://www.water.wa.gov.au/__data/assets/pdf_file/0018/4824/77811.pdf.
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- Taylor, A.R.; Barron, O.V.; Mule, S.; and Ibrahimi, T.; 2021. Groundwater baseline review of the Canning Basin, Western Australia. A technical report from CSIRO to GISERA. CSIRO Technical Report EP2021-1700; CSIRO, Australia. <https://doi.org/10.25919%2Fwsky-g072>

Figures

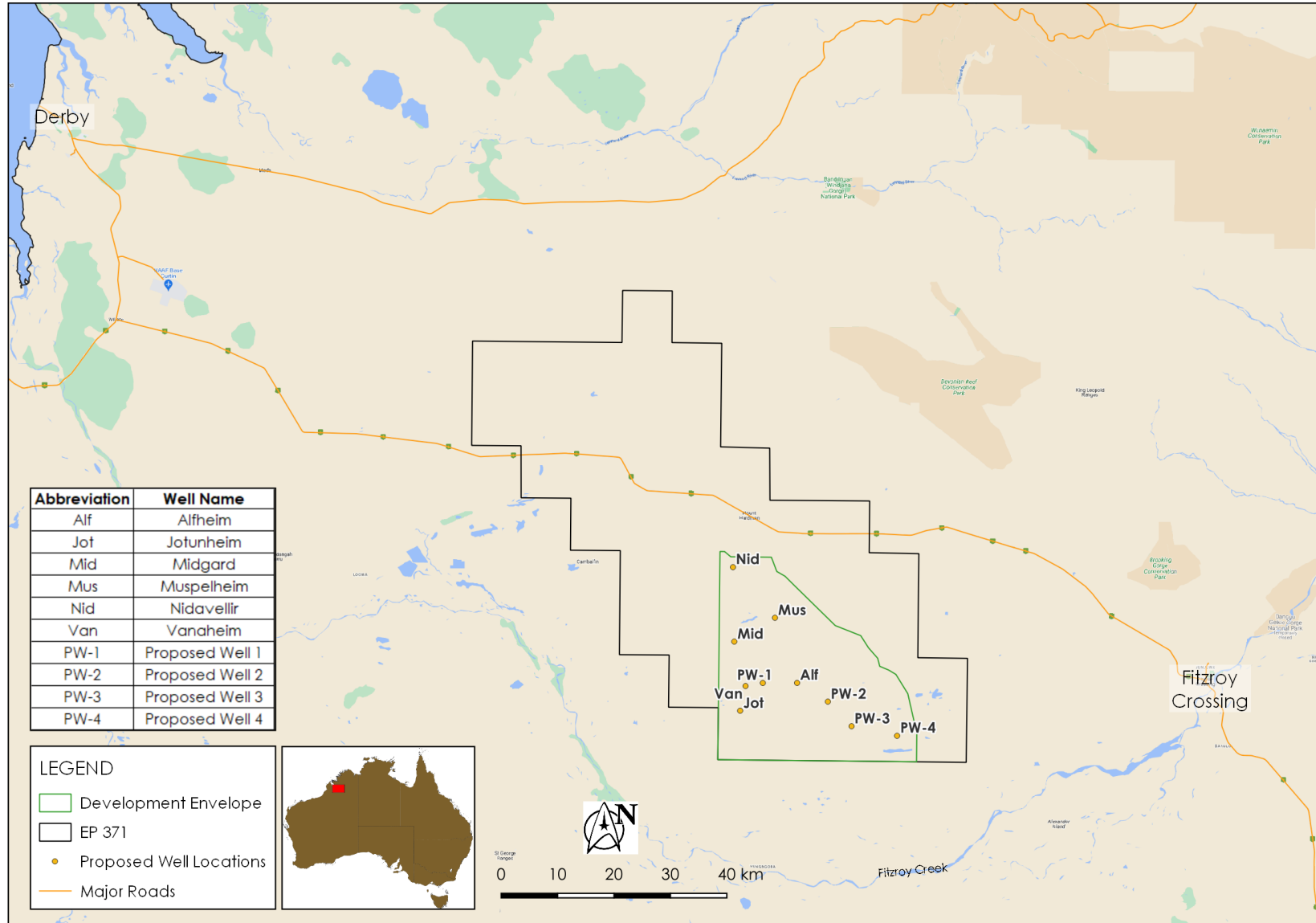


Figure 1-1. Map of the overall study area and locations of the proposed gas production wells

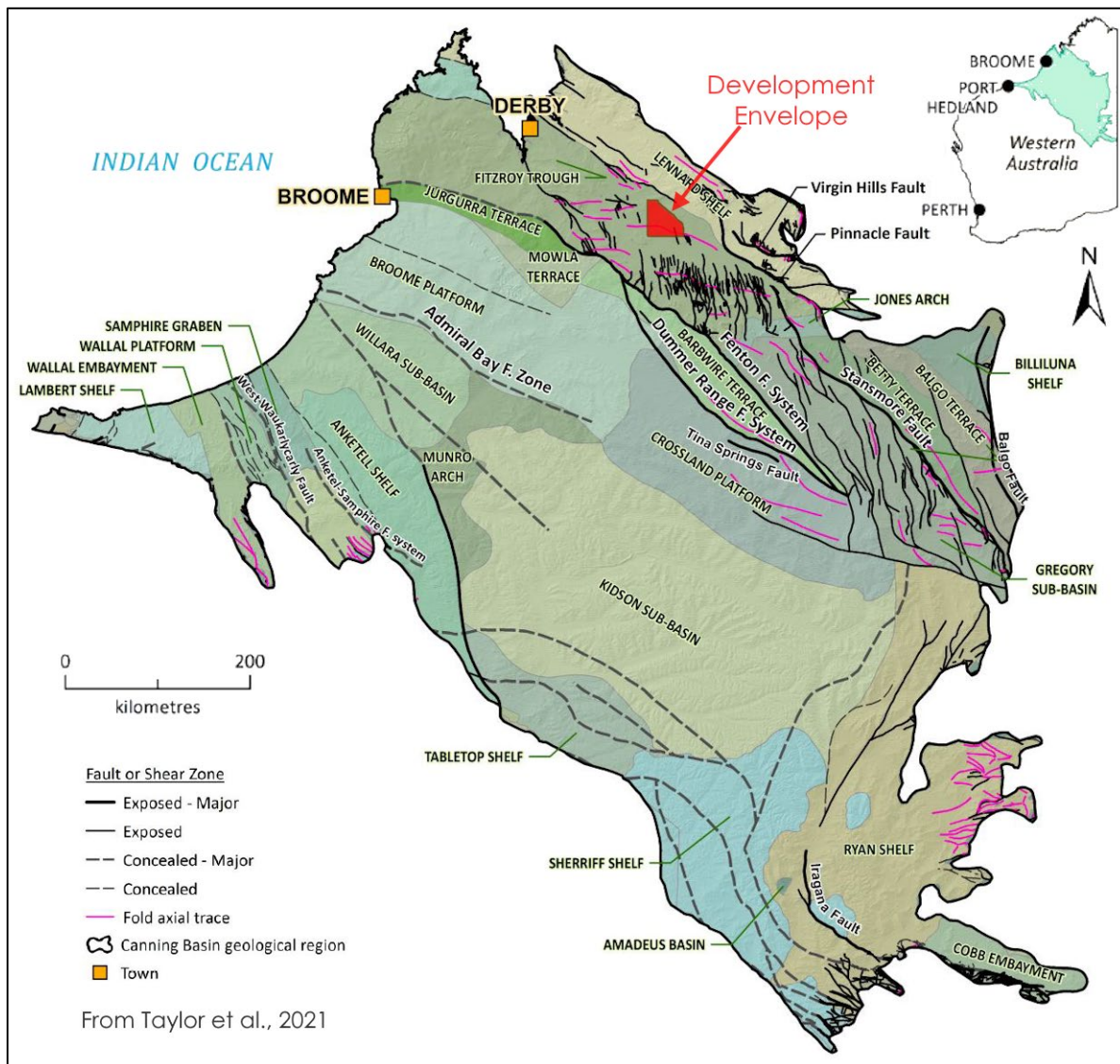


Figure 2-1. Tectonic and structural elements of the Canning Basin

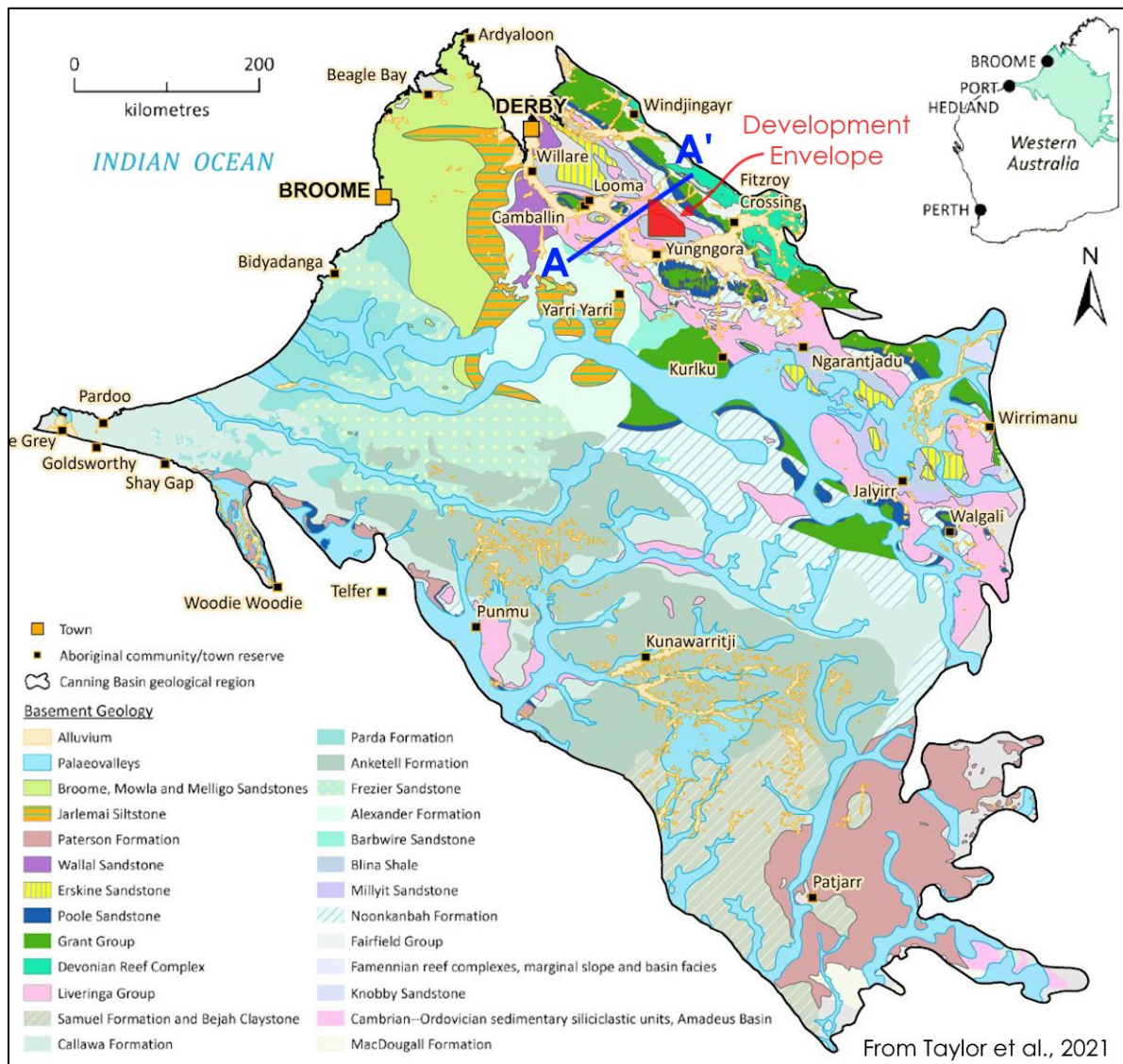


Figure 2-2. Surficial geology within the Canning Basin. The general location of the face of the block diagram in Figure 2-3 is represented by section line A-A'

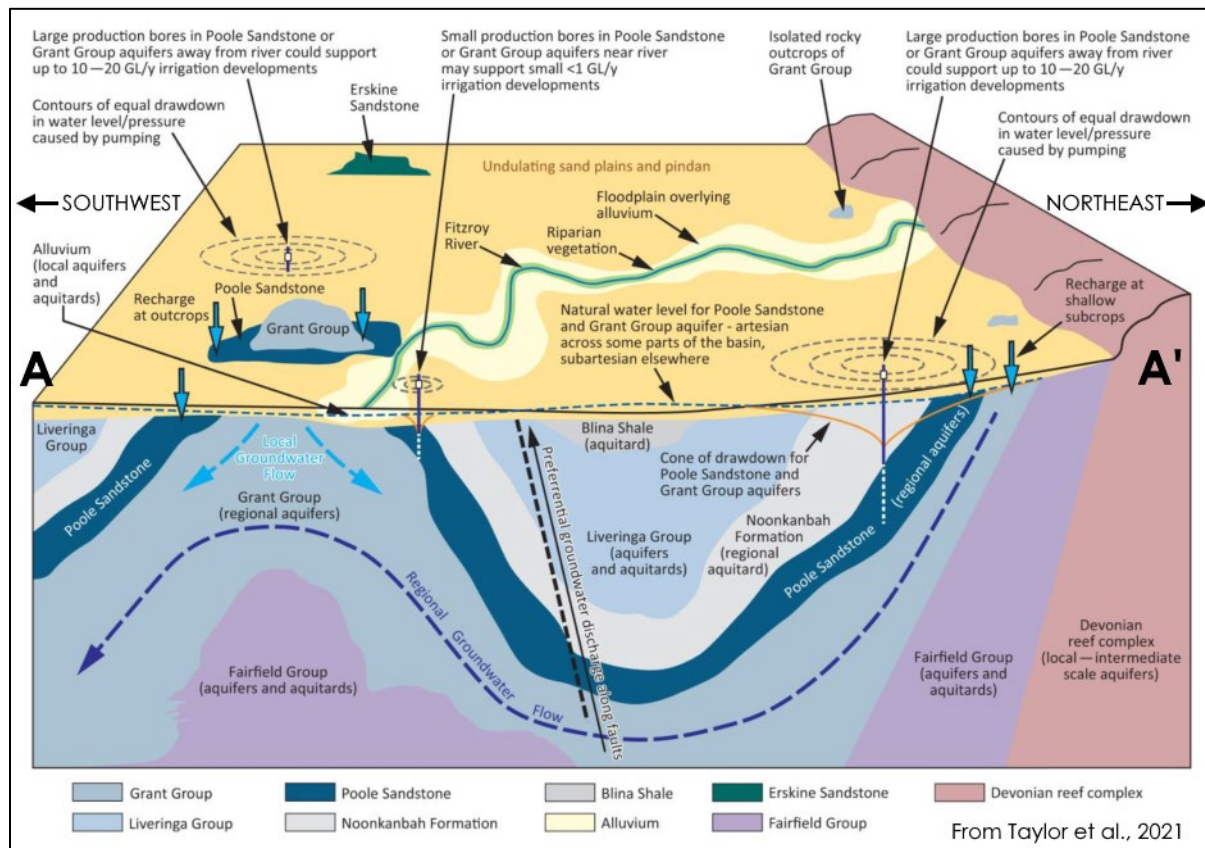


Figure 2-3. Simplified conceptual hydrogeologic block model showing the key aquifers within the Fitzroy Trough. The general location of the section that corresponds to the face of the block diagram is shown as the blue line (A-A') on Figure 2-2.

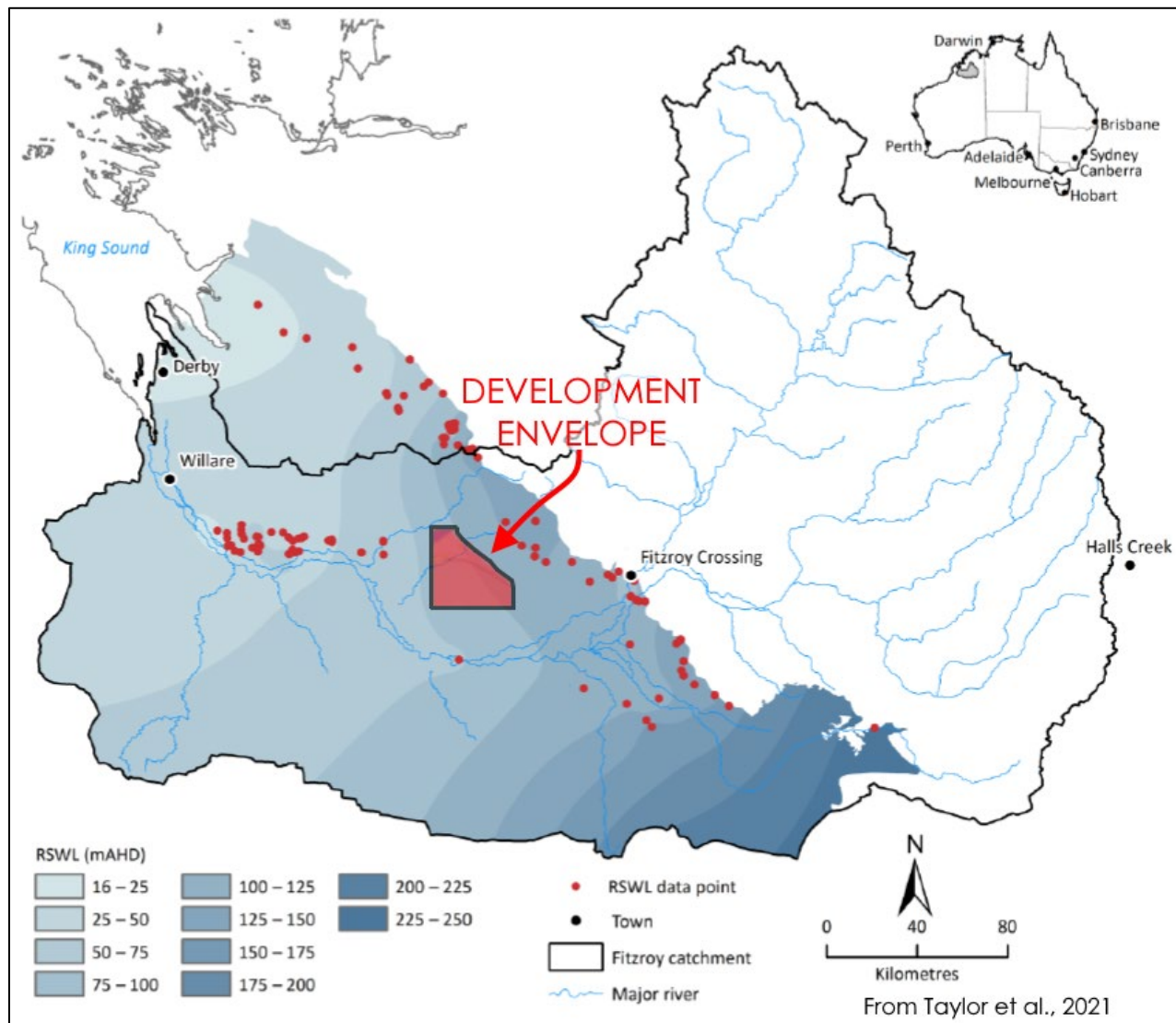


Figure 2-4. Potentiometric surface for the Grant Group and Poole Sandstone aquifers.

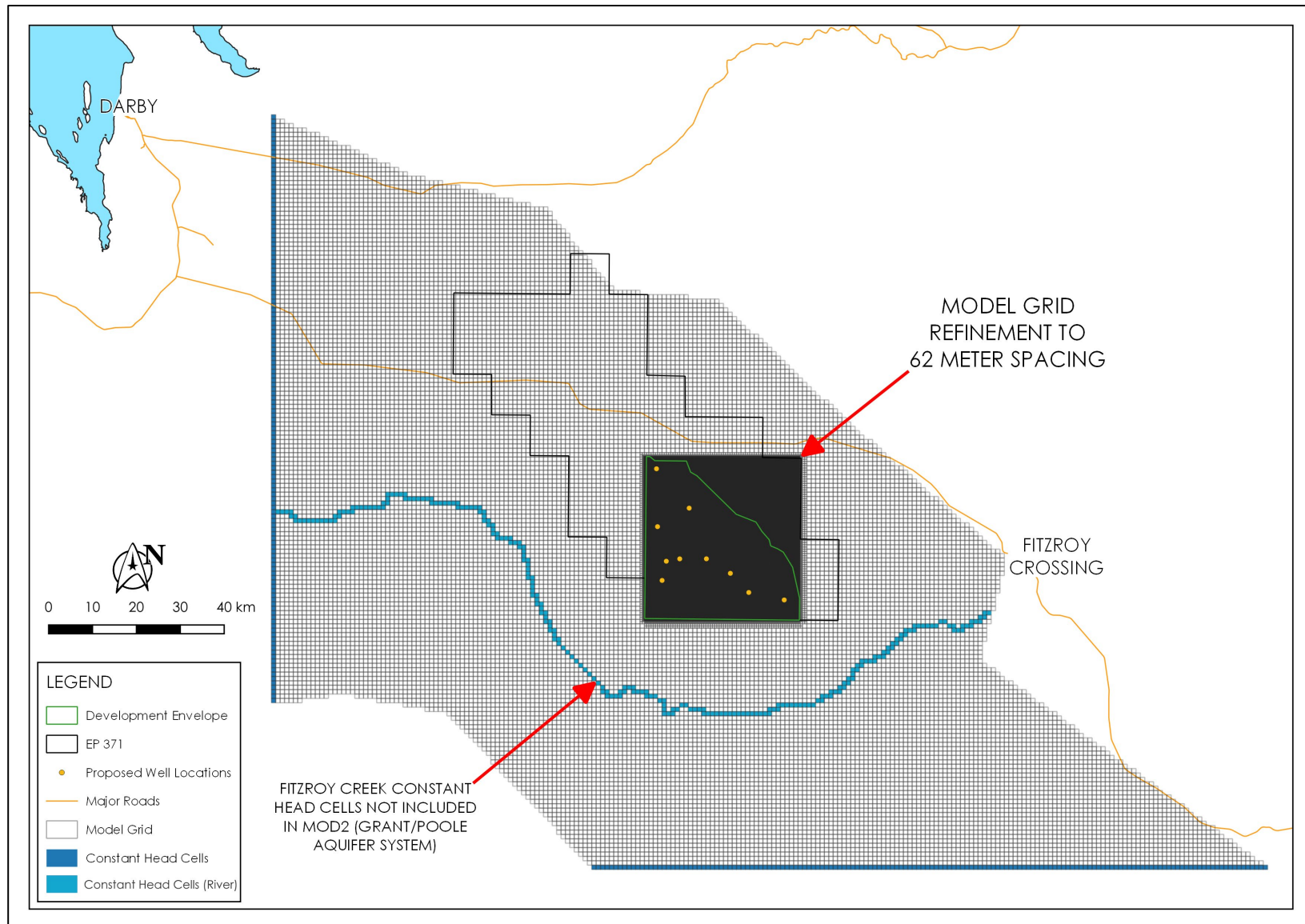


Figure 3-1. Map of MODFLOW 6 unstructured model grid with grid refinement within the development envelope.

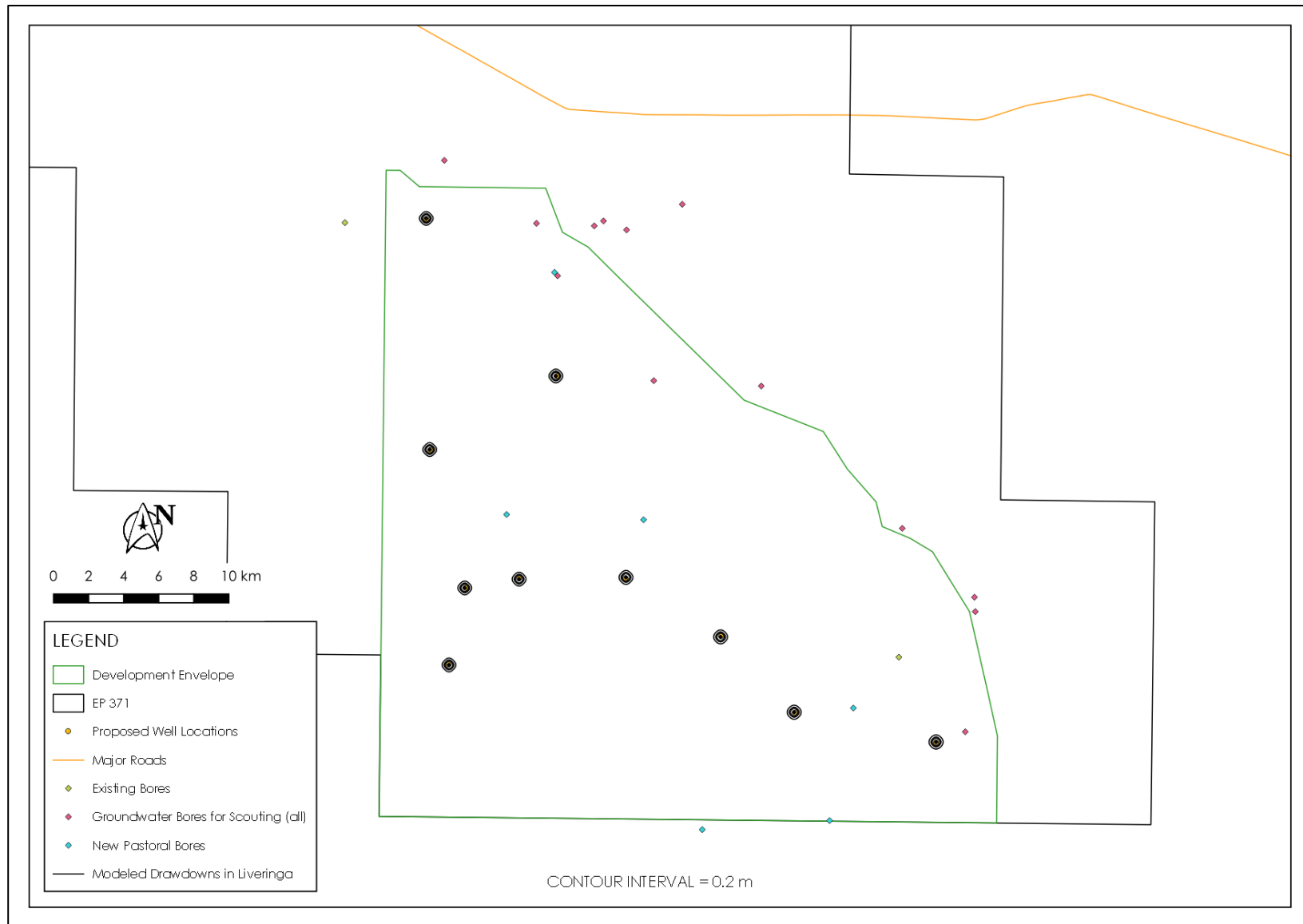


Figure 5-1. Mod 1 model results presented as drawdown contours after 6 months of pumping with contour interval = 0.2 meter.

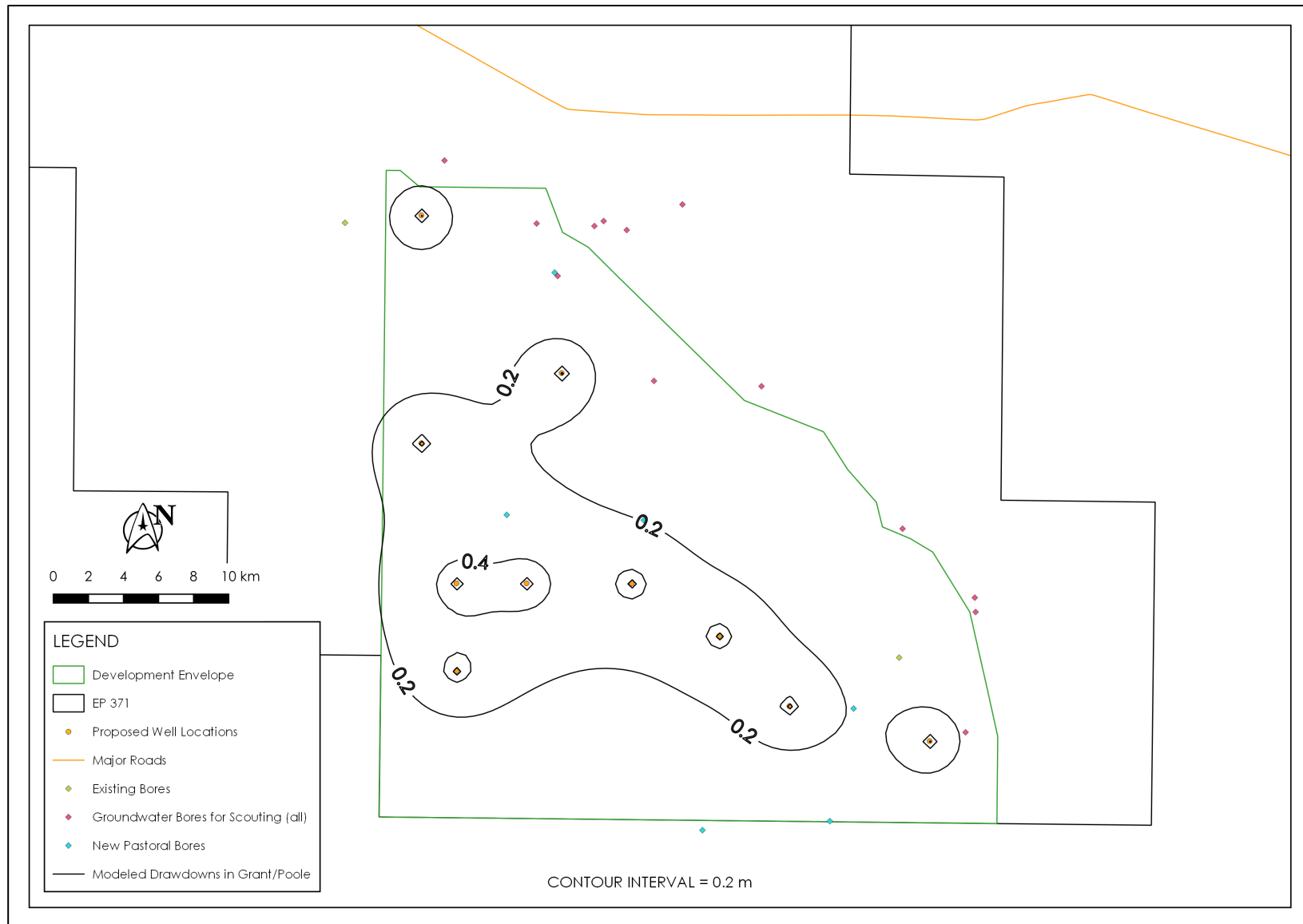


Figure 5-2. Mod 2 model results presented as drawdown contours after 6 months of pumping with contour interval = 0.2 meter.

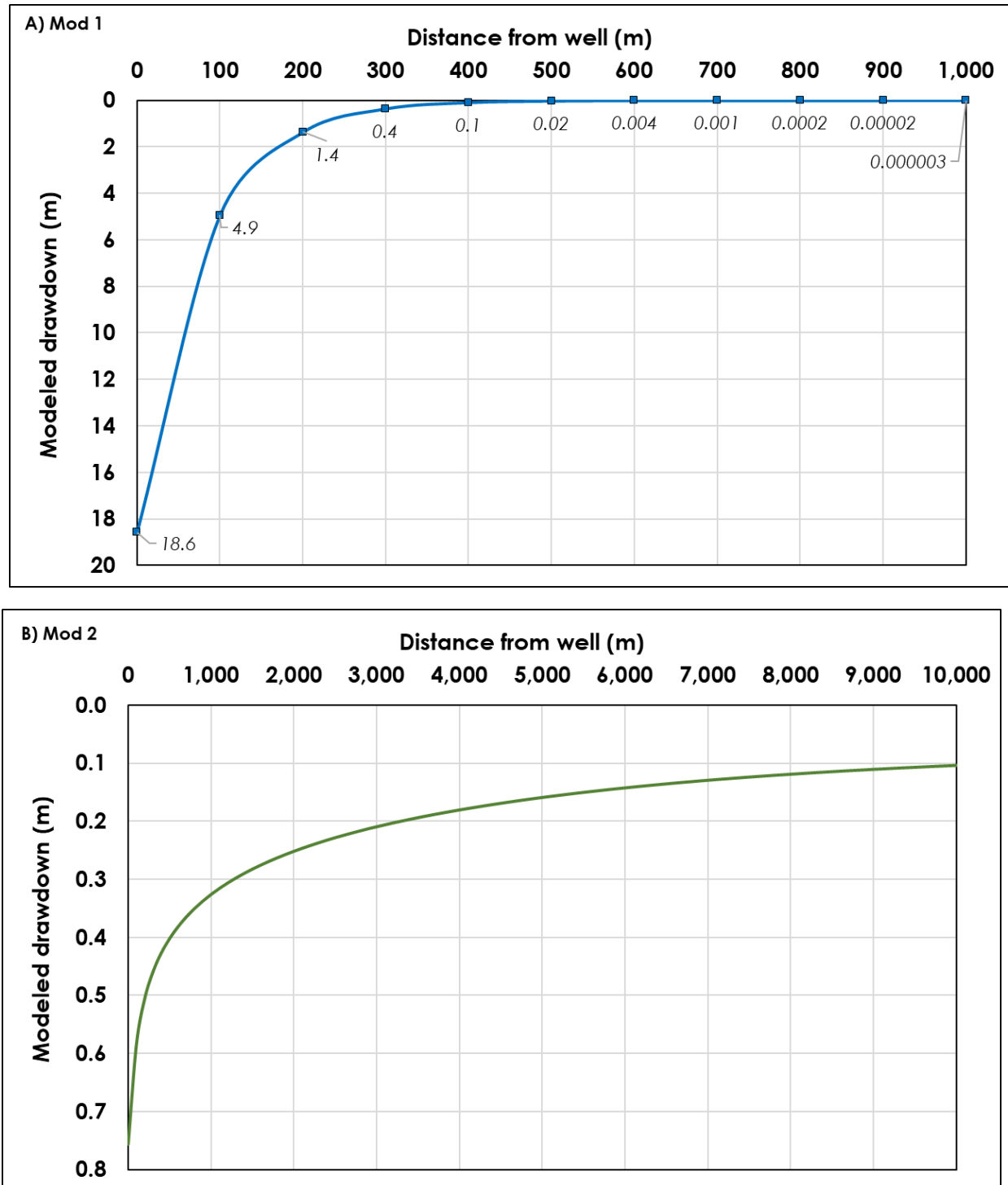


Figure 5-3. Model results presented as distance-drawdown plots after 6 months of pumping for the A) Mod 1 and B) Mod 2 simulations with pumping only applied to a single well. The *italic* numbers on A) are the modelled drawdowns at 100-m intervals from the pumping well.

Tables

Table 6-1. Summary of model sensitivity analysis for Mod 1. Values in column 5 are modelled drawdowns at the pumping bores. Sim00 is the model described in Section 4 & 5.

Sim No.	Q kL/d	K m/d	Sy	Avg at Pumping Bores m	Notes
Sim01	91.758 50%	0.00001	0.01	25.2	Pumping rate is sustainable for all modeled conditions Modeled drawdowns are <0.01 m at existing bores
Sim02			0.1	16.2	
Sim03			0.3	9.2	
Sim04		0.001	0.01	22.8	
Sim05			0.1	15.2	
Sim06			0.3	8.8	
Sim07		0.1	0.01	2.3	
Sim08			0.1	2.1	
Sim09			0.3	1.9	
Sim10	183.516 100%	0.00001	0.01	55.3	Pumping rate is sustainable for all modeled conditions Modeled drawdowns are <0.01 m at existing bores
Sim11			0.1	33.5	
Sim12			0.3	18.5	
Sim13		0.001	0.01	49.5	
Sim14			0.1	31.3	
Sim15			0.3	17.8	
Sim00		0.05	0.05	7.7	Modeled drawdowns are <0.01 m at existing bores
Sim16		0.1	0.01	4.6	
Sim17			0.1	4.3	
Sim18			0.3	3.8	
Sim19	275.274 150%	0.00001	0.01	95.2	Pumping rate is sustainable for all conditions, but could be marginal for the lowest Sy values Modeled drawdowns are <0.01 m at existing bores
Sim20			0.1	52.2	
Sim21			0.3	28.1	
Sim22		0.001	0.01	84.0	
Sim23			0.1	48.8	
Sim24			0.3	27.1	
Sim25		0.1	0.01	7.0	
Sim26			0.1	6.4	
Sim27			0.3	5.7	
Sim28	550.548 300%	0.00001	0.01	169.6	Pumping rate is not sustainable
Sim29			0.1	121.4	Significant loss of sat. thickness
Sim30			0.3	58.1	
Sim31		0.001	0.01	170.0	Pumping rate is not sustainable
Sim32			0.1	114.7	Significant loss of sat. thickness
Sim33			0.3	56.0	Pumping rate is sustainable for all other conditions. Modeled drawdowns are <0.01 m at existing bores
Sim34		0.1	0.01	14.2	
Sim35			0.1	13.1	
Sim36			0.3	11.4	

Table 6-2. Summary of model sensitivity analysis for Mod 2. Values in columns 5-8 are modelled drawdowns at the pumping bores and existing bores. Sim00 is the model described in Section 4 & 5.

Sim No.	Q kL/d	T m ² /d	S	Avg at Pumping Bores m	Min at Existing Bores m	Avg at Existing Bores m	Max at Existing Bores m	Notes
Sim01	91.758 50%	10	0.0001	9.9	0.1	0.7	2.2	Pumping rate is sustainable for all modeled conditions
Sim02			0.001	7.4	0.0	0.0	0.3	
Sim03			0.01	5.7	0.0	0.0	0.0	
Sim04		100	0.0001	1.7	0.3	0.5	1.1	Drawdowns greater than one meter at existing bores for lowest storativity range
Sim05			0.001	0.9	0.0	0.0	0.1	
Sim06			0.01	0.7	0.0	0.0	0.0	
Sim07		1000	0.0001	0.2	0.0	0.0	0.1	
Sim08			0.001	0.1	0.0	0.0	0.0	
Sim09			0.01	0.1	0.0	0.0	0.0	
Sim10	183.516 100%	10	0.0001	19.8	0.1	1.4	4.4	Pumping rate is sustainable for all modeled conditions
Sim11			0.001	14.8	0.0	0.1	0.6	
Sim12			0.01	11.5	0.0	0.0	0.0	
Sim13		100	0.0001	3.4	0.6	1.1	2.3	Drawdowns greater than one meter at existing bores for lowest storativity range
Sim14			0.001	2.0	0.0	0.1	0.4	
Sim15			0.01	1.5	0.0	0.0	0.1	
Sim00		265	0.001	0.8	0.0	0.1	0.3	
Sim16		1000	0.0001	0.5	0.2	0.3	0.4	Drawdowns greater than one meter at existing bores for lowest storativity range
Sim17			0.001	0.2	0.0	0.0	0.1	
Sim18			0.01	0.2	0.0	0.0	0.0	
Sim19	275.274 150%	10	0.0001	29.8	0.2	2.1	6.7	Pumping rate is sustainable for all modeled conditions
Sim20			0.001	22.3	0.0	0.1	0.9	
Sim21			0.01	17.2	0.0	0.0	0.0	
Sim22		100	0.0001	5.2	0.9	1.7	3.4	Drawdowns greater than one meter at existing bores for lowest storativity range
Sim23			0.001	3.0	0.0	0.2	0.6	
Sim24			0.01	2.2	0.0	0.0	0.1	
Sim25		1000	0.0001	0.9	0.4	0.5	0.7	
Sim26			0.001	0.5	0.1	0.1	0.3	
Sim27			0.01	0.3	0.0	0.0	0.1	
Sim28	550.548 300%	10	0.0001	59.5	0.3	4.2	13.4	Pumping rate is sustainable for all modeled conditions
Sim29			0.001	44.5	0.0	0.2	1.9	
Sim30			0.01	34.4	0.0	0.0	0.0	
Sim31		100	0.0001	10.4	1.9	3.4	6.9	Drawdowns greater than one meter at existing bores for lowest storativity range
Sim32			0.001	5.9	0.0	0.4	1.3	
Sim33			0.01	4.5	0.0	0.0	0.2	
Sim34		1000	0.0001	1.9	1.0	1.2	1.6	
Sim35			0.001	1.0	0.2	0.3	0.6	
Sim36			0.01	0.6	0.0	0.0	0.1	



Document No:	BNR_HSE_MP_016
Revision:	1
Issue Date:	10/06/2025

Appendix 5. Greenhouse Gas Environmental Monitoring Plan

***Uncontrolled in Hardcopy Format* Printed: 10-Jun-25 Use Latest Revision**

Author / Reviewer:	AES		Approver:	Michael Laurent		
Review Frequency: Extreme/High=1yr; Medium=2yr; Low=3yr		2	Date Review Due:	TBC	Page:	131 of 139



BENNETT RESOURCES

Valhalla Gas Exploration and Appraisal Program

Greenhouse Gas Environmental Management Plan

BNR_HSE_MP_014

VERSION HISTORY				
Ver. No.	Ver. Date	Author	Reviewer	Revision
1	10 Jan 2022	AF	SR	For EPA submission
2	01 May 2023	AF,MLL	ML	For EPA submission
3	11 May 2024	MLL, AF	ML	For EPA submission
4	14 May 2024	MLL, SS		For Peer Review
5	7 June 2024	MLL, SS	ML	For EPA submission
6	23 May 2025	KA, AF	ML	For EPA submission

AU +61 8 9200 1685

225 St Georges Terrace, Level 4
Perth, WA 6000 AUS

www.blackmtn.com



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Acronym / abbreviation

Terms / acronym	Definition / expansion
ACCU	Australian Carbon Credit Units
API	American Petroleum Institute
bbl	Barrel, a unit of volume for crude oil and petroleum products
BNR	Bennett Resources Pty Ltd
CH ₄	Methane
CNG	Compressed Natural Gas
CO ₂	Carbon dioxide
CO ₂ e	Carbon dioxide equivalent
CO ₂ e/GJ	Carbon dioxide equivalent per gigajoule
e.g.	For example
EMP	Environmental Management Plan
EP 371	Exploration Permit 371
EP Act	(WA) <i>Environmental Protection Act 1986</i>
EPA	(WA) Environmental Protection Authority
ESD	Environmental Scoping Document
FullCAM	Full Carbon Accounting Model
FY	Financial year
GHG	Greenhouse Gas
GHGEMP	Greenhouse Gas Management Plan
GJ/kL	Gigajoule per kilolitre
ha	Hectare
HFS	Hydraulic Fracturing Stimulation
i.e.	That is
kg/m ³	Kilogram per cubic metre
kL	Kilolitres
km ²	Square kilometres
kWh	Kilowatt per hour
LNG	Liquified Natural Gas
m	Metres
m ³	Cubic metres
ML	Megalitres
MMscf/d	Million standard cubic feet per day
NGER	National Greenhouse and Energy Reporting
NOx	Nitrogen Oxides



Terms / acronym	Definition / expansion
N ₂ O	Nitrous Oxide
PV	Photovoltaic
Proponent	Bennett Resources Pty Ltd
Proposal	Valhalla Gas Exploration and Appraisal Program
tC/ha	Tonnes of carbon per hectare
tCO ₂ e	Tonnes of carbon dioxide equivalent
tCO ₂ e/ha	Tonnes of carbon dioxide equivalent per hectare
tCO ₂ /tCH ₄	Tonnes of carbon dioxide equivalent per tonnes of Methane
tCO ₂ e/d	Tonnes of carbon dioxide equivalent per day
tpa CO ₂ -e	Tonnes of carbon dioxide equivalent per annum
US EPA	Environmental Protection Agency of the United States
WA	Western Australia
%	Percentage
~	Approximately



1 Executive summary

This Greenhouse Gas Environmental Management Plan (GHGEMP) has been prepared by Bennett Resources (BNR) to support the assessment, approval and implementation of the Valhalla Gas Exploration and Appraisal Program (the Proposal) under Part IV of the *Environmental Protection Act 1986* (EP Act).

Bennett Resources referred the Proposal to the Environmental Protection Authority (EPA) under Part IV of the EP Act on 24 December 2020 (EPA Assessment Number 2281). The EPA has decided to assess the Proposal at a level of Public Environmental Review.

This GHGEMP has been written in accordance with the “Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans” (EPA 2021a), the Greenhouse Gas Emissions Environmental Factor Guideline (EPA 2023) and the GHG EMP Template (EPA 2023). An executive summary of this GHGEMP is provided in Table 1-1.

Table 1-1: Executive summary of the GHGEMP

Proposal title	Valhalla Gas Exploration and Appraisal Program (EPA Assessment Number 2281)
Proponent name	Bennett Resources Pty Ltd
Proposal Description and Scope	The Proposal is to complete an unconventional exploration and appraisal drilling and hydraulic fracture stimulation (HFS) program on Petroleum Exploration Permit EP 371 in the Canning Basin.
Purpose of the GHGEMP	The purpose of this GHGEMP is to support the assessment, approval, and implementation of the Proposal under Part IV of the EP Act, and to provide management and monitoring actions for Greenhouse Gas (GHG) emissions resulting from the Proposal that are aligned with the intent of BNR’s Climate Change Policy, and the Western Australian Government Climate Policy (WA Government 2020). Monitoring of greenhouse gas emissions will be undertaken in accordance with the Valhalla Monitoring Plan.
Emissions estimates	It is expected that the proposal will comprise scope 1 emissions only. During phase one, maximum emissions will be <200,000 tCO ₂ e/year During phase two, maximum emissions will be <600,000 tCO ₂ e/year A maximum emissions estimate for the full program is 1,603,293 tCO ₂ e.
Trajectory of emissions reductions	In alignment with BNR’s Climate Change Policy (Appendix A) and the requirements of ESD Item 78, the long-term environmental outcome is to avoid, reduce, or mitigate 100% of scope 1 GHG emissions by 2050. This GHG EMP commits to avoid, reduce, or mitigate 43% of scope 1 GHG emissions by the end of year 5 (anticipated to be around 2030). No scope 2 or scope 3 emissions are expected to be produced through this proposal.
Other statutory decision-making processes which require reduction in GHG emissions	The trajectory of emissions, which is expected to reduce to zero after seven years from the commencement of the proposal, is consistent with the EPA’s GHG objective to reduce net GHG emissions in order to minimise the risk of environmental harm associated with climate change, and with ESD item 78.
Key components in the GHGEMP	The long-term environmental outcome for this GHGEMP is to avoid, reduce, or mitigate 100% of Scope 1 GHG emissions from the Proposal by 2050. This long-term outcome is supported by a single interim environmental outcome of the GHGEMP, to avoid, reduce, or mitigate 43% of Scope 1 GHG emissions from the Proposal by the end of the 5th year of the Proposal. These environmental GHGEMP outcomes and their associated indicators, response actions, monitoring and reporting requirements, are defined in Table 5-1 and Table 5-2.
GHGEMP reviews and reporting	This GHGEMP is intended to be dynamic and may be updated to reflect changes in management practices and the natural environment over time. It will be reviewed on a five-yearly cycle.
Proposed construction / commencement date	TBC – within Calendar Year 2025.



EMP required pre-construction / commencement?	Yes ☒ No ☐
Proposed project end of life/decommissioning date	TBC – within Calendar Year 2032

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2 Context, scope and purpose

2.1 Proponent, Proposal Description and Scope

Bennett Resources Pty Ltd (BNR), a wholly owned subsidiary of Black Mountain Energy Pty Ltd, is the proponent for the Proposal.

The Proposal is to complete an unconventional exploration and appraisal drilling and Hydraulic Fracture Stimulation (HFS) program within Petroleum Exploration Permit EP 371 (EP 371) in the Canning Basin, within the Shire of Derby / West Kimberley in Western Australia (WA).

The intent of the Proposal is to evaluate the large tight gas resource in the region which has the potential to offer long-term energy security to Australia. The onshore Canning Basin is an early Ordovician to early Cretaceous aged geological basin that covers approximately 430,000 km² in the West Kimberley region. The Proposal is targeting hydrocarbons present from the Laurel through to the Devonian Formations, ranging from 2,000 m to 5,000 m below ground level. The main target is the Laurel Formation, with hydrocarbons present at depths between 2,000 m and 4,000 m below ground level.

Table 2-1 provides a summary of the Proposal.

Table 2-1: Summary of the Proposal

Proposal title	Valhalla Gas Exploration and Appraisal Program (EPA Assessment Number 2281)
Proponent name	Bennett Resources Pty Ltd (BNR)
Short description	The Proposal is to undertake an unconventional exploration and appraisal drilling program within EP 371, located in the Canning Basin, West Kimberley of Western Australia. The Proposal includes the construction of up to 20 exploration wells within 10 well sites. The intent of the Proposal is to further appraise the extent of the tight gas reservoir in the Laurel Formation with hydrocarbon shows present at depths in the order of 2,000 m to 4,000 m below ground level. The exploration and appraisal program is expected to commence in 2024 or 2025.
Purpose of the GHGEMP	To meet the Environmental Scoping Document (ESD) Item 78: <i>Provide a greenhouse gas management plan, in accordance with EPA guidance, which demonstrates the proposal's trajectory towards net zero emissions by 2050.</i> The goal of ensuring net zero emissions by 2050 is in line with the Western Australian Government's Climate Policy, released in November 2020, which commits the government to working with all sectors of the economy to achieve net zero greenhouse gas emissions by 2050.

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2.2 Purpose of the GHGEMP

The purpose of this GHGEMP is to support the assessment, approval, and implementation of the Proposal under Part IV of the EP Act, and to provide management actions for Greenhouse Gas (GHG) emissions resulting from the Proposal that are aligned with the intent of BNR's Climate Change Policy, and the Western Australian Government Climate Policy (WA Government 2020). Monitoring of greenhouse gas emissions will be undertaken in accordance with the Valhalla Monitoring Plan.

The elements have been identified as having the potential to affect the Key Environmental Factor – Greenhouse Gas Emissions include:

- well testing (resulting in gas and condensate flaring)
- diesel fuel usage
- land clearing and fugitive emissions.

BNR has developed this GHGEMP to meet the Environmental Scoping Document (ESD) Item 78:

Provide a greenhouse gas management plan, in accordance with EPA guidance, which demonstrates the proposal's trajectory towards net zero emissions by 2050.

The goal of ensuring new zero emissions by 2050 is in line with the Western Australian Government's Climate Policy, released in November 2020, which commits the government to working with all sectors of the economy to achieve net zero greenhouse gas emissions by 2050.

Oil and gas exploration activities are reportable under the National Greenhouse and Reporting (NGER) scheme and can be covered by the Safeguard Mechanism if those activities form part of a facility that triggers the Safeguard Mechanism threshold, the threshold for application of the safeguard is exceedance of 100,000 tonnes CO₂-e per annum.

The drilling program is to drill and test multiple wells in a single year which will result in more than 100,000 tonnes of carbon dioxide (CO₂) equivalent in a year being produced. Given that the Proposal is also being assessed under the EPBC Act, and as the emission threshold is likely to be exceeded, the Proposal will be subject to the Safeguard Mechanism (DCCEEW 2021). Consequently, in accordance with the EPA Guidelines (EPA 2020) the implementation of this GHGMP under the EP Act is not required given it can be suitably managed under the Safeguard mechanism.

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Review Frequency: Extreme/High=1yr; Medium=2yr; Low=3yr	5	Date Review Due:		Page:	8 of 30

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3 GHGEMP components

This section of the GHGEMP identifies the emissions estimates, trajectory of emissions reductions and mitigation measures adopted to avoid, reduce or offset emissions.

3.1 Emissions estimates

3.1.1 Scope 1 emissions

An emissions inventory of direct Scope 1 GHG emissions is provided in Table 3-1. The methodologies used to calculate this inventory are provided in Appendix B. As detailed in Appendix B, the main sources of Scope 1 GHG emissions are (per well):

- gas and condensate flaring, comprising up to approximately 88,428 tCO_{2-e} (or 93.1%) of Scope 1 GHG emissions
- diesel fuel usage, comprising up to approximately 3,300 tCO_{2-e} (or 6.3%) of Scope 1 GHG emissions
- land clearing and fugitive emissions, comprising up to approximately 337 tCO_{2-e} (or 0.6%) of Scope 1 GHG emissions.

Table 3-1: Scope 1 GHG inventory

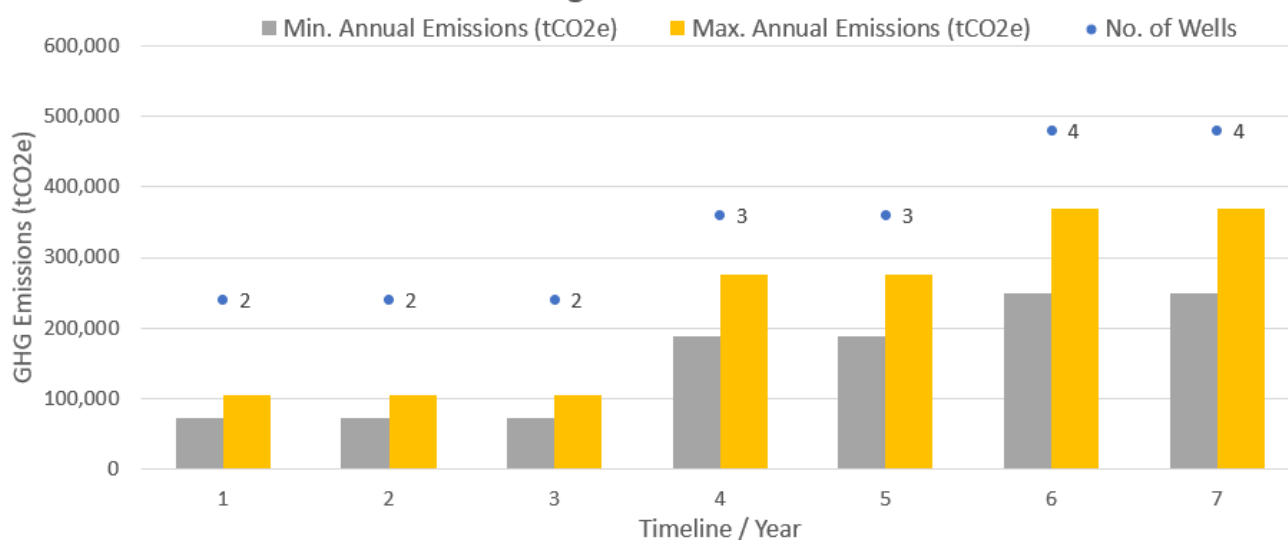
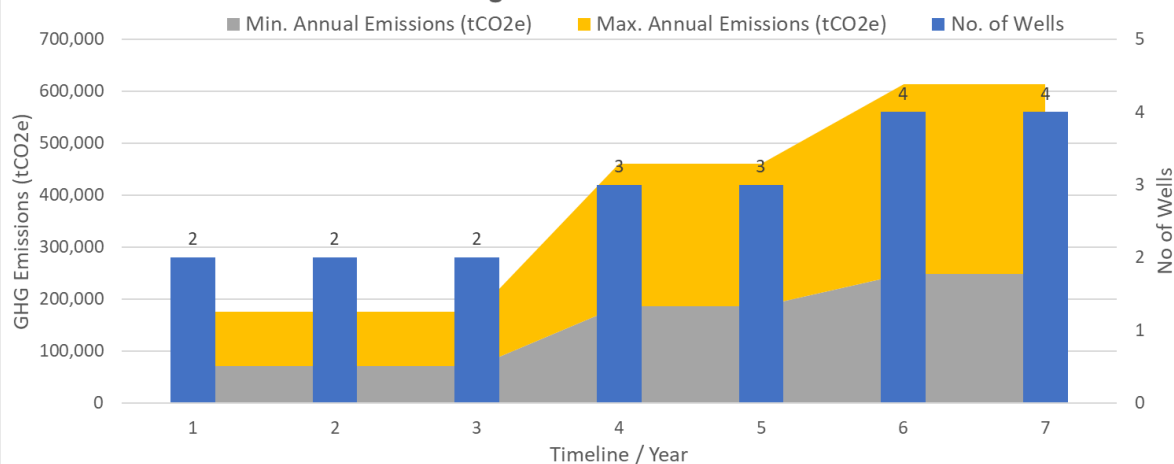
CO2 emissions per exploration and appraisal well	Input parameter	Phase I – 6 wells (tCO _{2-e})		Phase II – 14 wells (tCO _{2-e})		Calculation reference
		~60 days flaring	~90 ¹ days flaring	~60 days flaring	~90 days flaring	
Flare (per well)						
Gas	Phase I: 5.9 mmscf/d Phase II: 10.7 mmscf/d	29,747	44,620	53,948	80,921	NGER Guidelines (Government of Australia 2008) Section 3.44
Condensate	Phase I: 118 bbl/d Phase II: 214 bbl/d	2,760	4,140	5,005	7,507	NGER Guidelines (Government of Australia 2008) Section 3.52
Diesel usage (per well)						
Site preparation	20	54	54	54	54	NGER Guidelines (Government of Australia 2008) Section 2.41 with Table in Schedule 1 Part 3.
Drilling operations	316	857	857	857	857	
HFS operations	510	1,382	1,382	1,382	1,382	
Site reinstatement	20	54	54	54	54	
Transport (vehicles/rigs)	344	931	931	931	931	
Site power	8	15	22	15	22	

¹ BNR has estimated that to collect the required data, the well must be flowed during the period of maximum gas concentration for up to 90 days.



CO2 emissions per exploration and appraisal well	Input parameter	Phase I – 6 wells (tCO _{2-e})		Phase II – 14 wells (tCO _{2-e})		Calculation reference
		~60 days flaring	~90 ¹ days flaring	~60 days flaring	~90 days flaring	
Land clearing (per well)						
Land clearing emissions	5.1 ha per well 56.3 tCO ₂ -e/ha	287	287	287	287	FullCAM Model (Australian Government 2020)
Fugitive emissions (per well)						
Drill cuttings	Gas 0.12 tonnes	30	30	30	30	Based on volumes of drill cuttings and Valhalla gas saturation
Waste water	2 ML produced formation water	20	20	20	20	API GHG Emissions Methodologies for Oil and Gas (API 2009)
Total GHG emissions per well (tCO ₂ -e)		36,136	52,936	62,582	92,065	Scope 1 (direct emissions)
Total emissions exploration and appraisal program (tCO ₂ -e)	Phase I–6 wells Phase II–14 wells	216,814	314,378	876,144	1,288,915	Scope 1 (direct emissions)

To understand annualised emissions totals, an emission timeline has been developed for the Proposal. This is based upon the assumption that Phase I will take three years and Phase 2 will take an additional four years. Figure 3-1 provides annual GHG emission forecasts for the Proposal.

**Valhalla E & A Program Timeline #2 v Annual GHG Emissions****Valhalla E & A Program Timeline #2 v Annual GHG Emissions****Figure 3-1: Timeline for overall scope 1 GHG emissions of the Valhalla E&P Program**



3.1.2 Scope 2 emissions

As the Proposal does not intend to import power from third parties, no Scope 2 emissions are expected.

3.1.3 Scope 3 emissions

Although no Scope 3 emissions are expected, BNR is maintaining the possibility of selling condensate collected during the well test program to third parties as a recommended GHG mitigation measure. Through the implementation of this mitigation, BNR would avoid emissions associated with flaring of condensate during well testing. The quantity of Scope 3 emissions associated with the transportation and utilisation of condensate as a fuel was calculated on the basis that all condensate produced from the well tests for a maximum 90-day test period was captured and transported to Singapore via Wyndham where it was assumed to be processed and consumed. The Scope 3 emission inventory is provided as Table 3-2.

Table 3-2: Scope 3 GHG inventory

Scope 3 emissions per well	~60 days flaring	~90 days flaring
Condensate Volume (bbls)	222,240	333,360
Condensate Transport Emissions (tCO ₂ e)	13,952	20,928
Condensate Consumption Emissions (tCO ₂ e)	91,571	137,356
Total Scope 3 Emissions (tCO₂e)	105,523	158,284

3.2 GHG emissions benchmarking

As required under ESD Item 77, BNR completed an emissions benchmarking assessment to understand how the Proposal compares to other HFS projects. Specifically, BNR benchmarked the Proposal emissions against the following projects:

- Buru – Canning Basin – TGS14 Project
- Origin – Betaloo Basin – Valkerri Project
- Origin – Betaloo Basin – Kyalla Project
- Santos – McArthur Basin EP161 Project
- Imperial – McArthur Basin – Carpinteria 1.

In order to benchmark projects for their GHG emissions, typically, GHG emissions intensity values are calculated on a 'tCO₂e per tonne of product' basis for manufacturing projects or 'tCO₂e per kWh' basis for power generation projects such that project emissions can be compared. GHG emission intensities from gas exploration projects can be compared on both a 'per well per test day' and 'per well test' basis to benchmark the Proposal.

GHG emissions intensities on a 'per well per test day' basis for the Proposal is shown in Figure 3-2. The results indicate more emissions from the Valhalla well tests per day are expected due to the higher well test flow rates per day.

It should be noted that the Origin and Santos test programs are planned for a significantly longer period, up to 12 months compared to 2-3 months for the Valhalla Gas Exploration and Appraisal Proposal. Therefore, another comparison was made based on the planned minimum and maximum total emissions per well. Figure 3-3 provides planned total emissions per well. The results indicate that wells associated with Phase I of the Proposal are comparable with the permitted / planned total emissions of other projects in the Beetaloo Basin in the Northern Territory. Phase II wells from this Proposal are higher than the other projects due to their potentially higher flow test rates.

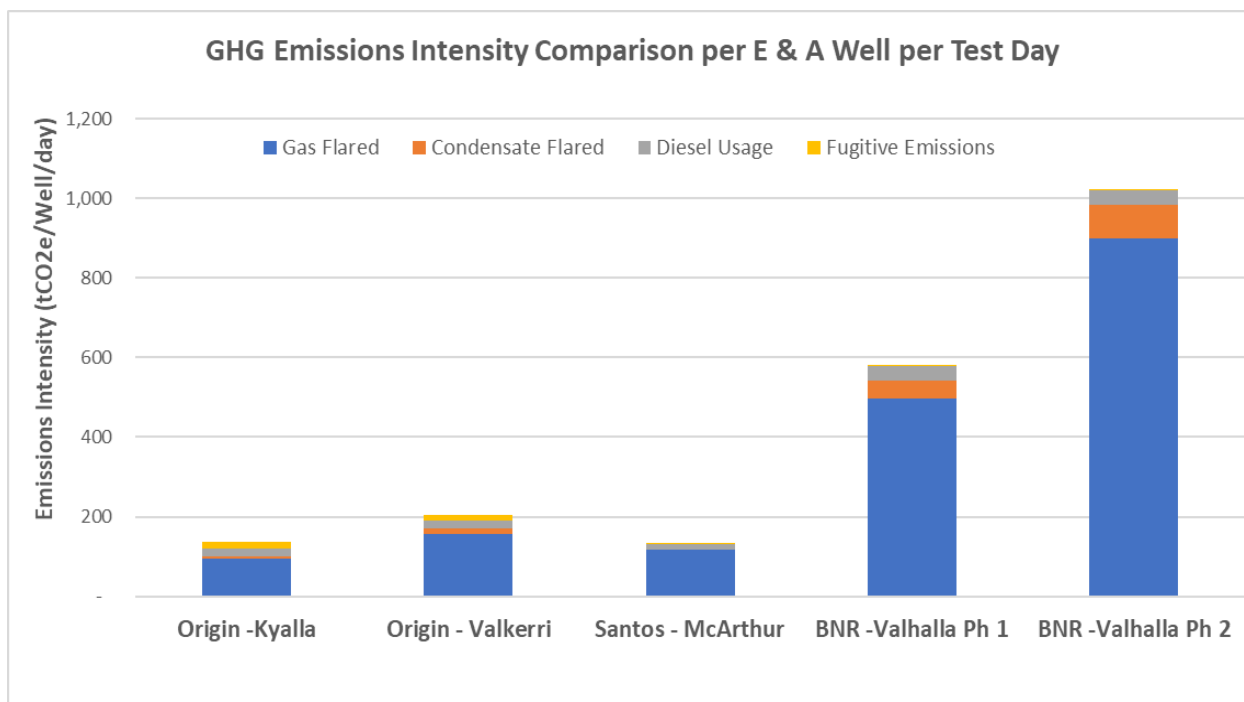


Figure 3-2: Benchmarking GHG emissions of the Valhalla Gas Exploration and Appraisal Program per well per test day

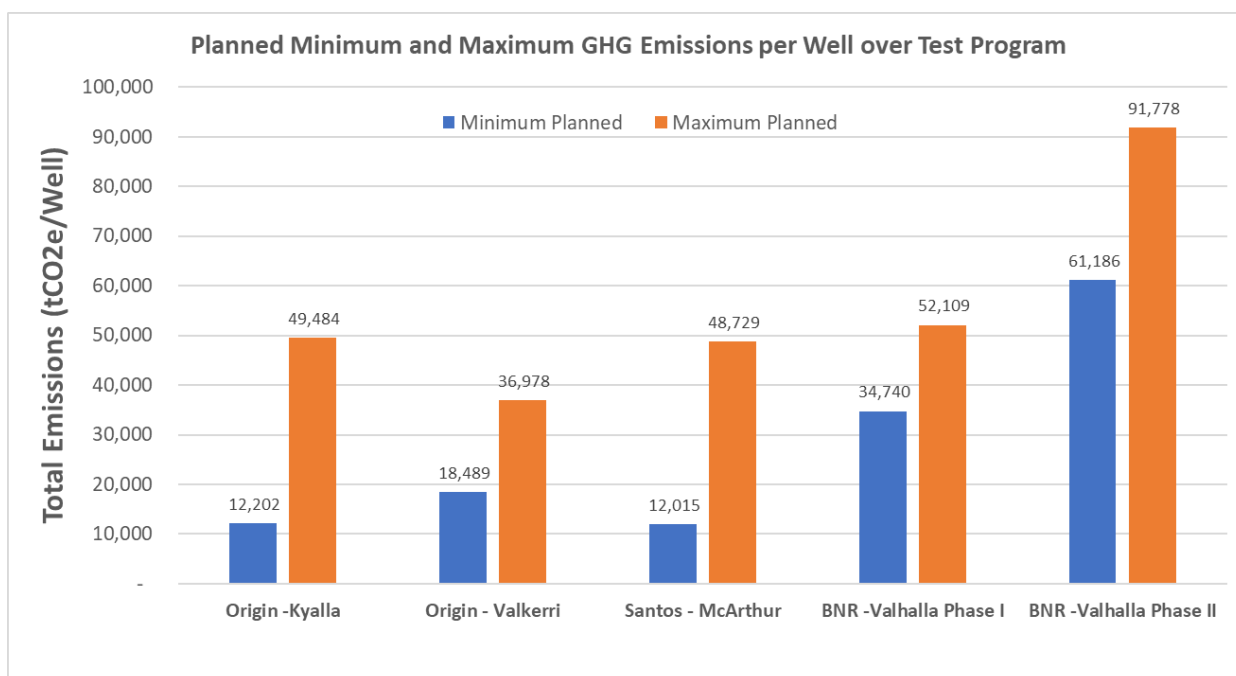


Figure 3-3: Benchmarking GHG emissions of the Valhalla Gas Exploration and Appraisal Program for planned total emissions per well



3.3 Trajectory of emissions reductions

BNR considers the use of an outcome based GHGEMP appropriate as GHG emissions can be, and are required to be, measured and/or quantified. Monitoring of GHG emissions will enable BNR to inform future field plans whilst demonstrating if interim and long-term environmental outcomes have been met. Given the nature of the Proposal which is limited to a seven-year exploration program, BNR plans to use the information gathered during this to inform GHG abatement opportunities for future field development.

In alignment with BNR's Climate Change Policy (Appendix A), the Western Australian Climate Policy (DWER 2020) and the requirements of ESD Item 78, the long-term environmental outcome for this GHGEMP is to avoid, reduce, or mitigate 100% of Scope 1 GHG emissions by 2050.

To support this long-term environmental outcome, the following interim outcome has been defined for this GHGEMP: to avoid, reduce, or mitigate 43%² of Scope 1 GHG emissions by the end of the year five (Figure 3-4).

On the basis that this GHGEMP will be reviewed on at least a five-yearly cycle (Section 7), the interim and long-term environmental outcomes are considered appropriate to meet BNR's and the State government's targets to achieve net zero emissions by 2050.

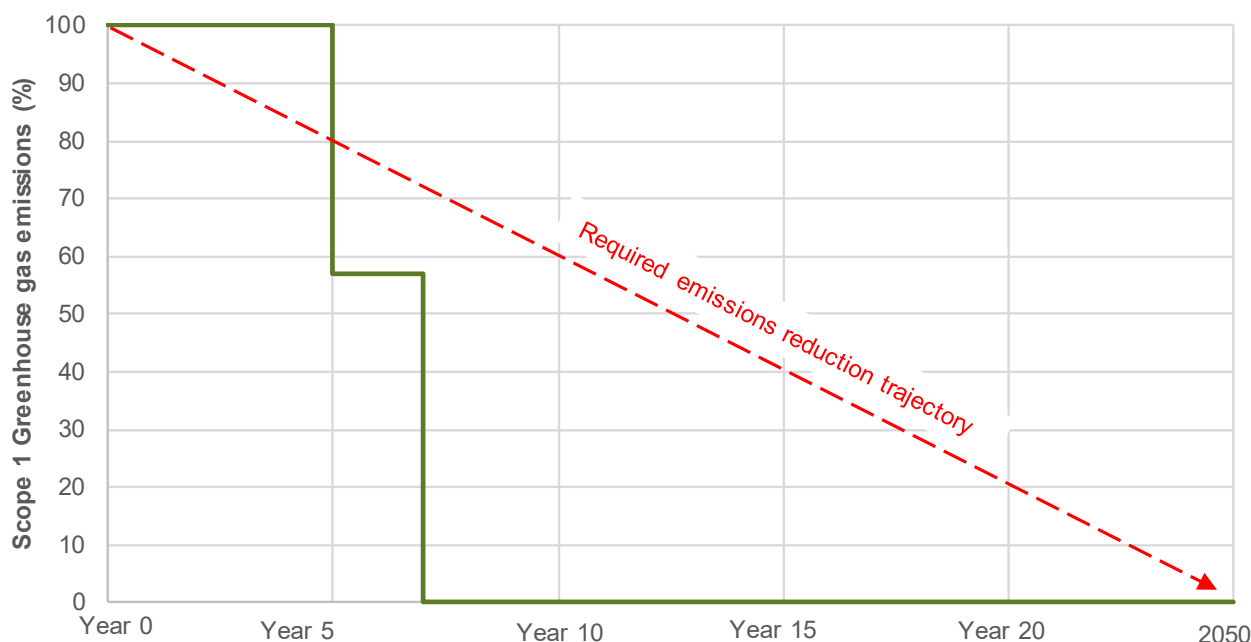


Figure 3-4: GHGEMP environmental outcomes for the Proposal

² Australia was a signatory to the Paris Agreement, which entered into force in 2016, and committed to reducing GHG emissions by 26–28% below 2005 levels by 2030. Subsequently, the Climate Change Bill, which passed the Senate in 2022, sets Australia's greenhouse gas emissions reduction targets at a 43% reduction by 2030 and net zero by 2050. Consequently, BNR has updated the interim GHG target with the emission reduction requirements set by the Climate Change Act.

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3.4 Mitigation measures adopted to avoid, reduce or offset scope 1 emissions

3.4.1 Consideration of the mitigation hierarchy

In line with the EPA's mitigation hierarchy for GHG emissions (avoid, reduce, or offset) (EPA 2021b), BNR has identified and assessed a range of emission mitigation opportunities. This assessment was facilitated by an independent GHG emissions consultant. The summary of the options and outcomes of the assessment are provided in Table 3-3.

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Table 3-3: Emission avoidance and reduction

Option	Description	Estimated tCO ₂ e mitigated for the Proposal	Mitigation hierarchy	Supporting details	Outcome
Well design – Horizontal vs Vertical	Single well pad vertical designs result in significantly more land clearing given the land required to install a single well is the same as that required for multiple wells. The use of efficient multi-well pad horizontal shale development results in a 50%-60% reduction in land use.	2,300 tCO ₂ e	Avoid	The Valhalla Exploration and Appraisal program utilises 10 well pads for drilling 20 wells, implementing an efficient multi-well drilling technique to minimise land clearing. The minimisation of land clearing reduces the impact associated with GHG emissions associated with the removal of vegetation. A total land cleared for the 20 well program is <110 ha of which 40 ha is associated with the well sites, therefore reducing overall land cleared by around 40%.	Selected
Flaring vs Venting	Gas flaring is carried out in accordance with Code of Practice requirements and as per US EPA 40 Code of Federal Regulations 63.11, with a flare tip combustion efficiency of 98%. Flaring converts methane to carbon dioxide and water, thus significantly reducing methane emissions. Carbon dioxide has a global warming potential 25 times lower than methane over a 100-year span, therefore the removal of methane is preferable.	10,000 tCO ₂ e	Avoid	Gas venting is avoided during the well completions and well tests and only permitted for operational or safety reasons. Two separate vertical stacks, one for flowback high pressure gas and a second low pressure flare to manage tank vapours (off storage tanks) would be used to ensure all methane at site is flared.	Selected
Selection of efficient diesel generators	The Tier 4 diesel engines have 90% lower NO _x and particulate matter emissions compared to Tier 3 engines and are fuel efficient resulting 15% GHG emissions reduction.	25,000 tCO ₂ e	Reduce	BNR will utilise the latest efficient units with highest emission standards for the Proposal. Specifically, these are currently industry best practice.	Selected
Condensate capture for sale or other use	The well test fluids during the exploration and appraisal program could be passed via a sand trap and 3-phase separator to remove water and condensate from the gas where the condensate could be stored and trucked out of site for sale to a refinery.	129,943 tCO ₂ e	Avoid	BNR is currently evaluating options for the sale of condensate produced from the well tests via Wyndham Port to Singapore, where Buru Energy already exports its oil.	Under consideration
Renewables (power generation)	The use of renewable energy such as solar photovoltaic (PV) for powering the drilling and HFS activities are impracticable because of	19,740 tCO ₂ e	Avoid	The solar PV power also needs to be supported with large batteries that can store energy to be supplied during the nights, therefore resulting in significantly higher costs. Furthermore, the rigs and HFS units need to be re-located to various sites	Not considered for use

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Option	Description	Estimated tCO ₂ e mitigated for the Proposal	Mitigation hierarchy	Supporting details	Outcome
	the finite period of drilling, and the requirement for continuous drilling.			during the drilling program which will make the use of renewable energy impracticable. A better alternative would be to use grid power, if available, for drilling, while the grid is supported by renewable power. The Canning Basin and Valhalla region do not have such a grid to support the project.	
Renewables (lighting towers)	The use of solar powered lighting units reduces the emissions associated with diesel powered towers.		Avoid	Solar powered lighting towers with battery backup are planned to be used in the project as shown along with other solar power based instrumentation and monitoring systems.	Selected
Gas capture for sale or other use	The Canning Basin does not have any gas infrastructure such that the flow test gas can be treated and sent to a gas pipeline for sale. Therefore, the only possibility would be to capture the gas as Compressed Natural Gas (CNG) or utilising micro Liquefied Natural Gas (LNG) facilities and supply it to energy users				
Compressed Natural Gas	The well test gas would be required to be dehydrated and compressed to around 250 bar to be stored in high pressure storage bullets which can then be used in gas engines for power generation in well test sites instead of diesel.	1,398,814 tCO ₂ e	Avoid	CNG can also be transported to power stations in Broome, Derby and other west Kimberley towns to replace LNG trucked from Karratha at present. CNG could also be used in dual-fuel engines for the drilling and HFS within the Valhalla Gas Exploration and Appraisal Program if equipment with suitable engine specifications is available locally. At present the sale of gas as CNG is considered unviable due the associated cost of capture, treatment and transportation to markets located far from the Valhalla field.	Not selected for use
Micro LNG	A relocatable micro LNG plant could also be used to capture the well head gas (as used in some US shale gas operations) if this equipment were available in the Australian market. The use of micro LNG option would require the well head gas to be pre-treated such that water, CO ₂ and freezable heavy hydrocarbons are removed from the gas to allow liquefaction of the gas.			LNG produced can be stored in transportable International Organization for Standardization containers and shipped to markets. Cryobox™ is a micro LNG technology, and other similar flare gas liquefaction technologies that provide relocatable pre-treatment units as used in the US shale gas industry. At present, the sale of LNG to local power stations is considered unviable with existing gas offtake contracts in place with power plant operations and the inability for the project proponents to commit to a fixed volume based on LNG supply contracts from the gas exploration and appraisal program.	Not selected for use

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3.4.2 Key assumptions and uncertainties

Table 3-4 details the key assumptions and uncertainties that BNR has identified with respect to the proposed approach to managing GHG emissions.

BNR has proposed environmental outcomes, and associated monitoring and response actions, in consideration of the current state of GHG policies and available technical advice. An adaptive management approach has been proposed that allows for changes to this GHGEMP if required in the future to remain aligned with contemporary policies and scientific advice.

Table 3-4: Assumptions and uncertainties

Assumptions and uncertainties	Comment
Emission estimates	As the Proposal is an exploration and appraisal project, the quantity of emissions estimates is based upon a historic understanding of the Laurel Formation in EP 371. The nature and quantity of emissions may differ to the estimations provided given the purpose of the Proposal is to further understand and evaluate the Laurel Formation.
State and Commonwealth GHG policies	State and Commonwealth government policies and targets continue to evolve.
Safeguard Mechanism	The scope of the proposal is limited to exploration activities. Development of a production facility is not within the scope of this proposal, however if the program is executed in accordance with the plan detailed in the Environmental Review Document [BNR_HSE_MP_014], the Proposal will emit more than 100,000 tonnes of carbon dioxide (CO ₂) equivalent in a year and subsequently be subject to the safeguard mechanism.
Market price carbon emissions	At this current time, there is no uniformly applied (i.e. on unit of carbon emitted) market price for carbon emissions (i.e. a carbon levy) within Australia.

3.5 Mitigation measures adopted to avoid, reduce or offset scope 2 emissions

This proposal will not produce scope 2 emissions, so mitigation measures are not required

3.6 Mitigation measures adopted to avoid, reduce or offset scope 3 emissions

Scope 3 emissions are not expected to be produced at this time. However, one of the mitigation measures being considered to reduce scope 1 emissions is to sell condensate through Wyndham to Singapore. This measure would produce more emissions overall (see Table 3 2, above), however would reduce scope 1 emissions. This project has no measures to mitigate scope 3 emissions other than a commitment to adopt best practice, should scope 3 emissions occur due to the sale of condensate.

3.7 Other statutory decision-making processes which require reduction in GHG emissions

The emissions reduction targets as specified in the Climate Change Bill have been considered and adopted within this GHGEMP.

3.8 Consistency with other GHG reduction tools

This GHGEMP is consistent with BNR's climate change policy.

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3.9 Offsets

3.10 Overview

Following the mitigation hierarchy, GHG emissions should preferentially be managed via avoidance or reduction measures. However, where further reductions are required, carbon offsets will be considered as a mitigation option. This may include both Australian and international carbon offsets.

BNR acknowledges that carbon offsets may be necessary to meet the environmental outcomes defined within this GHGEMP. Where and when required, BNR will acquire carbon offsets that meet the contemporary Australian acceptability standards (e.g., they should meet offset integrity principles and be based on clear, enforceable, and accountable methods).

At the time of writing, acceptable Australian carbon offsets may include:

- Australian Carbon Credit Units (ACCUs) issued under the Commonwealth Carbon Credits (Carbon Farming Initiative) Act 2011
- eligible offsets under the standard Climate Active Carbon Neutral Standard for Organisations (Climate Active 2020), in addition to ACCUs include:
 - verified emission reductions issued under the Gold Standard
 - verified carbon units issued under the Verified Carbon Standard
 - certified emissions reductions issued as per the rules of the Kyoto Protocol from Clean Development Mechanism projects
 - removal units issued by a Kyoto Protocol country on the basis of land use, land use change and forestry activities under Article 3.3 or Article 3.4 of the Kyoto Protocol.

Many offset projects also deliver social, economic, or environmental outcomes in addition to emission reductions (Climate Active 2019).

3.11 Preferred Offsets and Availability

In the event annual Scope 1 GHG emissions exceed 43 % of the estimated baseline emissions by the end of the 5th year of operations, the purchase of appropriate offsets will be undertaken to reach this outcome. Given the expected GHG emissions for phase one of the project are 52,936 tCO₂e per well, and for phase two 92,065 tCO₂e (Table 3-1), the expected maximum carbon offsets needed, after the fifth year of operations, would be 22,763 tCO₂e/well in phase one, and 39,588 tCO₂e/well in phase two.

BNR expects that ACCUs would be the offsets most likely to be applied to the Proposal, if required, and is confident that sufficient availability will exist. In 2023, 17.2 million ACCUs were issued by the Clean Energy Regulator, with at least 20 million ACCUs expected to be issued in 2024 (CER 2024).

The fastest growing types of ACCU projects are human induced regeneration (HIR) projects which more than doubled between 2022 and 2023, and reforestation projects which increased by 38% over the same period.

3.12 Projects operating beyond 2050

This proposal is expected to be completed within seven years of its commencement, so will not be in operation in 2050.

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4 Adaptive Management, Continuous Improvement and Review of the GHGEMP

A monitoring program (as described in Table 5-1 and Table 5-2, and in the Valhalla Monitoring Plan) is required to measure the effectiveness of the response actions as defined in this GHGEMP. The outcomes of the monitoring program will contribute to ongoing improvements in response actions to ensure an adaptive management approach is adopted.

BNR will implement an adaptive management framework that allows BNR to adapt and implement improvements as a result of monitoring against trigger and threshold criteria detailed in this document.

The following approaches will apply:

- monitoring data will be systematically evaluated
- the effectiveness and relevance of trigger level and threshold contingency actions will be evaluated to determine if any changes to response actions are required
- increased understanding of the hydrogeological regimes based on additional internal and external studies will be incorporated into the monitoring and management approach when newer relevant information becomes available where applicable.

Adaptive management practices that will be assessed as part of this approach may include:

- evaluation of the monitoring program, data and comparison to baseline data and reference sites on an annual basis to verify whether responses to project activities are the same or similar to predictions
- evaluation of assumptions and uncertainties of the management and monitoring program
- re-evaluation of the risk assessment and revision of risk-based priorities as a result of monitoring outcomes
- review of data and information gathered over the review period that has increased understanding of site environment in the context of the regional ecosystem
- assessment of changes which are outside the control of the project and the response actions identified.

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5 Reporting

This section of the GHG EMP identifies the legal provisions (components) that BNR will implement to ensure that the environmental outcomes are met during implementation of the Proposal.

In accordance with the guideline “Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans” (EPA 2021), this section identifies the indicators that will be used to measure performance and the monitoring that will be undertaken in relation to these indicators. It defines the response actions (trigger level and contingency actions) that will be undertaken if the indicators are exceeded.

Table 5-1 and Table 5-2 detail the components of this GHGEMP for each of the interim and long-term environmental outcomes.

BNR will report annually and will make reports publicly available on its website.

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Table 5-1: GHG EMP components – Interim 1 environmental outcome

EPA factor/s and objective/s	GHG Emissions – To reduce net GHG emissions to minimise the risk of environmental harm associated with climate change			
GHG EMP outcome/s	Interim 1: To avoid, reduce, or mitigate 28% of Scope 1 GHG emissions from the Proposal by the end of the 5th year of operations			
Key environmental values	Carbon budget			
Key impacts and risks	Contribution to Western Australia's GHG emissions, contribution to climate change and the risks to the environment from climate change			
Indicators	Response actions	Monitoring	Timing and Frequency	Reporting
Trigger criteria Annual Scope 1 GHG emissions from the Proposal are above the estimated baseline emissions: - Phase I (>52,936 tonne per well CO₂-e). - Phase II (>92,065 tonne per well CO₂-e).	Trigger level action If annual Scope 1 GHG emissions are above the estimated baseline emissions, then an investigation into the cause of the increased emissions will be undertaken and completed within the subsequent 12-month period and corrective actions implemented.	Indicator Scope 1 GHG emissions. Method GHG emissions will be monitored via various means including diesel inventories and flow meters.	- Diesel inventories will be maintained for all well sites on an annual basis. - Quantity of GHG associated with flaring activities will be monitored continuously. - Total Scope 1 GHG emissions will be calculated annually (based on financial year schedule) during operations.	Routine reporting – Annual Compliance Assessment Report to the DWER Compliance Branch Exceedance reporting to DWER Compliance Branch – exceedance of the threshold criteria and contingency actions that have been implemented – within 5 days.
Threshold criteria Annual Scope 1 GHG emissions from the Proposal are not 43% below the estimated baseline emissions by the end of the 5 th year of operations. - Phase I (>30,174 tonne per well CO₂-e). - Phase II (>52,477 tonne per well CO₂-e).	Threshold contingency actions If annual Scope 1 GHG emissions are not 43 % below the estimated baseline emissions by the end of the 5 th year of operations, then: - within the subsequent 6-month period, net emissions for the Proposal will be decreased by the purchase of appropriate offsets to reduce Scope 1 emissions to at or below 57% of the estimated baseline emissions - net emissions for the Proposal will be maintained at or below 57 % of the estimated baseline emissions (by reductions or offset purchases) until the Proposal is complete.			

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Table 5-2: GHG EMP components – Long-term environmental outcome

EPA factor/s and objective/s	GHG Emissions – To reduce net GHG emissions to minimise the risk of environmental harm associated with climate change			
GHG EMP outcome/s	Long-term: To avoid, reduce, or mitigate 100% of Scope 1 GHG emissions from the Proposal by 2050			
Key environmental values	Carbon budget			
Key impacts and risks	Contribution to Western Australia's GHG emissions, contribution to climate change and the risks to the environment from climate change			
Indicators	Response actions	Monitoring	Timing and Frequency	Reporting
Threshold criteria Annual Scope 1 GHG emissions from the Proposal are not 43% below the estimated baseline emissions by the end of the 5th year of operations. - Phase I (>30,174 tonne per well CO₂-e). - Phase II (>52,477 tonne per well CO₂-e). Methane levels above the detection limit (i.e. the laboratory LOR) of 3.3 mg/m³ following the completion of the Proposal.	Threshold contingency actions If annual Scope 1 GHG emissions are not 100 % below the estimated baseline emissions by FY 2050 of operations, then: - within the subsequent 6-month period, net emissions for the Proposal will be decreased by the purchase of appropriate offsets to reduce Scope 1 emissions to at or below 0 tpa CO₂-e - net emissions for the Proposal will be maintained at 0 tpa CO₂-e (by reductions or offset purchases) for the life of the Proposal. If methane levels above the detection limit (i.e. the laboratory LOR) of 3.3 mg/m³ are recorded following the completion of the Proposal, implementation of contingency measures will occur within 30 days of the exceedance including: - identify the reason for the exceedance and determine direct correlation to well site fugitive gas emissions, existing land use, or natural variation and review management measures with an adaptive management response - re-examine monitoring results (QA/QC) to validate data. - where the exceedance was not caused by the assets, no further action required - where the threshold exceedance can be attributed to the assets, implement adaptive management response that may include investigating assets to confirm if gas leakage is occurring and determine how leakage can be remediated, remediate assets to prevent further gas leakage and fugitive emissions, continue sampling/monitoring post remediation until at least two consecutive results reflect no significant deviation from ambient (baseline) samples.	Indicator Scope 1 GHG emissions. Methane emissions Method GHG emissions will be monitored via various means including diesel inventories and flow meters. In accordance with the Valhalla Monitoring Program, methane levels will be sampled at each well site using 24-hour air canisters. The location of methane emission monitoring will be based upon the location of the potential fugitive methane emissions arising post-activity.	- Diesel inventories will be maintained for all well sites on an annual basis. - Quantity of GHG associated with flaring activities will be monitored continuously. - Total Scope 1 GHG emissions will be calculated annually (based on financial year schedule) during operations. - Biennial methane sampling (pre-impact and post activity) at each well	Routine reporting – Annual Compliance Assessment Report to the DWER Compliance Branch

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6 Stakeholder consultation

Consistent with the EPA's expectations for this GHGEMP to align with the principles of environmental impact assessment, BNR consulted with stakeholders during the development of the EPA referral. Engagements relevant to this GHGEMP are presented below in Table 6-1.

Table 6-1: Stakeholder engagement relevant to this GHGEMP

Stakeholder	Method of engagement	Date of engagement	Summary of engagement
EPA	Meeting	24 Nov 2021	Discussed the Environmental Management Plan (EMP) guidelines and new structure.
EPA	Email correspondence	8 May 2024	GHG EMP guidelines and new structure
EPA	Response to Public Submissions	7 February 2025	Valhalla Exploration Drilling Response to Public Submissions – EPA Assessment No. 2281
EPA	Letter - Response to EPA Comments on Submissions	16 April 2025	Valhalla Exploration Drilling Response EPA comments on Response to Submissions – EPA Assessment No. 2281

For a full summary of stakeholder engagement records refer to the BNR Environmental Review Document (BNR_HSE_MP_013).

Any additional consultation regarding this GHGEMP will be captured in subsequent revisions.



7 Changes to GHGEMP

This GHGEMP is intended to be dynamic and may be updated to reflect changes in management practices and the natural environment over time. It will be reviewed on a five-yearly cycle. This approach will allow flexibility to adopt new approaches / management measures. The effectiveness and relevance of trigger level and threshold contingency actions will be evaluated on an annual basis, and any amendments to response actions will be completed on an as-needed basis. This will include:

- amendment of response actions that are not achieving the desired outcomes
- monitoring that identifies additional impacts requiring additional response actions or changes to existing response actions
- changes to relevant legislation that may affect the implementation of response actions
- improvements to management practices to achieve a greater environmental outcome
- updates to trigger and threshold criteria following the completion of baseline sample collection prior to commencing any groundwater extraction.

Specifically, a table summarising the changes following the template provided as Table 7-1 will be developed. This table will clearly indicate location and reason/s for changes. A tracked change version of the revised GHGEMP will be provided for all minor, non-structural changes to the document.

Table 7-1: GHGEMP review template

Complexity of changes	Minor revisions ☐	Moderate revisions ☐	Major revisions ☐		
Date revision submitted to EPA	DD/MM/YYYY				
Is the change proposed to be implemented under condition C3-3? If so, the proponent must provide a copy to the CEO at least 20 days before commencing implementation	Yes ☐		No ☐		
Proponent's operational requirement timeframe for approval of revision	< One Month ☐	< Six Months ☐	> Six Months ☐		
Reason for Timeframe	None ☐				
Item number	GHGEMP section number	GHGEMP page number	Summary of change	Reason for change	New or increased adverse impacts to the environment? Risk to the achievement of limits, outcomes or objectives?
1.					
2.					
3.					



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Western Australian Government. 2020. *Western Australian Climate Policy, a plan to position Western Australia for a prosperous and resilient low-carbon future.*

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Appendix A BNR Climate Change Policy

CLIMATE CHANGE POLICY

Black Mountain Exploration (BME) is committed to achieve the best possible balance between economic development and protection of the environment.

BME acknowledges the scientific consensus on climate change and the diverse effects that climate change may have on its customers, businesses, the economy and the communities in which it operates.

BME recognises that business has an important role to play in addressing climate change, and that its actions may deliver economic, social and environmental benefits over the long term. BME is committed to proactively managing the risks and to realising business opportunities associated with climate change. This policy applies to all BME activities.

BME will achieve net zero by 2050 by:

- Identifying opportunities to reduce Scope 1, 2 and 3 emissions through investments in research and technology, alternate energy sources, transport efficiency and process optimisation;
- Identifying and prioritising opportunities to leverage existing proven technology in renewable energy to reduce carbon emissions from power consumption;
- Exploring opportunities to minimise our consumption and contribution to waste;
- Adopting technology improvements as they become available and reasonably practicable to apply;
- Continuing to assess the acquisition or development of projects that have the potential to contribute to decarbonisation locally and globally (including offsets);
- Wherever possible and practicable, driving BME's emissions per unit of production below the mean of comparable peers;
- Being an active participant in various industry working groups; and
- Ensuring adequate resources are available to implement this policy including developing a broad ranging education and awareness campaign for our workforce and developing measures that will help guide our progress.

BME will strive to protect the environment and create sustainable businesses for future generations.

It is the responsibility of all employees, contractors and suppliers to comply with the requirements of this policy.

It is the responsibility of managers and supervisors to ensure this policy is implemented, reinforced and maintained through active leadership.

 BENNETT RESOURCES	Document No:	BNR_HSE_MP_014
	Revision:	6
	Issue Date:	27 May 2025

Appendix B GHG Inventory Methodology



VALHALLA GAS EXPLORATION PROGRAM GHG MANAGEMENT REPORT

REPORT PREPARED TO SUPPORT ENVIRONMENTAL REVIEW DOCUMENT WA EPA

NIM GNANENDRAN, PH.D.
NIMBLENG ENERGY CONSULTANTS
Perth, Western Australia.

JULY 23, 2021

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Executive Summary

The Valhalla Gas Exploration and Appraisal Program (Proposal) was referred to the EPA by Bennett Resources (BNR) under section 38 of the WA Environmental Protection Act 1986 (EP Act) on 24 December 2020. The EPA determined that the Proposal should be assessed under Part IV of the EP Act at the level of assessment of Public Environmental Review on 3 February 2021.

As part of the review the EPA has provided a draft Environmental Scoping Document that requires the Proposal EIA documentations to include detailed estimates of greenhouse gas emissions (Scope 1, Scope 2 and Scope 3), a benchmarking exercise comparing emissions from the Proposal to other similar exploration and appraisal projects, along with a GHG emissions reduction assessment for the Proposal. NimblEng Energy Consultants were contracted by BNR to complete these tasks such that it can form part of the GHG Management Program for the EPA submission. The GHG emissions estimations were carried out based on updated Proposal information. The key changes compared to the 2020 Referral relates to the following which has led to a marked increase in GHG emissions:

- introducing options to the time period for the two proposed phases, with Phase I consisting of 6 wells drilled over 1-3 years and Phase II consisting of 14 wells drilled over 2-4 years;
- the proposed Well Test rate was increased from 2.5 mmscf/d to 5.9 mmscf/d for the Phase I wells and 10.7 mmscf/d for Phase II for the test period of 60-90 days per well;
- the condensate production was estimated based on condensate to gas ratio of 20 bbls/mmscf resulting in 118 bbl/d in Phase I and 214 bbl/d in Phase II during well testing.

Direct GHG emissions sources from the Proposal (Scope 1) were categorized into the following:

- Land clearing;
- Diesel fuel usage;
- Fugitive emissions; and
- Well Test gas flaring.

GHG emissions from each category was estimated based on accepted methodologies used by the WA EPA and EPA NT for exploration and appraisal projects involving hydraulic fracture stimulation (HFS). The GHG emissions were calculated based on a per well, per day rate and then total emissions were estimated based on the minimum and maximum number of Well Test days. The variable nature of drilling campaigns in an exploration and appraisal program does not allow the project proponents to commit to fixed annual emission rates rather, provide a range of estimated emissions based on the drilling program envisaged. The success of the Phase I program is key to the continuation of the Phase II drilling campaign. Therefore, annual emissions estimates are provided as a 3-year program (Timeline #1) and a 7-year program (Timeline #2) with the minimum and maximum emission each year. The total GHG emissions range from 1,082,000 to 1,592,600 tCO₂e over the 20-well exploration and appraisal program.

A benchmarking exercise comparing direct emissions from the Valhalla Proposal along with three recently approved HFS based exploration projects in the NT was carried out. The results indicate the total emissions from these projects are comparable with Phase I of the Valhalla project, but Phase II emissions remained high due to the higher well test rates planned for the Valhalla Proposal.

GHG Emissions Reduction Assessment for the Proposal was based on number of RECs (Reduced Emissions Completions) proposed by the WA Scientific Inquiry into Fracking and the Code of Conduct in NT. The key focus of the emissions reduction relates to the capture and utilisation of the well test gas and condensate produced. The project proponents are currently evaluating options to export the condensate from the drilling program and capture part of the gas and utilise it in dual fuel engines on site to power the drilling and HFS operations.

In line with meeting the state NetZero 2050 target, the WA EPA has set a NetZero emissions trajectory to reduce or offset emissions on a year-on-year basis for new projects with annual emission of more than 100,000 tCO₂e. This report provides a quantitative estimate of GHG emissions that could be considered as above the NetZero 2050 trajectory for the Proposal that would be required to be offset by the proponents. Depending on how the EPA would assess the Valhalla exploration and appraisal program, the Proposal may or may not be required to offset carbon emissions due to the exploratory nature of the Proposal.

1 Background

The Valhalla Gas Exploration and Appraisal Program (Proposal) is located approximately 51 km Northwest of the townsite of Fitzroy Crossing (Shire of Derby-West Kimberley) in the Canning Basin Region in the State of Western Australia. It is located within the Petroleum Lease EP 371. Bennett Resources wholly owns the exploration lease which encompasses the proposed Valhalla Gas Exploration and Appraisal Program in its entirety[1].

The Proposal is to complete an unconventional gas exploration and appraisal drilling and Hydraulic Fracture Stimulation (HFS) program within Petroleum Exploration Permit EP 371 (EP 371). The Proposal includes the construction of up to 20 exploration wells within 10 well sites and is expected to commence in 2023 or 2024. The exploration program will be carried out in two phases where 6 wells will be drilled in the initial phase and based on the results the next 14 wells will be drilled in the second phase of the program.

On 24 December 2020, the Proposal was referred to the Environmental Protection Authority (EPA) under Section 38 of the Environmental Protection Act 1986. The Chairman of the EPA determined that the Proposal was required to be assessed via a Public Environmental Review. Subsequently, the EPA Services drafted an Environmental Scoping Document (ESD), which is yet to be finalised. The draft ESD provides details on the requirements to conduct GHG estimates (scopes 1, 2 & 3) and an Emissions Reduction Assessment for the Proposal. The assessment will inform (and be presented in) the Valhalla Environment Review Document (ERD) and GHG Management Plan (GHGMP).

1.1 Study Objective

The aim of this study is to provide a Greenhouse Gas emission estimate review and emissions reduction assessment for the Valhalla Gas Exploration and Appraisal Program. The study will address the following:

- Review of the GHG estimates already presented in the document “Valhalla Gas Exploration and Appraisal Program Section 38 Referral – Supporting Information Document” (BNR_ENV_RE_002), Section 6.3. Provide advice in regard to the adequacy of the estimates (including calculation methodology) and suggest any required updates to the estimates.
- Undertake a benchmarking exercise to compare GHG emission estimates against other HFS exploration projects.
- Conduct an Emissions Reduction Assessment with the intention of identifying options that the Company could implement to mitigate GHG Emissions to ALARP.

Further to the above the study will address EPA’s Environmental Scoping Document requirements,

Item No.	EPA ESD Requirement
74	Provide credible estimates of scope 1, scope 2 and scope 3 greenhouse gas emissions (annual and total) in tonnes of carbon dioxide equivalent (CO ₂ -e) over the life of the proposal. Detail methods used to estimate emissions.
75	Provide a breakdown of estimated scope 1 and scope 2 greenhouse gas emissions in tonnes of CO ₂ -e by all sources. Consider all proposed activities in determining the sources of emissions (e.g. clearing of land, site preparations, drilling operations,

	hydraulic fracture stimulation operations including flaring, potential leakage etc).
76	Provide calculations and calculation methodology for determining estimated emissions of CO2-e for all sources.
77	Benchmark the proposal's emissions against other hydraulic fracture stimulation exploration projects. Information which supports that the identified projects are comparable to the proposal should be included.
78	Provide a greenhouse gas management plan, in accordance with EPA guidance, which demonstrates the proposal's trajectory towards net zero emissions by 2050. The plan should include at a minimum: a) information required by 74 to 77 above. b) a graph and table showing regular targets reflecting an incremental reduction in emissions towards net zero emissions by 2050. Where the proposed emissions reduction targets do not demonstrate a trajectory towards net zero by 2050, articulate clearly a compelling reason why it is not possible to achieve this. c) mitigation (avoidance, reduction, offset) measures to be implemented with associated timeframes and evidence to demonstrate that the interim and long-term targets will be met. Where it is proposed that, following implementation of the avoidance and reduction measures, authorised offsets will be applied to meet the targets, evidence which supports that the mitigation measures are capable of achieving the stated targets is not required. d) Analysis of other potential abatement measures (e.g. renewables) relevant to the proposal that are not proposed to be implemented which provides the rationale to support that these measures are unable to be implemented. e) reporting requirements for publicly and periodically reporting against the stated targets.

1.2 Project Location

Access to the Proposal area is via the Great Northern Highway and Calwynyardah-Noonkanbah Road from the township of Fitzroy Crossing. A map of the Proposal area is provided in Figure 1-1.

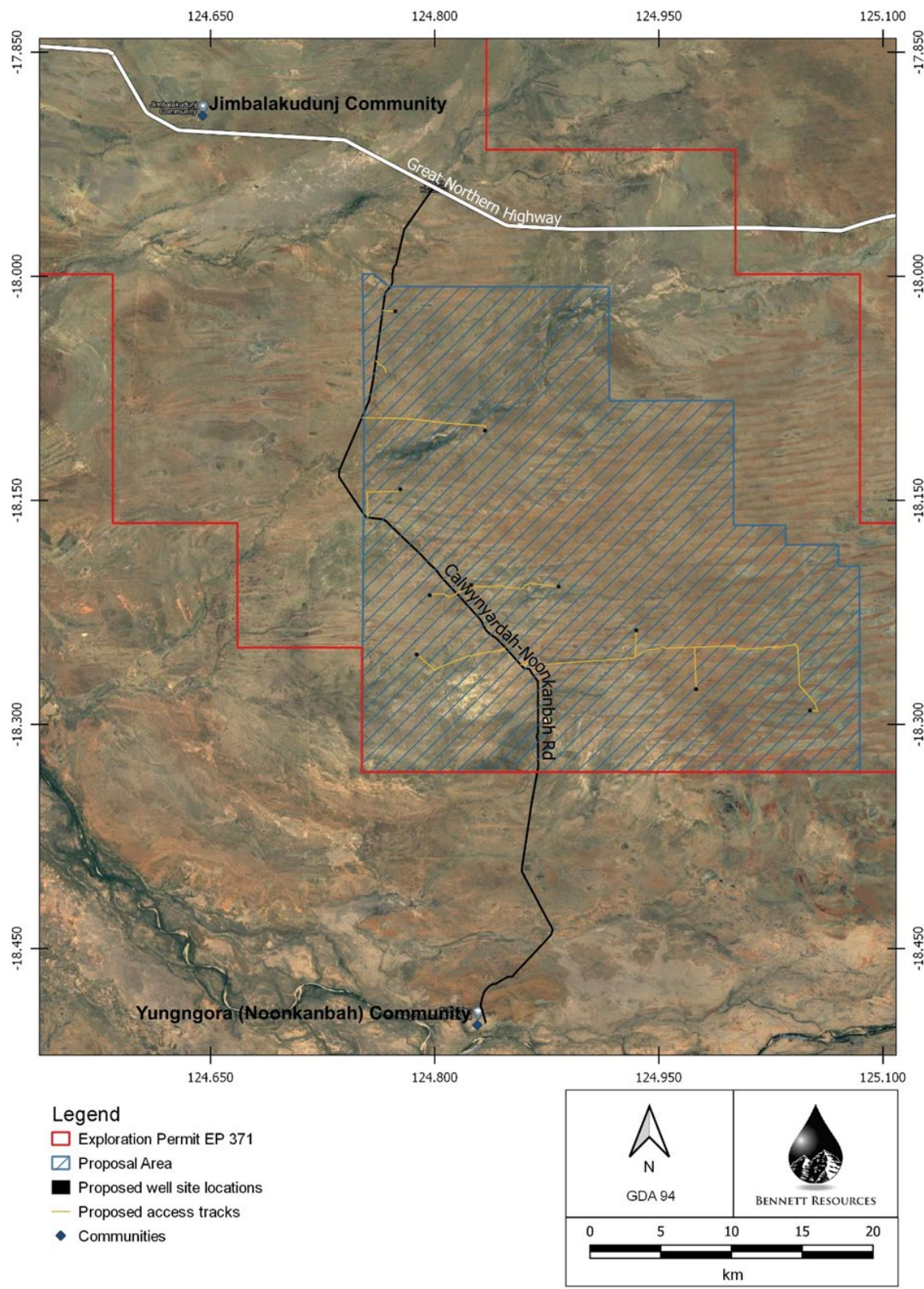


Figure 1-1: Valhalla Project Location

1.3 EPA Technical Guidance on GHG Mitigation

The WA EPA have provided a technical guidance for GHG emissions which is periodically updated from time to time for new or expanding operations with a GHG mitigation hierarchy of *avoid, reduce and offset*[2]. The Australian Government’s principal mitigation initiative is currently the Emissions Reduction Fund (ERF) and the associated safeguard mechanism. The safeguard mechanism applies to facilities with direct emissions (scope 1) in excess of 100,000 tonnes CO₂e per annum and requires liable entities to keep emissions at or below a predetermined (historical or calculated) emissions baseline. The EPA’s objective is to ensure that the mitigation hierarchy is applied such that greenhouse gas emissions from proposals are avoided or reduced, and residual emissions offset, in the planning, design and operational stages. The Valhalla Gas Exploration and Appraisal Drilling Program will abide by the EPA guidelines to reduce GHG emissions according to the mitigation hierarchy during the project lifecycle.

1.4 Project Assumptions

The following GHG Emissions estimates in Table 1-1 was provided by BNR as part of the Valhalla E & A Program EPA referral submission. As noted in the table significant part of the emissions are associated with the flaring of the well test gas during the appraisal period.

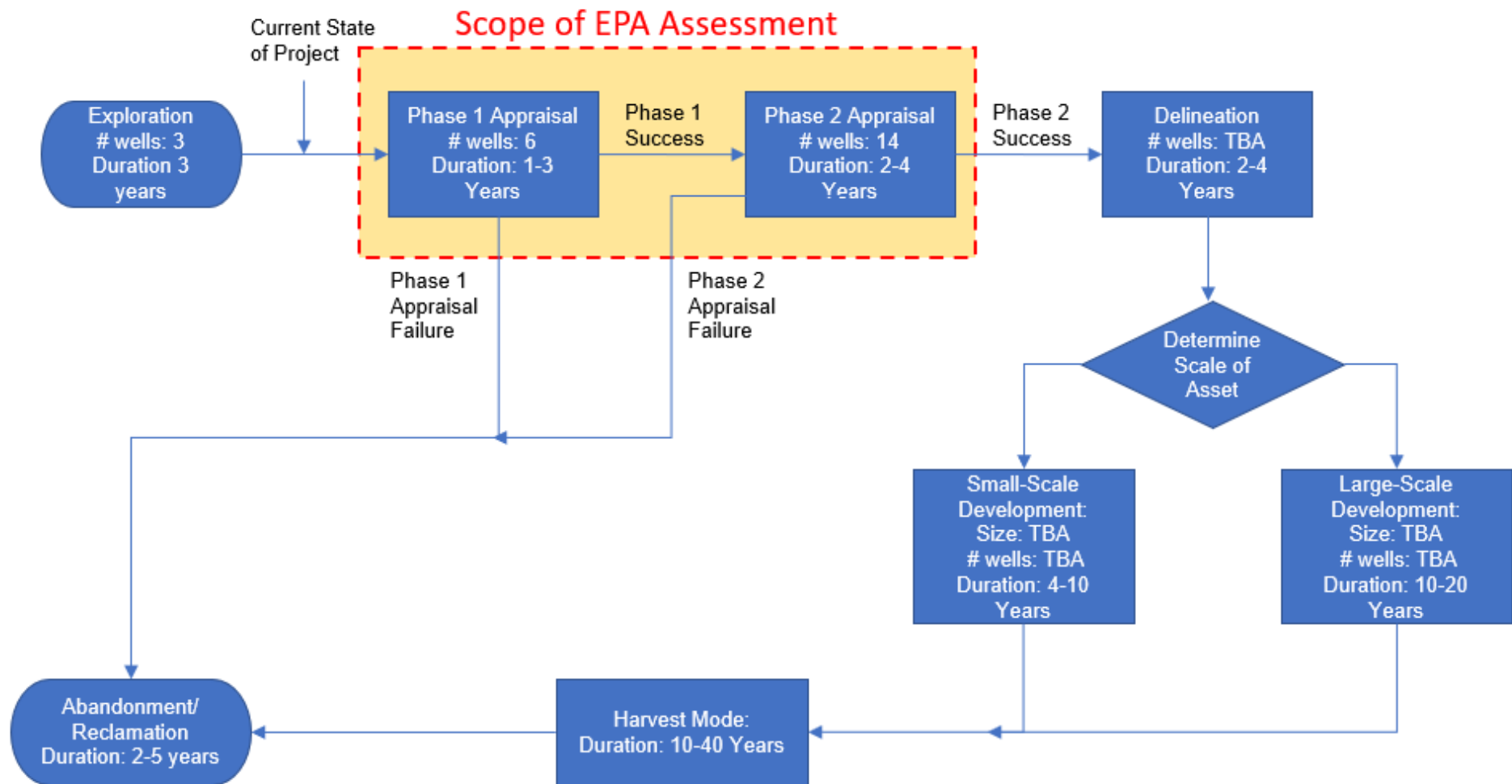
Table 6-9: Scope 1 GHG calculations per well

Activities	Emission source	Volume estimates (per well)	Total Scope 1 emissions per well (t CO ₂ -e)
Site preparation operations	Combustion emissions from diesel	20 m ³	54
Drilling operations	Combustion emissions from diesel during mobilisation	10 m ³	27
	Combustion emissions from diesel during Drilling operations	379 m ³	1,023
HFS operations	Combustion emissions from diesel during mobilisation	20 m ³	54
	Combustion emissions from diesel during HFS operations	300 m ³	809
	CH ₄ emissions during well testing	Gas Flow rate	Period of Flaring
~2.5 MMCFGPD		~90 days	
Site reinstatement	Combustion emissions from diesel	20 m ³	54
Total			17,021 t CO ₂ -e

Table 1-1: Current EPA Referral Submission for Valhalla E & A Program

During the period of GHG emissions evaluation, BNR advised the following key changes, which formed the basis of this study.

- (1) A Well test gas flow Rate 5.9 mmscf/d will be required to evaluate the 6 Wells from Phase I.
- (2) A Well test gas flow Rate 10.7 mmscf/d will be required to evaluate the 14 Wells from Phase II.
- (3) A condensate to gas ratio (CGR) of 20 bbl/mmscf was assumed for the Valhalla reservoirs.
- (4) A minimum test period of 60 days and maximum test period of 90 days is required per well.
- (5) The following Road Map was provided for Valhalla Gas development:



2 Review of GHG Emission Estimates

Based on the proposed activities associated with the Valhalla gas exploration and appraisal drilling program greenhouse gas emissions were estimated based on four activities as listed below,

- (1) Land Clearing.
- (2) Diesel Fuel Emissions.
- (3) Fugitive Emissions.
- (4) Well Testing Flaring.

These activities are directly associated with the operation of the proponent and are deemed as Scope 1 emissions. Indirect emissions associated with the Valhalla Exploration and Appraisal Drilling/HFS Operations Program is considered as Scope 2 emissions, such activities may include importation of power or other offsite energy supply activities related to the project. Scope 3 emissions are associated with all other indirect emission such as export of products from the project. The Valhalla Gas E & A program, at present, does not have the necessary infrastructure nor a market to export the gas or condensate from the project and intends to flare these hydrocarbons on site. Therefore, as a base case, no Scope 3 emissions are expected from the project. At present BNR is evaluating the possibility of selling the condensate after completing the initial appraisal wells and establishing a better understanding of the condensate volumes. Therefore, for completeness of this report Scope 3 emissions from condensate sale are also provided.

2.1 Land Clearing

The estimated land cleared for the 10 well sites (with 2 wells per site), access tracks and camp sites are tabulated below.

Land area	ha
Well Sites	40.1
Access Tracks	59.1
Camp Sites	2.8
Total	102

Table 2-1: Valhalla Exploration and Appraisal Drilling Program land clearing estimate

Forests, bushlands, grasslands and other vegetation, known as carbon sinks, remove carbon dioxide from the atmosphere. When such carbon sinks are cleared for industrial activity the associated loss of carbon sinks are counted as part of the greenhouse gas emissions estimate of the project. The Full Carbon Accounting Model (FullCAM) is a calculation tool for modelling Australia's GHG emissions from the land sector[3]. FullCAM is used in Australian National Greenhouse Gas Accounts for the land use change and forestry sectors. The FullCAM model estimates carbon stock change in ecosystems by considering above and below ground biomass, standing and decomposing debris and soil carbon resulting from land use activities. The latest version of the FullCAM model published in September 2020 was used for this estimate. Based on the spatial data input for the site location (Lat -18° N, Long 124° E), the following carbon mass estimate for calculated from the FullCAM model.

Component	(tC/ha)
Carbon mass of trees	16.4
Carbon mass of debris	13.9
Carbon mass of soil	25.9
Total Carbon mass on-site	56.3

Table 2-2: Site Carbon Mass Estimate

Based on the total land area cleared the total carbon emissions associated with land clearing is 5744 tCO₂e and the average per well carbon emissions for the 20 well program is estimated as 287 tCO₂e/well.

2.2 Diesel Fuel Emissions

The exploration and appraisal drilling program will involve several activities such as, site preparation, mobilisation of the drilling rig(s), drilling and completion of the exploration wells, mobilisation of the hydraulic fracturing rigs, hydraulic fracturing operations, testing of the wells, camp setup and operations of the camp during the drilling programs, transport of the workforce to and from site, and after the drilling activities are complete the reinstatement of the site. These activities are expected to be powered using diesel fuel for vehicle and in diesel engines. The following table provides an estimate of diesel fuel usage for these activities,

Per Well Data	Volume, KL
Site Preparation	20
Drilling Operations	316
HFS Operations	510
Site Reinstatement	20
Transport	344
Camp Site	8
Total	1218

Table 2-3: Diesel Fuel Usage per Well

The emissions from diesel fuel usage is estimated from National Greenhouse and Emissions Reporting (Measurement) Determination (2008) as updated in July 2020 and made under subsection 10(3) of the National Greenhouse and Energy Reporting Act 2007 [4]. Section 2.41 Method 1 of the NGER along with Fuel combustion emissions factors in Schedule 1 Part 3 for diesel fuel energy content factor and GHG emission factors as shown below,

Fuel	Energy Content	Emissions Factors (kgCO ₂ e/GJ)		
	(GJ/ KLit)	CO ₂	CH ₄	N ₂ O
Diesel	38.6	69.9	0.1	0.2

Table 2-4: NGER Emission Factors for Diesel Emissions

Based on the above emission factors average carbon emissions from diesel fuel usage per well was estimated as 3,300 tCO₂e/Well.

2.3 Fugitive Emissions

Fugitive emissions include gas lost directly to atmosphere through uncontrolled sources during the drilling and HFS operations. The American Petroleum Institute produced a Compendium of greenhouse gas emission methodologies for the oil and natural gas industry[5]. Several methodologies used here are based on US EPA GHG estimation tables and has been also used by proponents who have filed their application for HFS projects in the Northern Territory under their new Code of Practice. The following sources were considered the main fugitive emissions sources as part of the greenhouse gas management program,

- (i) Well completions: Completing new gas wells involves producing the fluids at a high rate to lift the excess sand to the surface and clear the well bore and formation to increase gas flow. Typically, the gas/liquid separator installed for normal well flow is not designed

for these high liquid flow rates and three-phase (gas, liquid, and sand) flow. Therefore, a common practice for this initial well completion step has been to produce the well to a pit or tanks where water, hydrocarbon liquids, and sand are captured, and slugs of gas vented to the atmosphere or flared. Completions can take anywhere from several hours to several weeks, during which time a substantial amount of gas may be released to the atmosphere or flared. Based on the following table from API compendium 25.9 tonnes/completion day of fugitive emissions was assumed.

Table 5-23. Production Segment CH₄ Emission Factors for Maintenance and Turnaround Activities

Source	CH ₄ Emission Factor ^a , Original Units	CH ₄ Emission Factor ^b , Converted to Tonnes Basis	CH ₄ Content Basis of Factor ^c	Uncertainty ^d (±%)
Vessel blowdowns	78 scfy/vessel	0.0015 tonnes/vessel-yr	78.8 mole %	326
Compressor starts ^e	8,443 scfy/compressor	0.1620 tonnes/compressor-yr	78.8 mole %	190
Compressor blowdowns	3,774 scfy/compressor	0.07239 tonnes/compressor-yr	78.8 mole %	179
Gas well workovers ^f (tubing maintenance)	2,454 scf/workover	0.04707 tonnes/workover	Not given	924
Oil well workovers ^f (tubing maintenance)	96 scf/workover	0.0018 tonnes/workover	Not given	Not available
Gathering gas pipeline blowdowns	309 scfy/mile	0.00593 tonnes/mile-yr 0.00368 tonne/km-yr	78.8 mole %	39.5
Onshore gas well completion ^g	1,712×10 ³ scf/completion-day	25.9 tonne/completion-day	78.8 mole %	Not available
Offshore gas well completion ^g	~8,700×10 ³ scf/completion-day	131.5 tonne/completion-day	78.8 mole %	Not available
Oil pump stations (maintenance) ^h	1.56 lb/yr-station	7.076E-04 tonnes/station-yr	Not given	Not available

Footnotes and Sources:

^a Shires, T.M. *Methane Emissions from the Natural Gas Industry, Volume 7: Blow and Purge Activities, Final Report*, GRI-94/0257.24 and EPA-600/R-96-080g, Gas Research Institute and U.S. Environmental Protection Agency, June 1996.

^b CH₄ emission factors converted from scf or m³ are based on 60°F and 14.7 psia. The CH₄ emission factors can be adjusted based on the relative concentrations of CH₄ and CO₂ to estimate CO₂ emissions.

^c Shires, T.M., and M.R. Harrison. *Methane Emissions from the Natural Gas Industry, Volume 6: Vented and Combustion Source Summary, Final Report*, GRI-94/0257.23 and EPA-600/R-96-080f, Gas Research Institute and U.S. Environmental Protection Agency, June 1996.

^d Uncertainty based on a 95% confidence interval.

^e An EPA Gas STAR paper on engine starts reports that typical production compressor engine start-ups vent 1,000 to 5,000 scf of gas with each start-up attempt (EPA Gas STAR, PRO Fact Sheet No. 101, September 2004). This equates to 0.015 to 0.076 tonnes CH₄/start-up attempt assuming 78.8 mole % CH₄ in the gas.

^f Factor taken from: Tilkiciglu, B.H. *Annual Methane Emission Estimate of the Natural Gas Systems in the United States*, Phase II, Pipeline Systems Incorporated (PSI), September 1990. An EPA Gas STAR paper on installing plunger lift systems in gas wells presents a gas well workover emission factor of 2000 scf CH₄/workover, which equates to 0.0384 tonnes CH₄/workover (EPA Gas STAR, Lessons Learned - Installing Plunger Lift Systems in Gas Wells, October 2003). Gas STAR also reports that the number of gas well workovers conducted in a year typically ranges from 1 to 15.

^g EIA, U.S. Natural Gas Markets: Mid-Term Prospects for Natural Gas Supply, December 2001. Cites data for initial rates of production for completions in 2000. Offshore factor interpolated from chart "Initial Flow Rates of New Natural Gas Well Completions, 1985-2000." The total gas basis was converted to a CH₄ basis assuming 78.8 mole % CH₄ in production using the GRI/EPA average CH₄ composition for production operations.

^h Tilkiciglu, B.H. and D.R. Winters. *Annual Methane Emission Estimate of the Natural Gas and Petroleum Systems in the United States*. Pipeline Systems Incorporated (PSI), December 1989.

Table 2-4: Fugitive Emissions from Onshore Wells (API –Compendium of greenhouse gas emission methodologies for the oil and natural gas industry Table 5-23)

Based on discussions with BNR, it was confirmed that RECs (Reduced Emissions Completions) will be used and no cold venting will occur during well completions and negligible amount of fugitive emissions are expected from well completions activities.

- (ii) Drill cuttings: Drill cutting generated during the drilling into hydrocarbon formation contain methane and other hydrocarbons. These cutting produce gaseous emissions from thermal desorption. The quantity of gas absorbed in the drill cuttings are estimated based on cutting volume, porosity and gas saturation.

In order to estimate the fugitive gas emission from drill cutting BNR indicated a total volume of 156m³ was used with a porosity of 8% and a gas saturation of 46.5%. The methane quantity associated with the drill cuttings was estimated as 1.18 tonnes per well and the associated GHG emission was estimated as 29.6 tCO₂e, assuming a 25tCO₂e/tCH₄ as per NGERs.

- (iii) Wastewater Storage: Emissions from wastewater recovered from flowback and held in storage tanks can be estimated using Compendium of greenhouse gas emission methodologies for the oil and natural gas industry Table 5-10. An emissions factor of 0.39896 tonnes of methane/ML of produced water was used.

In order to estimate the fugitive emissions from wastewater, BNR indicated a 2 ML per well would be recovered. Therefore, methane emissions were estimated at 0.78 tonnes per well and the associated GHG emissions was estimated as 19.5 tonnes CO₂e, assuming 25 tCO₂/tCH₄ as per NGERs.

Table 5-10. Produced Salt Water Tank Methane Flashing Emission Factors

Separator Pressure (psi)	Produced Water Salt Content	GRI/EPA Emission Rate ^a , Original Units (10 ⁶ lb CH ₄ /yr)	Water Tank Emission Factor	
			tonnes CH ₄ /1000 bbl produced water ^b	tonnes CH ₄ /1000 m ³ produced water
50	20%	1.6	0.0015	0.009185
250	20%	10.8	0.00986	0.06200
250	10%	16.4	0.0150	0.09414
250	2%	19.4	0.0177	0.11137
250	Average of 10.7% ^c	--	0.0142	0.08917
1000	20%	38.8	0.0354	0.22273
1000	10%	58.7	0.0536	0.33697
1000	2%	69.5	0.0634	0.39896
1000	Average of 10.7% ^c	--	0.0508	0.31955

Footnotes and Sources:

^a Emission factors developed from Table 5-5 of Shires, T.M., and M.R. Harrison. *Methane Emissions from the Natural Gas Industry, Volume 6: Vented and Combustion Source Summary, Final Report*, GRI-94/0257.23 and EPA-600/R-96-080f, Gas Research Institute and U.S. Environmental Protection Agency, June 1996.

^b Process simulation modeling based on 1990 annual salt water production of 497 million barrels from Energy Environmental Research Center, 1995.

^c Average of emission factors at 20, 10, and 2% salt.

Table 2-5: Fugitive Emissions from Produced Water Storage (API –Compendium of greenhouse gas emission methodologies for the oil and natural gas industry Table 5-23)

2.4 Well Testing Flare

As part of the drilling program the exploration and appraisals wells are flow tested over a minimum of 60 days and a maximum period of 90 days and at an average flow rate of 5.9 mmsc/d for the 6 wells in Phase 1 and 10.7 mmscf/d for the 14 wells in Phase 2 to evaluate the commercial viability of the Valhalla

shale gas formation. The produced hydrocarbons from the well tests are directed towards a flare with a minimum destruction efficiency of 98% to ensure maximum practical combustion of the hydrocarbons. Methane has a hydrocarbon potential 25-times more than CO₂ and hence gas is flared during all well tests to reduce greenhouse gas emissions. The expected condensate to gas ratio (CGR) in the Valhalla formation is around 20 bbl/mmscf, hence a condensate flow rate of 118 bbl/day is expected during Phase I of the well testing program and 214 bbl/d during Phase II of the well testing program. The condensate is assumed to be flared at site as a base case, while BNR is investigating the possibility of trucking the condensate out of site for sale.

The greenhouse gas associated with the flaring of the gas and condensate is estimated based on National Greenhouse and Emissions Reporting (Measurement) Determination (2008) as updated in July 2020 and made under subsection 10(3) of the National Greenhouse and Energy Reporting Act 2007 [4]. Section 3.44 Method 1 of the NGER along with Fuel combustion emissions factors as shown below,

Fuel	Emissions Factors (tCO ₂ /t Gas flared)		
	CO ₂	CH ₄	N ₂ O
Gas Flared	2.8	0.933	0.026
Condensate Flared	3.2	0.009	0.060

Table 2-6: NGER Emission Factors for Gas and Condensate Flared

The amount of gas flared was estimated based on an expected gas composition of CH₄ 87 mol%, C₂ 5.5 mol%, C₃ 2.7 mol% and inerts 4.8 mol% and the average density of gas of 0.79 kg/m³ at standard conditions. The average density of the condensate was assumed to be 750 kg/m³.

Based on the above emission factors and the estimated weight of gas and condensate flared per day of well testing along with GHG emissions associated with the gas and condensate flaring per day per well is shown in Table 2-7 below.

Emissions per Well per day	Phase I	Phase II
Gas Flared (tonnes/d)	131.9	239.2
Condensate Flared (tonnes/d)	14.1	25.5
GHG Emissions from Gas flared (tCO ₂ e/d)	496	899
GHG Emissions from Condensate flared (tCO ₂ e/d)	46	83

Table 2-7: Quantity of Gas and Condensate Flared and associated GHG Emissions.

A minimum and maximum emissions per well is based on the minimum well test period of 60 days and a maximum well test period of 90 days.

2.5 Summary of Scope 1 GHG Emissions

Based on the above GHG emissions calculations, results are presented for a single well and for the total number of wells over the minimum 60 day and maximum 90-day test period for Phase I and Phase II of the Valhalla Exploration and Appraisal program in Table 2-7 below,

CO2 Emissions per E&A Well	Input Parameter	Phase I - 6 Wells (t CO2e)		Phase II - 14 Wells (t CO2e)		Calculation Reference
		60 days Well Test	90 days Well Test	60 days Well Test	90 days Well Test	
Land Clearing (per well)						
Land Clearing Emissions	5.1 ha per Well, 56.3 tCO2e/ha	287	287	287	287	FullCAM Model (2020) https://www.industry.gov.au/data-and-publications/full-carbon-accounting-model-fullcam
Diesel Emissions (per well)						
Site Preparation	20	54	54	54	54	National Greenhouse and Energy Reporting Guidelines (https://www.legislation.gov.au/Details/F2017C00508) Section 2.41 with Table in Schedule 1 Part 3.
Drilling Operations	316	857	857	857	857	
HFS Operations	510	1,382	1,382	1,382	1,382	
Site Reinstatement	20	54	54	54	54	
Transport (Vehicles/Rigs)	344	931	931	931	931	
Site Power	8	15	22	15	22	
Well Test Flare (per well)						
Gas	Ph I: 5.9 mmscf/d Ph II: 10.7 mmscf/d	29,747	44,620	53,948	80,921	National Greenhouse and Energy Reporting Guidelines (https://www.legislation.gov.au/Details/F2017C00508) Section 3.44.
Condensate	Ph I : 118 bbl/d Ph II : 214 bbl/d	2,760	4,140	5,005	7,507	National Greenhouse and Energy Reporting Guidelines (https://www.legislation.gov.au/Details/F2017C00508) Section 3.52.
Fugitive Emissions (per well)						
Drill cuttings	Gas 0.12 tonnes	30	30	30	30	Based on volume of drill cuttings and Vallhalla gas saturation.
Waste Water Tank	2 ML flowback	20	20	20	20	API GHG Emissions Methodologies for Oil and Gas, Table 5-10
Total GHG Emissions per Well (tCO2e)		36,136	52,396	62,582	92,065	Scope 1 (direct emissions)
Total Emissions E&A Program (tCO2e)	Ph I 6 Wells Ph II 14 Wells	216,814	314,378	876,144	1,288,915	Scope 1 (direct emissions)

Table 2-7: Valhalla E & A Program GHG Emissions Summary

The results can be represented in a pie-chart for comparison of various sources of GHG emissions per well as shown in Figure 2-1 below.

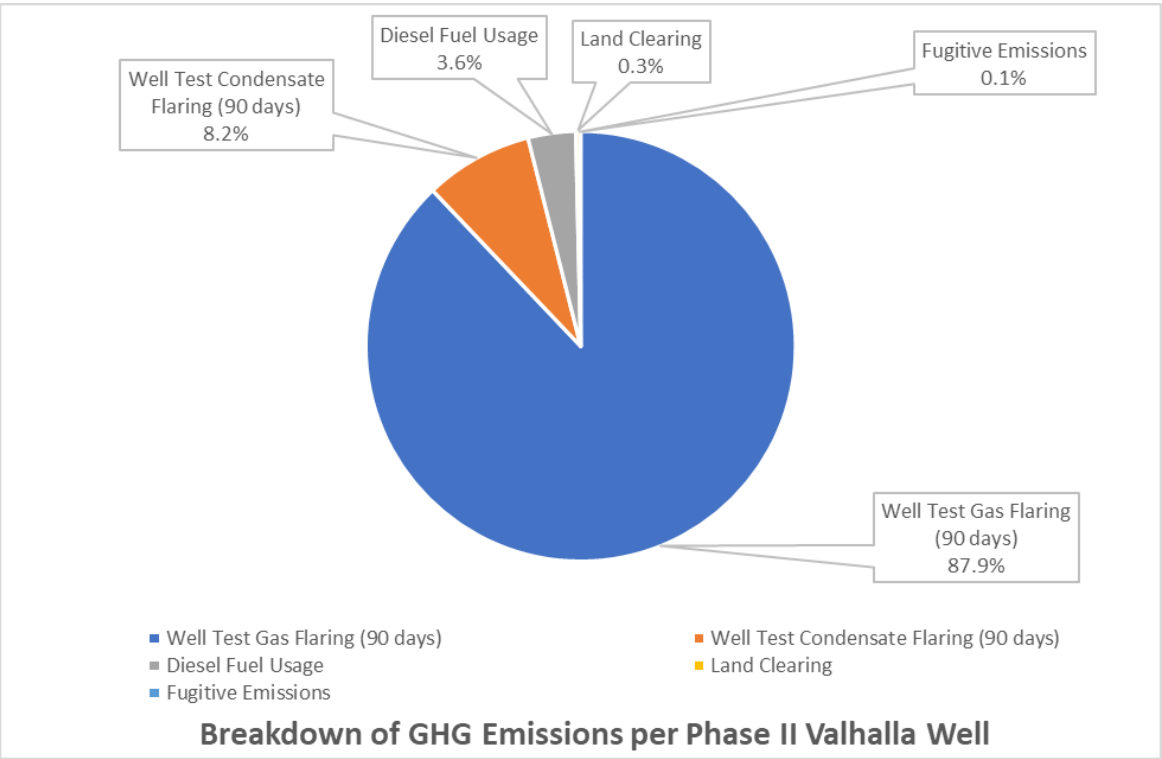
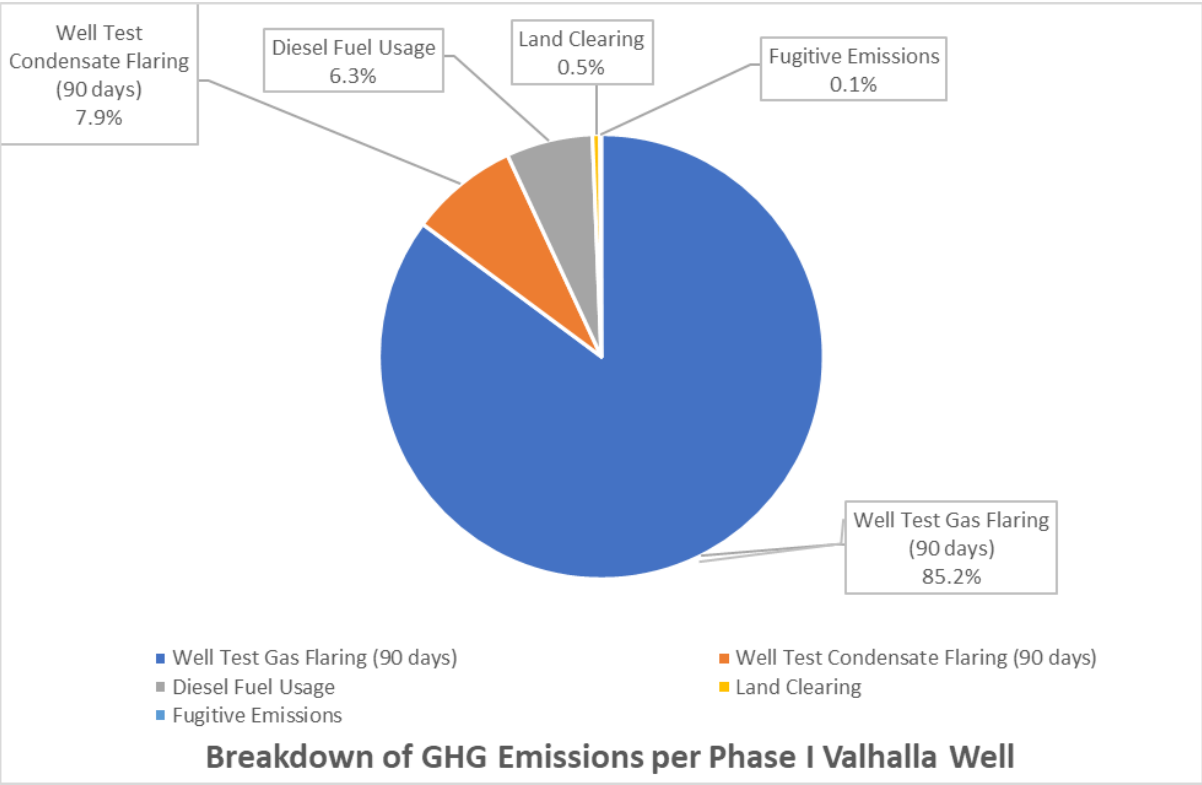


Figure 2-1: Breakdown of GHG Emissions per for 90-day Well Test for Phase I and Phase II of the Project

2.6 Project Overall Direct GHG Emissions (Scope 1)

The overall timeline of the Valhalla E & A Program could be between 3-7 years, where Phase I could take from 1-3 years and Phase II could take from 2-4 years depending on several technical and commercial factors. Therefore, two timelines and the associated GHG emissions for each of these timelines are provided below. Timeline #1 is an optimistic scenario where Phase I will be completed in Year 1 and Phase II will be completed in Year 2 and Year 3 of the Program. Timeline #2 is a resource constraint scenario where Phase I will take 3 years and Phase II will take another 4 years of the Program. Figure 2-2 provides annual GHG emissions for Timeline #1 and Figure 2-3 provides annual GHG emissions for Timeline #2 for the Valhalla E & A Program.

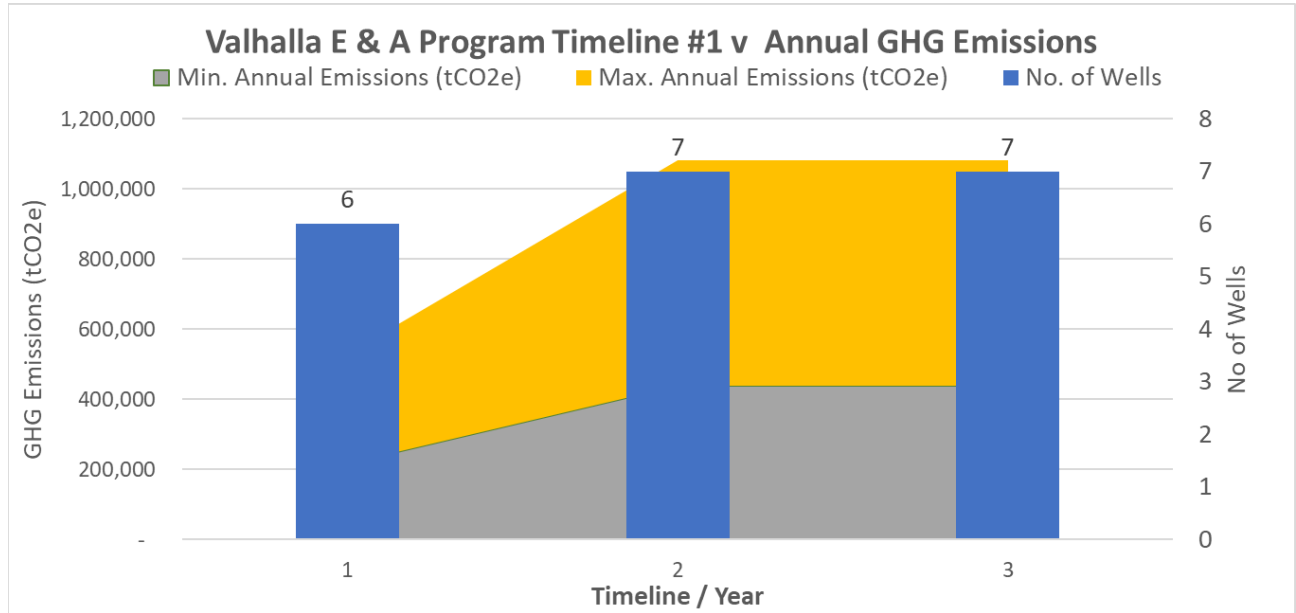


Figure 2-2: Timeline #1 for Overall Scope 1 GHG Emissions of the Valhalla E&P Program

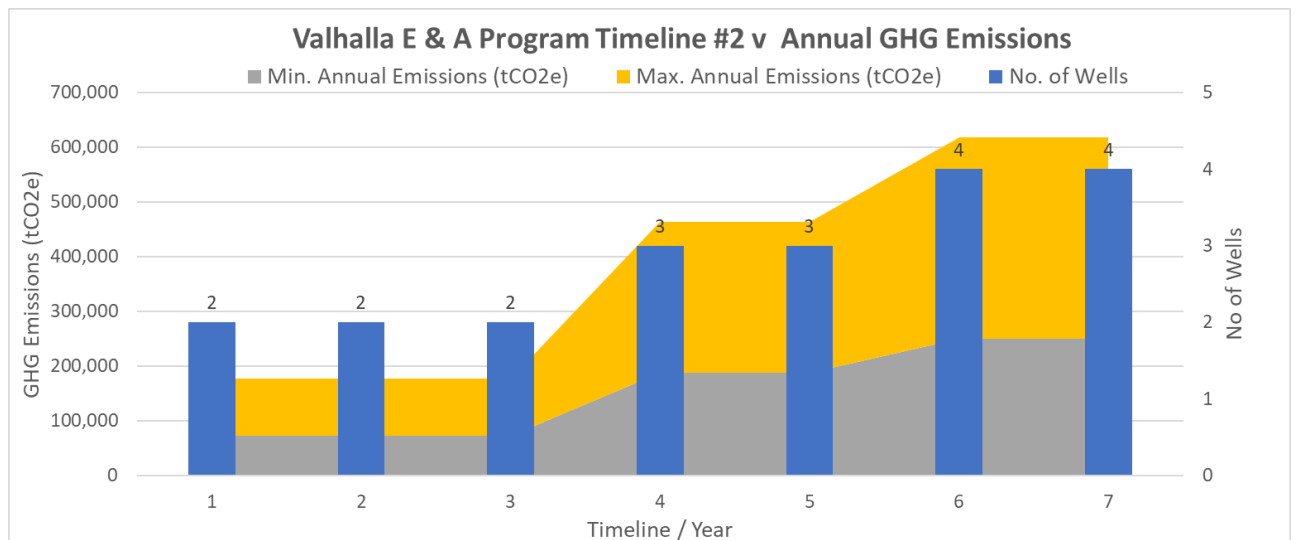


Figure 2-3: Timeline #2 for Overall Scope 1 GHG Emissions of the Valhalla E&P Program

2.7 Project Scope 2 Emissions

Indirect emissions from the generation of purchased energy consumed by a company is classified as Scope 2 emissions. The Valhalla Gas Exploration and Appraisal Program is intended to evaluate the quality of the gas field with drilling of exploration and appraisal wells, hydraulic fracture stimulation and flow tests. The E & P program does not intend to import power from third parties hence no Scope 2 emissions are envisaged as part of the project.

2.8 Project Scope 3 Emissions

All other indirect emissions not included in Scope 2 emissions that occur during the 7-years of the project is classified as Scope 3 emissions. The possibility of selling the condensate collected during the well test program to third parties rather than being flared at site is currently being evaluated as a recommended greenhouse gas mitigation measure. The emissions associated with the transportation and utilisation of condensate as a fuel is considered Scope 3 emissions for the project. For the purpose of this estimate the condensate produced from the well tests (minimum 60 day test period, maximum 90 day test period) was assumed to be collected and shipped from site. The condensate collected over the 7-years of the E & A program was assumed to be shipped from Wyndham to Singapore where it was assumed to be processed and consumed. A transportation emission factor of 130gCO₂e/tonne/km of condensate[6]. Fuel combustion emissions from the condensate was estimated based on NGERs Method 2.41 – Schedule 1 Table Part 3 assuming the properties of Kerosene [4] along with a 10% factor for emission associated with the refining and selling of the condensate.

Scope 3 Emissions	Min	Max
Condensate Volume (bbls)	222,240	333,360
Condensate Transport Emissions (tCO ₂ e)	13,952	20,928
Condensate Consumption Emissions (tCO ₂ e)	91,571	137,356
Total Scope 3 Emissions (tCO₂e)	105,523	158,284

Table 2-8: Scope 3 Emissions from Valhalla E & A Program

There are also other Scope 3 indirect emissions associated with the project including employee commuting, business travel and purchase of goods and services, which are considered minimal for the purpose of this estimation.

2.9 Breakdown of GHG Emissions

The results for the GHG emissions for the Valhalla E & A Program can be summarized as below considering both the condensate flaring and condensate sale option.

GHG Emissions (tCO₂e)	Condensate Flared		Condensate Sold	
	Min	Max	Min	Max
Scope 1	1,082,222	1,592,556	995,593	1,462,614
Scope 2	-	-	-	-
Scope 3	-	-	105,523	158,284
Total Emissions(tCO₂e)	1,082,222	1,592,556	1,101,116	1,620,898

Table 2-9: Overall Project Emissions from Valhalla E & A Program

It should be noted that the overall emissions with the condensate sale options is higher due to transportation and processing emission of the condensate. But the condensate would be utilized for an energy application rather than flared at site as a waste product displacing emissions from another source.

3 GHG Emissions Benchmarking

As part of the GHG emissions benchmarking exercise, carbon emissions from the Valhalla Exploration and Appraisal Program activities were compared with previous Buru Energy HFS exploration and appraisal drilling activity in the Canning Basin along with the recently approved drilling and HFS projects in the McArthur and Beetaloo sub-basins in the Northern Territory. A brief description of the other projects used for the benchmarking exercise is provided below with focus on critical emission sources such as the gas and condensate flare rates.

3.1 Buru – Canning Basin - TGS14 Project

Buru Energy carried out a HFS program in four wells Yullaroo-3, Yullaroo-4, Valhalla North-1 and Asgard-1 Wells in 2014, these wells were constructed in 2012/13 and the integrity of the wells were assessed prior to the HFS program in 2014 [7]. The activities for Tight Gas Pilot Exploration Program (TGS14) consist of hydraulic fracturing to stimulate the vertical component of the tight gas reservoir, the well flowed back and the resultant flow of gas and liquid hydrocarbons from the well was then measured and analysed over a period of time. The maximum well test flow rate of 2 mmscf/d was used during the tests where gas was flared over the 3-month testing period. Condensate removed from the well test separator was stored on site and trucked out for sales.

3.2 Origin - Betaloo Basin – Valkerri Project

Origin filed an Environmental Management Plan (EMP) for drilling, HFS and well testing of Velkerri 76 S2 exploration well on EP 76 in the Betaloo Basin in the Northern Territory in accordance the NT Petroleum (Environment) Regulations 2016, Code of Practice: Onshore Petroleum Activities in the Northern Territory [8]. The exploration well will consist of 2000-3000 m vertical component and horizontal section of 3000 m. The well testing program is planned for 3-12 months. A well testing rate of 2.5 TJ/d is envisaged with 37.5 bbl/d of condensate produced. The condensate will be flared along with the well test gas in a vertical flare.

3.3 Origin - Betaloo Basin – Kyalla Project

Origin has also filed EMP for a multi-well drilling, stimulation and well testing program in Kyalla 117 N2 [9]. Origin obtained approval for the Kyalla 117 N2-1H well in 2019 and have applied for Kyalla 117 N2-2H and Kyalla N2-3H drilling, HFS and well testing to utilise multi-well pads to improve efficiency and reduce environmental footprint in 2021. The program is intended to optimise multi-well pad layout of surface operations for potential future development scenario with the core objective of minimising the environmental footprint, including minimising land clearance, maximising water reuse and reducing greenhouse gas emissions. The exploration well will consist of 1500 m lateral length for 1H well and 2800 m lateral length for 2H and 3H wells. The well testing program is planned for 3-6 months. A well testing rate of 1.5 TJ/d is envisaged with 15 bbl/d of condensate produced. The condensate will be flared along with the well test gas in a vertical flare.

3.4 Santos – McArthur Basin EP161 Project

Santo has filed an EMP for a multi-well drilling, stimulation and well testing program with Tanumbirini 1, Tanumbirini 2H and Inacumba 1/1H wells in 2019[10]. The exploration well will consist of 2000 m lateral length for both wells. The well testing program is planned for 3-12 months. A well testing rate of 1.55 mmscf/d is planned with condensate produced will be trucked out of site and not flared.

3.5 Imperial – McArthur Basin – Carpinteria 1

Imperial filed an EMP with NT EPA for the drilling of the Carpenteria 1 well in EP 187 in the McArthur Basin for the vertical pilot well and with no HFS activities [11]. The drilling program will include inflow and production testing of the vertical zone where gas would be flared at 1.2 mmscf/d over a 90 day period.

3.6 Comparison of HFS Exploration and Appraisal Projects

A comparison table is provided summarizing project data along with the Valhalla E & A Project.

Project	List of Wells	No of Wells	Lateral Drilling, m	HFS	Gas Flare Rate	Condensate Flare Rate	Test Period
Origin -Kyalla	Kyalla 117 N-1H Kyalla 117 N-2H Kyalla 117 N-3H	3	1500-1800	Y	1.5 TJ/d	15 bbl/d	3-12 months
Origin - Valkerri	Velkerri 76 S2	1	3000	Y	2.5 TJ/d	37.5 bbl/d	3-6 months
Santos - McArthur	Tanumbirini x 2 Inacumba x 1	3	2000	Y	1.55 mmscf/d	NA	3-12 months
Imperial - Carpenteria 1	Carpenteria 1	1	NA	N	1.2 mmscf/d	NA	3 months
Buru-TGS14	Yulleroo 5 Yulleroo 6 Valhalla North 1 Asgard 1	4	NA	Y	2 mmscf/d	NA	3 months
BNR -Valhalla	Phase I - Refer ERD	6	1500	Y	5.9 mmscf/d	118 bbl/d	2-3 months
	Phase II- Refer ERD	14	3000	Y	10.7 mmscf/d	214 bbl/d	2-3 months

Table 3-1: Exploration & Appraisal Project Comparison Summary

3.7 Benchmarking Exercise

All Exploration and Appraisal projects are different and have unique components, for the purpose of this benchmarking comparison, the exploration wells with horizontal drilling and HFS was compared with the Valhalla E & A Program, hence the BuruTGS14 and Imperial Carpinteria 1 programs were not used for the benchmarking exercise.

In order to benchmark projects for their GHG emissions, typically, GHG emissions intensity values are calculated on a 'tCO₂e per tonne of product' basis for manufacturing projects or 'tCO₂e per kWh' basis for power generation projects such that project emissions can be compared. GHG emission intensities from gas exploration projects cannot be compared on such a basis. Therefore, couple of methods were used to benchmark the Valhalla E & A program gas exploration project emissions along with the Origin and Santos exploration programs. GHG emissions intensities on a per Well per Test Day for the Valhalla wells along with other projects is shown in Figure 3-1. The results clearly indicate significantly more emission from the Valhalla well tests per day due to its higher well test flow rates per day. It should be noted that the Origin and Santos test programs are planned for a significantly longer period from up to 3-12 months compared to 2-3 months for Valhalla. Therefore, another comparison could be made based on the planned minimum and maximum total emission per well from these exploration and appraisal programs. Figure 3-2 provides planned total emission per well from these projects.

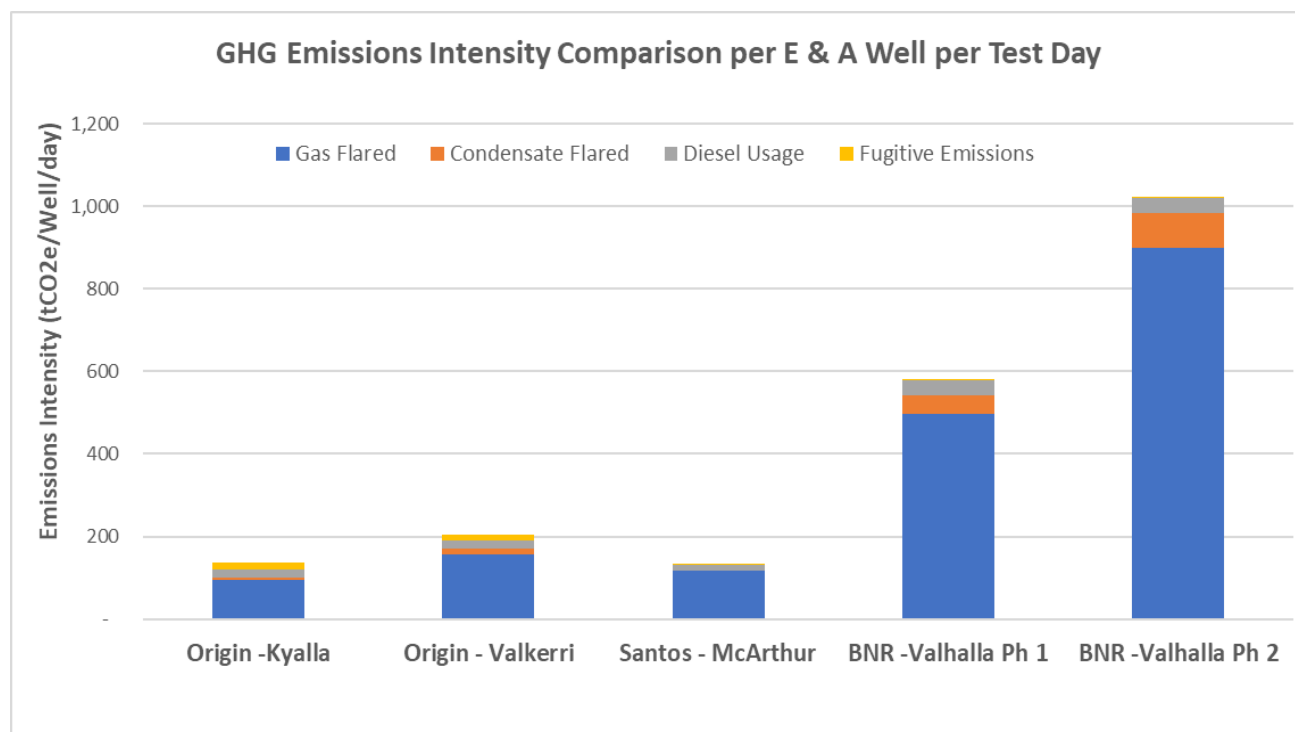


Figure 3-1: Benchmarking GHG Emission of the Valhalla E&P Program per Well per Test Day

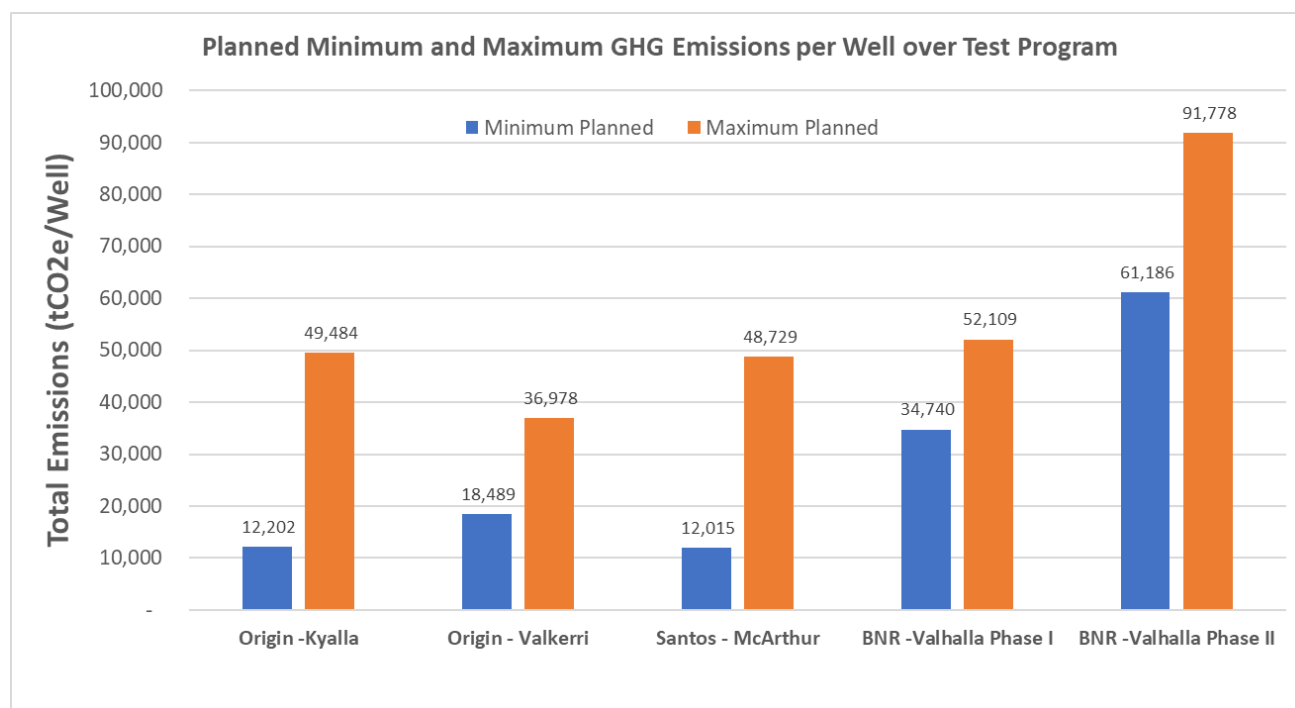


Figure 3-2: Benchmarking GHG Emission of the Valhalla E&P Program for planned total emissions per Well

The results indicate the Valhalla Phase I emissions are compatible with the permitted/planned total emissions of other projects in the Beetaloo Basin in the NT. The Valhalla Phase II emissions are higher

than the other projects due to its higher flow test rates which is at the later part of the project. It should be also noted that Origin-Kyalla program is based on 3 wells, Origin-Valkerri program is based on 1 well and Santos-McArthur program is based on 2 wells while Valhalla Phase I is based on 6 wells and Valhalla Phase II is based on 14 wells. The Valhalla E & A program provides a complete scale of the development program for the Valhalla field while the other project proponents have only provided the very early part of their E & A program.

3.8 GHG Emissions comparison with State and National Emissions

The following table provides a comparison of the total Valhalla E & A program GHG emissions from the 20-well program over the proposed two timelines as a percentage of the state and national GHG emissions.

	mtCO ₂ e	% of State Emissions	% of National Emissions
Annual WA State Emissions ¹ (2019)	91.85		
Annual Australian National Emissions ² (2019)	529.30		
Valhalla - Timeline #1 (3 Years)	1.59	0.58%	0.10%
Valhalla - Timeline #2 (7 Years)	1.59	0.25%	0.04%

[1] Based on 2019 WA GHG emissions. [2] Based on 2019 National GHG Emissions.

Table 3-2: GHG Emissions compared to State and National Emissions

The GHG emissions from the Valhalla E & A program contributes to a small fractional increase in the state GHG emissions and a much smaller fractional increase in the national GHG emissions.

4 GHG Emissions Reduction Assessment

This section outlines the measures incorporated into the Valhalla Exploration and Appraisal Program to reduce GHG emissions and reduce overall carbon footprint of the project. The following measures have been evaluated for the drilling and HFS operations as Reduced Emissions Completions (RECs), as recommended in the WA Scientific Inquiry into Hydraulic Fracking for the mitigation of greenhouse gas emissions.

4.1 Use of single pad for multiple horizontal drills.

Single well-pad vertical designs result in significantly less land clearing. The use of efficient multi-well pad horizontal shale development results 50%-60% reduction in land use as shown in Figure 4-1.

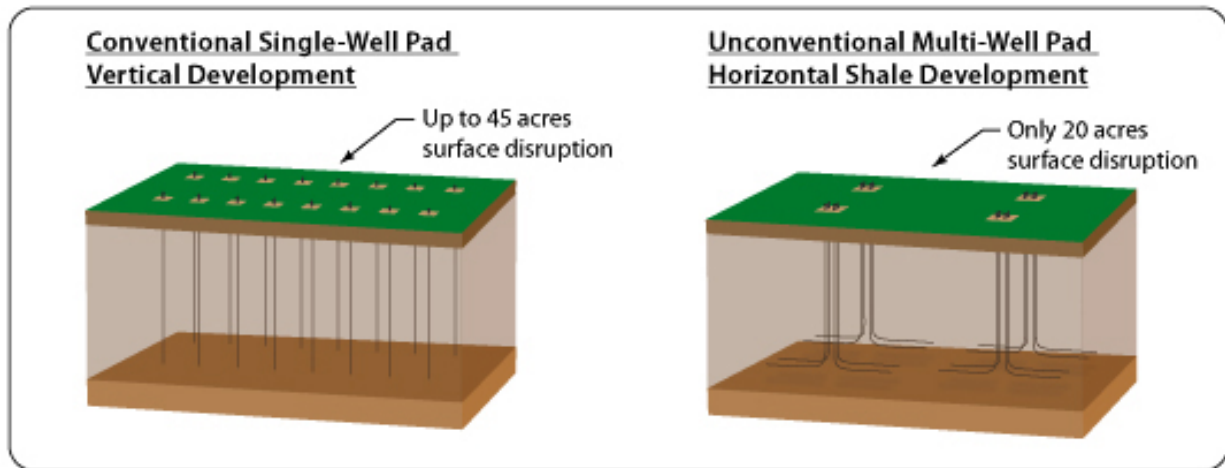


Figure 4-1: Single v Multi Well Pad designs

The Valhalla Exploration and Appraisal program utilizes 10 well pads for drilling 20 wells, implementing an efficient multi-well drilling technique to minimize land clearing. The minimization of land clearing reduces the impact associated with GHG emissions associated with the removal of vegetation. A total land cleared for the 20 well program is 102 ha of which 40 ha is associated with the well sites, therefore reducing overall land cleared by around 40%.

4.2 Use of latest (Tier 4 – US or Stage V -EU) diesel engines.

The diesel engines used for the drilling and HFS operations will employ the latest efficient units with highest emission standards. The Tier 4 diesel engines have 90% lower NOx and PM emission compared to Tier 3 engines and are fuel efficient resulting 15% GHG emissions reduction. In Europe, Stage V is the latest and the strictest tier of these regulations for emissions with regards to upstream oil and gas applications.

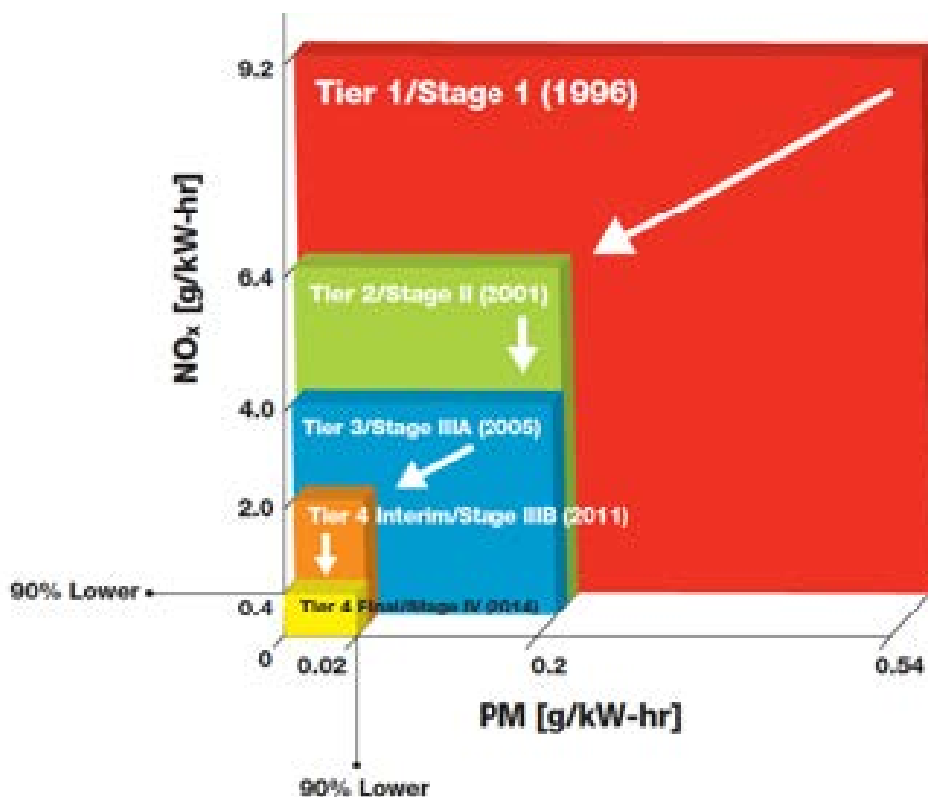


Figure 4-2: Tier 4 Diesel Engine Performance

4.3 Collection and sale of condensate.

As recommended by the WA Hydraulic Fracking Inquiry Report the well construction activities Reduced Emissions Completions (REC) should be employed where feasible so that gas and condensate is captured for sale or other use. The well test fluids during the exploration and appraisal program could be passed via a sand trap and 3-phase separator to remove water and condensate from the gas where the condensate could be stored and trucked out of site for sales to a refinery. BNR is currently evaluating options for the sale of condensate produced from the well tests via Wyndham Port to Singapore, where Buru Energy already exports its oil.

4.4 Flare Design

Gas venting is avoided during the well completions and well tests and only permitted for operational or safety reasons. Gas flaring is carried out in accordance with Code of Practice requirements and as per US EPA 40 CFR 63.11, with a flare tip combustion efficiency of 98%. Two separate vertical stacks, one for flowback high pressure gas and a second low pressure flare to manage tank vapors (off storage tanks) would be used to ensure all methane at site is flared. Both flare systems would utilize an auto-ignite system, gas assist, and a single pilot.



Figure 4-3: Multi-Stack Vertical Flare for low-pressure and high-pressure gas

4.5 Gas Capture

The Canning Basin does not have any gas infrastructure such that the flow test gas can be treated and sent to a gas pipeline for sale. Therefore, the only possibility would be to capture the gas as Compressed Natural Gas (CNG) or utilising Mini-LNG facilities as described below and supply it to energy users in the Kimberley.

4.5.1 Compressed Natural Gas

The well test gas would be required to be dehydrated and compressed to around 250 bar to be stored in high pressure storage bullets which can then be used in gas engines for power generation in Well Test sites instead of diesel. CNG can also be transported to power stations in Broome, Derby and other west Kimberley towns to replace LNG trucked from Karratha at present. CNG could also be used in dual-fuel engines for the drilling and HFS operations within the Valhalla E & A Program if equipment with suitable

engine specifications is available locally. At present the sale of gas as CNG is considered unviable due the associated cost of capture, treatment and transportation to markets located far from the Valhalla field.



Figure 4-4: CNG utilisation in duel-fuel engines (Source: GTUIT)

4.5.2 Micro LNG

A relocatable micro-LNG plant could also be used to capture the well head gas (as used in some US shale gas operations) if this equipment were available in the Australian market. The use of micro-LNG option would require the well head gas to be pretreated such that water, CO₂ and freezable heavy hydrocarbons are removed from the gas to allow liquefaction of the gas. The LNG produced can then be stored in transportable ISO containers and shipped to markets.

Cryobox™ is a mini-LNG technology and other similar flare gas liquefaction technologies that provides relocatable pre-treatment units as used in US shale gas industry [12].



Figure 4-5: Well head gas capture via Mini-LNG (Source: CryoBox)

At present the sale of LNG to local power stations is considered unviable with existing gas offtake contracts in place with power plant operations and the inability for the project proponents to commit to a fixed volume based LNG supply contract from the gas exploration and appraisal program.

4.5.3 Renewables

The use of renewable energy such as solar PV for powering the drilling and HFS operations are impracticable as significant number of solar panels will be required to be placed over a large area. The solar PV power also need to be supported with large batteries that can store energy to be supplied during the nights. Therefore, resulting in significantly higher costs. Further, the rigs and HFS units need to be re-located to various sites during the drilling program which will make the use of renewable energy impracticable. A better alternative would be to use grid power if available, for the drilling operations, while the grid is supported by renewable power. The Canning Basin and Valhalla region does not have such a grid to support the project. However, solar powered lighting towers with batteries backup are planned to be used in the project as shown in Figure 4-5 along with other solar power based instrumentation and monitoring systems.



Figure 4-5: GHG Mitigation Measures for the Projects

4.6 GHG Mitigation Summary

The 7-year 20 well Valhalla Gas Exploration & Appraisal program provides the complete scale of the planned drilling and HFS activities associated with the evaluation of the Valhalla formation. Significant part of the GHG emission of an exploration and appraisal drilling program is associated with the well test flow rates and the duration of the well tests. The overall GHG emission estimates are also dependent on the number of wells drilled in Phase I and Phase II of the program with potentially multiple drilling campaigns. The total number of wells drilled will highly depend on the success of each drilling campaign.

The maximum direct emission from the Valhalla E & A program was estimated as 1,597,856 mtCO₂e over the 7 years. The following GHG mitigation measures in accordance with the EPA hierarchy of avoid, reduce, offset GHG emissions are discussed below.

4.6.1 GHG Emissions Avoided

By incorporating industry best practice design the following measures were utilized in the Valhalla E & A program to minimize GHG emissions,

- (1) Multi-pad Well design: The Valhalla E & A program utilises 2 horizontal wells per well pad to minimize land clearing. The estimated GHG emission avoided is 2,300 tCO₂e for the project.
- (2) Dual-stack LP/HP Flare: Separate Low Pressure (LP) and High Pressure (HP) flares are used as part of the design to combust tank vapours and well test gas separately ensures any low pressure methane emissions on site is avoided. The estimated GHG emission avoided is 10,000 tCO₂e.

4.6.2 GHG Emissions Reduction

The following GHG emission reduction measures are currently being assessed to further reduce project GHG emissions.

- (1) Condensate Sale: The sale of condensate produced during the well tests currently being actively pursued by BNR as discussed previously. This would avoid up to 129,943 tCO₂e of GHG emissions on site during the project period.
- (2) Dual-Fuel Engines: The capture, dehydration, compression and storage of well test gas would allow it to be used in dual-fuel engines reducing the use of diesel and the associated emissions during the drilling and HFS operations. The estimated GHG reduction is around 33,500 tCO₂e over the project life.

Further to the above, it is envisaged the well test rates, well testing period and the number of appraisal wells can be reduced with learnings from each drilling/HFS campaign in Valhalla which will significantly reduce gas and condensate flaring and associated emissions.

Figure 4-6 provides a summary of GHG mitigation measures considered part of the GHG reduction exercise.

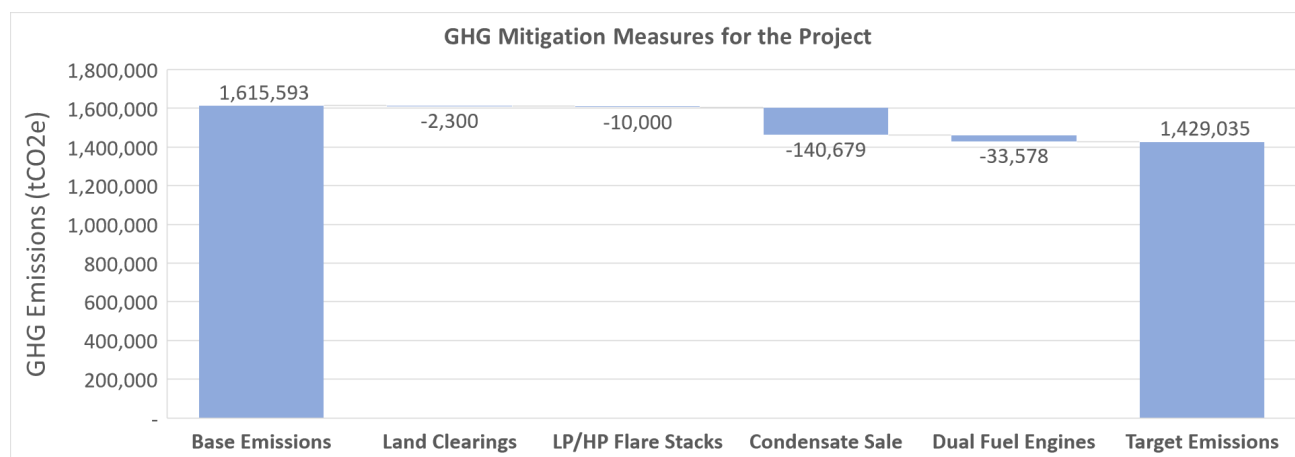


Figure 4-5: GHG Mitigation Measures for the Projects

The following section provides more details of the GHG offset requirements along with an estimate of GHG estimate for the project.

5 Valhalla E&A Program GHG Emissions v EPA NetZero 2050 Target

The WA EPA has been actively pursuing GHG emissions reduction in the state as the emissions from the state have increased by 11% in the past decade, mainly due to the commissioning of new LNG projects in the northwest of the state. The WA EPA has mandated emissions reduction targets for projects with more than 100,000 tCO₂e/year of GHG emissions. The EPA has requested project proponents demonstrate a trajectory of carbon emissions reductions towards NetZero by 2050. Refer to ESD Requirement 78 for Valhalla Project.

5.1 Valhalla NetZero Targets

The two possible Program timelines considered for the Valhalla E & A program are, Timeline #1 - 3 years from 2024 and Timeline #2 – 7 years from 2024 are shown in Figure 5-1 along with the EPA NetZero 2050 trajectory based on the year 2020 baseline set by the EPA. Based on the EPA assessment of exploration phase emissions of a shale gas development, the project would have to either reduce or offset the emission above its target emissions as shown in Figure 5-1 for each of the years of the Valhalla E&A Program.

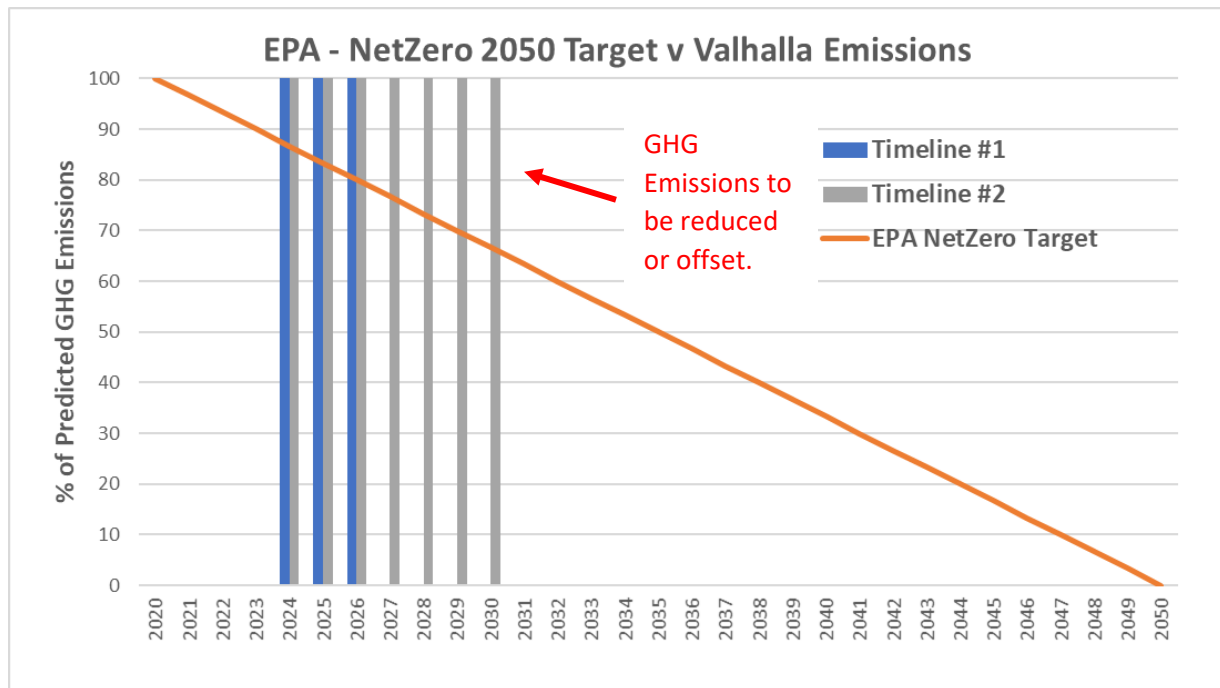


Figure 5-1: EPA NetZero Target v Valhalla Emissions

Table 5-1 provides a quantitative estimate of maximum GHG emissions and the reductions/offsets that could be mandated by EPA under the NetZero 2050 trajectory for the Valhalla E & A program under each of the two timelines considered. Depending on how EPA would assess a shale gas exploration project, BNR may or may not be required to offset part of the GHG emissions associated with the Valhalla E & A program beyond the annual EPA NetZero targets.

It should be noted that the GHG emissions offset/reduction quantities are much less for the optimistic drilling program Timeline #1 from 2024-2026 compared to Timeline #2. Hence, it would be beneficial for BNR to commit to a faster overall development timeline in a NetZero carbon environment.

Year		Timeline #1				Timeline #2			
		No of Wells	Max.Annual Emissions	Reduction Target	Reduced Emissions	No of Wells	Max.Annual Emissions	Reduction Target	Reduced Emissions
			tCO ₂ e	%	tCO ₂ e		tCO ₂ e	%	tCO ₂ e
1	2024	6	314,378	13	41,913	2	104,793	13	13,971
2	2025	7	644,457	17	107,399	2	104,793	17	17,464
3	2026	7	644,457	20	128,879	2	104,793	20	20,956
4	2027					3	276,196	23	64,439
5	2028					3	276,196	27	73,645
6	2029					4	368,261	30	110,467
7	2030					4	368,261	33	122,742
Total		20	1,603,293		278,190	20	1,603,293		423,684

Table 5-1: Annual GHG Emissions and Targeted Emission reduction under EPA NetZero 2050

The EPA NetZero target and the offset/reduction requirement information can be shown below in a graphic form over the two proposed Timelines as show in Figure 5-2 and 5-3 below.

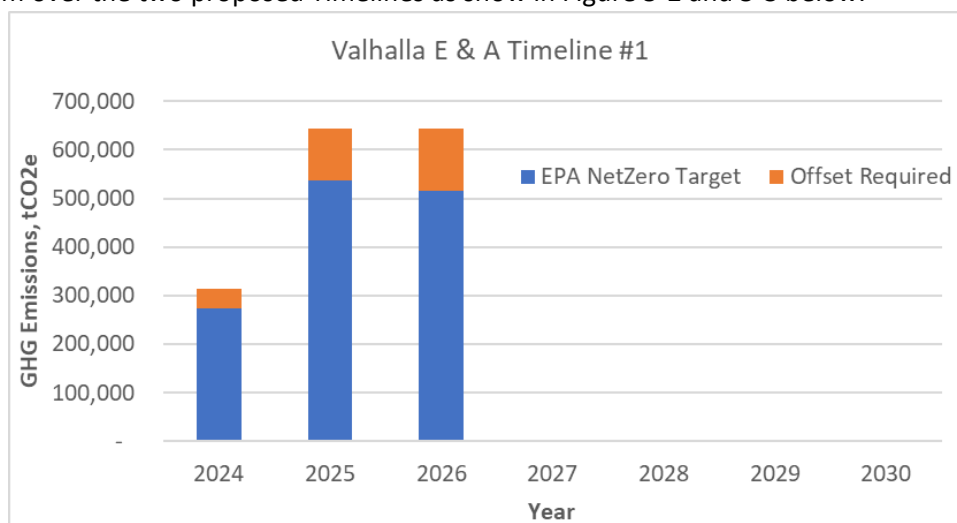


Figure 5-2: Timeline #1 - EPA NetZero Target v Emissions Offsets

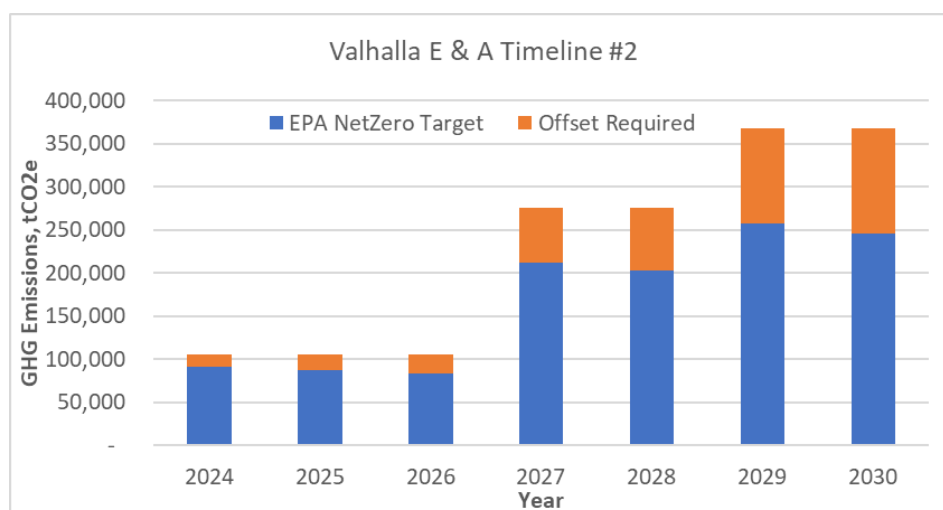


Figure 5-3: Timeline #2 - EPA NetZero Target v Emissions Offsets

EPA requires that the project proponents provide compelling reasons for not meeting the NetZero 2050 trajectory. As described in sections 4.5 and 4.6 reasonably practical measures such as sale of condensate and the use of dual fuel engines is currently evaluated and may be undertaken at some point to minimize GHG emissions if appropriate equipment is available and reasonably practicable to apply. This will enable the project to reduce annual emission by around 8-10%. The capture and sale of all well test flow gas is not viable due to a lack of gas markets close by and the unpredictable nature of an exploration and appraisal drilling program which cannot commit to the sale of fixed volumes and time frames unlike in a gas plant. BNR will be required to assess annual emissions and when deemed to have exceeded the EPA NetZero 2050 trajectory targets the project proponents could utilize authorized offsets mechanisms to meet these targets.

5.2 GHG (carbon) Offsets

The EPA advises that where carbon offsets are to be implemented, they should meet offset integrity principles and be based on clear, enforceable and accountable methods. For example, the EPA recognises Australian Carbon Credit Units (ACCUs) issued under the Carbon Credits (Carbon Farming Initiative) Act 2011 (Cth) as meeting these standards. Compliance offsets under the Safeguard Mechanism, as well as voluntary offsets purchased to reduce residual emissions, may contribute to a proponent's Greenhouse Gas Management Plan and will be recognised by the EPA [2].

BNR Climate Change Policy (June 2021) has committed to NetZero by 2050 and the Valhalla E & A Program is committed to progressively reduce emissions over the years to achieve this target. Depending on how EPA would assess a shale gas exploration project, BNR may or may not be required to offset part of the GHG emissions associated with the Valhalla E & A program beyond the EPA NetZero targets via an accredited Australia Carbon abatement program.

5.3 GHG Emissions Reporting

The WA EPA supports the requirements for proponents to periodically report against their interim targets as outline in their GHG Management Plan. EPA prefers this reporting to be aligned with the five-year milestone set out in Article 4 of the Paris Agreement. The EPA will also consider undertaking its own periodic statewide reporting, under section 16(i) of the EP Act, to provide public advice on GHG emissions and the progress of mitigation measures developed and implemented by major proposals within WA [2]. The Valhalla E&A program will meet all state and national GHG emissions reporting requirements.

It should be noted that corporate reporting thresholds for GHG emissions are much lower under the National Greenhouse and Energy Reporting Act 2007 (NGER Act) where 25,000 tCO₂ per facility and 50,000 tCO₂ per corporate group is mandated.

6 Concluding Remarks

The Valhalla E & A Program GHG emissions estimate was carried out based on the information provided by BNR for the drilling program and the HFS operations. The calculations and other relevant information are provided in a separate spreadsheet (NimblEng Valhalla GHG Emissions Estimate Rev G) as part of this report.

Hydraulic Fracture Stimulation (HFS) or fracking of shale gas formations has been carried out in Australia for over the past 50 years, with over 900 production wells have been fracture stimulated in the Cooper-Eromanga Basin in South Australia and Queensland[13]. Out of the 10,664 CSG wells drilled in Queensland, 8.8 percent have been hydraulically fractured within the Surat and Bowen Basins up until December 2017 [14]. The lifting of the moratorium on HFS in 2019 in Northern Territory has seen projects in the Beetaloo Basin ramp up over the past couple of years under the new Code of Conduct set by the NT Government. Similarly, the WA government is working on introducing its own Code of Conduct for the Shale Gas industry based on the WA Scientific Inquiry on Hydraulic Fracturing. One of the main concerns related to the shale gas industry has been associated with the GHG emissions during exploration, appraisal and development activities of the upstream sector due to the higher number of wells associated with shale gas projects and the flaring associated with the development compared to conventional gas field developments. Therefore, it is essential for the project proponents to tackle this issue early in the project and provide adequate GHG mitigation measures throughout the lifecycle of the project.

The WA EPA Assessment of the Valhalla Gas E & A program will be the first hydraulic fracturing project in WA since the lifting of the moratorium. The Environmental Protection Act process requires that proponents prepare detailed Environmental Impact Assessment (EIA) information that provides the public and regulatory agencies with the data they require to decide on project approval. The Environmental Management Plan (EMP) documents filed by proponents in the Beetaloo Basin in NT EPA over the past 3 years provides good guidance for projects in WA with respect to their EMPs.

The Valhalla E&A program annual emission could range from 100,000 – 600,000 tCO₂e per year depending on the number of wells drilled in a year, and the total GHG emissions could range from 1,093,000 to 1,603,300 tCO₂e depending on the number of test days utilised per well. In comparison the recently approved Waitsia Stage 2 Gas Project with a 250 TJ/d export capacity has annual emissions of 300,000 tCO₂e/y, and the proposed Pluto LNG Train 2 has annual emissions of 1,465,000 tCO₂e/yr. Therefore, one would expect EPA to scrutinise the Program's GHG emissions and proposed mitigation measures in detail. The Waitsia Stage 2 Gas Plant Project has committed to offset all CO₂ associated with the feed gas from the onset of the project and has committed to further reduce emissions as per the Figure 6-1 in line with EPA's NetZero 2050 trajectory [15]. Woodside's 2 train Pluto LNG facility has committed to reduce or offset emissions in order to meet WA EPA NetZero 2050 target as shown in Figure 6-2 [16].

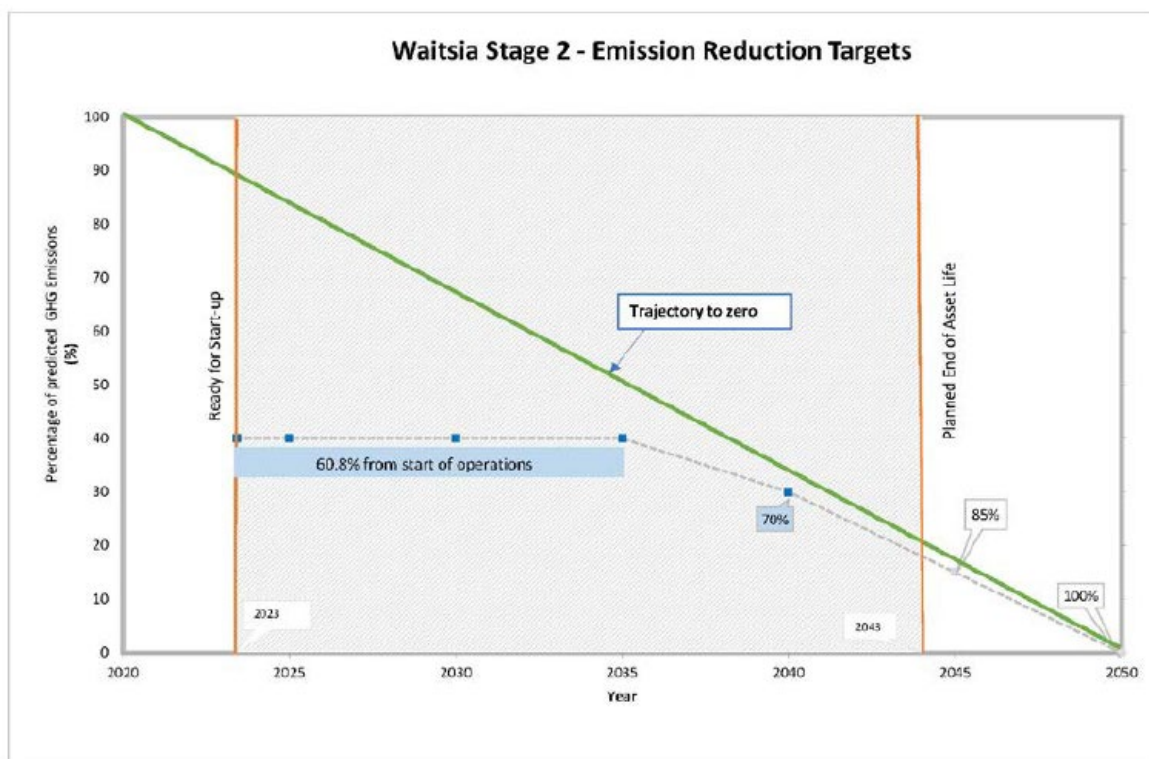


Figure 6-1: Waitsia Stage 2 Gas Plant NetZero Target (Mitsui E & P 2020)

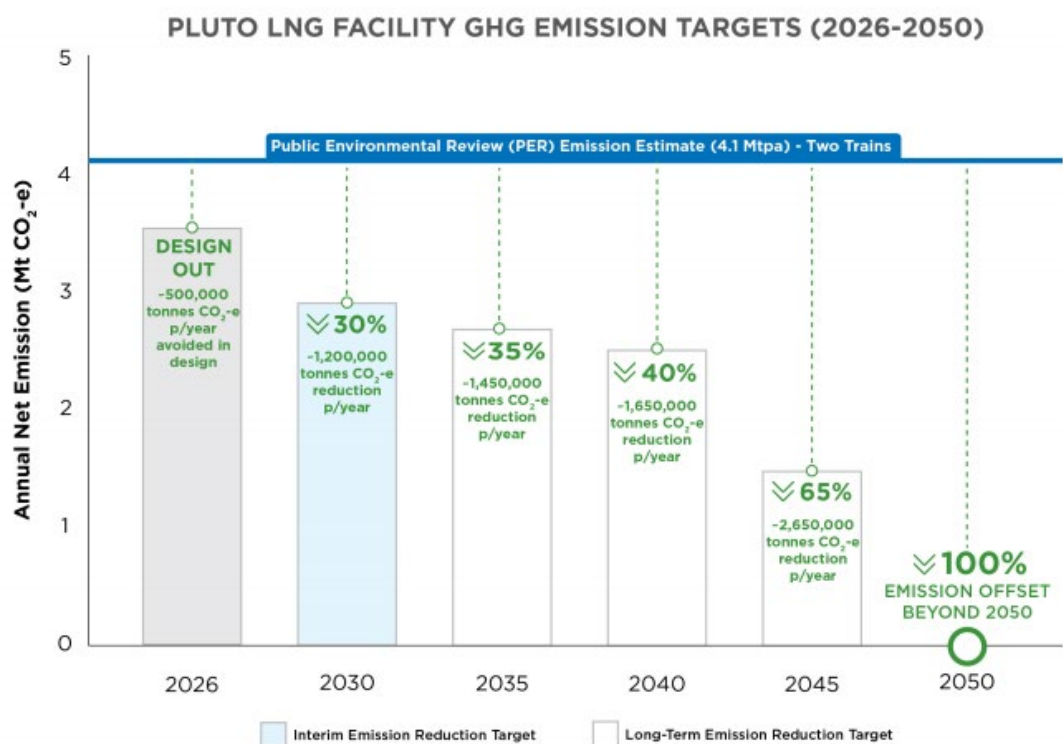


Figure 6-2: Pluto LNG Train 2 NetZero Target (Woodside, 2021)

The nature of an exploration and appraisal program does not allow project proponents to provide firm annual emissions estimate unlike a gas plant or an LNG plant. When developing a gas field, the execution and evaluation of each drilling campaign plays a significant role in subsequent drilling campaigns, number of wells, duration of the well tests and associated GHG emissions. The uncertain nature of the drilling campaigns does not allow project proponents to commit to upfront investment in gas and condensate capture and sales infrastructure from the onset of the exploration program. Therefore the Valhalla project proponents will be required to carefully evaluate capital costs of various capture options and ensure reasonably practical measures are undertaken to reduce emissions as much as possible while providing offsets when EPA NetZero emissions targets are deemed to be exceeded. This is also in line with other project in WA who are drilling conventional exploration and appraisal wells in the state and are currently flaring gas at the exploration phase of their projects. One possible alternative for BNR is to negotiate with EPA and agree to ‘carry forward’ mechanism for the carbon emissions from the exploration and appraisal phase in full or in part to the production phase and offset these emissions at the later part of the project.

Based on the current maximum flare rates over the 20 well E & A program a volume of nearly 17 bcf of gas and 334,000 bbls of condensate could be flared. At a sale price of 2 \$/GJ for gas and 30 \$/bbl for condensate puts the value of these hydrocarbons around \$ 45 million. The maximum emissions above the EPA NetZero trajectory that requires to be offset could be as high as 423,700 tCO₂e over the project life, which at a carbon price of \$50/tonne could cost over \$21 Million for the project. The Australian Carbon Credit Units (ACCUs) are currently trading at \$21/tCO₂e and several operators are currently using a carbon price of up to \$80/tCO₂e as part of their project costs to account for carbon emissions costs. BNR should carefully assess the impact of carbon price for the entire project while evaluating the GHG emissions reduction measures such as capture and utilization of gas as CNG or LNG from the project over the exploration, appraisal and development phase.

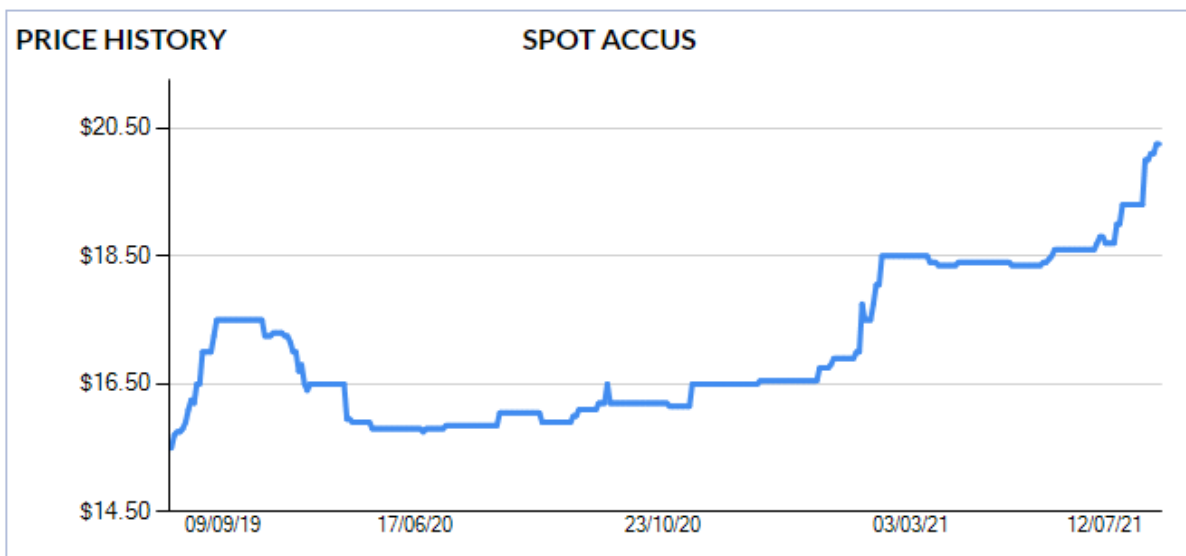


Figure 6-3: Australian Carbon Credit Units Price (July, 2021))

The Western Kimberley region utilises LNG trucked from Karratha (located nearly 1000km away) in Power plants in Broome, Derby and other remote towns. These power plants are operated by Energy

Developments Limited (EDL) who also operate the mini-LNG plant in Karratha to produce and supply LNG via multi-trailer trucks to these power plants. The total gas demand of these power plants range from 6-10 TJ/d. EDL is a potential customer if part of the gas can be captured and sold as LNG at an appropriate price.

The NetZero 2050 target set by the West Australian government has been a challenge for all gas developers in the state. The carbon abatement associated with the shale gas well tests during the exploration, appraisal and development phase of the project creates a bigger challenge in developing the Canning Basin due to the lack of existing gas infrastructure and a pipeline to market. The Canning Basin shale gas project proponents need to look at innovative concepts to capture this gas and get it to market as opposed to flaring at site where economically feasible. This would also help overcome public perceptions and regulatory pressures while providing confidence to the industry in setting a pathway for low-carbon shale gas development in the state. BNR is uniquely positioned to bring their US expertise in developing state-of-the-art low-carbon footprint shale development to Australia compared to other local shale developers.

7 Reference

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 BENNETT RESOURCES	Document No:	BNR_HSE_MP_014
	Revision:	6
	Issue Date:	27 May 2025

Appendix C Third party independent review of the GHG EMP



EVOLVEABLE
CONSULTING



VALHALLA GREENHOUSE GAS ENVIRONMENTAL MANAGEMENT PLAN

EXTERNAL PEER REVIEW

Prepared for:

AES

Peer Review Completed: June 2024

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Acronyms

Acronym	Description
ACCU	Australian Carbon Credit Units
AES	Australasian Environmental Solutions
BNR	Bennett Resources
CO _{2e}	Carbon Dioxide Equivalent
EP	Exploration Permit
EPA	Environmental Protection Authorities
GHG	Greenhouse Gas
GHG EMP	Greenhouse Gas Environmental Management Plan
HFS	Hydraulic Fracture Stimulation
MMcf/d	million cubic feet per day
TJ/day	Terajoule per day

Addendum to Peer Review Report

10th June 2024

Following the submission of the Valhalla Greenhouse Gas Emissions Management Plan (GHG EMP) Peer Review Report Revision 0 to Australasian Environmental Solutions (AES), the peer review process identified several recommendations.

AES thoroughly examined these recommendations and has since issued Revision 4 of the GHG EMP, which addresses the original Peer Review recommendations.

A subsequent review of additional information has been performed on the GHG EMP, the findings of which are encapsulated in the following summary.

This addendum documents the iterative process of review and refinement undertaken to ensure the GHG EMP's alignment with best practices and regulatory standards.

Recommendations	GHG EMP Rev 4 Peer Review
Emission targets: Increase Valhalla GHG EMP interim target to 43% reduction of baseline by 2030 to align with Commonwealth targets rather than the historical 28%.	Emission targets throughout the GHG EMP have been updated from 28% to 43%.
Methane monitoring: Given the duration of this program and the number of wells proposed, the GHG EMP should consider utilising methane detection technologies to verify ambient-level methane across the project locations after the completion of the exploration and appraisal program.	Under Section 5 of the GHG EMP, Table 5-2 demonstrates a commitment to methane monitoring after the completion of the Proposal if methane levels are above the detection limit of 3.3 mg/m ³ .
Offset location and type: Provide further detail on the preferred location or types of offsets that will be utilised to satisfy any emission liabilities.	The GHG EMP has been updated to include Section 3.11, preferred offsets and availability. This section provides detail on: • Estimated volumes of offsets • Preferred type of offsets • High-level assessment of near-term offset volume forecasts.
Offset availability: The GHG EMP should include an assessment of offset availability relevant to the worst-case potential emission liabilities and forecast market availability out to 2030.	

Basis of Conclusion

The additional information in the updated Revision 4 of the Valhalla GHG EMP addresses the identified recommendations in the Valhalla GHG EMP Peer Review Report Revision 0.

1 Introduction

Australasian Environmental Solutions engaged Evolveable Consulting Pty Ltd to perform an independent peer review of the Bennett Resources (BNR) Valhalla Greenhouse Gas Environmental Management Plan (GHG EMP) per the Western Australian Environmental Protection Authorities (EPA) *Environmental Factor Guideline: Greenhouse Gas Emissions*.

1.1 Scope

The scope of the peer review is to:

- Review emission calculations.
- Assess the demonstration of best practices relevant to the project scope.
- Review industry benchmarks, and
- Review offset liabilities and plans to satisfy (integrity and availability).

1.1.1 Project context

The project under review involves an unconventional exploration and appraisal drilling program, coupled with Hydraulic Fracture Stimulation (HFS), within the confines of Petroleum Exploration Permit EP 371 in the Canning Basin, located in the Shire of Derby/West Kimberley, Western Australia.

The primary objective of this proposal is to assess the substantial tight gas reserves anticipated in the area. Should the exploration efforts yield a petroleum resource, testing to ascertain the quality and volume of gas within the well will be necessary. The outcomes of these tests are crucial as they will inform the company's decision-making process regarding the commercial viability of the reserves.

The project is time-bound, considering the exploration and appraisal activities. Each well represents a unique emissions event, distinct from those associated with continuous operations related to a production phase. This delineation and context are essential as they underpin the practicality of implementing best practice technologies throughout the exploration and appraisal program.

1.2 Documentation Reviewed

As part of this process, the following documentation was reviewed:

- Bennet Resources, Valhalla Gas Exploration and Appraisal Program Greenhouse Gas Environmental Management Plan, Rev 4, BNR_HSE_MP_014
- GHG EMP Supporting documentation:
 - Data and calculations – Valhalla GHG Estimates_Rev G
 - Valhalla Exploration Program GHG Management Report Rev0
 - Appendix H.1 – Valhalla Air Quality and GHG Monitoring Report

- Independent Scientific Panel Inquiry into Hydraulic Fracture Stimulation in Western Australia Final Report to the Western Australian Government September 2018
- Government of Western Australia, Position Paper, Monitoring, mitigation and offsetting of Greenhouse Gas Emissions for hydraulic fracturing proposals in Western Australia.
- Northern Territory government, Code of Practice: Onshore Petroleum Activities in the Northern Territory
- United States Natural Gas STAR Program
- International Petroleum Industry Environmental Conservation Association. (2014, February 1). Green completions.
- Government of Australia's 2008 National Greenhouse and Energy Reporting (Measurement) Determination
- American Petroleum Institute's 2009 Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Natural Gas Industry

2 Emission and Target Review

2.1 Emission Estimates

As part of this review, the emissions quantifications were reviewed to ensure alignment with the requirements of the EPA *Greenhouse Gas Emissions Factor guideline*.

Section 3.1 of the GHG EMP outlines the emissions estimates for the project. This review concentrates on the material emission sources, gas and condensate flaring, which account for over 90% of the total project emissions.

A review of both calculations and assumptions was performed.

2.1.1 Scope 1

The emissions data and associated assumptions that formed the basis of the GHG EMP are consistent with recognised industry best practices in emissions accounting. Scope 1 and 3 emissions have been quantified using primarily:

1. Government of Australia's 2008 National Greenhouse and Energy Reporting (Measurement) Determination
2. American Petroleum Institute's 2009 Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Natural Gas Industry

The duration of exploration and appraisal activities will vary well to well. The GHG EMP provides a 60-day and 90-day well range, which covers a minimum and maximum scenario to cover this uncertainty.

The project is split into two phases, with Phase One maximum emissions estimated to be < 200,000 tonnes CO_{2e} per year and Phase Two maximum emissions estimated to be < 600,000 tonnes CO_{2e} per year. The total emission estimated for the exploration and appraisal program is 1,603,293 tonnes of CO_{2e}.

The methodology applied aligns with that specified within the Western Australian Government Position Paper on monitoring, mitigation and offsetting of Greenhouse Gas Emissions for hydraulic fracturing proposals in Western Australia in the context of exploration and appraisal program; as such, it does not estimate emissions for potential future operations.

2.1.2 Scope 2

Section 3.1.2 of the GHG EMP specifies that the exploration and appraisal program will operate independently without importing power from external sources; as such, there are no Scope 2 emissions.

2.1.3 Scope 3

The base case for the GHG EMP is that there will be no Scope 3 emissions as all produced fluids will be combusted via the flare.

The GHG EMP presents an alternate option that the proponent is considering: selling condensate produced during the well testing program to external parties, thereby reducing Scope 1 emissions associated with the condensate portion (approximately 129,000 tonnes CO_{2e}). This is a common practice in other regions where supporting infrastructure is readily available near the exploration site location, and demand for the condensate product exists.

Scope 3 estimates for this scenario have been estimated utilising the Government of Australia's 2008 National Greenhouse and Energy Reporting (Measurement) Determination.

Although this alternate scenario would directly reduce Scope 1 emissions, the end use of the condensate product is likely the same. When this end use is combined with transportation of the condensate between the site location and third party, the net emissions of this alternate scenario will increase compared to the base case.

2.2 Emission Targets

Section 3.3 of the GHG EMP proposes emission reduction targets that align with the historical Australian Commonwealth emission target of 28% below 2005 levels by 2030. Given Australia's increased commitment in 2022 to achieve 43% below 2005 levels by 2030, it is recommended that BNR align their commitment to the Commonwealth Government at a minimum.

Recommendation: Increase Valhalla GHG EMP interim target to 43% reduction of baseline by 2030 to align with Commonwealth targets.

3 Best Practice Review

A desktop literature review was conducted to gain insight into the best practices within the onshore gas exploration and appraisal industry in Western Australia and nationally.

International guidance was leveraged to understand best practices relevant to exploration and appraisal well greenhouse gas measures.

A summary of key guidance documents reviewed to inform this peer review is provided in Table 1.

TABLE 1: LITERATURE REVIEW OF EMISSION MITIGATION STRATEGIES IN ONSHORE PETROLEUM OPERATIONS

Guidance Document	Summary
Government of Western Australia: Monitoring, mitigation and offsetting of Greenhouse Gas Emissions for hydraulic fracturing proposals in Western Australia	This paper explains the State Government's position regarding implementing the Independent Scientific Panel Inquiry into Hydraulic Fracture Stimulation in Western Australia's (the Inquiry) recommendations for monitoring, mitigating, and offsetting greenhouse gas emissions from hydraulic fracturing proposals in Western Australia. Five key guiding principles are outlined, including the consideration of exploration activities. Since this paper was published, the Environmental Protection Authority has released further guidance on greenhouse gas emissions.
Independent Scientific Panel Inquiry into Hydraulic Fracture Stimulation in Western Australia Final Report to the Western Australian Government September 2018	Section 10.9 of the Inquiry Report discusses Green Completions, specifically Recommendation 12, which acknowledges that reduced (greens) emissions completions should be a requirement apart from the early exploratory phase of development. Section 10.10 states that GHG emissions from the exploration phase of unconventional gas exploration present a negligible environmental risk, even without reduced emission completions.

Northern Territory government, Code of Practice: Onshore Petroleum Activities in the Northern Territory. Link: Code of practice: Onshore petroleum activities in the Northern Territory	The Code of Practice for Onshore Petroleum Activities in the Northern Territory provides a framework for ensuring environmentally responsible petroleum operations within the region.
United States, Natural Gas STAR Program. Link: https://www.epa.gov/natural-gas-star-program/reduced-emission-well-completions-and-workovers	This initiative offers strategies for reduced emission well completions and workovers, aiming to minimise the environmental impact of natural gas operations.
IPIECA. (2014, February 1). Green completions. Link: https://www.ipieca.org/resources/energy-efficiency-solutions/units-and-plants-practices/green-completions-2014/	This resource offers insights into energy-efficient solutions for green completions in the oil and gas industry.

The review of best practice guidance indicates substantial opportunities for emission reductions throughout the well development phase and subsequent production and operational stages. However, it is recognised that the emission reduction opportunities for exploration and appraisal are somewhat constrained due to various factors, including, but not limited to:

- Site location
- Lack of pre-existing infrastructure, such as gas transmission networks.
- The regional context of the operations.

3.1 Scope 1

Section 3.4.1 of the GHG EMP summarises potential emission reduction opportunities, which was informed by a detailed study, the Valhalla Gas Exploration Program GHG Management Report.

This report reviewed national and international sources for information on industry best practices. It considered each of the proposed emission reduction opportunities in the context of the Valhalla Exploration and Appraisal program, including site location constraints, regional context, and regulatory regime. In addition, it considered the findings of the Western Australian Hydraulic Fracking Inquiry Report.

A total of nine emission reduction opportunities are identified for the project. Of the nine, four have been selected to reduce Scope 1 emissions. These are:

- Well design – Horizontal vs Vertical

- Flaring versus venting
- Selection of efficient diesel generators
- Renewables (lighting towers)

Condensate capture for sale or other use has been identified as an opportunity under consideration; however, the lifecycle perspective has been considered and presented within the GHG EMP. Whilst this presents an opportunity to reduce Scope 1 emissions, it shifts the emissions to Scope 3 while adding further transportation emissions. Additional details on this are provided in Section 3.2.3.

Three emission reduction opportunities were identified but not progressed due to commercial or technical feasibility. These were:

- Renewables for power generation
- Compressed Natural Gas
- Micro Liquified Natural Gas

Conclusion:

- The emission reduction opportunities proposed within the GHG EMP for exploration and appraisal activities align with national and international industry best practices when considering the project-specific context.

3.2 Scope 2

There are no Scope 2-related emissions on this project.

3.3 Scope 3

The project's base case scenario assumes no scope 3 emissions related to the consumption of gas and condensate, and test fluids will be flared onsite.

As detailed in Section 2.1.3 of this review, if the condensate portion of well test fluids is separated and captured, it could be utilised; however, considering the emissions related to the transport of these fluids combined with a similar end use, this would increase the project's net emissions.

3.4 Monitoring

A baseline GHG monitoring assessment was undertaken in 2021 to satisfy the requirements of the Monitoring, mitigation, and offsetting of GHG Emissions for hydraulic fracturing proposals in Western Australia. This evaluation included baseline methane measurements at three sites, with results below the detection threshold of 6.6 milligrams.

The GHG EMP Table 5-1 and Table 5-2 commit to monitoring the direct activity-related emissions but not ongoing monitoring of the broader ambient environment.

With technological advancements in methane detection in recent years, various cost-effective methods are now accessible for frequent monitoring of methane concentrations throughout the project area during operational activities.

The Code of Practice for Onshore Petroleum Activities in the Northern Territory outlines the routine periodic atmospheric monitoring programme requirements, including specific methane monitoring requirements prior to the exploration and production phases.

Recommendation: Given the duration of this program and the number of wells proposed, the GHG EMP should consider utilising methane detection technologies to verify ambient-level methane across the project locations after the completion of the exploration and appraisal program.

3.5 Industry Benchmarking

Section 3.2 of the GHG EMP provides a summary of industry benchmarking analysis. This section compares five analogous projects within Australia, evaluating them based on emissions intensity and total emissions per well.

For further context to support the peer review, international projects were reviewed by examining flow rate performance from comparable global developments to support the benchmarking context.

The benchmarking reveals that in emissions intensity—measured in tonnes of CO₂ equivalent (CO_{2e}) per well per day, Valhalla Phase 1 and Phase 2 exhibit the highest values among the projects evaluated. This higher intensity reflects the anticipated flow rates of the Valhalla project wells over a shorter duration (days) than other programs.

When analysed on a per-well basis, measured in total emissions per well, Valhalla Phase 1's potential maximum emission volumes align closely with those of the other projects. However, the emission volumes for Valhalla Phase 2 wells surpass the comparative projects for the minimum and maximum projected cases, attributed to the higher expected flow test rates due to reservoir properties.

Tamboran Resources has recently concluded an exploratory campaign in the Beetaloo Basin of the Northern Territory, identified as the Origin Energy Velkerri wells, as delineated in the GHG EMP. The appraisal of the SS-1H well yielded a flow rate of 2.9 million cubic feet per day (MMcf/d)¹, which, when normalised over a distance of 1,000 meters, equates to 5.8 MMcf/d. The original Origin Valkerri Greenhouse Gas Management Plan estimated a 2.5 TJ/day flow rate.

For the Valhalla wells, the proposed flow rates are estimated to be similar to the Tamboran Resources well in Phase 1 (5.9 MMcf/d) and approximately double in Phase 2 (10.7 MMcf/d).

¹ [ASX announcement: Tamboran Resources Corporation, April 2024](#)

This highlights the influence of expected well rates relative to emissions in exploration and appraisal activities.

As stated in Section 3.1 of this document, nine emissions reduction strategies have been evaluated, with several selected for implementation to reduce Scope 1 emissions.

4 Offset Integrity and Availability

In accordance with the EPA *Environmental Factor Guideline - Greenhouse Gas Emissions*, a review of the GHG EMP Offset commitments has been completed as part of this review.

Due to the project being exploration and appraisal, the volume of emissions will be proportional to the flaring durations required to gain sufficient data to understand the reservoir. The GHG EMP has set targets regarding emissions; if these are exceeded, this will trigger offset liabilities for the project.

A review of GHG emission calculations and targets estimates that the project's offset liabilities could be greater than 400,000 tonnes CO_{2e}.

The recommendation identified in Section 2.2 of this document regarding increasing the interim target to align with Australia's commitment may impact the number of offsets required for this proposal.

4.1 Offset Integrity

Section 3.9 of the GHGEMP has set the following offset integrity criteria.

- Australian Carbon Credit Units (ACCUs) issued under the Commonwealth Carbon Credits (Carbon Farming Initiative) Act 2011
- eligible offsets under the standard Climate Active Carbon Neutral Standard for Organisations (Climate Active 2020), in addition to ACCUs, include:
 - verified emission reductions issued under the Gold Standard
 - verified carbon units issued under the Verified Carbon Standard
 - Certified emissions reductions are issued per the Kyoto Protocol rules from Clean Development Mechanism projects.
 - removal units issued by a Kyoto Protocol country on the basis of land use, land use change and forestry activities under Article 3.3 or Article 3.4 of the Kyoto Protocol.

No details on the preferred location or types of offsets are provided within the GHG EMP.

Recommendation: Provide further detail on the preferred locations or types of offsets that will be utilised to satisfy any emission liabilities.

4.2 Offset Availability

The GHG EMP does not estimate potential liabilities due to the uncertain nature of exploration and appraisal activities. However, based on a review of calculations, liabilities could be greater than 400,000 tonnes CO_{2e} in a worst-case emissions scenario for the project.

No assessment relevant to the availability of offsets has been completed within the GHG EMP; however, in Section 3.9 of the GHG EMP BNR commits that where and when required, they will acquire carbon offsets that meet the contemporary Australian acceptability standards (e.g., they should meet offset integrity principles and be based on transparent, enforceable, and accountable methods).

Based on a review of ACCU volumes estimated for 2024, sufficient offsets will likely be available in the near term. However, the process for assessing this availability is not evident within the GHG EMP.

Recommendation: The GHG EMP should include an assessment of offset availability relevant to the worst-case potential emission liabilities and forecast market availability out to 2030.

5 Summary

Basis of Conclusion

We believe the evidence we have obtained is sufficient and appropriate to provide a basis for the conclusion regarding:

- Emissions quantification: The methodology and assumptions utilised to estimate emissions align with good emissions accounting practices.
- Demonstration of best practice: The scope 1 emission reduction opportunities assessed within the GHG EMP for exploration and appraisal activities align with both national and international industry best practices relevant to the context of the project based on the literature review performed.
- Offset integrity: BNR have committed to reputable carbon offset integrity standards within the GHG EMP.

Recommendations:

- Emission targets: Increase Valhalla GHG EMP interim target to 43% reduction of baseline by 2030 to align with Commonwealth targets rather than the historical 28%.
- Methane monitoring: Given the duration of this program and the number of wells proposed, the GHG EMP should consider utilising methane detection technologies to verify ambient-level methane across the project locations after the completion of the exploration and appraisal program.
- Offset location and type: Provide further detail on the preferred location or types of offsets that will be utilised to satisfy any emission liabilities.
- Offset availability: The GHG EMP should include an assessment of offset availability relevant to the worst-case potential emission liabilities and forecast market availability out to 2030.

We have:

- Used our professional judgement to assess the GHG emission quantification methodology for the Project along with the proposed emission reduction opportunities.
- Considered credible external literature sources to inform our basis for best practice mining design and operations and
- Ensured that the review team possessed the appropriate knowledge, skills and professional competencies.

Use of this Peer Review Report

This report has been prepared for AES to provide a conclusion on demonstrating best practice, offset integrity, and availability, but it may not be suitable for any other purpose.

This Peer Review is based on our current understanding and knowledge, which may evolve, and we make no express or implied representations or warranties regarding the accuracy or completeness of the conclusions in this report. We disclaim any assumption of responsibility for any reliance on this report.

Statement of independence, impartiality and competence

Evolveable Consulting is an independent environmental engineering company specialising in decarbonisation, sustainability, and circular economy services.

No team member has a business relationship with BNR, beyond that required of this assignment. Evolveable Consulting conducted this review independently, and to our knowledge, there has been no conflict of interest.

The review team has extensive experience conducting assurance reviews of engineering designs, environmental information, systems, and processes.





Appendix 6. Monitoring Data Overview

An overview of the monitoring bore details utilised for the regional baseline program is included in the table below.

Monitoring bore	2023 Schematic overview	Installation information	Earliest monitoring record
AB1D	- stick-up: 0.7 m - standing water level: 21.780 m btoc - screened interval: 67.0-76.6 m btoc - bottom of casing: 76.6 m btoc - ant ingress and some ant material build-up on walls from 20 m btoc	Contractor: Kimberley Water Installation Date: May 2014	14/05/2014
AB1S	- stick-up: 0.5 m - standing water level: 23.070 metres below top of casing (m btoc) - screened interval: 30.8-36.3 m btoc - bottom of casing: 36.3 m btoc - some white build-up on lower ~5 m of casing walls	Other details: Although Form-2 was for the production bore (not required form monitoring bores) all bores were installed at the same time. [refer to attachment A]	14/05/2014
VNB4S	- stick-up: 0.5 m - standing water level: 30.686 m btoc - screened interval: 36.6 m btoc - bottom of casing: 42.3 m btoc - no or minor build-up on casing walls	Contractor: Kimberley Water Installation Date: July 2014	13/07/20214
VNB4D.	- stick-up: 0.7 m - standing water level: 30.956 m btoc - screened interval: 66.9-78.3 m btoc - bottom of casing: 78.4 m btoc - minor build-up on casing walls	Although Form-2 was for the production bore (not required form monitoring bores) all bores were installed at the same time. [refer to attachment B]	13/07/20214

A summary of the environmental monitoring sampling results between 2014 and 2021 relevant to methane are provided in the tables below.

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Author / Reviewer:	AES		Approver:	Michael Laurent		
Review Frequency: Extreme/High=1yr; Medium=2yr; Low=3yr		2	Date Review Due:	TBC	Page:	132 of 139

**AB1S and AB1D environmental monitoring bores**

Stage of Previous Project	Monitoring Event	Sampled by	Methane LoR	Sampling Methodology
Baseline	14/05/2014	Buru	.01 mg/L	High-flow
Baseline	8/06/2014	Buru	.01 mg/L	High-flow
Baseline	16/08/2014	Buru	.01 mg/L	High-flow
Baseline	8/11/2014	Buru	.01 mg/L	High-flow
Baseline	10/02/2015	Buru	0.005 mg/L	High-flow
Baseline	27/3/2015	Buru	0.005 mg/L	High-flow
Baseline	19/05/2015	Buru	0.005 mg/L	High-flow
Baseline	16/06/2015	Buru	0.005 mg/L	High-flow
Baseline	19/07/2015	Buru	0.005 mg/L	High-flow
Baseline	19/08/2015	Buru	0.005 mg/L	High-flow
HF Operations	1/09/2015	Buru	0.005 mg/L	High-flow
HF Operations	15/09/2015	Buru	0.005 mg/L	High-flow
HF Operations	13/10/2015	Buru	0.005 mg/L	High-flow
HF Operations	18/11/2015	Buru	0.005 mg/L	High-flow
HF Operations	16/12/2015	Buru	0.005 mg/L	High-flow
Post Operations	20/04/2016	Buru	0.005 mg/L	High-flow
Post Operations	27/07/2016	Buru	0.005 mg/L	High-flow
Post Operations	12/10/2016	Buru	0.005 mg/L	High-flow
Post Operations	23/05/2017	Buru	0.005 mg/L	High-flow
Post Operations	29/11/2017	Buru	0.005 mg/L	High-flow
Post Operations	24/05/2018	Buru	0.005 mg/L	High-flow
Post Operations	18/10/2018	Buru	0.005 mg/L	High-flow
Post Operations	25/06/2019	Buru	0.005 mg/L	High-flow
Post Operations	26/05/2021	Bennett Resources	0.001 mg/L	Low-flow
Post Operations	22/08/2021	Bennett Resources	0.001 mg/L	Low-flow
Post Operations	20/11/2021	Bennett Resources	0.001 mg/L	Low-flow
Post Operations	07/05/2022	Bennett Resources	0.001 mg/L	Low-flow
Post Operations	04/08/2022	Bennett Resources	0.001 mg/L	Low-flow
Post Operations	10/11/2022	Bennett Resources	0.001 mg/L	Low-flow

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AES

Approver:

Michael Laurent

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2

Date Review Due:

TBC

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VNB4S and VNB4D environmental monitoring bores

Stage of Previous Project	Monitoring Event	Sampled	Methane LoR	Sampling Methodology
Baseline	13/07/2014	Buru	.01 mg/L	High-flow
Baseline	9/11/2014	Buru	.01 mg/L	High-flow
Baseline	9/02/2015	Buru	.01 mg/L	High-flow
Baseline	26/3/2015	Buru	.01 mg/L	High-flow
Baseline	19/05/2015	Buru	0.005 mg/L	High-flow
Baseline	15/06/2015	Buru	0.005 mg/L	High-flow
Baseline	19/07/2015	Buru	0.005 mg/L	High-flow
Baseline	19/08/2015	Buru	0.005 mg/L	High-flow
Baseline	31/08/2015	Buru	0.005 mg/L	High-flow
HF Operations	15/09/2015	Buru	0.005 mg/L	High-flow
HF Operations	12/10/2015	Buru	0.005 mg/L	High-flow
HF Operations	17/11/2015	Buru	0.005 mg/L	High-flow
HF Operations	15/12/2015	Buru	0.005 mg/L	High-flow
HF Operations	27/01/2016	Buru	0.005 mg/L	High-flow
Post Operations	20/04/2016	Buru	0.005 mg/L	High-flow
Post Operations	27/07/2016	Buru	0.005 mg/L	High-flow
Post Operations	12/10/2016	Buru	0.005 mg/L	High-flow
Post Operations	23/05/2017	Buru	0.005 mg/L	High-flow
Post Operations	29/11/2017	Buru	0.005 mg/L	High-flow
Post Operations	24/05/2018	Buru	0.005 mg/L	High-flow
Post Operations	18/10/2018	Buru	0.005 mg/L	High-flow
Post Operations	26/06/2019	Buru	0.005 mg/L	High-flow
Post Operations	26/05/2021	Bennett Resources	0.001 mg/L	Low-flow
Post Operations	22/08/2021	Bennett Resources	0.001 mg/L	Low-flow
Post Operations	20/11/2021	Bennett Resources	0.001 mg/L	Low-flow
Post Operations	20/03/2022	Bennett Resources	0.001 mg/L	Low-flow
Post Operations	06/05/2022	Bennett Resources	0.001 mg/L	Low-flow
Post Operations	04/08/2022	Bennett Resources	0.001 mg/L	Low-flow
Post Operations	09/11/2022	Bennett Resources	0.001 mg/L	Low-flow

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Approver:

Michael Laurent

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Issue Date:	10/06/2025

Discussion of sampling validity

Although not initially collected in the sampling suite (in 2020) on review of existing Data, Bennett Resources identified that methane had been recorded in the 2018 and 2019 period. Although this was trending downwards, BNR opted to re-commence sampling for methane in water.

The two key differences in monitoring methods, as detailed in the tables above, were:

1. the change in operator, and
2. change in methodology from a high flow to a low-flow methodology.

It should be noted that all water monitoring results have been submitted to the state regulator, The Department of Energy, Mines, Industry Regulation and Safety (DEMIRS), and the state Department of Water (DoW) as required under the Petroleum and Geothermal Energy Resources Act 1967. BNR are not aware of any inquiry or uncertainty regarding the submitted results from these Departments.

Change in operator (personnel)

The previous operator owned their own sampling equipment and the change in operator meant that a new approach to sampling must be implemented given the lack of access to the previous people involved in the sampling program. BNR utilised AES to complete groundwater sampling. AES ensured that a handover occurred in 2020 during the broader EP371 sampling program thus was not new to sampling on-ground within EP371 at these sites when sampling recommenced in 2021. Detailed field notes were completed by AES with these included as Attachment C.

Following completion of 2022 sampling, BNR opted to revert back to the existing required sampling regime committed to by the previous operator in accordance with the Petroleum and Geothermal Energy Resources Act 1967. This reduced sampling from quarterly (4 times a year) to 6-monthly and reduced the number of bores sampled (focussing on surveillance bores only) along with the parameters tested. Given the cost associated with sampling for dissolved gases, these constituents were removed given historic results were consistently below the limit of reporting.

With this change in program, BNR engaged GEMEC to be responsible for ongoing sampling within EP371. A review of sampling parameters post 2022 indicate that parameters have remained constant and consistent with earlier monitoring programs.

Change in method (equipment)

BNR switched to a low-flow methodology for multiple reasons. An analysis of the methodologies was completed in 2020, but consistent with the US EPA's Low Flow groundwater sampling procedures, BNR identified that changing to a low-flow methodology BNR would more likely get samples that were representative contaminants present (including dissolved gases) with less potential for operator variability and smaller purging volumes. Given the change in operator, BNR believed that this method would provide the most appropriate method for recording if dissolved gases were present or not.

Although BNR acknowledges that this change in methodology aligns with the reduction in methane records a lower limit of reporting was also introduced which would have accounted for lower trace readings if the gases were present and the samples were disturbed. On review all other constituents remained constant with limited variability post 2021 indicating that the change in methodology and operator was unlikely the reason for the absence of methane in the samples. Further to this, sampling in 2019 indicated that methane levels were trending back towards baseline levels suggesting that the samples collected between 2021 and 2022 were sufficient.

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Attachment A: Form 2 Asgard monitoring bore

Attachment B: Form 2 Valhalla monitoring bore

Attachment C: Field notes sampling 2021-2022

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Information to be provided on completion of a non-artesian well

Information to be provided to the Department of Water under the *Water Agencies (Powers) Act 1984* and Section 26E of the *Rights in Water and Irrigation Act 1914* and Regulation 39 of the *Rights in Water and Irrigation Regulations 2000*

Please note:

- All information is to be written clearly and in block letters.
- If insufficient room please use a separate piece of paper.
- It is the responsibility of the person carrying out the works to fill out this form.

Part 1: Details of any licence granted for the work under the *Rights in Water And Irrigation Act 1914* section 26D

Licence number

CAW

☐ Individual

☐ Company

Licensee's full name

Bureau

Part 2: Details of person carrying out the works

Company

KIMBALLY WATER

Driller

V Hoile

Driller licence number
(non-mandatory)

144

Driller classification
(non-mandatory)

CLASS 2

Postal address

P.O. 495

Broomie

Telephone

91 921 638

Facsimile

Email

KWATER@WESTNET.COM.AU

Part 3: Location of well

A 26D licence will list the premises on which well construction is to occur.

If the physical address of the well is different from the property address listed on the licence, contact the Department of Water prior to the commencement of construction.

Property address of well or other tenure details

ASGARD.

Well coordinates

☐ GPS reading

☐ Estimate

Zone

Easting/
latitude

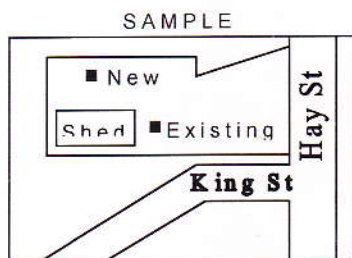
Datum

(e.g. GDA94/WGS84)

Northing/
longitude

GPS
reliability

Location plan – in the box below please sketch a plan showing position of well in relation to building, boundaries, road, nearest cross road and any additional information to assist in locating the well.



In the box to the right, please sketch a plan showing:

- location of all wetlands / watercourses / wells / soaks (existing and proposed).
- major improvements (house, large sheds etc).
- shaded sections to indicate areas under development.

Part 4: Construction details (All measurements are to be taken from ground level)

Production casing detail					
Material	Nominal bore	Diameter O.D (mm)	Wall thickness (mm)	Depth	
				From (m)	To (m)
PVC	200	225	16	0	210

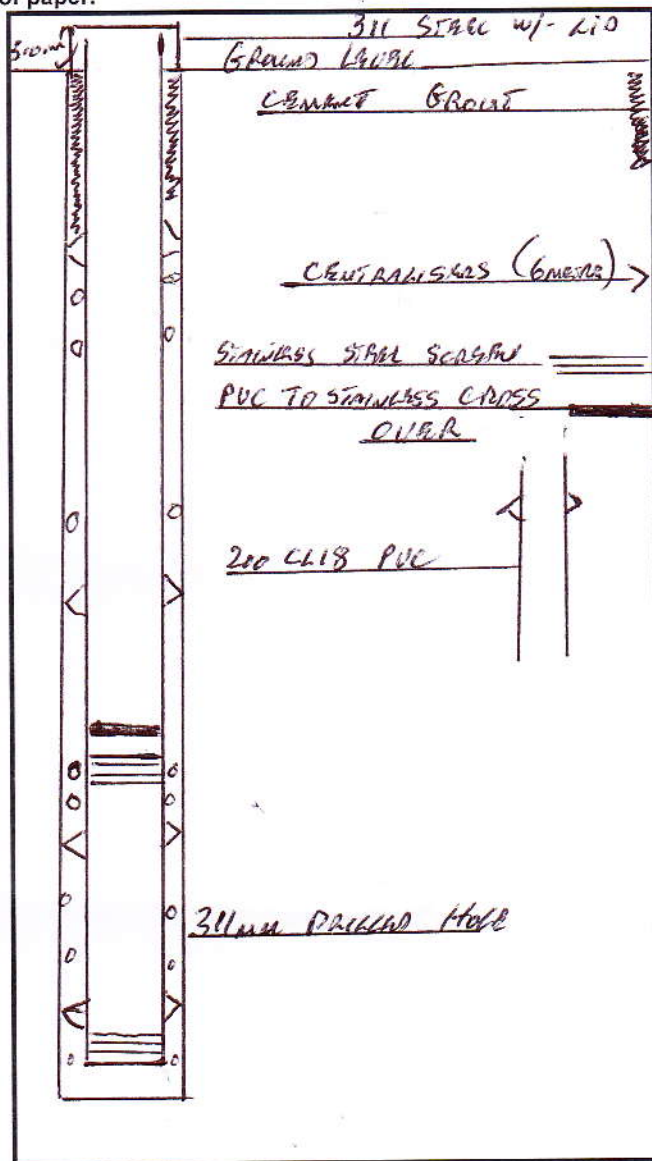
Screens/slots				
Screens/slot (type)	Diameter O.D (mm)	Aperture (mm)	Top of screen (m)	Bottom of screen (m)
STAINLESS	220	4	210	246
STEEL				
WADGE WIRE				

Gravel pack details		
Gravel size (mm)	From (m)	To (m)
	70	246

Annular fill		
Material type	From (m)	To (m)

Cementing detail		
☐ Pressure cement grouted	☒ Tremmie	
Casing diameter (mm O.D)	Depth	
	From (m)	To (m)
	2	70

Please complete well construction diagram in box provided below. If insufficient room please attach on separate piece of paper.



Total depth drilled (from ground level)

246

Geophysical log required as condition of licence?

☐ Yes

☒ No

Geophysical log taken? (attach log and contractor details)

☐ Yes

☒ No

From (m)	To (m)	Strata description (If insufficient room attach on separate page)
0	12	PINDAN - CALCAREOUS
12	36	CLAY - GRAVEL - LIVERINGA SILTSTONE
36	120	LIVERINGA SILTSTONE SMALL FRACTURES
120	190	- WITH SILTSTONE FRACTURES
190	220	SILTSTONE WITH SANDY FINE LAYERS
220	246	FRACTURED SILTSTONE MAIN AQUIFERS

Part 5: Particulars of well

Drilling start date refers to the date drilling begins. Do not include set up date.

Drilling completion date includes well development and testing.

Well name / number

Drilling start

13-4-2014

Drilling completion

20-4-2014

Drilling method used



Rotary air



Cable tool



Auger



Rotary mud



Sludge



Other (specify)

Final status of well



Ready to operate



Decommissioned



Other (specify)

Purpose (use) of well



Production



Investigation



Monitoring



Other (specify)

Part 6: Well development

Date (dd/mm/yy)

Duration of development

4

hours

Method



Airlift



Pump



Jetting



Surging

Development pump rate
(e.g. L/s, m³/day)

20 L/s

Part 7: Pump testing (If applicable)

Date start
(dd/mm/yy)

20/5/2014

Date end
(dd/mm/yy)

21-5-2014

Duration of test

24

hours



Step test



Constant rate



Other

Constant rate -
pump rate (e.g.
m³/day)

500 m³/day

Pump type (e.g. submersible)

SUBMERSIBLE

Water rest level
prior to test (m)

27

Measurements taken from



top of casing (TOC)



ground level (GL)



other (specify)

Final drawdown is the distance between the static water level measured prior to the test and the water level measured at the end of the pumping test.

Elevation of measurement
reference point if known
(metres AHD)



GPS



Estimate



other (specify)

Final drawdown

120 m

Recommended supply (e.g. m³/day)

1000 m³/day

Comments.....

Part 8: Field samples

Specify unit
measurements.

Collection method (e.g. pump test,
airlift)

PUMP TEST

Conductivity
(e.g. mS/m)

850 ppm



Temperature compensated



Temperature uncompensated

pH

7.8

Water temperature
at test

40°

Comments.....

Part 9: Lab samples

Lab samples
taken
(Please attach)



Yes



No

TDS (e.g. mg/l)

Please submit samples separately to form if not received before the 1 month submission deadline.

Part 10: Water levelsSWL
(Static water level) 27 mWater cut at 220 mMeasurements taken from ☒ top of casing (TOC) ☐ ground level (GL)
☐ other (specify) _____Date of reading
(dd/mm/yy) 22/5/2014

Comments.....

Part 11: Declaration and signatureCapacity of person
making declaration:

- ☒ An individual who carried out the work
- ☐ An officer who is a director or secretary of a corporation that carried out the work.
- ☐ Other (describe).....

I, VICTOR HOILZ (name of person making declaration) declare that the information provided on this form is true and correct.

Important information

- All information must be completed on the form unless otherwise indicated as optional for example; provision of the drillers licence number and classification fields are not mandatory and can be filled in at the drillers discretion. Provision of non-mandatory details would greatly assist the department in completion of its data set.
- Failure to complete all mandatory details and to submit the form to the department is an offence under the *Rights in Water and Irrigation Act 1914*.
- Under section 26E and regulation 39 within 1 month of completion of the construction of or deepening of the well, the person carrying out the work for a 26D licence must submit this form.
- Non-artesian wells in proclaimed areas require a licence unless exempted under the *Rights in Water and Irrigation Exemption (S26C) Order 2007*.

Where and how to submit this form

This form can be submitted by fax, post or in person to the appropriate Department of Water regional office. For assistance in completing this form contact your regional office.

Kimberley Region

Kununurra Regional Office
27 Victoria Hwy
Kununurra WA 6743
Tel: 08 9166 4100
Fax: 08 9168 3174
PO Box 625
Kununurra WA 6743

Midwest Gascoyne Region

Geraldton Regional Office
94 Sandford Street
Geraldton WA 6531
Tel: 08 9965 7400
Fax: 08 9964 5983
PO Box 81
Geraldton WA 6531

Carnarvon

Carnarvon District Office
211 Robinson Street
Carnarvon WA 6701
Tel: 08 9941 6100
Fax: 08 9941 4931
PO Box 81
Carnarvon WA 6701

Kwinana Peel Region

Mandurah Regional Office
107 Breakwater Parade
Mandurah WA 6210
Tel: 08 9550 4222
Fax: 08 9581 4560
PO Box 332
Mandurah WA 6210

South West Region

Bunbury Regional Office
35-39 McCombe Road
Bunbury WA 6230
Tel: 08 9726 4111
Fax: 08 9726 4100
PO Box 261
Bunbury WA 6231

Busselton

Busselton District Office
Suite 2, 72 Duchess Street
Busselton WA 6280
Tel: 08 9781 0188
Fax: 08 9754 4335
PO Box 269
Busselton WA 6280

South Coast Region

Albany Regional Office
5 Bevan Street
Albany WA 6330
Tel: 08 9842 5760
Fax: 08 9842 1204
PO Box 525
Albany WA 6331

Pilbara Region

Karratha Regional Office
Lot 4608 Cherratta Road
Karratha Industrial Estate
Karratha WA 6714
Tel: 08 9144 2000
Fax: 08 9144 2610
PO Box 836
Karratha WA 6714

Swan Avon Region

Victoria Park Regional Office
7 Ellam Street
Victoria Park WA 6100
Tel: 08 6250 8000
Fax: 08 6250 8050

Warren Blackwood District

Manjimup Regional Office
52 Bath Street
Manjimup WA 6528
Tel: 08 9771 1878
Fax: 08 9771 4335

Please retain a copy of this form for your records



Information to be provided on completion of a non-artesian well

Information to be provided to the Department of Water under the *Water Agencies (Powers) Act 1984* and Section 26E of the *Rights in Water and Irrigation Act 1914* and Regulation 39 of the *Rights in Water and Irrigation Regulations 2000*

Please note:

- All information is to be written clearly and in block letters.
- If insufficient room please use a separate piece of paper.
- It is the responsibility of the person carrying out the works to fill out this form.

Part 1: Details of any licence granted for the work under the *Rights in Water And Irrigation Act 1914* section 26D

Licence number

CAW

☐ Individual

☐ Company

Licensee's full name

Part 2: Details of person carrying out the works

Company

KIMBERLEY WATER

Driller

V HOILA

Driller licence number
(non-mandatory)

1444

Driller classification
(non-mandatory)

Postal address

P.O. 495

BLOOMIE

Telephone

08 91921638

Facsimile

Email

KWATER@WASTWATER.COM.AU

Part 3: Location of well

A 26D licence will list the premises on which well construction is to occur.

If the physical address of the well is different from the property address listed on the licence, contact the Department of Water prior to the commencement of construction.

Property address of well or other tenure details

Zone

Easting/
latitude

Datum

(e.g. GDA94/WGS84)

Well coordinates

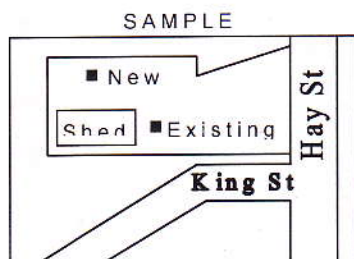
☐ GPS reading

☐ Estimate

Northing/
longitude

GPS
reliability

Location plan – in the box below please sketch a plan showing position of well in relation to building, boundaries, road, nearest cross road and any additional information to assist in locating the well.



In the box to the right, please sketch a plan showing:

- location of all wetlands / watercourses / wells / soaks (existing and proposed).
- major improvements (house, large sheds etc).
- shaded sections to indicate areas under development.

Part 4: Construction details (All measurements are to be taken from ground level)

Production casing detail					
Material	Nominal bore	Diameter O.D (mm)	Wall thickness (mm)	Depth	
				From (m)	To (m)
PVC	200	225	11	0	138

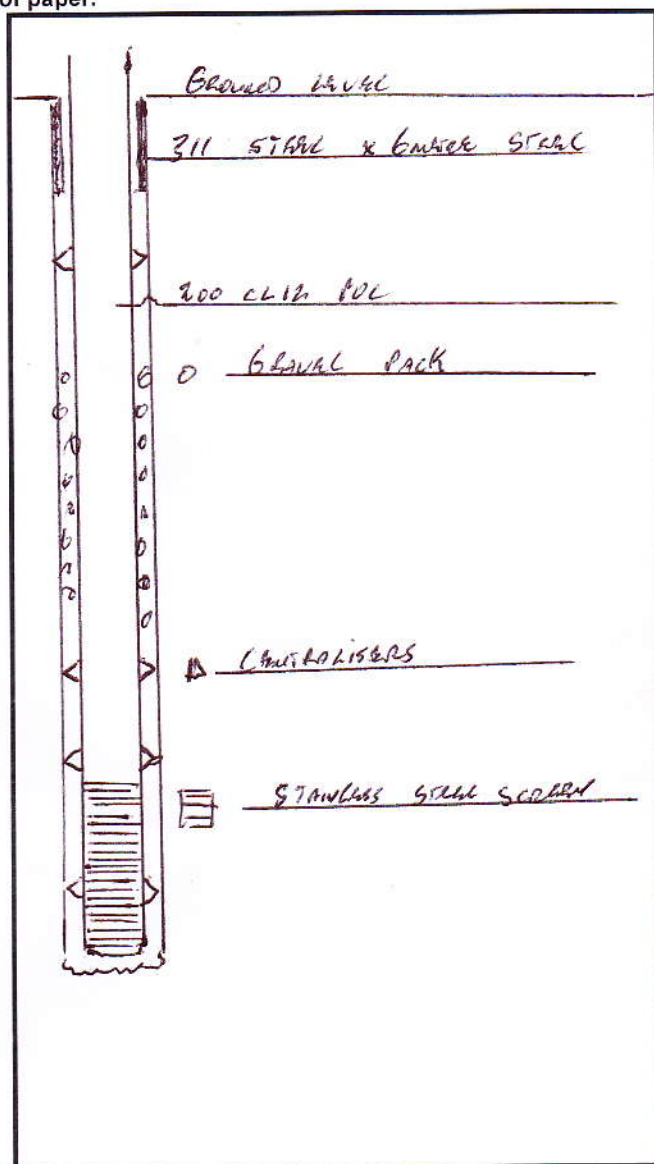
Screens/slots				
Screens/slot (type)	Diameter O.D (mm)	Aperture (mm)	Top of screen (m)	Bottom of screen (m)
STAINLESS	167	6	138	150
STEEL				
WEDGE WIRE				

Gravel pack details		
Gravel size (mm)	From (m)	To (m)
16-32	100	150

Annular fill		
Material type	From (m)	To (m)
CEMENT + 5%	0	100
BLASTONITE		

Cementing detail		
☐ Pressure cement grouted	☒ Tremmie	
Casing diameter (mm O.D)	Depth	
	From (m)	To (m)
320	0	100
STEEL		
+ ANNULUS		

Please complete well construction diagram in box provided below. If insufficient room please attach on separate piece of paper.



Total depth drilled (from ground level)

150

Geophysical log required as condition of licence?

☐ Yes

☒ No

Geophysical log taken? (attach log and contractor details)

☐ Yes

☒ No

From (m)	To (m)	Strata description (If insufficient room attach on separate page)
0	6	GRAVEL WITH BROWN CLAY
6	18	CEMENTED BROWN SILSTONE
18	24	FINE SOFT ~
24	120	~ BLACK GRAY SILSTONE
120	140	FINE FRACTURED ~
140	146	MEDIUM BROWN SOFT SAND
146	150	FRACTURED SILSTONE

Part 5: Particulars of well

Drilling start date refers to the date drilling begins. Do not include set up date.

Drilling completion date includes well development and testing.

Well name / number	VALHALLA NORTH Production Block		
Drilling start	24-6-2014	Drilling completion	1-7-2014
Drilling method used	☐ Rotary air ☐ Cable tool ☐ Auger ☒ Rotary mud		
	☐ Sludge ☐ Other (specify) _____		
Final status of well	☒ Ready to operate ☐ Decommissioned		
	☐ Other (specify) _____		
Purpose (use) of well	☒ Production ☐ Investigation ☐ Monitoring		
	☐ Other (specify) _____		

Part 6: Well development

Date (dd/mm/yy)	1-7-2014	Duration of development	3 hours
Method	☒ Airlift ☐ Pump ☐ Jetting ☐ Surging		
Development pump rate (e.g. L/s, m ³ /day)		13 l/sec	

Part 7: Pump testing (If applicable)

Date start (dd/mm/yy)		Date end (dd/mm/yy)		Duration of test	hours
☐ Step test ☐ Constant rate ☐ Other					
Constant rate - pump rate (e.g. m ³ /day)		Pump type (e.g. submersible)			
Water rest level prior to test (m)					
Measurements taken from ☐ top of casing (TOC) ☐ ground level (GL)					
☐ other (specify) _____					

Final drawdown is the distance between the static water level measured prior to the test and the water level measured at the end of the pumping test.

Elevation of measurement reference point if known (metres AHD)

☐ GPS ☐ Estimate
☐ other (specify) _____

Final drawdown	120 m	Recommended supply (e.g. m ³ /day)	13 l/sec
----------------	-------	---	----------

Comments: AIR LIFT TEST THROUGHOUT V. NOISE

Part 8: Field samples

Specify unit measurements.	Collection method (e.g. pump test, airlift)	AIR LIFT	
Conductivity (e.g. mS/m)		☐ Temperature compensated pH ☐ Temperature uncompensated	
Water temperature at test			

Comments: UNABLE TO CONDUCT FIELD TEST DUE TO FAULT WATER TEST N/A

Part 9: Lab samples

Lab samples taken (Please attach)

☒ Yes
☒ No

TDS (e.g. mg/l)

Please submit samples separately to form if not received before the 1 month submission deadline.

Part 10: Water levelsSWL
(Static water level) 140 mWater cut at 140 mMeasurements taken from ☒ top of casing (TOC) ☐ ground level (GL)
☐ other (specify) _____Date of reading
(dd/mm/yy) 1-7-2014

Comments.....

Part 11: Declaration and signatureCapacity of person
making declaration:

- ☒ An individual who carried out the work
- ☐ An officer who is a director or secretary of a corporation that carried out the work.
- ☐ Other (describe).....

I, Vicente R Hoile (name of person making declaration) declare that the information provided on this form is true and correct.

Important information

- All information must be completed on the form unless otherwise indicated as optional for example; provision of the drillers licence number and classification fields are not mandatory and can be filled in at the drillers discretion. Provision of non-mandatory details would greatly assist the department in completion of its data set.
- Failure to complete all mandatory details and to submit the form to the department is an offence under the *Rights in Water and Irrigation Act 1914*.
- Under section 26E and regulation 39 within 1 month of completion of the construction of or deepening of the well, the person carrying out the work for a 26D licence must submit this form.
- Non-artesian wells in proclaimed areas require a licence unless exempted under the *Rights in Water and Irrigation Exemption (S26C) Order 2007*.

Where and how to submit this form

This form can be submitted by fax, post or in person to the appropriate Department of Water regional office. For assistance in completing this form contact your regional office.

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Kununurra Regional Office
27 Victoria Hwy
Kununurra WA 6743
Tel: 08 9166 4100
Fax: 08 9168 3174
PO Box 625
Kununurra WA 6743

Midwest Gascoyne Region

Geraldton Regional Office
94 Sandford Street
Geraldton WA 6531
Tel: 08 9965 7400
Fax: 08 9964 5983
Po Box 81
Geraldton WA 6531

Carnarvon

Carnarvon District Office
211 Robinson Street
Carnarvon WA 6701
Tel: 08 9941 6100
Fax: 08 9941 4931
PO Box 81
Carnarvon WA 6701

Kwinana Peel Region

Mandurah Regional Office
107 Breakwater Parade
Mandurah WA 6210
Tel: 08 9550 4222
Fax: 08 9581 4560
PO Box 332
Mandurah WA 6210

South West Region

Bunbury Regional Office
35-39 McCombe Road
Bunbury WA 6230
Tel: 08 9726 4111
Fax: 08 9726 4100
PO Box 261
Bunbury WA 6231

Busselton

Busselton District Office
Suite 2, 72 Duchess Street
Busselton WA 6280
Tel: 08 9781 0188
Fax: 08 9754 4335
PO Box 269
Busselton WA 6280

South Coast Region

Albany Regional Office
5 Bevan Street
Albany WA 6330
Tel: 08 9842 5760
Fax: 08 9842 1204
PO Box 525
Albany WA 6331

Pilbara Region

Karratha Regional Office
Lot 4608 Cherratta Road
Karratha Industrial Estate
Karratha WA 6714
Tel: 08 9144 2000
Fax: 08 9144 2610
PO Box 836
Karratha WA 6714

Swan Avon Region

Victoria Park Regional Office
7 Ellam Street
Victoria Park WA 6100
Tel: 08 6250 8000
Fax: 08 6250 8050

Warren Blackwood District

Manjimup Regional Office
52 Bath Street
Manjimup WA 6528
Tel: 08 9771 1878
Fax: 08 9771 4335

Please retain a copy of this form for your records



BENNETT RESOURCES

Water Sampling – Field Data

Site GWC 1 EP 371 - Valhalla Program GWC 2 framework					Control Sites (Baseline)		
Samplers Present Alice de Vitry Michelle Carey					General Site Observations (weather etc) Warm / Hot weather Slight wind		
Date	Time	Bore Name	Depth to Water	In-Situ Testing	Sample Suite	QA/QC	Notes
30/03/2021	8:30 am	GWC 1 (Kufpec bore)	N/A pastoral (ind) bore	YSI: °C = 32.9 pH = 7.63 EC = 4530 µS/cm DO% = 31.4 ORP = 190.4 mV	Valhalla Program Baseline Suite	N/A	- No odour - Clear water
30/03/21	10:50 am	GWC 2	N/A Pastoral bore	YSI: °C = 35.5 / pH = 7.16 EC = 1856 µS/cm DO% = 9 ORP = -34.1 mV	"	FB1 = Field Blank 1. See CoC	- No odour - Clear water - Have to unscrew pipe to collect water

Attachment 1 – Field Data Sheet



BENNETT RESOURCES

Sampling – Field Data

Site		Valhalla Control Bore (GW) (EP 371)			25/5/21		
Samplers Present		Alice de Vitry (AES) Joe Sanderson			General Site Observations (weather etc) Note: • car parked down wind. GWC4 • car turned off at GWC2 (grass)		
Date	Time	Bore Name	Depth to Water	In-Situ Testing	Sample Suite	QA/QC	Notes
25/5/21	0830	GW C4	N/A	Temp: 25.2°C DO: 42.3% EC: 9510 µS/cm ² PH: 7.98 ORP: 69.5 mV	Valhalla Suite	N/A	• Bore water ran out after a while • Samples taken from bore tap. • Used Bucket. • Solids present. Ambient temp = 25°C • Colour clear. Strong easterly wind. • No odour
"	1155	GW C2 YSI did not settle.	N/A	Temp: 34.7°C DO: 50.2% EC: 1540 µS/cm ² PH: 7.22 ORP: -5 mV	Valhalla Suite	GWC-R	• NO TAP - pipe unscrewed. • constant pumping. • Used sample tube • Moderate easterly. • Ambient Temp:
"	1215	GW C2 YSI Repeat	N/A	T: 35.3°C DO: 13.7% PH: 7.14 EC: 1563 µS/cm ²	ORP: -52.1 mV Valhalla.	N/A	• 32°C ambient • Clear, no odour
"	1500	GW C1	N/A	TC: 34.4°C DO: 27.0% EC: 3640 µS/cm ² PH: 7.68 ORP: -13 mV 122.4	Valhalla Suite	GWC-FB1	• 33°C • Light wind • Clear, no odour
"							
26/5/21	0830	GW C5 (VNB 45)	30.6 m	TC: 30.6°C DO: 60.1% EC: 2426 µS/cm ² PH: 6.81 ORP: -5.6 mV	Valhalla Suite	GWC-FB2	• Depth taken from top of bore riser. • Clear, with some brownish particles • No odour. Medium wind
"	1350	GW C3 (A915) Top of casing	23.30 m	TC: 33.9°C DO: 55.7% EC: 5086 µS/cm ² PH: 7.20 ORP: -36.0 mV	Valhalla Suite	GWC-D	• Depth taken from top of bore riser. • Medium wind. • Clear, some brownish particles. • Tall grasses surrounding bore



BENNETT RESOURCES

Water Sampling – Field Data

Site Valhalla Control Bores (GW) (EP371)

21-22 August 2021

Samplers Present Alice de Vries
Tom Nottage (AES)

General Site Observations (weather etc)

Hot, dry weather
No to light winds

Date	Time	Bore Name	Depth to Water	In-Situ Testing	Sample Suite	QA/QC	Notes
21/08/21	07:50 am	(AB1S) GWC3	23.22 m	28.3°C pH 7.35 25.9% DO 5045 EC μ S/cm 10.5 ORP	Valhalla Suite	GWC-FB2 8:00 am	Engine on for pump operation Very slight wind, easterly No odour 24°C Slight orange sand/particles but otherwise clear
21/08/21	09:30 am	GWC2	N/A	34.8°C pH 7.31 EC 1658 DO 20% -37.8 ORP		GWC-R	No wind 33°C No odour, clear colour
21/08/21	11:10 am	GWC1	N/A	34.6°C pH 7.71 EC 3901 DO 72% 134.9 ORP		GWC-FB1	" 35°C
21/08/21	13:20 pm	GWC4	N/A	34.7°C pH 7.12 EC 12,125 DO 51% 105.9 ORP			Slight SE wind 38°C No odour Slight yellow colour
22/08/21	11:40 am	(IMB4S) GWC5	30.36 m	33.5°C pH 7.02 EC 2724 15.8% DO -35.2 ORP	✓	GWC-D	Very slight wind, easterly Engine on for pump operation 30°C No odour

↓
pump not working
- likely due to low water level. Bailer used

SLIGHT RED (DISCOLOURATION) particles



BENNETT RESOURCES

Water Sampling – Field Data

Site VACHALLA / EP 371							
Samplers Present TN / SV					General Site Observations (weather etc) HOT, DRY - SOUTHERLY WINDS		
Date	Time	Bore Name	Depth to Water	In-Situ Testing	Sample Suite	QA/QC	Notes
16/11/21	1215	GW2	N/A	35.8°C 7.15 pH 23.5% DO 1546 SPC -34.9 ORP		N/A	
16/11/21	1515	GW1 GW2	N/A	36.5°C 7.59 pH 110 ORP 3210 SPC 34 % DO		FB1 (1500) RINS (1500)	
17/11/21 16/11/21	1150	GW1 GW4	N/A	37.7°C 7.34 pH 19.8% DO 10084 SPC -91.8 ORP		FB2 FB1 R D	(1140) (1150) (1200)
17/11/21	1415	VACHALLA NORTH PRODUCTION BORE	N/A	37.4°C 7.10 pH 27.8% DO 1941 SPC 480 ORP		N/A	



U

Field Data Sheet

Site	VAHALLA			Type of fieldwork (groundwater etc)	
Samplers Present	TN / DB			General Site Observations (weather etc)	Weather = Very hot
Date/Time	Site Name	QA/QC	Sampling Suite	In-Situ Measurements	Notes + additional measurements
11:50 20/11	GWLC3	N/A		34.4°C 7.29 pH 31.2 DO% 4739 SPC 101 ORP	DEPTH = 23.29 m
20/11 12:30	AB2D	N/A		33.5°C 7.39 pH 25.2 DO% 4889 SPC 105.2 ORP	DEPTH = 21 m
20/11 14:40	VNB45 (GWLC5)	N/A		34.5°C 6.95 pH 21.1 DO% 2299 SPC -71.7 ORP	DEPTH = 30.45 m
20/11 15:20	VNB1D	N/A		36.2°C 7.45 pH 29.1% DO 2012 SPC 87.0 ORP	DEPTH = 30.94



BENNETT RESOURCES

Water Sampling – Field Data

Site					EP 371		
Samplers Present					General Site Observations (weather etc)		
TOM NOTTALL STEP VINCIQUERRA					VERY HOT, STRONG WESTERLY		
Date	Time	Bore Name	Depth to Water	In-Situ Testing	Sample Suite	QA/QC	Notes
20/10/21	1315	GWC-2	N/A		36°C 7.00pH -17.40rP 12.700% 1431500 17332	GWC-D GWC-R	YSI METER CALIBRATED IN VEHICLE DUE TO LOW BATTERY
20/10/21	1545	GWC-1	N/A		36.2°C 7.60pH 115.30rP 33.600% 1431500 3346500	N/A	
20/10/21	1415	N/A	N/A			GWC-FB1	FIELD FB1 BLANK TAKEN AT VALNOLA 1+2 WELLSITE
21/10/21	0750	GWC-4	N/A		32.2°C 7.63pH -202.20rP 57.4% DO 1431500 10214500	N/A GWC-FB2	FIELD BLANK TAKEN AT CAR NEAR BORE (STRONG SULFUR SMELL FROM BORE)



Document No:	BNR_HSE_MP_016
Revision:	1
Issue Date:	10/06/2025

Appendix 7. Groundwater Management Plan

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BENNETT RESOURCES

Valhalla Gas Exploration and Appraisal Program

Groundwater Management Plan

BNR_HSE_MP_015

VERSION HISTORY				
Ver. No.	Ver. Date	Author	Reviewer	Revision
1	10 Jan 2022	AES	SR	Draft
2	01 Jul 2023	AES	ML	Final
3	26 Apr 2024	MLL, AES	ML	Final
4	07 Feb 2025	MLL, AES	ML	Final
5	29 May 2025	MLL, AES	ML	Final

AU +61 8 9200 1685

225 St Georges Terrace, Level 4
Perth, WA 6000 AUS

www.blackmtn.com



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Acronym / abbreviation / definition

Terms / acronym	Definition / expansion
AER	Annual Environmental Report
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
Baseline groundwater monitoring	Refers to the measurement of groundwater levels and collection of groundwater samples to determine water quality prior to the commencement of proposed activities
BNR	Bennett Resources Pty Ltd
DEMIRS	(WA) Department of Energy, Mines, Industry Regulation and Safety (from 1 Dec 2023)
DMIRS	Former (WA) Department of Mines, Industry Regulation and Safety, now DEMIRS
DMP	Former (WA) Department of Mines and Petroleum; now DEMIRS
DoW	Former (WA) Department of Water; now DWER
DWER	(WA) Department of Water and Environmental Regulation
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
e.g.	For example
EP 371	Exploration Permit 371
EP Act	(WA) Environmental Protection Act 1986
EPA	(WA) Environmental Protection Authority
ERD	Environmental Review Document
GDE	Groundwater Dependent Ecosystems
GWMP	Groundwater Management Plan
ha	Hectare
HFS	Hydraulic Fracture Stimulation
i.e.	That is
kL	Kilolitres
km	Kilometres
km ²	Square kilometres
m	Metres
ML	Megalitres
Proposal	Valhalla Gas Exploration and Appraisal Program
QA/QC	Quality Assurance / Quality Control
SD	Standard Deviation
Surveillance groundwater monitoring	Refers to monitoring that occurs after commencement of an activity and is not considered to be representative of 'baseline' conditions. Any data collected after commencement of a petroleum activity should be directly compared to baseline data and relevant standards to determine whether changes have occurred
WA	Western Australia

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Terms / acronym	Definition / expansion
~	Approximately



1 Executive summary

This Groundwater Management Plan (GWMP) has been prepared by Bennett Resources (BNR) to support the assessment, approval and implementation of the Valhalla Gas Exploration and Appraisal Program (the Proposal) under Part IV of the *Environmental Protection Act 1986* (EP Act).

Bennett Resources referred the Proposal to the Environmental Protection Authority (EPA) under Part IV of the EP Act on 24 December 2020 (EPA Assessment Number 2281). The EPA has decided to assess the Proposal as Public Environmental Review. The Environmental Review Document (ERD) is to include environmental impact assessment (EIA) and management information, including this environmental management plan (EMP), which will be subject to an eight-week public review period.

This GWMP has been written in accordance with the guideline "Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans" (EPA 2021). An executive summary of this GWMP is provided in Table 1-1.

Table 1-1: Executive summary of the GWMP

Proposal title	Valhalla Gas Exploration and Appraisal Program (EPA Assessment Number 2281)
Proponent name	Bennett Resources Pty Ltd
Ministerial Statement number	The Proposal is currently being assessed by the EPA (Assessment 2281) and a Ministerial Statement and associated proposal implementation conditions are yet to be issued.
Purpose of the GWMP	The purpose of this GWMP is to detail the monitoring requirements along with response actions for trigger and threshold criteria that are required for the Proposal.
EPA key environmental factor and objective, and GWMP outcomes	Inland Waters – EPA objective: <i>To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.</i> GWMP outcomes: - no long-term changes to groundwater levels - no short or long-term changes to groundwater quality.
Condition clauses	No Ministerial Statement at the time of preparing the GWMP.
Key components in the GWMP	The key components of this GWMP are: - baseline groundwater monitoring: which refers to the measurement of groundwater levels and collection of groundwater samples to determine water quality prior to the commencement of proposed activities. - surveillance groundwater monitoring: which refers to monitoring that occurs after commencement of an activity and is not considered to be representative of 'baseline' conditions. Any data collected after commencement of a petroleum activity should be directly compared to baseline data and relevant standards to determine whether changes have occurred. - trigger and threshold criteria and subsequent response actions - annual reporting (including results of monitoring).
Proposed construction / commencement date	TBC – within Calendar Year 2026.
EMP required pre-construction / commencement?	Yes ☒ No ☐



2 Context, scope and rational

2.1 Proposal

The Proposal is to complete an unconventional exploration and appraisal drilling and Hydraulic Fracture Stimulation (HFS) program within Petroleum Exploration Permit EP 371 (EP 371) in the Canning Basin, within the Shire of Derby / West Kimberley in Western Australia (WA). The intent of the Proposal is to evaluate the large tight gas resource in the region which has the potential to offer long-term energy security to Australia. The onshore Canning Basin is an early Ordovician to early Cretaceous aged geological basin that covers approximately 430,000 km² in the West Kimberley region. The Proposal is targeting hydrocarbons present from the Laurel through to the Devonian Formations, ranging from 2,000 m to 5,000 m below ground level. The main target is the Laurel Formation, with hydrocarbons present at depths between 2,000 m and 4,000 m below ground level. Table 2-1 provides a summary of the proposal.

Table 2-1: Summary of the Proposal

Proposal title	Valhalla Gas Exploration and Appraisal Program (EPA Assessment Number 2281)
Proponent name	Bennett Resources Pty Ltd (BNR)
Short description	The Proposal is to undertake an unconventional exploration and appraisal drilling program within EP 371, located in the Canning Basin, West Kimberley of Western Australia. The Proposal involves constructing up to 20 exploration wells within 10 well sites. The intent of the Proposal is to further explore and appraise the extent of the tight gas reservoirs present from the Laurel through to the Devonian Formations, at depths ranging from 2,000 m to 5,000 m below ground level. The exploration and appraisal program are expected to commence in 2026.

2.2 Key environmental factors

Two key elements have been identified as having the potential to affect the Key Environmental Factor – Inland Waters. These are:

- water abstraction for process water and camp supply
- gas exploration method (unconventional).

A summary of the Inland Waters environmental factor with a specific focus on these elements and subsequent impacts relating to this activity is included below in Table 2-2.

Table 2-2: Summary of key environmental factor – Inland Waters

EPA objective	To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.
Policy and guidance	• Environmental Key Factor Guideline – Inland Waters (EPA 2018) • Australian and New Zealand Environment and Conservation Council (ANZECC) Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ 2018) • Department of Water – Water Quality Protection Notice 26 (liners for containing pollutants, using synthetic membranes) (DoW 2013) • Department of Mines and Petroleum (DMP) / Department of Water (DoW). Guideline for groundwater monitoring in the onshore petroleum and geothermal industry (DMP & DoW 2016).
Project activities	• water abstraction for process water and camp supply • gas exploration method (unconventional).
Environmental values / receptors	• Liveringa and Grant Group (including Poole Sandstone and Reeves) Aquifers • the Groundwater Dependent Ecosystem (GDE) Mount Hardman (associated with the Liveringa Aquifer) • other groundwater users (>18 km away from the Development Envelope).
Potential impacts – direct impacts	• changes to groundwater levels (groundwater drawdown) associated with water extraction • contamination of surficial aquifers due to lost circulation.

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Potential impacts	- contamination of aquifers through unplanned fracture heights - contamination of surficial aquifers from an accidental release at the surface of drilling fluids, HFS chemicals, liquid hydrocarbons or produced formation water.
– indirect impacts	

2.3 Condition requirements

The Proposal is currently being assessed by the EPA (Assessment 2281) and a Ministerial Statement and associated proposal implementation conditions are yet to be issued. Should this Proposal be approved for implementation, any conditions relating to this GWMP will be included in this section.

2.4 Rationale and approach

This section provides a concise description of the rationale and approach for this Plan. Specifically, the following sub-sections summarise:

- the site-specific environmental values, existing and/or potential uses, ecosystem health condition or sensitive component of the key environmental factor which will be affected (Section 2.4.1)
- study findings (Section 2.4.3)
- key assumptions and uncertainties (Section 2.4.4)
- management approach (Section 2.4.5)
- rational for choice of indicators (Section 2.4.6).

2.4.1 Receiving environment

The Development Envelope is situated in the Canning Basin region within the Fitzroy River catchment. The Canning Basin is considered the second largest groundwater resource in Australia after the Great Artesian Basin. It is a large sedimentary basin covering an onshore area of more than 450,000 km² (DoW 2012). The major regional aquifer systems in the Canning Basin are (in order of decreasing age):

- Grant Formation
- Liveringa Formation
- Wallal Sandstone
- Broome Sandstone.

Data from three petroleum wells drilled within the Development Envelope by the previous operator of EP 371 provides a detailed two-dimensional cross section of the aquifers located within the Development Envelope. Specifically, the major aquifers that are present within the Development Envelope include the:

- Liveringa aquifer
- Grant Group (including the Poole Sandstone aquifer).

A detailed summary of these aquifers with reference to local data has been provided in the Environmental Review Document for the Proposal (BNR_HSE_MP_013) and has not been duplicated here. However, a summary of the values of these aquifers is provided in Table 2-3 and Table 2-4.

Water quality of the Liveringa aquifer within the Development Envelope is well understood given the sampling programs that have been conducted for previous petroleum activities within EP 371.

Data provided from the Yungngora Community (over the past 4 years) and Fitzroy Crossing public drinking water source area reserve have been used to inform the water quality of the Poole Sandstone aquifer. These were selected as they are the closest groundwater users that extract water for potable drinking purposes. The Poole Sandstone aquifer is hydrogeologically similar to and considered to be part of the Grant Group.

Information regarding the aquifer quality of the Liveringa and Poole Sandstone aquifers is provided in the ERD and has not been duplicated here.

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Table 2-3: Summary of Liveringa Aquifer values

Aquifer	Liveringa
Recharge mechanism	Rainfall on outcrop areas
Connectivity with other aquifers	Limited – underlain by the Noonkanbah (shale) Formation that is considered an aquitard, and is ~357 m thick
Number of baseline samples and duration of program	At least 21 samples (per bore) over 5 years
Number of groundwater licences within the Development Envelope	4
Regional use	• unlicensed livestock bores • main roads • oil and gas.

Table 2-4: Summary of Poole Sandstone Aquifer values

Aquifer	Grant Group (including Poole Sandstone)
Recharge mechanism	Rainfall on outcrop and shallow outcrops (none present within the Development Envelope)
Connectivity with other aquifers	Marginal – underlain by the Grant formation with similar rocks to the Poole Sandstone. The Grant group is underlain by the Anderson (shale) Formation that is considered an aquitard and is ~184–279 m thick
Number of baseline samples and duration of program	At least 5 samples (per bore) over 3 years
Number of groundwater licences within the Development Envelope	One, however, there are no known extraction bores.
Regional use	• oil and gas operators • mining operators • main roads • unlicensed for uses such as livestock and domestic bores • potential tourist operations • Indigenous community bores.

2.4.2 Environmental outcomes

The overall purpose of this GWMP is to quantify the potential environmental impacts and risks associated with the Proposal activities on inland waters. In meeting this objective, BNR will be able to verify the outcomes of the ERD which state that the impacts and risks are not significant given the manner in which the Proposal is planned to be implemented.

It should be noted that source-receptor pathways are clearly described in Section 5.4 of the ERD and will not be repeated here. However, in short, all impact pathways fall into two key categories:

- Groundwater contamination event
 - surface release (Section 5.4.5.5 and Section 5.4.5.6 of the ERD)
 - subsurface release (Section 5.4.5.2 and Section 5.4.5.4 of the ERD)
- Groundwater drawdown event
 - Groundwater abstraction (Section 5.4.5.1 of the ERD)

Based upon the groundwater monitoring program selected for the Proposal (Section 3.1), an outcome-based approach has been selected given the ability to collect quantitative data that enables unbiased scientific analysis

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to be completed. Further to this, the quantitative groundwater indicators for this GWMP have been based on baseline regional and local data, enabling outcomes to be selected for the Proposal.

Consequently, the following outcomes have been defined for this GWMP:

- No long-term changes to groundwater levels
- No short or long-term changes to water quality.

2.4.3 Groundwater Drawdown

2.4.3.1 Study findings

To inform the impact assessment associated with groundwater drawdown to other groundwater users and the Mount Hardman Creek GDE, BNR utilised a study by Rockwater (2016) that considered groundwater drawdown associated with HFS water abstraction within the Development Envelope. To complete the drawdown modelling, Rockwater utilised Modflow Pro version 8.0.45, which incorporates MODFLOW, a groundwater modelling software designed by the US Geological Survey (McDonald and Harbaugh 1988). The model was set up with a rectangular grid of 57 rows, 57 columns and two layers covering an area of 5 km by 5 km centred on a single production bore. Layer 1 extends to 50 m depth, and Layer 2 to 170 m depth. Model cell sizes range from 25 m by 25 m near the production bore, to 100 m by 100 m in peripheral areas.

The model was set up initially with parameters that are typical of a minor aquifer such as the Liveringa but was calibrated with drawdown data observed during field monitoring. The model was run to predict groundwater level drawdowns arising from pumping a bore over a six-month period at the average rate required to produce 33,400 kL. The calculated drawdowns after six months of extraction are shown for each model layer in Figure Table 2-1. Modelling predicted that drawdowns of 1 m or more could extend up to 410 m from a production bore at the (deep) level of the screens in the production bore, but that there would be smaller drawdowns in the top 50 m of the Liveringa formation: 1.2 m close to the bore decreasing to 1 m at a distance of about 56 m from the bore, and 0.1 m at 690 m distance. Although the modelling is based on assumed parameters and the results are not unique, the calculated drawdowns are consistent with monitoring on the bores at the Valhalla North 1 and Asgard 1 well sites, where drawdowns at shallow depths (albeit with lower pumping rates) have been very small, and difficult to distinguish from normal seasonal fluctuations of about 0.2 to 1 m (depending on the frequency and magnitude of recharge events). For an overview of groundwater depth over the course of historic groundwater monitoring, refer to Appendix H of the Environmental Review Document (BNR_HSE_MP_013).

Using an extraction volume of 100,000 kL (100 ML) (which is the conservative maximum extraction for a Phase II well for the Proposal), the model predicted that a short-term drawdown of 1 m or more could extend up to 780 m from the extraction water bore at the (deep) level of the screens in the extraction bore (Rockwater 2016). The model predicted that even with pumping for the maximum volume of 100 ML, groundwater levels would be expected to recover rapidly to within 0.2 m of baseline levels within hours of stopping extraction and to fully recover within weeks.

This model was not considered to be sophisticated enough and the potential for a drawdown of up to one metre raised concern through discussions with DWER. Therefore, additional modelling work was commissioned from Intera Geosciences Pty Ltd. MODFLOW 2005 was used to complete a detailed quantitative model to better understand groundwater drawdown. The Groundwater Vistas (ESI) modelling software was used to develop the input files, run the model executables and process model output. Two primary models were developed, one simulating the unconfined Liveringa Group (Mod 1) and one simulating the Poole aquifer system (Mod 2). A full explanation of the modelling approach is contained in annex to this management plan.

Model results are presented as mapped drawdown contours with a minimum contour of 0.2 m and a 0.2 m contour interval, which was chosen as normal seasonal fluctuations can range between 0.2 m and one metre, so any values less than 0.2 m are likely not significant relative to natural variations.

The modelled drawdown at the end of the six-month pumping period for Mod 1 showed the radius of the 0.2 m drawdown contour was within 400 metres of each pumping bore, so would have no impact on any existing bores or groundwater systems.

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The results from Mod 2 were similar, with predicted drawdowns of up to 0.4 m, which is expected to be difficult to distinguish from normal seasonal variations in water levels of 0.2 – 1 M (Rockwater 2016).

Note, this means that the short-term drawdown will have less effect on the environment than seasonal fluctuations, given a maximum drawdown of between 0.2 and 0.4 m and a recovery to 0.1 m within one year of the cessation of pumping.

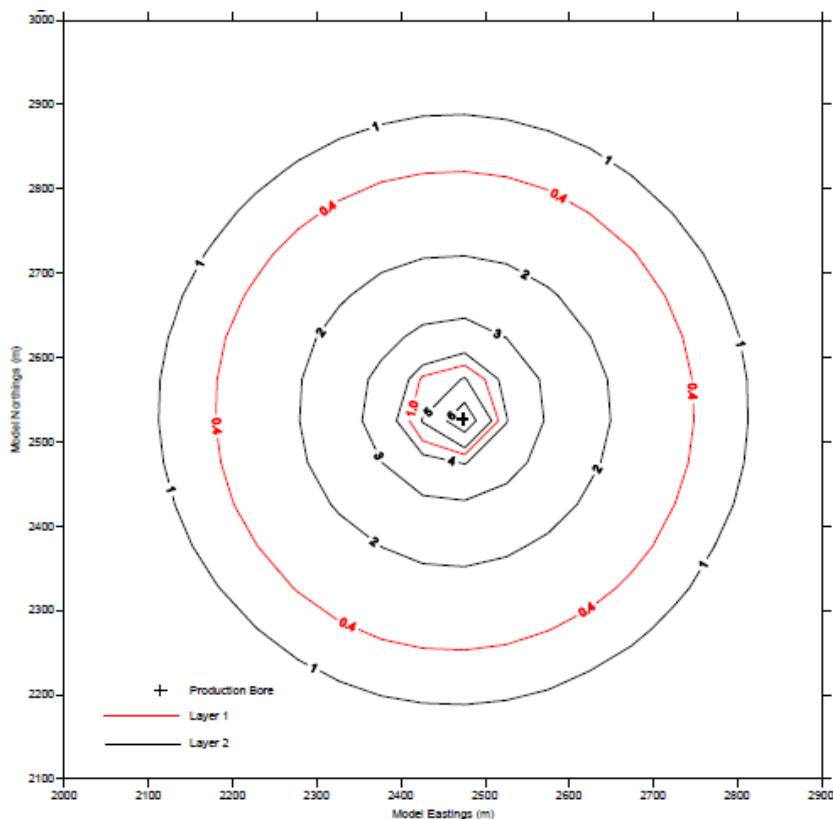


Figure 2-1 Drawdown contours associated with the extraction of 33,306 kL (Rockwater model)

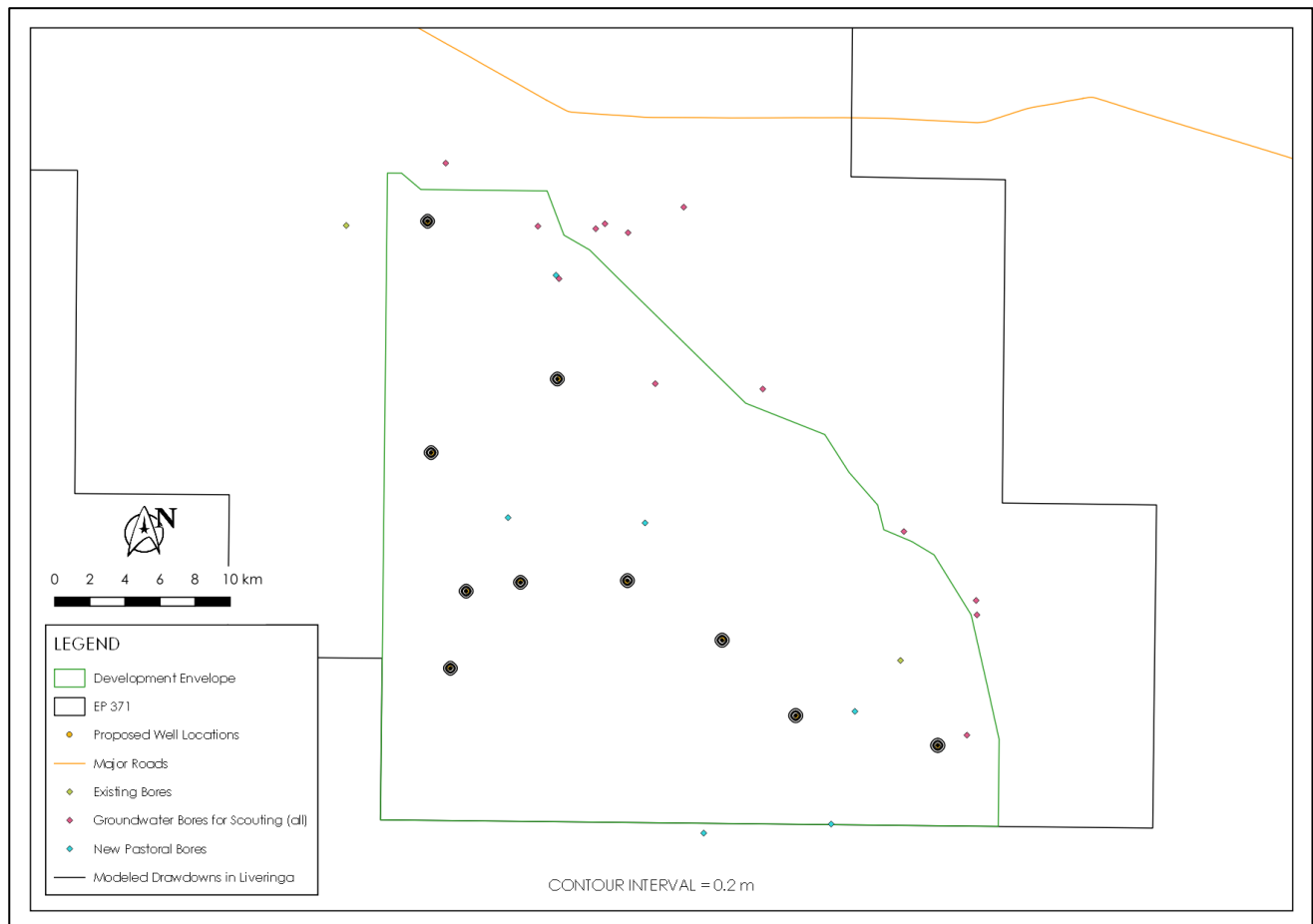


Figure 2-2: Mod 1 model results presented as drawdown contours after six months of pumping, with contour interval = 0.2 m (Intera model)



Figure: Mod 2 model results presented as drawdown contours after six months of pumping with contour interval = 0.2 m (Intera model)

The results from Mod 1 indicate that abstraction of the required water volumes will not result in any noticeable impact to existing bores, and that the nearest GDE (Mount Hardman Creek or the Fitzroy River) are too far to experience any significant impacts.

The results from Mod 2 indicate that abstraction of the required water volumes from the Poole aquifer system would potentially induce temporary drawdowns of between 0.2 and 0.4 metres, and that these would likely recover within a year after the end of the pumping period. The impacts represent a very small percentage of the available water column in each well and would likely not induce any economic impact on existing wells.

Note, this model was considered conservative, as it assumed all rig supply bores to pump concurrently, which was unlikely to happen. In addition, recharge was not included in any of the model simulation.

2.4.3.2 Key assumptions and uncertainties

In accordance with EPA (2021), key assumptions or parameters that are used to support any numerical modelling are to be described in the GWMP. Specifically, key assumptions and uncertainties used in numerical groundwater modelling to understand the potential for water level drawdown associated with the Proposal are detailed in Table 2-5.

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Table 2-5 Key assumptions and uncertainties

Number	Assumptions and Uncertainties	Comment
1	Number and location of extraction bores	BNR plans to install two extraction bores at each well site. Although modelling is based upon a single bore, abstraction bores are anticipated to either alternate or draw with reduced rates such that modelling from a single bore provides a conservative worst-case scenario.
2	Volume of water required to be extracted for the Proposal	The conservation maximum volume of water per well site is estimated to be 100 ML. Modelling volume was less (33 ML) but on review of a much larger number provided in Rockwater (2016) (100 ML), the modelling outcomes are expected to be sufficient to inform the EIA.

2.4.4 Groundwater Contamination

2.4.4.1 Study Findings

BNR has developed a series of groundwater studies to inform and support both the environmental impact assessment within the PER and the ongoing monitoring and management of groundwater during the Proposal. The purpose of the local groundwater characterisation field study was to review the quality of the Liveringa Aquifer within the Development Envelope using historical groundwater data. The local groundwater characterisation study focused on several bores near the project area, namely:

- AB1D
- AB1S
- VNB4S
- VNB4D.

These bores were considered suitable for providing appropriate historical baseline data because:

- AB1D, AB1S, VNB4S and VNB4D are located up-gradient of previous historical petroleum activities conducted in EP 371
- these four are screened within the Liveringa Aquifer and although the bore logs are not available for the monitoring bores schematics are available for these bores
- BNR validated bore schematics placing a camera down hole in July 2023. All four were shown to be intact and suitable for the purposes of collecting baseline groundwater samples. A summary of these recordings is:
 - AB1S
 - i. stick-up: 0.5 m
 - ii. standing water level: 23.070 m below top of casing (m btoc)
 - iii. screened interval: 30.8-36.3 m btoc
 - iv. bottom of casing: 36.3 m btoc
 - v. some white build-up on lower ~5 m of casing walls
 - AB1D
 - vi. stick-up: 0.7 m
 - vii. standing water level: 21.780 m btoc
 - viii. screened interval: 67.0-76.6 m btoc
 - ix. bottom of casing: 76.6 m btoc
 - x. ant ingress and some ant material build-up on walls from 20 m btoc

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- VNB4S
 - xi. stick-up: 0.5 m
 - xii. standing water level: 30.686 m btoc
 - xiii. screened interval: 36.6 m btoc
 - xiv. bottom of casing: 42.3 m btoc
 - xv. no or minor build-up on casing walls
- VNB4D
 - xvi. stick-up: 0.7 m
 - xvii. standing water level: 30.956 m btoc
 - xviii. screened interval: 66.9-78.3 m btoc
 - xix. bottom of casing: 78.4 m btoc
 - xx. minor build-up on casing walls
- VNB4S / VNB4D and AB1D / AB1S are located on the northwest and southeast of the proposed disturbance footprint respectively (Figure 2-16), thus providing geographical coverage across the project area
- groundwater flow is westerly (Figure 2-16), thus providing water quality at different hydrogeological gradients.

The local groundwater characterisation study on the four bores into the Liveringa was undertaken over five years (two of the four bores continued to be monitored for a further two years). BNR has mapped specific CoPC over the sampling period in Figure 2-3 to Figure 2-13. The CoPC selected to be presented here are relevant because they are the indicator constituents used to determine if any release from petroleum activities (including drilling or HFS fluids) has occurred. These are consistent with those identified by the 'Groundwater Monitoring in the onshore petroleum and geothermal industry – Guideline' (DMP & DoW 2016).

Except for the April 2016 sampling event, long-term data analysis indicates that groundwater chemistry influenced by the geology is stable.

Table 2-6: Summary of groundwater monitoring bores sampled

Location	Bore name	Number of sampling events	Total sampling duration
Asgard 1 well site	AB1D	23	>5 years
	AB1S	23	>5 years
Valhalla North 1 well site	VNB4D	21	>5 years
	VNB4S	21	>5 years

Figure 2-3 to Figure 2-13 show data from ongoing monitoring of bores in the Liveringa Aquifer in accordance with Buru Energy's and BNR's *Groundwater Baseline and Surveillance Monitoring Program*. One anomalous reading can be seen across all tested elements from VNB4S from samples taken on 19 April 2016. The causes of the anomalous results were immediately examined. BNR determined that that:

- i) The VNB4S water bore was the reference bore located upstream of the well site, so the cause of the result was highly unlikely to be attributable to historical subsurface activities; and
- ii) The VNB4S water bore was the first bore sampled on that day, and it was possible that the bore pump and hose had not been adequately purged prior to sampling commencing.

A resampling of the bore was subsequently undertaken on 10 May 2016. When tested by SGS Australia, it showed that the range of values for BTEX, chloride and other constituents were within the range of values previously observed. During the development of this document, BNR engaged with DWER to discuss these



outcomes and BNR came to the decision that the anomalous reading would not impact baseline groundwater data.

Baseline methane levels within the Liveringa indicate some natural variation, however it is otherwise considered stable. As detailed in Figure 2-13, increased methane concentrations were recorded in 2018 and 2019 before sampling in 2021 indicated levels had returned to baseline levels. On further investigation, all bores sampled in this area between 2018 and 2019 experienced an increase in methane levels, including those bores that were located hydraulically upgradient (in consultation with DWER (AB1D/S and VNB4D/S)) in a location that would enable the previous operator to differentiate between activity-related and natural occurring events. This area experienced, flood events followed by heatwaves in 2018, resulting in mass cattle death across the Noonkanbah Station. As the Liveringa is believed to be mainly recharged from rainfall on outcrop areas (Lindsay & Commander, 2005) it is likely that these events caused increased organics through surface recharge which produced the increased dissolved methane readings. Additional constituent analysis has determined this is not associated with the previous operator's activities.

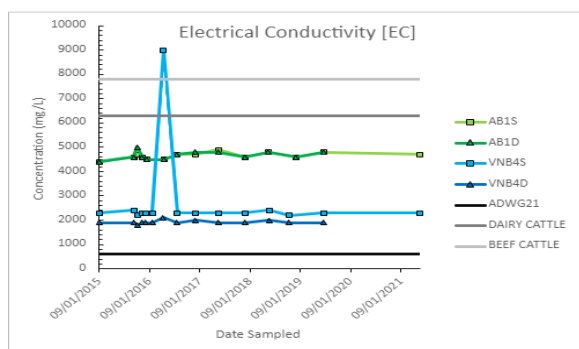


Figure 2-3: Electrical conductivity [Liveringa]

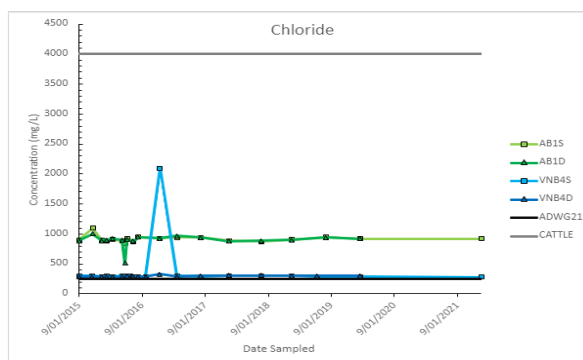


Figure 2-4: Chloride [Liveringa]

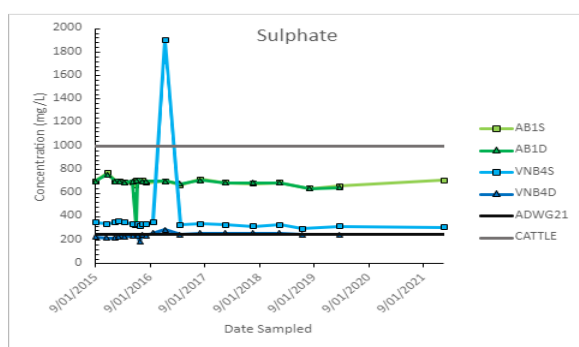


Figure 2-5: Sulfate [Liveringa]

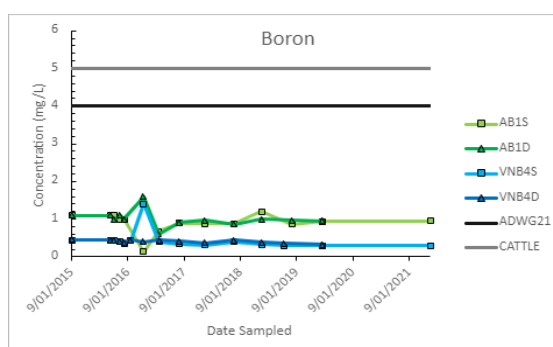


Figure 2-6: Boron [Liveringa]

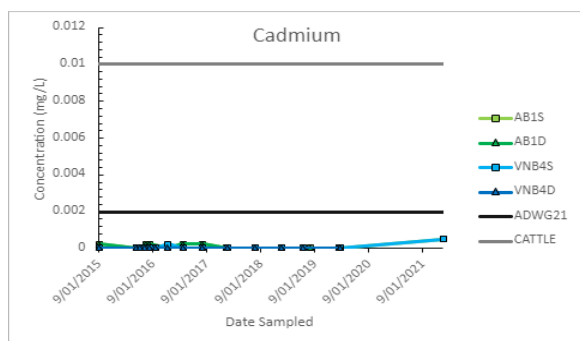


Figure 2-7: Cadmium [Liveringa]

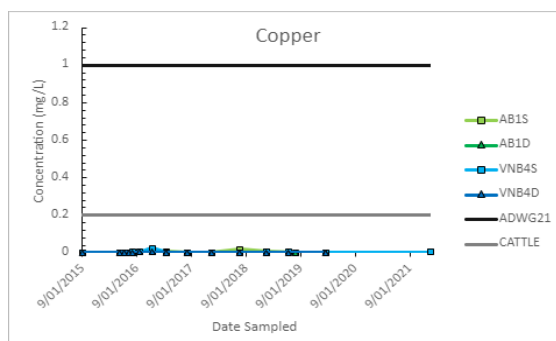


Figure 2-8: Copper [Liveringa]

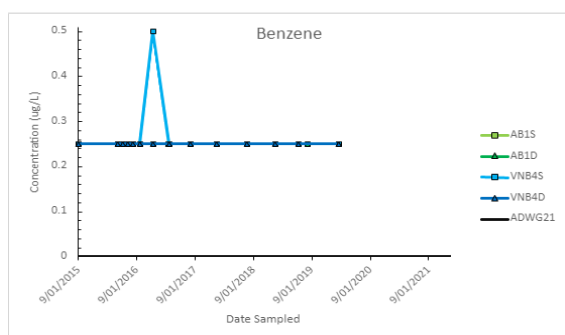


Figure 2-9: Benzene [Liveringa]

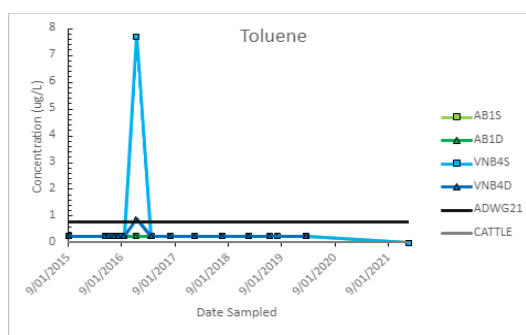


Figure 2-10: Toluene [Liveringa]

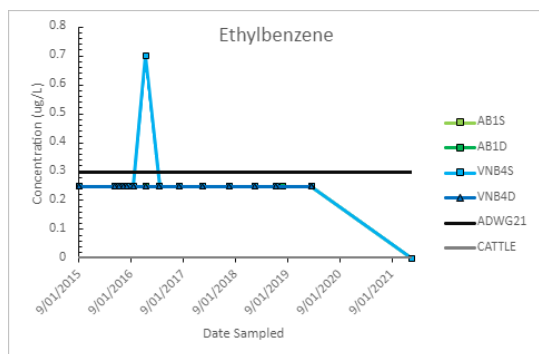


Figure 2-11: Ethylbenzene [Liveringa]

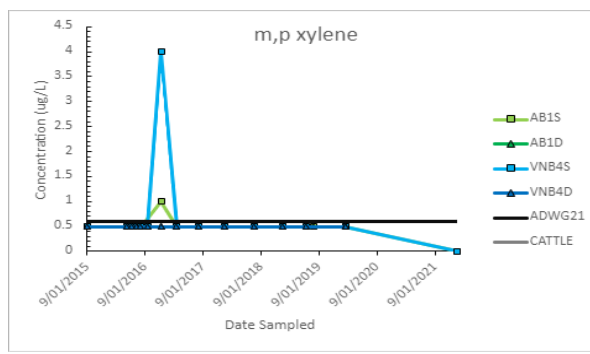


Figure 2-12: Xylene [Liveringa]

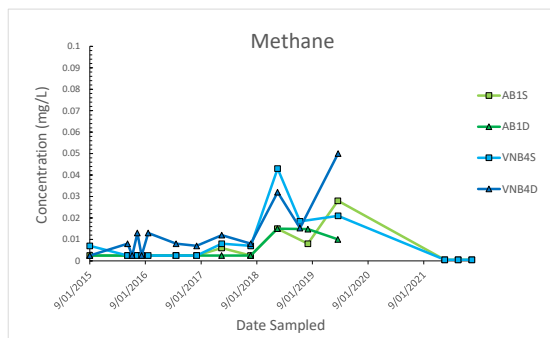


Figure 2-13: Methane [Liveringa]



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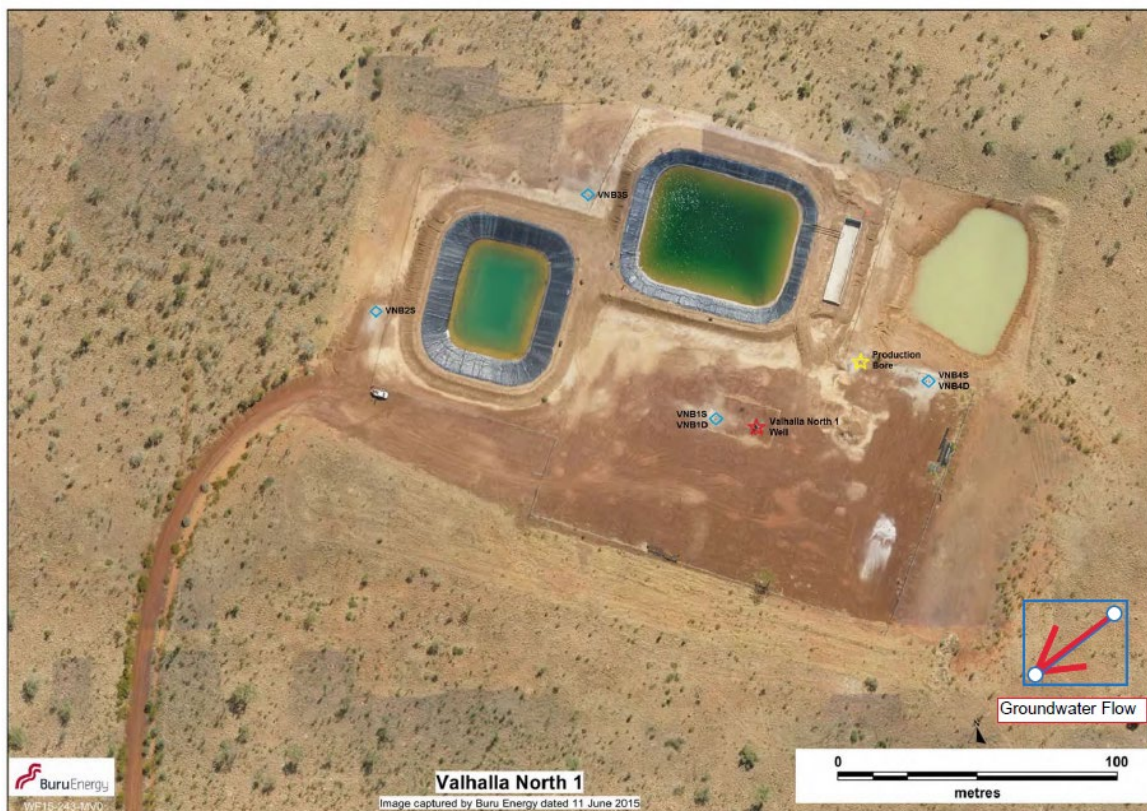


Figure 2-14: Location of VNB4S / VNB4D and AB1D / AB1S and proximity to existing infrastructure

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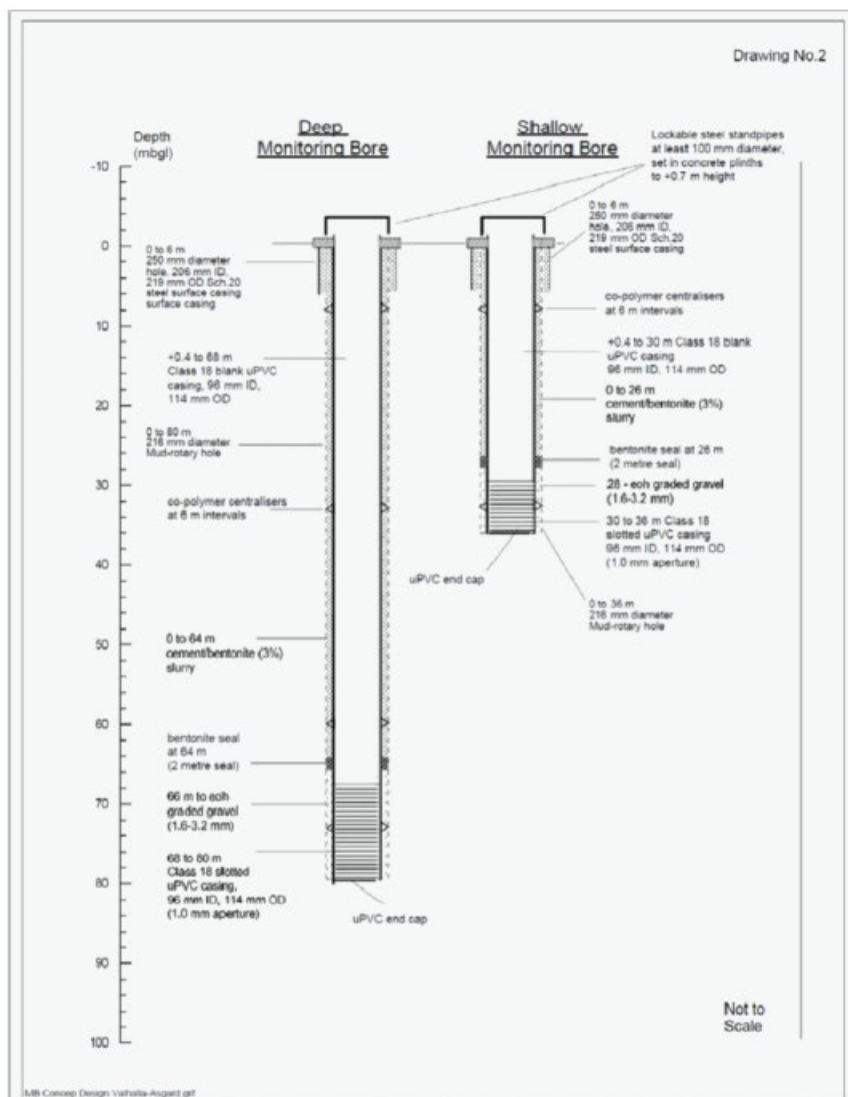


Figure 2-15: Schematic of the Asgard and Valhalla North groundwater monitoring bores

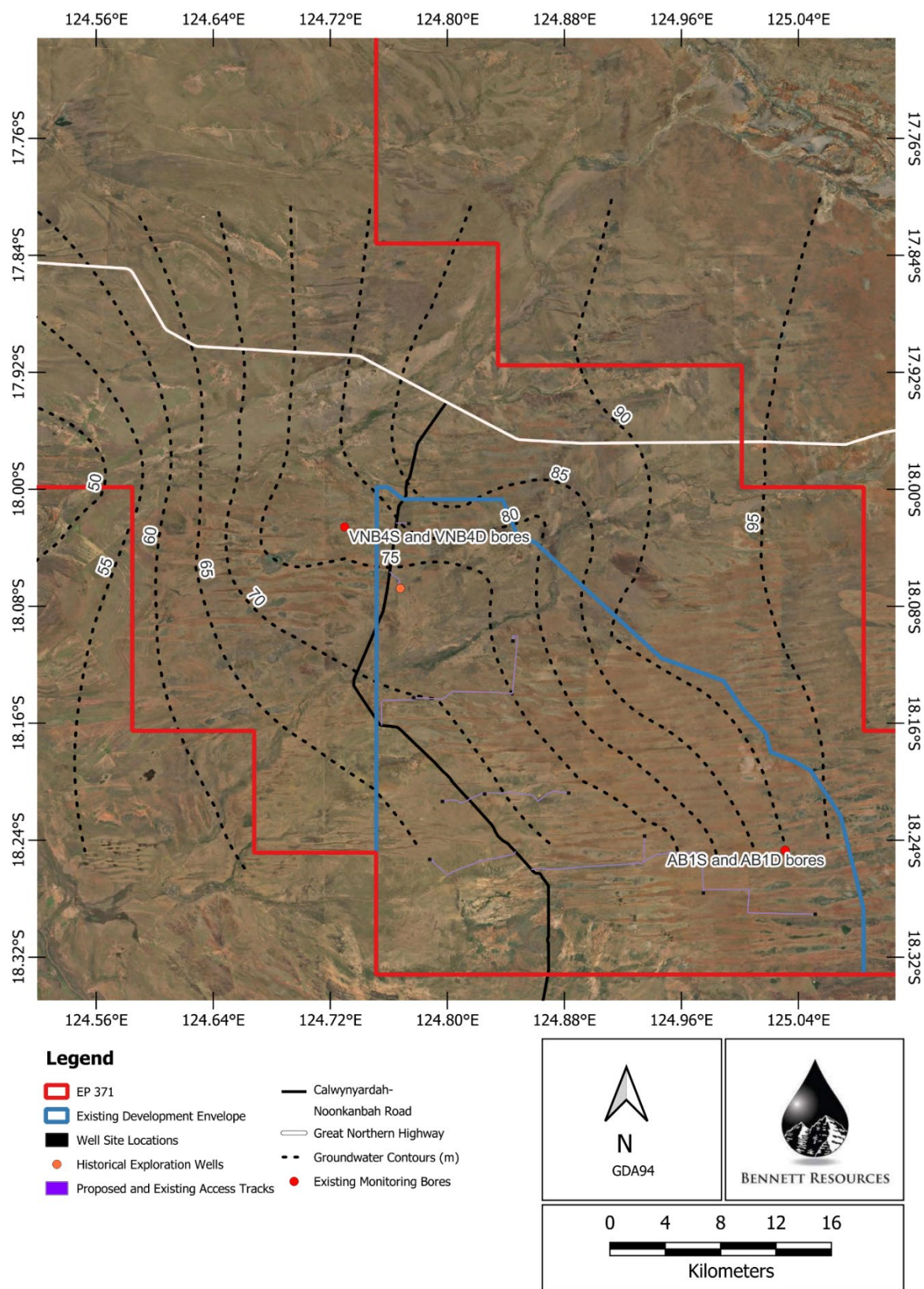


Figure 2-16: Location of Livinginga groundwater sampling bores for local groundwater characterisation and groundwater contours



2.4.4.2 Key assumptions and uncertainties

Key assumptions and uncertainties associated with regional baseline information are detailed in Table 2-5.

Table 2-7 Key assumptions and uncertainties

Number	Assumptions and Uncertainties	Comment
1	Proximity of bores to proposed well site's	BNR plans to install additional monitoring bores on the well sites to collect local data as part of a baseline data collection process once the well sites are cleared. BNR will gather enough baseline ground water collection data to ensure seasonal variation is captured corresponding to a single a year.
2	Fluctuation of constituents of Potential Concern in 2018-2019	Baseline samples were collected from AB1S and VNB1S for 18 months starting in 2014 and completing in August 2015. Over this time a number of methane readings above the LOR (being 0.005) were recorded across Valhalla and Asgard aquifers indicating that methane may naturally fluctuate in the Liveringa aquifer. These readings were between 0.005 (LOR) and 0.015. HFS commenced in August 2015. During this period and the years that followed (2018) methane readings were stable hovering at or below 0.02 which was determined to be not inconsistent with the baseline readings. Between 2018 and 2019 all bores sampled onsite experienced an increase in methane levels. The operator at the time reviewed their field notes (reviewed by BNR) which suggested no additional outside activities could have contaminated the source, the samples were collected by the same people from 2017 and the only "petroleum activities to occur over this period" were relatively non-invasive down hole activities for Asgard completed in 2019 (not in 2018 when the increases were first identified). All other activities on site were limited to maintenance of existing hardstands ruling out potential contamination sources attributable to petroleum activities. BNR sampled VNB4S and AB1S in 2021 for methane with both bores returning methane levels that were below the methane LoR (0.001 mg/L). the methodology involved low-flow sampling to reduce purging volumes completed by the previous operator and to minimize disruption of the samples as much as possible. Given that that VNB4S and AB1S are up the hydraulic gradient from the well and the fracking activities, if methane would have been released from the wellbore, it is extremely unlikely that it would have been recorded upgradient (and thus in these bores). These bores were specifically located in consultation with DWER to ensure they were upgradient of the wellbore in a location that would enable the operator to differentiate between activity related and natural occurring events. Given all bores spiked over this period of time (not just the baseline / environmental bore), this indicates there may have been a broader change to groundwater across the canning basin (not restricted to Valhalla and Asgard locations). Given that the data doesn't indicate an increase in Total Dissolved Solids (TDS), Barium, Boron, or other highly concentrated Trace Metals (which would be expected in correlate with an increase in methane if it was attributed to the petroleum activity) BME expects that these results may be attributable to other naturally occurring events experienced in the Canning Basin at this time. In 2018, the region experienced a large drought, with significant heatwaves and then subsequent flooding events resulting in mass reported cattle death across the Noonkanbah Station. It is possible that these events could explain an increase in methane over this period of time (i.e. decomposition of organic material) and infiltrating the surficial aquifer. The only other explanation available to BNR is operator error which seems unlikely given the person responsible for sampling during 2017 was responsible for sampling in 2018 and 2019.



Number	Assumptions and Uncertainties	Comment
3	Hydrogeological uncertainty	BNR has access to a large amount of information within the West Kimberley from the previous operator including over 450 sampling events across 42 locations to support regional baseline characterisation Monitoring bores installed on Asgard and Valhalla well sites (located upgradient of the petroleum well) comprise over 45 sampling events over eight years BNR is aware of the significant amount of data collated by DWER in and around the Fitzroy River associated with the Fitzroy Surface Water and Ground Water Interaction Project 2010 detailing 133 pastoral bores and 95 indigenous community bores. A large amount of data exists to provide sufficient certainty regarding geochemistry of the Liveringa Aquifer in the region. Regardless BNR plan to utilise a 6 month baseline program to collect data on the well site then continue with an 18 month sampling program from a monitoring bore located up-gradient to ensure that each well site has 24 month's worth of geochemical and physical groundwater data to clearly detail local seasonal variance.

2.4.5 Management approach

BNR plans to implement outcome-based indicators under this GWMP. This approach has been determined to be the most appropriate as the outcome can be readily measured with clear thresholds set to enable a level of protection to be achieved.

2.4.6 Rationale for choice of indicators and/or response actions

The indicators proposed are based on the following rationale:

- groundwater modelling indicates that the Liveringa aquifer is in a state of dynamic equilibrium
- groundwater modelling indicates that a drawdown of groundwater is not expected to result in a significant impact to sensitive receptors or other users within proximity of the Proposal
- establishment of outcome-based indicators is achievable, and monitoring of groundwater parameters provide a direct insight into any potential environmental impact arising from the Proposal
- the adaptive management framework enables for clear decisions regarding water extraction to be made where any impacts may be observed. Where additional mitigation is implemented, the timeframe for mitigation to take effect is expected to be relatively short given the dynamic nature and throughflow of groundwater in the region.

A summary of the specific indicators and their justification is provided below.

2.4.6.1 Groundwater Quality

The DMP and DoW guideline (2016), details a comprehensive list of analytes that is standard for onshore oil and gas projects in WA. Specifically, the guideline recommends that the following criteria be sampled:

- in-field parameters, including water level and dissolved oxygen
- physico-chemical parameters
- ions, including chloride and sulphate
- total metals, including arsenic and chromium
- dissolved gases
- benzene, toluene, ethylbenzene, xylene, naphthalene
- other hydrocarbons.



As the Scientific Inquiry states: An enforceable Code of Practice should include the requirement to test for, and assess the risk from, a comprehensive list of analytes in groundwater, produced and flowback water, including geogenic chemicals and radon, BNR has taken to include the following analytes to be included in the sampling plan:

- radon
- uranium
- geogenic chemicals.

To understand the specific Indicators or Constituents of Potential Concern (CoPC), BNR reviewed the potential environmental impacts and risks as detailed in the Valhalla Gas Exploration and Appraisal Program, Section 38 Assessment – Environmental Review Document (BNR_HSE_MP_013). The Proposal indicates the following fluids having the potential to impact water quality:

- surface release of drilling fluids and HFS fluids
- subsurface release of drilling fluids
- subsurface release of HFS fluids.

On this basis, the following analytes have been identified for the Proposal to be used as indicators of spill events:

- barium
- cadmium
- chloride
- chromium III
- sulfate
- Total Petroleum Hydrocarbons (TPH)

BNR reviewed the Assessment and Management of Contaminated Sites: Contaminated Sites Guidelines (DER 2014), to identify various health screening levels (Table 2-6). However, given the absence of health screening levels for most constituents, BNR has opted to utilize a before and after impact analysis for the data of these indicators. This ensures that should local geology impact water quality, the collection of baseline samples will enable historic averages to be collected, and simple average / standard deviation analysis be utilized to understand water quality variance.

Table 2-8: Groundwater Health Screening Levels

Analyte	Indicators
barium	-
cadmium	-
chloride	-
chromium III	-
sulfate	500 mg/kg (DER 2014)
TPH (C10-C14)	-
TPH (C15-C18)	-
TPH (C6-C9)	-

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2.4.6.2 Groundwater Levels

As detailed in Section 2.4.3, groundwater levels fluctuate naturally between 0.2 to 1 m (depending on the frequency and magnitude of recharge events). For an overview of groundwater depth over the course of historic groundwater monitoring, refer to Appendix I Rockwater 2016 Hydrological Assessment of the Environmental Review Document (BNR_HSE_MP_013).

Consequently, BNR has adopted a trigger / threshold indicator of 1 m for groundwater level as historical data indicates natural variation of up to 1 m is present within the Development Envelope.

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3 GWMP components

This section of the GWMP identifies the legal provisions (components) in Table 3-1 that BNR will implement to ensure that the environmental outcomes are met during the implementation of the Proposal.

In accordance with the guideline “Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans” (EPA 2021), this section identifies the indicators that will be used to measure performance and the monitoring that will be undertaken in relation to these indicators. It defines the response actions (trigger level and contingency actions) that will be undertaken if the indicators are exceeded. Table 3-1 details the components of this plan, including monitoring and reporting commitments. Further information regarding monitoring has been described in Section 3.1.

BNR will update Table 3-1 in consultation with both the Department of Water and Environmental Regulations (DWER) and the Department for Energy, Mining, Industry Regulation and Safety (DEMIRS) prior to implementation of any drilling activity. This will include the review of trigger and threshold criteria following the completion of well site-specific baseline sampling.

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Table 3-1: GWMP components

EPA factor/s and objective/s		Inland Waters – To maintain environmental quality and to minimise the risk of environmental harm, so that environmental values are protected			
GWMP outcome/s		- no long-term changes to groundwater levels - no short or long-term changes to groundwater quality			
Key environmental values		- Liveringa and Poole Aquifers - the Groundwater Dependent Ecosystem (GDE) Mount Hardman (associated with the Liveringa Aquifer) - other groundwater users (pastoral stations and fixed receptors >18 km away from the Development Envelope).			
Key impacts and risks		- changes to groundwater levels - contamination of groundwater from surface and subsurface spills			
Indicators		Response actions	Monitoring	Frequency	Reporting (Section 3.2)
Groundwater Level					
GWMP outcome – No long-term changes to groundwater levels	Trigger criteria Groundwater level measured at the upgradient control bore exceed historical average groundwater level values of 0.7 m.	Trigger level actions - identify the reason for the change in groundwater levels and determine direct correlation to the Proposal activities or natural variation and review management measures with an adaptive management response. This may include cessation of groundwater pumping until levels return to their historical average levels and an increase in data collection and monitoring - re-examine groundwater level monitoring results (QA / QC) to validate data - where the threshold exceedance was not caused by the Proposal, resume standard groundwater level monitoring frequency - where the groundwater level threshold exceedance was caused by the Proposal, take steps to remedy the impact (for example cessation of pumping) re-monitor and increase monitoring frequency (to monthly [where quarterly sampling is being undertaken] or fortnightly [where monthly sampling is being undertaken]).	Refer to section 3.1	Refer to section 3.1	Routine reporting – Annual Compliance Assessment Report to the DWER Compliance Branch Exceedance reporting to DWER Compliance Branch – exceedance of the threshold criteria and contingency actions that have been implemented – within 5 days.
	Threshold criteria When the groundwater level, measured at the upgradient control bore, exceed historical average groundwater levels of 0.7 m over two consecutive monitoring events which are attributable to the Proposal.	Threshold contingency actions Initiate implementation of contingency measures including: - where the groundwater level threshold exceedance was not caused by the Proposal, resume standard monitoring frequency - where the threshold exceedance can be attributed to the Proposal activities: - implement adaptive management response (modified abstraction) management guidance within Section 4. This may include			

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		• ceasing abstraction, and sourcing water from other sources or reducing abstraction volumes ○ once response actions have been completed, extend the monitoring program and increase frequency (to monthly [where quarterly sampling is being undertaken] or fortnightly [where monthly sampling is being undertaken]) until level values recover ○ continue to implement actions to remediate the exceedance until approval to cease has been given by the relevant regulator.			
Groundwater Quality					
GWMP outcome – No short or long-term changes to groundwater quality	Trigger criteria Changes to groundwater quality at defined monitoring locations (Table 3-2) attributable to the project where they meet the following conditions: • 2 out of 3 successive samples fall outside the mean $\pm$ 1 Sigma (SD) limit • 4 out of 5 successive samples fall outside the mean $\pm$ 1 Sigma (SD) limit • 8 consecutive points on the same side of the mean.	Trigger level actions • identify the reason for the change in water quality and determine direct correlation to the Proposal activities or natural variation and review management measures with an adaptive management response. • re-examine water quality or groundwater level monitoring results (QA / QC) to validate data • where the threshold exceedance was not caused by the Proposal, resume standard water quality monitoring frequency • where the water quality threshold exceedance was caused by the Proposal, take steps to remedy the impact (for example stop stimulation activities) re-monitor and increase monitoring frequency (to monthly [where quarterly sampling is being undertaken] or fortnightly [where monthly sampling is being undertaken]). Threshold contingency actions Initiate implementation of contingency measures including: • ground truth the water quality monitoring results to validate findings of the assessment and/or determine/identify what may be causing the exceedance. Where cause is identified during ground truthing and can be rectified, undertake action immediately. For actions which require alternate resources, schedule works to be undertaken as soon as possible • where the water quality threshold exceedance was not caused by the Proposal, resume standard monitoring frequency • where the threshold exceedance can be attributed to the Proposal activities: ○ implement adaptive management response management guidance within Section 4. This may include: • ceasing the petroleum activity to enable source of release to be investigated and mitigated • installing additional monitoring bores up-gradient of the wellbore in consultation with DWER[#]			
	Threshold criteria Changes to groundwater and surface water quality at defined monitoring locations (Table 3-2) attributable to the project where they meet the following condition: 1 sample falls outside the mean $\pm$ 2Sigma (SD) limit.		Refer to section 3.1	Refer to section 3.1	Routine reporting – Annual Compliance Assessment Report to the DWER Compliance Branch Exceedance reporting to DWER Compliance Branch – exceedance of the threshold criteria and contingency actions that have been implemented – within 5 days.

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		• increasing monitoring frequency (to monthly [where quarterly sampling is being undertaken] or fortnightly [where monthly sampling is being undertaken]) ○ once response actions have been completed, extend the monitoring program and increase to monthly until groundwater quality values recover ○ continue to implement actions to remediate the exceedance until approval to cease has been given by the relevant regulator.			
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3.1 Groundwater monitoring program

To clearly understand if the indicators (trigger and threshold criteria) have been met or exceeded, BNR has developed a groundwater monitoring program (Table 3-2) to be implemented over the life of the Proposal and following decommissioning/site reinstatement. This includes groundwater monitoring. Specifically, the monitoring program will be used to:

- establish local Liveringa aquifer site conditions by sampling for sufficient time to collect seasonal variation corresponding to a single year prior to commencing the petroleum activity.
- establish duration and frequency of baseline and surveillance monitoring for the duration of the Proposal and following decommissioning; and
- inform termination criteria for groundwater sampling.

Table 3-2: Groundwater monitoring program

Overview	BNR has developed this monitoring program to collect and analyse local groundwater quality at all well sites associated with the Proposal located within the Development Envelope.
Relevant guidelines	• Guidelines for groundwater quality protection in Australia: National Water Quality Management Strategy, Department of Agriculture and Water Resources (Australian Government 2013) • National Water Quality Management Strategy. Australian and New Zealand Environment and Conservation Council / Agricultural and Resource Management Council of Australia and New Zealand (ANZECC / ARMCANZ) (Australian Government 2018) • Health screening levels for petroleum hydrocarbons in soil and groundwater. Technical report No. 10. Australian Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (Friebel and Nadebaum 2011) • Guideline for groundwater monitoring in the onshore petroleum and geothermal industry (DMP & DoW 2016) • Environmental Factor Guideline – Inland Waters (EPA 2018) • National Environment Protection (Assessment of Site Contamination) Measure 1999. Schedule B1, as amended 16 May 2013 (National Environment Protection Council 2013) • National Water Quality Management Strategy Australian Drinking Water Guidelines (NHMRC and NRMCC 2011 (updated March 2021)) • Contaminated Sites Groundwater and Surface Water Chemical Screening Guideline. Western Australian Department of Health (DoH 2014) • <i>Water Quality Protection Note 30</i> (WQPN 30), Department of Water (Western Australian Government 2006, updated August 2023) • Minimum Requirements for Water Bores in Australia (National Uniform Drillers Licensing Committee 2011).
Purpose	To determine if the Proposal has had any adverse impacts to groundwater quality and groundwater levels during its implementation.
Monitoring approach	Sampling location: <u>Liveringa aquifer:</u> • each well site will have three Liveringa monitoring bores installed¹ for each well pad that is: ○ one control bore upgradient from the well and produced formation water evaporation pond, located as far as possible from the contamination sources (noting the EPA's preference for a separation distance approximately 100m which we be considered during wellsite design). <i>BNR Notes that provisions can be made to allow disturbance required for installation and access of the control bore outside of the 'locked' disturbance footprint. These provisions will be managed by DEMIRS.</i>

¹ Installation and drilling of all water bores will be hydrostratigraphically logged in detail and geophysical interpretation of groundwater quality collected, for the interval where fresh aquifers are known to be present. Annulus seals and gravel packs will be used, where necessary, to isolate the zone being monitored and prevent potential cross contamination via the bore casing as required by the Minimum Requirements for Water Bores in Australia (National Uniform Drillers Licensing Committee 2011) required to be followed as detailed in the Groundwater monitoring in the onshore petroleum and geothermal industry guideline (DMP & DoW 2016). BNR will conduct validation water samples (along with QA/QC samples of any fluids / water used for the bore installation process) at a point of discharge from the circulation system to understand if cross contamination may be occurring as evidenced by fluid constituent presence associated with bore installation. This may involve the use of tracer dyes, but these specifics are subject to local conditions, aquifer depths and will be direct by a hydrogeologist during bore installation.

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- one impact monitoring bore within approximately 20 m down-gradient of the produced formation water evaporation pond.
- one impact monitoring bore down gradient and within approximately 20 m of the production well/s.
- monitoring bores will be constructed with similar screened intervals targeting the top, middle and bottom of the vertical extent of the Liveringa aquifer in consultation with DWER.
- the location of the bores has been selected to coincide with different perceived risks (i.e., a surface release from the evaporation pond or loss of well containment) or a migration of fluids through a fault to the Liveringa Aquifer and to inform natural variation or contamination events that may occur upgradient not related to the petroleum activity.
- the location of the monitoring bores will be identified in consultation with DWER and DEMIRS prior to installation.

Poole aquifer

- only two monitoring bores will be installed at the base of the Poole Aquifer for this Proposal within the Development Envelope:
 - one up-gradient from the production well, located as far as possible from potential contamination sources as possible (noting the EPA's preference for a separation distance of at least 100m which we be considered during wellsite design). *BNR Notes that provisions can be made to allow disturbance required for installation and access of the control bore outside of the 'locked' disturbance footprint. These provisions will be managed by DEMIRS*
 - one located down-gradient from either the first or second exploration well, as close as possible to the well and no further than the edge of the lease.
- both Poole bores will be screened at the base of the Poole aquifer in consultation with DWER. and appropriately constructed to mitigate risks of a hydraulic short circuit
- the location of all monitoring bores will be identified in consultation with DWER and DEMIRS prior to installation

Sampling frequency – Baseline:**Liveringa aquifer**

- baseline samples from the Liveringa will be collected quarterly from at least the upgradient control bore prior to conducting drilling activities from the up-hydraulic gradient control monitoring bore (on each wellsite) to gather seasonal variation over a single a year (i.e. captures seasonal groundwater high post wet season, and seasonal groundwater low post dry season).
- where impact / surveillance bores are installed prior to drilling activities commencing², they will join the baseline sampling program to gather as much data as possible prior to drilling activities commencing.

Poole aquifer

- baseline samples from the only two Poole bores installed for the Proposal will be collected at least 6 months prior to drilling either the first or second exploration well.

Sampling frequency – Surveillance:

- during proposal implementation samples of all Liveringa monitoring bores will be collected quarterly.
- during proposal implementation (of either the first or second exploration well), samples of all Poole monitoring bores will be collected quarterly.
- if telemeters are installed in the Liveringa monitoring bores, BNR will implement:
 - continuous telemetered monitoring of all monitoring bores for PH, EC, TDS and ground water depth
 - annual in field sampling event of all monitoring bores telemetry is no longer utilised in the field, and
 - following completion of HFS where no significant variation from baseline is identified (and where telemetry is no longer utilised), the sampling frequency will drop to a single down gradient Liveringa bore twice a year and continue until the termination criteria is achieved (noting provisions to increase monitoring frequency should trigger or threshold criteria be met.
- if telemeters are not installed in the Liveringa monitoring bores, BNR will implement:

² There are a number of reasons that down gradient impact (surveillance) bores cannot be installed pre activity and meet the 12-month baseline requirements with, the major reason being operational constraints. The location of the wells and the ponds on the wellsite are subject to detailed wellsite design and engineering. To inform the wellsite design and engineering, the drilling rig that will be utilized needs to be contracted, given the rig will determine the layout of infrastructure to ensure that everything is positioned to enable the rig to operate safely. The Rig will not be contracted until all approvals are in place (resulting in multiple dependencies that result in significant time delay). If the impact bores are installed too early, there is the potential for them to be:

1. damaged given well cellar and pond construction requires heavy civil / earthmoving machinery, and
2. mispositioned resulting in them not being optimally placed for identifying contamination events arising from the activity.



	- monthly in field sampling during HFS activities (noting provisions to increase monitoring frequency (per updated trigger and threshold criteria), and - daily sampling of adequate screening parameters (i.e. PH, EC, TDS and groundwater depth). Of all wells. - following completion of HFS activities, samples will revert to quarterly and where no significant variation from baseline is identified, the sampling frequency will drop to a single down gradient Liveringa bore twice a year and continue until the termination criteria is achieved (noting provisions to increase monitoring frequency should trigger or threshold criteria be met). - where changes are identified during or after HFS activities, the frequency of sampling may be increased, and additional groundwater sampling bores installed (as required) to gain a clear understanding of any potential impact consistent with identified threshold and trigger criteria actions (Table 3-1). - this monitoring program (including bore location, frequency and methodology) can be reviewed by BNR and DWER post implementation and in accordance with Section 4.2 of this GWMP. Analysis: - as per the DMP and DoW guideline (2016), a comprehensive list of analytes will be sampled including: - in-field parameters, including water level and dissolved oxygen - physico-chemical parameters - ions, including chloride and sulphate - total metals, including arsenic and chromium - dissolved gases - benzene, toluene, ethylbenzene, xylene, naphthalene - other hydrocarbons. - radon - uranium - geogenic chemicals - surveillance samples will be compared to local baseline samples and upgradient monitoring bores to determine if there are changes to the groundwater that could be attributed to the Proposal.
Termination criteria	Surveillance monitoring at each individual well site will be terminated following data collection of at least four consecutive sampling events following decommissioning where: chemical/hydrocarbon constituents are below relevant benchmarks or guideline values or have returned to within the expected natural dynamics of baseline state and/or control sites.

3.1.1 Groundwater Sampling Location

The layout of the well site sampling bores has been specifically chosen to support both baseline and surveillance monitoring (Figure 3-1). The upgradient bore will enable BNR to compare ambient groundwater quality against the downgradient sampling bores in real time over the course of the activity and clearly show:

1. if a spike in a Constituent of Potential Concern is experienced in the downgradient bore but not the upgradient bore, then the spike is most likely associated with the petroleum activity, and is then unlikely to be associated with natural variation,
2. if a spike in a Constituent of Potential Concern is experienced in all bores during implementation of the proposal, that the spike is unlikely to be associated with the petroleum activity.

By installing an upgradient bore, BNR is able to achieve a more scientifically robust approach for groundwater sampling with sufficient data to inform natural variation, identification of scenarios that may cause groundwater contamination that are not associated with the petroleum activity whilst enabling the activity to commence in a timely manner. This is not inconsistent with the previously unconventional gas activities in the Kimberley with the groundwater monitoring program designed with DWER previously. Installation of additional downgradient bores can be considered following triggering events such as:

1. positive leak detection events (indicating the integrity of the top layer of the pond has been compromised), or
2. well pressure monitoring indicates well integrity may be compromised.

BNR will ensure that the location of all monitoring bores are discussed and agreed with DWER.

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3.1.2 Groundwater Sampling Duration

BNR believes the hydrogeology of the Liveringa is sufficiently understood to support a baseline sampling program to ensure seasonal variation is captured corresponding to a single a year (i.e. captures seasonal groundwater high post wet season, and seasonal groundwater low post dry season) as:

1. BNR has access to a large amount of information within the West Kimberley from the previous operator including over 450 sampling events across 42 locations to support regional baseline characterisation
2. Monitoring bores installed on Asgard and Valhalla well sites (located upgradient of the petroleum well) comprise over 45 sampling events over eight years
3. With the exception of data in 2018-2019, which is most likely influenced from natural events, existing data from Asgard and Valhalla well sites show variation of constituents within the Liveringa are stable with sufficient information to understand local seasonal variability
4. BNR is aware of the significant amount of data collated by DWER in and around the Fitzroy River associated with the *Fitzroy Surface Water and Ground Water Interaction Project 2010* detailing 133 pastoral bores and 95 indigenous community bores.
5. BNR has included threshold criteria contingency measures for installation of additional bores outside of the wellsite and upgradient should any further doubt be shed on natural variability / or should an event occur.

3.2 Reporting

The environmental outcomes will be routinely reported in the Part IV Compliance Assessment Report. This report will include:

- an overall statement of compliance with this GWMP
- analysis against the trigger and threshold criteria (Table 3-1) for each year
- declaration of compliance status against each of the requirements detailed in the Groundwater Monitoring Program
- a description regarding the effectiveness of any adaptive response actions that have been implemented.

In the event that threshold criteria are exceeded during the annual reporting period, exceedances will be reported to the DWER compliance branch within five days.

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4 Adaptive management and review of the GWMP

4.1 Monitoring and adaptive management

A monitoring program (as defined in Section 3.1) is required to measure the effectiveness of the response actions as defined in this GWMP. The outcomes of the monitoring program will contribute to ongoing improvements in response actions to ensure an adaptive management approach is adopted.

BNR will implement an adaptive management framework that allows BNR to adapt and implement improvements as a result of monitoring against trigger and threshold criteria detailed in this document.

The following approaches will apply:

- monitoring data will be systematically evaluated
- the effectiveness and relevance of trigger level and threshold contingency actions will be evaluated to determine if any changes to response actions are required
- increased understanding of the hydrogeological regimes based on additional internal and external studies will be incorporated into the monitoring and management approach when newer relevant information becomes available where applicable.

Adaptive management practices that will be assessed as part of this approach may include:

- evaluation of the groundwater monitoring program, data and comparison to baseline data and reference sites on an annual basis to verify whether responses to project activities are the same or similar to predictions
- evaluation of assumptions and uncertainties of the management and monitoring program
- re-evaluation of the risk assessment and revision of risk-based priorities as a result of monitoring outcomes
- review of data and information gathered over the review period that has increased understanding of site environment in the context of the regional ecosystem
- assessment of changes which are outside the control of the project and the response actions identified.

4.2 Management plan review

This GWMP is intended to be dynamic and may be updated to reflect changes in management practices and the natural environment over time. Specifically, this GWMP will be reviewed and updated (as required):

- following completion of baseline monitoring and prior to commencing surveillance monitoring to ensure that the trigger and threshold criteria are updated in consultation with DWER
- annually
- and each time a new Environment Plan (under the *Petroleum and Geothermal Energy Resources Act 1967*) is approved.

This approach will allow flexibility to adopt new approaches / management measures. The effectiveness and relevance of trigger level and threshold contingency actions will be evaluated on an annual basis, and any amendments to response actions will be completed on an as-needed basis. This will include:

- amendment of response actions that are not achieving the desired outcomes
- monitoring that identifies additional impacts requiring additional response actions or changes to existing response actions
- changes to relevant legislation that may affect the implementation of response actions
- improvements to management practices to achieve a greater environmental outcome

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- updates to trigger and threshold criteria following the completion of baseline sample collection prior to commencing any groundwater extraction.

Specifically, a table summarising the changes following the template provided as Table 4-1 will be developed. This table will clearly indicate location and reason/s for changes. A tracked change version of the revised GWMP will be provided for all minor, non-structural changes to the document.

Table 4-1: GWMP review template

Complexity of changes	Minor revisions ☐		Moderate revisions ☐		Major revisions ☐	
Number of key environmental factors	One ☐		2-3 ☐		> 3 ☐	
Date revision submitted to EPA		DD/MM/YYYY				
Proponent's operational requirement timeframe for approval of revision		< One Month ☐		< Six Months ☐		> Six Months ☐
Reason for Timeframe		None ☐				
Item number	GWMP section number	GWMP page number	Summary of change		Reason for change	
1.						
2.						
3.						

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5 Stakeholder consultation

Consistent with the EPA's expectations for this GWMP to align with the principles of EIA, BNR consulted with stakeholders, including the Department of Water and Environmental Regulation (DWER), during the development of the EPA referral. Engagements relevant to this GWMP are presented below in Table 5-1.

Table 5-1: Stakeholder engagement relevant to this GWMP

Stakeholder	Method of engagement	Date of engagement	Summary of engagement
Department of Communities	Email	08 Nov 2021	Enquired if the Yungngora Community groundwater bore data for the Poole Sandstone aquifer (provided by the Department) could be made publicly available in the ERD. The Department declined. As an action, BNR have compared the data and instead summarised similarities/differences without disclosing any data.
Department of Communities	Email	09 Jun 2021	Requested drinking water data from the groundwater bores monitored at the Yungngora Community, to obtain information from the deeper aquifers.
DWER	Meeting	09 Jun 2021	Continued discussion regarding the proposed groundwater monitoring program. DWER requested that background information on the underlying Poole Sandstone and Grant Group aquifers should be included in the ERD.
EPA	Phone	04 Jun 2021	Discussed baseline monitoring requirements from the draft ESD and requested to remove the requirement to sample at each well site for a period of 24 months and change to sampling representative control sites for a period of 24 months.
DWER	Phone	03 Jun 2021	Arranged a meeting to discuss DWER's feedback on the proposed Valhalla baseline groundwater monitoring program.
DWER	Email	26 May 2021	Discussed the suitability of the Valhalla baseline groundwater monitoring program, with regard to monitoring control sites only within the Liveringa Aquifer. Questioned that the other deeper aquifers must be discussed.
Noonkanbah Station manager	Phone	13 May 2021	Discussed the availability of bore logs from pastoral bores on the station; unofficial bore logs could be made available. Re-confirmed that BNR could sample water from the pastoral bores by unscrewing pipes or opening taps. Mentioned that access roads and fence line tracks would be graded at the end of May, and mustering activities would commence early June.
Blina Station manager	Phone and email	23 Mar 2021	Discussed sampling station bores for the baseline groundwater monitoring program – station accepted. Discussed the availability of a bore log for a bore located on Blina Station. Confirmed that BNR could sample water from that bore by opening the tap.
DWER	Email	22 Mar 2021	Reviewed sampling methodology and locations for baseline control site groundwater monitoring program. Enquired about availability of bore logs and any existing data for any pastoral bores.
Noonkanbah Station manager	Phone and email	08 Mar 2021	Discussed sampling station bores for the baseline groundwater monitoring program – station accepted. Enquired about the availability of bore logs from pastoral bores on the station. Confirmed that BNR could sample water from the pastoral bores.
EPA	Response to Submission process	Q1 2025	EPA Services provided comments on the GWMP throughout the public comments process. BNR has worked through the Response to comment process to update the GWMP to reflect those inputs.

For a full summary of stakeholder engagement records refer to the BNR Environmental Review Document (BNR_HSE_MP_013). Any additional consultation regarding this GWMP will be captured in subsequent revisions.

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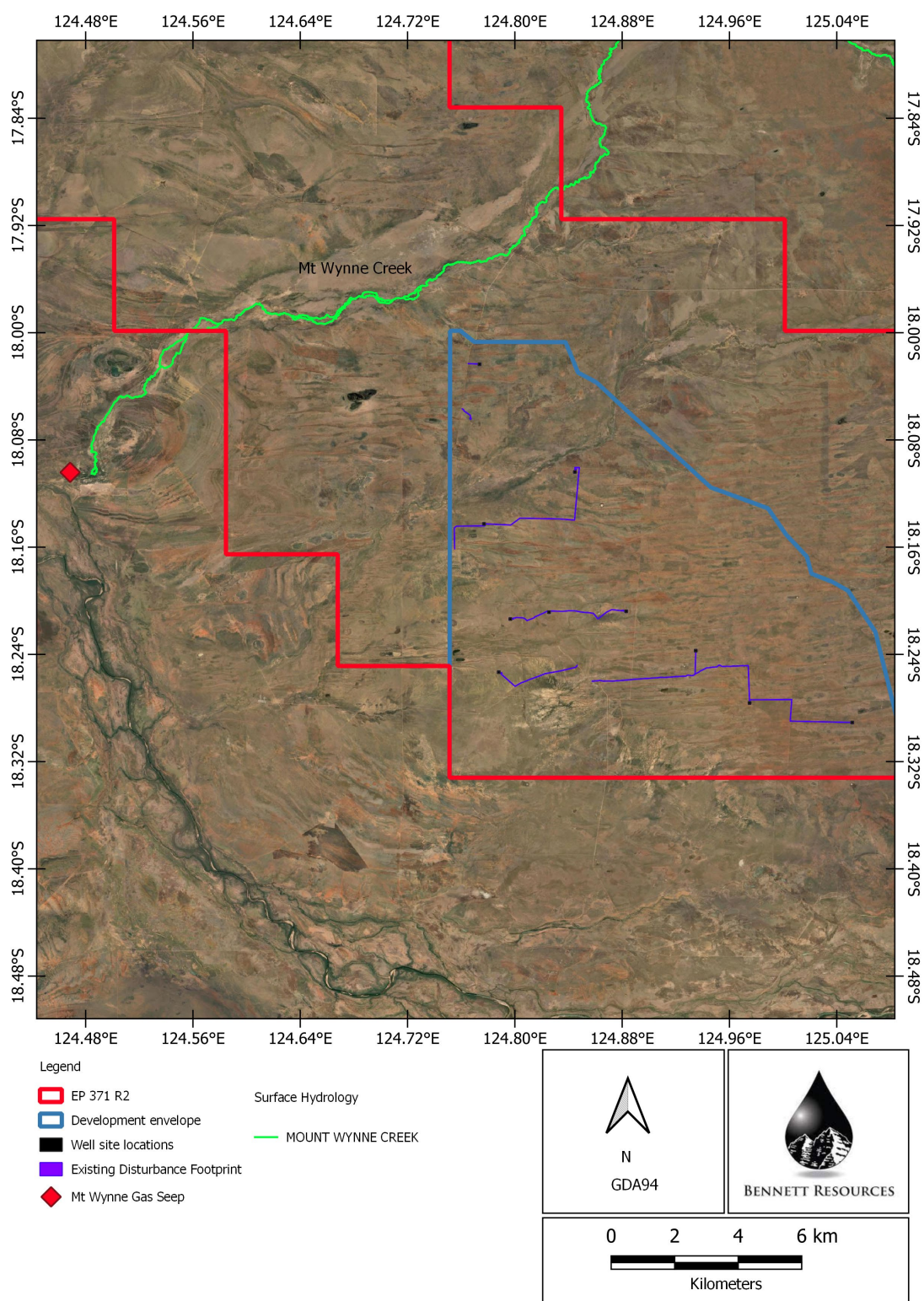
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Appendix 8. Figure showing Mount Wynne Creek and Mount Wynne Seep



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Appendix 9. Valhalla Human Health Risk Assessment

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Human Health Risk Assessment

Valhalla Gas Exploration and Appraisal Program

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VERSION HISTORY				
Ver. No.	Ver. Date	Author	Reviewer	Revision
0	14 Dec 2021	AdV	SKR, AF	For peer review
1	10 Jan 2022	AdV	AF	For EPA submission
2	01 July 2023	AF	ML	For EPA submission
3	23 May 2025	AF	ML	For EPA submission

AU +61 8 9200 1685

225 St Georges Terrace, Level 14
Perth, WA 6000 AUS

www.blackmountainenergy.com

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Acronym / abbreviation

Terms / acronym	Definition / expansion
BNR	Bennett Resources Pty Ltd
CoPC	Constituent of potential concern
DoH	Department of Health
EP Act	<i>Environmental Protection Act 1986</i>
EPA	Environmental Protection Authority
ERD	Environmental Review Document
ESD	Environmental Scoping Document
Ha	hectares
HFS	Hydraulic fracture stimulation
HHRA	Human Health Risk Assessment
km	kilometres
m	meter
PM	Particulate matter
Proposal	Valhalla Gas Exploration and Appraisal Program
TO	Traditional Owner
VOC	Volatile Organic Compounds
µg	micrograms

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1 Overview

Bennett Resources (BNR) has prepared a site-specific Human Health Risk Assessment (HHRA) for the Valhalla Gas Exploration and Appraisal Program (the Proposal). The requirement to undertake a HHRA risk assessment was specified by the Environmental Protection Authority (EPA) in the Environmental Scoping Document (ESD), ESD requirement #52 for the environmental factor Social Surroundings:

Provide a peer-reviewed, site-specific human health risk assessment, addressing potential short and long-term health impacts of the proposal that addresses health risks from:

- a. *airborne chemicals;*
- b. *chemicals proposed to be used in drilling and hydraulic fracture stimulation;*
- c. *fluids and those expected to be present in produced or flowback water;*
- d. *storage and handling of drilling and hydraulic fracture fluids; and*
- e. *storage and disposal of drilling and hydraulic fracturing flowback fluids (including wastewater).*

Note: peer-reviewed, site-specific human health risk assessments will be provided to the Department of Health for comment.

The interest and scrutiny arise from the development of a new unconventional project following the lifting of the HFS (hydraulic fracture stimulation) moratorium and the lack of public knowledge relating to impacts and risks associated with the project in region of the West Kimberley. Prior to undertaking the Proposal, the scope of potential impacts to the public that may emerge needs to be understood, verified and shared with stakeholders, as well as with the public during the Section 38 referral under the *Environmental Protection Act 1986* (EP Act). This HHRA will define the scope of impacts to public health in a site-specific context for the Proposal, based on a risk-based framework approach.

The closest relevant human receptor, an Indigenous Community, is aware and supportive of the Proposal. They are currently knowledgeable of the risks to the environment and of the chemical sources arising from the Proposal given in the past they have supported and worked for a similar unconventional project, now part of Bennett Resources' existing assets. Community members and associated workers such as pastoralists travelling within the Proposal's area understand that they are not considered susceptible or vulnerable populations likely to be exposed by the Proposal's activities.

With the extensive environmental awareness and the depth of hydrogeological knowledge of the local and regional setting, all transport mechanisms have been adequately considered. It must be highlighted that all potential pathways were explored during the preparation of this HHRA, and that the feasible and reasonable pathways and thus associated risks are the focus of this risk assessment. Where necessary, where other exposure media and pathways were not detailed, the HHRA has clarified why these were not feasible for detailed inclusion in the HHRA. This HHRA will be included in the Proposal's Environmental Review Document (ERD) for assessment by the EPA.

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2 Methodology

This HHRA has been prepared in accordance with the Health Risk Assessment (Scoping) Guidelines (DoH 2010). The guidelines provide a framework for the health risk assessment component for Environmental and Health Impact Assessment processes. Specifically, the guideline is used to determine if a detailed Health Impact Assessment is required.

BNR used this process to determine which (if any) Health Hazards and subsequent Health Impacts required further detailed assessment. Procedurally, this HHRA follows a standard risk assessment approach (Figure 2-1) being:

- the activity is detailed and key issues identified relevant to the risk assessment
- hazards associated with the activities are identified
- exposure pathways associated with the hazards are identified
- the adverse effects to human health (Impacts) arising from exposure are defined
- consequence mitigation identified

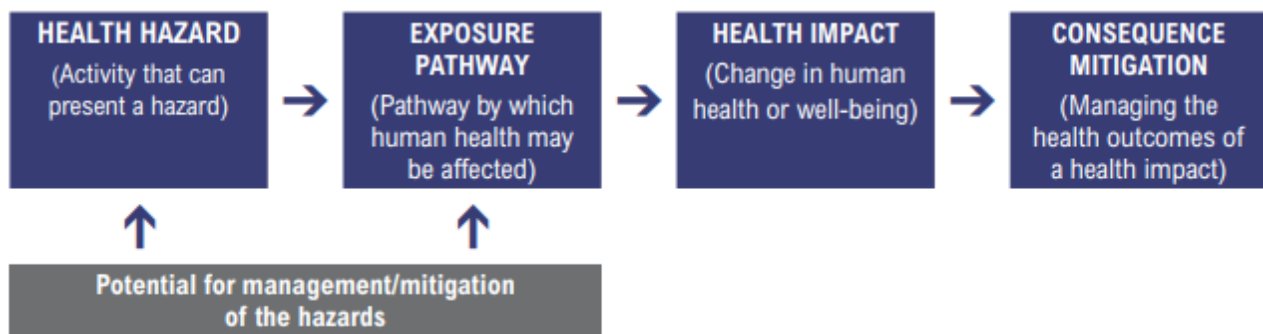


Figure 2-1: Links between health hazards and health impacts (DoH 2010)

All stages of the HHRA model are closely linked, and thus the outcomes of one stage of the assessment may affect the progression or outcomes of the subsequent assessment stage. As with all BNR risk assessments, a precautionary principle / approach has been considered applied to manage any uncertainty in the HHRA.

2.1 Project Context

2.1.1 Location and existing land use

The Proposal is located on the active Blina and Noonkanbah pastoral stations, on the Warlangurru and Noonkanbah Native Title Areas, respectively. Yungngora People of the Yungngora Community are employed by Noonkanbah Station and regularly travel on the station to verify cattle presence, feedstock, groundwater pastoral bore operation and associated watering troughs. Blina Station workers occasionally travel to the southern border of Blina Station which intersects the northern section of the Development Envelope to verify their cattle and station equipment. Cattle are free roaming, and pastoralists use existing station and BNR tracks to access specific areas of the station all throughout the Development Envelope

In addition to pastoral activities, the Traditional Owners (TOs) of the land and members of the Yungngora Community, including some Warlangurru People residing at the Jimbalakudunj Community, use the land within and surrounding the Development Envelope for cultural practices, such as hunting and gathering of traditional foods, initiations and education. The land in this region is also used for recreational purposes such as swimming and fishing. The TOs are made aware of all BNR presence and activities on the permit, with sufficient notice and engagement prior to undertaking any activities and visits to the sites.

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2.1.2 Receptor Analysis

Receptors relevant to the scope of this HHRA have been grouped into two categories:

- Fixed
- Non-fixed
- Out of scope.

Fixed

BNR has defined fixed receptors as locations where humans are known to reside or be present for long periods of time. For the purpose of this assessment these include:

- the Jimbalakudunj Community – located ~20 km from the nearest proposed well site and the general Development Envelope
- the Yungngora Community – located ~28 km from the nearest proposed well site and ~20 km from the general Development Envelope

The Jimbalakudunj Community, although located closer to proposed well sites than the Yungngora Community, was not identified as a receptor of the identified potential health hazards. However, the members of the Jimbalakudunj Community travel along the permit road to access the Yungngora Community and attend meetings, particularly as Warlangurru People reside in both communities, however do not often use the land itself for other reasons. Given the distance to the proposed activities and to any of the hazards, with separation from the Great Northern Highway, no exposure pathways have been associated with the Jimbalakudunj Community as a fixed receptor.

No other tourist or public access locations are present within the Development Envelope, thus no other locations are known where humans have the potential to reside or be present for a long period of time.

Non-Fixed

The existing land use throughout the Development Envelope is pastoral use. Consequently, any pastoral station worker conducting activities throughout the station has the potential to be non-fixed receptor. For context Blina Station comprises a total area of 254,600 ha. Noonkanbah Station covering the majority of the Development Envelope comprises a total area of 172,400 ha and employs less than 10 people, with the number of workers generally doubling during the mustering season. Approximately four Yungngora locals are employed by the station. Given that the disturbance footprint of this Proposal is limited to 109 ha, the potential direct impact is limited to <0.03% of the total pastoral stations.

To further define the non-fixed receptors, pastoralists verifying the operation of pastoral bores, which may include touching the bore equipment and bore water, have been identified as those closest to the exposure pathway for non-fixed receptors. In addition to pastoral use, as stated in Section 2.1.1, TOs use the land within and surrounding the Development Envelope for cultural practices and recreational purposes. TOs utilising the land for such reasons may be defined as non-fixed receptors. Specific cultural locations where TOs may occasionally frequent are not located in close proximity of the Proposal's disturbance footprint. Consultation with the TOs has shown that BNR is aware of these areas of cultural importance to the community members.

As the Calwynyardah-Noonkanbah Road runs through the Development Envelope, this has been considered another non-fixed receptor as users of the Calwynyardah-Noonkanbah Road do not reside in this specific area nor are located along the road for a long period of time. As direct exposure to any road user is not expected, this receptor has not been considered further.

Out of scope

As detailed in Section 5.4.3.6 of the Environmental Review Document (BNR_HSE_MP_013) there are no permanent water bodies within the Development Envelope. The Mount Hardman Creek is a non-perennial water body and only flows during the wet season. As there is no vulnerable shallow aquifer in communication with seasonal creeks the use of such waterbodies will not result in any exposure, thus it has not been considered further.

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2.2 Step 1 – Hazard

As defined by DoH, a Health Hazard is defined as:

The elements of an organisation's activities that present a hazard or source of risk to health or well-being and may be an event, incident or circumstances. They are activities or elements of a proposal that can interact with human health to represent a risk to health or well-being. Examples are air or water emissions, noise and displacement or relocation of people (DoH 2010).

To understand the potential health hazards associated with the Proposal, BNR developed a conceptual model which is presented in Figure 2-2. This model identifies the Health Hazards for the Proposal as being limited to:

- air emissions
- groundwater emissions
- soil contamination.

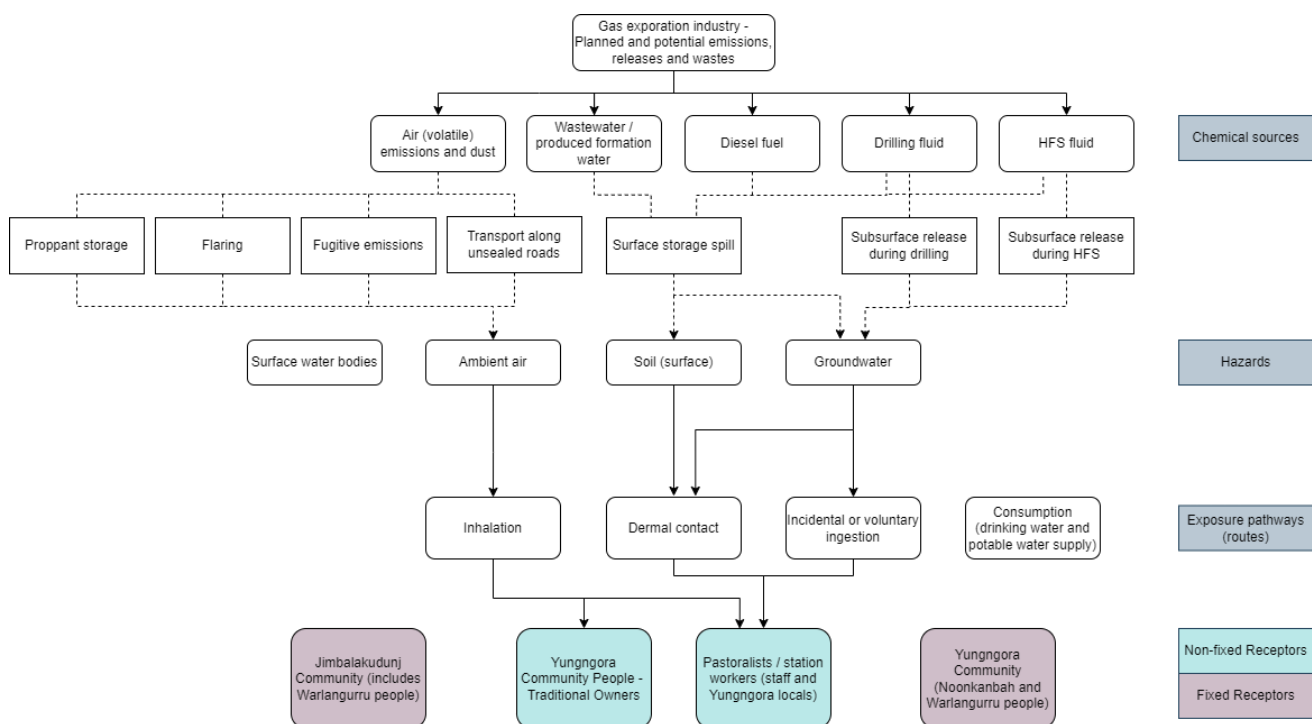


Figure 2-2: Site-specific conceptual site model illustrating the source – pathway – receptor analysis undertaken for the HHRA

2.3 Risk Assessment Process

The risk assessment process undertaken for the Proposal was completed following four steps:

- Step 1 the identification of the hazards
- Step 2 defines the feasible pathways from each of the hazards
- Step 3 determines the potential health impacts from the hazards through the identified exposure pathways
- Step 4 consists of the risk assessment itself.

The consequence of the described health impact is defined, whereby the magnitude of the impact is detailed, in qualitative or quantitative terms. Once the consequence defined, the likelihood of the consequence is determined, where the frequency and probability of the consequence occurring is evaluated, in qualitative or quantitative terms. The combination of the consequence and the likelihood of that particular consequence occurring results in the inherent health risk level for the specific hazard. The risk level is considered as an

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indication of the significant of a health or well-being impact. If required, depending on this risk level, risk management criteria (management of mitigation measures required to reduce negative impact of enhance positive impact) may be applied in order to reduce the risk to human health.

2.3.1 Step 2 – Exposure

An exposure assessment was initially undertaken for each of the hazards in accordance with the DoH Health Risk Assessment (Scoping) Guidelines (DoH 2010) and in consideration with the principles set out in the DoH environmental health risk assessment process (enHealth 2012).

As defined by DoH, an exposure is defined as:

The Pathway by which human health may be affected (DoH 2010).

Given that the sources of hazards are clearly understood (refer to Section 3.1, Section 3.2 and Section 3.3), assessment of exposure to these sources was completed by considering the receptors with the potential to be exposed and consideration as to the magnitude, frequency, and duration of potential exposure (WHO 2004).

2.3.2 Step 3 – Health Impact

An impact (or risk) assessment was undertaken for each of the hazards in accordance with the DoH Health Risk Assessment (Scoping) Guidelines (DoH 2010) and in consideration with the principles set out in the DoH environmental health risk assessment process (enHealth 2012).

As defined by DoH, health impacts are defined as:

the overall effects, direct or indirect, of activities on the health of a population. The variation and vulnerability among sectors of the population need to be considered (DoH 2010).

2.3.3 Step 4 – Risk Assessment

Consistent with DoH guidelines (DoH 2010), BNR assessed the:

- Consequences, in accordance with the definitions provided in Table 2-1
- Likelihood, in accordance with the definitions provided in Table 2-2
- Risk Level, in accordance with the definitions provided in Table 2-3
- Risk Management Criteria, in accordance with the definitions provided in Table 2-4.

Table 3-1: Categories for Health Consequences (source (DoH 2010))

Category	Acute Health Consequences (per Hazard or outbreak)	Chronic Health Consequences(per Project Lifecycle)
Catastrophic 1	>1 fatality OR >5 permanent disabilities OR Non-permanent injuries requiring hospitalisation for 5–10% of population at risk OR Acute health effect requiring hospitalisation for >5-10% of population at risk	Chronic health effect requiring medical treatment for 10–15% of population at-risk*
Massive 2	1 fatality OR 2–5 permanent disabilities OR Non-permanent injuries requiring hospitalisation for 2–5% of population at risk OR Acute health effect requiring hospitalisation for	Chronic health effect requiring medical treatment for 5–10% of population at-risk*

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	>2–5% of population at risk	
Major 3	No fatality AND (1 permanent disability OR Non-permanent injuries requiring hospitalisation for >1–2% of population at risk OR Acute health effect requiring hospitalisation for >1–2% of population at risk OR Evacuation is necessary)	Chronic health effect requiring medical treatment for 2–5% of population at-risk*
Moderate/ Significant 4	No fatality AND No permanent disability AND (Non-permanent injuries requiring hospitalisation for 1–2% of population at risk OR Acute health effect requiring hospitalisation for 1–2% of population at risk AND No evacuation	Chronic health effect requiring medical treatment for 1–2% of population at-risk*
Minor 5	No fatality AND No permanent disability AND (Non-permanent injuries requiring hospitalisation for 1–5 persons OR no acute health effect requiring hospitalisation) AND No evacuation	Chronic health effect requiring medical treatment for about 0–1% of population at-risk*
Negligible/slight 6	No fatality AND No permanent disability AND No non-permanent injuries requiring hospitalisation AND No acute health effect requiring hospitalisation AND No evacuation	No chronic health effect requiring medical treatment

Table 3-2: Likelihood Categories for Health Impact Assessments (source (DoH 2010))

Likelihood Descriptor		Frequency of Incident or outbreak with Non-Chronic Health Effect	% Chance of Chronic Health Effect during life of project
1	Rare/remote	Once in more than 10 years	Up to 5%
2	Unlikely	Once in 5 – 10 years	6 – 30%
3	Possible/ occasionally	Once in 3 – 5 years	31% – 60%
4	Likely	Once in 1 to 3 years	61% – 90%
5	Almost certain	More than once a year	Over 90%

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Table 3-3: Qualitative Risk Matrix for Health Impact Assessments (source (DoH 2010))

Likelihood	Consequences					
	Slight/negligible	Minor	Moderate	Major	Massive	Catastrophic
Almost Certain	Low	Medium	High	Extreme	Extreme	Extreme
Likely	Low	Low	Medium	High	Extreme	Extreme
Possible	Very Low	Low	Low	Medium	High	Extreme
Unlikely	Very Low	Very Low	Low	Low	Medium	High
Rare/remote	Very Low	Very Low	Very Low	Low	Low	Medium

Table 3-4: Risk management criteria according to risk rating at scoping stage (source (DoH 2010))

Risk Rating	Risk Mitigation/Management Criteria
Extreme	Potentially unacceptable: modification of proposal required
High	Major mitigation/management (including offsets) may be required – Assessment required of health hazards
Medium	Substantial mitigation/management required – Assessment required of health hazards
Low	Some mitigation/management may be required – No detailed assessment of health hazards required but addressed with routine controls
Very Low	No further assessment required

2.4 Peer Review

BNR engaged Geosyntech consultants (Geosyntech) to complete a review of this HHRA. BNR sent through Revision 0 to Geosyntech to which a response was provided (included as Appendix A). In summary Geosyntech provided the following recommendations (Summarised):

- BNR consider Surface Water Resources, and describing these even if no exposure pathway existed
- To include more information on Constituents of Potential Concern (COPC)
- To discuss surface release and exposure to groundwater systems

In summary, Geosyntech stated:

Overall, the study is very close to complete, is well ordered, easy to follow, and consistent with relevant administrative authority guidelines. Excepting additional discussion regarding the projected nature and extent of proposal CoPCs, and in recognition of the very low potential for exposure to populations outside Valhalla Gas workers, it is unlikely that a more detailed and comprehensive HHRA will be required.

BNR addressed the recommendations from Geosyntech in Revision 1 of this HHRA.

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3 Health Risk Assessment

3.1 Air

3.1.1 Hazard

Exposure to air emissions is limited to dust emissions and volatile organic compounds (VOCs).

The health hazards (activities that can present a hazard and interact with human health) from air include:

- VOCs and dust from transport along unsealed roads / tracks
- Dust from proppant (fine sand) storage on site
- VOCs and products of incomplete combustion (PICs) from flaring during well testing activities on site
- VOCs as fugitive emissions from the well following completion of HFS activities.

These health hazards will be limited to the duration of the activities at each well site and transport along the roads and tracks during mobilisation and demobilisation of the Proposal equipment.

3.1.2 Exposure

Monitoring from other programs have demonstrated that VOCs rapidly dissipate upon release with no ground level exposures above human health criteria/screening levels (Ramboll 2019). As such, no further consideration of human health impacts from VOCs have been considered given there is no potential exposure to Fixed or Non-fixed receptors.

As such, health impacts associated with changes to ambient air are associated with the following pathway:

- Inhalation (respiratory system) associated with dust from sand storage onsite.

BNR reviewed the Proposal's Chemical Inventory (Appendix A of the Valhalla Environmental Review Document [BNR_HSE_MP_013]) to identify products that contained:

- suspected carcinogens
- mutagens,
- developmental toxicants and endocrine disruptors.

These were then further refined to understand those products that pose a human health risk via inhalation. Specifically for the water-based drilling fluid, cementing system and HFS fluid, the following Constituents of Potential Concern (CoPC) were identified as posing a human health risk:

- Silica.

Typically, proppant (or RCS) is comprised of naturally occurring sand grains, resin coated sand (RCS) or high-strength ceramic materials that range in size from 106um to 1180 um. Based upon the typical size of proppant, silica can be measured onsite through monitoring of particulate matter (PM) given that the presence of proppant (or RCS) would show up during monitoring for fine particulates. Baseline studies identified a range of environmental concentrations for PM_{2.5} and PM₁₀ onsite dependant on various environmental conditions. The Valhalla Monitoring Plan (Appendix C of the Valhalla Environmental Review Document [BNR_HSE_MP_016]) details 24-hour average – Health indicators for PM_{2.5} and PM₁₀. BNR will monitor for these over the course of the Proposal.

As detailed in Section 5.5.3.1 of the ERD, the closest public communities (Aboriginal communities) are located 20 km and 28 km from the closest proposed well sites within the Development Envelope. No other fixed sensitive human receptors are known to occur within the Development Envelope.

Consequently, no exposure to fixed receptors is expected to arise from dust emissions associated with the Proposal.

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As stated in Section 2.1.2, pastoral workers and travelling Yungngora Community TOs have the potential to be present within the Development Envelope over the course of the Proposal. These workers and people using the land for traditional purposes are considered Non-fixed receptors and exposure would only occur in the event they were located within proximity of the well site during HFS activities. As dust from the proppant storage is expected to be influenced by the weather and wind conditions, and as baseline monitoring has indicated existing PM levels within the Development Envelope fluctuate due to the weather conditions, the change to ambient air quality levels is not expected to be significant.

3.1.3 Impact

It is well established that dust emissions can have adverse impacts (adverse changes) on human health. These health impacts can be both short-term (acute) and long-term (chronic). Dust particles (i.e. in the PM₁₀ and PM_{2.5} size ranges) including fine sand particles that are readily inhaled are associated with a range of chronic health effects. Both fine and coarse dust particles can cause acute health effects (e.g. eye or breathing irritation) and also deposit and remain on surfaces leading to soiling.

Further to this, a completed HHRA, in accordance with DoH guidelines (DoH 2010), is provided in Table 3-1.

Table 4-1: Human Health Risk Assessment – Air

	Description
Consequence	The generation of dust on unsealed roads already occurs within the Development Envelope from community members travelling to and from the Yungngora and Jimbalakudunj Communities, and from pastoral activities along existing access tracks and transportation of cattle using road trains on the unsealed Calwynyardah-Noonkanbah Road. Current PM₁₀ dust levels along the road often exceed the daily health guideline levels of 50 µg/m³ most days of the week. Dust resulting from the Proposal will only increase the current dust concentrations along the Calwynyardah-Noonkanbah Road during transportation of equipment to and from the well sites, and specifically on parts of the road located at least >20 km away from the closest community. Proppant, or frac sand, is expected to be stored on each well site and protected from wind and equipment that may disturb the sand. The mechanical handling of sand for storage on site and during the preparation of HFS fluid may generate dust that can temporarily disperse to the exterior of the well site fences. Given the distance to potential Non-fixed human receptors in the Development Envelope, the temporal nature of their presence in the area, and as the Proposal has more separation than recommended in accordance with EPA Guidance (EPA 2005), the Proposal is not expected to result in any chronic health effects requiring medical treatment.
Likelihood	In accordance with DoH guidelines, BNR does not believe that the Proposal would result in one event / incident of chronic health in more than 10 years and consequently the likelihood of exposure is considered rare / remote. The reason to this is that the public (including TOs from the Yungngora Community and pastoralists) is restricted from site access, and exposure will be limited to the duration of the activity which will be limited to months (at each well site). Consequently, the duration of exposure will be limited, the extent to which humans can be exposed is limited and the nature of the exposure (as detailed in Section 5.6.3 in the ERD) is limited.
Inherent Risk Level	Based upon the DoH qualitative Health Impact Assessment risk matrix, the level of risk is: Very Low .
Uncertainty	BNR has completed monitoring of existing dust and VOC air quality within the Development Envelope. Consequently, during the implementation of the Proposal, BNR will be able to monitor the changes to air quality associated with the Proposal. Given the robust amount of baseline data combined with the proposed monitoring program and actions in Appendix C of the ERD, there is limited uncertainty associated with the Proposal.
Health Risk management	Based upon the DoH risk management criteria, no further assessment is required.

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3.2 Surface water

3.2.1 Hazard

No planned emissions or discharges arising from the Proposal will interact with any surface waters and as such no exposure to surface waters from planned activities will occur. Consequently, health hazards could only arise from contact with surface waters where an unplanned surface release event occurs, which is then transported into a surface water body being used by non-fixed receptors.

The only surface water feature in close proximity to the Proposal is Mount Hardman Creek. Mount Hardman Creek is a non-perennial water body and only flows during the wet season. Consequently, an unplanned release event would need to occur during the wet season (given any release during the dry season would not reach the surface water feature and would be cleaned up prior to the wet season) and as such the only potential spill event that could occur in these circumstances is a flooding event.

3.2.2 Exposure

Standard construction, petroleum storage, and petroleum use mitigation measures (ERD Table 5-11) will be applied to this activity; therefore, the likelihood of such a spill event occurring during flooding is extremely low (if at all credible). Further to this engagement with Traditional Owners and the Pastoral station did not identify that Mount Hardman Creek is used for any activities that would result in non-fixed receptors being present during a flood event. Suggesting that the potential for human exposure is not credible given:

- exposure could only occur in the wet season
- mitigations are in place to prevent unplanned spill events (thus these would need to fail for a unplanned spill event to occur during flooding)
- in the event of flooding the site will not be frequented
- if these failed non-fixed receptors would not be present

3.3 Groundwater

3.3.1 Hazard

Exposure to groundwater is limited to CoPCs that may reach Liveringa Aquifer groundwater used by pastoral station bores screened in the same aquifer. The health hazards (activities that can present a hazard and interact with human health) from groundwater include:

- surface release of drilling fluids and HFS fluids
- subsurface release of drilling fluids
- subsurface release of HFS fluids.

3.3.2 Exposure

Groundwater contamination is associated with unplanned events, specifically relating to drilling or HFS fluid systems. Groundwater exposure to humans is limited to those events that reach the Liveringa Aquifer groundwater used by pastoral station bores screened in the same aquifer. The closest utilised pastoral bores are located >1.5 km away from the closest proposed well site.

Although the release of subsurface HFS fluids was identified as a chemical source, HFS fluids will only have the potential to be released along the HFS zones between 2,000 m and 5,000 m below ground. As such, any release would be contained by the thick shale layers from the Laurel and Anderson formations as described in Section 5.4.5.4 of the ERD. With over 1.5 km separation between the targeted Laurel Formation during HFS activities and any Community bores used for potable water screened in the Poole and Grant aquifers, a subsurface release of HFS fluids was not considered to result in a feasible exposure pathway.

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The release of drilling fluids to an aquifer is only a hazard whilst drilling through the Liveringa Aquifer. As detailed in Section 5.4.5.2 of the ERD, BNR are required to utilise low-toxicity water-based drilling fluids when installing the surface casing. Once the surface casing is installed, there is no risk of drilling fluid loss as the surface casing provides a barrier between the drilling fluids and the aquifer. Consequently, the health hazard from groundwater specifically includes:

- Lost circulation events causing contamination of groundwater during the installation of the surface casing (drilling activity).

As stated in Section 2.1.2, pastoral workers and community members traditionally using the land have the potential to be present within the Development Envelope over the course of the Proposal. These people are considered Non-fixed receptors and exposure would only occur if:

- an unplanned release of drilling fluids occurred during installation of the surface casing
- the pastoral bores are located down gradient of the well site
- pastoral bores were in operation and CoPCs were pumped to the surface

Consequently, exposure to contaminated groundwater is extremely unlikely. However, should this occur, health impacts associated with changes to groundwater are limited to the following pathways:

- dermal contact
- incidental and voluntary ingestion

Consumption (drinking water) has been differentiated from incidental or voluntary ingestion, and was not considered further given that the surficial Liveringa Aquifer is not used for potable water purposes or for Community water supplies. The pathway 'incidental or voluntary ingestion' was considered given that pastoral workers are known to drink raw bore water whilst working, and TOs may know the location of these pastoral bores and use the water if needed when hunting and roaming in the permit area.

BNR reviewed the Chemical Inventory (Appendix A of the Valhalla Environmental Review Document [BNR_HSE_MP_013]) to identify products that contained:

- suspected carcinogens
- mutagens,
- developmental toxicants and endocrine disruptors.

These were then further refined to understand those products that pose a human health risk via dermal contact or ingestion. Specifically for the water-based drilling fluid, cementing system and HFS fluid, the following COPC were identified:

- Nitrilotriacetic acid, trisodium salt monohydrate
- Sulfuric acid

The outcomes of local groundwater characterisation is included as Appendix H of the Valhalla Environmental Review Document (BNR_HSE_MP_013). These studies identified a range of environmental concentrations for relevant CoPCs, including chloride and sulfate. These ranges indicate levels are relatively steady throughout the Development Envelope. Concentrations will continue to be monitored and management actions undertaken in accordance with the trigger and threshold criteria detailed in the Groundwater Management Plan (Appendix I of the Valhalla Environmental Review Document [BNR_HSE_MP_015]).

As detailed in Section 5.4.5.5 of the Environmental Review Document (BNR_HS_MP_013), based on the depth to groundwater, any surface release is expected to take 70–300 days to travel from the ground surface to the water table (Rockwater 2016). With the mitigations in place, BNR did not deem this a credible hazard, thus it has not been considered any further.

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3.3.3 Impact

It is well established that the quality of groundwater, when used for drinking purposes, can have adverse impacts on human health. These health impacts can be both short-term (acute) and long-term (chronic) depending on the CoPCs, the concentration of CoPCs and the duration of consumption of water. Although Liveringa Aquifer groundwater is not extracted and drunk as potable water, or stored for potable water supplies for communities or residences, as discussed in Section 3.2.2, only dermal contact and incidental or voluntary ingestion of non-treated non-potable bore water have been identified as feasible exposure pathways for groundwater. Dermal contact with non-treated bore water with higher concentrations of CoPCs may potentially lead to skin irritations, including skin dryness. Incidental or voluntary ingestion of non-treated bore water, in general, may result in aesthetically displeasing tastes and potentially temporary upset stomachs, based upon the expectation that a limited amount of bore water is ingested occasionally.

Further to this, a completed HHRA, in accordance with DoH guidelines (DoH 2010), is provided in Table 3-2.

Table 4-2: Human Health Risk Assessment – Groundwater

	Description
Consequence	A local and regional groundwater characterisation of the Liveringa Aquifer, including of the CoPCs identified as indicator constituents for drilling fluid, has shown that groundwater quality varies within the Development Envelope. Previous operational and surveillance monitoring on site during similar drilling operations in the Development Envelope showed no significant variation in CoPC data that was attributable to drilling activities. With the limited amount of drilling fluid potentially released at the subsurface, the dilution of CoPCs, and the migration of any CoPCs to the location of pastoral bores, the quality of the groundwater abstracted away from any of the well sites (>1.5 km) is not expected to differ from natural variations. Similar petroleum industry activities occur around the state, where low-toxicity drillings fluids are used. Low-toxicity drilling fluids are planned to be used by BNR that are not expected to result in environmental impacts, nor health impacts. Given the distance to the Non-fixed TO receptors using the whole permit area, and their infrequent presence around the pastoral bores, the Proposal is not expected to result in any chronic health effects to TOs using the land for cultural or recreational purposes, that would require medical treatment. Despite the more regular presence of station workers around the pastoral bores and frequency of contact with bore water, the Proposal is still not expected to result in any chronic health effects to station workers that would require medical treatment.
Likelihood	In accordance with DoH guidelines, BNR does not believe that the Proposal would result in one event / incident of chronic health in more than 10 years and consequently the likelihood of exposure is considered rare / remote. The reason to this is that the community members are not expected to use or touch groundwater from pastoral bores unless needed in case of thirst, given their remote location within the bush in the Development Envelope away from the Community residences. Additionally, pastoralists are aware that the groundwater abstracted from their bores are for cattle watering purposes. Pastoralists will regularly clean and maintain the cattle troughs where bore water is run through. Voluntary drinking directly from the bore pump pipe is common during station activities. As such, the dermal and ingestion exposures are limited to if and when these Non-fixed receptors are purposefully visiting the pastoral bores. Consequently, the duration of exposure will be limited, the extent to which the public can be exposed is limited and the nature of the exposure (as detailed in the Consequence section above) is limited.
Inherent Risk Level	Based upon the DoH qualitative Health Impact Assessment risk matrix, the level of risk is: Very Low.
Uncertainty	The previous operator of the permit completed groundwater monitoring on bores within existing well sites that underwent drilling and HFS activities, which showed no significant variation in CoPC data that was attributable to drilling activities. BNR has completed further groundwater monitoring, including baseline monitoring within the Development Envelope to further understand the existing groundwater quality of the Liveringa Aquifer (in which pastoral bores are screened and in which Proposal monitoring bores will be screened) within the Development Envelope. Consequently, during the implementation of the Proposal, BNR will be able to monitor if any changes to groundwater quality associated with the Proposal occur. Given the robust amount of baseline data combined with the proposed monitoring program and actions in Appendix C of the ERD, there is limited uncertainty associated with the Proposal.

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Health Risk management	Based upon the DoH risk management criteria, no further assessment is required.
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3.4 Soil

3.4.1 Hazard

Soil contamination has the potential to occur from an unplanned release (spill event) on site over the course of the Proposal. Specifically, the onsite surface spill events may include spills from:

- drilling fluids
- HFS fluids during pumping
- wastewater – produced formation water
- diesel fuel storage.

3.4.2 Exposure

Exposure to humans is limited to those events that result in contamination outside of the well site. With the exception of well site access tracks (that are likely to be used for pastoral access once installed), the closest Non-fixed receptors (pastoral workers) who would be regularly visiting the area surrounding the well sites would be located ~1.5 km away given this is the distance to the closest pastoral bore.

This health hazard will be limited to each well site and the immediate perimeter (i.e. the firebreaks) during operation of the Proposal. The current pastoral activity within the Development Envelope around all proposed well sites is limited to cattle grazing. The land is not used for other agricultural reasons and is not used from crop growth for human consumption.

These station workers are considered Non-fixed receptors and exposure would only occur if:

- an unplanned release occurred that resulted in contamination outside of the well site
- the station workers were on-site at the time of release.

Consequently, exposure is extremely unlikely. However, should this occur, health impacts associated with changes to soil are limited to the following pathways:

- dermal contact.

3.4.3 Impact

Dermal contact of contaminated soil with higher concentrations of CoPCs may lead to skin irritations, including skin dryness. Dermal contact may also lead to dermal absorption of CoPCs from soil. Impacts would be expected to be acute (short-term), and dependant by a variety of physical and chemical factors, including the type of CoPCs, the soil-chemical contact time, the degree of chemical saturation of the CoPCs in soil, the area of exposed skin, continuity/duration of soil-skin contact (exposure time), the amount of soil adhering to the skin and the amount of contaminant absorbed through the skin (NEPC 1999).

The substances for which dermal contact from soil and associated impacts are most likely to be significant are lipophilic compounds that are relatively long lived in the environment, accumulate in the body, and present a chronic (e.g., carcinogenic) risk (Spalt, et al. 2009).

Further to this, a completed HHRA, in accordance with DoH guidelines (DoH 2010), is provided in Table 3-3.

Table 4-3: Human Health Risk Assessment – Soil

	Description
Consequence	As detailed in the ERD in Section 5.2.3.2 and in the human health hazard for soil in this HHRA, spills from drilling fluids, produced formation water and diesel fuel have the potential to contaminate soil and affect Non-fixed receptors. On this basis, the analytes considered both as indicators of spill events and

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	as CoPCs for human health are Total Recoverable Hydrocarbons from diesel, Barium, Chloride, Cadmium and Chromium III from drilling fluids, HFS fluids and produced formation water. Similar petroleum industry activities occur around the state, where low-toxicity drillings fluids are used. Low-toxicity drilling fluids are planned to be used by BNR that are not expected to result in environmental impacts, nor health impacts. Regional baseline soil quality sampling, including for the above CoPCs, have shown that soil quality varies throughout the Development Envelope. Should a spill event occur on site during operations and contamination occur outside of the well site, this would result in the presence and/or increase of these specific CoPCs in soil prior to BNR immediately implementing management measures and remediation of the contaminated soil. Dermal contact with the CoPCs characteristic of the chemical sources is not expected to result in significant health impacts, primarily due to the nature of the exposure pathway and the very temporal nature of the exposure. Contact with these CoPCs will result in irritation and sensitization only if the skin contact is prolonged. Given the predicted distance to Non-fixed sensitive receptors at least 1.5 km away, the frequency of their presence in the surrounding area (approximately once a week), and the unlikely long-term skin exposure should a spill event occur, the Proposal is not expected to result in any chronic health effects requiring medical treatment.
Likelihood	In accordance with DoH guidelines, BNR does not believe that the Proposal would result in one event / incident of chronic health in more than 10 years and consequently the likelihood of exposure is considered rare / remote. The reason to this is that the public is restricted from site access, the hazards are unlikely to go beyond the delimitation of the well sites, and remediation of any hazard is planned to occur as soon as possible to limit impacts to the environment in the first instance. Consequently, the duration of exposure will be limited, the extent to which the public can be exposed is limited and the nature of the exposure is limited.
Inherent Risk Level	Based upon the DoH qualitative Health Impact Assessment risk matrix, the level of risk is: Very Low .
Uncertainty	BNR has undertaken baseline soil monitoring within the Development Envelope to understand the existing soil quality of the different soils within region. Consequently, during the implementation of the Proposal, BNR will be able to monitor if any changes to soil quality associated with the Proposal occur. Given the robust amount of baseline data combined with the proposed monitoring program and actions in Appendix C of the ERD, there is limited uncertainty associated with the Proposal.
Health Risk management	Based upon the DoH risk management criteria, no further assessment is required.



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4 Conclusions

This HHRA has presented plausible evidence of the exposure pathways linking the source of contamination and the exposed receptors. With the exception of air emissions (associated with dust generation), all exposure mechanisms are based upon unplanned events that are well understood in the industry with suitable management and consequence mitigation measures in place.

All risks were deemed to be very low according to characterisation in accordance with the DoH risk matrix, which determined that no further risk characterisation is required.

No specific human health risk management or the implementation of mitigation measures are necessary and this is consistent with advice from the Department of Health that indicate that detailed Human Health Risk Assessment is required when the source of the risk is located within close proximity of sensitive receptors.

This Human Health Risk Assessment demonstrates that the Proposal is not expected to have an impact on public health at the Yungngora and Jimbalakudunj Communities, nor on the associated pastoral station workers and Traditional Owners travelling on the land within the Development Envelope.

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Appendix A. Peer Review of Human Health Risk Assessment, Valhalla Gas Exploration and Appraisal Program

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TECHNICAL MEMORANDUM

Date: January 7, 2022

To: Samantha Richardson
Black Mountain Energy, Perth, WA

From: Travis Kline, MEM, BCES,
Geosyntec Consultants, Inc., Washington DC
David Reynolds, Ph.D., CEnvP (SC), Sydney, NSW

Subject: Peer Review of *Human Health Risk Assessment*, Valhalla Gas
Exploration and Appraisal Program, Bennett Resources, December 14,
2021

1. INTRODUCTION

Overall, the document is well-organized and conforms to the recommendations and structure as outlined in *Health Risk Assessment (Scoping) Guidelines* (DoH 2010). These guidelines provide a framework for the health risk assessment component for the Environmental and Health Impact Assessment processes, and incorporate, by reference, Department of Health (DoH) and Ageing and enHealth Council (2002, 2012) environmental health risk assessment guidelines as well as DoH human health risk and hazard guidelines issues for Western Australia (DoH 2006).

2. Recommendations

- a. **Surface Water Resources:** There is no discussion of surface water bodies (e.g., creeks, ponds) within the proposal area, although Section 2.1.1 lists swimming and fishing as relevant recreational activities in consideration of local communities. It is understood that there are no permanent water bodies within the development envelope, with Mt. Hardman Creek, a seasonal water body, the closest for consideration. Given that there is no vulnerable shallow aquifer in communication with even seasonal creeks, the predominant release mechanism associated with potential environmental exposure is the catastrophic failure and release of hydraulic fracturing fluid from container trucks or the lined retention ponds. The document could benefit from a discussion surrounding the low potential for surface water impacts and clarification of how flowback water will be managed on-site (e.g., impoundment construction, lining, secondary containment, if any). Surface water, as a receiving medium, should be added to Figure 2-2, if only to designate the absence of a complete exposure pathway under foreseeable future conditions.
- b. **Constituents of Potential Concern (CoPCs):** The document could benefit from a discussion of the CoPCs at issue. Section 3, Health Risk Assessment, notes volatile

organic compounds (VOCs) and dust in ambient air and drilling fluids and HFS fluids in groundwater. Table 3-3 lists the potential presence of diesel range hydrocarbons, barium, cadmium, and chromium in soil, resulting from drilling fluids, but there is no discussion of surfactants, algicides, lubricants, etc., associated with hydraulic fracturing fluids. It is understood that indirect inhalation of off-gassing VOCs or dust by populations other than Valhalla Gas employees is likely to be very minimal, given the large ambient air mixing zone. Direct contact with soil, impacted by localized spills at well heads during development, by non-Valhalla Gas employees is not anticipated, except as a component of trespassing. The pastoral bores do not supply residential drinking water, but they do supply water for cattle and, as noted by Bennett, periodic ingestion by station workers or transients. I will defer to Valhalla in regard to specific CoPCs in light of the need to protect business confidential/proprietary mixtures, but in the absence of more detail with regard to type of chemical and anticipated concentration in environmental media, it is impossible to judge the accuracy or defensibility of generalized, qualitative assessment and elicited outcomes, such as “potentially temporary upset stomachs.” In addition, Section 3.3 notes that some CoPCs could be associated with bioaccumulation. In light of cattle watering (Liveringa aquifer, low susceptibility from well development) and biotrophic transfer, the document could benefit from additional clarification. I am in agreement that there is low potential for chronic exposure (even if carcinogenic constituents are present) and very low potential for negative acute exposures; however, additional detail regarding specific CoPCs and anticipated ranges of environmental concentrations (perhaps in comparison to relevant health-based screening criteria) would significantly support the document as a defensible decision management tool and obviate the need for a detailed HHRA in the eyes of EPA and DoH.

- c. **Soil to Groundwater Leaching:** There is limited to no discussion of surficial releases and their potential impact to groundwater. I am unsure of the depth to the Liveringa (or the screen depth of pastoral bores completed in the Liveringa), but if it is within 30 mbgs, leaching and transfer to groundwater (and anticipated dilution/attenuation) is worth mentioning. Figure 2-2 can be updated to show surface soil to subsurface soil to groundwater as a contributing pathway (unless the depth to the Liveringa is too extreme). It is also worth mentioning that surficial releases will attenuate with depth and that there are no anticipated complete exposure pathways associated with subsurface soil for populations other than Valhalla Gas workers. Figure 2-2 should also be updated to include incidental ingestion of soil in any complete exposure pathway identifying dermal contact with soil.
- d. **Minor Clarifications:** The HHRA was not reviewed from a purely editorial perspective, although the following minor corrections are noted:
 - i. **Section 3.1.1, Hazard:** VOCs should be defined as volatile organic compounds (not carbons).
 - ii. **Section 3.1.1, Hazard:** The third bullet in this list should be revised to reflect: “VOCs and products of incomplete combustion (PICs) from flaring during well testing activities on site.”
 - iii. **Ramboll 2019.** Geosyntec did not conduct a thorough review of Ramboll 2019 but notes that this study reflects one specific operation. Geosyntec has not judged whether this operation is sufficiently similar in scope and nature to the Valhalla proposal, but is in general agreement that the low-level emissions associated with these activities will readily dissipate in the ambient air breathing zone, given the huge mixing zone available under proposed operations. Geosyntec does note that the only identified human health concern in the Ramboll 2019 study was predicated on dust and driven by background conditions (i.e., PM2.5, Caversham monitoring station), not specific to the study area.

3. SUMMARY & CONCLUSION

Overall, the study is very close to complete, is well ordered, easy to follow, and consistent with relevant administrative authority guidelines. Excepting additional discussion regarding the projected nature and extent of proposal CoPCs, and in recognition of the very low potential for exposure to populations outside Valhalla Gas workers, it is unlikely that a more detailed and comprehensive HHRA will be required.

Sincerely,



Travis Kline, MEM BCES
Senior Principal



David Reynolds
Senior Principal

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