Appendix M Stakeholder Engagement Log

Part A - Stakeholder Engagement Log Summary

Confidential and commercial-in-confidence communications with NLC and pastoralists is summarised in the below table and provided to the Minister separately.

Date	Originator of communication		Company and person of contact		Contact type	Summary of contact	Does it trigger merit review?	A statement of the interest holder's response to stakeholder	Change to EMP required?	Details of changes the interest holder has made as a resulting from stakeholder engagement
					9 (1) f	**9(1)c**	**9 (1)d**	**9 (1) e**		**9 (1)g**
10/07/2018	Origin Energy		NLC	G McDonald	Written	Origin request to obtain site clearances for its proposed 2018/19/20 exploration program. This request included a description of the proposed activities (including up to 10 wells at each location, estimated duration and summary of key environmental considerations and risk controls.	No	NA	NA	Pre-2019 Regulations and data capture requirements.
17/07/2018	Origin Energy		NLC	G McDonald	Written	Origin provided additional information regarding maps and proposed site locations.	No	NA	NA	Pre-2019 Regulations and data capture requirements.
16/11/2018	NLC		Origin Energy	S Stonier	Written	NLC Conditions of Work Report to Operator _Origin_181115 received. Report summarised clearance activities, identified restricted work areas and conditions of work.	No	Yes	Yes	Identified restricted work areas and conditions of work add to the EMP where relevant. Pre-2019 Regulations and data capture requirements.
03/04/2019 - 10/04/2019	Origin Energy		NLC/TO	NLC/TO	Meetings	x6 on country meetings in Elliott with Native Title family groups regarding NLC Cleared Areas CA3 (Amungee NW1H (existing well site location), CA5 (Kyalla 117) and CA10 (Velkerri 76). 8 May 2019: One meeting in Darwin with Native Title family for NLC Cleared Areas from Sacred Site Clearance and Avoidance Survey in response to Origin's WPS. All meetings included an overview of the proposed work program and the environmental controls to address environmental risks. Origin used story boards to present and discuss key aspects regarding the environment and its protection.	No	NA	NA	NA
3/09/2019	Origin Energy		NLC	G McDonald	Meeting	Meeting to discuss future site clearances and scope amendment by Origin. Additional information on lease pad layout and revised site list include.	No	NA	NA	NA
29/06/2020	Origin Energy		NLC	NLC	Meeeting	Meeting to provide an update of the Beetaloo exploration project and discuss sacred sites clearances.	No	Ongoing consultation/engagement with NLC regarding Origins current and future activities.	No	N/A
23/07/2020	Origin Energy		NLC	NLC	Workshop	Overview of future project phases and approvals processes.	No	Origin and NLC discussed the various phases of the project from exploration to development and the various activities associated.	No	N/A
27/10/2020	Origin Energy		NLC	NLC	Meeting	Ongoing meeting to discuss sacred site clearances and exploration activities.	No	Origin discussed a range of future exploration activities and provided a summary of the relevant site and environmental constraints	No	N/A
28/03/2021	Origin Energy		NLC	NLC	Face to Face	Origin conducted Annual on Country meetings with NTHs from across the Beetaloo Basin. NLC facilitated these consultations and were present at all meetings. One meeting in Katherine (Minyeri and Mataranka groups); one meeting in Elliott (Marlinja and Borroloola group) and one meeting in Darwin for Darwin-based Native Title Holder families.	No	Story (visual) boards used by Origin to explain and communicate what exploration occurred in 2020 and what the planned 2021 exploration program involved regarding activities at Amungee, Kyalla and Velkerri.	No	N/A
17/08/2021	Origin Energy		NLC	NLC	Email	Origin informed the NLC that Origin had made an explanatory document available publicly on its website, outlining Origin's engagement with Native Title Holders.	No	N/A	No	No
23/09/2021	Origin Energy		NLC	NLC	Email	Origin submitted a work clearance request to the NLC (sacred site avoidance survey request).	No	N/A	No	No
25/10/2021	Origin Energy		NLC	NLC	Meeting	Meeting to discuss Origin's forward program, including activities around the Amungee NW site and broader Beetaloo.	No	Origin discussed a range of topics including the forward exploration project	No	N/A
29/10/2021	Origin Energy		NLC	NLC	Email	Annual work program update providing them information on Origin's forward exploration program.	No	N/A	No	N/A
29/11/2021 – 03/12/2021	NLC		Origin Energy		Email	NLC seeking shapefiles and to go with the work program to progress GIS and anthropology research.	No	03/12/2021: Shapefiles and mapping information provided to NLC in relation to CY22 work program.	No	N/A

Date	Originator of communication		Company and person of contact		Contact type	Summary of contact	Does it trigger merit review?	A statement of the interest holder's response to stakeholder	Change to EMP required?	Details of changes the interest holder has made as a resulting from stakeholder engagement
21/01/2022	Origin Energy		NLC	NLC	Telcon	Origin contact NLC to discuss logistics options for Annual on Country meetings.	No	NLC to internally consider options for coordinating annual on country meetings.	No	N/A
31/01/2022	Origin Energy		NLC	NLC	Email	Origin provide NLC with an Annual Work Report.	No	No	No	N/A
18/01/2022 – 31/01/2022	Origin Energy		NLC	NLC	Email	NLC request for a copy of Origin's visual story boards.	No	31/01/2022: Origin provided NLC with a copy of the visual 'Story Boards' previously used in Annual on Country engagements.	No	N/A
31/01/2022 – 04/02/2022	Origin Energy		NLC	NLC	Email	Origin notification of ETA for addendum work program.	No	04/02/2022: Origin provided Addendum work program (CY22) to NLC.	No	N/A
11/02/2022	Origin Energy		NLC	NLC	Telecon	Origin provides NLC with a verbal operational update and discusses logistics and arrangements for Annual on Country engagements	No	No	No	N/A
18/02/2022	Origin Energy		NLC	NLC	Telecon	Origin provides NLC with a verbal operational update and discusses logistics and arrangements for Annual on Country engagements.	No	No	No	N/A
25/02/2022	Origin Energy		NLC	NLC	Telecon	Origin provides NLC with a verbal operational update and discusses logistics and arrangements for Annual on Country engagements.	No	No	No	N/A
15/03/2022	Origin Energy		NLC	NLC	Telecon	Origin provides update to change in schedule for civils for calendar year 2022 campaign	No	NLC advise Origin that Cultural Manager program is on hold subject to COVID restrictions	No	N/A
15/05/2022	Origin Energy	I Bywaters	Amungee Mungee	C Martel (for Amungee Mungee)	Email	Setting out upcoming changes to scope re step out locations	No	No	No	N/A
18/03/2022	Origin Energy	D Armstrong	Amungee Mungee	A Brown	Telcon	Discussion regarding scope change re step out locations	No	Clarification sought around program scope changes and impacts to access agreement negotiations. Pastoralist is seeking to reduce multiple engagement to a mechanism that would allow Origin full access	No	Origin clarified that a change in scope does not alter current agreement negotiations or timing.
22/03/2022	Origin Energy		NLC	NLC	Email	Origin provides schedule update to NLC regarding calendar year 2022 activities.	No	No	No	N/A
12/04/2022	Origin Energy		NLC	NLC	Email	Origin provides NLC with updated work program notice and shape files.	No	No	No	N/A
13/04/2022	Origin Energy		NLC	NLC	Email	Origin provides information to NLC regarding upcoming planned scouting activities.	No	NLC request to be kept informed.	No	N/A
22/04/2022	Origin Energy	I Bywaters D Armstrong K Johnston	Amungee Mungee	A Brown, C Martel	Meeting	Access agreement negotiations - meeting included Adrian providing feedback about the location of the ANW2 lease location needing to be 1km from his water infrastructure. This was the first time this was raised to Origin.	No	As per comms dated 22/03/2022. Origin continuing to work with pastoralist on alternative access and gravel pit locations.	Yes	Requires a modification to the Amungee Multi-well EMP for a revised location of NW2 step-out. See comms dated 28/06 and 30/06.
29/04/2022	NLC		Origin Energy		Email	NLC requests update from Origin regarding when seismic EMP will be submitted.	No	Origin responds to NLC on 29/4/22 that the seismic EMP is anticipated to be submitted in June.	No	N/A
5/05/2022	Origin Energy	D Armstrong	Amungee Mungee	A Brown	Letter/email	Explanation of how this SEP sits in with access agreements and previously provided SEP.	No	N/A	No	N/A
5/05/2022	A Brown	Amungee Mungee	Origin Energy	D Armstrong	Email	Questions re SEP and any material changes in the document.	No		No	N/A
6/05/2022	Origin Energy	D Armstrong	Amungee Mungee	A Brown	Email	Clarifications regarding attachments to the letter including SEPs. Responses to questions about activities.	No	Advice on appropriate livestock fencing, movements and access; overview of current groundwater bores.	No	N/A
6/05/2022	Origin Energy		NLC	NLC	Email	Origin communicates to NLC that pre-disturbance scouting activities identified cultural heritage finds.	No	NLC acknowledges email and requests buffer to be maintained	No	N/A
10/05/2022	Origin Energy	D Armstrong	Amungee Mungee	A Brown	Telcon	Pastoralist unhappy with proposal to keep ANW2 in original proposed location.	No	Origin continuing to work with pastoralist on alternative access and gravel pit locations.	Yes	Requires a modification to the Amungee Multi-well EMP for a revised location of NW2 step-out.
13/05/20220	Origin Energy	I Bywaters	Amungee Mungee	A Brown	Email	Confirm that a suitable alternative location for ANW2 has not yet been found, confirm adjusted ANW1 fence line at the request of the pastoralist.	No	Origin continuing to work with pastoralist on alternative access and gravel pit locations.	Yes	Requires a modification to the Amungee Multi-well EMP for a revised location of NW2 step-out.

Date	Originator of communication		Company and person of contact		Contact type	Summary of contact	Does it trigger merit review?	A statement of the interest holder's response to stakeholder	Change to EMP required?	Details of changes the interest holder has made as a resulting from stakeholder engagement
19/05/2022	NLC		Origin Energy	NLC	Email	NLC informs Origin that the NLC has sent letters to Native Title Holder groups to arrange on-country meetings (information sessions).	No	No	No	N/A
20/05/2022	Origin Energy		NLC	NLC	Telcon	Origin provides a schedule update to NLC and discusses planning for annual on country meetings.	No	No	No	N/A
22/05/2022	Origin Energy	D Armstrong	Hayfield-Shenandoah	V Dyer	Email	Issue of stakeholder engagement pack to pastoralist.	No	N/A	No	N/A
31/05/2022	Origin Energy		Native Title Holders; and NLC	NLC	Meeting	Origin attends Elliott and engages with Native Title Holders and NLC regarding Origin activities.	No	N/A	No	N/A
1/06/2022	Origin Energy		Native Title Holders	NLC	Meeting	Origin attends Elliott and engages with Native Title Holders regarding Origin activities.	No	N/A	No	N/A
2/06/2022	Origin Energy		Native Title Holders	NLC	Meeting	Origin attends Marlinja and engages with Native Title Holders and NLC regarding Origin activities.	No	N/A	No	N/A
3/06/2022	Origin Energy		Native Title Holders; and NLC	NLC	Meeting	Origin attends Katherine and engages with Native Title Holders and NLC regarding Origin activities.	No	N/A	No	N/A
6/06/2022	Origin Energy	I Bywaters	Amungee Mungee	C Martel (for Amungee Mungee)	Email	Request for clarification about SEP activities v comparison to access agreement and negotiation notice (as per Origin email of 05/05/2022).	No	N/A	No	N/A
7/06/2022	V Dyer		Hayfield-Shenandoah	Origin	Email	Request for clarification on activities described in the SEP issued on 22/05/2022.	No	26/02/2022 Origin provided responses and clarification to pastoralist.	No	No
8/06/2022	NLC		Origin Energy	NLC	Telecon	NLC seeks Origin's availability to attend an engagement in Mataranka on 10/06/2022 regarding Origin activities.	No	Origin attends Mataranka on 10/06/22 and engages with Native Title Holders and NLC regarding Origin activities.	No	N/A
10/06/2022	Origin Energy		NLC	NLC	Email	Origin provides NLC with visual Story Board information regarding upcoming Work program (same information used during on-country meetings with Native Title Holders).	No	No	No	N/A
28/06/2022	Origin Energy	D Armstrong	Amungee Mungee	A Brown	Email	Proposed location of the Amungee NW2 drill site and pad, outside a 1 km zone from the stock water point in the southeast corner of this paddock and away from the laneway.	Yes	28/06/2022 Pastoralist requested additional coordinates of the location.	Yes	Amended wording in activity description indicating the use of Amungee NW main camp as the default for ANW2.
30/06/2022	Origin Energy	D Armstrong	Amungee Mungee	A Brown	Email	Additional map of proposed ANW2 step-out	No		No	N/A
4/07/2022	Origin Energy	L Pugh	DIPL	N Perera	Email	Access points for the Amungee delineation EMP and regulated activities.	No	N/A	No	N/A

PART B Detailed stakeholder summary of information provided and relevant Regulations sections

Section 7(2)(a)	Stakeholder	Document & content	Date provided
(i) "the regulated activity the interest holder proposes to carry out"	Pastoralist	Stakeholder engagement pack: • Section 6 a detailed description of the proposed activities covered under this EMP.	04/05/2022 (Amungee Mungee) 23/05/2022 (Shenandoah East)
	NLC/traditional owners	• Annual on country meetings • Story boards • Annual work program communications • Face to face meetings • Work clearance requests • Condition of work reporting	Refer table, Part A
(ii) "the location (or locations) where it isproposed to carry out the activity"	Pastoralist	Stakeholder engagement pack: • Section 5 provides details of the location of the proposed activities covered under this EMP.	04/05/2022 (Amungee Mungee) 23/05/2022 (Shenandoah East)
	NLC/traditional owners	• Annual on country meetings • Story boards • Annual work program communications • Face to face meetings • Work clearance requests • Condition of work reporting	Refer table, Part A
(iii) "the anticipated environmental impacts and environmental risks of the activity"	Pastoralist	Stakeholder engagement pack: • Section 6 provides details of the environmental outcomes, impacts and risks associated with the activities covered by this EMP.	04/05/2022 (Amungee Mungee) 23/05/2022 (Shenandoah East)
	NLC/traditional owners	• Annual on country meetings • Annual work program communications • Face to face meetings • Sacred site clearances and discussions • Work clearance requests • Condition of work reporting	Refer table, Part A
(v) "the possible consequences of carrying out the activity to the stakeholder's rights or activities"	Pastoralist	Stakeholder engagement pack: • Section 8 provides details of possible consequences of carrying out the activity to the	04/05/2022 (Amungee Mungee) 23/05/2022 (Shenandoah East)

Section 7(2)(a)	Stakeholder	Document & content	Date provided
		stakeholder's rights or activities associated with the activities covered by this EMP.	
	NLC/traditional owners	• Annual on country meetings • Annual work reports • Annual work program communications • Face to face meetings • Sacred site clearances and discussions • Work clearance requests • Condition of work reporting	Refer table, Part A

2021 Work Program Clearance Request

(For Potential Exploration Works from 2022)

EP98, 117, 76 – Beetaloo Joint Venture (Origin / Falcon)

Version:	**1.0**
Submitted:	
Presented by:	Origin Energy
Review Date:	September 23 2021

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3 APPENDICES 9

1 OVERVIEW

Origin's *Northern Territory Government permit commitments* across Exploration Permit 98 (EP), Exploration Permit 76 (EP76) and EP117 (the Permits) require Origin to complete ongoing exploration wells to be drilled and stimulated. Since 2015, Origin has drilled six wells (Kalala S 1, Beetaloo W 1, Amungee NW 1, Amungee NW 1H, Kyalla 117 N2 1 and Kyalla 117 N2 1H) in the Beetaloo sub-basin (Beetaloo), with a seventh well (Velkerri 76 S2 1) underway in September 2021. Results collected from Origin's Beetaloo exploration program have highlighted the various shales within the Beetaloo are potentially suitable for a future shale development. Origin's exploration program is therefore designed to further investigate and delineate these areas of potential perspectivity.

The Amungee NW 1H well (Figure 1). was hydraulic fracture stimulated (HFS) in 2016 (prior to the introduction of a moratorium in September 2016) with the initial results demonstrating a potential recoverable shale resource. Origin recently completed a series of additional tests on the Amungee NW 1H well, which has prompted Origin to undertake ongoing activities in this area to further delineate and expand the understanding of this potential resource.

Origin respectfully requests the Northern Land Council's assistance to facilitate a *Sacred Site Clearance Survey* of two (2) potential future exploration areas (Figure 3) to comply with the obligations of the Exploration Agreement(s) and to support an application for Aboriginal Areas Protection Authority (AAPA) certification for exploration activity as described below.

This application is designed to provide coverage for Origin's current proposed activities within these area over the next 1-5 years, with all or a subset of the proposed activities likely to occur.

2 PROPOSED WORK PROGRAM

The proposed work program for **each of the clearance areas** can be summarised as:

- **Acquisition of 200km^2 of 2D and/or 3D seismic** acquisition utilising potentially various seismic sources (small dynamite charges or vibroseis)
- **Civil construction** of up to 4 well pads and associated infrastructure (water bores, access tracks, gravel pits, camp pads, laydowns, helipads etc.)
- **Drilling, hydraulic fracture stimulating, completing and well testing** up to 8 wells per lease pad
- **Operation and maintenance** of all infrastructure
- **Decommissioning and rehabilitating** all infrastructure.

Origin looks forward to ongoing engagement with the NLC and Traditional Owners across the Permits to ensure annual work programs are communicated clearly and in advance of the commencement of activities.

2.1 Detailed Activity List

The following activities would be required to complete works within **each of the clearance areas** included in this request:

1. Scouting, surveying, and small-scale surface and shallow subsurface sampling of soils to support geotechnical studies and environmental evaluation.
2. Acquisition of 200km^2 of 2D and/or 3D reflection seismic surveys, including line preparation and land clearing activities.
3. Civil construction activities, including the construction of:
    - 4 additional 7.5 hectare lease pads to accommodate exploration well drilling, stimulation and testing activities
    - 4 additional 1.2 ha camp pads adjacent to each of the 4 lease pads to accommodate personnel during exploration activities.
    - 4 additional 1 ha helipad adjacent to each of the 4 lease pads
    - Construction and operation of up to 5 gravel pits, with a total disturbance of 15

hectares

- Construction of up to 5 hectares of Laydown/storage areas within the disturbance
- Construction of access tracks to connect all lease pads and infrastructure to the Carpentaria highway
- Construction of firebreaks around infrastructure
- Construction of fence lines and gates around infrastructure

4. Temporary worker camp construction and operation
5. Drilling of up to 6 groundwater monitoring / extraction bores and associated extraction and usage of groundwater at each of the 4 lease pads
6. Drilling of up to 8 petroleum wells per lease pad, including the vertical and horizontal components.
7. Hydraulic Fracture Stimulation (HFS) of all petroleum wells
8. Well testing of petroleum exploration wells, including flaring, beneficial usage of gas and wastewater storage and treatment
9. Electricity generation onsite, including from diesel or gas fired generators
10. Subsurface diagnostic tests and data collection (including diagnostic fracture injection tests (DFIT), Cement bond logging (CBL), production logging tools (PLT), gas and water bound tracers etc.)
11. Microseismic monitoring during HFS activities
12. Onsite offices, workshops, amenities, and storage areas required to support activities
13. Storage and treatment of drilling fluids and wastewater onsite
14. Onsite disposal of drilling cuttings and muds through onsite encapsulation or mix bury cover
15. Routine site (surface) monitoring and maintenance
16. Routine well inspection, monitoring and maintenance
17. Suspension and/or abandonment of the wells
18. Rehabilitation of disturbed areas (lease pad, camp pad and access tracks)
19. All activities required to support the above (such as bulk chemical storage and use, bulk fuel storage and use, waste management, equipment and materials transport, helicopter movements, monitoring, maintenance etc).
20. All activities to allow good oilfield practise in support of the above activities

It should be noted that the proposed activities are likely to occur over a 5-year period. It is also anticipated that not all of the activities will be undertaken.

All exploration activities require Origin to submit an Environmental Management Plan (EMP) for assessment by the Northern Territory Regulator(s), which details how environmental risks and impacts will be managed appropriately. Origin will provide approved EMPs to the NLC as part of our annual submission of documents and is happy to discuss any elements of such EMPs on request by the NLC or host Traditional Owners.

More detailed descriptions of the above activities are provided in Appendix 1.

2.2 Areas

The attached maps (Figure 3) and digital GIS files detail the location of two (2) potential activity areas, requested for Sacred Site Clearance surveying.

Once feedback regarding the proposed sites has been obtained from host Traditional Owners, the NLC and relevant pastoral lessees, the documentation will be finalised for review at an On-Country Meeting.

2.3 Request

Origin respectfully requests that the NLC coordinates the following to allow exploration activities to proceed:

a. Sacred Site Clearance survey the proposed sites, and associated access routes (if applicable) as soon as practicable.

b. Coordination of an On-Country Meeting as soon as practicable post the completion of the survey work.

2.4 Figures

Figure 1	Current base map of Origin operated permits and wells drilled to date
Figure 2	Summary of wells drilled to date and NLC cleared locations to date
Figure 3	Summary map of two additional proposed activity areas requested for Sacred Site Clearance survey

2.5 Appendices

Appendix 1	Indicative Regulated Activity Descriptions
Appendix 2	Environmental Management

2.6 Attachments

Attachment A	GIS files of proposed sites, and access routes requested for Sacred Site Clearance survey.

Figure 1 - Current base map of Origin operated permits and wells drilled to date

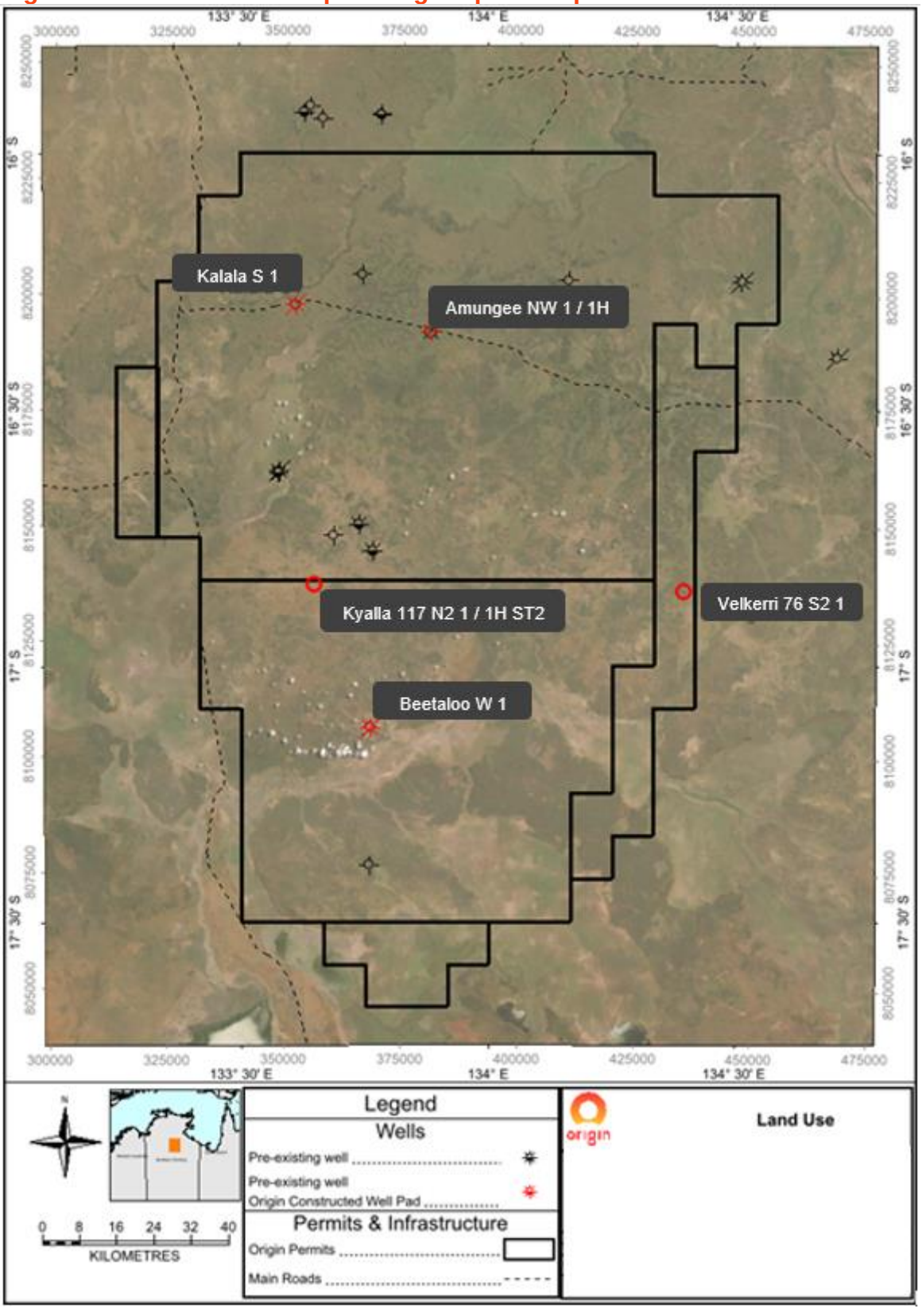


Figure 1 - Overview of Origins Beetaloo Basin Exploration permits and existing wells drilled to date

Figure 2 - Summary of wells drilled to date and NLC cleared locations

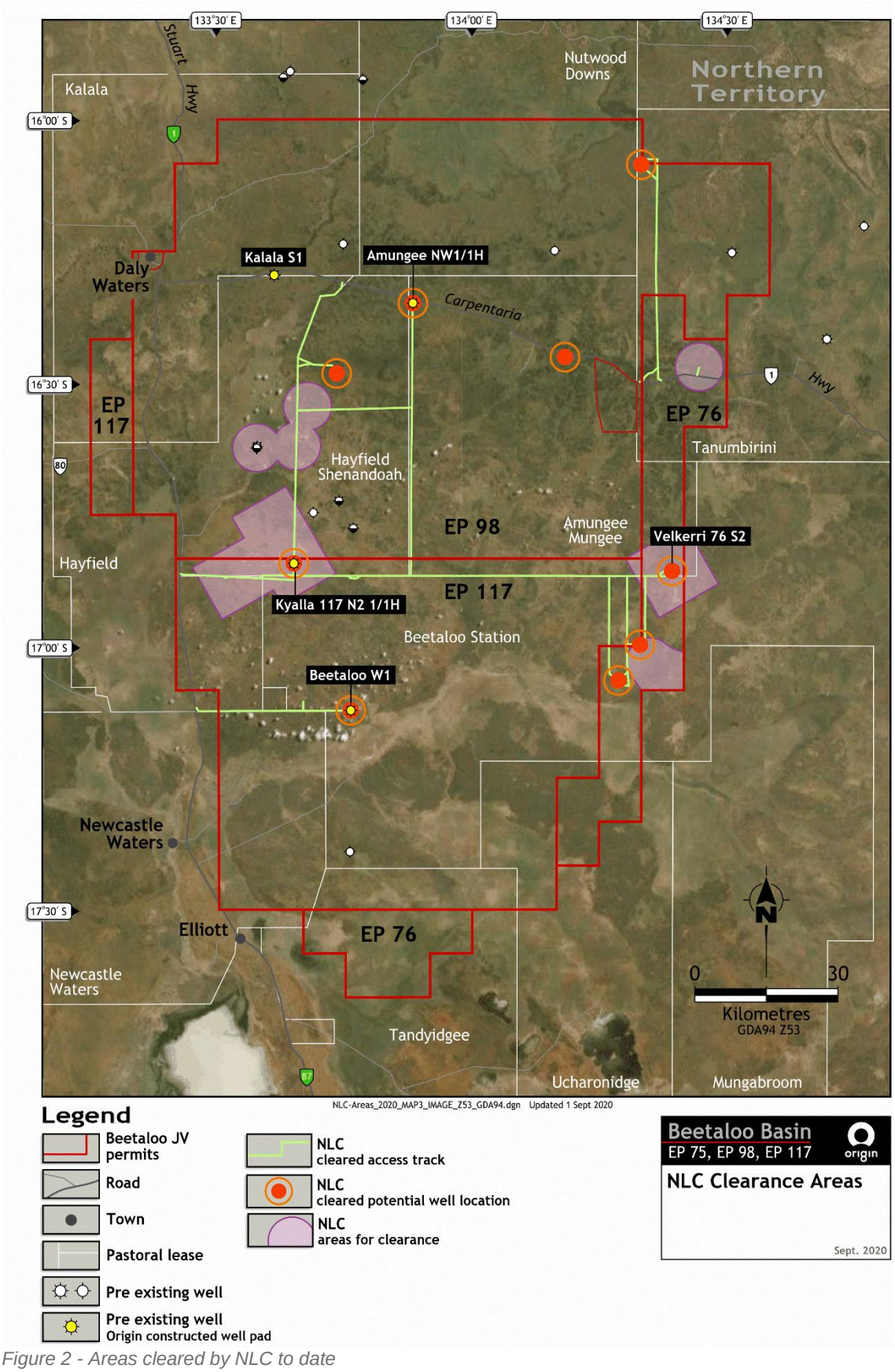


Figure 2 - Areas cleared by NLC to date

Figure 3- Summary map of additional proposed activity areas requested for Sacred Site Clearance surveys

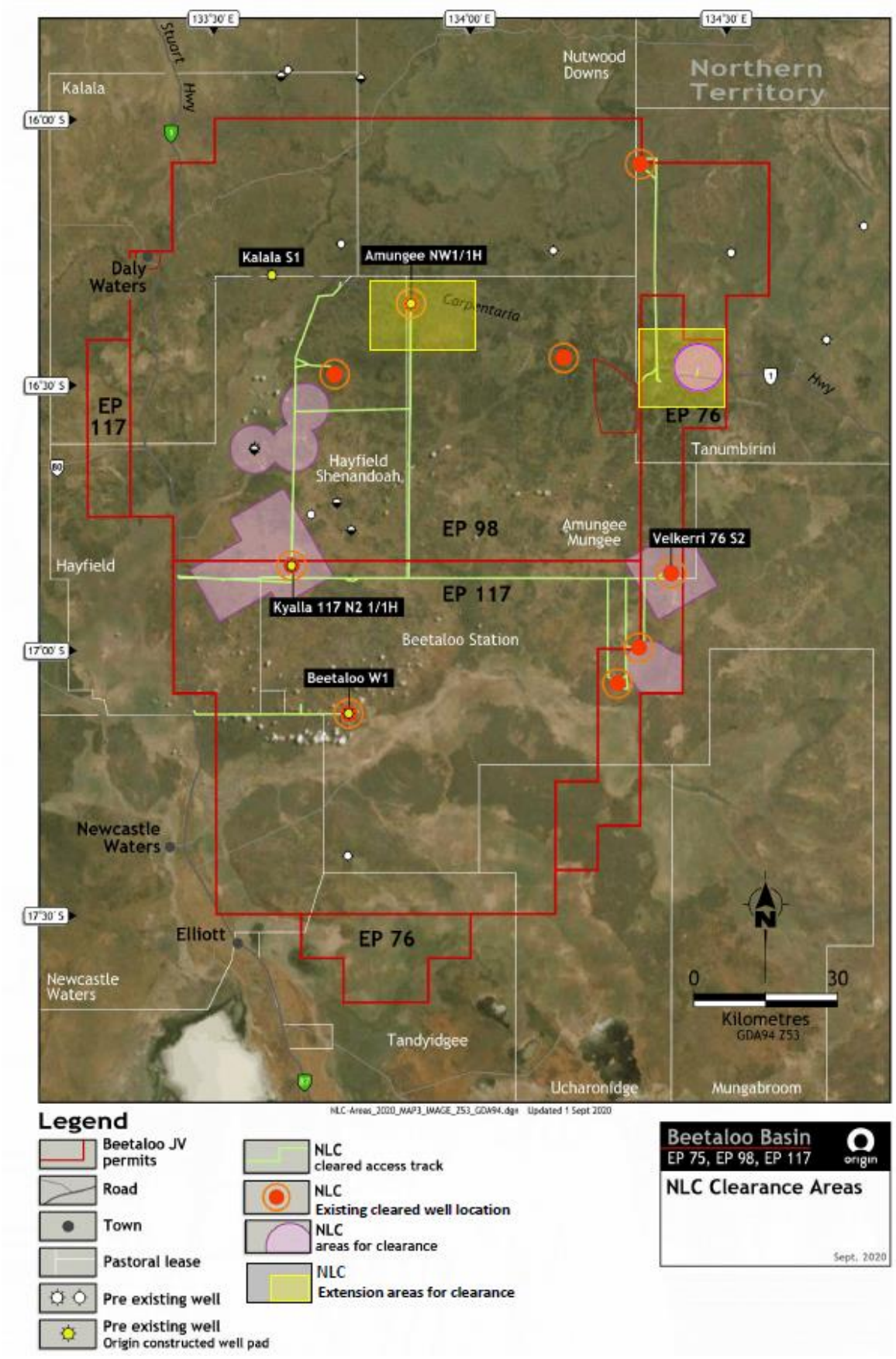


Figure 3 - Extension areas requested for NLC clearance (yellow polygons)

3 APPENDICES

3.1 Appendix 1

The following information and table details of the proposed exploration activties proposed **within each of the proposed clearance areas**. These descriptions are indicative and general in nature, minor departures from such descriptions are likely to occur and such departures are covered by the content of this activity description.

Site scouting and assessment

The first step of the process when undertaking exploration activities is site selection. Proposed sites are chosen based upon their assessed chances of exploration success and are ranked as either a priority site (highly prospective) or a contingent site (if a priority site is unavailable due to a constraint). The selection of a site from a subsurface point of view, is often based upon existing exploration information (or lack of), such as seismic data, inferred resource depth (within the oil generating window for example) and previous drilling results. It also includes an assessment of geohazards, such as known major faults or structural features. Once a location has been proposed, each site is assessed for suitability using a multi-criteria analysis. This analysis covers a number of disciplines, including cultural, environmental, pastoralist, regulatory and constructability requirements. Once proposed sites have been identified, each site is assessed using a desktop screening process covering the following:

- Cultural constraints- sites are chosen to avoid known sacred sites and other restricted areas identified through previous NLC field clearance reports, AAPA certificates or heritage mapping.
- Environmental constraints- proximity to sensitive ecological features such as water courses, flood heights, high conservation areas, threatened species and habitats and sensitive soil units
- Leaseholder constraints- proximity to existing pastoral infrastructure and activities, such as cattle yards, fence lines, access tracks, water supply networks, water bores, homesteads and laneways. At this stage, leaseholders are engaged to ensure early input into the location of potential exploration sites. Activities also considers timing constraints such as mustering.
- Regulatory constraints- proximity to water bores, well pad spacing, landscape amenity and proximity to roads and communities.

The number of sites are re-ranked and potentially eliminated based upon their constraints assessment. A revised list of sites will then undergo field “scouting”, to further assess their suitability. Scouting involves assessment by a number of different specialists with a “scouting party”. Scouting activities include:

- NLC field clearance-Origin submits its proposed work program to NLC annually and then initiates field clearance surveys. Traditional owners are then engaged by the NLC and inspect all sites to determine the potential for sacred sites or other areas of cultural significance in the vicinity of the activity. A final report is submitted to AAPA by NLC to generate AAPA certificates which outline the activity constraints and no -go areas.
- Environmental- areas are inspected by ecologists to ground truth for areas of potential high conservation, evidence of threatened flora and fauna, overland flow paths, drainage lines, soil erosion susceptibility, areas of high habitat value (such as large hollow bearing trees) buffer zones (from high conservation value areas) and future rehabilitation constraints, . The infrastructure (including access tracks, lease pads and associated infrastructure) is orientated to minimise clearing (such as picking open woodland rather than dense Bullwaddy or Lancewood communities) and impacts on overland flow. A land condition assessment is completed for the proposed sites.
- Archaeological scouting- detailed scouting is completed by a qualified archaeologist to identify any artefacts (such as spear tips, axes, stone workings etc.), scar trees or potential heritage features at the proposed sites. This is undertaken in addition to the NLC Traditional Owner clearances.

• Constructability assessment- Constructability constraints are identified including geotechnical assessments, cut/fill requirements, soil types, rig operational requirements (orientation) and access construction constraints (such as access track design, water course crossings etc.). This often includes preliminary pegging of the proposed location

Once the location of infrastructure has been proposed and finalised, the final location is pegged and surveyed. The engineering designs are updated and issued for construction.

Civil construction

Once a site has been selected, the next step in the exploration well process is construction of access roads and water bores (groundwater monitoring and extraction bores) are typically the first construction activity. The proposed access tracks will be constructed to connect the Carpentaria Highway to the proposed lease pad and gravel pits, with the highway intersection upgraded in accordance with the Department of Infrastructure and Planning (DIPL) requirements. A small ~20 person temporary camp will be mobilised to site to support civil construction activities, with the temporary camp located on the camp pad or another cleared area in the vicinity of the planned infrastructure. The temporary camp will be a self-sufficient unit consisting of a kitchen, mess, offices, accommodation, gym, storage areas, power generation, fuel storage, NTG compliant sewage treatment system and treated effluent irrigation area.

Access tracks will be typically constructed (or upgraded) up to a width of 14m to allow 2-way traffic flow in accordance with the NT Standard Drawings (CS3003) for Typical Cross Section for Rural Environment – Pastoral Access Road 2. In some sections the width of access track disturbance may extend beyond the nominated width to accommodate cut out drains, culverts and truck turn outs etc. Access tracks will be typically sheeted with gravel to accommodate anticipated traffic volume. To minimise land clearing and disturbance, existing pastoral tracks or disturbed areas (such as historic seismic lines) will be utilised (and upgraded to the required specification as appropriate) where possible.

Once the initial access tracks have been cleared and formed, a water bore drilling rig will be mobilised to site. Two sets of groundwater monitoring bores (up to 6 bores in total) will be located within the disturbance footprint of the proposed large exploration well lease pad. The groundwater monitoring bores are required to be drilled on each exploration lease 6 months before stimulation activities, in accordance with the Code of Practice. In some cases, the second set of groundwater monitoring bores (referred to as impact monitoring bores) may be installed upon completion of the drilling of the exploration well. All groundwater monitoring bores are required to be constructed in accordance with the Minimum Construction Requirements for Water Bores in Australia.

Groundwater monitoring bores are required to be installed in all the regional aquifers (where present and saturated), which include the Undifferentiated Cretaceous sediments, Anthony Lagoon Formation and Gum Ridge Formation. These groundwater bores are used to monitor groundwater quality and level before and after stimulation, to detect any changes in groundwater parameters due to stimulation activities. These bores are also utilised to provide water to support for civil construction, well drilling, hydraulic fracturing and ongoing operations. Water may also be taken from pastoral bores, with formal permission from the pastoralist. All water take is required to be licenced under the NT *Water Act 1992*, with a Water Extraction Licence to be obtained covering all proposed take.

Once access tracks and water bores have been constructed, the lease pad, camp pad, helipad and laydown yard will be constructed. Construction typically involves the clearing of vegetation, grubbing to remove vegetation roots, stripping of topsoil (to maintain viability), levelling, sheeting with gravel and then compacting to achieve the working surface to support exploration infrastructure. Topsoil and felled vegetation will be stored around the edge of infrastructure, which will be used an erosion and sediment control measure. Additional erosion and sediment controls will be constructed around the disturbed areas (such as rock check drains, woah boys and diversion drains).

The lease pad will be constructed with additional infrastructure to support ongoing operations. This includes:

- A sediment retention pond will be installed to manage surface water within the lease, with water captured onsite tested and released into the adjacent area.
- A lined drilling sump to contain all drilling fluid, drilling muds, cuttings, cement returns and waste sand. The drilling sump will generally be able to contain up to approximately 3000m3 of material (approximately 75m long x 25m wide x 4.5m deep), with the final capacity determined by the proposed drilling depth and horizontal length.
- A flare pit used to combust all encountered liquid hydrocarbons in purpose designed flares (a flare pit may not be required where liquid hydrocarbons are not anticipated)
- three x 8m^3 concrete lined well cellars to accommodate the wellhead equipment and blow-out preventer (BOP). The cellars are transported to the site in one (1) piece and lowered into an excavated pit. A shallow conductor casing is installed within the cellar to approximately 20m

using an auger. The shallow conductor casing is designed to prevent the upper sections of the exploration well from caving in when drilling through the unconsolidated sediments. The cellar itself will be fenced at all times to exclude fauna ingress. Cellars will be typically separated from each other by 10m-20m

- An earthen bund consisting of topsoil/ subsoils used to prevent offsite release of wastewater during wastewater storage onsite.
- A fence and firebreak around the entire exploration site

Figure 4 Overview of an exploration site within the Beetaloo undergoing lease and camp pad construction, with water bore drilling underway.

Gravel will be extracted to support infrastructure construction from a new 5 hectare gravel pit that will be located with the Aboriginal Area Protection Authority (AAPA) cleared area. An additional geotechnical investigation will be undertaken to confirm the most suitable gravel pit location, to ensure the amount of clearing and land disturbance is minimised. The typical configuration of a gravel pit is provided in Figure 5, with the final location of the gravel pit to be confirmed with the pastoralist prior to construction.

Gravel pits will typically have two access points (one in and one out). Topsoils and subsoils will be stripped, segregated and used to form an earther berm around the site to prevent overland flow from entering or exiting the pit. Felled vegetation will be placed on the outer berm of the pit to increase stability. Where the pit void represents a hazard to cattle, the gravel pit will be fenced when not in operation.

Figure 5 Picture of a typical working gravel pit located within the Beetaloo

Seismic Survey

Subsurface seismic imaging will be completed around lease pad. The seismic program involves the acquisition of up to 200km^2 of 2D or 3D seismic to develop localised geological knowledge of the underlying formations. It is anticipated that the seismic program will be executed over a number of years, typically with approximately 40km^2 of surveys being completed during each campaign.

The aim of a seismic survey is to produce detailed images of the various rock types and their location beneath the earth's surface. This information is used to determine the location and size of oil and gas reservoirs. The seismic method uses a sound wave source either dynamite (Figure 6) or Vibroseis trucks (Figure 7) to propagate sound waves into the earth. The sound waves that reflect off underground rock formations are captured by recording sensors called geophones (Figure 8). Analysing the time sound waves take to return provides valuable information about rock types and an estimate of depth for rock formations. The returning reflections are recorded in a digital format and sent to a seismic data processing centre to produce a cross-section image of the layers of the earth’s crust (process seismic image).

Figure 6 Examples of small rigs that could be used for drilling source holes for a dynamite survey

Figure 7 Example of Loaded charge in hole ready for detonation and example of a charge used in dynamite seismic survey acquisition. Change length is approx. 400-500mm in length

Figure 7 Example of a vibrioses utilised during seismic acquisition (noting a vibroseis is not used if dynamite is the selected energy source)

Figure 8 Left: Example of geophone used for 3D Seismic and Microseismic, Right: Example of geophone deployment for both 3D Seismic and Microseismic.

The use of small dynamite charges is an environmental friendly approach that minimises the requirement to clear seismic lines. Small charges are placed at regular intervals along a line either by hand or utilising a track based ATV or similar. This approach reduces the need to clear vegetation, with the charges being able to be placed around vegetation to reduce clearing. Small amount of clearing may still be required to access extremely dense vegetation, but this is anticipated to be minimal. An image of a typical small seismic charge used during a New Zealand seismic shoot is provided in **Figure *6***

If Vibroseis trucks are selected for the seismic source then line clearing may be required so that the Vibroseis trucks can drive and operate over the survey area. Where possible, existing cleared areas will be utilised to reduce disturbance. . Seismic lines will be selected in a manner to avoid any large habitat trees or sensitive flora, with no material clearance to be undertaken in watercourses and associated riparian vegetation. In areas with low vegetation density (such as open Eucalypt / Corymbia woodland) ground disturbance will be restricted to the removal of rocks and fallen branches and the

slashing of grasses and shrubs to provide effective ground contact of the seismic vibro-source and the geophones and minimise the risk of fire. An example of low impact clearing is provided in Figure *12*. Where ground clearance is unavoidable, such disturbance will be undertaken with a grader and the access width shall be no more than 1 blade width wide (4m) with minimal ground disturbance sufficient to provide for safe vehicle access. Some patches of lancewood (Acacia shirleyi) and Bullwaddy (Macropteranthes kekwickii) are present along the proposed seismic lines. These areas represent the thickest vegetation and will require clearing with a D6 dozer.

Figure 9 seismic line construction for vibroseis source acquisition

To reduce the risk of bushfire, no vegetation mulching is proposed. Felled vegetation will be pushed to the side of the seismic line during operations. The felled vegetation will be returned across the seismic line upon completion of seismic activities to aid in rehabilitation and assist in erosion and sediment control. Root stocks are to be left in place as much as practicable to allow for rapid re-establishment of vegetation. Based on previous experience in the region, most areas will naturally regenerate following rehabilitation following the wet season. Rehabilitation monitoring will occur on an annual basis until the vegetation has become re-instated, with maintenance on rehabilitated area undertaken as required.

Surveying commences shortly after line preparation. The field surveyors use real time kinematic GPS receivers to position receiver points for the surveys. Surveyors mark the ground with biodegradable paint, or points are marked by wooden stakes. Line detours may also be marked with temporary biodegradable flagging.

Each survey team consists of one surveyor in a light 4WD vehicle or ATV, and generally makes only one pass over any given section of line. Back tracking may occur in areas where vehicle access routes have deviated from the true line position and markers must be inserted by personnel on foot. This may occur in areas of riparian vegetation if there is adequate access either side of the watercourse.

Recording normally commences two to three weeks after the start of line preparation. This operation is the largest part of the seismic operation in terms of personnel and vehicles. The size of the crew will vary depending on the recording technique used, terrain and season and recording is generally restricted to daylight hours.

Work commences with the deployment of nodal geophones supported by light 4WD vehicles or ATVs. The nodal geophones are autonomous units, containing the actual geophone as well as battery and data storage in one unit. These nodes are deployed at regular intervals along the non-cleared lines perpendicular to the source lines, these may be able to be carried through areas of riparian vegetation to avoid any damage to vegetation where access permits.

Recording will commence once the survey areas has been laid out with geophones. This layout is termed ‘the spread’ and picks up the acoustic energy reflected from subsurface layers. If Dynamite is the energy

source, then the shots will be let off in sequence and recorded by all the geophones. If Vibroseis is the energy source then the truck(s) drive along source lines vibrating the ground at a set intervals with the energy is recorded by all the geophones.

After the energy source is finished the geophones are collected, rehabilitation and data analysis can commence.

Microseismic Monitoring

Microseismic Surveys are undertaken to monitor 'listen to' the Hydraulic Fracture Stimulation Operations. Microseismic can assist Origin in analysing the performance of the Stimulation.

During stimulation water and sand are injected by high pressure into the reservoir rock creating small fractures. As these small fracture initiate (crack) and propagate (further cracking) away for the well bore they generate pressure waves (seismic energy) that can be measured on the surface with extremely sensitive sensors. These sensors called Geophones or Seismic Receivers are individual weatherproof units that contain a sensitive seismic recording device, memory storage, a long-life battery and GPS locator. The sensors are cylindrical and 4cm wide and 13cm tall.

The Geophones are deployed 10-20 metres apart along line over an area of 30-40km2 around the well. Geophone deployment locations are located on foot by GPS locator. A handheld battery drill is used to create a 4cm diameter hole with an auger bit, a small quantity of water may be used to stabilise the soil. The Geophone is inserted into the hole so that the top of the receiver is flush with the surface of the ground (Figure 8).

The Geophones deployed prior to the commencement of stimulation and retrieved after the stimulation has concluded.

The Geophones are retrieved by creating a small divot next to the Geophone and the Geophone is pushed into the divot and then pulled out of the ground. Stubborn geophones may need to be dug out with a small trowel, small holes and divots are filled in with any disturbed soil.

Deployment and Retrieval of the Geophones is undertaken in small teams of 2 or 3 people, with the number of deployment teams depending on survey size. The teams are supported by a light 4WD vehicle or an All-Terrain Vehicle to carry equipment, gear, water, communication (radio/satellite phone), first aid kits and safety gear.

No line clearing or heavy machinery is required, and the activity is considered to have a minimal impact, similar to that of scouting activities.

Camp construction and operation

Once all the access tracks and civils work is completed, a temporary camp and drilling package would be brought in to undertake the drilling activity. An image of a commissioned drilling rig and associated infrastructure is provided in Figure 10**Error! Reference source not found.**.

The temporary camp will typically be the first infrastructure mobilised to site to support operations. The camp will be a self-contained facility with accommodation rooms, kitchen, dining mess, offices, ablutions, gymnasium, storerooms, refrigeration, water storage, power generation, solid waste management, fuel storage, water treatment, sewage treatment and sewage irrigation area. The camp will typically accommodate approximately 50 to 100 people at a time.

Potable water for the camp will either be trucked to site or generated onsite with a purpose designed water treatment unit. All grey and black water will be treated using an NTG compliant sewage treatment system, with treated effluent irrigated in a spray field adjacent to the camp.

Exploration well drilling

A drilling rig package consists of the main rig package as well as supporting vehicles and pieces of equipment. Generally, the following equipment would be on site during the drilling operation:

- The main drilling rig package consisting of a rig floor, a mast or derrick, and the rig diesel engine.
- Racks for storing drill pipe or casing and potentially a "pipe arm", which is a piece of equipment designed to bring pipe and casing up to the drill floor.
- The rig's drilling fluid system including tanks and pipes for storing and pumping fluid down the drill string.

- A smaller rig camp (~8 people) and ablutions block to accommodate critical drill staff required to be onsite during night-time operations.
- An air drilling system consisting of piping and air compressors for directing compressed air down the drill string may also be used.
- Storage trailers and racks for equipment such as mud chemicals, drill pipe, casing, and other equipment used down hole to complete the operation.
- Freshwater storage tanks (typically 1.9ML -3.5ML)
- A work/welding shop.
- Portable onsite offices.
- Ablution block, wastewater treatment plan and effluence irrigation area.
- Chemical storage areas
- Power generators
- Bulk diesel storage areas
- Third party equipment such as cementing trucks, coil tube unit and wireline evaluation units would also be required on site intermittently as per operational requirements.

Trucks delivering equipment and consumables (e.g. drilling consumables, fuel, food and water) would be travelling to and from the site regularly. There would also be regular light vehicle activity to transfer people between the drilling rig and camp.

Once the drilling rig is rigged up, tested, and functional, the drilling of the vertical section of the exploration well will commence. An overview of a drilling rig is provided in Figure 10. A large diameter drill string (also known as the bottom hole assembly or “BHA”) would be used to drill a ~15-25” hole to a depth shallower than the Anthony Lagoon formation (if present and saturated). This section would be drilled with fresh water and “sweeps” (intermittent volumes) of higher viscosity fluid to help remove cuttings out of the hole. A large diameter string of casing (referred to as a conductor casing) would then be set and cemented at this depth.

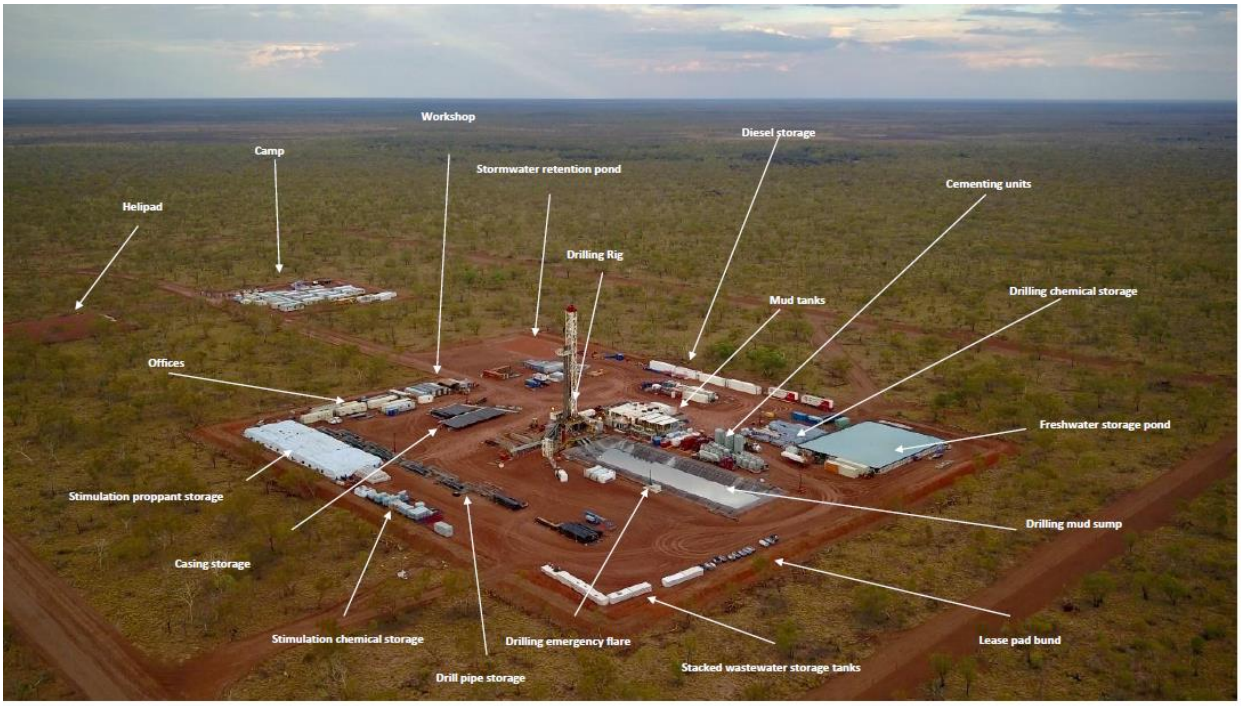


Figure 10 Typical well site layout during drilling. This site is the existing Kyalla 117 N2 site.

The drilling rig would then be set up to drill through the Gum Ridge Formation into the Antrim Plateau Volcanics (assuming they are present). At this point a further string of casing (referred to the surface casing) would be run and cemented to seal the aquifer off from the rest of the wellbore. A blow out

preventer (BOP) would be installed on top of the string of casing and pressure tested. A successful pressure test would ensure the BOP is functioning correctly and confirm the integrity of the casing and cement.

Drilling will then recommence and a few metres into the underlying formation. A test known as a “leak off” test would then be conducted to understand the rock strength; this involves applying just enough pressure to the fluid in the hole to break the formation. The information gained during this test is critical for maintaining the integrity of the hole as it indicates how much pressure can be safely applied to the formation, and also the maximum mud-weight that can be used to provide well control. Following a successful test, drilling will proceed to a depth selected by geologists, reservoir engineers and drilling engineers based on subsurface understanding and well objectives. A further string of casing (the intermediate casing) will then be installed and cemented to seal off previous formations, and if so, the casing shoe would then be drilled out and another leak off test conducted.

The final hole section (referred to as the “production hole section”) covers the primary hydrocarbon reservoir section(s) and is drilled to the well total depth (TD). TD is likely to be less than 4000m below the ground surface, with the final depth dependent on the target formation and its encountered prospectively. Drilling activities could also include coring, a process in which a drill bit with a cylindrical opening is used to cut-out rock cores for geological, geochemical and geomechanical studies.

Once TD is reached, the BHA is pulled out of the hole and the well cleaned by means of circulation. Following wellbore conditioning, a series of special tools are run down and up the hole to measure various aspects of the reservoir fluids and rocks. This process is known as wireline logging. Wireline logging activities may also include sidewall coring, a process that allows small cores/rock samples to be cut from the side of the hole using wireline tools.

Diagnostic Fracture Injection Tests (DFIT) may be run to further investigate rock properties. The DFIT has become the primary safety and transient test for ultra-low permeability shales. It involves injecting small volumes of water at low rates to create small fractures, allowing the resulting pressure to fall naturally. The fluid contains no proppant hence the fracture relaxes and closes naturally when pressure is released. The pressure decay is monitored onsite and the data acquired is analysed to aid in reservoir characterisation. The DFIT can be carried out while the rig is on site or after the rig has been mobilized.

If the well is to have a horizontal section, the well will be deviated above the production reservoir. The production hole section is drilled with the help of steering tools, which are used to gradually build the inclination so the well penetrates the prospective reservoir zone with a horizontal alignment usually for a total length of 1000-3000 m. In addition, logging while drilling (LWD) tools may be employed to enable measurement of rock properties such as the natural radiation signature or resistivity of the rocks, in order to facilitate identifying key changes in rock type down the wellbore. The horizontal well is typically cased and cemented, awaiting hydraulic fracture stimulation.

During drilling, a KCl/NaCl/Polymer or Synthetic based fluid system is likely to be the base fluid for drilling. Drilling mud is required to maintain well control, provide formation stability, lubricate and control the temperature of the bit, and lift drill cuttings to surface. A KCl/Polymer fluid system consists of water with salt (to prevent formation swelling) and a viscosifying agent (usually the naturally occurring mineral bentonite or a starch similar to those used in food manufacturing (i.e. guar gum)).

Waste drilling muds, cuttings and fluids produced during drilling are directed to the drilling sump for ongoing storage and management. Drilling waste (muds, cuttings and fluids) will remain in the sump until all drilling activities have been completed. The drilling wastes will then be evaporated with all residual fluid removed from site to an offsite disposal facility prior to final sump rehabilitation. The drilling wastes will be sampled and a risk assessment completed to determine the suitability for onsite mix-bury-cover or encapsulation. Where the drilling waste material cannot be disposed of on the site safely, the drilling waste will be removed to a third party facility and the sump backfilled.

Hydraulic Fracture Stimulation

Upon completion of drilling, activities, a frack spread will be mobilised to site to commence hydraulic fracture stimulation (HFS or stimulation) activities. A frack spread consists of:

- Data Van – on-site office to execute stimulation activities
- Water Storage - tanks will be constructed on-site, capable of managing both make-up water and flowback water. Tanks will be double lined with leak detection capable of monitoring any leaks between the primary and secondary liner
- Proppant Trailer - a large sand storage and delivery trailer that holds the proppant

- Hydration Unit – used to add stimulation additives and viscosifying fluids • Blender Unit – used to mix proppant and fluid additives, prior to its injection into the well
- High Pressure Pumps – pumps which inject the hydraulic fracturing fluid mixtures from the Blender Unit down the well, via the surface lines and hydraulic fracturing wellhead or coiled tubing unit
- Coiled Tubing Unit – a large length of coiled steel pipe that can be temporarily installed in the well to perform various downhole operations • Wireline unit – plug and perforation deployment
- Ancillary support buildings – offices, workshop, cranes, chemical storage area, equipment storage, power generation and all other activities required to support stimulation activities.

Stimulation involves the injection of a slurry, primarily consisting of water and sand (proppant), plus a small percentage of chemicals at high pressure into the target section of the horizontal wellbore approximately 1000m – 4000m below ground level (depending on the depth of the target formation). Typically, 92-96% or higher of the total volume in stimulation fluids is a combination of fresh water and sand, with the remainder as fluid-conditioning additives (~2-4-%).

Prior to the commencement of stimulation activities, the integrity of the well is tested with a cement bond log and pressure casing test. This integrity report is submitted to the regulator prior to the commencement of stimulation activities. Once the integrity of the well is confirmed, stimulation activities will commence. The stimulation fluid is pressurised by the high-pressure pumping units and directed downhole via a manifold to the discrete target intervals along the horizontal wellbore (referred to as ‘stages’). Each stage will be isolated and perforated using a plug and perforation gun assembly deployed via a wireline unit. As the pressure is sustained, the fractures propagate radially from the well, through the target rock. Once optimal fracture propagation has been achieved, the proppant (sand) is pumped down the well and into the open fractures. This process is repeated for each stage. The final number of stages pumped in each well is dependent on the useable length of the horizontal wellbore and in-situ geological conditions. Once all stages are complete, the well is suspended awaiting completion and well testing activities.

During each stimulation wellbore pressures are monitored to ensure the operations have not compromised the integrity of the production casing or the cement barriers. A Maximum Allowable Operating Pressure (MAOP) is an important engineering parameter used to define the operating envelope (i.e. the safe maximum pressure that should not be exceeded). The maximum allowable pumping pressure (MAPP) is set below the MAOP to allow for uncertainty and provide an additional safety margin so the MAOP is not exceeded. In addition, continuous groundwater level monitoring and ongoing field testing is completed on the control and impact groundwater monitoring bores to detect any changes in groundwater characteristics that could be associated with stimulation activities.

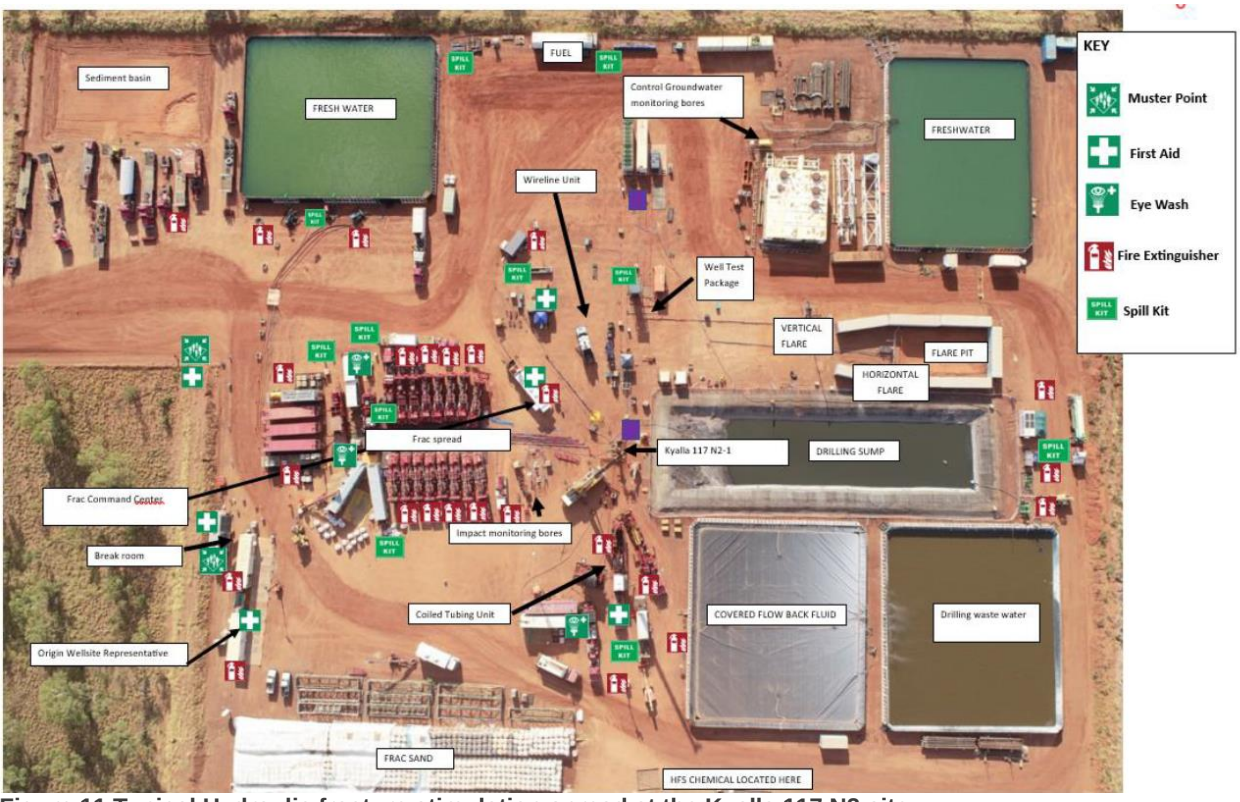


Figure 11 Typical Hydraulic fracture stimulation spread at the Kyalla 117 N2 site.

Extended Production Testing

After the completion of HFS operations, the well will be initially flowed back for several days to remove any residual sand and sediment from the well. The well with then be “completed”, with a completion rig or coil tubing unit mobilised to site to install production tubing, downhole gauges, artificial lift etc within the well. Once completed, the well will be brought online and a production test completed to measure the volumes of water and gas flow produced from the reservoir to assess the technical and commercial potential of the resource. In some cases, a nitrogen lift may be completed using a coil tubing unit to initiate early production until the well can sustain itself.

Production tests may typically range from 1 month to 24 months, depending on operational requirements. During a production test, hydrocarbons (liquids and gaseous) and water (flowback) are measured and separated onsite in a separator. Produced gas will either be flared onsite or beneficial utilised in onsite power generation. Condensate will be stored within condensate storage tank for offset trucking or sent to the flare for combustion. Flowback is directed into purpose built enclosed and open wastewater tanks where it will be stored and evaporated onsite (“treated”) until offsite disposal. To assist in managing flowback volumes across the basin, flowback may be moved to and from the site to maximise the use of water management infrastructure in the region.

Figure 12 Example of a well test underway at an exploration site in the Beetaloo Basin.

Well suspension and decommissioning

Once all well testing operations are completed a decision is made to either safely suspend the well (e.g. for further testing or evaluation work in the future) or to plug and decommission the well. If the well is suspended, all suspension operations and procedures are conducted in accordance with regulatory requirements and industry best practise. This includes periodic exploration well intervention and maintenance, surface well head maintenance, surface infrastructure maintenance, performing routine site inspections and ongoing environmental monitoring (groundwater, weeds, erosion and methane leaks).

The plug and decommissioning process includes setting cement plugs in the hole to isolate permeable zones and prevent cross flow between different rock layers exposed by the drilling process. A cement plug would also be set across the open hole section and previous casing and pressure tested to ensure it acts as an effective fluid barrier to surface. Another plug would be set inside the casing prior to removing the BOP and cutting the casing off at surface. Finally, cement would be poured into the casing stump at surface and a plaque installed to identify the decommissioned well.

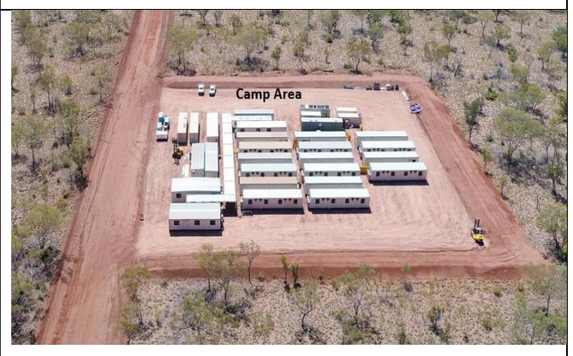
Once the well has been fully decommissioned, all associated temporary equipment would be then removed from the site. All disturbed areas (e.g. lease pad, gravel pits, camp pads etc.) will then be rehabilitated and re-vegetated back to a safe, stable, non-polluting landform that is consistent with the surrounding landscape. The only infrastructure that would be kept includes water bores (potentially for monitoring and / or for pastoralist's use) and any roads required to access them.

A detailed description of the activities, their timing and typical duration is provided in Table 2. Pictures of selected activities have also been provided to assist in understanding the size and nature of the activities. It should be noted that these pictures are indicative and activities may differ based on the site specific constraints, final design and operational requirements. Additional information on each of the activities can be provided upon request.

Table 1 Description of proposed regulated activity details withc each of the clearance areas

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Access track construction Access tracks will be constructed to connect up the proposed infrastructure to existing roads. Tracks will be constructed in accordance with NT Standard Drawings (CS3003) for Typical Cross Section for Rural Environment – Pastoral Access Road 2. The access track will align with the existing seismic line disturbance to minimise vegetation clearing. The access track will typically be less than 14m wide, with sections up to 20m wide where truck turn outs, erosion and sediment control and cut out drains are required. Gravel will be used to form up the access track in places to enable all weather access. Where access tracks intersect with main roads (such as the Carpentaria highway), the intersection will be upgraded to accommodate turning truck traffic in accordance with the department of Infrastructure, Planning and Logistic (DIPL) design requirements Access tracks are anticipated to be the first piece of infrastructure constructed to enable preliminary activities, such as the construction of groundwater monitoring bores.	<50ha (dependent on access track length)	<12 people	Fist activity required to enable civil construction and drilling.	Access tracks are likely to be continually maintained and surfaced throughout the life of the activity	
Seismic consists of the following: 200km^2 of seismic acquisition will be undertaken. **Dynamite charges- minimal disturbance approach** It is anticipated that the survey will be collected using dynamite, to minimise the clearing of vegetation. In such a case, vegetation clearing will be restricted to extremely dense vegetation where site access is prevented. The charges are approximately 1kg and will be installed within a 200m grid pattern, to a depth of approximately 10-15m underground. The charges will be installed using a small ATV/ 4wd mounted auger (refer Figure 6). The charges are packed into place and detonated in a controlled fashion with appropriate exclusion zones. The created detonation zone is kept underground, with no surface disturbance anticipated. The detonated charge create a “thud sound” which can be heard within 2-4km radius and felt within a 200m radius (typically)	10ha to 500ha	Up to 35	Before or after exploration well drilling with the final time to be finalised.	3 – 6 weeks per campaign	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
vibroseis (if utilised) If the seismic energy source is Vibroseis truck(s) then line clearing will be required so that they drive and operate over the survey area. wide Source lines, for Vibroseis trucks to operate on, will need to be cleared4km every 200m. Existing cleared areas will be utilised where possible to reduce disturbance. The line tolerances for weaving around vegetation are allowed. Seismic lines will also be in a manner to avoid any large habitat trees or sensitive flora, with no clearance to be undertaken in watercourses and associated riparian vegetation. **Surveying:** Surveyors mark the ground with biodegradable paint, or points are marked by wooden stakes. Line detours may also be marked with temporary biodegradable flagging. A survey team in a light 4WD vehicle or ATV, will make generally one pass over any given section of line. **Recording:** Recording normally commences two to three weeks after the start of line preparation. This operation is the largest part of the seismic operation in terms of personnel and vehicles. The size of the crew will vary depending on the recording technique used, terrain and season and recording is generally restricted to daylight hours. Geophones are deployed at regular intervals along non cleared lines perpendicular to the source lines. If Dynamite is the energy source, then the shots will be let off in sequence and recorded by all the geophones. If Vibroseis is the energy source then the truck(s) drive along source lines vibrating the ground at set intervals with the energy is recorded by all the geophones. After the energy source is finished the geophones are collected rehabilitation and data analysis commence. **Rehabilitation:** Felled vegetation will be pushed to the side of the seismic line during operations. The felled vegetation will be returned across the seismic line upon completion of seismic activities to aid in rehabilitation and assist in erosion and sediment control. Root stocks are to be left in place as much as practicable to allow for rapid re-establishment of vegetation. Based on previous experience in the region, most areas will naturally regenerate following rehabilitation following the wet season.					 e.g. of rehabilitation efforts in progress (HESS, 2013). e.g. of recruitment of vegetation post rehabilitation of open *Eucalyptus* woodland (HESS, 2013).
Groundwater (monitoring and extraction) bore installation Installation of up to 3 control and 3 impact groundwater monitoring bores (6 in total) may be constructed on each of the lease pad within the underlying aquifers. These bores are required under the Code of Practice to establish baseline groundwater level and quality data prior to completing hydraulic fracture stimulation activities. Monitoring bores are required to be drilled at least 6 months prior to stimulation activities and are often the first activity undertaken on a site (other than access tracks). Monitoring will continue throughout the life of the activity. The bores will also be used for groundwater extraction to support exploration activities. The construction of the groundwater monitoring bores will utilise a water bore drilling rig to construct the bores, identical to the rig used to drill pastoral water bores. All groundwater monitoring bores will be constructed in accordance with the Minimum Construction Requirements for Water Bores in Australia. Bores may drilled into the Anthony Lagoon formation (if present and saturated), Gum Ridge formation and potentially the Bukalara Sandstone. Waste cuttings, drilling fluids, muds and formation fluids will be collected in a small earthen sump and managed in alignment with the practices outlined in the. Minimum Construction Requirements for Water Bores in Australia. The fluid (which is anticipated to be fresh) will	N/A located on proposed lease pad	<12 people	The drilling of water bores is generally one of the first activities undertaken to provide water for construction and drilling activities. Additional monitoring bores are also likely to be drilled prior to stimulation	<4 weeks	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
be discharged to grade and the area surrounding the lease. The formation cuttings and drill muds will be mixed with soil onsite and incorporated into the lease pad surface.					
Lease pad construction Each proposed lease pad will be constructed to approximately 7.5 hectares to accommodate exploration well drilling, stimulation, testing and ongoing wastewater storage and treatment. Each lease pad will be located within the proposed clearance area, with the final location based upon seismic information combined with cultural, environmental, pastoralist and regulatory constraints., . Once a suitable site has been selected the lease pad will be cleared of vegetation, grubbed and stripped of topsoil down to approximately 100mm (depending on the depth of topsoil onsite). Topsoil will be stored around the edge of the lease pad to form a bund, which will be used as both an erosion and sediment control measure and wastewater containment bund. The lease pad will then be levelled, compacted and surface with gravel to accommodate exploration activities. Erosion and sediment controls will be constructed around the disturbed areas (such as rock check drains, woah boys and diversion drains). A sediment retention pond will be installed to manage surface water within the lease. Water captured onsite will be tested and released into the adjacent area. A drilling sump, flare pit and well cellars will be constructed onsite. The drilling sump will be lined with an impermeable liner to contain all drilling fluid, drilling muds, cuttings, cement returns and waste sand. The drilling sump will generally be able to contain up to approximately 3000m^3 of material (approximately 75m long x 25m wide x 4.5m deep). The drilling sump/ broader site will be fenced to prevent livestock access. The well cellars will be constructed on the proposed lease to accommodate the wellhead equipment and blow-out preventer (BOP). The cellars are concrete lined and will be prefabricated off-site. The cellars are transported to the site in one (1) piece and lowered into an excavated pit. A shallow conductor casing is installed within the cellar to approximately 20m using an auger. The shallow conductor casing is designed to prevent the upper sections of the exploration well from caving in when drilling through the unconsolidated sediments. The cellar itself will be fenced at all times to exclude fauna ingress. Cellars will be typically separated from each other by 10m-20m..	7.5 ha	<24 people	Prior to exploration drilling	2-8 weeks	
Camp pad construction and camp operation A camp pad up to 1.2 ha will be constructed adjacent to each proposed lease pad to accommodate a temporary 70 man camp (typically less than 70 man) to support civil construction and exploration (drilling, stimulation, testing and decommissioning) activities. Smaller, mobile camps may also be utilised across the clearance area during operations where required 9for example to support seismic activities). The camp pad will be cleared of vegetation, grubbed and stripped of topsoil down to approximately 100mm (depending on the depth of topsoil onsite). Topsoil will be stored around the edge of the camp pad. The camp pad will then be levelled, compacted and surface with gravel to accommodate exploration activities. Erosion and sediment controls will be constructed around the disturbed areas (such as rock check drains, woah boys and diversion drains). Camps will be constructed with kitchens, offices, ablution blocks, accommodation blocks, storage containers, gymnasium, refrigeration, water treatment plan, sewage treatment plant, waste management areas, water storages, power generation, diesel storage tanks and car parking.	1.2ha	<60 people (including housed staff)	For duration of activity	For duration of activity	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
All waste will be covered/ stored in a manner that prevents feral animal access. An approved wastewater (sewage) treatment plant will be utilised to treat all sewage, with treated effluence irrigated in a fenced area adjacent to the camp (no clearing required). Treated effluence treatment and irrigation will occur in accordance with the NT Department of Health requirements.					
Helipad pad construction and operation A 1ha helipad may be constructed to accommodate wet season operations adjacent to each lease pad. Where prolonged access to the site is restricted, personnel and material will be helicoptered to and from site. The helicopter pad will be cleared of vegetation, grubbed and stripped of topsoil down to approximately 100mm (depending on the depth of topsoil onsite). Topsoil will be stored around the edge of helipad. The helipad will then be levelled, compacted, surface with gravel and then fenced. Erosion and sediment controls will be constructed around the disturbed areas (such as rock check drains, woah boys and diversion drains).	1ha	N/A	For duration of activity	For duration of activity	
Laydown/storage yard construction and operation Laydown/ storage yard may be constructed along access track to each of the proposed sites to store materials, wastes, water tanks, equipment and other material as required. The laydown yard will be fenced to prevent access. These are typically 2.5 hectares in size. The laydown/ storage yard will be cleared of vegetation, grubbed and stripped of topsoil down to approximately 100mm (depending on the depth of topsoil onsite). Topsoil will be stored around the edge of helipad. The yard will then be levelled, compacted, surface with gravel and then fenced. Erosion and sediment controls will be constructed around the disturbed areas (such as rock check drains, woah boys and diversion drains).	2.5ha	N/A	During exploration activities (as required)	For duration of activity	
Gravel pit construction and operation. Up to 15 hectares of gravel pits (multiple pits, anticipated to be ~5) will be constructed to support the construction of infrastructure onsite. The exact location of pits within the clearance area will be determined based on operational requirements (i.e. pits are constructed as close as needed to infrastructure) and through further testing Each gravel pit area will be progressively cleared of vegetation in 1-2 hectare stages (to minimise the required disturbance). Each pit stage will be stripped of topsoil down to approximately 100mm (depending on the depth of topsoil onsite). Topsoil will be stored around the edge of the lease pad to form a bund, which will be used as both an erosion and sediment control measure and to prevent overland flow access to the site. Subsoils will also be stripped, segregated from topsoil and stockpile around the edges of the gravel pit. Gravel will be periodically extracted from the pit, with the pit designed to drain internally. The Erosion and sediment controls will be constructed around the disturbed areas (such as rock check drains, diversion drains and bank stabilisation using fallen debris).	Gravel pit <15ha	<6 people	For duration of activity	For duration of activity	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Once gravel activities are finished, the pit will be reshaped, with subsoils re-instated. Topsoils will be spread and fallen vegetation returned to aid site stability. The area will be temporarily fenced (where required) to allow vegetation regrowth. Seed maybe added to the site to support natural regeneration if required. The pits may be converted to pastoral watering points where appropriate and approved by pastoralists. An access track will be constructed to each pit, with the length of access track to be determined based on location of the pit The access track will typically be less than 14m wide, with sections up to 20m wide where truck turn outs, erosion and sediment control and cut out drains are required.					
Exploration well drilling Up to 8 petroleum exploration wells are proposed to be drilled at each site. Wells may be drilled in stages (i.e. 1 or 2 at a time) or progressively (i.e. 8 wells drilled over 5 years)Each well will be drilled into an underlying prospective petroleum reservoir (each as the Velkerri shale, Kyalla shale or other formation) to a typical maximum depth of 4000m. Each well will be deviated into the horizontal position, with a lateral drilled up to 3000m (please note the depth and lateral length may change based on operational require. ments). Each petroleum well is designed and constructed in accordance with the Code of Practice for Onshore Petroleum Activities within the Northern Territory (Code of Practice) to maintain well integrity and protect aquifers and the environment. A Well operations management plan (WOMP) is required to be submitted to the regulator and approved prior to the drilling of any wells. The WOMP outlines the well design and drilling practices that will be deployed to ensure compliance with the Code of Practice and protect underlying aquifers and the environment. Each well is anticipated to be constructed with multiple casing and cement strings, typically 5- consisting of a shallow conductor casing, deeper conductor casing, surface casing, intermediate casing and production casing. Once the well design is approved by the Northern Territory government (NTG), a rig package will be mobilised to site, which consists of a drilling rig (comprising rig matting, a rig floor, mast or derrick, rig engine, blow out preventor, catwalk, safety flare etc.), pipe racks, casing strings, drilling rods, rig fluid system (mud tanks, shakers, mud treatment system and pipework) storage trailers, bunded chemical storage areas, workshop portable onsite offices, crib huts, mini-rig camp and sewage treatment system and irrigation area), freshwater storage tanks, diesel power generation, cement trucks, bulk fuel storage, water transfer pumps, fork lifts, lighting towers, crane etc. The rig will be constructed over the pre-installed conductor casing and cellar. Once functional, drilling will proceed down below the first encountered aquifer, where the first casing section of the well will be installed (either in the Anthony Lagoon Formation if present and saturated or the Gum Ridge formation (anticipated to be present). A BOP will then be installed, to ensure any influxes of gas, water or pressure are able to be safely managed during drilling of the remaining sections of the well. The drilling rig will continue to drill the various other casing and cement sections. The integrity of each of these casing strings is tested through a combination of leak off tests, casing pressure tests, cement return tracking and cement bond logs. Upon completion of drilling, a barrier integrity verification report is submitted to the regulator summarising the integrity of the well. This report is publicly available. Once each well is finished drilling, the well head is installed and the rig is either “walked” to the next adjacent location with the process repeated or mobilised to a new location. A low toxicity water-based drilling mud is to be used as the base fluid for drilling, which primarily contain salts and polymers. Drilling mud is required to maintain well control, provide formation stability, lubricate and control the temperature of the drill bit and lift	N/A located on proposed lease pad	<60 people	Pastoralist to be notified when drilling proposed	Typically 60- 90 days per well	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
cuttings to the surface. The fluid system consists of water with a sodium or potassium-based salt (to prevent formation swelling) and a viscosifying agent such as bentonite. Other low toxicity chemicals such as barite, citric acid, sodium bicarbonate and loss circulation material (fibres such as coconut coir or nut hulls etc.) may also be used. The chemicals used for drilling are consistent with those used for water bore drilling. Waste drilling muds, fluids, cuttings and mineral waste (such as cement returns, sand etc.) brought to surface will be stored in the lined drilling sump. Drilling fluids will be evaporated and then removed from the sump and disposed of offsite. Solid waste within the drilling sump will be allowed to dry out and then either removed from site or disposed of onsite in accordance with the Code of Practice. Where onsite disposal is proposed, a risk assessment will be completed demonstrating that the activity can occur with no residual environmental harm. Onsite disposal can include encapsulation or mix bury cover, depending on the site specific details and final composition of the drilling waste material. Subsurface diagnostic tools will be run on the well during and after drilling to understand the nature of the target reservoir. Some sections of the formation may be cored or have sidewall samples collected, which will add further analysis of the reservoir properties. To assist with determining the suitability and capacity of these formations for potential gas extraction activities, diagnostic fracture injection test (DFIT) may be conducted across a number of shale intervals to evaluate the geo-mechanical and reservoir properties of the targeted formation. Prior to a DFIT, a cement bond log and casing pressure test is completed to ensure the integrity of the cement and steel casing. A DFIT involves the injecting of small volumes of a water (approximately 30 barrels (5,000L) per DFIT) at low pumping rates to create a small fracture in the target interval. The well is shut-in, and the pressure allowed to fall-off naturally. Monitoring the fall-off pressure over time allows information to be derived about the reservoir. The fluid does not contain proppant so that the fracture closes naturally when the fluid leaks off into formation. The analysis of pressure, during injection and after shut-in, provide powerful tools for understanding and subsequently informing the design for a future hydraulic fracturing process (not in this scope). Any returned fluid will be stored within double lined tanks and disposed of offsite at a licenced facility. All waste drilling fluids, muds, cuttings, DFIT return fluid and cement returns will be managed in the existing lined drilling sump on-site. Once drilling has been completed, this material will be sampled as per the code of practice and a detailed risk assessment completed to determine whether onsite encapsulation or mix bury cover can occur in ana environmental acceptable manner. In most cases, drilling wastes will be dewatered, blended with native soil and encapsulated within an impermeable liner. A cap of clean material will be placed over the liner to enable vegetation growth.					
Hydraulic Fracture Stimulation Upon completion of drilling activities, a frack spread will be mobilised to site to commence hydraulic fracture stimulation (HFS or stimulation) activities on each of the drilled wells. A frack spread consists of: • Data Van – on-site office to execute stimulation activities • Water Storage - tanks will be constructed on-site, capable of managing both make-up water and flowback water. Tanks will be double lined with leak detection capable of monitoring any leaks between the primary and secondary liner • Proppant Trailer - a large sand storage and delivery trailer that holds the proppant • Hydration Unit – used to add stimulation additives and viscosifying fluids • Blender Unit – used to mix proppant and fluid additives, prior to its injection into the well • High Pressure Pumps – pumps which inject the hydraulic fracturing fluid mixtures from the Blender Unit down the well, via the surface lines and hydraulic fracturing wellhead or coiled tubing unit • Coiled Tubing Unit – a large length of coiled steel pipe that can be temporarily	N/A located on proposed lease pad	<50 people	Post exploration well drilling	2- 8 weeks per well depending on stimulation size	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
installed in the well to perform various downhole operations • Wireline unit – plug and perforation deployment • Ancillary support buildings – offices, workshop, cranes, chemical storage area, equipment storage, power generation and all other activities required to support stimulation activities. Stimulation involves the injection of a slurry, primarily consisting of water and sand (proppant), plus a small percentage of chemicals at high pressure into the target section of the horizontal wellbore approximately 1000m – 4000m below ground level (depending on the depth of the target formation). Typically, 90% or higher of the total volume in stimulation fluids is a combination of fresh water and sand (~6-8%), with the remainder as fluid-conditioning additives (~2-4-%). Prior to the commencement of stimulation activities, the integrity of the well is tested with a cement bond log and pressure casing test. This integrity report is submitted to the regulator prior to the commencement of stimulation activities. The stimulation fluid is pressurised by the high-pressure pumping units and directed downhole via a manifold to the discrete target intervals along the horizontal wellbore (referred to as 'stages'). Each stage will be isolated and perforated using a plug and perforation gun assembly deployed via a wireline unit. As the pressure is sustained, the fractures propagate radially from the well, through the target rock. Once optimal fracture propagation has been achieved, the proppant (sand) is pumped down the well and into the open fractures. This process is repeated for each stage. The final number of stages pumped in each well is dependent on the useable length of the horizontal wellbore and in-situ geological conditions. Once all stages are complete, the well is suspended awaiting completion and well testing activities. Wellbore pressures are monitored during each stimulation, to ensure the operations have not compromised the integrity of the production casing or the cement barriers. A Maximum Allowable Operating Pressure (MAOP) is an important engineering parameter used to define the operating envelope (i.e. the safe maximum pressure that should not be exceeded). The maximum allowable pumping pressure (MAPP) is set below the MAOP to allow for uncertainty and provide an additional safety margin so the MAOP is not exceeded.					
Exploration well completion Once each well has been stimulated, a completion rig will be mobilised to site to "complete" the well. This involves installing downhole equipment such as packers, plugs, production tubing, artificial lift etc. required to enable the production testing.	N/A located on proposed lease pad	<12 people	Post stimulation	1-2 weeks	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Well testing Once the well has been completed, the well will be brought online and tested. To enable the testing, a well test package will be installed at the site consisting of: • Separators (to separate gas, condensate and water) • Flares (either a vertical or horizontal), • Flare pit (if a horizontal flare is utilised • surface pipework, manifolds, and tanks • communication and generator shacks • workshops/ storerooms • bulk diesel tanks • wastewater storage tanks (converted freshwater storage tanks used for stimulation makeup water) • Water transfer equipment • Wastewater evaporation and treatment units • Camp accommodation. The exploration well will be underbalanced (or “unloaded”) to initiate production, either through its own energy or through artificial lift (such as through a Nitrogen lift or pump). The fluid and gas will be sent through a separator, with all hydrocarbon metered and flared. Flowback water will be discharged from the separator into designated wastewater storage tanks. Well testing will typically be undertaken form a period of 1- 24 months- depending on the objective of the well. Multiple well testing operations may be required to test the behaviour of the formation to determine whether extended shut ins can affect well productivity. Gas will be used beneficially onsite to reduce greenhouse gas emissions where possible. This includes the use in power generation for hosting data servers, digital miners or other beneficial activities.	N/A located on proposed lease pad	<12 people during production testing	During exploration activities	Typically 30 days to 24 months.	
Wastewater tank storage Flowback wastewater will be treated on site via evaporation (or other treatment technologies such as enhanced evaporation units, brine crystallisation etc.) and removed from site upon completion of activities. Double lined wastewater tanks will be utilised to store wastewater, with the volume and number of tanks installed dependent on the anticipated flowback return volume. Wastewater storage tanks have continuous level monitoring, with leak detection sensors located within the interstitial space between the primary and secondary liners. It is anticipated that between 10ML to 30ML of tanks storage may be installed onsite, with a combination of enclosed tanks and open treatment tanks. In accordance with the Code of Practice, sufficient enclosed tank capacity must be onsite to store all wastewater. Flowback can only be stored within open tanks where undergoing treatment (such as evaporation). Open evaporation tanks must have a 1:1000 annual re-occurrence Interval (ARI) wet or dry season freeboard (i.e. available tank space to accommodate rainfall), which is typically 1.3M or 0.3M respectively. The lease pad or a specifically constructed wastewater storage areas will be bunded to contain 110% of the volume of the largest tank stored onsite.	N/A located on proposed lease pad	<4 persons	During wastewater storage activities.	3-36 months	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Wastewater storage tanks may be deployed for extended periods of time to allow ongoing evaporation or treatment. Wastewater from other sites across the basin may also be used to stored onsite, to assist in wastewater treatment/ management. The treatment of wastewater may also be undertaken within origin infrastructure footprint (such as lease pads or laydown yard) to reduce the amount of offsite wastewater trucking.					
Flaring During well testing and where gas cannot be beneficially used, produced hydrocarbons (gas and liquids) will be flared onsite. Two flares may be utilised, with a vertical flare used to manage gas and a horizontal flare used to manage condensate where it is anticipated to be encountered. The vertical flare will be an American Petroleum Industry (API) 537 and a US EPA AP 42 compliant unit, with a 98% combustion efficiency. The vertical flare will have a constant pilot flame, with an autoignition system that provides electrical impulses to a spark plug continuously. If the flare was to go out, the spark would ignite the flare within 1.3 seconds. A horizontal flare may be utilised to combust condensate if produced during well testing. A horizontal flare will been equipped with 3 independent nozzles, located in a 20mx 10m clay lined pit. Flares will be located at least 45m from the surrounding vegetation, with flaring not undertaken during total fire ban periods.	N/A located on proposed lease pad	<12 people during production testing	During exploration activities	During production testing.	
Condensate management (Storage and trucking) Where condensate (liquids rich gas that “condenses” when brought to the surface) is generated, it is separated and stored within double lined condensate tanks. Condensate may either then be trucked offsite for beneficial use or combusted in the horizontal flare.	N/A	1-2 trucks per day	During exploration activities	During production testing.	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Wet season operations Exploration activities (including drilling, stimulation and well testing operations) may occur over the wet season. Where wet season operations are undertaken the following risk controls will be implemented: • All chemicals, fuels, equipment, tanks and materials required for ongoing operations will be stored on-site prior to the onset of the wet season • All equipment required to respond to emergency situations will be on-site; this includes earth moving equipment, vacuum trucks, wireline rigs, cementing equipment etc. and equipment and material to deal with well control issues, spills and other emergency events. • All chemicals storage areas will be bunded, with covers used (where safe and appropriate) to prevent rain ingress and bund overflows • Enclosed tanks will be utilised as the primary measure to store wastewater with enough enclosed tank capacity to store all wastewater on-site • Enclosed wastewater storage volume will be sufficient to manage all wastewater stored onsite • Open working evaporation tanks and mud sumps will have enough freeboard to manage an entire 1:1000 ARI wet season event (not just one (1) rainfall event but an entire season's rainfall total) • Helicopters will be used to transport people and supplies into and out of the site when access is restricted • No transportation of wastewater or chemicals will be undertaken during the wet season unless a risk assessment is undertaken that demonstrates the risk is As Low As Reasonably Practicable (ALARP) and acceptable (as per the Code of Practice) • Wastewater storage area is bunded, which will prevent all off-site release of chemicals and stormwater. • During flowback wastewater, stormwater will be retained on-site via the sediment retention pond prior to release. • Overland flow will be diverted around lease pads.	N/A	N/A	October – May	7 months of the year	
Microseismic Monitoring consists of the following: • **Geophone Deployment:** A week before hydraulic fracture stimulation, up to 9 personnel from the operator or a contractor will access a 30-40km^2 area around each of the proposed lease pad and deploy geophones 10-30 metres apart, the deployment will take up to 7 days. Deployment locations are determined by GPS locator. Deployment will be undertaken on foot with crew supported by light 4WD or All-Terrain Vehicle(s) depending on access and crew size. • **Geophone Retrieval:** After the hydraulic fracture stimulation operations have concluded, up to 9 personnel from the operator or a contractor will access a 30-40km^2 area around each of the proposed lease pad to retrieve geophones. The retrieval will take up to 7 days. Geophones are located using GPS locator, once identified they are retrieved from the ground, with any divot filled in. Retrieval will be undertaken on foot with crew supported by light 4WD or All-Terrain Vehicle(s) depending on access and crew size.	No disturbance required	3-9 personnel.	Deployment of Geophones before stimulation. Retrieval of Geophones after stimulation.	1 month (one week deployment, two weeks Stimulation, one week collection)	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Site monitoring and inspections consisting of the following: • **Groundwater monitoring:** Groundwater monitoring bores are required to be installed on the lease pad before the commencement of hydraulic fracture stimulation activities. Groundwater monitoring is undertaken at the site commencing 6 months before stimulation and then quarterly for 3 years after. Groundwater monitoring involves purging a monitoring bore of water, measuring field parameters (level, electrical conductivity) and collecting laboratory samples and • **Site and exploration well monitoring-** an operator or contractor will access the site to perform checks on the exploration well and stability of the site. Checks include pressure readings and visual checks of valve integrity. In some cases, a helicopter may be utilised to complete the inspections. Surveys are completed fortnightly. • **Weed inspections-** Access to the site by several contractors/ Origin personnel in light vehicles to identify weeds. In some cases, a helicopter may be utilised. Contractors may perform spot sprays with a NTG recommended weed treatment. Surveys are completed pre and post wet season. • **Erosion and sediment control inspections-** Access to the site by several contractors/ origin personnel in light vehicles to identify erosion or stability issues. Inspection will be used to schedule maintenance to repair any defects identified. In some cases, a helicopter may be utilised to complete the inspections. Surveys are completed pre and post wet season. • **Gas leak detection surveys-** Access to the site by 2- 3 contractors or Origin personnel in light vehicles to perform mandatory gas testing using handheld gas meters. Surveys are completed every 6 months. • **Build up pressure monitoring-** Post stimulation and well testing, the exploration well may be shut in with pressure monitoring equipment installed to monitor build up pressure. This requires the installation of a solar panel and telemetry equipment, with monthly equipment inspections (typically)	N/A	<2-6 people	Fortnightly/ 6 monthly (depending on activity)	1 day per inspection	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Site maintenance (lease pad, camp pad, access tracks and gravel pit) Each site will be periodically maintained, which includes grading, erosion and sediment control repair, vegetation management, firebreak management, weed management, fence repair and all other ancillary activities required to maintain a site and associated with infrastructure. This includes maintenance of the access tracks. The work will be undertaken by civil maintenance contractors and Origin personnel.	N/A	<10 people	6 monthly- pre and post wet season maintenance	<7 days per activity depending on the nature of the activity.	
Well head maintenance Maintenance is completed annually on each well. Maintenance primarily includes valve checking, testing, greasing and (in some cases) replacement, as well as any other activities required to maintain the integrity of the well**.**	N/A located on proposed lease pad	<20 people depending on activity	Annually	< 7 days per activity- depending on nature of maintenance.	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Well intervention- data acquisition and testing Subsurface activities may be undertaken periodically on each of the well to perform maintenance or collect additional information on the properties of the well or the reservoir. These type of well interventions typically include performing cement bond logs, casing pressure tests, running reservoir evaluation or production logging tools, cement and casing remediation activity (if required during the life of the well), setting downhole mechanical plugs and gauges, casing perforation, subsurface barrier maintenance/ installation and production tubing installation/repair or replacement. This generally involves the use of a variety of equipment dependent on the activity being completed. This typically may involve any of the following equipment: completion rig, coil tubing, wireline unit, data van, cement or pump truck, crane, trucks, power generation, support trucks and other support vehicles.	N/A located on proposed lease pad	<20 people depending on activity	Ad hoc requests- typically 2 interventions within the next 5 years	<10 days per activity	
Petroleum well plugging and decommissioning. Once a petroleum well is no longer required, each well will be decommissioned. Decommissioning involves the permanent removal of the well through the placement of cement plugs to isolate the target reservoir from overlying aquifers in accordance with the Code of Practice: Onshore Petroleum Activities within the Northern Territory (Code of Practice). Once plugs are installed, they are pressure tested to confirm the underlying formations have been adequately sealed off. The well head is then removed. A permanent marker is added to indicate the location of the plugged and abandoned well.	N/A located on proposed lease pad	<12	End of well life	<10 days	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Chemical and fuel storage- All chemicals and fuels (diesel) required to support exploration activities will be stored in accordance with the relevant regulatory requirements, including the use of secondary containment (bunding) onsite. The Code of Practice has implemented a range of additional controls, including requirements for routine inspections, emergency response procedures and spill management. Anticipated chemical and fuel volumes vary dependent on activity, but may involve the storage of the following types of chemicals and volumes: • Stimulation and drilling chemicals (friction reducers, surfactants, crosslinkers, breakers, buffers, acids, bases, biocides, scale inhibitors, corrosion inhibitors, clay stabilisers, loss of circulation material, drilling muds, salts etc.) Volumes are typically less than 20KL per chemical, with some chemicals stored at higher (such as pH control) or lower (such as biocides and corrosion inhibitors) volumes depending on their purpose and planned use. • Diesel – typically 100KL stored but may be 500KL if wet season activities are proposed. • Other chemicals and hydrocarbons- such as oils and greases, lubricants, hydraulic fluid, cleaning chemicals, domestic chemicals etc. used to support operations.	0.5ha (on existing lease pad or laydown yard)	N/A	During exploration activities	During exploration activities.	
Waste management: Any waste generated during exploration activities will be stored onsite in accordance with the NT *Waste Management and Pollution Control Act 1998* and Code of Practice and transported offsite to a licenced waste management facility. All wastes (other than drilling mineral waste) will be stored within skips or equivalent and removed from site at the end of each activity.	N/A	1 -2 trucks during operations	During explorations activities	During explorations activities	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Groundwater extraction: Groundwater extractions from the purpose built groundwater monitoring onsite or another approved extraction bore (which may include trucking water from adjacent properties) will be completed periodically to support exploration activities. All groundwater take will likely be from the Gum Ridge Formation and will be licenced under Origin's existing Water Extraction Licence (WEL) GRF 10285. A new WEL may be submitted covering take an alternative formation where present. It is anticipated that groundwater extraction volumes to support this program will be in the order of 100- 150ML, primarily used to stimulate the 3 wells. Once drilling and stimulation has ceased, minimal ongoing water extraction from the site will be required.	N/A	N/A	Ongoing to support exploration activities.	During exploration activities	
Traffic management Access to the Velkerri 76 N1 site will be via the newly constructed access track, located approximately 20km west of the Tanumbirini station main access point. Minor traffic disruptions may occur during the construction of the access track intersection with the Carpentaria highway. During this period, a traffic management plan will be implemented, with traffic control utilised in accordance with DIPL requirements. Peak traffic volumes are anticipated to be associated with the drilling rig mobilisation and demobilisation. Traffic volumes may reach up to 44 vehicles per day spread over a 4 week period. During operations (drilling, stimulation or well testing), vehicle movements to the site are anticipated to be less than 10 movements per day. This period is likely to extend typically 60 days per exploration well, 45 days per stimulation and during the duration of a well test (30-365 days). Once the well is suspended or decommissioned, vehicle movements will reduce down to 1 vehicle per fortnight or 1 vehicle per 6 months respectively.	N/A	N/A	During operations	During operations	
Site rehabilitation Within 6 months of the E&A wells at Velkerri 76 N1 being plugged and decommissioned, the site will be rehabilitated. This involves: a) the removal of all surface facilities (well heads, fencing, water bores, tanks etc.) b) deep ripping of compacted surfaces c) recontouring landforms d) respreading of topsoil from the topsoil stockpiles, e) re-seeding (if required;) and f) ongoing monitoring and maintenance of the rehabilitation.	N/A		Within 6 months of the plugging and abandonment of all E&A wells	<14 days, with ongoing monitoring and maintenance	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures

3.2 Appendix 2

3.21 Environmental Management Plans

An approved Environmental management plans (EMP) is required to be in place for all proposed regulatory petroleum activities in the Northern Territory. EMPs are submitted to the Department of Environment, Parks and Water Security (DEPWS) detailing the potential environmental impacts, risks and proposed mitigation measures associated with a proposed exploration activity. The plan is also required to demonstrate how it complies with the Code of Practice: Onshore Petroleum Activities in the Northern Territory (the code of practice), which was developed as a recommendation of the NT Inquiry into Hydraulic Fracturing. The Code of Practice outlines a range of minimum standards that must be followed to ensure all impacts to the environment are as low as reasonably practicable (ALARP) and acceptable. Aspects covered by an EMP and the Code of Practice include

- Management of Sacred Site / Cultural Heritage,
- protection of groundwater water resources, including well integrity standards and groundwater monitoring
- Biodiversity impacts from land clearing
- Bushfire prevention and management,
- weed prevention, detection and management,
- Waste management, including solid and wastewater management
- Spill management
- erosion and sediment control,
- protection of Surface water
- environmental nuisance (dust, noise and vibration)
- Community impacts and nuisance (traffic, noise, vibration, dust and amenity)
- Greenhouse gas emission management and mitigation

3.22 Summary of Environmental outcomes, impacts, risk and controls

An overview of the potential environmental outcomes, potential impacts and risks associated with the proposed exploration activities within this clearance request are summarised in Table 3. This information will also be provided in the EMP covering the proposed regulated activity, which will be submitted to the Department of Environment, Parks and Water Security (DEPWS) for formal assessment and approval.

An environmental outcome means an outcome that will be achieved if the environmental impacts and environmental risks of a regulated activity are reduced to a level that is as ALARP, and acceptable.

Environmental impacts are defined as any adverse change, or potential adverse change, to the environment resulting wholly or partly from a regulated activity.

Environmental risks are defined as the chance of something happening that will have an environmental impact, measured in terms of environmental consequences and the likelihood of those consequences happening.

Both the consequence and likelihood of a potential impact can be reduced through the adoption of controls, which must be applied to reduce a risk down to an ALARP and acceptable level.

Table 2 Environmental outcomes, impacts, risk and controls

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
Groundwater use and quality	• To manage exploration activities to prevent unsustainable depletion of groundwater resources • Preserve groundwater quality to protect environmental and pastoral use	• No adverse changes to groundwater quantity is anticipated to be associated with exploration activities. • Impacts to aquifers levels anticipated to be negligible, with rapid recharge observed from other Gum Ridge Formation bores utilised within the Basin. • No material changes to groundwater quality anticipated form exploration activities. • No impact to Groundwater Dependent Ecosystem's (GDE) or stygofauna from exploration activities (extraction and well construction) • Reduction in pastoral productivity through reduced groundwater volumes	• Low risk of groundwater contamination from drilling fluids during construction of the conductor/ surface casing in the Cambrian Limestone Aquifers due to the selection of low toxicity drilling fluids • Low risk of cross flow of deep formations (such as the target shales) to shallow aquifers through inappropriate well barrier design and construction due to the presence of the Code of Practice controls and verification processes. • Low risk of crossflow through fracture growth into aquifer from stimulation activities allowing the migration of fluid and gas due to the controls within the Code of Practice and underlying separation distance between the target formation and Cambrian Limestone aquifers. • Low risk of stimulation activity inducing seismic activity that enables cross formational flow between shallow aquifers due to seismic stability of region and lack major faults or fracture zones. • Low risk of stimulated zones intersecting offset wells (including the adjacent horizontal wells) or intersecting an existing geohazard due to seismic control, pressure monitoring during stimulation and lack of older petroleum wells in close proximity. • Low risk of crossflow/well integrity caused by the deviation of an E&A well into the adjacent well during drilling due to downhole GPS tracking tools and proximity alarms • Low risk of leakage of either flowback,	• All petroleum wells are to be designed, constructed, operated and decommissioned in accordance with the mandatory controls within the Code of Practice. The Code of Practice outlines specific controls measures designed to protect underlying groundwater resources including: ○ Exploration wells designed with multiple cement and steel casing barriers to protect aquifers ○ Drilling fluids and muds must have a low residual toxicity ○ Groundwater monitoring must be completed before and after stimulation to detect contamination ○ Well integrity confirmation to prove barrier performance aquifer isolation (casing pressure tests, formation leak off tests, cement bond logs etc.). ○ Separation between stimulated shale resources and aquifers must be sufficient to ensure the risk of fracture growth is ALARP ○ Pressure monitoring completed to ensure maximum allowable operating pressure is not exceeded during stimulation. ○ Ongoing well integrity monitoring and maintenance throughout the life of each well to ensure aquifers are protected ○ All wells are to be decommissioned in accordance with the Code of Practice, with cement plugs utilised to

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			produced water, or hydrocarbons (liquid and gaseous) from suspended or abandoned wells to groundwater due to well design and integrity management. • Low risk of surface contamination from storage and disposal of drilling fluids, additives, muds and cuttings on-site due to low toxicity of drilling muds and disposal risk assessment process. • Low risk of groundwater contamination from surface spills from storage, handling and transportation of flowback water due to the storage and spill management requirements outlined int eh Code of Practice. • Low risk of groundwater contamination from the storage, handling and transportation of chemicals, fuels and wastes due to the mandatory code of practice controls (such as mandated use of secondary containment) • Low risk of groundwater contamination from overtopping of drilling sumps and flowback tanks (including during wet season) due to level alarms and use of enclosed tanks. • Low risk of groundwater contamination from a failure of flowback storage tank due to the design standards of the tank (cyclone rated steel tank structures) and routine integrity inspections • Low risk from over extraction of groundwater for civils, drilling and stimulation activities due to limited nature of take (one off), yield of the Cambrian Limestone Aquifers and available allocation volumes (as assessed in the	separate aquifer units. • All surface storages of wastewater and chemicals to have secondary containment to prevent spills to the ground • An emergency response plan must be implemented outlining how spills and emergencies will be responded to. • Drilling fluids and wastes to be stored within a lined sump • Flowback wastewater must be stored in double lined tanks with leak detection and level monitoring • Double lined enclosed wastewater tanks with leak detection and level monitoring utilised to store all wastewater, with open treatment tanks used to reduce wastewater volumes • All open treatment tanks are to be operated with a 1:1000Annual re-occurrence interval (ARI) wet season or dry season (whichever is applicable) freeboard • All wastewater to be transferred to enclosed tanks within 8 hours of a significant rainfall event occurring (such as a cyclone) • Groundwater monitoring from monitoring bores installed at the site must be completed prior to and after stimulation to detect any contamination. • All water take covered by an existing Water Extraction Licence (WEL) GRF 10285 • New extraction bores must model potential impact on adjacent pastoral bores prior to

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			WEL).	being added to WEL. • All water take to be metered and reported quarterly to the regulator • No pastoralists groundwater bores within 3 km of the Velkerri 76 N1 site.
Soils	• Avoid, minimise and control soil erosion and discharge of sediment or soil into waterways or established drainage systems • Minimise disturbance of soil, vegetation and drainage during site activities • Prevent the contamination of soil to maintain the viability of soil resources • Minimise residual impacts to pastoralist usage of exploration areas	• Clearing of vegetation to support exploration activities. • Soil compaction from access tracks, leases and seismic lines. • Increased sedimentation transportation from disturbed areas • Loss of productivity of disturbed areas until final rehabilitation has been achieved	• Medium risk of soil erosion from cleared areas (access tracks, lease pads, camp pads, gravel pits and laydown areas) occurring on disturbed sites due to high intensity wet seasons. Risk is a low consequence (minor impact), possible (<50% chance of occurring) event. • Low risk Reduction in land production through poor erosion and sediment control practices • Low risk of spills/leaks from the on-site storing and handling of fuels. Condensate, hydrocarbons, drilling additives, stimulation additives, flowback fluid, solid wastes, storage and transportation of wastes causing soil contamination. • Low risk of drill sump and flowback tank overtopping due to mandatory freeboard and monitoring controls • Low risk of chemical and waste transportation accident causing soil contamination due to licenced chemical/ waste provider use, spill response and emergency response requirements. • Low risk of contamination from on-site disposal of drill muds and cuttings with site specific assessment completed to ensure disposal is	• Site selected to avoid sensitive soil units and slopes which may increase erosion hazard. • All land clearing (including during the establishment of seismic lines) to align with the requirements of the code of Practice and NT Land Clearing Guidelines (2019) • Erosion and sediment control practices to be utilised at all disturbed sites to minimise erosion. • Sites (including gravel pits) maintained to minimise sediment releases, with erosion and sediment control plan in place • Pre and post wet season monitoring completed on all disturbed areas (including seismic lines) to identify and repair erosion • Construction within the wet season to be avoided to reduce the erosion risk. • Vegetation clearing watercourses to be avoided as far as reasonably practicable (i.e. only when a new access is required to be constructed) • During seismic surveys, vegetation clearing within open woodlands to be minimal • All chemicals and fuels to be stored with secondary containment as per

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			environmentally acceptable. • Low risk of contamination from a flowback wastewater tank failure due to the structural design of the tanks, site bunding, emergency response requirements and spill management requirements. • Low risk of wastewater evaporation mist transported offsite during wastewater treatment due to wind speed/direction cut offs and routine site inspections during operations. • Low risk of greywater and sewerage disposal from camp wastewater treatment plants due to the irrigation area being appropriately sized, fenced and quality aligning with the NT Department of Health requirements. • Low risk of reduction in land production through poor infrastructure placement as infrastructure is located along an existing seismic line and no sensitive soil types are present in the immediate vicinity. • Low risk of reduction in land productivity from poor rehabilitation due to mandatory rehabilitation requirements and security bond requirements	code of Practice. • During wastewater storage, the site is to be fully bunded to contain the volume of an entire wastewater tank if a structural failure occurred • Flowback wastewater must be stored in double lined tanks with leak detection and level monitoring • Double lined enclosed wastewater tanks with leak detection and level monitoring utilised to store all wastewater, with open treatment tanks used to reduce wastewater volumes • All open treatment tanks and sumps are to be operated with a 1:1000Annual re-occurrence interval (ARI) wet season or dry season (whichever is applicable) freeboard • All wastewater to be transferred to enclosed tanks within 8 hours of a significant rainfall event occurring (such as a cyclone) • Stormwater to be retained onsite during wastewater storage and tested prior to release • All spills of chemicals and wastewater to be cleaned up upon detection. • Irrigation of greywater and treated effluent to be undertaken in accordance with DoH requirements • Disposal of drilling muds, cuttings and mineral waste to be undertaken in accordance with Code of Practice, with onsite disposal only permitted where the potential harm to the environment can be

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
				demonstrated as ALARP and acceptable. • Site to be rehabilitated back to pre-existing/ agreed state with pastoralist input.
Emissions (dust, greenhouse and combustion emissions)	• Avoid environmental nuisance at sensitive receptors • Minimise impacts to pastoralists and surrounding ecological communities from dust • Minimise greenhouse gas emissions	• Dust on vegetation in the immediate vicinity of activities reduces plant palatability • Impacts of dust nuisance to birds and fauna in the immediate vicinity of activities, specifically access tracks and seismic lines • Emissions from the combustion of diesel. • Generation of Greenhouse gasses	• Low risk of dust impacts generated during Civil activities, drilling operations, well testing due to use of dust suppression and routine maintenance of access tracks and infrastructure • Low risk of reduction in regional air quality resulting from emissions from the combustion of diesel due to the temporal nature of the activities and selection of efficient equipment. • Low risk of reduction in regional air quality from gas and condensate flaring due to the combustion efficiency of the flare and operating procedures. • Low risk of air emissions from chemical releases during drilling and stimulation activities impacting livestock, fauna and people due to chemical handling procedures limiting emissions during mixing. • Medium risk of bushfire from accidental ignition by site activities (civil works, drilling, flaring, grinding) or personnel. The consequence of a fire is considered serious, with the likelihood Highly unlikely. • Low risk of uncontrolled release of gas impacting a receptor during drilling, stimulation, barrier failure, operator error or vehicle collision due to the well design, blow out prevention, well integrity and	• Site located away from sensitive receptors, such as homesteads • Dust suppression to be used on access tracks, lease pads and gravel pits to minimise dust emissions • Dust levels consistent with standard pastoral activities (such as mustering/truck load outs) on the property • Venting of raw gas is tightly controlled under the Code of Practice, with no material volume of gas to be vented • A reduced emission completion (flare) to be utilised to combust all hydrocarbons • Flares to be compliant with USEPA design standards, including 98% flare efficiency • Stimulation chemical mixing procedures deployed (such as enclosed hoppers) that minimises dust emissions • Firebreaks to be maintained around well and camp pads to minimise bushfire risk • Flaring exclusion zones to be maintained around flare • No flaring during total fire bans • Slashing, grinding and other higher risk fire activities to be undertaken with appropriate controls to mitigate he risk of bushfire (such as buffer zones, use of fir trailers,

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			lack of sensitive receptors preventing impacts. • Low risk of leak of gas from wells due to the well design, routine leak detection and repair and separation distance from receptors,	fire breaks etc.) • During seismic surveys, no vegetation is to be mulched and bushfire management protocols implemented. • Vehicles to be equipped with fire extinguishers • 6 monthly gas leak detection on all exploration wells.
Surface Water	• Avoid and minimise the potential contamination caused by the discharge of sediment or contaminated storm water to waterways or established drainage systems. • Contain any potential contaminants for treatment or disposal.	• Increased sedimentation transportation from disturbed areas (access tracks, lease pads, seismic lines etc.)	• Low risk of contamination from a flowback wastewater tank failure due to the structural design of the tanks, site bunding, emergency response requirements and spill management requirements. • Low risk of drill sump and flowback tank overtopping due to mandatory freeboard and monitoring controls • Low risk of a transportation accident releasing chemical or wastewater (drilling fluid and flowback) due to the use of licenced wastewater/ chemical transportation providers, spill management and emergency response requirements. • Low risk of spills to surface water from chemicals and fuel storage and handling activities due to use of secondary containment and separation distance to watercourses. • Low risk of stormwater releases from activities contaminating surface water due to stormwater segregation and testing procedures. • Low risk of infrastructure changing surface hydrology and flow due to	• No take of surface water permitted or proposed • Lease pad located approximately 3.2KM from the mapped stream order 1 stream (Williams and an un-named tributary of Jiberu Creek) • Seismic activities to: ○ avoid vegetation clearing as much as practicable ○ In open woodlands, limit clearing to grasses and shrubs ○ Maintain viable root stock to promote rapid rehabilitation ○ Avoid seismic lines in water courses (unless co-located with an access track) • Site maintained to minimise sediment releases, with erosion and sediment control plan in place • Double lined enclosed wastewater tanks with leak detection and level monitoring utilised to store all wastewater, with open treatment tanks used to reduce wastewater volumes • All wastewater tanks engineered to

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			infrastructure design and avoidance of overland flow locations. • Low risk of changes to terrestrial ground surface levels associated with seismic activity due to the stability of the basin and geomechanical properties of the target and overlying formations.	withstand failure, cyclone rated construction • All open treatment tanks and sumps are to be operated with a 1:1000Annual re-occurrence interval (ARI) wet season or dry season (whichever is applicable) freeboard • All wastewater to be transferred to enclosed tanks within 8 hours of a significant rainfall event occurring (such as a cyclone) • During wastewater storage, the site is to be fully bunded to contain the volume of an entire wastewater tank if a structural failure occurred • All spills of chemicals and wastewater to be cleaned up upon detection. • Irrigation of greywater and treated effluent to be undertaken in accordance with DoH requirements • No offsite releases of drilling or stimulation wastewater proposed or permitted • Stormwater retained onsite during wastewater storage, with testing completed prior to offsite release • Site selected to avoid major structural features, such as faults • Basin is seismically stable, with low seismic activity reported.
Flora and Fauna	• Minimise disturbance to flora and fauna • No disturbance to high conservation areas	• Clearing of vegetation communities (such as Open Corymbia/eucalypt woodland, Bullwaddy and/ or Lancewood) to support	• Low risk of impacts to sensitive vegetation communities from seismic activities, with high ecological areas avoided • Low risk of threatened fauna mortality during clearing, with all sites to be inspected prior	• Seismic activities to: ○ avoid clearing of mature trees and protected flora ○ In open woodlands, limit

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
	• Avoid the introduction of weeds • Avoid the spread of existing weeds • Minimise the loss of pastoral productivity	exploration activities (lease pad extension and seismic lines). • Loss of fauna and flora habitat • Loss of livestock grazing area • Loss of productivity of disturbed areas until final rehabilitation has been achieved	to clearing to avoid fauna. • Low risk of vehicle and machinery noise and lighting on well pads and access tracks causing material impacts to threatened fauna or livestock. • Low risk of contamination from a flowback wastewater tank failure due to the structural design of the tanks, site bunding, emergency response requirements and spill management requirements. • Medium risk of introduction and spread of weeds in the area due to equipment washdowns, inspection and certification requirements. Monitoring and routine treatment completed on identified outbreaks. Impact from weed introductions/spread is considered moderate, with likelihood Unlikely. • Medium risk of bushfire from accidental ignition by site activities (civil works, seismic activities, drilling, flaring, grinding) or personnel on fauna, flora and land productivity. The consequence of a fire is considered serious, with the likelihood Highly unlikely. • Low risk of flora, fauna and livestock being trapped and drowning in storage tanks, sumps and pits due to the design of storages and fencing. • Low risk of contaminants in water and soil pass through the food chain and bioaccumulate in fauna causing detrimental impacts to local species and communities due to chemical storage and handling practices. Fences are utilised to restrict livestock access. • Low risk of vehicle collisions with fauna –	clearing to grasses and shrubs ○ Maintain viable root stock to promote rapid rehabilitation ○ No seismic lined in riparian ○ Implement fire management controls, include rapid response • No mulching of vegetation to occur which reduces risk to fire • Vegetation to be walked down and inspected for fauna prior to clearing. Where fauna are identified, work shall stop in the immediate vicinity until they leave the area. • Site to be fully fenced during operations • Open pits to be fully fenced to prevent livestock access • Sumps to have fauna ladders or liner material (such as coletanche) with sufficient friction to allow fauna to escape. • Gravel pits to be left open to act as watering point for livestock when not in use • Vehicle speed limit restricted to 60km/hr • Dust suppression used to limit dust impacts to vegetation • Limited night-time activities proposed. • Site to be rehabilitated back to pre-existing/ agreed state with pastoralist • All equipment and loads to be

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			fauna mortality results in a localised impact to listed threatened species, due to avoidance of night-time driving, speed limit restrictions and number of vehicle movements. • Low risk of reduction in land productivity from poor rehabilitation due to mandatory rehabilitation requirements and security bond requirements Reduction in land production through bushfire • Low risk of impacts to flora and fauna through the encouragement of feral animals and other pest species leading to competition with native species. This includes the introduction of cane toads.	inspected and certified weed free prior to entry • 6 monthly weed inspections to be completed with all identified weeds treated. • Weeds sprayed periodically to restrict weed numbers.
Environmental Nuisance and Amenity- including dust, noise, light, odour and vibration	• Minimise impacts to pastoralist operations	• Construction of exploration infrastructure onsite changes land use from pastoral to industrial. • Light and noise nuisance to fauna and livestock in immediate vicinity of activity • Increased traffic to proposed exploration area • Noise, light, odour and dust emissions in the immediate vicinity of the lease pad. • A visible hue visible from operations at at night during flaring or from activity lighting. • Noise impacts from helicopter movements • Noise and vibration impacts during seismic activties.	• Low of changes in property amenity through the construction and operation of exploration infrastructure due to location of activities and separation distance from receptors • Low risk of increased vehicle accident or traffic impacts through associated with no material traffic volumes anticipated and limited peak traffic periods. • Low risk of adverse impacts to fauna from traffic are not anticipated, with impact levels consistent with standard road traffic levels. • Low risk of helicopter movements causing impacts to receptors based on location of site away from homesteads	• Sites located ~10-20km from nearest homestead • Site is located away from pastoralist main access points • Maximum peak traffic during mobilisation and demobilisation is likely to be typically less than<44 vehicle movements per day for 2 weeks. • Speed limit restricted on the access tracks to <60km/hr • Dust suppression to be utilised to minimise dust emissions • Where helicopter movements are planned, the pastoralist to be engaged prior to ensure helicopter do not interfere with pastoral activities. • Seismic surveys to avoid sensitive receptors, such as homesteads, local communities, sacred sites etc.

Part C Stakeholder engagement pack provided to pastoralists

4 May 2022

Bullwaddy Pastoral Co Pty Ltd ACN 167 021 543
as trustee for the Brown Family Trust ABN 34 691 803 536
care of [redacted]

Email: [redacted]

BY EMAIL

Dear Adrian,

Issue of Stakeholder Engagement Pack (SEP) regarding proposed exploration and appraisal activities on NT Portion 1079, Volume 786 Folio 762 (Amungee Mungee Station

Origin is in the early stages of exploration and appraisal in the Beetaloo Basin. There are many stages in the exploration and appraisal process before a decision can be made to move to production. The activities proposed in the near term are intended to demonstrate the technical and commercial viability of the resource by strategic placement of wells within selected prospective areas and/or formations. The current phase (referred to by Origin as the 'Beetaloo Stage 3 E&A Scope') is located on Amungee Mungee Station at the locations referred to as 'Amungee NW1' (**ANW1**) and 'Amungee NW2' (**ANW2**).

In order to meet the regulated requirements, Origin issues Stakeholder Engagement Packs (**SEPs**) and seeks pastoralist feedback prior to the submission of an Environmental Management Plan (**EMP**). Origin will provide more detailed information about proposed activities as part of the negotiation of an access agreement. Before activities can commence, there needs to be an approved EMP, and executed access agreement that has been approved by the Minister (**approved access agreement**).

In calendar year 2022, Origin proposes approved access agreements only in respect of only the ANW1 and ANW2 well locations, and 2D seismic scope.

1. Stakeholder Engagement for Environmental Management Plans

Attachment A is the SEPs for future well locations on Amungee Mungee Station (known as 'Amungee Step Out Locations', at Amungee NW2, Amungee NW4, Amungee NW5 and Amungee NW6) and a 2D seismic program.

So that all relevant documents may be read in conjunction with each other, please also find attached:

- Attachment B**,** the Stakeholder Engagement Pack for Amungee NW1, previously provided to the you by email from Dave Armstrong on 3 November 2021; and

- Attachment C, the email sent to you on 8 April 2022, detailing proposed amendments to ANW1 activities and inclusion of control bore and gravel pit by way of an amendment to the EMP already submitted.

Stakeholder engagement has been undertaken for Amungee NW1 location and gravel pit and control bore at the Amungee NW2 and the relevant EMP (including the amendment set out in the email at Attachment C) has been submitted and is currently being assessed.

The activities set out in the SEP at Attachment A will be the subject of a new EMP, which is currently in draft. We would welcome your questions or feedback on this SEP. Origin notes that you have already provided some feedback to David Armstrong and Robert Wear in relation to the proposed locations of activities and infrastructure. Your feedback will be incorporated into next revisions of the maps.

2. Near Future Proposed Access Agreements

Origin proposes to permit the initial scope, by way of separate access agreement negotiations as follows:

a. New approved access agreement 1 – full ANW1 scope plus one control bore and gravel pit at the ANW2 location;
b. New approved access agreement 2 – full ANW2 scope; and
c. New approved access Agreement 3 – 2D seismic scope.

Any future scope would be the subject of separate negotiations, depending on the results of the ANW1 and ANW2 locations, and the 2D seismic.

Attachment D provides detailed information about Beetaloo Stage 3 E&A Scope, the activities which Origin proposes to permit by the access agreements set out at 2a-2c.

3. Origin Contacts

Should you have any queries about the above and attached please contact David Armstrong on [redacted].

Kind Regards

Isha Bywaters
Land Access Lead
Upstream Growth

Amungee Station

Petroleum (Environment) Regulations

Stakeholder Engagement Pack

Pastoralist Engagement Pack

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Pastoralist Engagement Pack

1. Introduction

Origin Energy B2 Pty Ltd (Origin) is a registered holder and the operator of exploration permits (**EPs**) 76, 117 and 98, located in the Beetaloo Sub-basin. As a part of Origin's forward exploration work program an Environment Management Plan (**EMP**) will be submitted to the Minister for Environment for approval, covering a series of regulated activities proposed for the Amungee Mungee Station (being NT Portion 1079, Perpetual Pastoral Lease 01100).

The proposed scope is divided into near-term anticipated to commence in 2022, and longer-term likely to occur in 2023 and beyond. Overall, the proposed EMP includes the construction of 4 new exploration well sites and the drilling, stimulation, testing, maintenance and decommissioning (and all associated ancillary activities) of up to 12 new explorations wells. It should be noted that the scope of the EMP is designed to provide Origin flexibility in choosing future Exploration and Appraisal (**E&A**) well locations, with all or a subset of activities undertaken.

The anticipated near-term 2022 scope includes:

- Construction of a new exploration well pad, including camp pad, helipad, laydown yard, water bores, fence lines and all associated infrastructure
- Drilling, stimulation, testing, maintenance, suspension and decommissioning of a horizontal petroleum well
- Wastewater management and treatment
- Drilling waste management and onsite disposal
- Access tracks linking the exploration well pad locations to the Carpentaria Highway
- Acquisition of up to 158 km of 2D seismic, including seismic line preparation, node deployment and seismic acquisition.
- Micro-seismic data acquisition and associated works. Induced seismic monitoring and associated works.
- Construction and ongoing operation of a new gravel pit (s)
- All activities required to support the above (such as bulk chemical storage and use, bulk fuel storage and use, waste management, equipment and materials transport, helicopter movements, monitoring, maintenance, etc).

Longer term scope anticipated to commence in 2023 and beyond includes:

- Construction of 3 additional exploration well pad locations, including camp pads, helipads, laydown yards, water bores, fence lines and all associated infrastructure
- Drilling, stimulation, testing, maintenance, suspension and decommissioning of up to 11 petroleum wells
- Operations of camps at each location
- Micro-seismic data acquisition and associated works. Induced Seismic monitoring and associated works.
- 3D and 2D seismic data acquisition and associated works.
- Wastewater management and treatment on each of the proposed new locations
- drilling waste management and disposal
- Access tracks linking each of the exploration well pad locations to the Carpentaria highway; and
- Construction and ongoing use of gravel pit(s)
- Maintenance and monitoring of each of the proposed petroleum exploration wells
- Suspension and decommissioning of the proposed petroleum exploration wells

- Rehabilitation of disturbance areas
- All activities required to support the above (such as bulk chemical storage and use, bulk fuel storage and use, waste management, equipment and materials transport, helicopter movements, monitoring, maintenance, etc).

The proposed regulated activities are described further in section 6.

2. Stakeholder engagement process

Under Section 6 (2) of the Northern Territory (NT) Petroleum (Environment) Regulations 2016 (**PER**), an EMP can only be submitted to the Minister for approval after the interest holder (Origin) has carried out stakeholder engagement in relation to the regulated activity to which the plan relates.

The requirements of stakeholder engagement are outlined in section 7 of the PER. Specifically, the interest holders are required to provide the following information to each stakeholder:

- the regulated activity the interest holder proposes to carry out
- the location (or locations) where it is proposed to carry out the activity
- the anticipated environmental impacts and environmental risks of the activity
- the proposed environmental outcomes in relation to the activity; and
- the possible consequences of carrying out the activity to the stakeholder's rights or activities.

This Stakeholder Engagement Pack (SEP) is designed to fulfill the stakeholder engagement requirements as defined under the PER. Once stakeholder engagement has been completed, Origin will submit an EMP covering all or parts of the proposed activities as described in this document. All engagement after this allocated time will be considered "ongoing stakeholder engagement".

Origin proposes that any questions or feedback to the information provided in this pack is formalised via the form included in Appendix A within 28 days of receipt of the SEP. This review timeframe is consistent with the EMP public comment timeframe legislated in the PER for EMPs involving drilling or hydraulic fracturing. This is considered a reasonable period for the stakeholder to respond to the information provided.

Origin will ensure that all responses are reviewed and responded to promptly. Origin also offers a face to face or virtual meeting with the stakeholder where subject matter experts can present the information in this pack and answer any questions. These meetings should be arranged within 14 days of receipt of the pack so engagement can be scheduled within the allocated engagement period.

3. Scope

The scope of this SEP is to satisfy the stakeholder engagement requirements defined under the PER prior to the submission of EMPs covering activities proposed under this SEP.

The regulated activities covered in this SEP are associated with the entire lifecycle of the proposed petroleum exploration wells, from site preparation, through to drilling, stimulation, testing, site decommissioning and all ancillary activities to support. The EMP (or variations of such) will be in force for the next 5 years (the maximum duration of an EMP in accordance with the PER), with revisions required to update the activities within the EMP beyond this period.

Acceptance of this SEP and subsequent approval of an EMP by the NTG is not an approval to commence the activities. This SEP and subsequent EMP(s) are designed to satisfy the requirements under the PER for the regulated activities proposed. This SEP does not cover other activity approvals, such as the land access and compensation agreements (LACA) required to be obtained prior to commencement.

The requirements for compensation and access agreements for proposed regulated activities are covered under the NT *Petroleum Act 1984* and Petroleum Regulations 2020 and will occur under a separate engagement process. To avoid any confusion or doubt, any comments received relating to the LACA or other activity/approval not subject to this SEP, will be addressed by Origin separately from this stakeholder engagement process.

4. Background

Origin holds the EPs in the Barkly region under the Beetaloo Joint Venture with Falcon Oil and Gas. The EPs cover 18,512 square kilometres (km^2) of largely pastoral leases on the Sturt Plateau, part of the Barkly Tableland, within the NT (Figure 1). These tenures were granted by the NT Minister for Mining and Industry[1] under the NT *Petroleum Act 1984*.

Origin exploration and appraisal program is designed to prove up the concept of producing hydrocarbons from a range of geological formations within the Beetaloo Sub-basin. Exploration sites are chosen based on prospectively, with data collected across the basin underpinning decisions on where forward exploration sites are proposed. The regulated activities proposed under this SEP are anticipated to commence within the 2022 to 2027 period, with ongoing engagement with stakeholders informing them of proposed activity timing or commencement likelihood.

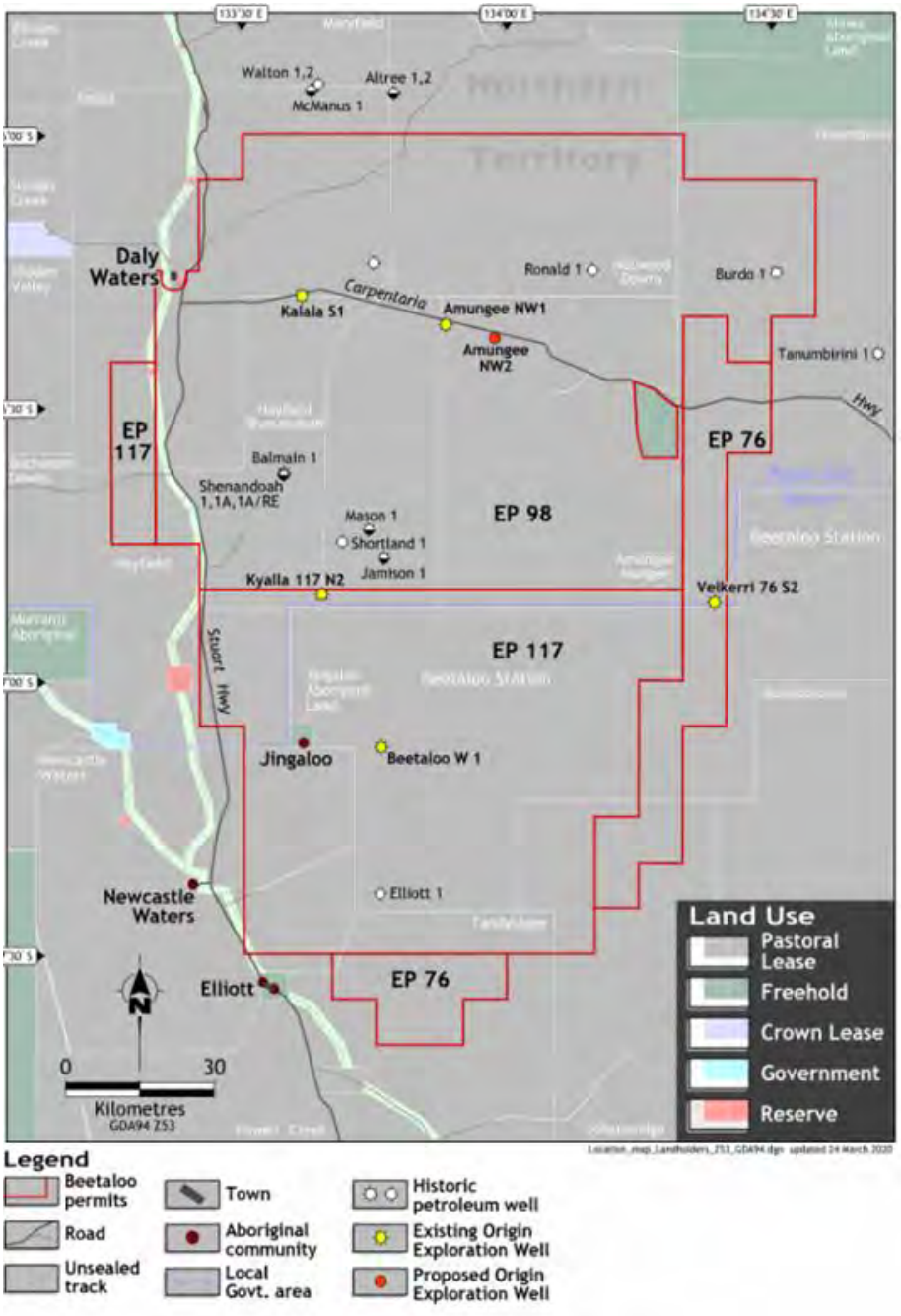


Figure 1 Location of Origin permit *a*rea

[1] Formally the Minister for Mines and Energy.

5. Location of the Regulated Activities

The proposed exploration activities are located on the Amungee Mungee Pastoral station. The location of the activities is provided in Table 1 and illustrated in Figures 2 – 4.

Table 1 Infrastructure location

Exploration Permit (EP)	Infrastructure description	Proposed disturbance area	Proposed Location		
			GDA94 Zone*	Approx Easting	Approx Northing
EP 98	Amungee NW2 lease pad, camp pad, helipad, laydown, firebreaks and fence lines	18ha	53	390770.114	8189631.353
EP 98	Amungee NW2 access track upgrade	2km	Refer figure 3		
EP 98	ANW2 gravel pit	5 ha	53	390809.049	8188373.231
EP 98	ANW2 gravel pit access track	3km			
EP98	Contingent gravel pit x 2	10 (5 ha each)	To be confirmed with pastoralist if required		
EP 98	Amungee NW4 lease pad, camp pad, helipad, laydown, firebreaks and fence lines	15ha	53	390301.779	N: 8187004.084
EP 98	Amungee NW4 access track upgrade	6km	Refer figure 3		
EP 98	Amungee NW5 lease pad, camp pad, helipad, laydown, firebreaks and fence lines	15ha	53	380624.977	8186912.143
EP98	Amungee NW5 access track upgrade	7km	Refer figure 3		
EP 98	Amungee NW6 lease pad, camp pad, helipad, laydown, firebreaks and fence lines	15ha	53	391411.122	8194134.882
EP98	Amungee NW6 access track upgrade	5km	Refer figure 3		
EP 98	Amungee step out 2D seismic	158km of 2D lines x 5m widths = 79ha	Refer figure 3		
Total maximum disturbance		144 ha and 23.5km of Access tracks			

** Universal Transverse Mercator (UTM) geographic coordinate system is Geocentric Datum of Australia (GDA) 94.*

^ This is a conservatively high figure, with the final disturbance like to be significantly smaller

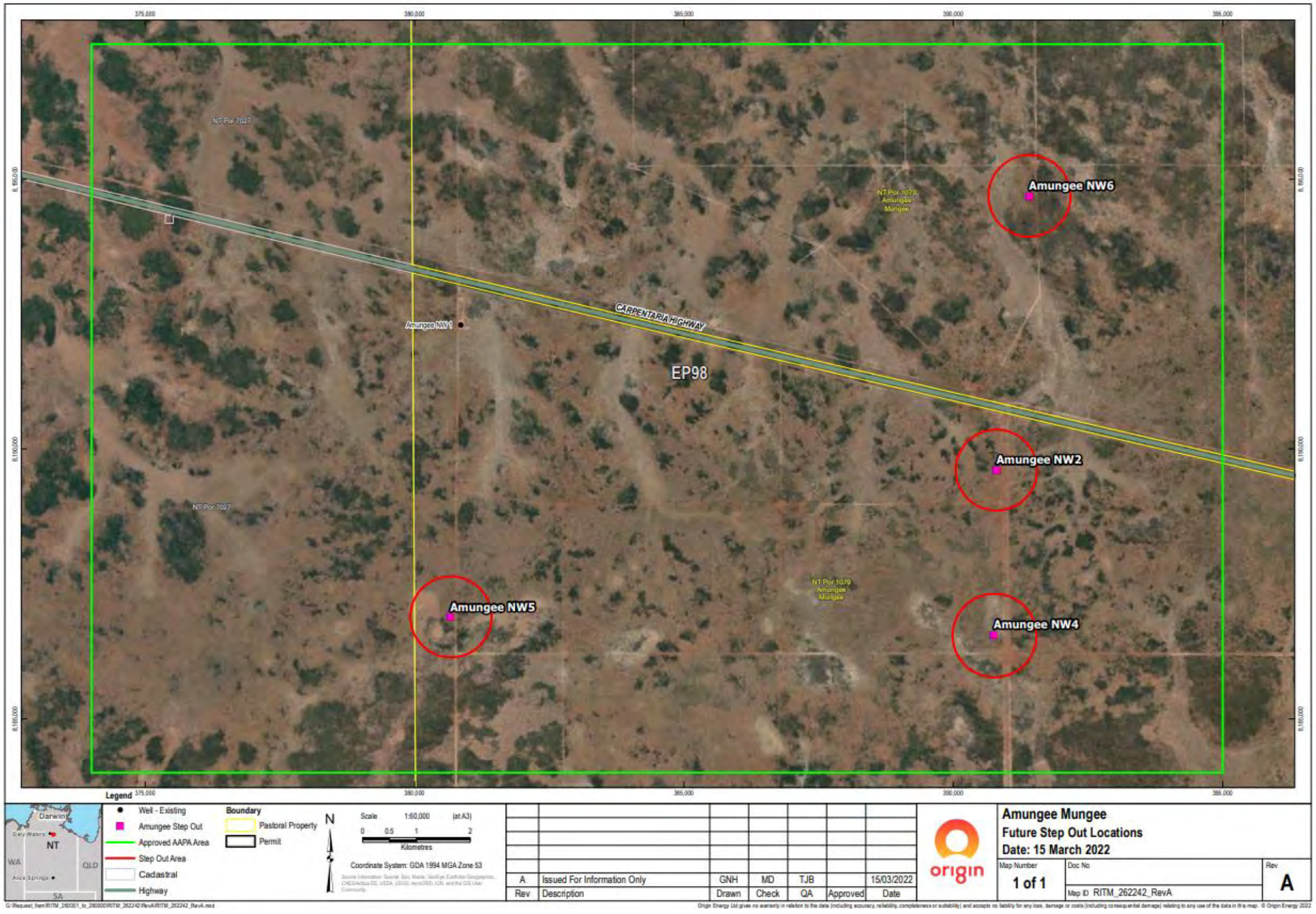
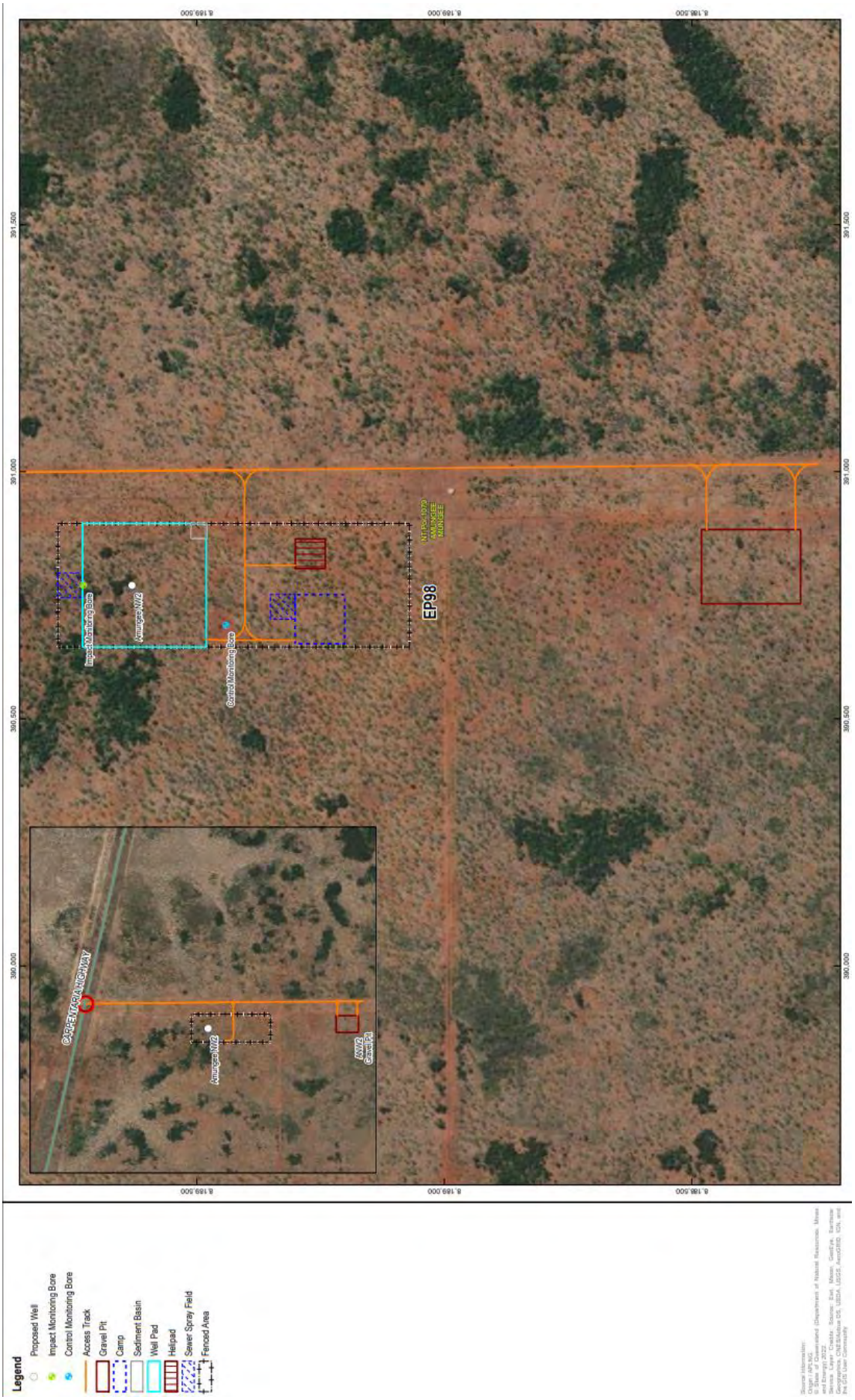


Figure 2 Location of the Amungee Mungee proposed regulation activities within Origin's tenure


Legend
Proposed Well
Impact Monitoring Bore
Control Monitoring Bore
Access Track
Gravel Pit
Camp
Sediment Basin
Well Pad
Helipad
Sewer Spray Field
Fenced Area
EP98
Impact Monitoring Bore
Control Monitoring Bore
Kmungee NW2
CAPELLA-MACKUNDA HIGHWAY

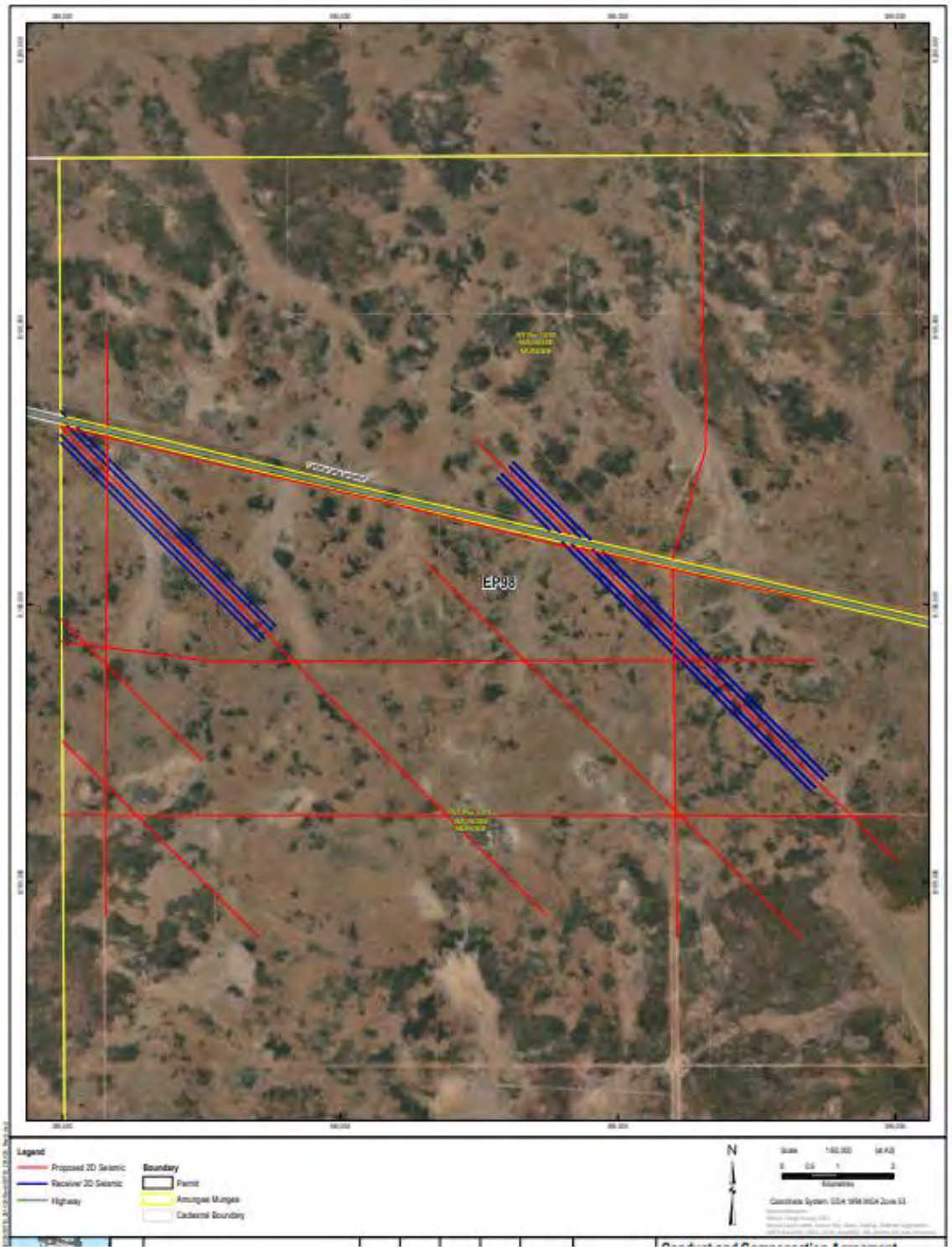
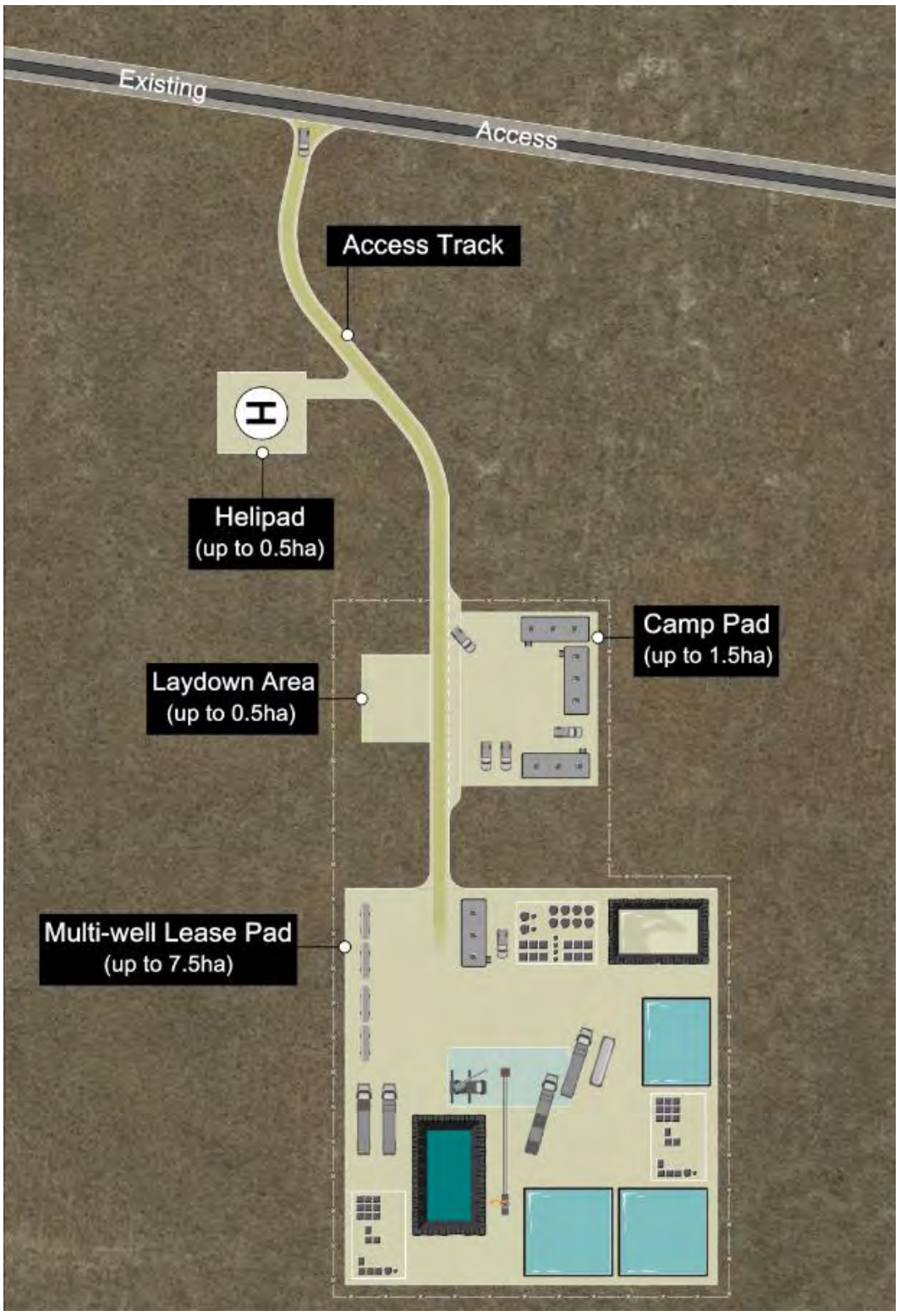


Figure 3 Proposed regulated activities on the Amungee Mungee Station – 2D Seismic

Figure *4* Typical Lease Pad Layout – Future Step Out Locations



6. Description of the Regulated activity

6.1 Summary

The activities are associated with the proposed drilling, stimulation and well testing of 12 new exploration wells located at 4 new well sites across the Amungee Mungee Station. The proposed regulated activities include:

- Civil construction activities covering:
  - the construction of 4 new exploration well locations, each containing a lease pad (5.5 ha to 7.5 ha), with a camp (1.5 ha), helipad (1 ha), laydown (1 ha), fence lines and firebreaks (2.5 ha)
  - upgrade to the access track intersections with the Carpentaria Highway (2 intersections)
  - ongoing access track and infrastructure maintenance
  - construction, operation and maintenance of up to 3 gravel pits with a total area of 15 ha
- Installation of up to 4 groundwater monitoring/extraction bores at each proposed exploration well site.
- Acquisition of up to 158 km 2D reflection seismic lines and associated works, including line preparation and land clearing activities.
- Acquisition of 3D reflection seismic survey and associated works, including line preparation and land clearing activities.
- Drilling of up to 12 new petroleum exploration wells.
- Completion of the proposed additional petroleum exploration wells.
- Hydraulic Fracture Stimulation (HFS) of the proposed petroleum exploration wells.
- Well testing of the proposed exploration wells, including flaring, power generation and beneficial usage of the gas.
- Storage and treatment of freshwater, flowback and other petroleum derived wastewater onsite.
- Subsurface diagnostic tests and data collection on each petroleum exploration well.
- Drilling and flowback wastewater storage and treatment at each of the proposed exploration well sites.
- Construction and operation of a temporary worker camps at each site.
- Microseismic monitoring and induced seismic monitoring during HFS activities.
- Onsite encapsulation/ mix bury cover of drilling cuttings and mud at each location, including the disposal of drilling waste from other exploration sites at each well where required.
- Maintenance and monitoring of each of the proposed petroleum exploration wells and infrastructure.
- Suspension and decommissioning of the proposed petroleum exploration wells.
- Rehabilitation of disturbance areas.
- All activities required to support the above (such as bulk chemical storage and use, bulk fuel storage and use, bulk sand storage and use, waste management, equipment and materials transport, helicopter movements, monitoring, maintenance, etc).

Images of exploration lease pad construction, exploration well drilling, well stimulation and well testing are provided in Figure 4 to Figure 7.

Figure *4* Overview of an exploration site within the Beetaloo undergoing lease and camp pad construction, with water bore drilling underway

Figure 5 Typical well site layout during drilling; this is the existing Kyalla 117 N2 site

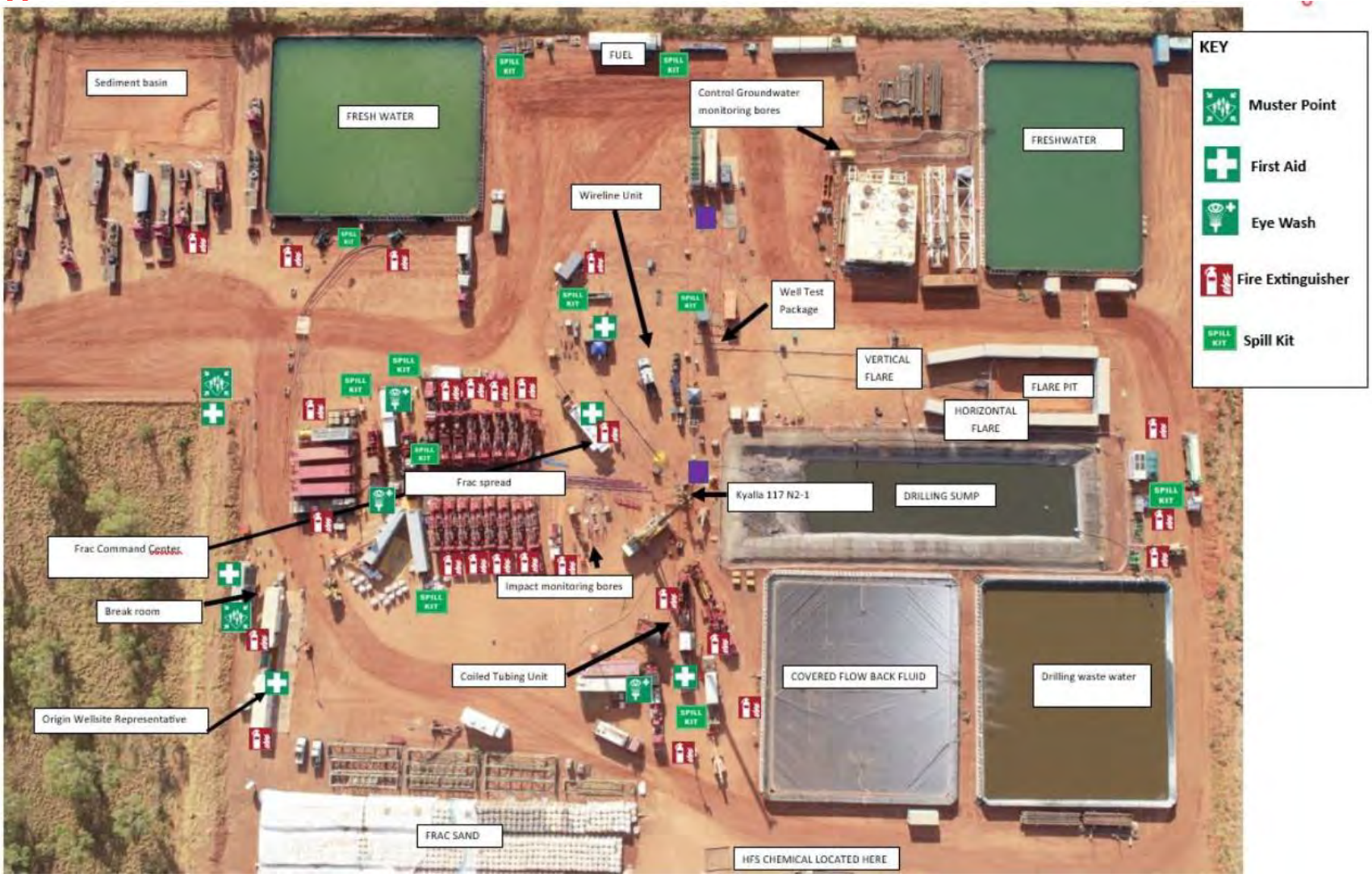


Figure 6 Typical hydraulic fracture stimulation spread at the Kyalla 117 N2 site

Figure 7 Example of a well test underway at the existing Amungee NW location

6.2 Activity description

The following information details of the proposed exploration activities on the Amungee Mungee Station. These descriptions are indicative and general in nature, minor departures from such descriptions are likely to occur and such departures are covered by the content of this SEP or through ongoing communication with the pastoralist. The information has also been summarised in Table 2 with the relevant activity description and picture.

Table 2 Description of proposed regulated activity

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Groundwater monitoring bore installation Groundwater monitoring bores will be constructed using a water bore drilling rig, identical to the rig used to drill pastoral water bores. All groundwater monitoring bores will be constructed in accordance with the *"Minimum Construction Requirements for Water Bores in Australia"*. Bores may be drilled into the Anthony Lagoon Formation (if present and saturated), and/or Gum Ridge Formation. Waste cuttings, drilling fluids, muds and formation fluids will be collected in a small earthen sump and managed in alignment with the practices outlined in the *"Minimum Construction Requirements for Water Bores in Australia"*. The fluid (which is anticipated to be fresh) will be discharged to ground in the area surrounding the lease. The formation cuttings and drill muds will be mixed with soil onsite and incorporated into the lease pad surface.	Located within lease pad disturbance	<6 people	Typically prior to exploration well site construction	2-4 weeks	
Civil construction of lease pads, camp pads, laydowns, helipad, fence lines and firebreaks Each proposed lease pad, including camp pad, laydown yard, helipad, firebreaks and fence lines will be surveyed and demarcated. The sites will be cleared of vegetation, grubbed and stripped of topsoil. Topsoil will be stored around the edge of the lease pad to form a bund, which will be used as both an erosion and sediment control and wastewater containment bund. The lease pad will be levelled, compacted and surfaced with gravel to accommodate exploration activities. Erosion and sediment controls will be constructed around the disturbed areas (such as rock check drains, woah boys and diversion drains). A sediment retention pond will be installed to manage surface water within the lease. Water captured onsite will be tested and released into the adjacent area. A drilling sump, flare pit and 3 well cellars will be constructed on each lease pad. Drilling sumps will be lined with an impermeable liner to contain all drilling fluid, drilling muds, cuttings, cement returns and waste sand. Drilling sump holding capacity is approximately 3000 m^3 of material. The drilling sump / broader site will be fenced to prevent livestock access. Three additional 8 m^3 cellars will be constructed on each of the proposed leases to accommodate the wellhead equipment and blow-out preventer (BOP). The site will be fully fenced with a 20 – 50 m firebreak installed as an asset protection zone. Each of the access track intersections with the Carpentaria Highway are also likely to be upgraded to comply with DIPL requirements, with a turn in bay and sealing of the road verge. During this period, traffic control will be deployed to manage the activity.	13.5 ha	<20 people	Prior to exploration drilling	8-12 weeks	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Access track construction To minimise disturbance, existing pastoral access tracks will be upgraded as a priority. Access tracks will be graded, formed and sheeted within gravel (where required) to maintain a safe driving surface. The new access track will be less than 10 m wide; with provisions for a 6 m formed surface and 2m shoulder as per the *NTG Standard Drawings (CS3003) for Typical Cross Section for Rural Environment – Pastoral Access Road 2* (Appendix A). Diversion drains, cut outs and creek bed level crossings will be used to manage overland flow and prevent erosion. Access tracks will be periodically maintained to keep in good working order.	23.5km	<10 people	During civil construction activities	4-6 weeks	
Camp pad construction and camp operation Purpose-built camps will be constructed to support operations. Each camp will be a self-contained facility with accommodation rooms, kitchen, dining mess, offices, ablutions, gymnasium, storerooms, refrigeration, water storage, power generation, solid waste management, fuel storage, water treatment, sewage treatment and sewage irrigation area. All waste will be covered / stored in a manner that prevents feral animal access. An approved wastewater (sewage) treatment plant will be installed to treat all sewage, with treated effluence irrigated in a fenced area adjacent to the camp. Treated effluence treatment and irrigation will occur in accordance with the NT Department of Health requirements.	N/A- disturbance included in overall exploration site disturbance.	<60 people (including housed staff)	For duration of activity	For duration of activity	
Gravel pit construction and operation Up to 3 gravel pits will be constructed within the vicinity of the proposed exploration areas. Each pit will be cleared of vegetation, grubbed and stripped of topsoil down to approximately 100 mm (depending on the depth of topsoil onsite). Subsoils will be removed from the pit and segregated from topsoil. Topsoil and subsoils will be stored around the edge of the lease pad to prevent overland flow into the pit. Upon completion, the pit will be recontoured to leave a slight depression, with subsoils and topsoil reinstated to allow vegetation to re-establish. B-doubles and triples will typically transport gravel to the required point.	<15ha	<6	Constructed to support civil construction activities.	For duration of activity	

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Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
2D and 3D Seismic consists of the following: It is anticipated that seismic surveys will be collected using a combination of small seismic charges and vibroseis. The seismic charges are approximately 1kg and will be installed within a grid pattern for 3D or along a line for 2D, to a depth of approximately 15 – 20 m underground. The charges will be installed using a small, mounted drill rig. The charges are packed into place and detonated in a controlled fashion with appropriate exclusion zones. The created detonation zone is kept underground, with no surface disturbance anticipated. The detonated charge creates a "thud sound" which can be heard within 2 km radius and felt within a 100 – 200 m radius (typically). To enable vibroseis truck(s) access, line clearing will be required so that they drive and operate over the survey area. Source lines, for vibroseis trucks to operate on, will need to be cleared 5 m wide. Existing cleared areas will be utilised where possible to reduce disturbance. The line tolerances for weaving around vegetation are allowed. Seismic lines will also be in a manner to avoid any large habitat trees or sensitive flora, with no clearance to be undertaken in watercourses and associated riparian vegetation.	158 km of 2D lines x 5 m widths = 79 ha 203 km^2 of 3D reflection seismic survey	Up to 35	Before or after exploration well drilling with the final time to be confirmed	3 – 8 weeks per site	 e.g. of rehabilitation efforts in progress (HESS, 2013). e.g. of recruitment of vegetation post rehabilitation of open *Eucalyptus* woodland (HESS, 2013).

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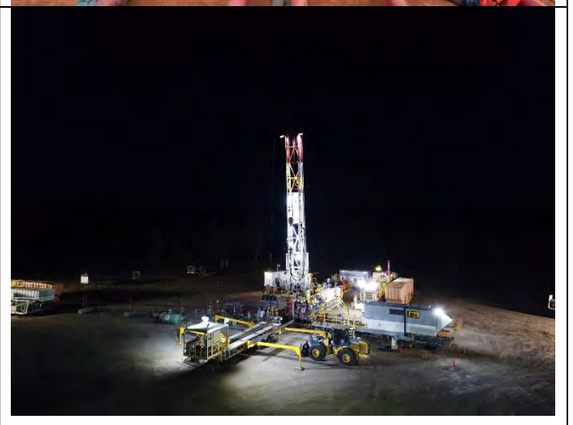
Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Microseismic survey and Induced Seismic Monitoring Microseismic Surveys are undertaken to monitor 'listen to' the Hydraulic Fracture Stimulation Operations on each of the sites. Seismic Receivers called geophones are individual weatherproof units that contain a sensitive seismic recording device, memory storage, a long-life battery and GPS locator. The Geophones are deployed 5-25 metres apart along lines or in a grid over an area of 30-40km2 around each of the well during stimulation activities. Geophone deployment locations are located on foot by GPS locator. A handheld battery drill is used to create a 4cm diameter hole with an auger bit, a small quantity of water may be used to stabilise the soil. The Geophone is inserted into the hole so that the top of the receiver is flush with the surface of the ground (see picture) The Geophones deployed prior to the commencement of stimulation and retrieved after the stimulation has concluded. Deployment and retrieval of the Geophones is undertaken in small teams of 2 or 3 people, with the number of deployment teams depending on survey size. The teams are supported by a light 4WD vehicle or an All-Terrain Vehicle to carry equipment, gear, water, communication (radio/satellite phone), first aid kits and safety gear. Induced Seismic Monitoring will be undertaken at the same time as the Microseismic monitoring. A temporary seismic receiver is installed ~1km from the well site, with a small amount of other equipment such as solar panels and data transfer equipment. The equipment can be fenced off with temporary fencing if there are cattle in the area. The data from the seismic receiver is sent wirelessly back to the well site to enable live monitoring of seismic events during Hydraulic Fracture Stimulation. The Induced Seismic Monitoring equipment is installed prior to Hydraulic Fracture Stimulation, and remains installed, collecting data for up to 2 months after the conclusion of Hydraulic Fracture Stimulation. No line clearing or heavy machinery is required for either activity, and the activities are considered to have a minimal impact, like that of scouting activities.	Variable – similar to scouting over a 30-40km^2 area	Up to 10	Before or after exploration well drilling with the final time to be confirmed	4-10 weeks per site	
Exploration well drilling Up to 12 additional petroleum exploration wells are proposed to be drilled across the 4 new locations. Each well will be drilled into an underlying prospective petroleum reservoir (anticipated to be the Velkerri shale) to a typical maximum depth of 1000 – 4000 m. Each well will be deviated into the horizontal position, with a lateral drilled up to 3000 m. Each petroleum well is designed and constructed in accordance with the Code of Practice for Onshore Petroleum Activities within the NT (Code of Practice) to maintain well integrity and protect aquifers and the environment. A Well operations management plan (WOMP) is required to be submitted to the regulator and approved prior to the drilling of any wells. The WOMP outlines the well design and drilling practices that will be deployed to ensure compliance with the Code of Practice and protect underlying aquifers and the environment. Each well is anticipated to be constructed with multiple casing and cement strings, typically 4 casing strings (conductor casing, surface casing, intermediate casing and production casing). Once the well design is approved by the NTG, a rig package will be mobilised to site, which consists of a drilling rig (comprising rig matting, a rig floor, mast or derrick, rig engine, blow out preventor, catwalk, safety flare etc.), pipe racks, casing strings, drilling rods, rig fluid system (mud tanks, shakers, mud treatment system and pipework) storage trailers, bunded chemical storage areas, workshop portable onsite offices, crib huts, mini-rig camp and sewage treatment system and irrigation area), freshwater storage tanks, diesel power generation, cement trucks, bulk fuel storage, water transfer pumps, fork lifts, lighting towers, crane, etc. The rig will be constructed over the pre-installed stove pipe and cellar. Once functional, drilling will proceed down below the first encountered aquifer, where the first casing section of the well will be installed (either in the Anthony Lagoon Formation if present and saturated or the Gum Ridge formation (anticipated to be present). After the surface casing is set, a BOP will be installed, to ensure any influxes of gas, water or pressure are able to be safely managed during drilling of the remaining sections of the well. The drilling rig will continue to drill the other casing and cement sections. The integrity of each of these casing strings is tested through a combination of leak off tests, casing pressure tests, cement return tracking and cement bond logs. Upon completion of drilling, a barrier integrity verification report is	N/A located on proposed lease pad	<60 people	Pastoralist to be notified when drilling proposed	Typically 60 – 90 days per well	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
submitted to the regulator summarising the integrity of the well. Once each well is finished drilling, the well head is installed, and the rig is either “walked” to the next adjacent location with the process repeated or mobilised to a new location. A low toxicity water-based drilling mud is to be used as the base fluid for drilling, which primarily contain salts and polymers. Drilling mud is required to maintain well control, provide formation stability, lubricate and control the temperature of the drill bit and lift cuttings to the surface. The fluid system consists of water with a sodium or potassium-based salt (to prevent formation swelling) and a viscosifying agent such as bentonite. Other low toxicity chemicals such as barite, citric acid, sodium bicarbonate and loss circulation material (fibres such as coconut coir or nut hulls etc.) may also be used. The chemicals used for drilling are consistent with those used for water bore drilling. Waste drilling muds, fluids, cuttings and mineral waste (such as cement returns, sand etc.) brought to surface will be stored in the lined drilling sump. Drilling fluids will be evaporated and then removed from the sump and disposed of offsite. Solid waste within the drilling sump will be allowed to dry out and then either removed from site or disposed of onsite in accordance with the Code of Practice. Where onsite disposal is proposed, a risk assessment will be completed demonstrating that the activity can occur with no residual environmental harm. Onsite disposal can include encapsulation or mix bury cover, depending on the site-specific details and final composition of the drilling waste material. Subsurface diagnostic tools will be run on the well during and after drilling to understand the nature of the target reservoir. Some sections of the formation may be cored or have sidewall samples collected, which will add further analysis of the reservoir properties. To assist with determining the suitability and capacity of these formations for potential gas extraction activities, diagnostic fracture injection test (DFIT) may be conducted across several shale intervals to evaluate the geo-mechanical and reservoir properties of the targeted formation. Prior to a DFIT, a cement bond log and casing pressure test is completed to ensure the integrity of the cement and steel casing. A DFIT involves the injecting of small volumes of a water (approximately 30 barrels (5,000 L) per DFIT) at low pumping rates to create a small fracture in the target interval. The well is shut-in, and the pressure allowed to fall-off naturally. Monitoring the fall-off pressure over time allows information to be derived about the reservoir. The fluid does not contain proppant so that the fracture closes naturally when the fluid leaks off into formation. The analysis of pressure, during injection and after shut-in, provide powerful tools for understanding and subsequently informing the design for a future hydraulic fracturing process (not in this scope). Any returned fluid will be stored within double lined tanks and disposed of offsite at a licenced facility.					
Hydraulic Fracture Stimulation Upon completion of drilling activities at each site, a frack spread will be mobilised to site to commence hydraulic fracture stimulation (HFS or stimulation) activities on each drilled well. A frack spread consists of: • Data van: On-site office to execute stimulation activities. • Water storage: Tanks will be constructed on-site, capable of managing both make-up water and flowback water. Tanks will be double lined with leak detection capable of monitoring any leaks between the primary and secondary liner. Tank number will depend on encountered flowback volume and can range between 5 – 12 tanks (the exact number may be more or less than the anticipated number). • Proppant trailer: A large sand storage and delivery trailer that holds the proppant. • Hydration unit: Used to add stimulation additives and viscosifying fluids. • Blender unit: Used to mix proppant and fluid additives, prior to its injection into the well. • High pressure pumps: Pumps which inject the hydraulic fracturing fluid mixtures from the blender unit down the well, via the surface lines and hydraulic fracturing wellhead or coiled tubing unit. • Coiled tubing unit: A large length of coiled steel pipe that can be temporarily installed in the well to perform various downhole operations. • Wireline unit: Plug and perforation deployment. • Ancillary support buildings: Offices, workshop, cranes, chemical storage area, equipment storage, power generation and all other activities required to support stimulation activities. Stimulation involves the injection of a slurry, primarily consisting of water and sand (proppant), plus a small percentage of chemicals at high pressure into the target section of the horizontal wellbore approximately 1000 m – 4000 m below ground level (depending on the depth of the target formation).	N/A located on proposed lease pad	<50 people	Post exploration well drilling	2 – 8 weeks per well depending on stimulation size	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Typically, 90% or higher of the total volume in stimulation fluids is a combination of fresh water and sand (~6 – 8%), with the remainder as fluid-conditioning additives (~2 – 4%). Prior to the commencement of stimulation activities, the integrity of the well is tested with a cement bond log and pressure casing test. This integrity report is submitted to the regulator prior to the commencement of stimulation activities. The stimulation fluid is pressurised by the high-pressure pumping units and directed downhole via a manifold to the discrete target intervals along the horizontal wellbore (referred to as 'stages'). Each stage will be isolated and perforated using a plug and perforation gun assembly deployed via a wireline unit. As the pressure is sustained, the fractures propagate radially from the well, through the target rock. Once optimal fracture propagation has been achieved, the proppant (sand) is pumped down the well and into the open fractures. This process is repeated for each stage. The final number of stages pumped in each well is dependent on the useable length of the horizontal wellbore and in-situ geological conditions.					
Well completion Once each well has been stimulated, a completion rig will be mobilised to site to "complete" the well. This involves installing downhole equipment such as packers, plugs, production tubing, artificial lift required to enable the production testing.	N/A located on proposed lease pad	<12 people	Post stimulation	1 – 2 weeks	
Well testing Once each well has been completed, the well will be brought online and tested for a period of 1 to 24 months. To enable the testing, a well test package will be installed at the site consisting of: • separators (to separate gas, condensate and water) • flares (either a vertical or horizontal), • flare pit (if a horizontal flare is utilised • surface pipework, manifolds, and tanks • communication and generator shacks • workshops/ storerooms • bulk diesel tanks • wastewater storage tanks (converted freshwater storage tanks used for stimulation makeup water) • water transfer equipment • wastewater evaporation and treatment units • camp accommodation. Each of the exploration wells will be underbalanced (or "unloaded") to initiate production, either through its own energy or through artificial lift (such as through a Nitrogen lift or pump). The fluid and gas will be sent through a separator, with all hydrocarbon metered and either flared or beneficially used onsite (for power generation etc.). Flowback water will be discharged from the separator into	N/A located on proposed lease pad	<12 people during production testing	During exploration activities	Typically 1 to 24 months	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
designated wastewater storage tanks. Multiple well testing operations may be required to test the behaviour of the formation to determine whether extended shut ins can affect well productivity. After or during production testing operations the well/s may be shut in for a period to allow the pressure to naturally build up to assess reservoir pressure.					
Wastewater tank storage Flowback refers to water utilised for HFS that is "flowed-back" to surface. It typically is highly saline (saltier than seawater) and contains contaminants that require careful management to ensure they are not released to the environment. Flowback wastewater will be treated on site via evaporation (or other treatment technologies) and removed from site upon completion of activities. Evaporation is used to minimise the volume of wastewater required to be transported offsite, reducing the amount of truck movements. Double lined wastewater tanks will be utilised to store wastewater, with the volume and number of tanks installed dependent on the anticipated flowback return volume. Wastewater storage tanks have continuous level monitoring, with leak detection sensors located within the interstitial space between the primary and secondary liners. It is anticipated that up to 30 ML of tank storage may be installed onsite, with a combination of enclosed tanks and open treatment tanks. In accordance with the Code of Practice, sufficient enclosed tank capacity must be onsite to store all wastewater. Flowback can only be stored within open tanks where undergoing treatment (such as evaporation). Open evaporation tanks must have a 1:1000 annual re-occurrence Interval (ARI) wet or dry season freeboard (i.e., available tank space to accommodate rainfall), which is typically 1.3 M or 0.3 M respectively. The lease pad or a specifically constructed wastewater storage areas will be bunded to contain 110% of the volume of the largest tank stored onsite. Wastewater storage tanks may be deployed for extended periods of time to allow ongoing evaporation or treatment. Treatment of wastewater may also be undertaken onsite, with water treatment options such as submerged combustion units, enhanced evaporation units etc. utilises to reduce wastewater volume onsite. Wastewater from other sites across the basin may also be used to stored onsite, to assist in wastewater treatment/ management.	N/A located on proposed lease pad	<4 persons	During wastewater storage activities	3 – 36 months	

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Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Flaring During well testing, all produced hydrocarbons (gas and liquids) will be flared onsite unless they can be beneficially used (for power generation etc.). Two flares may be installed, with a vertical flare used to manage gas and a horizontal flare used to manage condensate. The vertical flare will be an American Petroleum Industry (API) 537 and a US EPA AP 42 compliant unit, with a 98% combustion efficiency. The vertical flare (see figure) will have a constant pilot flame, with an autoignition system that provides electrical impulses to a spark plug continuously. If the flare was to go out, the spark would ignite the flare within 1.3 seconds. A horizontal flare may be used to combust condensate if produced during well testing. A horizontal flare will be equipped with 3 independent nozzles, located in a 20 m x 10 m clay lined flume. Flares will be located at least 45 m from the surrounding vegetation, with flaring not undertaken during total fire ban periods.	N/A located on proposed lease pad	<12 people during production testing	During exploration activities	During production testing	
Condensate management Where condensate (liquids rich gas that “condenses” when brought to the surface) is generated, it is separated and stored within double lined condensate tanks. Condensate may either then be trucked offsite or combusted in the horizontal flare. Condensate is not anticipated to be generated in sufficient quantities at the proposed locations.	N/A	1-2 trucks per day	During exploration activities	During production testing	
Drilling waste management All waste drilling fluids, muds, cuttings, DFIT return fluid and cement returns will be managed in a lined drilling sump on-site. Once drilling has been completed, this material will be sampled as per the Code of Practice and a detailed risk assessment completed to determine whether onsite encapsulation or mix bury cover can occur in an environmentally acceptable manner. In most cases, drilling wastes will be dewatered, blended with clean fill and encapsulated onsite within an impermeable liner. It will then be buried with capping material to enable vegetation re-establishment. To reduce the number of sites where material is mix-buried covered, multiple wells from other locations may be disposed of at a selected location. An overview of the mix bury cover process is provided in Attachment B.	N/A- within proposed lease pad	< 6 people	Upon completion of drilling activities	7 days	

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Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Wet season operations Exploration activities (including drilling, stimulation and well testing operations) may occur over the wet season. Where wet season operations are undertaken the following risk controls will be implemented: • All chemicals, fuels, equipment, tanks and materials required for ongoing operations will be stored on-site prior to the onset of the wet season. • All equipment required to respond to emergency situations will be on-site; this includes earth moving equipment, vacuum trucks, wireline rigs, cementing equipment etc. and equipment and material to deal with well control issues, spills and other emergency events. • All chemicals storage areas will be bunded, with covers used (where safe and appropriate) to prevent rain ingress and bund overflows. • Enclosed tanks will be utilised as the primary measure to store wastewater with enough enclosed tank capacity to store all wastewater on-site (see figure). • Enclosed wastewater storage volume will be sufficient to manage all wastewater stored onsite. • Open working evaporation tanks and mud sumps will have enough freeboard to manage an entire 1:1000 ARI wet season event (not just one (1) rainfall event but an entire season's rainfall total). • Helicopters will be used to transport people and supplies into and out of the site when access is restricted. • No transportation of wastewater or chemicals will be undertaken during the wet season unless a risk assessment is undertaken that demonstrates the risk is As Low as Reasonably Practicable (ALARP) and acceptable (as per the Code of Practice). • Wastewater storage area is bunded, which will prevent all off-site release of chemicals and stormwater practicable (ALARP). • During flowback wastewater stormwater will be retained on-site via the sediment retention pond prior to release. • Overland flow will be diverted around lease pads.	N/A	N/A	October - May	7 months of the year	
Site monitoring and inspections consisting of the following: • **Groundwater monitoring:** Groundwater monitoring bores are required to be installed on the lease pad before the commencement of hydraulic fracture stimulation activities. Groundwater monitoring is undertaken at the site commencing 6 months before stimulation and then quarterly for 3 years after. Groundwater monitoring involves purging a monitoring bore of water, measuring field parameters (level, electrical conductivity) and collecting laboratory samples and • **Site and exploration well monitoring:** An operator or contractor will access the site to perform checks on the exploration well and stability of the site. Checks include pressure readings and visual checks of valve integrity. In some cases, a helicopter may be utilised to complete the inspections. Surveys are completed fortnightly. • **Weed inspections:** Access to the site by several contractors/ Origin personnel in light vehicles to identify weeds. In some cases, a helicopter may be utilised. Contractors may perform spot sprays with a NTG recommended weed treatment. Surveys are completed pre and post wet season. • **Erosion and sediment control inspections:** Access to the site by several contractors/ Origin personnel in light vehicles to identify erosion or stability issues. Inspection will be used to schedule maintenance to repair any defects identified. In some cases, a helicopter may be utilised to complete the inspections. Surveys are completed pre and post wet season. • **Gas leak detection surveys:** Access to the site by 2 – 3 contractors / Origin personnel in light vehicles to perform mandatory gas testing using handheld gas meters. Surveys are completely.	N/A	<2 – 6 people	Fortnightly/ 6 monthly (depending on activity)	1 day per inspection	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Site maintenance (**lease pad, camp pad, access tracks and gravel pit):** Includes grading, erosion and sediment control repair, vegetation management, firebreak management, weed management, fence repair and all other ancillary activities required to maintain a site and associated with infrastructure. This includes maintenance of the access track interception with the Carpentaria Highway. The work will be undertaken by civil maintenance contractors and Origin personnel.	N/A	<10 people	6 monthly; pre and post wet season maintenance	<7 days per activity, depending on the nature of the activity	

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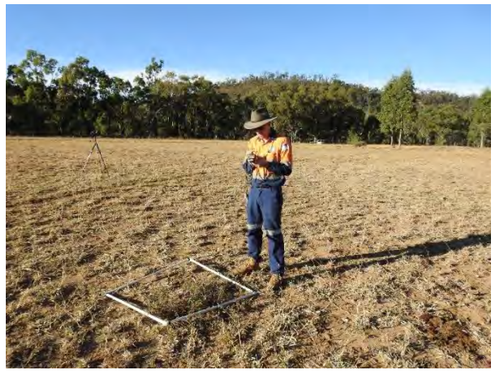
Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Well head maintenance: Maintenance is completed annually on each well. Maintenance includes valve checking, testing, greasing and (in some cases) replacement, as well as any other activities required to maintain the integrity of the well.	N/A located on proposed lease pad	<20 people depending on activity	Annually	< 7 days per activity, depending on nature of maintenance	
Well intervention, data acquisition and testing: Subsurface activities may be undertaken periodically on each of the well to perform maintenance or collect additional information on the properties of the well or the reservoir. These type of well interventions typically include performing cement bond logs, casing pressure tests, running reservoir evaluation or production logging tools, cement and casing remediation activity (if required during the life of the well), setting downhole mechanical plugs and gauges, casing perforation, subsurface barrier maintenance/ installation and production tubing installation/repair or replacement. This generally involves the use of a variety of equipment dependent on the activity being completed. This typically may involve any of the following equipment: completion rig, coil tubing, wireline unit, data van, cement or pump truck, crane, trucks, power generation, support trucks and other support vehicles.	N/A located on proposed lease pad	<20 people depending on activity	Ad hoc requests, typically 2 interventions within the next 5 years	<10 days per activity	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Petroleum well plugging and decommissioning: Once a petroleum well is no longer required, each well will be decommissioning. Decommissioning involves the permanent removal of the well through the placement of cement plugs to isolate the target reservoir from overlying aquifers in accordance with the Code of Practice: Onshore Petroleum Activities within the Northern Territory (Code of Practice). Once plugs are installed, they are pressure tested to confirm the underlying formations have been adequately sealed off. The well head is then removed. A permanent marker is added to indicate the location of the plugged and abandoned well.	N/A located on proposed lease pad	<12 people	End of well life	<10 days	
Chemical and fuel storage: All chemicals and fuels (diesel) required to support exploration activities will be stored in accordance with the relevant regulatory requirements, including the use of secondary containment (bunding) onsite. The Code of Practice has implemented a range of additional controls, including requirements for routine inspections, emergency response procedures and spill management. Anticipated chemical and fuel volumes vary dependent on activity, but may involve the storage of the following types of chemicals and volumes: • Stimulation and drilling chemicals (friction reducers, surfactants, crosslinkers, breakers, buffers, acids, bases, biocides, scale inhibitors, corrosion inhibitors, clay stabilisers, loss of circulation material, drilling muds, salts etc.). Volumes typically less than 20 KL per chemical, with some chemicals stored at higher (such as pH control) or lower (such as biocides and corrosion inhibitors) volumes depending on their purpose and planned use. • Diesel – typically 100 KL stored but may be 500 KL if wet season activities are proposed. • Other chemicals and hydrocarbons: including oils and greases, lubricants, hydraulic fluid, cleaning chemicals, domestic chemicals etc. used to support operations.	N/A- located on existing area	N/A	During exploration activities	During exploration activities	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Waste management: Any waste generated during exploration activities will be stored onsite in accordance with the *Waste Management and Pollution Control Act 1998* and Code of Practice and transported offsite to a licenced waste management facility. All wastes (other than drilling mineral waste) will be stored within skips or equivalent and removed from site at the end of each activity.	N/A	1 -2 trucks during operations	During explorations activities	During explorations activities	
Groundwater extraction: Groundwater extractions from the purpose-built groundwater monitoring onsite or another approved extraction bore (which may include trucking water from adjacent properties) will be completed periodically to support exploration activities. All groundwater take will likely be from the Gum Ridge Formation and will licenced under Origin's existing Water Extraction Licence (WEL) GRF 10285. A new WEL may be submitted covering additional groundwater take and alternative groundwater formations, where required. It is anticipated that groundwater extraction volumes to support this program is anticipated to be less than 250 ML/year (spread across multiple sites), primarily used during the initial stimulation. Once drilling and stimulation has ceased, minimal ongoing water extraction from the site will be required.	N/A	N/A	Ongoing to support exploration activities	During exploration activities	
Traffic management: Access to each of the proposed exploration sites is via the Carpentaria highway. Peak traffic volumes are anticipated to be associated with the drilling rig mobilisation and demobilisation. Traffic volumes may reach up to 44 vehicles per day spread over a 4-week period. During operations (drilling, stimulation or well testing), vehicle movements to the site are anticipated to be less than 10 movements per day. This period is likely to extend typically 60 days per exploration well, 45 days per stimulation and during the duration of a well test (30 – 365 days). Once the well is suspended or decommissioned, vehicle movements will reduce to 1 vehicle per fortnight or 1 vehicle per 6 months respectively.	N/A	N/A	During exploration activities	During large mobilisations or works within the road corridor	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Site rehabilitation: Within 6 months of the E&A wells at a site is plugged and decommissioned, the site will be rehabilitated. This involves: a) the removal of all surface facilities (e.g. well heads, fencing, water bores, tanks), b) deep ripping of compacted surfaces, c) recontouring landforms, d) respreading of topsoil from the topsoil stockpiles, e) re-seeding (if required), and f) ongoing monitoring and maintenance of the rehabilitation.	N/A		Within 6 months of the plugging and abandonment of all E&A wells	<14 days, with ongoing monitoring and maintenance	 

7. Environmental outcomes, impacts and risk

The environmental outcomes, potential impacts and risks associated with the ongoing exploration activities are summarised in Table 3. This information will also be provided in an EMP covering the proposed regulated activity, which will be submitted to the Department of Environment, Parks and Water Security (DEPWS) for formal assessment and approval.

Under the PER, an environmental outcome means an outcome that will be achieved if the environmental impacts and environmental risks of a regulated activity are reduced to a level that is as ALARP, and acceptable.

Environmental impacts are defined by the PER as any adverse change, or potential adverse change, to the environment resulting wholly or partly from a regulated activity.

Environmental risks are defined by the PER as the chance of something happening that will have an environmental impact, measured in terms of environmental consequences and the likelihood of those consequences happening.

Both the consequence and likelihood of a potential impact can be reduced through the adoption of controls, which must be applied to reduce a risk down to an ALARP and acceptable level.

Table 3 Environmental risks and controls of proposed variation

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
Groundwater use and quality	• To manage exploration activities to prevent unsustainable depletion of groundwater resources • Preserve groundwater quality to protect environmental and pastoral use	• No adverse changes to groundwater quantity are anticipated to be associated with exploration activities. • Impacts to aquifers levels anticipated to be minor, with rapid recharge observed from other Gum Ridge Formation bores utilised within the Basin. • No material changes to groundwater quality anticipated from exploration activities. • No impact to Groundwater Dependent Ecosystem's (GDE) or stygofauna from exploration activities (extraction and well construction). • No reduction in pastoral productivity through reduced groundwater volumes.	• Low risk of groundwater contamination from drilling fluids during construction of the conductor/ surface casing in the Cambrian Limestone Aquifers due to the selection of low toxicity drilling fluids • Low risk of cross flow of deep formations (such as the target shales) to shallow aquifers through inappropriate well barrier design and construction due to the presence of the Code of Practice controls and verification processes. • Low risk of crossflow through fracture growth into aquifer from stimulation activities allowing the migration of fluid and gas due to the controls within the Code of Practice and underlying separation distance between the target formation and Cambrian Limestone aquifers. • Low risk of stimulation activity inducing seismic activity that enables cross formational flow between shallow aquifers due to seismic stability of region and lack major faults or fracture zones. • Low risk of stimulated zones intersecting offset wells (including the adjacent horizontal wells) or intersecting an existing geohazard due to seismic control, pressure monitoring during stimulation and lack of older petroleum wells in proximity. • Low risk of crossflow/well integrity caused by the deviation of an E&A well into the adjacent well during drilling due to downhole GPS tracking tools and proximity alarms. • Low risk of leakage of either flowback,	• All petroleum wells are to be designed, constructed, operated and decommissioned in accordance with the mandatory controls within the Code of Practice. The Code of Practice outlines specific controls measures designed to protect underlying groundwater resources including: o Exploration wells designed with multiple cement and steel casing barriers to protect aquifers. o Drilling fluids and muds must have a low residual toxicity. o Groundwater monitoring must be completed before and after stimulation to detect contamination. o Well integrity confirmation to prove barrier performance aquifer isolation (casing pressure tests, formation leak off tests, cement bond logs, etc). o Separation between stimulated shale resources and aquifers must be sufficient to ensure the risk of fracture growth is ALARP. o Pressure monitoring completed to ensure maximum allowable operating pressure is not exceeded during stimulation. o Ongoing well integrity monitoring and maintenance throughout the life of each well to ensure aquifers are protected. o All wells are to be decommissioned in accordance with the Code of

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			produced water, or hydrocarbons (liquid and gaseous) from suspended or abandoned wells to groundwater due to well design and integrity management. • Low risk of surface contamination from storage and disposal of drilling fluids, additives, muds and cuttings on-site due to low toxicity of drilling muds and disposal risk assessment process. • Low risk of groundwater contamination from surface spills from storage, handling and transportation of flowback water due to the storage and spill management requirements outlined in the Code of Practice. • Low risk of groundwater contamination from the storage, handling and transportation of chemicals, fuels and wastes due to the mandatory code of practice controls (such as mandated use of secondary containment). • Low risk of groundwater contamination from overtopping of drilling sumps and flowback tanks (including during wet season) due to level alarms and use of enclosed tanks. • Low risk of groundwater contamination from a failure of flowback storage tank due to the design standards of the tank (cyclone rated steel tank structures) and routine integrity inspections. • Low risk from over extraction of groundwater for civils, drilling and stimulation activities due to limited nature of take (one off), yield of the Cambrian Limestone Aquifers and available allocation volumes (as assessed in the	Practice, with cement plugs utilised to separate aquifer units. • All surface storages of wastewater and chemicals to have secondary containment to prevent spills to the ground. • An emergency response plan must be implemented outlining how spills and emergencies will be responded to. • Drilling fluids and wastes to be stored within a lined sump. • Flowback wastewater must be stored in double lined tanks with leak detection and level monitoring. • Double lined enclosed wastewater tanks with leak detection and level monitoring utilised to store all wastewater, with open treatment tanks used to maximise evaporation and reduce wastewater volumes held onsite. • All open treatment tanks are to be operated with a 1:1000 ARI wet season or dry season (whichever is applicable) freeboard. • All wastewater to be transferred to enclosed tanks within 8 hours of a significant rainfall event occurring. • Groundwater monitoring from monitoring bores installed at the site must be completed prior to and after stimulation to detect any contamination. • All water take will be covered by an existing Water Extraction Licence (WEL) GRF 10285. • New extraction bores must model potential

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			WEL). • Low risk that seismic charges impact pastoralist groundwater bores or groundwater quality.	impact on adjacent pastoral bores prior to being added to WEL. • All water take will be metered and reported quarterly to the regulator. • Agreement with pastoralists to be obtained where proposed site is within 1 km of a pastoral bore. • Seismic surveys to have an industry standard buffer of typically 100 m from the nearest extraction bore. • Seismic charges are biodegradable, with any unexploded ordinance likely to rapidly degrade (weeks).
Soils	• Avoid, minimise and control soil erosion and discharge of sediment or soil into waterways or established drainage systems • Minimise disturbance of soil, vegetation and drainage during site activities • Prevent the contamination of soil to maintain the viability of soil resources • Minimise residual impacts to pastoralist usage of exploration areas	• Clearing of up to 228.9 ha to support exploration activities. • Soil compaction from access tracks and leases. • Increased sedimentation transportation from disturbed areas. • Loss of productivity of disturbed areas until final rehabilitation has been achieved.	• Medium risk of soil erosion from cleared areas (access tracks, lease pads, camp pads, gravel pits, seismic lines and laydown areas) occurring on disturbed sites due to high intensity wet seasons. Risk is a low consequence (minor impact), possible (<50% chance of occurring) event. • Low risk Reduction in land production through poor erosion and sediment control practices. • Low risk of spills/leaks from the on-site storing and handling of fuels. Condensate, hydrocarbons, drilling additives, stimulation additives, flowback fluid, solid wastes, storage and transportation of wastes causing soil contamination. • Low risk of drill sump and flowback tank overtopping due to mandatory freeboard and monitoring controls.	• Site is selected to avoid sensitive soil units and slopes which may increase erosion hazard. • Site selection to take on pastoralist feedback about existing site conditions (e.g. overland flow). • All land clearing to align with the requirements of the code of Practice and NT Land Clearing Guidelines (2019). • Seismic activities to: o Avoid vegetation clearing as much as practicable through use of seismic charges if possible. o In open woodlands, limit clearing to grasses and shrubs. o Maintain viable root stock to promote rapid rehabilitation. o Avoid seismic lines in water courses (unless co-located with an access

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			• Low risk of chemical and waste transportation accident, causing soil contamination due to licenced chemical/ waste provider use, spill response and emergency response requirements. • Low risk of contamination from on-site disposal of drill muds and cuttings with site specific assessment completed to ensure disposal is environmentally acceptable. • Low risk of contamination from a flowback wastewater tank failure due to the structural design of the tanks, site bunding, emergency response requirements and spill management requirements. • Low risk of wastewater evaporation mist transported offsite during wastewater treatment due to wind speed/direction cut offs and routine site inspections during operations. • Low risk of greywater and sewerage disposal from camp wastewater treatment plants due to the irrigation area being appropriately sized, fenced and quality aligning with the NT Department of Health requirements. • Medium risk of bushfire from accidental ignition by site activities (civil works, seismic, drilling, flaring, grinding) or personnel. The consequence of a fire is considered serious, with the likelihood 'unlikely'. • Low risk of reduction in land production through poor infrastructure placement as	track). • Erosion and sediment control practices to be utilised at all disturbed sites to minimise erosion. • Sites (including gravel pits) maintained to minimise sediment releases, with erosion and sediment control plan in place. • Pre and post wet season monitoring completed on all disturbed areas to identify and repair erosion. • Construction within the wet season to be avoided to reduce the erosion risk. • No vegetation clearing in major watercourses proposed. • All chemicals and fuels to be stored with secondary containment as per code of Practice. • During wastewater storage, the site is to be fully bunded to contain the volume of an entire wastewater tank if a structural failure occurred. • Flowback wastewater must be stored in double lined tanks with leak detection and level monitoring. • Double lined enclosed wastewater tanks with leak detection and level monitoring used to store all wastewater, with open treatment tanks used to maximise evaporation and reduce wastewater volumes held onsite. • All open treatment tanks and sumps are to be operated with a 1:1000 ARI wet season or dry season (whichever is applicable) freeboard.

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			infrastructure is located along an existing seismic line and no sensitive soil types are present in the immediate vicinity. • Low risk of reduction in land productivity from poor rehabilitation due to mandatory rehabilitation requirements and security bond requirements.	• All wastewater to be transferred to enclosed tanks within 8 hours of a significant rainfall event occurring. • Stormwater to be retained onsite during wastewater storage and tested prior to release. • All spills of chemicals and wastewater to be cleaned up upon detection. • Irrigation of greywater and treated effluent to be undertaken in accordance with DoH requirements. • Fire breaks to be utilised around all well sites, with minimum separation distances of 45m between flares and vegetation. • Grinding, welding and other higher risk fire activities to be undertaken away from vegetation/ in manners that avoid bushfire risk. • Vehicles to be equipped with fire extinguishers. • No flaring during total fire bans. • Fire response to be implemented during seismic program, with spotters and fire trailers utilised to put out spot fires during work • Seismic civils to be preferentially completed during either early wet or early dry. • Disposal of drilling muds, cuttings and mineral waste to be undertaken in accordance with Code of Practice, with onsite disposal only permitted where the potential harm to the environment can be demonstrated as ALARP and

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
				acceptable. • Site to be rehabilitated back to pre-existing/ agreed state with pastoralist input.
Emissions (dust, greenhouse and combustion emissions)	• Avoid environmental nuisance at sensitive receptors • Minimise impacts to pastoralists and surrounding ecological communities from dust • Minimise greenhouse gas emissions	• Dust on vegetation in the immediate vicinity of activities reduces plant palatability • Impacts of dust nuisance to birds and fauna in the immediate vicinity of activities, specifically access tracks and seismic lines • Emissions from the combustion of diesel. • Generation of Greenhouse gasses are anticipated to be approximately 100KTCO$_2$e- per year	• Low risk of dust impacts generated during Civil activities, drilling operations, well testing due to use of dust suppression and routine maintenance of access tracks and infrastructure. Productivity declines from dust impacts are anticipated to be temporal in nature • Low risk of reduction in regional air quality resulting from emissions from the combustion of diesel due to the temporal nature of the activities and selection of efficient equipment. • Low risk of reduction in regional air quality from gas and condensate flaring due to the combustion efficiency of the flare and operating procedures. • Low risk of air emissions from chemical releases during drilling and stimulation activities impacting livestock, fauna and people due to chemical handling procedures limiting emissions during mixing. • Medium risk of bushfire from accidental ignition by site activities (civil works, seismic, drilling, flaring, grinding) or personnel. The consequence of a fire is considered serious, with the likelihood 'unlikely'. • Low risk of uncontrolled release of gas impacting a receptor during drilling,	• Dust suppression to be used on access tracks, lease pads and gravel pits to minimise dust emissions. • Dust levels are anticipated to be temporal in nature- primarily during the dry season. • Venting of raw gas is tightly controlled under the Code of Practice, with no material volume of gas to be vented. • A reduced emission completion (flare) to be utilised to combust all hydrocarbons. • Flares to be compliant with USEPA design standards, including 98% flare efficiency. • Site located away from sensitive receptors, such as homesteads. • Stimulation chemical mixing procedures deployed (such as enclosed hoppers) that minimises dust emissions. • Fire breaks to be utilised around all well sites, with minimum separation distances of 45m between flares and vegetation. • Grinding, welding and other higher risk fire activities to be undertaken away from vegetation/ in manners that avoid bushfire risk. • Vehicles to be equipped with fire extinguishers.

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			stimulation, barrier failure, operator error or vehicle collision due to the well design, blow out prevention, well integrity and lack of sensitive receptors preventing impacts. • Low risk of leak of gas from wells due to the well design, routine leak detection and repair and separation distance from receptors.	• No flaring during total fire bans. • Fire response to be implemented during seismic program, with spotters and fire trailers utilised to put out spot fires during work • Seismic civils to be preferentially completed during either early wet or early dry. • 6 monthly gas leak detection on all exploration wells.
Surface Water	• Avoid and minimise the potential contamination caused by the discharge of sediment or contaminated storm water to waterways or established drainage systems. • Contain any potential contaminants for treatment or disposal.	• Increased sedimentation transportation from disturbed areas	• Low risk of contamination from a flowback wastewater tank failure due to the structural design of the tanks, site bunding, emergency response requirements and spill management requirements. • Low risk of drill sump and flowback tank overtopping due to mandatory freeboard and monitoring controls • Low risk of a transportation accident releasing chemical or wastewater (drilling fluid and flowback) due to the use of licenced wastewater/ chemical transportation providers, spill management and emergency response requirements. • Low risk of spills to surface water from chemicals and fuel storage and handling activities due to use of secondary containment and separation distance to watercourses. • Low risk of stormwater releases from activities contaminating surface water due to stormwater segregation and testing procedures.	• No take of surface water permitted or proposed. • Sites are not located within proximity of any mapped water courses. • Site maintained to minimise sediment releases, with erosion and sediment control plan in place. • Double lined enclosed wastewater tanks with leak detection and level monitoring utilised to store all wastewater, with open treatment tanks used to maximise evaporation and reduce wastewater volumes held onsite. • All wastewater tanks engineered to withstand failure; cyclone rated construction. • All open treatment tanks and sumps are to be operated with a 1:1000 ARI wet season or dry season (whichever is applicable) freeboard. • All wastewater to be transferred to enclosed tanks within 8 hours of a significant rainfall event occurring.

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			• Low risk of infrastructure changing surface hydrology and flow due to infrastructure design and avoidance of overland flow locations. • Low risk of changes to terrestrial ground surface levels associated with seismic activity due to the stability of the basin and geomechanical properties of the target and overlying formations.	• During wastewater storage, the site is to be fully bunded to contain the volume of an entire wastewater tank if a structural failure occurred. • All spills of chemicals and wastewater to be cleaned up upon detection. • Irrigation of greywater and treated effluent to be undertaken in accordance with DoH requirements. • No offsite releases of drilling or stimulation wastewater proposed or permitted. • Stormwater retained onsite during wastewater storage, with testing completed prior to offsite release. • Site selected to avoid major structural features, such as faults. • Basin is seismically stable, with low seismic activity reported. • Minimal disturbance seismic lines utilised where rootstock is maintained to increase stability and aid in vegetation recovery.

Flora and Fauna (including livestock)	• Minimise disturbance to flora and fauna
	• No disturbance to high conservation areas
	• Avoid the introduction of weeds
	• Avoid the spread of existing weeds
	• Minimise the loss of pastoral productivity
	• Minimise impacts to
		• Clearing of up to 162.2 ha of regionally extension vegetation communities (such as Open Corymbia/Eucalypt woodland, Bullwaddy and/ or Lancewood) to support exploration activities.
		• Loss of fauna and flora habitat
		• Loss of livestock grazing area
		• Loss of productivity of
			• Low risk of threatened fauna mortality during clearing for seismic lines or well pad extension, with all sites to be inspected prior to clearing to avoid fauna.
			• Low risk of vehicle and machinery noise and lighting on well pads and access tracks causing material impacts to threatened fauna or livestock.
			• Low risk of contamination from a flowback wastewater tank failure due to the structural design of the tanks, site bunding, emergency response requirements and spill management
				• Vegetation to be walked down and inspected for fauna prior to clearing. Where fauna is identified, work shall stop in the immediate vicinity until they leave the area.
				• Seismic activities to:
				  • avoid vegetation clearing as much as practicable
				  • In open woodlands, limit clearing to grasses and shrubs
				  • Maintain viable root stock to

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
	livestock	disturbed areas until final rehabilitation has been achieved • Disturbance of flora, fauna and livestock from seismic charge noise and vibration	requirements. • Medium risk of introduction and spread of weeds in the area due to equipment washdowns, inspection and certification requirements. Monitoring and routine treatment completed on identified outbreaks. Impact from weed introductions/spread is considered moderate, with likelihood 'unlikely'. • Medium risk of bushfire from accidental ignition by site activities (civil works, drilling, flaring, grinding and seismic activities) or personnel on fauna, flora and land productivity. The consequence of a fire is considered serious, with the likelihood 'unlikely' (<30% chance of occurring). • Low risk of flora, fauna and livestock being trapped and drowning in storage tanks, sumps and pits due to the design of storages and fencing. • Low risk of contaminants in water and soil pass through the food chain and bioaccumulate in fauna causing detrimental impacts to local species and communities due to chemical storage and handling practices. Fences are utilised to restrict livestock access. • Low risk of vehicle collisions with fauna – fauna mortality results in a localised impact to listed threatened species, due to avoidance of night-time driving, speed limit restrictions and number of vehicle movements. • Low risk of reduction in land productivity from poor rehabilitation due to mandatory rehabilitation requirements and security	promote rapid rehabilitation • Avoid seismic lines in water courses (unless co-located with an access track) • Muster cattle away from seismic area in consultation with pastoralist • Lease pads to be fully fenced during operations. • Open pits to be fully fenced to prevent livestock access. • Sumps to have fauna ladders or liner material (such as Coletanche) with sufficient friction to allow fauna to escape. • Gravel pits to be left open to act as watering point for livestock when not in use. • Vehicle speed limit restricted to 60 km/hr. • Dust suppression used to limit dust impacts to vegetation. • Site to be rehabilitated back to pre-disturbance conditions as per the Code of Practice. • All equipment and loads to be inspected and certified weed free prior to entry • 6 monthly weed inspections to be completed with all identified weeds treated. • Weeds sprayed periodically to

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			bond requirements Reduction in land production through bushfire • Low risk of impacts to flora and fauna through the encouragement of feral animals and other pest species leading to competition with native species. This includes the introduction of cane toads. • Low risk of disturbance to livestock from seismic charges due to small nature of charges. Noise anticipated to be audible within 2 km and vibration felt typically <200 m. • Low risk of impacts to cattle/pastoralist productivity due to gates being left open and cattle escaping (consequence “moderate”, Likelihood unlikely)	restrict weed numbers. • Fire breaks to be utilised around all well sites, with minimum separation distances of 45m between flares and vegetation. • Grinding, welding and other higher risk fire activities to be undertaken away from vegetation/ in manners that avoid bushfire risk. • Vehicles to be equipped with fire extinguishers. • No flaring during total fire bans. • Fire response to be implemented during seismic program, with spotters and fire trailers utilised to put out spot fires during work • Seismic civils to be preferentially completed during either early wet or early dry. • Grids to be installed at areas with frequent access requirements • Gate ‘mates”, signage, inductions and gate monitoring programs implemented to ensure gates are not left open.
Environmental Nuisance and Amenity- including dust, noise, light, odour and vibration	• Minimise impacts to pastoralist operations	• Construction of exploration infrastructure onsite changes land use from pastoral to industrial. • Light and noise nuisance to fauna and livestock in immediate vicinity of activity	• Low of changes in property amenity through the construction and operation of exploration infrastructure due to location of activities and separation distance from receptors • Low risk of increased vehicle accident or traffic impacts through associated with no material traffic volumes anticipated and	• Site located >15 km from pastoralist homestead. • Site is located away from pastoralist main access points. • Maximum peak traffic during mobilisation and demobilisation is likely to be typically <44 vehicle

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
		• Increased traffic to proposed exploration area • Noise, light, odour and dust emissions in the immediate vicinity of the lease pad. • A visible hue visible from the Carpentaria may be present at night during flaring or from activity lighting. • Noise impacts from helicopter movements	limited peak traffic periods. • Low risk of adverse impacts to fauna from traffic are not anticipated, with impact levels consistent with standard road traffic levels. • Low risk of helicopter movements causing impacts to receptors based on location of site away from homesteads • Low risk of disturbance to livestock from seismic charges due to small nature of charges- noise anticipated to be audible within 2 km and vibration felt typically <200 m.	movements per day for 2 weeks. • Speed limit restricted on the access tracks to <60 km/hr. • Dust suppression to be utilised to minimise dust emissions during major equipment moves. • Where helicopter movements are planned, the pastoralist to be engaged prior to ensure helicopter do not interfere with pastoral activities. • During seismic surveys, detonations will not occur when cattle are in proximity. Cattle will be mustered way from seismic area in consultation with pastoralist.

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8. Consequences for Stakeholder Rights and Activities

8.1 Stakeholders Rights

Pastoral Lessees within the Northern Territory have non-exclusive rights to conduct their pastoral activities on the land granted under the Northern Territory Pastoral Lands Act (2016). Origin respects these legal rights and seeks a sustainable relationship with Pastoral Lessees so that both parties can co-exist on the land. Origin proposes to achieve this via the following key principles:

1. Formal stakeholder engagement aligned with the requirements of Section 7.2 (a) of the Northern Territory Petroleum (Environment) Regulations 2016.
2. Structured and timely process for the execution of an access agreement and associated compensation under the Northern Territory Petroleum Regulations 2020.
3. Mutually agreed ongoing, regular engagement and communications.

Origin's impacts to stakeholder rights are limited to accessing and utilisation of defined sections of the pastoral lease for authorised petroleum exploration activities. Impacts to rights are restricted to a loss of pastoral productivity over the areas for which Origin has established infrastructure, such as lease pads, camp pads, gravel pits and access tracks. Access to demarcated zones around the well pad is also restricted, to ensure stakeholder and community safety.

8.2 Stakeholders Activities

In accordance with s.7.2 of the PER, Origin is required to provide the pastoralists information on the potential consequences of undertaking the regulated activities on a stakeholder's rights.

A summary of the potential consequences of the activity and mitigation controls are summarised in Table 3 Potential consequences and control measures.

Table 3 Potential consequences of the activity on stakeholders' activities

Pastoralist Activity	Potential Consequence to Activities	Mitigations
Pastoral time	• Impact to pastoralist time as they are required to engage with Origin as a part of the planning and approval for the proposed activity.	• Origin undertakes engagement in good faith, with information provided in a variety of formats to reduce time pressures as far as reasonably practicable.
Pastoralist site access	• Exploration vehicles along access track may interact with pastoralist activities- mustering and pastoralist vehicles. • Restricted access to exploration well and fenced area during the length of proposed activities. • Restricted access during seismic surveys.	• Pastoralist engaged throughout exploration activity planning to incorporate pastoralist feedback into activity to reduce impacts. • Camps with workers bussed to site (where possible) to minimise vehicle movements. • Hazardous areas to be fenced and signed to communicate potential safety hazards. • Compensation to be paid for loss of available grazing land and disturbance.
Pastoral activities- grazing and mustering	• Minor elevated levels of noise in the immediate vicinity of the well pad during exploration activities (limited noise at all other times). • Potential elevated noise and vibration within vicinity of seismic shoot (typically within 2-500m of activity).	• Pastoralist engaged throughout exploration activity planning to minimise impact on cattle and pastoral activities. • Compensation to be paid for loss of available grazing land and disturbance. • Full fencing of well pad to restrict cattle. • Speed limits restricted to 60 km/hr.

Pastoralist Activity	Potential Consequence to Activities	Mitigations
	• Disturbance of cattle in the immediate vicinity of the activity when works are undertaken. • Dust impacts on immediate adjacent vegetation has the potential to temporarily reduce yield, similar to existing pastoral tracks. • Reduction in pastoral productivity through poor rehabilitation. • Potential introduction or spread of weeds. • Helicopter movements in vicinity of pastoral activities may disturb cattle/ mustering operations. • Potential impacts on cattle and pastoral business where gates are left open.	• Dust control utilised to reduce dust emissions. • Site to be rehabilitated back to pre-existing state, with security bond in place if company fails to rehabilitate. • Weed management plan implemented, including requirements for weed hygiene inspections and certificates on all equipment and vehicles. • 6 monthly weed monitoring and spraying of weeds using a NT Government approved treatment. • Pastoralist to notified and engaged prior to commencing helicopter movements to mitigate interference. • Induction with all exploration contractors and staff in relation to pastoral operations. This induction to be developed with input from pastoralist. • Use of grids, gate signage, inductions and regular gate monitoring and reporting to pastoralist to minimise occurrence of gates being left open. • On-going liaising with pastoralist throughout on ground operations.
Pastoral activities- ongoing productivity of area post rehabilitation	• Reduction in productivity due to erosion and sediment releases. • Reduction in productivity due to wastewater, chemical/fuel spills. • Reduction in pastoral productivity through poor rehabilitation. • Potential introduction or spread of weeds.	• Routine site maintenance completed to ensure functioning of erosion and sediment control. • All fuels and chemicals to be stored within secondary containment, with no storage of hydraulic fracture stimulation flowback work drilling wastewater. • All spills remediated as required in the EMP/spill management plan. • End of life rehabilitation to return land back to pre-existing state or as agreed to with pastoralist. • Rehabilitation security with NTG retained. • Weed management plan implemented, including requirements for weed hygiene inspections and certificates on all equipment and vehicles. • 6 monthly weed monitoring and spraying of weeds using a NT Government approved treatment.
Pastoral access to groundwater	• No anticipated impacts as proposed groundwater take is to be covered under a WEL.	• All groundwater take to be authorised under a WEL. • Water extraction from pastoralist bores not proposed, unless specifically approved by pastoralist through an agreement.

Pastoralist Activity	Potential Consequence to Activities	Mitigations
Pastoral access to surface water	• No anticipated impacts as no surface water take, interference or wastewater discharges proposed.	• No surface water proposed to be taken.
Pastoralist's amenity	• Minor elevated levels of noise in the immediate vicinity of the well pad during activities consistent with the 2016 drilling campaign. • During seismic charge detonation, noise is infrequent and typically a dull thud. • Visual presence of infrastructure within pastoralist lease. • Potential visible hue form flare and night-time at distance.	• Site to be located away from main pastoralist entry points and homestead. • Noise and vibration from seismic surveys is typically a dull thud not felt outside of 200 m or heard outside of 2 km. • Site selection to avoid placing flares and exploration activities on regional high points.

9. Stakeholder Engagement Plan Feedback

All feedback on the proposed activities and their potential impacts, risks and proposed controls should be provided to Origin via the feedback form in Appendix A within the 28-day time period. Where no comments on contents relating to the requirements of the PER are received within the 28-day period, the PER Stakeholder Engagement requirements will be considered fulfilled. Ongoing stakeholder engagement will then proceed.

All lessee comments and associated Origin responses will be documented and provided to DEPWS as a part of the EMP approval process.

10. Ongoing Stakeholder Engagement

To keep the Amungee Mungee Pastoral representatives informed of the status of the regulated activities, the following ongoing engagement is proposed:

- Quarterly engagement on the status of exploration activities
- Fortnightly engagement prior to the commencement of activities under this SEP
- Adhoc engagement as requested by the Beetaloo Pastoral Representative
- Future engagement on additional petroleum exploration activities (If and when proposed) which are not covered under this EMP

Alternative engagement frequencies can be accommodated at the request of the nominated representative.

Origin would also like to extend an invitation to the Pastoral lessees to attend any of the proposed exploration activities to further seek comfort in their understanding and to highlight the nature in which operations are conducted.

11. Commonly used Acronyms & Abbreviations

Acronym	Meaning
AAPA	Aboriginal Areas Protection Authority
ALARP	As Low as Reasonably Practicable
BMP	Bushfire Management Plan
CBL	Cement Bond Log
Code of Practice	Code of Practice: Onshore Petroleum Activities within the Northern Territory
DEPWS	Department of Environment, Parks and Water Security
DIPL	Department of Infrastructure, Planning and Logistics
DFIT	Diagnostic Fracture Injection Test
DoH	Department of Health
E&A	Exploration and Appraisal
EC	Electrical Conductivity
EPA	Environment Protection Authority (NT)
EP	Exploration Permit (e.g. EP76, EP98 and EP117)
EMP	Environmental Management Plan
ERP	Emergency Response Plan
ESCP	Erosion and Sediment Control Plan
GHG	Greenhouse Gas
Ha	hectare
HFS	Hydraulic Fracture Stimulation
JV	Joint Venture
Km	Kilometre
m	metre
NT	Northern Territory
NTG	Northern Territory Government
RWA	Restricted Work Area
SPMP	Spill Management Plan
TO	Traditional Owner
WEL	Water Extraction Licence
WMP	Weed management Plan

Acronym	Meaning
WOMP	Well Operations Management Plan
WWMP	Wastewater Management Plan

Appendix A – Stakeholder Feedback Form

Stakeholder Feedback Form NT-2050-95-AQ-0003

Stakeholder:	
Document Referenced:	
Controlled Doc Number:	

#	Ref	Comment	Date	Origin Feedback	Date

Appendix B Drilling sump mix bury cover

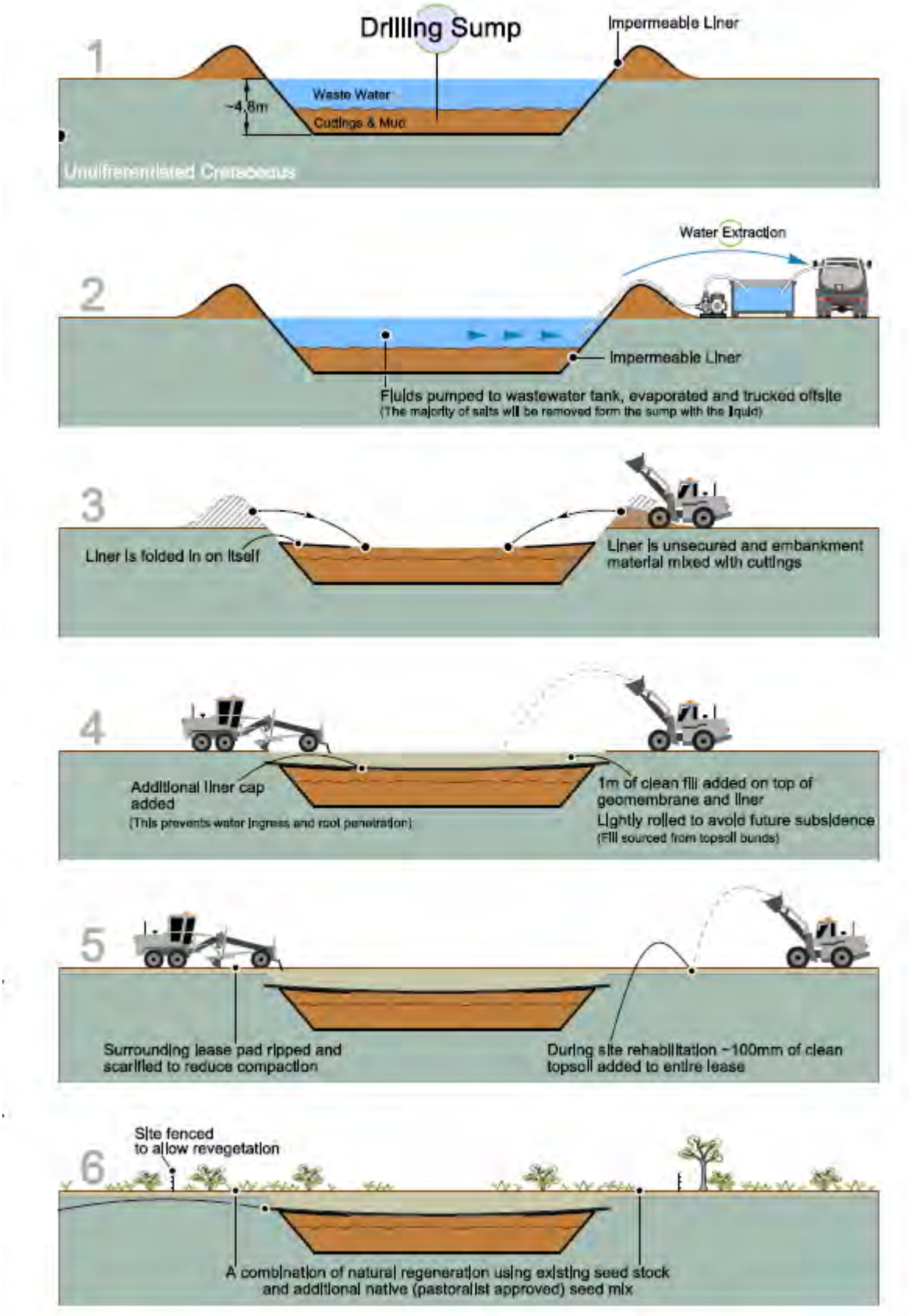
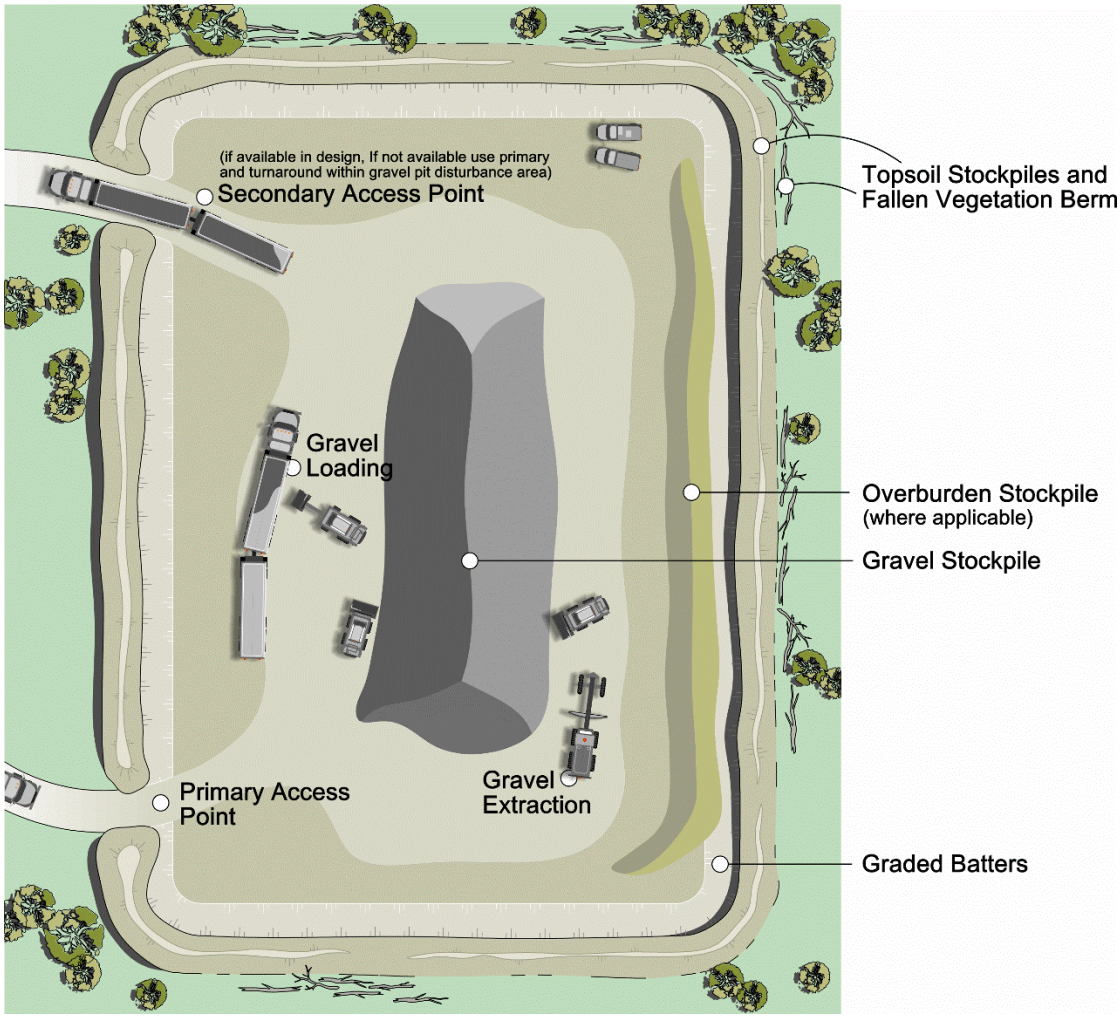
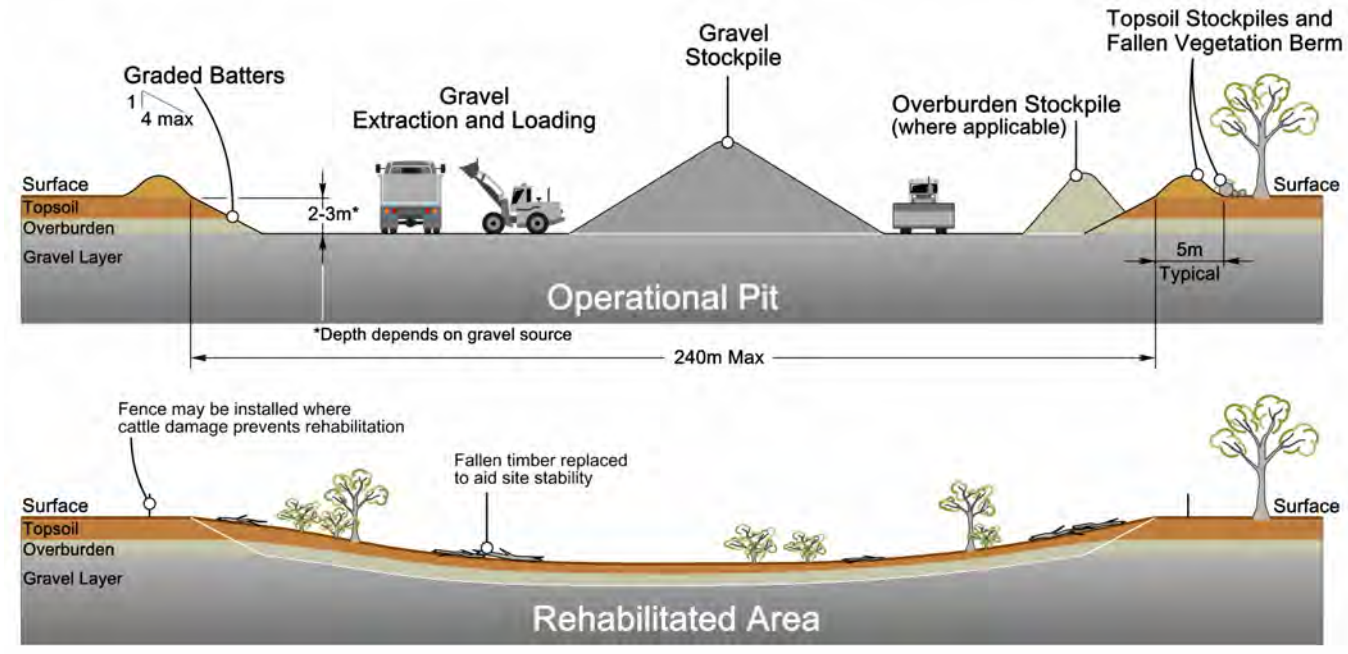


Figure 8 Illustration of the onsite burial of drilling waste at each location

Appendix C Gravel Pit Generic Layout, Operations and Rehabilitation





Amungee Station

Petroleum (Environment) Regulations

Stakeholder Engagement Pack

Pastoralist Engagement Pack

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Pastoralist Engagement Pack

1 Introduction

Origin Energy B2 Pty Ltd (Origin) is a registered holder and the operator of exploration permits (**EPs**) 76, 117 and 98, which are located in the Beetaloo Sub-basin. As a part of Origin's forward exploration work program an Environmental Management Plan (**EMP**) will be submitted to the Minister for Environment for approval, covering the regulated activities associated with the construction and testing of:

- up to four (4) new petroleum exploration wells; and
- stimulation of one (1) existing petroleum and exploration well,

on Amungee Mungee Station (being NT Portion 1079, Perpetual Pastoral Lease 01100).

Two (2) of the proposed new petroleum exploration wells will be located on the existing Velkerri 76 S2 site, along with the one (1) existing well (which requires stimulation). The other two (2) proposed new exploration wells will be located on the existing Amungee NW site, which will be expanded to accommodate multiple wells (adjacent to the existing Amungee Nw-1H exploration well) The proposed regulated activities are anticipated to commence within the 2022-2026 period, with a decision to proceed based upon future exploration results within the basin.

The proposed regulated activities are described in section 5 and can be summarised as:

- Civil construction activities covering the expansion of the existing Amungee NW lease and camp pad construction of a new helipad, laydown yard and ongoing access track and infrastructure maintenance.
- Drilling of groundwater monitoring / extraction bores;
- Acquisition of 3D reflection seismic surveys, including line preparation and land clearing activities around each of the Amungee NW and Velkerri 76 S2 sites;
- Drilling, hydraulic fracture stimulation, completion and well testing of up to 4 additional petroleum exploration wells and stimulation of 1 existing vertical petroleum exploration well. (2 additional wells on the Amungee NW lease and 2 additional exploration wells on the Velkerri 76 S2 lease to bring the total approved wells to 3 petroleum wells per site);
- Micro-seismic data acquisition and associated works;
- Storage and treatment of flowback and other petroleum derived wastewater onsite;
- Maintenance and monitoring of each of the proposed petroleum exploration wells;
- Suspension and decommissioning of the proposed petroleum exploration wells;
- Rehabilitation of disturbance areas;
- Ongoing gravel extraction form the existing gravel pits along the Velkerri 76 S2 access track (Gravel pit 4, 7 and 12), including the importation of gravel pits from adjacent pastoral properties or DIPL pits;
- All activities required to support the above (such as bulk chemical storage and use, bulk fuel storage and use, waste management, equipment and materials transport, helicopter movements, monitoring, maintenance etc.

Under Section 6 (2) of the *Northern Territory (NT) Petroleum (Environment) Regulations 2016* (***PER***), an EMP can only be submitted to the Minister for approval after the interest holder (Origin) has carried out stakeholder engagement in relation to the regulated activity to which the plan relates.

The requirements of stakeholder engagement are outlined in section 7 of the PER. Specifically, the interest holders are required to provide the following information to each stakeholder:

- the regulated activity the interest holder proposes to carry out;
- the location (or locations) where it is proposed to carry out the activity;
- the anticipated environmental impacts and environmental risks of the activity;
- the proposed environmental outcomes in relation to the activity; and
- the possible consequences of carrying out the activity to the stakeholder's rights or activities.

This Stakeholder Engagement Pack (SEP) is designed to fulfill the stakeholder engagement requirements as defined under the PER. Once stakeholder engagement has been completed, Origin will submit an EMP covering all or parts of the proposed activities as described in this document.

This Stakeholder Engagement Pack (SEP) is designed to fulfill the stakeholder engagement requirements as defined under the PER. Once stakeholder engagement has been completed, Origin will submit EMPs covering the proposed activities as described in this document.

Origin proposes that any questions or feedback to the information provided in this pack is formalised via the form included in Appendix A within 28 days of receipt of the SEP. This review timeframe is consistent with the EMP public comment timeframe provided by the Northern Territory Government (NTG) under the PER for EMPs involving drilling and hydraulic fracture stimulation. This is considered a reasonable period for the stakeholder to respond to the information provided.

Origin will ensure that all responses are reviewed, and feedback provided as appropriate. Origin also offers a face to face or virtual meeting with the Stakeholder where subject matter experts can present the information in this pack and answer any questions. These meetings should be arranged within 14 days of receipt of the pack so this engagement can be scheduled within the allocated engagement period.

It should be noted that Origin is committed to ongoing stakeholder engagement beyond the legislated minimum requirements. Engagement with stakeholders will continue throughout the duration of the proposed activities

2 Scope

The scope of this SEP is to satisfy the stakeholder engagement requirements defined under the PER prior to the submission of EMPs covering activities proposed under this SEP.

The regulated activities covered in this SEP are associated with the entire lifecycle of the proposed petroleum exploration wells proposed, from site preparation, through to drilling, stimulation, testing, site decommissioning and all ancillary activities to support. The EMP (or variations of such) will be in force for the next 5 years (the maximum duration of an EMP in accordance with the PER), with revisions required to update the activities within the EMP beyond this period.

Acceptance of this SEP and subsequent approval of an EMP by the NTG is not an approval to commence the activities. This SEP and subsequent EMP are designed to satisfy the requirements under the PER for the regulated activities proposed and does not cover other activity approvals, such as the land access and compensation agreements (LACA) required to be obtained prior to commencement.

The requirements for compensation and access agreements for proposed regulated activities are covered under the *Northern Territory Petroleum Act 1984* and *Petroleum Regulations 2020* and will occur under a separate engagement process. To avoid any confusion or doubt, any comments received relating to the LACA or other activity/approval not subject to this SEP, will be addressed by Origin separately from this stakeholder engagement process.

3 Background

Origin holds the EPs in the Barkly region under the Beetaloo Joint Venture with Falcon Oil and Gas. The EPs cover 18,512 square kilometres (km^2) of largely pastoral leases on the Sturt Plateau, part of the Barkly Tableland, within the Northern Territory (Figure 1). These tenures were originally granted by the NT Minister for Mines and Energy under the NT *Petroleum Act 1984*.

Origin is in the middle of a 5-year work program which is designed to prove up the concept of producing hydrocarbons from a range of geological formations within the Beetaloo Sub-basin. Exploration sites are chosen based on prospectively, with data collected across the basin underpinning decisions on where forward exploration sites are proposed. The regulated activities proposed under this SEP are anticipated to commence within the 2022 to 2027 period, with ongoing engagement with stakeholders informing them of proposed activity timing or commencement likelihood.

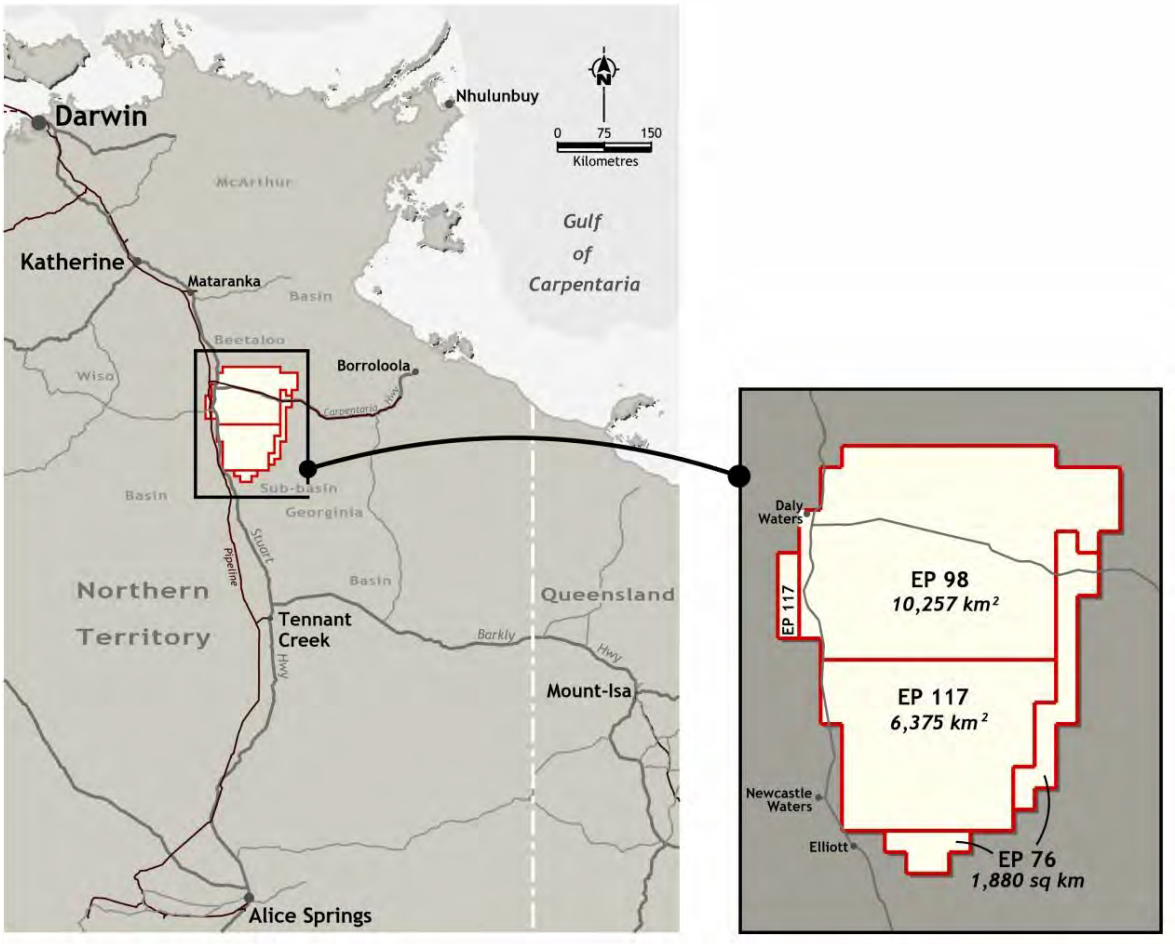

Figure 1 Location of Origin Permit Area.

4 Location of the Regulated Activities

The proposed exploration activities are located on the Amungee Mungee Pastoral station. Access to the site is via the Carpentaria highway (Amungee NW) and Hayfield/Shenandoah Station access track (Velkerri 76 S2).

The location of the activities are provided in Table 1, Figure 1, Figure 2, Figure 3 and Figure 4.

Table 1 Infrastructure location.

Exploration Permit	Infrastructure Description	Approximate existing Area	Proposed revised disturbance area	Proposed Location		
				GDA94 Zone*	Approx Easting	Approx Northing
EP 76	Existing Velkerri 76 S2 Lease Pad	7.5h	No change (7.5ha)	53	435569.3125	816335
EP 76	Existing Velkerri 76 S2 Camp pad	1.2ha	No change (1.2ha)	53	435888	8136328
EP 76	Existing Velkerri 76 S2 Helipad	1ha	No change (1ha)	53	436059.3438	8136074

Exploration Permit	Infrastructure Description	Approximate existing Area	Proposed revised disturbance area	Proposed Location		
				GDA94 Zone*	Approx Easting	Approx Northing
EP117 & EP 76	Existing Access track	55km	No change	53	396143.0625	8135091
EP 117	Gravel pit 4	2.5	No change (2.5ha)	53		
EP 76	Gravel pit 7	2.5	No change (2.5ha)	53	435500.083	8135139.602
EP 76	Gravel pit 12	2.5	No change (2.5ha)	53		
EP 76	Velkerri 76 S2 Seismic acquisition	N/A	100ha	Refer figure 4		
EP 98	Amungee NW Seismic acquisition	N/A	100ha	Refer figure 3		
EP 98	Amungee NW lease pad	3ha	10ha	53	380973.6	8192345
EP 98	Amungee NW camp pad	1ha	1.2ha	53	380862.3	8192758
EP 98	Amungee Nw helipad	N/A	1ha	53	380862.3	8192758
EP 98	Existing Amungee NW Access track	~1km	No change	53	380907.7	8192747
EP 98	Amungee NW Laydown	0 ha	0.5 ha	53	380862.3	8192758
Total			228.9ha^			

** Universal Transverse Mercator (UTM) geographic coordinate system is Geocentric Datum of Australia (GDA) 94.*

^ This is a conservatively high figure, with the final disturbance like to be significantly smaller

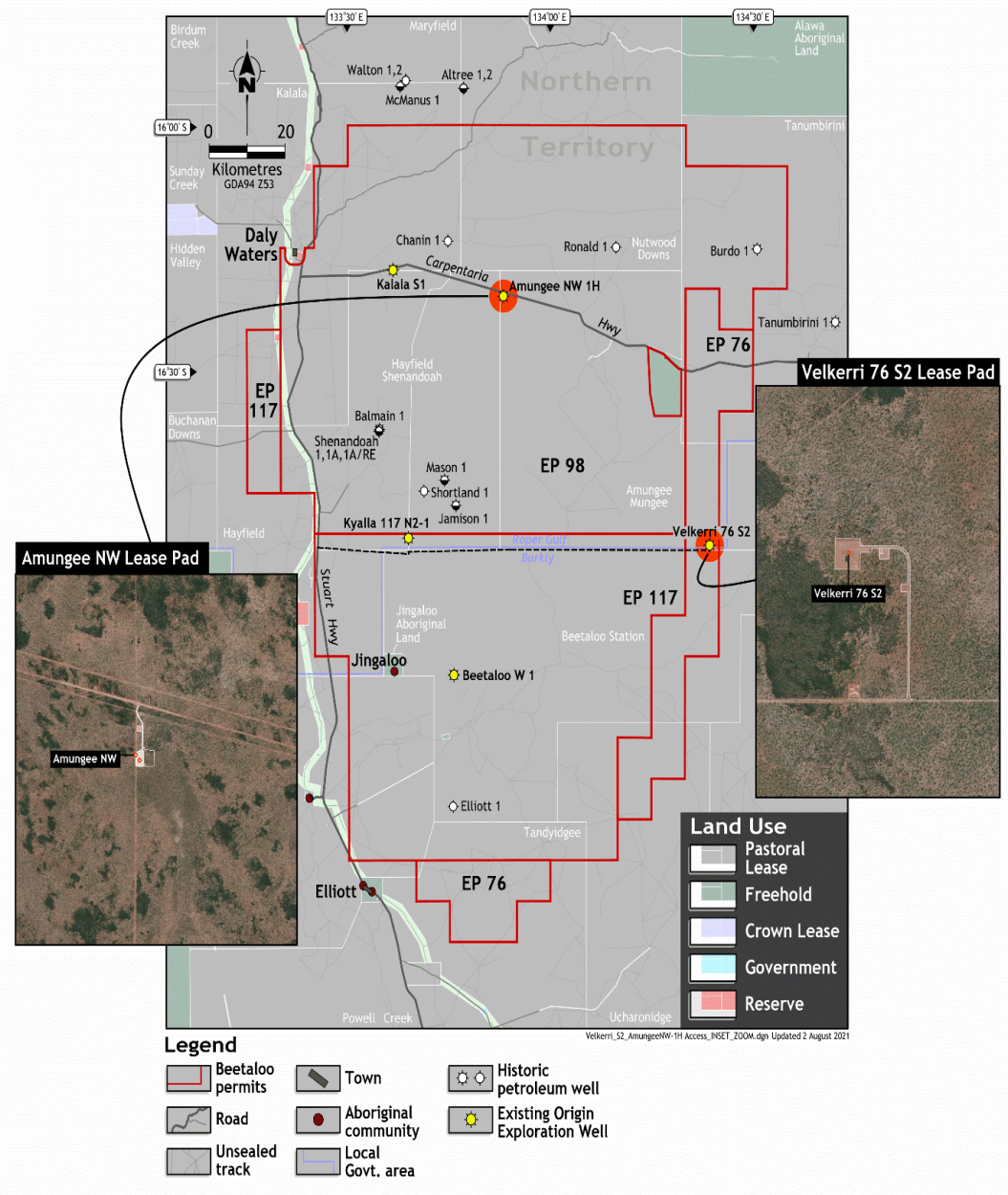

Figure 2 Existing Amungee NW and Velkerri 76 S2 locations within Origin's Beetaloo tenure

Pastoralist Engagement Pack

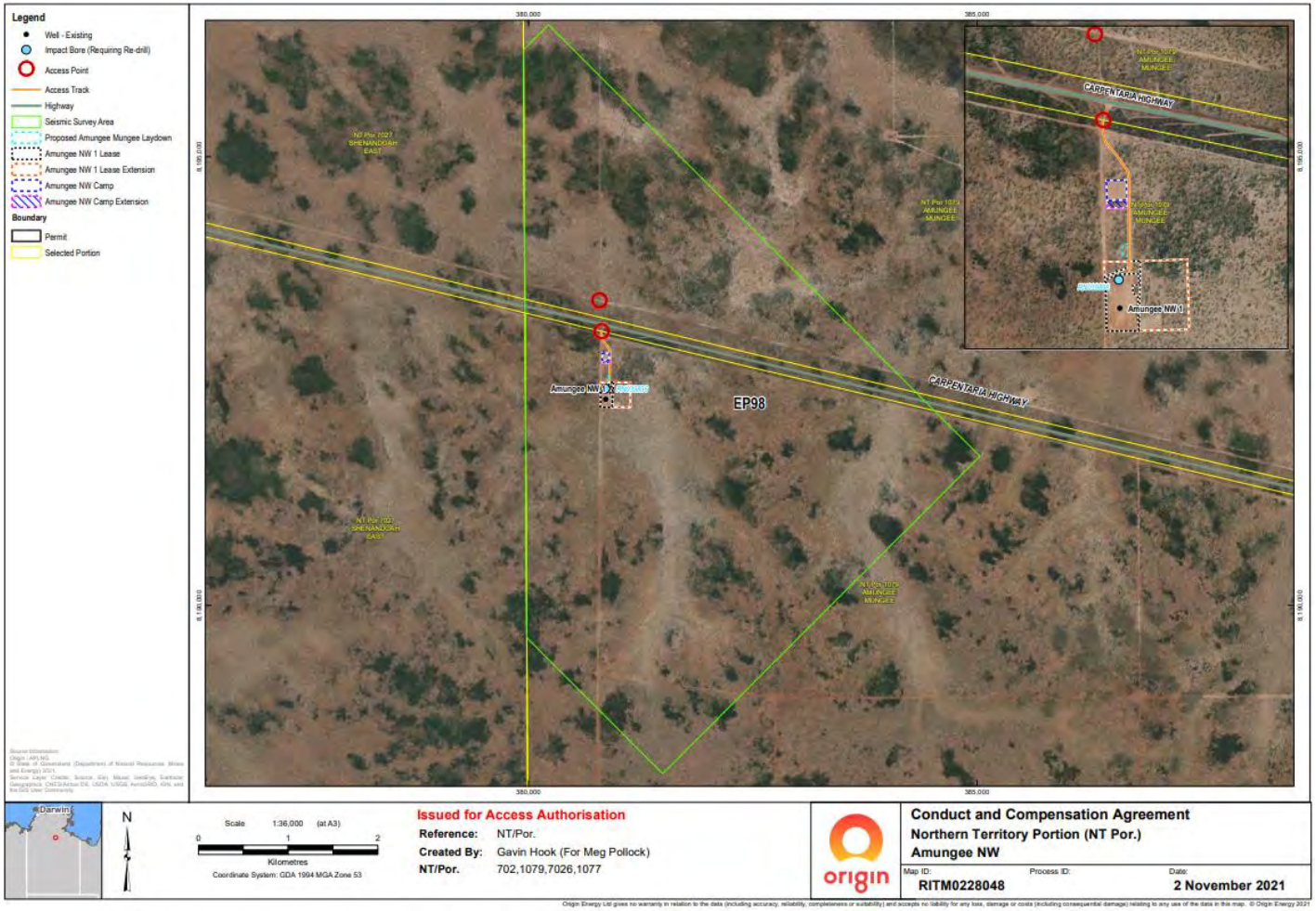

Figure 3 Amungee NW location map (proposed Stage 3 scope)

Pastoralist Engagement Pack

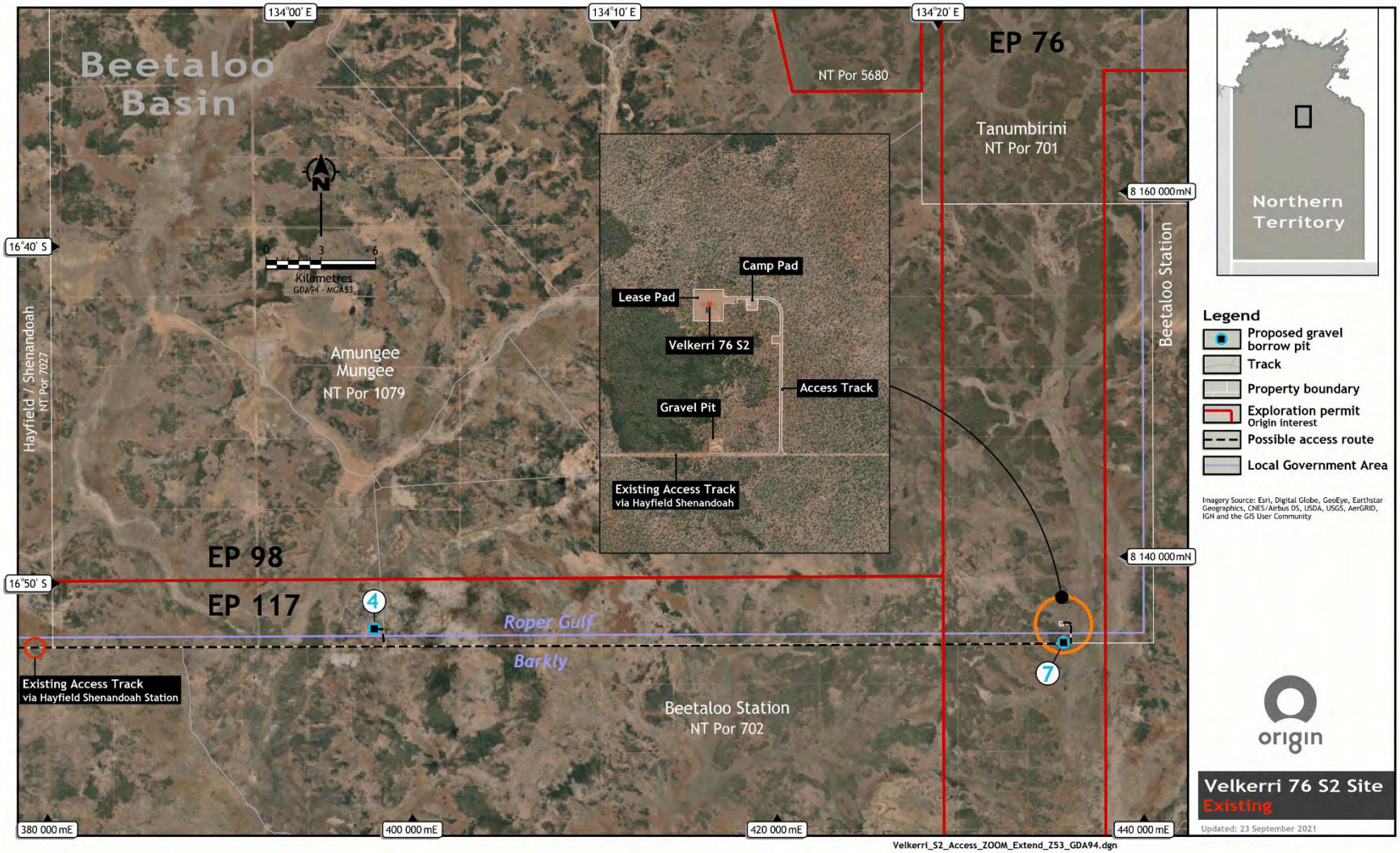

Figure 4 Existing Velkerri 76 S2 site.

5 Description of the Regulated activity

5.1 Summary

The activities associated with the proposed drilling, stimulation and well testing of 4 additional wells, and the stimulation and well testing of the existing vertical well Velkerri 76 S2 1 includes:

The proposed regulated activities proposed regulated activities include:

- Use of the existing Amungee NW and Velkerri 76 S2 lease pad, camp pad, access tracks, gravel pits and all other existing infrastructure (such as water bores)
- Civil construction activities covering:
    - the expansion of the existing Amungee NW site (from 3 hectares to up to 10hectares)
    - Expansion of the existing Amungee Camp pad from 1 to 1.2ha
    - Construction of a new helipad to 1 hectare
    - Upgrade to the Amungee NW site access track interception with the Carpentaria highway
    - ongoing access track and infrastructure maintenance
- Groundwater monitoring bore drilling at the Amungee NW site (if required)
- Acquisition of up to 40km^2 of 3D reflection seismic surveys, including line preparation and land clearing activities at the Amungee NW site.
- Acquisition of up to 40km^2 of 3D reflection seismic surveys, including line preparation and land clearing activities at the Velkerri 76 S2 site.
- Drilling of up to 4 additional petroleum exploration wells; 2 additional wells on the Amungee NW lease and 2 additional exploration wells on the Velkerri 76 S2 lease
- Stimulation and production testing of the existing vertical well Velkerri 76 S2 1
- Completion of the proposed additional petroleum exploration wells
- Hydraulic Fracture Stimulation of the proposed petroleum exploration wells
- Well testing of the proposed exploration wells, including flaring, power generation and beneficial usage of the gas
- Storage and treatment of freshwater, flowback and other petroleum derived wastewater onsite
- Subsurface diagnostic tests and data collection on each petroleum exploration well
- Drilling and flowback wastewater storage and treatment at the Velkerri 76 S2 and Amungee NW sites
- Construction and operation of a temporary worker camps at the Velkerri 76 S2 and Amungee NW sites
- Microseismic monitoring and Induced Seismic Monitoring during HFS activities
- Onsite encapsulation of drilling cuttings and mud at the Velkerri 76 S2 and Amungee NW sites
- Maintenance and monitoring of each of the proposed petroleum exploration wells
- Suspension and decommissioning of the proposed petroleum exploration wells,
- Ongoing gravel extraction from the existing gravel pits along the Velkerri 76 S2 access track (Gravel pit 4, 7 and 12), including the importation of gravel pits from adjacent pastoral properties or DIPL pits
- Rehabilitation of disturbance areas: and
- All activities required to support the above (such as bulk chemical storage and use, bulk fuel

storage and use, bulk sand storage and use, waste management, equipment and materials transport, helicopter movements, monitoring, maintenance etc

5.2 Activity description

The following information and table details of the proposed exploration activties proposed on the Amungee Mungee Station. These descriptions are indicative and general in nature, minor departures from such descriptions are likely to occur and such departures are covered by the content of this SEP.

Groundwater monitoring/ extraction bore drilling

Groundwater monitoring bores are required to be installed in all the recognised regional aquifers (where present and saturated). Monitoring bores have already been installed (or are approved to be constructed) at both the Amungee NW and Velkerri 76 S2 sites. Additional monitoring/extraction bores may be installed on each of the site as required if the existing bores failed/ were insufficient to meet regulatory monitoring requirements (such as the existing Amungee water extraction bore).

Groundwater bores are used to monitor groundwater quality and level before and after stimulation, to detect any changes in groundwater parameters due to stimulation activities. These bores are also utilised to provide water to support for civil construction, well drilling, hydraulic fracturing and ongoing operations. Water may also be taken from pastoral bores, with formal permission from the pastoralist. All water take is required to be licenced under the NT *Water Act 1992*, with a Water Extraction Licence (WEL) to be obtained covering all proposed take. The NTG may notify the pastoralist of Origin's intention to add a monitoring/extraction bore to their WEL.

Where additional groundwater monitoring/extraction bores are required, these bores will be constructed with a water bore drilling rig. Each bore will be constructed in accordance with the minimum monstruction requirements for water bores in Australia. The drilling of bores will typically take 2 weeks per bore, with all encountered drill cuttings and formation water disposed of at the location as per the minimum construction requirements for water bores in Australia.

Civil construction

The Amungee NW and Velkerri 76 S2 sites are existing, with civil construction activities generally restricted to:

- Expansion of the existing Amungee NW lease pad and camp pad
- Construction of helipad and laydown area
- Upgrade of the existing Amungee access track intersection with the Carpentaria highway to meet DIPL requirements (such as sealing to protect road verge)
- Construction of 2 additional well cellars on the Velkerri 76 S2 site
- Ongoing use of gravel pits
- Ongoing maintenance of all new and existing infrastructure

The existing Amungee lease pad will be expanded from approximately 3 hectares up to approximately 10ha. The camp pad will also be expanded from 0.8ha to 1.2ha to accommodate future camp activities. A new helipad up to 1 ha may also be constructed to accommodate the movement of people and equipment by helicopter where access to site has been restricted or during emergency situations. Please note the estimates of disturbance may be expanded larger to support ongoing programs with consultation with the pastoralist. The expansion of the lease pad, camp pad and construction of the new helipad will include:

- the clearing of vegetation, grubbing to remove vegetation roots, stripping of topsoil (to maintain viability), levelling, sheeting with gravel and then compacting to achieve the working surface to support exploration infrastructure
- Construction of an earthen bund consisting of topsoil/ subsoils used to prevent offsite release of wastewater during wastewater storage onsite.
- Installation of erosion and sediment controls around the disturbed areas (such as rock check drains, woah boys and diversion drains).

- Installation of a sediment retention pond will be installed to manage surface water within the lease, with water captured onsite tested and released into the adjacent area.
- Construction of a lined drilling sump to contain all drilling fluid, drilling muds, cuttings, cement returns and waste sand. The drilling sump will generally be able to contain up to approximately 3000m^3 of material (approximately 75m long x 25m wide x 4.5m deep), with the final capacity determined by the proposed drilling depth and horizontal length.
- Two additional 8m^3 concrete lined well cellars to accommodate the wellhead equipment and blow-out preventer (BOP) at each site (Amungee Nw and Velkerri 76 S2). The cellars are transported to the site in one (1) piece and lowered into an excavated pit. A shallow conductor casing is installed within each cellar to approximately 20m using an auger. The shallow conductor casing is designed to prevent the upper sections of the exploration well from caving in when drilling through the unconsolidated sediments. The cellar itself will be fenced at all times to exclude fauna ingress. Cellars will be typically separated from each other by 10m-20m
- A fence and approximately 20-50m firebreak around the entire exploration site

Figure 5 Overview of an exploration site within the Beetaloo undergoing lease and camp pad construction, with water bore drilling underway.

Gravel will be extracted to support infrastructure construction from existing gravel pits located on the Amungee Mungee pastoral station (refer Table 1) or pits within the road corridor/adjacent property. The typical configuration of a gravel pit is provided in ***Figure 6***.

Figure 6 Picture of a typical working gravel pit located within the Beetaloo

Seismic Survey

Subsurface seismic imaging will be completed around the Velkerri 76 S2 and Amungee NW lease pads as per the following

- the acquisition of up to 40km^2 around the existing Amungee NW site, including the clearing of up to 100 hectares of vegetation
- the acquisition of up to 40km^2 around the existing Velkerri 76 S2 site, including the clearing of up to 100 hectares of vegetation

The aim of each of the seismic surveys is to produce detailed images of the various rock types and their location beneath the earth's surface. This information is used to determine the location and size of oil and gas reservoirs. The seismic method uses a sound wave source from an energy source at the surface to propagate sound waves into the earth. The energy source may be from either small seismic charges placed below ground (Figure 8 and ***Figure 8***) or Vibroseis trucks (***Figure 11***).The sound waves that reflect off underground rock formations are captured by recording sensors called geophones (***Figure 10***). Analysing the time sound waves take to return provides valuable information about rock types and an estimate of depth for rock formations. The returning reflections are recorded in a digital format and sent to a seismic data processing centre to produce a cross-section image of the layers of the earth's crust (processed seismic image).

Seismic acquisition through the use of seismic charges is the preferred approach, as this reduces the required land clearing substantially (~90% less clearing). Small explosive charges are placed at 15-20m below the ground surface in a 200m grid either by hand or utilising a track-based ATV or similar (Figure 7). In some cases, a helicopter may be utilised to move a small rig between sites. The charges are packed into place using gravel, bentonite seal and backfilled cuttings. This approach reduces the need to clear vegetation, with the charges being able to be placed around vegetation to reduce clearing. Small amount of clearing may still be required to access extremely dense vegetation, but this is anticipated to be minimal. The detonation of the seismic charges are anticipated to be contained below ground, with no expulsion of earth the surface. An image of a typical small seismic charge used during a New Zealand seismic shoot is provided in ***Figure 8***.

Figure 7 example of a small rig that could be utilised for installing seismic charges during a seismic survey

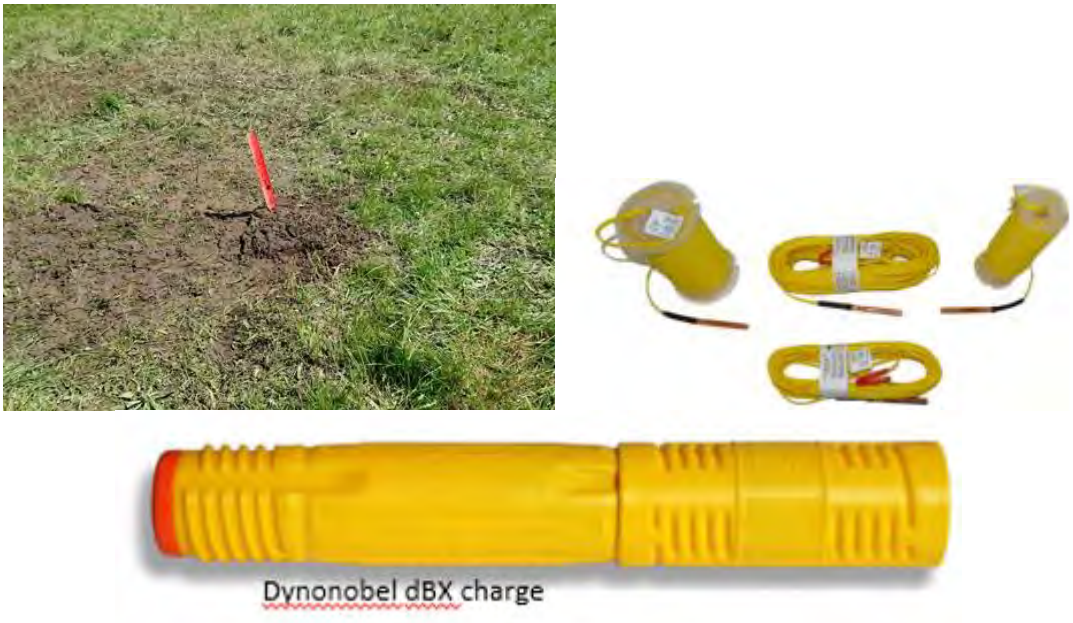

Figure 8 Example of Loaded seismic charge in hole ready for detonation and example of a charge used in seismic survey acquisition. Charge length is approx. 400-500mm in length

If the use of seismic charge is not feasible, Vibroseis trucks will be used for the seismic source. Line clearing will be required so that the Vibroseis trucks can drive and operate over the survey area. To reduce disturbance, existing cleared areas will be utilised where possible. The line position, plus tolerances for weaving the line around vegetation etc are pre-programmed into GPS units. Seismic lines will also be located in a manner to avoid any large habitat trees or sensitive flora, with minimal clearance to be undertaken in watercourses and associated riparian vegetation. In areas with low vegetation density (such as open Eucalypt / Corymbia woodland) ground disturbance will be restricted to the removal of rocks and fallen branches and the slashing of grasses and shrubs to provide effective ground contact of the seismic vibro-source and the geophones and minimise the risk of fire (such as in Figure 9) . Where ground clearance is unavoidable such disturbance will be undertaken with a grader and the access width shall be no more than 1 blade width wide (4m) with minimal ground disturbance sufficient to provide for safe vehicle access. Some patches of lancewood (Acacia shirleyi) and Bullwaddy (Macropteranthes kekwickii) are present along the proposed seismic lines. These areas represent the thickest vegetation and will require clearing with a D6 dozer.

Figure 9 Seismic line construction

To reduce the risk of bushfire, no vegetation mulching is proposed, with a spotter vehicle with a fire tender will be used during clearing activities. Any fires detected will be promptly put out. Felled vegetation will be pushed to the side of the seismic line during operations. The felled vegetation will be returned across the seismic line upon completion of seismic activities to aid in rehabilitation and assist in erosion and sediment control. Root stocks are to be left in place as much as practicable to allow for rapid re-establishment of vegetation. Based on previous experience in the region, most areas will naturally regenerate following rehabilitation following the wet season. Rehabilitation monitoring will occur on an annual basis until the vegetation has become re-instated, with maintenance on rehabilitated area undertaken as required.

Surveying commences shortly after line preparation. The field surveyors use real time kinematic GPS receivers to position receiver points for the surveys. Surveyors mark the ground with biodegradable paint, or points are marked by wooden stakes. Line detours may also be marked with temporary biodegradable flagging.

Each survey team consists of one surveyor in a light 4WD vehicle or ATV, and generally makes only one pass over any given section of line. Back tracking may occur in areas where vehicle access routes have deviated from the true line position and markers must be inserted by personnel on foot. This may occur in areas of riparian vegetation if there is adequate access either side of the watercourse.

Recording normally commences two to three weeks after the start of line preparation. This operation is the largest part of the seismic operation in terms of personnel and vehicles. The size of the crew will vary depending on the recording technique used, terrain and season and recording is generally restricted to daylight hours.

Work commences with the deployment of nodal geophones supported by light 4WD vehicles or ATVs. The nodal geophones are autonomous units, containing the actual geophone as well as battery and data storage in one unit. These nodes are deployed at regular intervals along the non cleared lines perpendicular to the source lines, these may be able to be carried through areas of riparian vegetation to avoid any damage to vegetation where access permits. The installation of nodes requires minimal disturbance, as illustrated in ***Figure 10***.

Figure 10 example of a deployed node

Recording will commence once the survey areas has been laid out with geophones. This layout is termed ‘the spread’ and picks up the acoustic energy reflected from subsurface layers. If Dynamite is the energy source, then the shots will be let off in sequence and recorded by all the geophones. If Vibroseis is the energy source then the truck(s) drive along source lines vibrating the ground at a set interval with the energy is recorded by all the geophones (Figure 11). A data recording truck is located within the field to download all the nodes to (Figure 12).

After the energy source is finished the geophones are collected, rehabilitation and data analysis can commence.

Figure 11 Example of a vibrioses utilised during seismic acquisition

Figure 12 Data recording van used during seismic acquisition

Figure 13 Left: Example of geophone used for 3D Seismic and Microseismic, Right: Example of geophone deployment for both 3D Seismic and Microseismic.

Microseismic Monitoring and Induced Seismic Monitoring

Microseismic Surveys are undertaken to monitor 'listen to' the Hydraulic Fracture Stimulation Operations on each of the sites. Microseismic can assist Origin in analysing the performance of the Stimulation.During stimulation water and sand are injected by high pressure into the reservoir rock creating small fractures. As these small fracture initiate (crack) and propagate (further cracking) away for the well bore they generate pressure waves (seismic energy) that can be measured on the surface with extremely sensitive sensors. These sensors called Geophones or Seismic Receivers are individual weatherproof units that contain a sensitive seismic recording device, memory storage, a long-life battery and GPS locator. The sensors are cylindrical and 4cm wide and 13cm tall.

The Geophones are deployed 10-20 metres apart along a line or in a grid over an area of 30-40km2 around each of the well pads during stimulation activities. Geophone deployment locations are located on foot by GPS locator. A handheld battery drill is used to create a 4cm diameter hole with an auger bit, a small quantity of water may be used to stabilise the soil. The Geophone is inserted into the hole so that the top of the receiver is flush with the surface of the ground (**Figure 13**).

The Geophones deployed prior to the commencement of stimulation and retrieved after the stimulation has concluded.

The Geophones are retrieved by creating a small divot next to the Geophone and the Geophone is pushed into the divot and then pulled out of the ground. Stubborn geophones may need to be dug out with a small trowel, small holes and divots are filled in with any disturbed soil.

Deployment and retrieval of the Geophones is undertaken in small teams of 2 or 3 people, with the number of deployment teams depending on survey size. The teams are supported by a light 4WD vehicle or an All-Terrain Vehicle to carry equipment, gear, water, communication (radio/satellite phone), first aid kits and safety gear.

No line clearing or heavy machinery is required, and the activity is considered to have a minimal impact, like that of scouting activities.

Induced Seismic Monitoring will be undertaken at the same time as the Microseismic monitoring. A temporary seismic receiver is installed ~1km from the well site, with a small amount of other equipment such as solar panels and data transfer equipment. The equipment can be fenced off with temporary fencing if there are cattle in the area. The data from the seismic receiver is sent wirelessly back to the well site to enable live monitoring of seismic events during Hydraulic Fracture Stimulation. The Induced Seismic Monitoring equipment is installed prior to Hydraulic Fracture Stimulation, and remains installed, collecting data for up to 2 months after the conclusion of Hydraluic Fracture Stimulation.

Camp construction and operation

Temporary camps will be utilised at the existing camp pads at Amungee NW and Velkerri 76 S2 to support operations. Each camp will be a self-contained facility with accommodation rooms, kitchen, dining mess, offices, ablutions, gymnasium, storerooms, refrigeration, water storage, power generation, solid waste management, fuel storage, water treatment, sewage treatment and sewage irrigation area. The camp will typically accommodate approximately 50 to 100 people at a time.

Potable water for the camp will either be trucked to site or generated onsite with a purpose designed water treatment unit or sourced externally. All grey and black water will be treated using an NTG compliant sewage treatment system, with treated effluent irrigated in a spray field adjacent to the camp.

Exploration well drilling

A drilling package will be mobilised to each of the sites to commence drilling activity. An image of a commissioned drilling rig and associated infrastructure is provided in Figure 14.

A drilling rig package consists of the main rig package as well as supporting vehicles and pieces of equipment. Generally, the following equipment would be on site during the drilling operation:

- The main drilling rig package consisting of a rig floor, a mast or derrick, and the rig diesel engine.
- Racks for storing drill pipe or casing and potentially a “pipe arm”, which is a piece of equipment designed to bring pipe and casing up to the drill floor.
- The rig’s drilling fluid system including tanks and pipes for storing and pumping fluid down the drill string.
- A smaller rig camp (~8 people) and ablutions block to accommodate critical drill staff required to be onsite during night-time operations.
- An air drilling system consisting of piping and air compressors for directing compressed air down the drill string may also be used.
- Storage trailers and racks for equipment such as mud chemicals, drill pipe, casing, and other equipment used down hole to complete the operation.
- Freshwater storage tanks (typically -3.5ML)
- A work/welding shop.
- Portable onsite offices.
- Ablution block, wastewater treatment plan and effluence irrigation area.
- Chemical storage areas
- Power generators

- Bulk diesel storage areas
- Third party equipment such as cementing units and silos, mud logging equipment and wireline evaluation units would also be required on site intermittently as per operational requirements.

Trucks delivering equipment and consumables (e.g. drilling consumables, fuel, food and water) would be travelling to and from the site regularly. There would also be regular light vehicle activity to transfer people between the drilling rig and camp.

Once the drilling rig is rigged up, tested, and functional, the drilling of the vertical section of the exploration well will commence. An overview of a drilling rig is provided in Figure 14. A large diameter drill string (also known as the bottom hole assembly or "BHA") would be used to drill a ~15-25" hole to drill through the Anthony Lagoon formation (if present and saturated). This section would be drilled with fresh water and "sweeps" (intermittent volumes) of higher viscosity fluid to help remove cuttings out of the hole. A large diameter string of casing (referred to as a conductor casing) would then be set and cemented at this depth. If the Anthony Lagoons Formation isn't present at the location this section could be drilled through the Gum Ridge Formation.

The drilling rig would then be set up to drill through the Gum Ridge Formation into the Antrim Plateau Volcanics or underlying Proterozoic strata (assuming they are present). At this point a further string of casing (referred to the surface casing) would be run and cemented to seal the aquifer off from the rest of the wellbore. A blow out preventer (BOP) would be installed on top of the string of casing and pressure tested. A successful pressure test would ensure the BOP is functioning correctly and confirm the integrity of the casing and cement.

Drilling will then recommence and a few metres into the underlying formation. A test known as a "leak off" test would then be conducted to understand the rock strength; this involves applying just enough pressure to the fluid in the hole to break the formation. The information gained during this test is critical for maintaining the integrity of the hole as it indicates how much pressure can be safely applied to the formation, and also the maximum mud-weight that can be used to provide well control. Following a successful test, drilling will proceed to a depth selected by geologists, reservoir engineers and drilling engineers based on subsurface understanding and well objectives. A further string of casing (the intermediate casing) will then be installed and cemented to seal off previous formations, and if so, the casing shoe would then be drilled out and another leak off test conducted.

The final hole section (referred to as the "production hole section") covers the primary hydrocarbon reservoir section(s) and is drilled to the well total depth (TD). TD is likely to be less than 4000m below the ground surface, with the final depth dependent on the target formation and its encountered prospectively. Drilling activities could also include coring, a process in which a drill bit with a cylindrical opening is used to cut-out rock cores for geological, geochemical and geomechanical studies. The well will be deviated above the production reservoir. The production hole section is drilled with the help of steering tools, which are used to gradually build the inclination so the well penetrates the prospective reservoir zone with a horizontal alignment usually for a total length of 1000-3000 m. In addition, logging while drilling (LWD) tools may be employed to enable measurement of rock properties such as the natural radiation signature or resistivity of the rocks, in order to facilitate identifying key changes in rock type down the wellbore. The horizontal well is typically cased and cemented, awaiting hydraulic fracture stimulation.

Diagnostic Fracture Injection Tests (DFIT) may be run to further investigate rock properties. It involves injecting small volumes of water at low rates to create small fractures, allowing the resulting pressure to fall naturally. The fluid contains no proppant hence the fracture relaxes and closes naturally when pressure is released. The pressure decay is monitored onsite and the data acquired is analysed to aid in reservoir characterisation. The DFIT can be carried out while the rig is on site or after the rig has been demobilized.

During drilling, a KCl/NaCl/Polymer or Synthetic based fluid system is likely to be the base fluid for drilling. Drilling mud is required to maintain well control, provide formation stability, lubricate and control the temperature of the bit, and lift drill cuttings to surface. A KCl/Polymer fluid system consists of water with salt (to prevent formation swelling) and a viscosifying agent (usually the naturally occurring mineral bentonite or a starch similar to those used in food manufacturing (i.e. guar gum)).

Waste drilling muds, cuttings and fluids produced during drilling are directed to the drilling sump for ongoing storage and management. Drilling waste (muds, cuttings and fluids) will remain in the sump until all drilling activities have been completed. The drilling wastes will then be evaporated with all residual fluid removed from site to an offsite disposal facility prior to final sump rehabilitation. The drilling wastes will be sampled and a risk assessment completed to determine the suitability for onsite mix-bury-cover

or encapsulation. Where the drilling waste material cannot be disposed of on the site safely, the drilling waste will be removed to a third party facility and the sump backfilled.

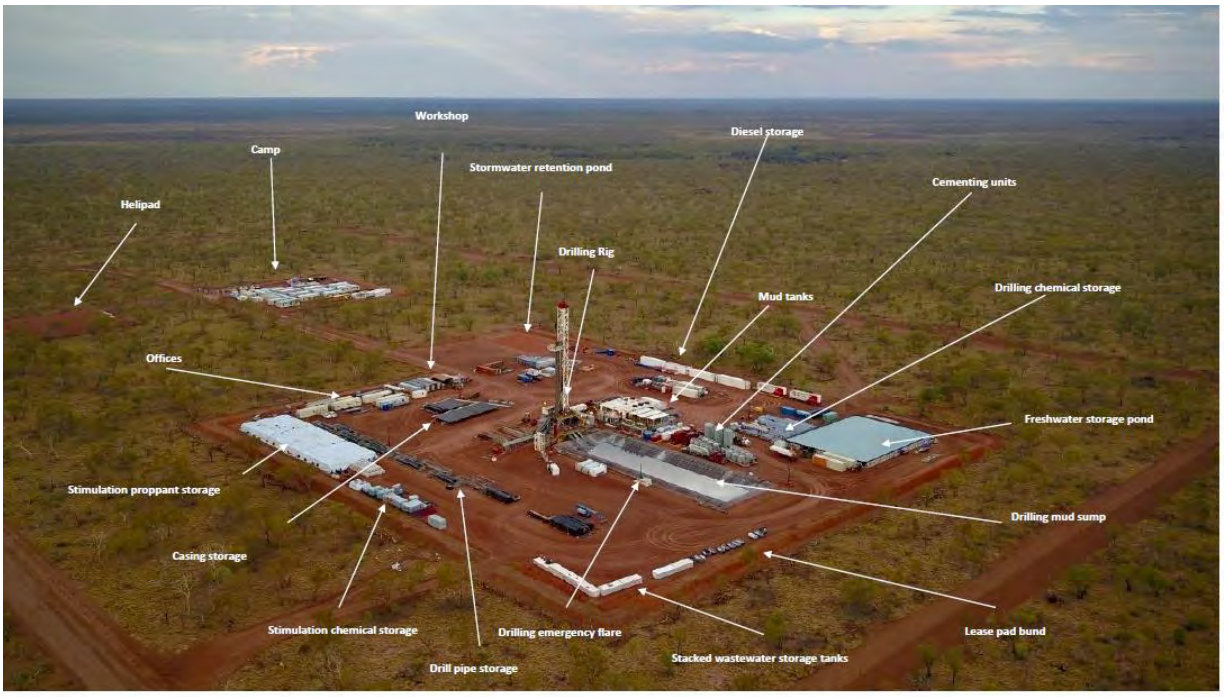

Figure 14 Typical well site layout during drilling. This site is the existing Kyalla 117 N2 site.

Hydraulic Fracture Stimulation

Upon completion of drilling activities, a frack spread will be mobilised to site to commence hydraulic fracture stimulation (HFS or stimulation) activities on each well. A frack spread consists of:

- Data Van – on-site office to execute stimulation activities
- Water Storage - tanks will be constructed on-site, capable of managing both make-up water and flowback water. Tanks will be double lined with leak detection capable of monitoring any leaks between the primary and secondary liner. The number of tanks will depend on the size of the proposed stimulations and will typically be between 5- 12 tanks (additional tanks me be brought on as required to support operations). Frac tanks (~500 bbl) will also be used on location to store fresh water to support HFS operations.
- Proppant Trailer - a large sand storage and delivery trailer that holds the proppant
- Hydration Unit – used to add stimulation additives and viscosifying fluids
- Blender Unit – used to mix proppant and fluid additives, prior to its injection into the well
- High Pressure Pumps – pumps which inject the hydraulic fracturing fluid mixtures from the Blender Unit down the well, via the surface lines and hydraulic fracturing wellhead or coiled tubing unit
- Coiled Tubing Unit – a large length of coiled steel pipe that can be temporarily installed in the well to perform various downhole operations
- Wireline unit – plug and perforation deployment
- Ancillary support buildings – offices, workshop, cranes, chemical storage area, equipment storage, power generation and all other activities required to support stimulation activities.

Stimulation involves the injection of a slurry, primarily consisting of water and sand (proppant), plus a small percentage of chemicals at high pressure into the target section of the horizontal wellbore approximately 1000m – 4000m below ground level (depending on the depth of the target formation). Typically, 92-96% or higher of the total volume in stimulation fluids is a combination of fresh water and sand, with the remainder as fluid-conditioning additives (~2-4-%).

Prior to the commencement of stimulation activities, the integrity of the well is tested with a cement bond log and pressure casing test. This integrity report is submitted to the regulator prior to the commencement of stimulation activities. Once the integrity of the well is confirmed, stimulation activities will commence. The stimulation fluid is pressurised by the high-pressure pumping units and directed downhole via a manifold to the discrete target intervals along the horizontal wellbore (referred to as ‘stages’). Each stage

will be isolated and perforated using a plug and perforation gun assembly deployed via a wireline unit. As the pressure is sustained, the fractures propagate radially from the well, through the target rock. Once optimal fracture propagation has been achieved, the proppant (sand) is pumped down the well and into the open fractures. This process is repeated for each stage. The final number of stages pumped in each well is dependent on the useable length of the horizontal wellbore and in-situ geological conditions. Once all stages are complete, the well is suspended awaiting completion and well testing activities.

During each stimulation, the wellbore pressures of each well are monitored to ensure the operations have not compromised the integrity of the production casing or the cement barriers. A Maximum Allowable Operating Pressure (MAOP) is an important engineering parameter used to define the operating envelope (i.e. the safe maximum pressure that should not be exceeded). The maximum allowable pumping pressure (MAPP) is set below the MAOP to allow for uncertainty and provide an additional safety margin, so the MAOP is not exceeded. In addition, continuous groundwater level monitoring and ongoing field testing is completed on the control and impact groundwater monitoring bores to detect any changes in groundwater characteristics that could be associated with stimulation activities.

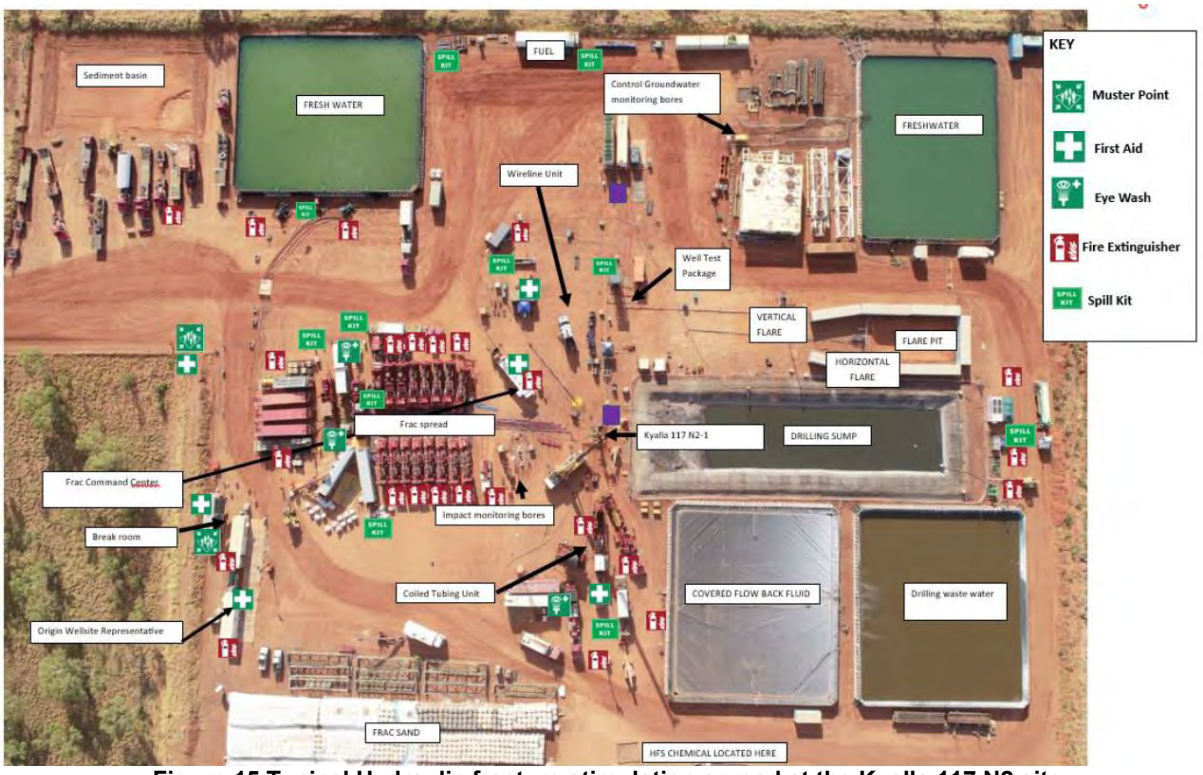

Figure 15 Typical Hydraulic fracture stimulation spread at the Kyalla 117 N2 site.

Extended Production Testing

After the completion of HFS operations, each well will be initially flowed back for several days to remove any residual sand and sediment. Each well with then be “completed”, with a completion rig or coil tubing unit mobilised to site to install production tubing, downhole gauges, artificial lift etc within the well. Once completed, the well will be brought online and a production test completed to measure the volumes of water and gas flow produced from the reservoir to assess the technical and commercial potential of the resource. In some cases, a nitrogen lift may be completed using a coil tubing unit to initiate early production until the well can sustain itself.

Production tests may typically range from 1 to 24 months, depending on operational requirements. During a production test, hydrocarbons (liquids and gaseous) and water (flowback) are measured and separated onsite in a separator. Produced gas will either be flared onsite or beneficial utilised in onsite power generation. Any encountered condensate will be stored within condensate storage tank for offset trucking or sent to the flare for combustion. Flowback is directed into purpose built enclosed and open wastewater tanks where it will be stored and either treated using enhanced evaporation methods (such as submerged combustion, enhanced evaporation) or evaporated onsite (“treated”) until offsite disposal. To assist in managing flowback volumes across the basin, flowback may be moved to and from the site to maximise the use of water management infrastructure in the region. At the end of production testing, or at a time in the production testing phase, the well/s may be shut in for a period of time to allow collection of pressure data which will provide information on reservoir pressure in the subsurface.

Figure 16 Example of a well test underway at the existing Amungee NW location

Once all well testing operations are completed a decision is made to either safely suspend each of the wells (e.g. for further testing or evaluation work in the future) or to plug and decommission the wells. If the well is suspended, all suspension operations and procedures are conducted in accordance with regulatory requirements and industry best practise. This includes periodic exploration well intervention and maintenance, surface well head maintenance, surface infrastructure maintenance, performing routine site inspections and ongoing environmental monitoring (groundwater, weeds, erosion and methane leaks).

The plug and decommissioning process includes setting cement plugs in the hole to isolate permeable zones and prevent cross flow between different rock layers exposed by the drilling process. A cement plug would also be set across the open hole section and previous casing and pressure tested to ensure it acts as an effective fluid barrier to surface. Another plug would be set inside the casing prior to removing the BOP and cutting the casing off at surface. Finally, cement would be poured into the casing stump at surface and a plaque installed to identify the decommissioned well.

Once each of the wells have been fully decommissioned, all associated temporary equipment would be then removed from the site. All disturbed areas (e.g. lease pad, gravel pits, camp pads etc.) will then be rehabilitated and re-vegetated back to a safe, stable, non-polluting landform that is consistent with the surrounding landscape. The only infrastructure that would be kept includes water bores (potentially for monitoring and / or for pastoralist's use) and any roads required to access them.

A detailed description of the activities, their timing and typical duration is provided in Table 2. Pictures of selected activities have also been provided to assist in understanding the size and nature of the activities. It should be noted that these pictures are indicative and activities may differ based on the site specific constraints, final design and operational requirements. Additional information on each of the activities can be provided upon request.

Table 2 Description of proposed regulated activity details

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Amungee NW civil construction The Amungee NW lease pad will be expanded from 3 hectares to 10 hectares to accommodate the proposed exploration well drilling, stimulation, testing and ongoing wastewater storage and treatment activities. The camp pad will also be expanded form 0.8ha to 1.2ha. A new helipad up to 1 ha may also be constructed to support helicopter movements (where required). A 0.5 ha laydown yard may also be constructed. To accommodate the proposed scope, the area adjacent to the existing lease pad will be cleared of vegetation, grubbed and stripped of topsoil down to approximately 100mm (depending on the depth of topsoil onsite). Please note, this may be extended beyond this area if required to support ongoing operations (and in consultation with the pastoralist). Topsoil will be stored around the edge of the lease pad to form a bund, which will be used as both an erosion and sediment control measure and wastewater containment bund. The lease pad will then be levelled, compacted and surface with gravel to accommodate exploration activities. Erosion and sediment controls will be constructed around the disturbed areas (such as rock check drains, woah boys and diversion drains) A sediment retention pond will be installed to manage surface water within the lease. Water captured onsite will be tested and released into the adjacent area. A drilling sump, flare pit and 2 well cellars will be constructed onsite. The drilling sump will be lined with an impermeable liner to contain all drilling fluid, drilling muds, cuttings, cement returns and waste sand. The drilling sump will generally be able to contain up to approximately 5000m^3 of material (approximately 100m long x 25m wide x 4.5m deep). The drilling sump/ broader site will be fenced to prevent livestock access. Two additional 8m^3 cellars will be constructed on the proposed lease to accommodate the wellhead equipment and blow-out preventer (BOP). The cellars are concrete lined and will be prefabricated off-site. The cellars are transported to the site in one (1) piece and lowered into an excavated pit. A shallow conductor casing is installed within the cellar to approximately 20m using an auger. The shallow conductor casing is designed to prevent the upper sections of the exploration well from caving in when drilling through the unconsolidated sediments. The cellar itself will be fenced at all times to exclude fauna ingress. Cellars will be typically separated from each other by 10m-20m. The access track interception with the Carpentaria highway is also likely to be upgraded to comply with DIPL requirements, with a turn in bay and sealing of the road verge. During this period, traffic control will be deployed to manage the activity.	12.2 ha	<20 people	Prior to exploration drilling	4-8 weeks	
Velkerri 76 S2 civil preparation works The Velkerri 76 site has been constructed already to accommodate multiple wells. Civil construction activities will be restricted to the construction of Two additional 8m^3 cellars to accommodate the wellhead equipment and blow-out preventer (BOP). The activity is described in the previous row.	N/A	<6	Prior to drilling	<7 days	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Camp pad construction and camp operation The existing camp pads at Amungee NW and Velkerri 76 S2 will be used to support the proposed operations Camps will be constructed with kitchens, offices, ablution blocks, accommodation blocks, storage containers, gymnasium, refrigeration, water treatment plan, sewage treatment plant, waste management areas, water storages, power generation, diesel storage tanks and car parking. All waste will be covered/ stored in a manner that prevents feral animal access. An approved wastewater (sewage) treatment plant will be utilised to treat all sewage, with treated effluence irrigated in a fenced area adjacent to the camp (no clearing required). Treated effluence treatment and irrigation will occur in accordance with the NT Department of Health requirements.	N/A	<60 people (including housed staff)	For duration of activity	For duration of activity	
Gravel pit construction and operation. Existing gravel pits outlined in Table 1 or gravel from pits located in adjacent properties/ DIPL pits will be utilised to support civil construction and maintenance activities.	N/A- existing approved activity.				
Seismic consists of the following: **Seismic charges- minimal disturbance approach** It is anticipated that the survey will be collected using small seismic charges to minimise the clearing of vegetation. In such a case, vegetation clearing will be restricted to extremely dense vegetation where site access is prevented. The charges are approximately 1kg and will be installed within a 200m grid pattern, to a depth of approximately 10-15m underground. The charges will be installed using a small ATV/ 4wd/helicopter mounted auger (refer ***Figure 7***). The charges are packed into place and detonated in a controlled fashion with appropriate exclusion zones. The created detonation zone is kept underground, with no surface disturbance anticipated. The detonated charge create a “thud sound” which can be heard within 2km radius and felt within a 200m radius (typically) **Vibroseis (if utilised)** If the seismic energy source is Vibroseis truck(s) then line clearing will be required so that they drive and operate over the survey area. Source lines, for Vibroseis trucks to operate on, will need to be cleared 4km metres wide every ~200m over the survey area. Existing cleared areas will be utilised where possible to reduce disturbance. The line tolerances for weaving around vegetation are allowed. Seismic lines will also be in a manner to avoid any large habitat trees or sensitive flora, with no clearance to be undertaken in watercourses and associated riparian vegetation. **Surveying:** Surveyors mark the ground with biodegradable paint, or points are marked by wooden stakes. Line detours may also be marked with temporary biodegradable flagging. A survey team in a light 4WD vehicle or ATV, will make generally one pass over any given section of line. **Recording:** Recording normally commences two to three weeks after the start of line preparation. This operation is the largest part of the seismic operation in terms of personnel and vehicles. The size of the crew	~20-140 ha (depending on energy source)	Up to 35	Before or after exploration ell drilling with the final time to be finalised.	3 – 8 weeks per site	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
will vary depending on the recording technique used, terrain and season and recording is generally restricted to daylight hours. Geophones are deployed at regular intervals along non cleared lines perpendicular to the source lines. If Dynamite is the energy source, then the shots will be let off in sequence and recorded by all the geophones. If Vibroseis is the energy source then the truck(s) drive along source lines vibrating the ground at set intervals with the energy is recorded by all the geophones. After the energy source is finished the geophones are collected rehabilitation and data analysis commence. **Rehabilitation:** Felled vegetation will be pushed to the side of the seismic line during operations. The felled vegetation will be returned across the seismic line upon completion of seismic activities to aid in rehabilitation and assist in erosion and sediment control. Root stocks are to be left in place as much as practicable to allow for rapid re-establishment of vegetation. Based on previous experience in the region, most areas will naturally regenerate following rehabilitation following the wet season.					 e.g. of rehabilitation efforts in progress (HESS, 2013). e.g. of recruitment of vegetation post rehabilitation of open *Eucalyptus* woodland (HESS, 2013).
Groundwater monitoring bore installation Existing groundwater monitoring/ extraction bores are located on the sites. Additional groundwater monitoring bores may be constructed on each site within the underlying aquifers. The construction of the groundwater monitoring bores will utilise a water bore drilling rig to construct the bores, identical to the rig used to drill pastoral water bores. All groundwater monitoring bores will be constructed in accordance with the Minimum Construction Requirements for Water Bores in Australia. Bores may drilled into the Anthony Lagoon formation (if present and saturated), Gum Ridge formation. Waste cuttings, drilling fluids, muds and formation fluids will be collected in a small earthen sump and managed in alignment with the practices outlined in the. Minimum Construction Requirements for Water Bores in Australia. The fluid (which is anticipated to be fresh) will be discharged to grade and the area surrounding the lease. The formation cuttings and drill muds will be mixed with soil onsite and incorporated into the lease pad surface.	N/A- located within the existing disturbance	<6 people	Typically prior to exploration well drilling	<4 weeks	
Exploration well drilling Up to 2 additional petroleum exploration wells are proposed to be drilled at each site (2 at the Amungee NW and 2 at the Velkerri 76 S2 site). Each well will be drilled into an underlying prospective petroleum reservoir (anticipated to be the Velkerri shale) to a typical maximum depth of 3000m. Each well will be deviated into the horizontal position, with a lateral drilled up to 3000m. Each petroleum well is designed and constructed in accordance with the Code of Practice for Onshore Petroleum Activities within the Northern Territory (Code of Practice) to maintain well integrity and protect aquifers and the environment. A Well operations management plan (WOMP) is required to be submitted to the regulator and approved prior to the drilling of any wells. The WOMP outlines the well design and drilling practices that will be deployed to ensure compliance with the Code of Practice and protect underlying aquifers and the environment. Each well is anticipated to be constructed with multiple casing and cement strings, typically 4 casing strings (conductor casing, surface casing, intermediate casing and production casing). Once the well design is approved by the Northern Territory government (NTG) A rig package will be mobilised to site, which consists of a drilling rig (comprising rig matting, a rig floor, mast or derrick, rig engine, blow out preventor, catwalk, safety flare etc.), pipe racks, casing strings, drilling rods, rig fluid system (mud tanks, shakers, mud treatment system and pipework) storage trailers, bunded chemical storage areas, workshop portable onsite offices, crib huts, mini-rig camp and sewage treatment system and irrigation area), freshwater storage tanks, diesel power generation, cement trucks, bulk fuel storage, water transfer pumps, fork lifts, lighting towers, crane etc.	N/A located on proposed lease pad	<60 people	Pastoralist to be notified when drilling proposed	Typically 60- 90 days per well	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
The rig will be constructed over the pre-installed stove pipe and cellar. Once functional, drilling will proceed down below the first encountered aquifer, where the first casing section of the well will be installed (either in the Anthony Lagoon Formation if present and saturated or the Gum Ridge formation (anticipated to be present). After the surface casing is set, a BOP will be installed, to ensure any influxes of gas, water or pressure are able to be safely managed during drilling of the remaining sections of the well. The drilling rig will continue to drill the various other casing and cement sections. The integrity of each of these casing strings is tested through a combination of leak off tests, casing pressure tests, cement return tracking and cement bond logs. Upon completion of drilling, a barrier integrity verification report is submitted to the regulator summarising the integrity of the well. This report is publicly available. Once each well is finished drilling, the well head is installed and the rig is either “walked” to the next adjacent location with the process repeated or mobilised to a new location. A low toxicity water-based drilling mud is to be used as the base fluid for drilling, which primarily contain salts and polymers. Drilling mud is required to maintain well control, provide formation stability, lubricate and control the temperature of the drill bit and lift cuttings to the surface. The fluid system consists of water with a sodium or potassium-based salt (to prevent formation swelling) and a viscosifying agent such as bentonite. Other low toxicity chemicals such as barite, citric acid, sodium bicarbonate and loss circulation material (fibres such as coconut coir or nut hulls etc.) may also be used. The chemicals used for drilling are consistent with those used for water bore drilling. Waste drilling muds, fluids, cuttings and mineral waste (such as cement returns, sand etc.) brought to surface will be stored in the lined drilling sump. Drilling fluids will be evaporated and then removed from the sump and disposed of offsite. Solid waste within the drilling sump will be allowed to dry out and then either removed from site or disposed of onsite in accordance with the Code of Practice. Where onsite disposal is proposed, a risk assessment will be completed demonstrating that the activity can occur with no residual environmental harm. Onsite disposal can include encapsulation or mix bury cover, depending on the site specific details and final composition of the drilling waste material. Subsurface diagnostic tools will be run on the well during and after drilling to understand the nature of the target reservoir. Some sections of the formation may be cored or have sidewall samples collected, which will add further analysis of the reservoir properties. To assist with determining the suitability and capacity of these formations for potential gas extraction activities, diagnostic fracture injection test (DFIT) may be conducted across a number of shale intervals to evaluate the geo-mechanical and reservoir properties of the targeted formation. Prior to a DFIT, a cement bond log and casing pressure test is completed to ensure the integrity of the cement and steel casing. A DFIT involves the injecting of small volumes of a water (approximately 30 barrels (5,000L) per DFIT) at low pumping rates to create a small fracture in the target interval. The well is shut-in, and the pressure allowed to fall-off naturally. Monitoring the fall-off pressure over time allows information to be derived about the reservoir. The fluid does not contain proppant so that the fracture closes naturally when the fluid leaks off into formation. The analysis of pressure, during injection and after shut-in, provide powerful tools for understanding and subsequently informing the design for a future hydraulic fracturing process (not in this scope). Any returned fluid will be stored within double lined tanks and disposed of offsite at a licenced facility. All waste drilling fluids, muds, cuttings, DFIT return fluid and cement returns will be managed in a lined drilling sump on-site. Once drilling has been completed, this material will be sampled as per the code of practice and a detailed risk assessment completed to determine whether onsite encapsulation or mix bury cover can occur in ana environmental acceptable manner. In most cases, drilling wastes will be dewatered, blended and encapsulated within an impermeable m					

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Hydraulic Fracture Stimulation Upon completion of drilling activities at each site, a frack spread will be mobilised to site to commence hydraulic fracture stimulation (HFS or stimulation) activities on each drilled well. A frack spread consists of: • Data Van – on-site office to execute stimulation activities • Water Storage - tanks will be constructed on-site, capable of managing both make-up water and flowback water. Tanks will be double lined with leak detection capable of monitoring any leaks between the primary and secondary liner. Tank number will depend on encountered flowback volume and can range between 5- 12 tanks (the exact number may be more or less than the anticipated number) • Proppant Trailer - a large sand storage and delivery trailer that holds the proppant • Hydration Unit – used to add stimulation additives and viscosifying fluids • Blender Unit – used to mix proppant and fluid additives, prior to its injection into the well • High Pressure Pumps – pumps which inject the hydraulic fracturing fluid mixtures from the Blender Unit down the well, via the surface lines and hydraulic fracturing wellhead or coiled tubing unit • Coiled Tubing Unit – a large length of coiled steel pipe that can be temporarily installed in the well to perform various downhole operations • Wireline unit – plug and perforation deployment • Ancillary support buildings – offices, workshop, cranes, chemical storage area, equipment storage, power generation and all other activities required to support stimulation activities. Stimulation involves the injection of a slurry, primarily consisting of water and sand (proppant), plus a small percentage of chemicals at high pressure into the target section of the horizontal wellbore approximately 1000m – 4000m below ground level (depending on the depth of the target formation). Typically, 90% or higher of the total volume in stimulation fluids is a combination of fresh water and sand (~6-8%), with the remainder as fluid-conditioning additives (~2-4-%). Prior to the commencement of stimulation activities, the integrity of the well is tested with a cement bond log and pressure casing test. This integrity report is submitted to the regulator prior to the commencement of stimulation activities. The stimulation fluid is pressurised by the high-pressure pumping units and directed downhole via a manifold to the discrete target intervals along the horizontal wellbore (referred to as 'stages'). Each stage will be isolated and perforated using a plug and perforation gun assembly deployed via a wireline unit. As the pressure is sustained, the fractures propagate radially from the well, through the target rock. Once optimal fracture propagation has been achieved, the proppant (sand) is pumped down the well and into the open fractures. This process is repeated for each stage. The final number of stages pumped in each well is dependent on the useable length of the horizontal wellbore and in-situ geological conditions. Once all stages are complete, the well is suspended awaiting completion and well testing activities. Wellbore pressures are monitored during each stimulation, to ensure the operations have not compromised the integrity of the production casing or the cement barriers. A Maximum Allowable Operating Pressure (MAOP) is an important engineering parameter used to define the operating envelope (i.e. the safe maximum pressure that should not be exceeded). The maximum allowable pumping pressure (MAPP) is set below the MAOP to allow for uncertainty and provide an additional safety margin so the MAOP is not exceeded.	N/A located on proposed lease pad	<50 people	Post exploration well drilling	2- 8 weeks per well depending on stimulation size	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Well completion Once each well has been stimulated, a completion rig will be mobilised to site to "complete" the well. This involves installing downhole equipment such as packers, plugs, production tubing, artificial lift etc. required to enable the production testing.	N/A located on proposed lease pad	<12 people	Post stimulation	1-2 weeks	
Well testing Once each well has been completed, the well will be brought online and tested for a period of 1 to 24 months (typically-). To enable the testing, a well test package will be installed at the site consisting of: • Separators (to separate gas, condensate and water) • Flares (either a vertical or horizontal), • Flare pit (if a horizontal flare is utilised • surface pipework, manifolds, and tanks • communication and generator shacks • workshops/ storerooms • bulk diesel tanks • wastewater storage tanks (converted freshwater storage tanks used for stimulation makeup water) • Water transfer equipment • Wastewater evaporation and treatment units • Camp accommodation. Each of the exploration wells will be underbalanced (or "unloaded") to initiate production, either through its own energy or through artificial lift (such as through a Nitrogen lift or pump). The fluid and gas will be sent through a separator, with all hydrocarbon metered and either flared or beneficially used onsite (for power generation etc.). Flowback water will be discharged from the separator into designated wastewater storage tanks. Multiple well testing operations may be required to test the behaviour of the formation to determine whether extended shut ins can affect well productivity. After or during production testing operations the well/s may be shut in for a period of time to allow the pressure to naturally build up in order to assess reservoir pressure.	N/A located on proposed lease pad	<12 people during production testing	During exploration activities	Typically 1 to 24 months.	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Wastewater tank storage Flowback refers to water utilised for HFS that is “flowed-back” to surface. It typically is highly saline (saltier than seawater) and contains contaminants that require careful management to ensure they are not released to the environment. Flowback wastewater will be treated on site via evaporation (or other treatment technologies) and removed from site upon completion of activities. Evaporation is used to minimise the volume of wastewater required to be transported offsite, reducing the amount of truck movements. Double lined wastewater tanks will be utilised to store wastewater, with the volume and number of tanks installed dependent on the anticipated flowback return volume. Wastewater storage tanks have continuous level monitoring, with leak detection sensors located within the interstitial space between the primary and secondary liners. It is anticipated that up to 30ML of tank storage may be installed onsite, with a combination of enclosed tanks and open treatment tanks. In accordance with the Code of Practice, sufficient enclosed tank capacity must be onsite to store all wastewater. Flowback can only be stored within open tanks where undergoing treatment (such as evaporation). Open evaporation tanks must have a 1:1000 annual re-occurrence Interval (ARI) wet or dry season freeboard (i.e. available tank space to accommodate rainfall), which is typically 1.3M or 0.3M respectively. The lease pad or a specifically constructed wastewater storage areas will be bunded to contain 110% of the volume of the largest tank stored onsite. Wastewater storage tanks may be deployed for extended periods of time to allow ongoing evaporation or treatment. Treatment of wastewater may also be undertaken onsite, with water treatment options such as submerged combustion units, enhanced evaporation units etc. utilises to reduce wastewater volume onsite. Wastewater from other sites across the basin may also be used to stored onsite, to assist in wastewater treatment/ management.	N/A located on proposed lease pad	<4 persons	During wastewater storage activities.	3-36 months	
Flaring During well testing, all produced hydrocarbons (gas and liquids) will be flared onsite unless they can be beneficially used (for power generation etc.). Two flares may be utilised, with a vertical flare used to manage gas and a horizontal flare used to manage condensate where it is anticipated to be encountered. The vertical flare will be an American Petroleum Industry (API) 537 and a US EPA AP 42 compliant unit, with a 98% combustion efficiency. The vertical flare will have a constant pilot flame, with an autoignition system that provides electrical impulses to a spark plug continuously. If the flare was to go out, the spark would ignite the flare within 1.3 seconds. A horizontal flare may be utilised to combust condensate if produced during well testing. A horizontal flare will been equipped with 3 independent nozzles, located in a 20mx 10m clay lined flume. Flares will be located at least 45m from the surrounding vegetation, with flaring not undertaken during total fire ban periods.	N/A located on proposed lease pad	<12 people during production testing	During exploration activities	During production testing.	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Condensate management Where condensate (liquids rich gas that “condenses” when brought to the surface)) is generated, it is separated and stored within double lined condensate tanks. Condensate may either then be trucked offsite or combusted in the horizontal flare.	N/A	1-2 trucks per day	During exploration activities	During production testing.	
Wet season operations Exploration activities (including drilling, stimulation and well testing operations) may occur over the wet season. Where wet season operations are undertaken the following risk controls will be implemented: • All chemicals, fuels, equipment, tanks and materials required for ongoing operations will be stored on-site prior to the onset of the wet season • All equipment required to respond to emergency situations will be on-site; this include earth moving equipment, vacuum trucks, wireline rigs, cementing equipment etc. and equipment and material to deal with well control issues, spills and other emergency events. • All chemicals storage areas will be bunded, with covers used (where safe and appropriate) to prevent rain ingress and bund overflows. • Enclosed tanks will be utilised as the primary measure to store wastewater with enough enclosed tank capacity to store all wastewater on-site. • Enclosed wastewater storage volume will be sufficient to manage all wastewater stored onsite. • Open working evaporation tanks and mud sumps will have enough freeboard to manage an entire 1:1000 ARI wet season event (not just one (1) rainfall event but an entire seasons rainfall total). • Helicopters will be used to transport people and supplies into and out of the site when access is restricted. • No transportation of wastewater or chemicals will be undertaken during the wet season unless a risk assessment is undertaken that demonstrates the risk is As Low As Reasonably Practicable (ALARP) and acceptable (as per the Code of Practice). • Wastewater storage area is bunded, which will prevent all off-site release of chemicals and stormwater practicable (ALARP). • During flowback wastewater stormwater will be retained on-site via the sediment retention pond prior to release. • Overland flow will be diverted around lease pads.	N/A	N/A	October - May	7 months of the year	

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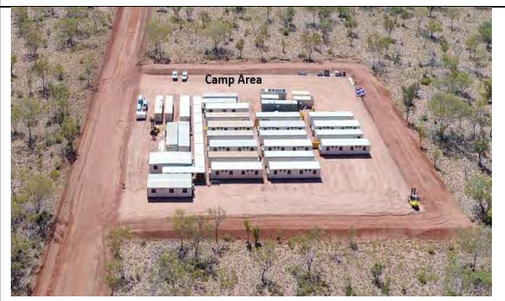
Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Site monitoring and inspections consisting of the following: • **Groundwater monitoring:** Groundwater monitoring bores are required to be installed on the lease pad before the commencement of hydraulic fracture stimulation activities. Groundwater monitoring is undertaken at the site commencing 6 months before stimulation and then quarterly for 3 years after. Groundwater monitoring involves purging a monitoring bore of water, measuring field parameters (level, electrical conductivity) and collecting laboratory samples and • **Site and exploration well monitoring-** an operator or contractor will access the site to perform checks on the exploration well and stability of the site. Checks include pressure readings and visual checks of valve integrity. In some cases, a helicopter may be utilised to complete the inspections. Surveys are completed fortnightly. • **Weed inspections-** Access to the site by several contractors/ Origin personnel in light vehicles to identify weeds. In some cases, a helicopter may be utilised. Contractors may perform spot sprays with a NTG recommended weed treatment. Surveys are completed pre and post wet season. • **Erosion and sediment control inspections-** Access to the site by several contractors/ origin personnel in light vehicles to identify erosion or stability issues. Inspection will be used to schedule maintenance to repair any defects identified. In some cases, a helicopter may be utilised to complete the inspections. Surveys are completed pre and post wet season. • **Gas leak detection surveys-** Access to the site by 2- 3 contractors/ origin personnel in light vehicles to perform mandatory gas testing using handheld gas meters. Surveys are completely.	N/A	<2-6 people	Fortnightly/ 6 monthly (depending on activity)	1 day per inspection	
Site maintenance (**lease pad, camp pad, access tracks and gravel pit)-**includes grading, erosion and sediment control repair, vegetation management, firebreak management, weed management, fence repair and all other ancillary activities required to maintain a site and associated with infrastructure. This includes maintenance of the access track interception with the Carpentaria highway. The work will be undertaken by civil maintenance contractors and Origin personnel.	N/A	<10 people	6 monthly- pre and post wet season maintenance	<7 days per activity depending on the nature of the activity.	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Well head maintenance- maintenance is completed annually on each well. Maintenance primarily includes valve checking, testing, greasing and (in some cases) replacement, as well as any other activities required to maintain the integrity of the well**.**	N/A located on proposed lease pad	<20 people depending on activity	Annually	< 7 days per activity- depending on nature of maintenance.	
Well intervention- data acquisition and testing- subsurface activities may be undertaken periodically on each of the well to perform maintenance or collect additional information on the properties of the well or the reservoir. These type of well interventions typically include performing cement bond logs, casing pressure tests, , running reservoir evaluation or production logging tools, cement and casing remediation activity (if required during the life of the well) , setting downhole mechanical plugs and gauges, casing perforation, subsurface barrier maintenance/ installation and production tubing installation/repair or replacement.. This generally involves the use of a variety of equipment dependent on the activity being completed. This typically may involve any of the following equipment: completion rig, coil tubing, wireline unit, data van, cement or pump truck, crane, trucks, power generation, support trucks and other support vehicles.	N/A located on proposed lease pad	<20 people depending on activity	Ad hoc requests- typically 2 interventions within the next 5 years	<10 days per activity	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Petroleum well plugging and decommissioning. Once a petroleum well is no longer required, each well will be decommissioning. Decommissioning involves the permanent removal of the well through the placement of cement plugs to isolate the target reservoir from overlying aquifers in accordance with the Code of Practice: Onshore Petroleum Activities within the Northern Territory (Code of Practice). Once plugs are installed, they are pressure tested to confirm the underlying formations have been adequately sealed off. The well head is then removed. A permanent marker is added to indicate the location of the plugged and abandoned well.	N/A located on proposed lease pad	<12 people	End of well life	<10 days	
Temporary camp activities to support exploration activities. The temporary camp may be constructed onsite to support exploration activities, with a kitchen, offices, accommodation, power generation, diesel storage, water treatment and ancillary support infrastructure. A camp includes onsite sewage treatment and irrigation system, with treated effluent irrigated adjacent to the camp in accordance with the NT Department of Health guidelines for waste treatment and irrigation. The irrigation area will be fenced to limit livestock access.	N/A located on proposed camp pad	50-100 people	Activity to coincide with any well intervention or maintenance which requires onsite camp support (most work will be run out of Daly Waters to avoid the use of a camp).	As required to support exploration activities.	

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Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Chemical and fuel storage- All chemicals and fuels (diesel) required to support exploration activities will be stored in accordance with the relevant regulatory requirements, including the use of secondary containment (bunding) onsite. The Code of Practice has implemented a range of additional controls, including requirements for routine inspections, emergency response procedures and spill management. Anticipated chemical and fuel volumes vary dependent on activity, but may involve the storage of the following types of chemicals and volumes: • Stimulation and drilling chemicals (friction reducers, surfactants, crosslinkers, breakers, buffers, acids, bases, biocides, scale inhibitors, corrosion inhibitors, clay stabilisers, loss of circulation material, drilling muds, salts etc.)- volumes typically less than 20KL per chemical, with some chemicals stored at higher (such as pH control) or lower (such as biocides and corrosion inhibitors) volumes depending on their purpose and planned use. • Diesel – typically 100KL stored but may be 500KL if wet season activities are proposed. • Other chemicals and hydrocarbons- such as oils and greases, lubricants, hydraulic fluid, cleaning chemicals, domestic chemicals etc. used to support operations.	N/A- located on existing area	N/A	During exploration activities	During exploration activities.	
Waste management: Any waste generated during exploration activities will be stored onsite in accordance with the Waste Management and Pollution Control Act and Code of Practice and transported offsite to a licenced waste management facility. All wastes (other than drilling mineral waste) will be stored within skips or equivalent and removed from site at the end of each activity.	N/A	1 -2 trucks during operations	During explorations activities	During explorations activities	

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Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Groundwater extraction: Groundwater extractions from the purpose built groundwater monitoring onsite or another approved extraction bore (which may include trucking water from adjacent properties) will be completed periodically to support exploration activities. All groundwater take will likely be from the Gum Ridge Formation and will licenced under Origin's existing Water Extraction Licence (WEL) GRF 10285. A new WEL may be submitted covering take an alternative formation where present. It is anticipated that groundwater extraction volumes to support this program is anticipated to be less than 175ML, primarily used during the initial stimulation. Once drilling and stimulation has ceased, minimal ongoing water extraction from the site will be required.	N/A	N/A	Ongoing to support exploration activities.	During exploration activities	
Traffic management- Access to the Amungee NW site is via the Carpentaria highway, along the north western Amungee property boundary. The Velkerri 76 s2 site is accessed by the adjacent pastoral station (Hayfield/Shenandoah) at the South/ West corner of the Amungee Property. site will be via the newly constructed access track, located approximately 20km west of the Tanumbirini station main access point. Peak traffic volumes are anticipated to be associated with the drilling rig mobilisation and demobilisation. Traffic volumes may reach up to 44 vehicles per day spread over a 4 week period. During operations (drilling, stimulation or well testing), vehicle movements to the site are anticipated to be less than 10 movements per day. This period is likely to extend typically 60 days per exploration well, 45 days per stimulation and during the duration of a well test (30-365 days). Once the well is suspended or decommissioned, vehicle movements will reduce down to 1 vehicle per fortnight or 1 vehicle per 6 months respectively.	N/A	N/A	During exploration activities	During large mobilisations or works within the road corridor.	
Site rehabilitation- within 6 months of the E&A wells at a site is plugged and decommissioned, the site will be rehabilitated. This involves a) the removal of all surface facilities (well heads, fencing, water bores, tanks etc.) b) deep ripping of compacted surfaces c) recontouring landforms d) respreading of topsoil from the topsoil stockpiles, e) re-seeding (if required) and f) ongoing monitoring and maintenance of the rehabilitation.	N/A		Within 6 months of the plugging and abandonment of all E&A wells	<14 days, with ongoing monitoring and maintenance	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures

6 Environmental outcomes, impacts and risk

The environmental outcomes, potential impacts and risks associated with the ongoing exploration activities are summarised in Table 3. This information will also be provided in an EMP covering the proposed regulated activity, which will be submitted to the Department of Environment, Parks and Water Security (DEPWS) for formal assessment and approval.

Under the PER, an environmental outcome means an outcome that will be achieved if the environmental impacts and environmental risks of a regulated activity are reduced to a level that is as ALARP, and acceptable.

Environmental impacts are defined by the PER as any adverse change, or potential adverse change, to the environment resulting wholly or partly from a regulated activity.

Environmental risks are defined by the PER as the chance of something happening that will have an environmental impact, measured in terms of environmental consequences and the likelihood of those consequences happening.

Both the consequence and likelihood of a potential impact can be reduced through the adoption of controls, which must be applied to reduce a risk down to an ALARP and acceptable level.

Table 3 Environmental risks and controls of proposed variation

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
Groundwater use and quality	• To manage exploration activities to prevent unsustainable depletion of groundwater resources • Preserve groundwater quality to protect environmental and pastoral use	• No adverse changes to groundwater quantity is anticipated to be associated with exploration activities. • Impacts to aquifers levels anticipated to be negligible, with rapid recharge observed from other Gum Ridge Formation bores utilised within the Basin. • No material changes to groundwater quality anticipated from exploration activities. • No impact to Groundwater Dependent Ecosystem's (GDE) or stygofauna from exploration activities (extraction and well construction) • No reduction in pastoral productivity through reduced groundwater volumes	• Low risk of groundwater contamination from drilling fluids during construction of the conductor/ surface casing in the Cambrian Limestone Aquifers due to the selection of low toxicity drilling fluids • Low risk of cross flow of deep formations (such as the target shales) to shallow aquifers through inappropriate well barrier design and construction due to the presence of the Code of Practice controls and verification processes. • Low risk of crossflow through fracture growth into aquifer from stimulation activities allowing the migration of fluid and gas due to the controls within the Code of Practice and underlying separation distance between the target formation and Cambrian Limestone aquifers. • Low risk of stimulation activity inducing seismic activity that enables cross formational flow between shallow aquifers due to seismic stability of region and lack major faults or fracture zones. • Low risk of stimulated zones intersecting offset wells (including the adjacent horizontal wells) or intersecting an existing geohazard due to seismic control, pressure monitoring during stimulation and lack of older petroleum wells in close proximity. • Low risk of crossflow/well integrity caused by the deviation of an E&A well into the adjacent well during drilling due to downhole GPS tracking tools and proximity alarms • Low risk of leakage of either flowback,	• All petroleum wells are to be designed, constructed, operated and decommissioned in accordance with the mandatory controls within the Code of Practice. The Code of Practice outlines specific controls measures designed to protect underlying groundwater resources including: o Exploration wells designed with multiple cement and steel casing barriers to protect aquifers o Drilling fluids and muds must have a low residual toxicity o Groundwater monitoring must be completed before and after stimulation to detect contamination o Well integrity confirmation to prove barrier performance aquifer isolation (casing pressure tests, formation leak off tests, cement bond logs etc.). o Separation between stimulated shale resources and aquifers must be sufficient to ensure the risk of fracture growth is ALARP o Pressure monitoring completed to ensure maximum allowable operating pressure is not exceeded during stimulation. o Ongoing well integrity monitoring and maintenance throughout the life of each well to ensure aquifers are protected o All wells are to be decommissioned in accordance with the Code of Practice,

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			produced water, or hydrocarbons (liquid and gaseous) from suspended or abandoned wells to groundwater due to well design and integrity management. • Low risk of surface contamination from storage and disposal of drilling fluids, additives, muds and cuttings on-site due to low toxicity of drilling muds and disposal risk assessment process. • Low risk of groundwater contamination from surface spills from storage, handling and transportation of flowback water due to the storage and spill management requirements outlined int eh Code of Practice. • Low risk of groundwater contamination from the storage, handling and transportation of chemicals, fuels and wastes due to the mandatory code of practice controls (such as mandated use of secondary containment) • Low risk of groundwater contamination from overtopping of drilling sumps and flowback tanks (including during wet season) due to level alarms and use of enclosed tanks. • Low risk of groundwater contamination from a failure of flowback storage tank due to the design standards of the tank (cyclone rated steel tank structures) and routine integrity inspections • Low risk from over extraction of groundwater for civils, drilling and stimulation activities due to limited nature of take (one off), yield of the Cambrian Limestone Aquifers and available allocation	with cement plugs utilised to separate aquifer units. • All surface storages of wastewater and chemicals to have secondary containment to prevent spills to the ground • An emergency response plan must be implemented outlining how spills and emergencies will be responded to. • Drilling fluids and wastes to be stored within a lined sump • Flowback wastewater must be stored in double lined tanks with leak detection and level monitoring • Double lined enclosed wastewater tanks with leak detection and level monitoring utilised to store all wastewater, with open treatment tanks used to reduce wastewater volumes • All open treatment tanks are to be operated with a 1:1000Annual re-occurrence interval (ARI) wet season or dry season (whichever is applicable) freeboard • All wastewater to be transferred to enclosed tanks within 8 hours of a significant rainfall event occurring (such as a cyclone) • Groundwater monitoring from monitoring bores installed at the site must be completed prior to and after stimulation to detect any contamination. • All water take covered by an existing Water Extraction Licence (WEL) GRF 10285 • New extraction bores must model potential impact on adjacent pastoral bores prior to

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			volumes (as assessed in the WEL). • Low risk that seismic charges impact pastoralist groundwater bores or groundwater quality	being added to WEL. • All water take to be metered and reported quarterly to the regulator • No pastoralists groundwater bores within 1km km of the Amungee NW site. • Seismic surveys to have an industry standard buffer of typically 100m from the nearest extraction bore. • Seismic charges are biodegradable, with any unexploded ordinance likely to rapidly degrade (weeks)
Soils	• Avoid, minimise and control soil erosion and discharge of sediment or soil into waterways or established drainage systems • Minimise disturbance of soil, vegetation and drainage during site activities • Prevent the contamination of soil to maintain the viability of soil resources • Minimise residual impacts to pastoralist usage of exploration areas	• Clearing of up to 228.9 hectares to support exploration activities. • Soil compaction from access tracks and leases. • Increased sedimentation transportation from disturbed areas • Loss of productivity of disturbed areas until final rehabilitation has been achieved	• Medium risk of soil erosion from cleared areas (access tracks, lease pads, camp pads, gravel pits, seismic lines and laydown areas) occurring on disturbed sites due to high intensity wet seasons. Risk is a low consequence (minor impact), possible (<50% chance of occurring) event. • Low risk Reduction in land production through poor erosion and sediment control practices • Low risk of spills/leaks from the on-site storing and handling of fuels. Condensate, hydrocarbons, drilling additives, stimulation additives, flowback fluid, solid wastes, storage and transportation of wastes causing soil contamination. • Low risk of drill sump and flowback tank overtopping due to mandatory freeboard and monitoring controls • Low risk of chemical and waste transportation accident causing soil contamination due to licenced chemical/ waste provider use, spill	• Site selected to avoid sensitive soil units and slopes which may increase erosion hazard. • All land clearing to align with the requirements of the code of Practice and NT Land Clearing Guidelines (2019) • Seismic activities to: o avoid vegetation clearing as much as practicable through use of seismic charges if possible o In open woodlands, limit clearing to grasses and shrubs o Maintain viable root stock to promote rapid rehabilitation o Avoid seismic lines in water courses (unless co-located with an access track) • Erosion and sediment control practices to be utilised at all disturbed

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			response and emergency response requirements. • Low risk of contamination from on-site disposal of drill muds and cuttings with site specific assessment completed to ensure disposal is environmentally acceptable. • Low risk of contamination from a flowback wastewater tank failure due to the structural design of the tanks, site bunding, emergency response requirements and spill management requirements. • Low risk of wastewater evaporation mist transported offsite during wastewater treatment due to wind speed/direction cut offs and routine site inspections during operations. • Low risk of greywater and sewerage disposal from camp wastewater treatment plants due to the irrigation area being appropriately sized, fenced and quality aligning with the NT Department of Health requirements. • Low risk of reduction in land production through poor infrastructure placement as infrastructure is located along an existing seismic line and no sensitive soil types are present in the immediate vicinity. • Low risk of reduction in land productivity from poor rehabilitation due to mandatory rehabilitation requirements and security bond requirements	sites to minimise erosion. • Sites (including gravel pits) maintained to minimise sediment releases, with erosion and sediment control plan in place • Pre and post wet season monitoring completed on all disturbed areas to identify and repair erosion • Construction within the wet season to be avoided to reduce the erosion risk. • No vegetation clearing in major watercourses proposed. • All chemicals and fuels to be stored with secondary containment as per code of Practice. • During wastewater storage, the site is to be fully bunded to contain the volume of an entire wastewater tank if a structural failure occurred • Flowback wastewater must be stored in double lined tanks with leak detection and level monitoring • Double lined enclosed wastewater tanks with leak detection and level monitoring utilised to store all wastewater, with open treatment tanks used to reduce wastewater volumes • All open treatment tanks and sumps are to be operated with a 1:1000Annual re-occurrence interval (ARI) wet season or dry season (whichever is applicable) freeboard • All wastewater to be transferred to enclosed tanks within 8 hours of a significant rainfall event occurring

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
				(such as a cyclone) • Stormwater to be retained onsite during wastewater storage and tested prior to release • All spills of chemicals and wastewater to be cleaned up upon detection. • Irrigation of greywater and treated effluent to be undertaken in accordance with DoH requirements • Disposal of drilling muds, cuttings and mineral waste to be undertaken in accordance with Code of Practice, with onsite disposal only permitted where the potential harm to the environment can be demonstrated as ALARP and acceptable. • Site to be rehabilitated back to pre-existing/ agreed state with pastoralist input.
Emissions (dust, greenhouse and combustion emissions)	• Avoid environmental nuisance at sensitive receptors • Minimise impacts to pastoralists and surrounding ecological communities from dust • Minimise greenhouse gas emissions	• Dust on vegetation in the immediate vicinity of activities reduces plant palatability • Impacts of dust nuisance to birds and fauna in the immediate vicinity of activities, specifically access tracks and seismic lines • Emissions from the combustion of diesel. • Generation of Greenhouse gasses are anticipated to be approximately 100KTCO_2^{e-} per year	• Low risk of dust impacts generated during Civil activities, drilling operations, well testing due to use of dust suppression and routine maintenance of access tracks and infrastructure • Low risk of reduction in regional air quality resulting from emissions from the combustion of diesel due to the temporal nature of the activities and selection of efficient equipment. • Low risk of reduction in regional air quality from gas and condensate flaring due to the combustion efficiency of the flare and operating procedures. • Low risk of air emissions from chemical releases during drilling and stimulation activities impacting livestock, fauna and people due to chemical handling	• Dust suppression to be used on access tracks, lease pads and gravel pits to minimise dust emissions • Dust levels consistent with standard pastoral activities (such as mustering/truck load outs) on the property • Venting of raw gas is tightly controlled under the Code of Practice, with no material volume of gas to be vented • A reduced emission completion (flare) to be utilised to combust all hydrocarbons • Flares to be compliant with USEPA design standards, including 98% flare efficiency • Site located away from sensitive receptors, such as homesteads • Stimulation chemical mixing procedures

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			procedures limiting emissions during mixing. • Medium risk of bushfire from accidental ignition by site activities (civil works, drilling, flaring, grinding) or personnel. The consequence of a fire is considered serious, with the likelihood Highly unlikely. • Low risk of uncontrolled release of gas impacting a receptor during drilling, stimulation, barrier failure, operator error or vehicle collision due to the well design, blow out prevention, well integrity and lack of sensitive receptors preventing impacts. • Low risk of leak of gas from wells due to the well design, routine leak detection and repair and separation distance from receptors,	deployed (such as enclosed hoppers) that minimises dust emissions • Firebreaks to be maintained around well and camp pads to minimise bushfire risk • Flaring exclusion zones to be maintained around flare • Slashing, grinding and other higher risk fire activities to be undertaken away from vegetation/ in manners that avoid bushfire risk • Vehicles to be equipped with fire extinguishers • No flaring during total fire bans • 6 monthly gas leak detection on all exploration wells.
Surface Water	• Avoid and minimise the potential contamination caused by the discharge of sediment or contaminated storm water to waterways or established drainage systems. • Contain any potential contaminants for treatment or disposal.	• Increased sedimentation transportation from disturbed areas	• Low risk of contamination from a flowback wastewater tank failure due to the structural design of the tanks, site bunding, emergency response requirements and spill management requirements. • Low risk of drill sump and flowback tank overtopping due to mandatory freeboard and monitoring controls • Low risk of a transportation accident releasing chemical or wastewater (drilling fluid and flowback) due to the use of licenced wastewater/ chemical transportation providers, spill management and emergency response requirements. • Low risk of spills to surface water from chemicals and fuel storage and handling activities due to use of	• No take of surface water permitted or proposed • Site located approximately 5.5KM from the mapped stream order 1 stream (at Velkerri 76 S2) and ~25km form the closest stream order 1 at Amungee NW • Site maintained to minimise sediment releases, with erosion and sediment control plan in place • Double lined enclosed wastewater tanks with leak detection and level monitoring utilised to store all wastewater, with open treatment tanks used to reduce wastewater volumes • All wastewater tanks engineered to withstand failure, cyclone rated construction • All open treatment tanks and sumps are to

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			secondary containment and separation distance to watercourses. • Low risk of stormwater releases from activities contaminating surface water due to stormwater segregation and testing procedures. • Low risk of infrastructure changing surface hydrology and flow due to infrastructure design and avoidance of overland flow locations. • Low risk of changes to terrestrial ground surface levels associated with seismic activity due to the stability of the basin and geomechanical properties of the target and overlying formations.	be operated with a 1:1000Annual re-occurrence interval (ARI) wet season or dry season (whichever is applicable) freeboard • All wastewater to be transferred to enclosed tanks within 8 hours of a significant rainfall event occurring (such as a cyclone) • During wastewater storage, the site is to be fully bunded to contain the volume of an entire wastewater tank if a structural failure occurred • All spills of chemicals and wastewater to be cleaned up upon detection. • Irrigation of greywater and treated effluent to be undertaken in accordance with DoH requirements • No offsite releases of drilling or stimulation wastewater proposed or permitted • Stormwater retained onsite during wastewater storage, with testing completed prior to offsite release • Site selected to avoid major structural features, such as faults • Basin is seismically stable, with low seismic activity reported. • Minimal disturbance seismic lines utilised where rootstock is maintained to increase stability and aid in vegetation recovery.
Flora and Fauna	• Minimise disturbance to flora and fauna • No disturbance to high	• Clearing of up to 162.2 hectares of regionally extension vegetation communities (such as Open	• Low risk of threatened fauna mortality during clearing for seismic lines or well pad extension , with all sites to be inspected prior to clearing to avoid fauna.	• Vegetation to be walked down and inspected for fauna prior to clearing. Where fauna are identified, work shall stop in the immediate vicinity until they

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
	conservation areas • Avoid the introduction of weeds • Avoid the spread of existing weeds • Minimise the loss of pastoral productivity	Corymbia/eucalypt woodland, Bullwaddy and/ or Lancewood) to support exploration activities. • Loss of fauna and flora habitat • Loss of livestock grazing area • Loss of productivity of disturbed areas until final rehabilitation has been achieved • Disturbance of flora, fauna and livestock from seismic charge noise and vibration	• Low risk of vehicle and machinery noise and lighting on well pads and access tracks causing material impacts to threatened fauna or livestock. • Low risk of contamination from a flowback wastewater tank failure due to the structural design of the tanks, site bunding, emergency response requirements and spill management requirements. • Medium risk of introduction and spread of weeds in the area due to equipment washdowns, inspection and certification requirements. Monitoring and routine treatment completed on identified outbreaks. Impact from weed introductions/spread is considered moderate, with likelihood Unlikely. • Medium risk of bushfire from accidental ignition by site activities (civil works, drilling, flaring, grinding and seismic activities) or personnel on fauna, flora and land productivity. The consequence of a fire is considered serious, with the likelihood Highly unlikely. • Low risk of flora, fauna and livestock being trapped and drowning in storage tanks, sumps and pits due to the design of storages and fencing.. • Low risk of contaminants in water and soil pass through the food chain and bioaccumulate in fauna causing detrimental impacts to local species and communities due to chemical storage and handling practices. Fences are utilised to restrict livestock access. • Low risk of vehicle collisions with fauna –	leave the area. • Seismic activities to: o avoid vegetation clearing as much as practicable o In open woodlands, limit clearing to grasses and shrubs o Maintain viable root stock to promote rapid rehabilitation o Avoid seismic lines in water courses (unless co-located with an access track) o Muster cattle away form seismic area in consultation with pastoralist • Lease pads to be fully fenced during operations • Open pits to be fully fenced to prevent livestock access • Sumps to have fauna ladders or liner material (such as coletanche) with sufficient friction to allow fauna to escape. • Gravel pits to be left open to act as watering point for livestock when not in use • Vehicle speed limit restricted to 60km/hr • Dust suppression used to limit dust impacts to vegetation • Limited night-time activities proposed. • Site to be rehabilitated back to pre-

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			fauna mortality results in a localised impact to listed threatened species, due to avoidance of night-time driving, speed limit restrictions and number of vehicle movements. • Low risk of reduction in land productivity from poor rehabilitation due to mandatory rehabilitation requirements and security bond requirements Reduction in land production through bushfire • Low risk of impacts to flora and fauna through the encouragement of feral animals and other pest species leading to competition with native species. This includes the introduction of cane toads. • Low risk of disturbance to livestock from seismic charges due to small nature of charges- noise anticipated to be audible within 2km and vibration felt typically <500m	existing/ agreed state with pastoralist • All equipment and loads to be inspected and certified weed free prior to entry • 6 monthly weed inspections to be completed with all identified weeds treated. • Weeds sprayed periodically to restrict weed numbers. • Fire response to be implemented during seismic shoot
Environmental Nuisance and Amenity- including dust, noise, light, odour and vibration	• Minimise impacts to pastoralist operations	• Construction of exploration infrastructure onsite changes land use from pastoral to industrial. • Light and noise nuisance to fauna and livestock in immediate vicinity of activity • Increased traffic to proposed exploration area • Noise, light, odour and dust emissions in the immediate vicinity of the lease pad. • A visible hue visible from the Carpentaria may be present at night during flaring or from activity lighting. • Noise impacts from helicopter	• Low of changes in property amenity through the construction and operation of exploration infrastructure due to location of activities and separation distance from receptors • Low risk of increased vehicle accident or traffic impacts through associated with no material traffic volumes anticipated and limited peak traffic periods. • Low risk of adverse impacts to fauna from traffic are not anticipated, with impact levels consistent with standard road traffic levels. • Low risk of helicopter movements causing impacts to receptors based on location of site away from homesteads • Low risk of disturbance to livestock from seismic charges due to small nature of charges- noise anticipated to be audible	• Site located >20km from pastoralist homestead • Site is located away from pastoralist main access points • Maximum peak traffic during mobilisation and demobilisation is likely to be typically less than<44 vehicle movements per day for 2 weeks. • Speed limit restricted on the access tracks to <60km/hr • Dust suppression to be utilised to minimise dust emissions during major equipment moves • Where helicopter movements are planned, the pastoralist to be engaged prior to ensure helicopter do not

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
		movements	within 2km and vibration felt typically <500m	interfere with pastoral activities. • During seismic surveys, detonations will not occur when cattle are in close proximity- cattle will be mustered way from seismic area in consultation with pastoralist

.

7 Consequences for Stakeholder Rights and Activities

7.1 Stakeholders Rights

Pastoral Lessees within the Northern Territory have non-exclusive rights to conduct their pastoral activities on the land granted under the Northern Territory Pastoral Lands Act (2016). Origin respects these legal rights and seeks a sustainable relationship with Pastoral Lessees so that both parties' can co-exist on the land. Origin proposes to achieve this via the following key principles:

1. Formal stakeholder engagement aligned with the requirements of Section 7.2 (a) of the Northern Territory Petroleum (Environment) regulations 2016
2. Structured and timely process for the execution of an access agreement and associated compensation under the *Northern Territory Petroleum Regulations 2020*
3. Mutually agreed ongoing, regular engagement and communications

Origin's impacts to stakeholder rights are limited to accessing and utilisation of defined sections of the pastoral lease for authorised petroleum exploration activities. Impacts to rights are restricted to a loss of pastoral productivity over the areas for which Origin has established infrastructure, such as lease pads, camp pads, gravel pits and access tracks. Access to demarcated zones around the well pad is also restricted, to ensure stakeholder and community safety.

7.2 Stakeholders Activities

In accordance with S7.2 of the PER, Origin is required to provide the pastoralists information on the potential consequences of undertaking the regulated activities on a stakeholder's rights.

A summary of the potential consequences of the activity and mitigation controls are summarised in Table 3 Potential consequences and control measures

Table 3 Potential consequences of the activity on stakeholders' activities

Pastoralist Activity	Potential Consequence to Activities	Mitigations
Pastoralist site access	• Exploration vehicles along access track may interact with pastoralist activities- mustering and pastoralist vehicles • Restricted access to exploration well and fenced area during the length of proposed activities. • Restricted access during seismic surveys	• New access to be constructed along previously cleared seismic line which will minimise impacts to existing pastoral tracks • Pastoralist engaged throughout exploration activity planning to incorporate pastoralist feedback into activity to reduce impacts. • Camps with workers bussed to site to be utilised to minimise vehicle movements. • Hazardous areas to be fenced and signed to communicate potential safety hazards. • Compensation to be paid for loss of available grazing land and disturbance.
Pastoral activities- grazing and mustering	• Minor elevated levels of noise in the immediate vicinity of the well pad during exploration activities (limited noise at all other times) • Potential elevated noise and vibration within vicinity of seismic shoot (typically within 2-500m of activity) • Disturbance of cattle in	• Pastoralist engaged throughout exploration activity planning to minimise impact on cattle and pastoral activities. • Compensation to be paid for loss of available grazing land and disturbance. • Full fencing of well pad to restrict cattle • Speed limits restricted to 60km/hr • Dust control utilised to reduce dust emissions • Site to be rehabilitated back to pre-existing

Pastoralist Activity	Potential Consequence to Activities	Mitigations
	the immediate vicinity of the activity when works are undertaken • Dust impacts on immediate adjacent vegetation has the potential to temporarily reduce yield- similar to existing pastoral tracks. • Reduction in pastoral productivity through poor rehabilitation • Potential introduction or spread of weeds • Helicopter movements in vicinity of pastoral activities may disturb cattle/ mustering operations	state, with security bond in place if company fails to rehabilitate. • Weed management plan implemented, including requirements for weed hygiene inspections and certificates on all equipment and vehicles. • 6 monthly weed monitoring and spraying of weeds using a NT Government approved treatment • Pastoralist to notified and engaged prior to commencing helicopter movements to mitigate interference.
Pastoral activities- ongoing productivity of area post rehabilitation	• Reduction in productivity due to erosion and sediment releases • Reduction in productivity due to wastewater, chemical/fuel spills • Reduction in pastoral productivity through poor rehabilitation • Potential introduction or spread of weeds	• Routine site maintenance completed to ensure functioning of erosion and sediment control • All fuels and chemicals to be stored within secondary containment, with no storage of hydraulic fracture stimulation flowback work drilling wastewater. • All spills remediated as required in the EMP/spill management plan • End of life rehabilitation to return land back to pre-existing state or as agreed to with pastoralist • Rehabilitation security with NTG retained. • Weed management plan implemented, including requirements for weed hygiene inspections and certificates on all equipment and vehicles. • 6 monthly weed monitoring and spraying of weeds using a NT Government approved treatment
Pastoral access to groundwater	• No anticipated impacts as proposed water take is to be covered under a WEL.	• All take to be authorised under a Water Extraction Licence • Water extraction from pastoralist bores not proposed, unless specifically approved by pastoralist through an agreement
Pastoral access to surface water	• No anticipated impacts as no surface water take, interference or wastewater discharges proposed.	• No surface water proposed to be taken.

Pastoralist Activity	Potential Consequence to Activities	Mitigations
Pastoralists amenity	• Minor elevated levels of noise in the immediate vicinity of the well pad during activities consistent with the 2016 drilling campaign • During seismic charge detonation, noise is infrequent and typically a dull thud • Visual presence of infrastructure within pastoralist lease • Potential visible hue form flare and night-time at distance	• Site to be located away from main pastoralist entry points and homestead. • Noise and vibration from seismic surveys is typically a dull thud not felt outside of 200m or heard outside of 2km. • Site selection to avoid placing flares and exploration activities on regional high points

8 Stakeholder Engagement Plan Feedback

All feedback on the proposed activities and their potential impacts, risks and proposed controls should be provided to Origin via the feedback form in Appendix A within the 28-day time period. Where no comments on contents relating to the requirements of the PER are received within the 28 day period, the PER Stakeholder Engagement requirements will be considered fulfilled. Ongoing stakeholder engagement will then proceed.

All lessee comments and associated Origin responses will be documented and provided to DEPWS as a part of the EMP approval process.

9 Ongoing Stakeholder Engagement

To keep the Tanumbirini Pastoral representatives informed of the status of the regulated activities, the following ongoing engagement is proposed:

- Quarterly engagement on the status of exploration activities
- Fortnightly engagement prior to the commencement of activities under this SEP
- Adhoc engagement as requested by the Beetaloo Pastoral Representative
- Future engagement on additional petroleum exploration activities (If and when proposed) which are not covered under this EMP

Alternative engagement frequencies can be accommodated at the request of the nominated representative.

Origin would also like to extend an invitation to the Pastoral lessees to attend any of the proposed exploration activities to further seek comfort in their understanding and to highlight the nature in which operations are conducted.

10 Commonly used Acronyms & Abbreviations

Acronym	Meaning
AAPA	Aboriginal Areas Protection Authority
ALARP	As Low As Reasonably Practicable
BMP	Bushfire Management Plan
CBL	Cement Bond Log
Code of Practice	Code of Practice: Onshore Petroleum Activities within the Northern Territory
DEPWS	Department of Environment, Parks and Water Security
DIPL	Department of Infrastructure, Planning and Logistics
DFIT	Diagnostic Fracture Injection Test
DoH	Department of Health
E&A	Exploration and Appraisal
EC	Electrical Conductivity
EPA	Environment Protection Authority (NT)
EP	Exploration Permit (e.g. EP76, EP98 and EP117)
EMP	Environmental Management Plan
ERP	Emergency Response Plan
ESCP	Erosion and Sediment Control Plan
GHG	Greenhouse Gas
Ha	hectare
HFS	Hydraulic Fracture Stimulation
JV	Joint Venture
Km	Kilometre
m	metre
NT	Northern Territory
NTG	Northern Territory Government
RWA	Restricted Work Area
SPMP	Spill Management Plan
TO	Traditional Owner
WEL	Water Extraction Licence

WMP	Weed management Plan
WOMP	Well Operations Management Plan
WWMP	Wastewater Management Plan

Appendix A – Stakeholder Feedback Form

Stakeholder Feedback Form NT-2050-95-AQ-0003

Stakeholder:	
Document Referenced:	
Controlled Doc Number:	

#	Ref	Comment	Date	Origin Feedback	Date

Bywaters, Isha

From: David Armstrong [redacted]
Sent: Friday, 8 April 2022 10:31 AM
To: Adrian Brown
Cc: Emma Brown; Wear, Robert; Bywaters, Isha
Subject: Re: Origin - Amungee NW2 - Scope of Work Information
Attachments: RITM_263778_JustWell_Gravel_Bore copy.pdf

Hi Adrian

I'm just touching base to follow up on the email below sent on the 22/3/22 regarding Origin's proposed operations on Amungee that would make up the on-ground activities as part of the current access agreement which is under negotiations.

As mentioned in the email, Origin have requested your comments on the location of the gravel pit and the control monitoring bore (and the activities in general). We have had several discussions regarding gravel pits and Origin's right to extract gravel however Origin needs clarification from you that there aren't any specific issues with the locations from a pastoral operations perspective. We haven't received anything negative from you on the locations of the monitoring bore or the gravel pit, but it would be good to have confirmation from you as we lock in those locations.

Moving forward Origin has requested an amendment to the EMP that had already been submitted for assessment by the regulator. As assessment of an EMP is separate to land access negotiations, we will continue to work through the terms of the access agreement. Activities will not commence until we have agreed an access agreement with you.

Please give me a call if you wish to discuss further

Regards

Dave

DAVID ARMSTRONG

Managing Director

[redacted]

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On 22 Mar 2022, at 5:36 pm, David Armstrong [redacted] wrote:

Hi Adrian,

As discussed at our meeting in Darwin on the 1/3/22 and phone call on 18/3/22, Origin is proposing an amended scope of work which is one well at the Amungee NW1 site and another well at the new Amungee NW2 site (which is one of locations that I showed on the map at our meeting in Darwin), pending site review from you. As discussed, the scope of work Origin wish to focus on under the current access agreement negotiations is the one well at Amungee NW1, a ground water monitoring bore at Amungee NW2, access track at Amungee NW2 and a gravel pit to support construction at both the well locations.

To facilitate this Origin is preparing a revised Environmental Management Plan (**EMP**) which it intends to submit for approval. The proposed activities would not commence until there is an executed access agreement. This amended EMP includes the additional regulated activities on Amungee station (listed below in table 1). Table 1 gives a description of the proposed activities, the environmental outcomes, environmental risks and outcomes of the activities on the stakeholders' rights, as per the petroleum regulations. As mentioned the new scope includes the drilling of a groundwater monitoring bore at the Amungee NW2 location, construction and operation of a new gravel pit and use of an existing pastoral access track (identified on the attached map with the ID RITM0263778 dated 22 March 2022). The proposed site is located approximately 11km East/SE of the existing Amungee NW1 site

Can you please review this information and give comment including comment on the proposed site location of the control bore (which is within the vicinity of the proposed future Amungee NW2 well, which is not the subject of this EMP or the current access agreement negotiations) and the gravel pit, so if it is not suitable, we can work with you on alternative options.

I understand you and Charlie have been busy however I do look forward to your review of the proposed access agreement. If you could have a review of terms from Charlie back to Origin by COB Friday 25/3/22 I would appreciated that.

Look forward to catching up at the NTCA conference.

Regards,

Dave

DAVID ARMSTRONG

[redacted]

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Table 1- description of regulated activities.

Activity description	Environmental outcome	Environmental risks and impacts	Environmental controls	Impacts om the stakeholders rights.	Activity exampl
Groundwater monitoring bore installation A groundwater monitoring bores will be constructed on the Amungee NW2 site using a water bore drilling rig, identical to the rig used to drill pastoral water bores. The groundwater bore will be constructed in accordance with the *"Minimum Construction Requirements for Water Bores in Australia"*. The bore will target the Gum Ridge Formation, with another bore drilled into the Anthony Lagoon Formation if present (considered unlikely). Waste cuttings, drilling fluids, muds and formation fluids will be collected in a small earthen sump and managed in alignment with the practices outlined in the *"Minimum Construction Requirements for Water Bores in Australia"*. The fluid (which is anticipated to be fresh water with low toxicity additives) will be discharged to ground	Maintain the functionality of the surrounding environment (including soils and groundwater	Impact to groundwater resources through poor bore construction Soil erosion Introduction of weeds Impacts to soils from spills and	Groundwater bores to be constructed in accordance with the Minimum construction requirements for water bores in Australia Implementation of erosion and sediment controls All equipment to be free of weed bearing material and certified weed free	Time impacts through activity negotiations Disturbance of grazing activity/ livestock in the immediate vicinity of activity Reduced availability of grazing land Reduced palatability of grasses adjacent to	

Activity description	Environmental outcome	Environmental risks and impacts	Environmental controls	Impacts om the stakeholders rights.	Activity exampl
in the area surrounding the lease. The formation cuttings and drill muds will be mixed with soil onsite and incorporated into the lease pad surface. Minimal clearing is proposed to install the control monitoring bore, with disturbance less than 0.25Ha. Cattle panels/ a small fence may be installed around the bore to protect it from cattle. A gate may be installed on the laneway to access the site.		poor cuttings management Dust generation Disturbance of pastoral activities	Spill management practices to be implemented, including bunding and spill response procedures Cuttings to be dispose of onsite through mix bury cover Dust suppression to be utilised to minimize dust generation Access terms, including gate controls, speed limits, livestock notifications etc. to be agreed with pastoralists and implemented through inductions and routine reporting.	access tracks through dust generation	
Gravel pit construction and operation A new gravel will be constructed approximately 1.5km south of the Amungee NW2 site. The pit will be approximately 5 ha in size and utilized to support the construction lease pads and associated infrastructure at the Amungee NW site and future explorations sites. The Gravel pit will be cleared of vegetation, grubbed and stripped of topsoil down to approximately 100mm (depending on the depth of topsoil onsite). Subsoils will be removed from the pit and segregated from topsoil. Topsoil and subsoils will be stored around the edge of the lease pad to prevent overland flow into the pit. Upon completion, the pit will be recontoured to leave a slight depression, with subsoils and topsoil reinstated to allow vegetation to re-establish. An access track to and from the pit will be constructed, with gates (and potentially grids) installed in the laneway to access the site. B-doubles and triples will typically transport gravel to the required destination.	Maintain the functionality of the surrounding environment (including soils, grazing land	Soil erosion Introduction of weeds Dust generation Disturbance of pastoral activities	Implementation of erosion and sediment controls All equipment to be free of weed bearing material and certified weed free Spill management practices to be implemented, including bunding and spill response procedures Dust suppression to be utilised to minimize dust generation Access terms, including gate controls, speed limits, livestock notifications etc. to be agreed with pastoralists and implemented through inductions and routine reporting. Gravel pits to be left in a safe manner to minimize the impact to cattle	Time impacts through activity negotiations Disturbance of grazing activity/ livestock in the immediate vicinity of activity Reduced availability of grazing land Reduced palatability of grasses adjacent to access tracks through dust generation	<image006.jpg>

Attachment D

Amungee Mungee Station

CY22 Scope – Amungee NW1 (**ANW1**) and Amungee NW2 (**ANW2**)

1. Description of the Regulated Activity

The activities are associated with the proposed drilling, stimulation and well testing of 2 new exploration wells located within the Amungee Mungee Station. The proposed regulated activities include:

- Civil construction activities covering:
    - ANW1 – the extension of existing ANW1 lease pad(up to 4 ha)
    - ANW2 - the construction of 1 new exploration well, containing a lease pad (5.5 ha to 7.5 ha), with a camp (1.5 ha), helipad (1 ha), laydown (1 ha), fence lines and firebreaks (2.5 ha)
    - upgrade to the access track intersections with the Carpentaria Highway (2 additional intersections)
    - ongoing access track and infrastructure maintenance
    - construction, operation and maintenance of up to 1 gravel pits with a total area of 3 ha
- Installation of up to 3 groundwater monitoring/extraction bores at the proposed exploration well sites.
- Acquisition of up to 158 km 2D reflection seismic lines and associated works, including line preparation and land clearing activities.
- Drilling of up to 2 new petroleum exploration well.
- Completion of the proposed additional petroleum exploration wells.
- Hydraulic Fracture Stimulation (HFS) of the proposed petroleum exploration wells.
- Well testing of the proposed exploration wells, including flaring, power generation and beneficial usage of the gas.
- Storage and treatment of freshwater, flowback and other petroleum derived wastewater onsite.
- Subsurface diagnostic tests and data collection on the petroleum exploration wells.
- Drilling and flowback wastewater storage and treatment at the proposed exploration wells.
- Construction and operation of a temporary worker camp.
- Microseismic monitoring and induced seismic monitoring during HFS activities.
- Onsite encapsulation/ mix bury cover of drilling cuttings and mud at each location, including the disposal of drilling waste from other exploration sites.
- Maintenance and monitoring of the proposed petroleum exploration wells and infrastructure.
- Suspension and decommissioning of the proposed petroleum exploration wells.
- Rehabilitation of the disturbance areas.
- All activities required to support the above (such as bulk chemical storage and use, bulk fuel storage and use, bulk sand storage and use, waste management, equipment and materials transport, helicopter movements, monitoring, maintenance, etc).

2. Infrastructure and Location

The proposed exploration activities are located on the Amungee Mungee Pastoral station.

Table 1 below provides a list of all proposed infrastructure and locations.

Exploration Permit (EP)	Infrastructure description	Proposed disturbance area	Proposed Location		
			GDA94 Zone*	Approx Easting	Approx Northing
EP 98	Amungee NW1 lease pad, camp pad, helipad, laydown, firebreaks and fence lines	10.5ha	53	380973.6	8192345
EP 98	Amungee NW1 access track upgrade	1km	Refer to figure 2		
EP 98	Amungee NW2 lease pad, camp pad, helipad, laydown, firebreaks and fence lines	18ha	53	390770.114	8189631.353
EP 98	Amungee NW2 access track upgrade	4km	Refer figure 3		
EP 98	ANW2 gravel pit	3 ha	53	390809.049	8188373.231
Total maximum disturbance		31.5 ha and 5km of Access tracks			

** Universal Transverse Mercator (UTM) geographic coordinate system is Geocentric Datum of Australia (GDA) 94.*

^ This is a conservatively high figure, with the final disturbance like to be significantly smaller

Table 1 Infrastructure location

Figure 1 below shows the proposed location of the Amungee NW1 and Amungee NW2 step out locations.

Figure 2 below shows the proposed Amungee NW1 Lease Pad Layout.

Figure 3 below shows the proposed Amungee NW2 Lease Pad Layout.

Figure 4 below shows the proposed 2D Seismic.

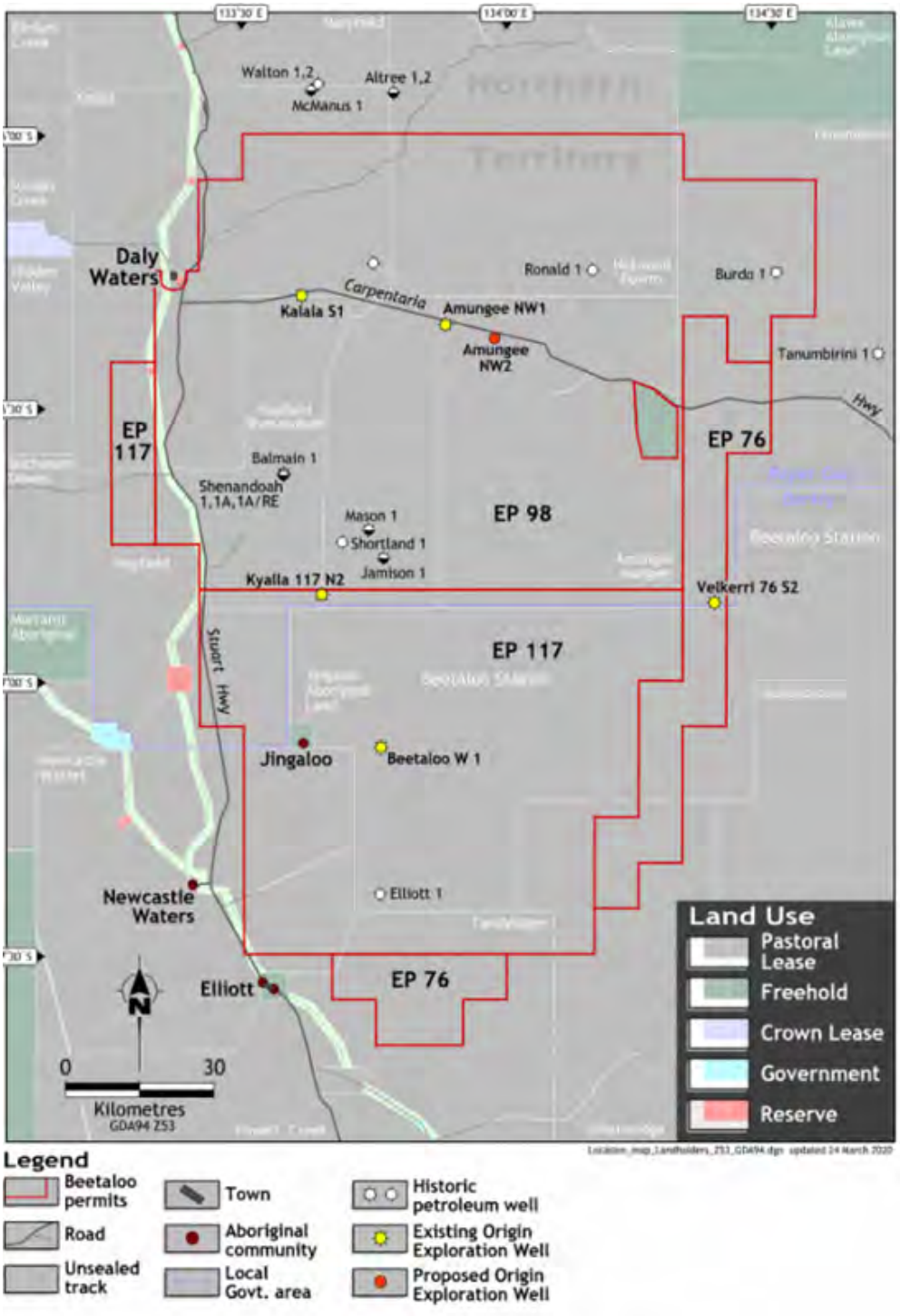

Figure 1 Location of Origin permit area

Figure 2 Proposed Amungee NW1 – Lease Pad Layout

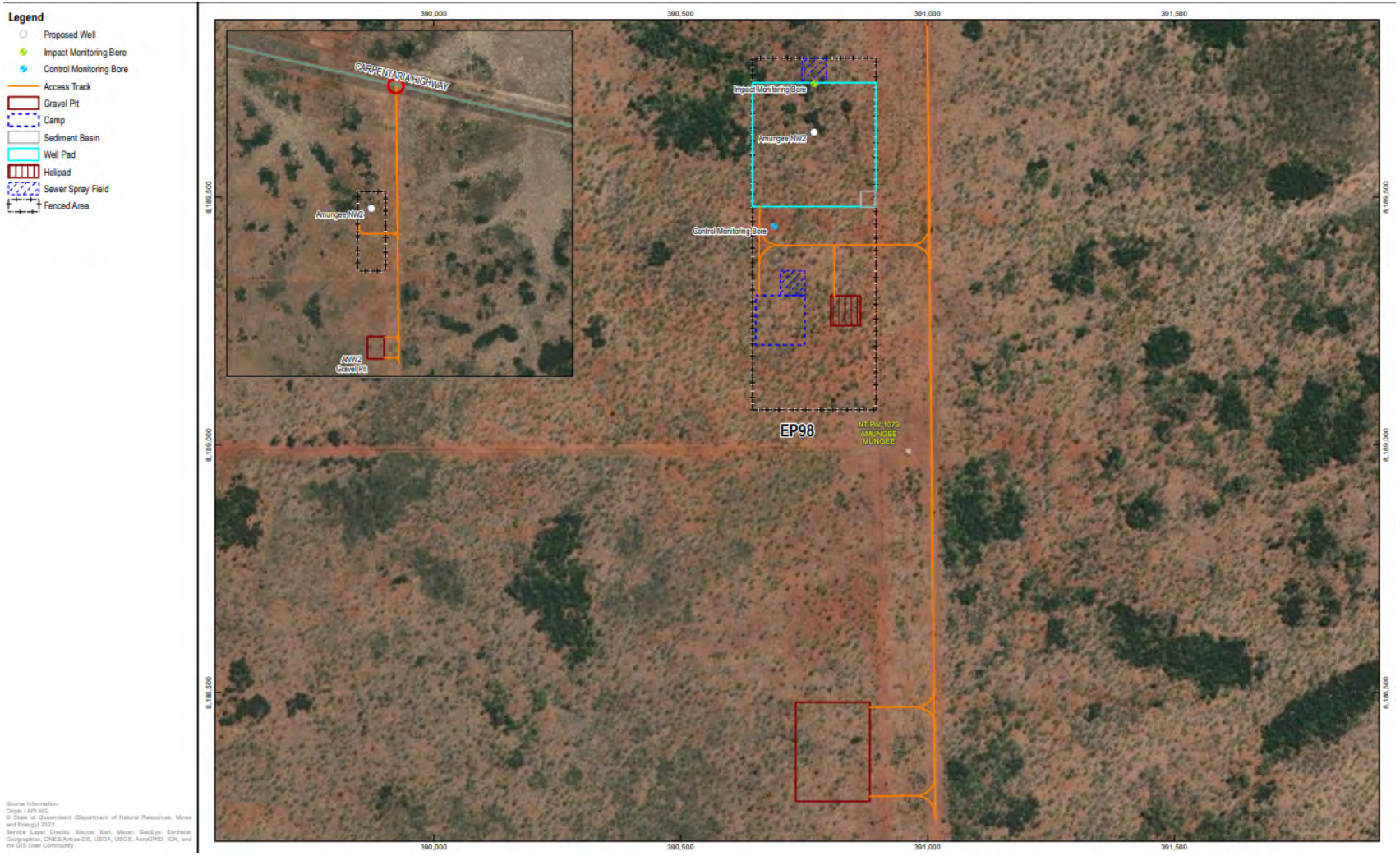

Figure *3* Proposed Amungee NW2 – Lease Pad Layout

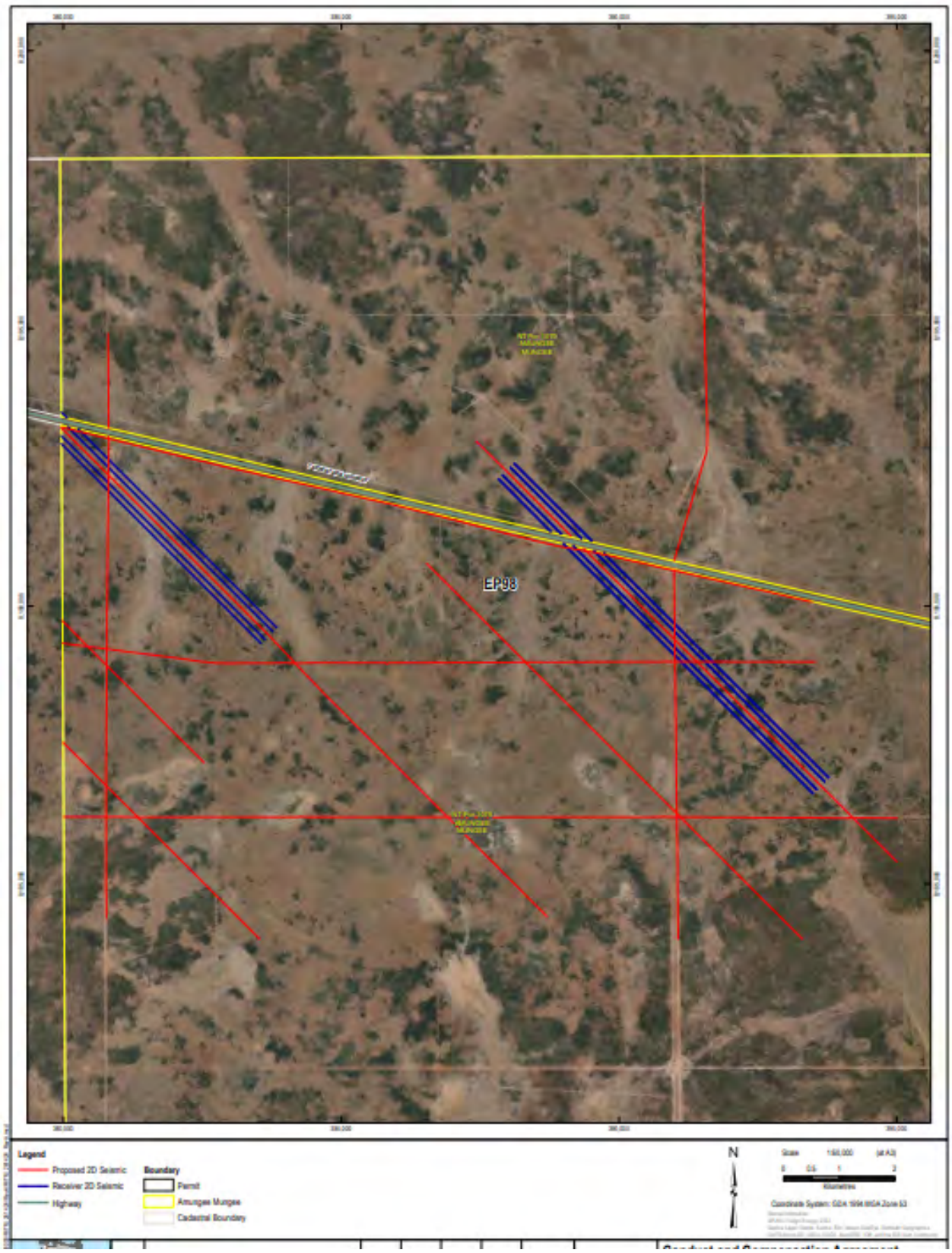

Figure *4* Proposed Amungee NW2 2D Seismic

From: David Armstrong
To: Adrian Brown
Cc: Emma Brown; Charlie Martel; Bywaters, Isha; Wear, Robert
Subject: Re: Stakeholder Engagement Information Pack Amungee NW2
Date: Thursday, 5 May 2022 10:28:42 AM
Attachments: image003.png

Adrian

Re the info you just received

- Attachment A is a new SEP. None of the locations shown in those maps have changed since I shared draft maps with you recently, although they may change on the basis of your recent feedback, and we will point out these changes to you.
- Attachments B and C have already been provided to you and are unchanged. They are provided for reference only.
- Attachment D provides the full scope which is proposed under three access agreements to be negotiated in calendar year 2022.

Have we addressed the following;

- Ability to get cattle back off the hwy at NW1 -

The proposed fence line will be moved as per our discussions (me, you, Robbie). The gate off the hwy will lead straight into the paddock. Origin will put a gate into their site at the entrance to the camp. The fence will follow the infrastructure.

-
- Origins site monitoring of NW1 for livestock behind the fence.

Origin inspects the site weekly and it will be fenced with industry standard stock proof fence. I'm happy to discuss installing a prefab trap gate leading out of the well pad but would your cattle walk through that and there's the issue that it may come open, or putting a tank and trough in the well site however I'm against installing a trough as it will attract animals into the site. For what its worth I have never seen cattle get through a well maintain fence around a drill site and I see this as the best form of mitigating any issues. Happy to discuss further

-
- Access down our boundary fence.

Currently you have access down that fence line via gates through the well pad. Once Robbie has cleared the bunding, the pad will be fenced separately and you will have clear access down the fence line with no gates. We can discuss further and provide a map

-
- New location of NW2.

It's currently been scouted in a new location as discussed with you on Sunday night

-
- New access off the why into NW2

Your feedback on Sunday night regarding access tracks to the Amungee 2 site is noted and will be part of the access agreement negotiations for that activity.

-
- reduction in area required for NW1.

As discussed on Sunday night the fence will follow the infrastructure and no more land will be fenced in other than needed.

Charlie requested information on the bores drilled at the Amungee NW1 site. Briefly, what is described as 'shallow bores' are approximately 6 meters deep used for monitoring and drilled in 2016. The 'deep bores' are the camp supply bore and one supply bore on the pad were drilled in 2016 and the other supply bore on the pad was drilled in 2018. This is just a brief run down for you and more information will come.

If I've missed anything let me know and I'll get back to you.

Cheers

Dave

DAVID ARMSTRONG

Managing Director
[redacted]

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> On 5 May 2022, at 8:22 am, Adrian Brown [redacted]> wrote:
>
> Hi Dave,
>
> Is there any further information in this pack that is different to what has been supplied before, as it seems the same as what has been shared earlier.
>
> Is it possible to share a marked up version, as this is exactly what I am talking about, having to allocated hours into reading this new pack that you may have already sent through.
>
> Have we addressed the following;

- Ability to get cattle back off the hwy at NW1
- Origins site monitoring of NW1 for livestock behind the fence.
- Access down our boundary fence.
- New location of NW2.
- New access off the why into NW2
- reduction in area required for NW1.

Regards,

Bilba Group

Adrian Brown
Managing Director

[redacted]

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From: David Armstrong [redacted]
Sent: Thursday, 5 May 2022 7:59 AM
To: Adrian Brown [redacted]
Cc: Emma Brown [redacted]; Charlie Martel [redacted] Isha Bywaters [redacted]>; Robbie Wear [redacted]
Subject: Stakeholder Engagement Information Pack Amungee NW2

Adrian

Please see attached;

A covering letter explaining why you have been sent this information and what each attachment is.

- Attachment A - Stakeholder Engagement Information Pack (SEP)covering the Amungee NW2 site. This well has been discussed as it is connected to the monitoring water bore that access is currently being negotiated. As mentioned in the covering letter this bore and hence the well location has been moved at your request and up-dated maps will be provided once scouting has finished this week.
- Attachment B - You have been provided with this SEP previously and this is explained in the covering letter.
- Attachment C - emails regarding amendments to Amungee NW1 activities.
- Attachment D - Operational scope summary including maps of the Amungee NW1 site. As mentioned in the covering letter, a map showing the up-dated

fence line location around the well pad and camp site as discussed between yourself, Robbie and me, will be provided.

As always at your request, Origin are happy to make available appropriate people to explain any aspect of the information provided. I'm also available to meet with you at a time and place that suits to discuss any aspect of Origins operations.

Regards

Dave

DAVID ARMSTRONG

Managing Director

[redacted]

<image001.png>

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From:	David Armstrong
To:	Val Dyer
Cc:	Justin Dyer; Wear, Robert; Hanson, Matthew
Subject:	Stakeholder Engagement Pack (SEP) - Proposed Well location - Shenandoah East
Date:	Monday, 23 May 2022 9:27:57 AM
Attachments:	image003.png Pastoralist Engagement Pack- Hayfield Step out.pdf

Hi Val, hope you're well.

Please see attached a Stakeholder Engagement Pack (SEP) for your consideration. This information pack is in regards to the proposed Well pad location for drilling in the north east corner of Shenandoah East. The location is on a seismic line that Origin are looking to do this year as part of the current access agreement.

The purpose of the SEP is to fully inform you of what Origin propose to undertake. It includes a description of operations including potential environmental and pastoral impacts. As always Origin offer any appropriate staff or contractors that you may wish to speak to in order to be fully informed. You requested this meeting with the last SEP about seismic and unfortunately due to circumstances we didn't have it. You may now feel its appropriate for this meeting to take place and Origin would be more than happy to put this together for you.

As always a land access and compensation agreement will need to be in place prior to any regulated activities taking place and Origin will send this through shortly.

Your feed back on this SEP would be greatly appreciated and if you have any questions please contact me

Robbie and I will be in the Daly Waters area over the next couple of weeks so I will give you a call to discuss this SEP further.

Regards

Dave

DAVID ARMSTRONG

Managing Director

[redacted]

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Shenandoah East Station
Amungee Step Out

Petroleum (Environment) Regulations
Stakeholder Engagement Pack

Pastoralist Engagement Pack

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Pastoralist Engagement Pack

1. Introduction

Origin Energy B2 Pty Ltd (Origin) is a registered holder and the operator of exploration permits (**EPs**) 76, 117 and 98, located in the Beetaloo Sub-basin. As a part of Origin's forward exploration work program an Environment Management Plan (**EMP**) will be submitted to the Minister for Environment for approval, covering a series of regulated activities proposed for the Shenandoah East Station (being NT Portion 7027)

The proposed EMP includes the construction of a new exploration well site and the drilling, stimulation, testing, maintenance and decommissioning (and all associated ancillary activities) of up to 3 new explorations wells. It should be noted that the scope of the EMP is designed to provide Origin flexibility in choosing future Exploration and Appraisal (**E&A**) well locations, with all or a subset of activities undertaken.

The anticipated scope includes:

- Construction of a new exploration well pad referred to as Amungee NW3, including camp pad, helipad, laydown yard, water bores, fence lines and all associated infrastructure
- Drilling, stimulation, testing, maintenance, suspension and decommissioning of up to 3 horizontal petroleum wells
- Operations of camp at each location
- Wastewater management and treatment
- Drilling waste management and onsite disposal
- Access tracks linking the exploration well pad locations to the Carpentaria Highway
- Acquisition of up to 25 km of 2D seismic, including seismic line preparation, node deployment and seismic acquisition.
- Micro-seismic data acquisition and associated works. Induced seismic monitoring and associated works.
- Construction and ongoing operation of a new gravel pit
- Maintenance and monitoring of each of the proposed petroleum exploration wells
- Suspension and decommissioning of the proposed petroleum exploration wells
- Rehabilitation of disturbance areas
- All activities required to support the above (such as bulk chemical storage and use, bulk fuel storage and use, waste management, equipment and materials transport, helicopter movements, monitoring, maintenance, etc).

The proposed regulated activities are described further in section 6.

2. Stakeholder engagement process

Under Section 6 (2) of the Northern Territory (NT) Petroleum (Environment) Regulations 2016 (**PER**), an EMP can only be submitted to the Minister for approval after the interest holder (Origin) has carried out stakeholder engagement in relation to the regulated activity to which the plan relates.

The requirements of stakeholder engagement are outlined in section 7 of the PER. Specifically, the interest holders are required to provide the following information to each stakeholder:

- the regulated activity the interest holder proposes to carry out
- the location (or locations) where it is proposed to carry out the activity
- the anticipated environmental impacts and environmental risks of the activity
- the proposed environmental outcomes in relation to the activity; and
- the possible consequences of carrying out the activity to the stakeholder's rights or activities.

This Stakeholder Engagement Pack (SEP) is designed to fulfill the stakeholder engagement requirements as defined under the PER. Once stakeholder engagement has been completed, Origin will submit an EMP covering all or parts of the proposed activities as described in this document. All engagement after this allocated time will be considered “ongoing stakeholder engagement”.

Origin proposes that any questions or feedback to the information provided in this pack is formalised via the form included in Appendix A

Origin will ensure that all responses are reviewed and responded to promptly. Origin also offers a face to face or virtual meeting with the stakeholder where subject matter experts can present the information in this pack and answer any questions.

3. Scope

The scope of this SEP is to satisfy the stakeholder engagement requirements defined under the PER prior to the submission of EMPs covering activities proposed under this SEP.

The regulated activities covered in this SEP are associated with the entire lifecycle of the proposed petroleum exploration wells, from site preparation, through to drilling, stimulation, testing, site decommissioning and all ancillary activities to support. The EMP (or variations of such) will be in force for the next 5 years (the maximum duration of an EMP in accordance with the PER), with revisions required to update the activities within the EMP beyond this period.

Acceptance of this SEP and subsequent approval of an EMP by the NTG is not an approval to commence the activities. This SEP and subsequent EMP(s) are designed to satisfy the stakeholder engagement requirements under the PER for the regulated activities proposed. This SEP does not cover other activity approvals, such as the land access and compensation agreements (LACA) required to be obtained prior to commencement.

The requirements for compensation and access agreements for proposed regulated activities are covered under the NT *Petroleum Act 1984* and Petroleum Regulations 2020 and will occur under a separate engagement process. To avoid any confusion or doubt, any comments received relating to the LACA or other activity/approval not subject to this SEP, will be addressed by Origin separately from this stakeholder engagement process.

4. Background

Origin holds the EPs in the Barkly region under the Beetaloo Joint Venture with Falcon Oil and Gas. The EPs cover 18,512 square kilometres (km^2) of largely pastoral leases on the Sturt Plateau, part of the Barkly Tableland, within the NT (Figure 1). These tenures were granted by the NT Minister for Mining and Industry[1] under the NT *Petroleum Act 1984*.

Origin exploration and appraisal program is designed to prove up the concept of producing hydrocarbons from a range of geological formations within the Beetaloo Sub-basin. Exploration sites are chosen based on prospectively, with data collected across the basin underpinning decisions on where forward exploration sites are proposed. The regulated activities proposed under this SEP are anticipated to commence within the 2022 to 2027 period, with ongoing engagement with stakeholders informing them of proposed activity timing or commencement likelihood.

[1] Formally the Minister for Mines and Energy.

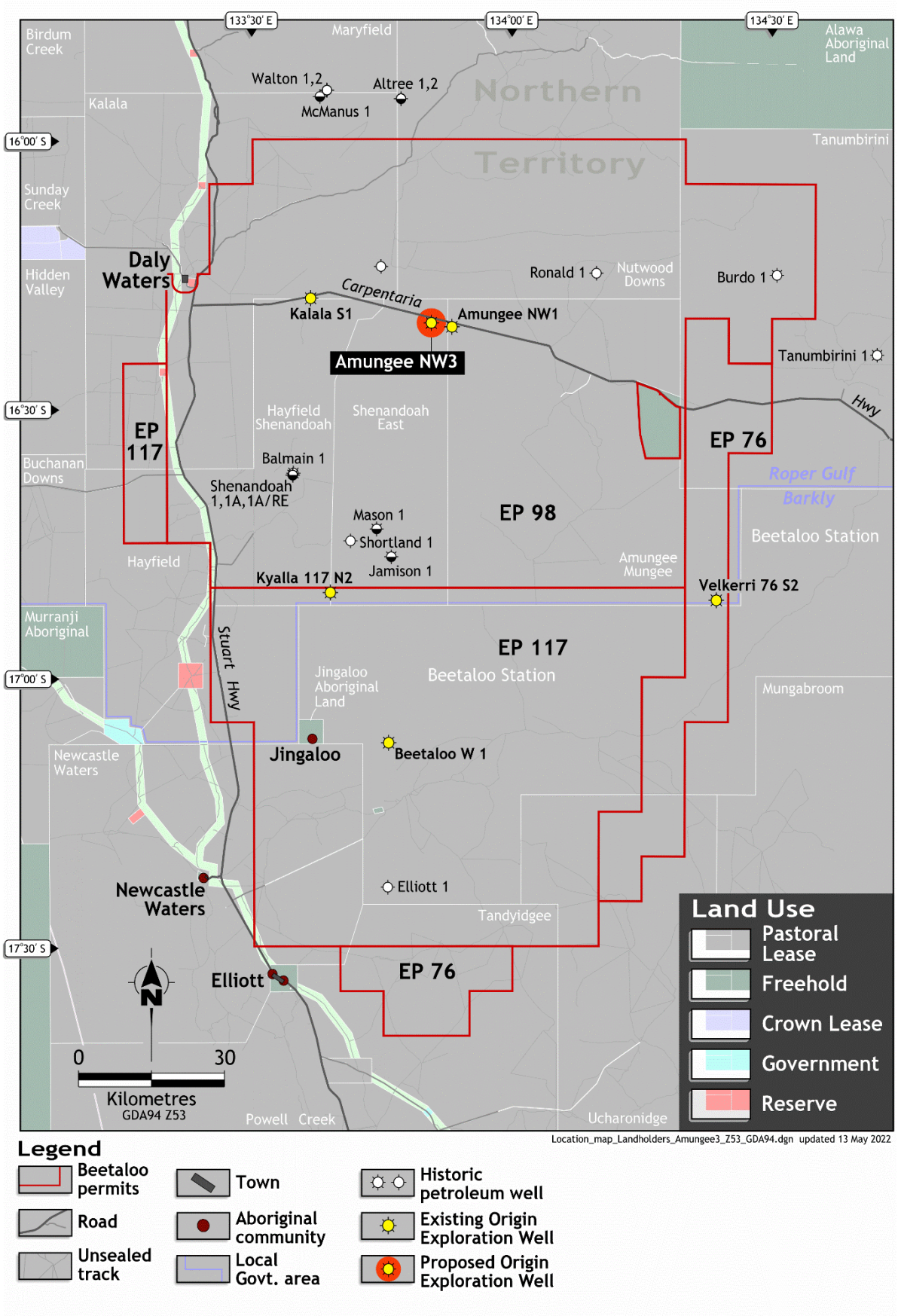


Figure 1 Location of Origin permit area and Amungee NW3

5. Location of the Regulated Activities

The proposed exploration activities are located on the Shenandoah East Pastoral station. The location of the activities is provided in Table 1 and illustrated in Figures 2 – 4.

Table 1 Infrastructure location

Exploration Permit (EP)	Infrastructure description	Proposed disturbance area	Proposed Location		
			GDA94 Zone*	Approx Easting	Approx Northing
EP 98	Amungee NW3 lease pad (7.5 ha), camp pad (1.2 ha), helipad (0.5ha), laydown (0.5 ha), firebreaks and fence lines (4 ha)	13.7ha	53	376621	8193107
EP 98	Amungee NW3 access track	~1km = 1 ha	Refer figure 3		
EP 98	ANW3 gravel pit and access track	5 ha Gravel Pit ~1km Access Track = 1ha	53	375750	8194125
EP 98	Amungee NW3 step out 2D seismic	25km of 2D lines x 5m widths = 12.5ha	Refer figure 3		
Total maximum disturbance		31.2ha and 2km of Access tracks = 2 ha			

** Universal Transverse Mercator (UTM) geographic coordinate system is Geocentric Datum of Australia (GDA) 94.*

^ This is a conservatively high figure, with the final disturbance like to be significantly smaller

Figure 2 Amungee NW3 Lease Pad Layout – Conceptual Design

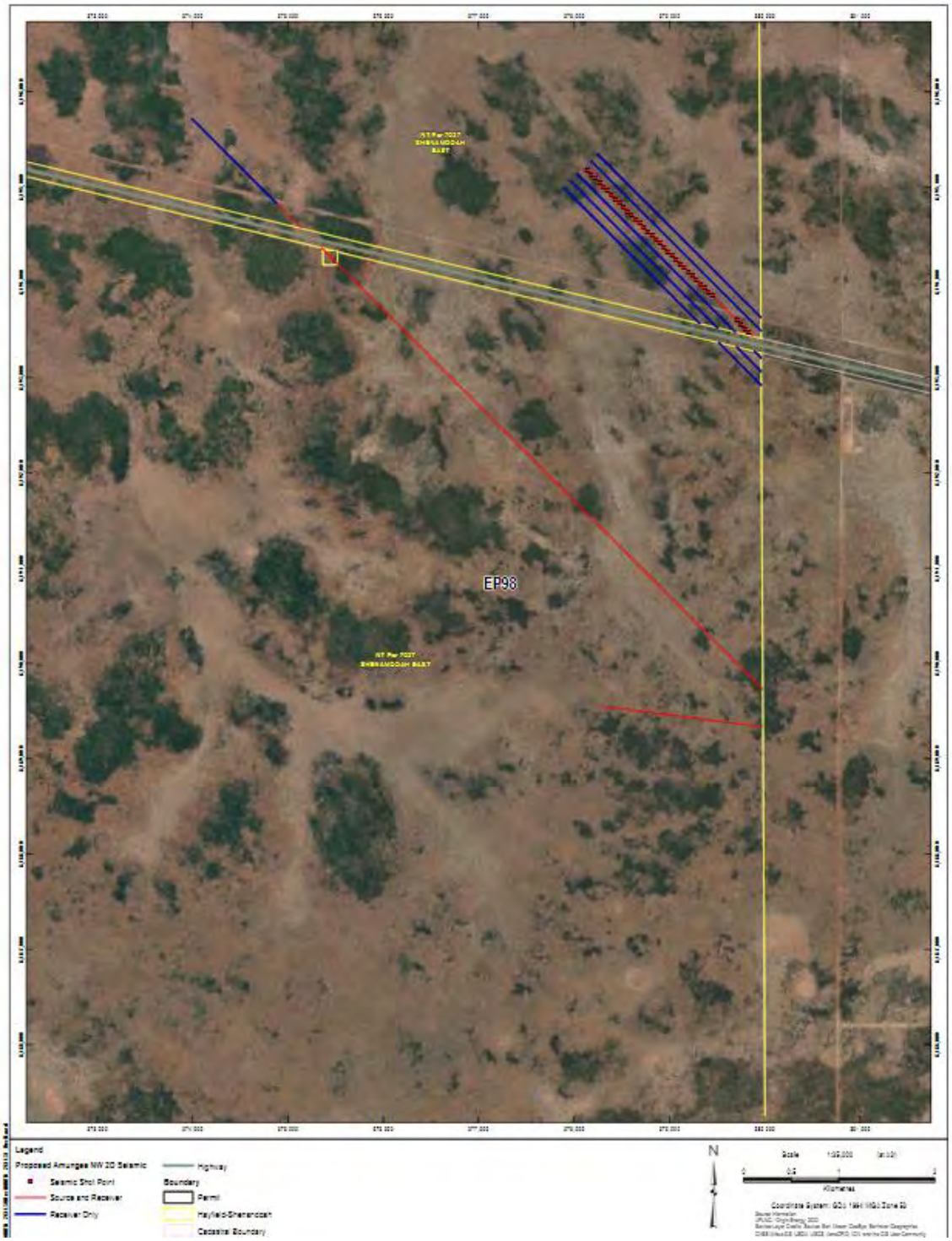


Figure *3* Shenandoah East Seismic Location – Conceptual Design

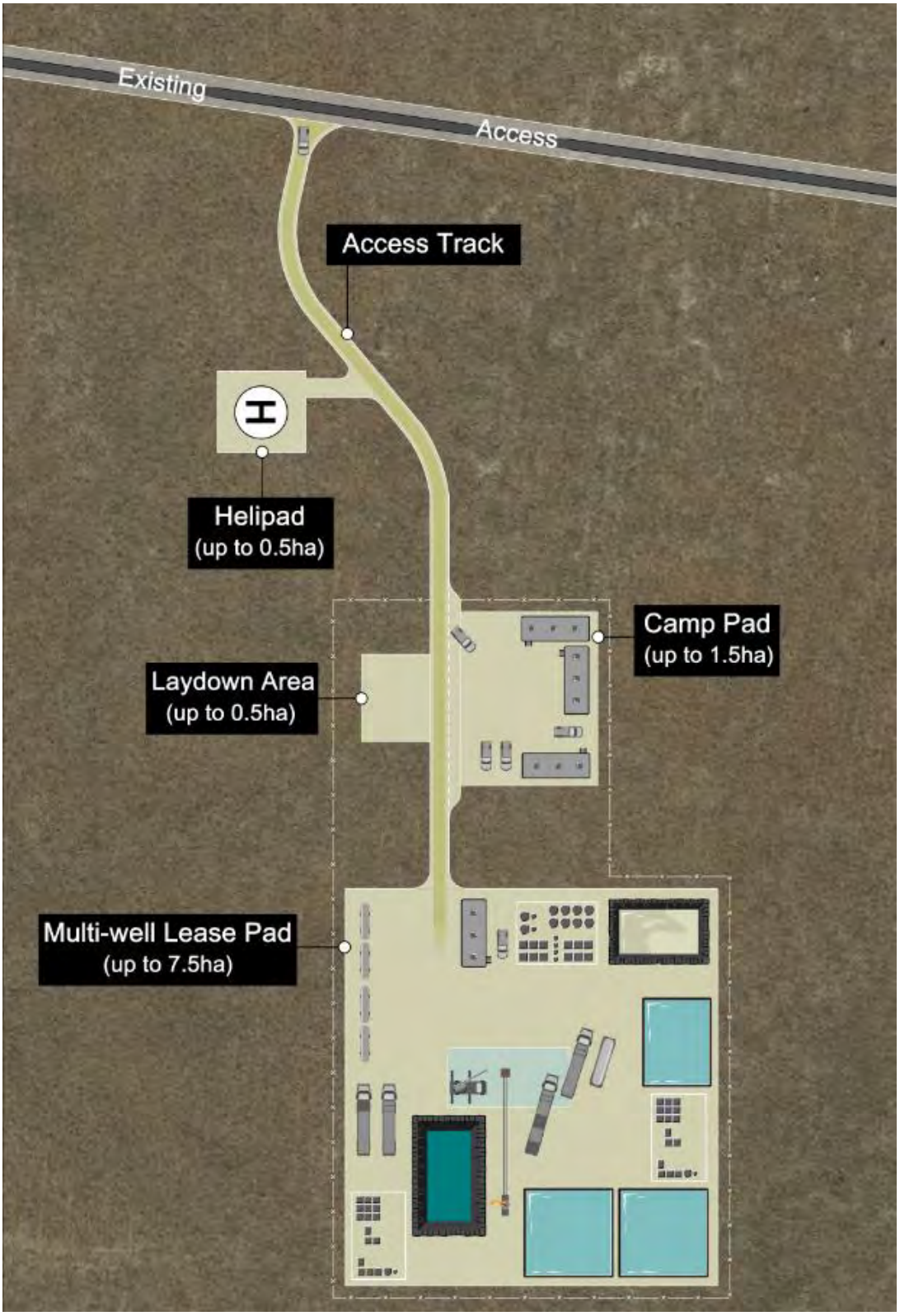


Figure *4* Typical Lease Pad Layout – Future Step Out Locations

6. Description of the Regulated activity

6.1 Summary

The activities are associated with the proposed drilling, stimulation and well testing of 3 new exploration wells located at 1 new well sites across the Shenandoah East Station. The proposed regulated activities include:

- Civil construction activities covering:
  - the construction of 1 new exploration well locations, containing a lease pad (to 7.5 ha), with a camp (1.2 ha), helipad (0.5 ha), laydown (0.5 ha), fence lines and firebreaks (4 ha)
  - construction of an access track connecting the proposed location with the Carpentaria Highway , including the creation of an intersection.
  - ongoing access track and infrastructure maintenance
  - construction, operation and maintenance of a gravel pits with a total area of 5 ha
- Installation of up to 4 groundwater monitoring/extraction bores at the exploration location
- Acquisition of up to 25 km 2D reflection seismic lines and associated works, including line preparation and land clearing activities.
- Drilling of up to 3 new petroleum exploration wells.
- Completion of the proposed additional petroleum exploration wells.
- Hydraulic Fracture Stimulation (HFS) of the proposed petroleum exploration wells.
- Well testing of the proposed exploration wells, including flaring, power generation and beneficial usage of the gas.
- Storage and treatment of freshwater, flowback and other petroleum derived wastewater onsite.
- Subsurface diagnostic tests and data collection on each petroleum exploration well.
- Drilling and flowback wastewater storage and treatment at each of the proposed exploration well sites.
- Construction and operation of a temporary worker camps at each site.
- Microseismic monitoring and induced seismic monitoring during HFS activities.
- Onsite encapsulation/ mix bury cover of drilling cuttings and mud at each location, including the disposal of drilling waste from other exploration sites at each well where required.
- Maintenance and monitoring of each of the proposed petroleum exploration wells and infrastructure.
- Suspension and decommissioning of the proposed petroleum exploration wells.
- Rehabilitation of disturbance areas.
- All activities required to support the above (such as bulk chemical storage and use, bulk fuel storage and use, bulk sand storage and use, waste management, equipment and materials transport, helicopter movements, monitoring, maintenance, etc).

Images of exploration lease pad construction, exploration well drilling, well stimulation and well testing are provided in Figure 2 to Figure 5.

Figure *2* Overview of the Kyalla 117 N2 exploration site undergoing lease and camp pad construction, with water bore drilling underway

Figure 3 Typical well site layout during drilling; this is the existing Kyalla 117 N2 site

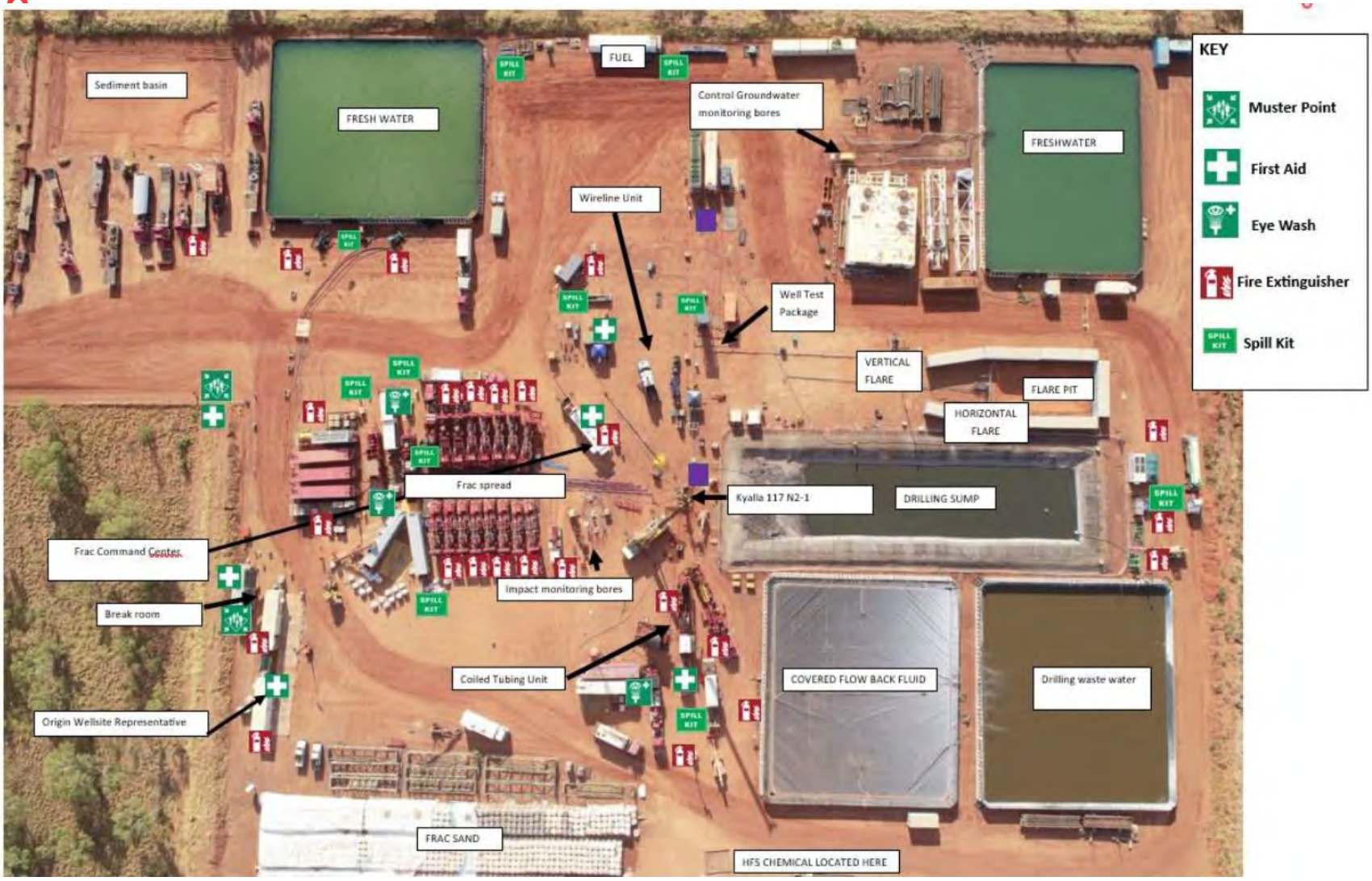


Figure 4 Typical hydraulic fracture stimulation spread at the Kyalla 117 N2 site

Figure 5 Example of a well test underway at the existing Amungee NW location

6.2 Activity description

The following information details of the proposed exploration activities on the Shenandoah East Station. These descriptions are indicative and general in nature, minor departures from such descriptions are likely to occur and such departures are covered by the content of this SEP or through ongoing communication with the pastoralist. The information has also been summarised in Table 2 with the relevant activity description and picture.

Table 2 Description of proposed regulated activity

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Groundwater monitoring bore installation Groundwater monitoring bores will be constructed using a water bore drilling rig, identical to the rig used to drill pastoral water bores. All groundwater monitoring bores will be constructed in accordance with the *"Minimum Construction Requirements for Water Bores in Australia"*. Bores may be drilled into the Anthony Lagoon Formation (if present and saturated), and/or Gum Ridge Formation. Waste cuttings, drilling fluids, muds and formation fluids will be collected in a small earthen sump and managed in alignment with the practices outlined in the *"Minimum Construction Requirements for Water Bores in Australia"*. The fluid (which is anticipated to be fresh) will be discharged to ground in the area surrounding the lease. The formation cuttings and drill muds will be mixed with soil onsite and incorporated into the lease pad surface.	Located within lease pad disturbance	<6 people	Typically prior to exploration well site construction	2-4 weeks	
Civil construction of exploration lease pad, camp pad, laydown, helipad, fence lines and firebreaks The proposed lease pad, including camp pad, laydown yard, helipad, firebreaks and fence lines will be surveyed and demarcated. The sites will be cleared of vegetation, grubbed and stripped of topsoil. Topsoil will be stored around the edge of the lease pad to form a bund, which will be used as both an erosion and sediment control and wastewater containment bund. The lease pad will be levelled, compacted and surfaced with gravel to accommodate exploration activities. Erosion and sediment controls will be constructed around the disturbed areas (such as rock check drains, woah boys and diversion drains). A sediment retention pond will be installed to manage surface water within the lease. Water captured onsite will be tested and released into the adjacent area. A drilling sump, flare pit and 3 well cellars will be constructed on the lease pad. A drilling sump will be lined with an impermeable liner to contain all drilling fluid, drilling muds, cuttings, cement returns and waste sand. Drilling sump holding capacity is approximately 3000 m^3 of material. The drilling sump / broader site will be fenced to prevent livestock access. Three additional 8 m^3 cellars will be constructed on each of the proposed leases to accommodate the wellhead equipment and blow-out preventer (BOP). The site will be fully fenced with a 20 m firebreak installed as an asset protection zone. The access track intersections with the Carpentaria Highway will be constructed to comply with DIPL requirements, with a turn in bay and sealing of the road verge. During this period, traffic control will be deployed to manage the activity.	13.7 ha	<20 people	Prior to exploration drilling	8-12 weeks	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Access track construction Access tracks will be cleared, grubbed, graded, formed and sheeted within gravel (where required) to maintain a safe driving surface. The new access track will be approximately 10 m wide; with provisions for a 6 m formed surface and 2m shoulder as per the *NTG Standard Drawings (CS3003) for Typical Cross Section for Rural Environment – Pastoral Access Road 2* (Appendix A). Turn in and passing bays may also be constructed in areas which may extend the width of the track in specific areas. Diversion drains, cut outs and creek bed level crossings will be used to manage overland flow and prevent erosion. Access tracks will be periodically maintained to keep in good working order.	2km	<10 people	During civil construction activities	1-2 weeks	
Camp pad construction and camp operation Purpose-built camps will be constructed to support operations. Each camp will be a self-contained facility with accommodation rooms, kitchen, dining mess, offices, ablutions, gymnasium, storerooms, refrigeration, water storage, power generation, solid waste management, fuel storage, water treatment, sewage treatment and sewage irrigation area. All waste will be covered / stored in a manner that prevents feral animal access. An approved wastewater (sewage) treatment plant will be installed to treat all sewage, with treated effluence irrigated in a fenced area adjacent to the camp. Treated effluence treatment and irrigation will occur in accordance with the NT Department of Health requirements.	N/A- disturbance included in overall exploration site disturbance.	<60 people (including housed staff)	For duration of activity	For duration of activity	
Gravel pit construction and operation A gravel pit will be constructed within the vicinity of the proposed exploration areas. Each pit will be cleared of vegetation, grubbed and stripped of topsoil down to approximately 100 mm (depending on the depth of topsoil onsite). Subsoils will be removed from the pit and segregated from topsoil. Topsoil and subsoils will be stored around the edge of the lease pad to prevent overland flow into the pit. Upon completion, the pit will be recontoured to leave a slight depression, with subsoils and topsoil reinstated to allow vegetation to re-establish. B-doubles and triples will typically transport gravel to the required point.	<5ha	<6	Constructed to support civil construction activities.	For duration of activity	

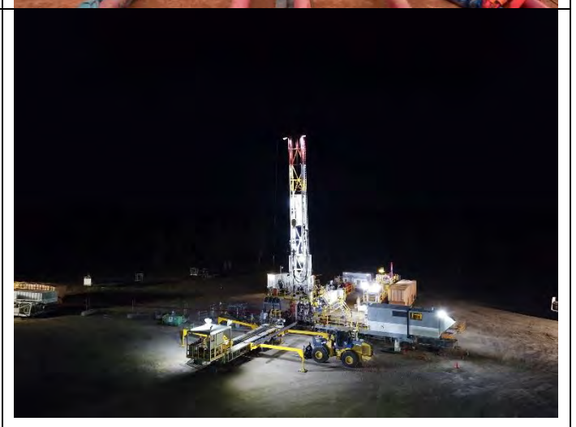
Pastoralist Engagement Pack

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
2D Seismic consists of the following: It is anticipated that seismic surveys will be collected using a combination of small seismic charges and vibroseis. The seismic charges are approximately 1kg and will be installed along a line for 2D, to a depth of approximately 15 – 20 m underground. The charges will be installed using a small, mounted drill rig. The charges are packed into place and detonated in a controlled fashion with appropriate exclusion zones. The created detonation zone is kept underground, with no surface disturbance anticipated. The detonated charge creates a "thud sound" which can be heard within 2 km radius and felt within a 100 – 200 m radius (typically). To enable vibroseis truck(s) access, line clearing will be required so that they drive and operate over the survey area. Source lines, for vibroseis trucks to operate on, will need to be cleared 5 m wide. Existing cleared areas will be utilised where possible to reduce disturbance. The line tolerances for weaving around vegetation are allowed. Seismic lines will also be in a manner to avoid any large habitat trees or sensitive flora, with no clearance to be undertaken in watercourses and associated riparian vegetation.	25 km of 2D lines x 5 m widths = 12.5 ha	Up to 35	Before or after exploration well drilling with the final time to be confirmed	3 – 8 weeks per site	 e.g. of rehabilitation efforts in progress (HESS, 2013). e.g. of recruitment of vegetation post rehabilitation of open *Eucalyptus* woodland (HESS, 2013).

Pastoralist Engagement Pack

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Microseismic survey and Induced Seismic Monitoring Microseismic Surveys are undertaken to monitor 'listen to' the Hydraulic Fracture Stimulation Operations on the proposed well site. Seismic Receivers called geophones are individual weatherproof units that contain a sensitive seismic recording device, memory storage, a long-life battery and GPS locator. The Geophones are deployed 5-25 metres apart along lines or in a grid over an area of 30-40km2 around each of the well during stimulation activities. Geophone deployment locations are located on foot by GPS locator. A handheld battery drill is used to create a 4cm diameter hole with an auger bit, a small quantity of water may be used to stabilise the soil. The Geophone is inserted into the hole so that the top of the receiver is flush with the surface of the ground (see picture) The Geophones deployed prior to the commencement of stimulation and retrieved after the stimulation has concluded. Deployment and retrieval of the Geophones is undertaken in small teams of 2 or 3 people, with the number of deployment teams depending on survey size. The teams are supported by a light 4WD vehicle or an All-Terrain Vehicle to carry equipment, gear, water, communication (radio/satellite phone), first aid kits and safety gear. Induced Seismic Monitoring will be undertaken at the same time as the Microseismic monitoring. A temporary seismic receiver is installed ~1km from the well site, with a small amount of other equipment such as solar panels and data transfer equipment. The equipment can be fenced off with temporary fencing if there are cattle in the area. The data from the seismic receiver is sent wirelessly back to the well site to enable live monitoring of seismic events during Hydraulic Fracture Stimulation. The Induced Seismic Monitoring equipment is installed prior to Hydraulic Fracture Stimulation, and remains installed, collecting data for up to 2 months after the conclusion of Hydraulic Fracture Stimulation. No line clearing or heavy machinery is required for either activity, and the activities are considered to have a minimal impact, like that of scouting activities.	Variable – similar to scouting over a 10-15km^2 area	Up to 10	Before or after exploration well drilling with the final time to be confirmed	4-10 weeks per site	
Exploration well drilling Up to 3 additional petroleum exploration wells are proposed to be drilled on the new location. Each well will be drilled into an underlying prospective petroleum reservoir (anticipated to be the Velkerri shale) to a typical maximum depth of 2000- 3000 m. Each well will be deviated into the horizontal position, with a lateral drilled up to 3000 m. Each petroleum well is designed and constructed in accordance with the Code of Practice for Onshore Petroleum Activities within the NT (Code of Practice) to maintain well integrity and protect aquifers and the environment. A Well operations management plan (WOMP) is required to be submitted to the regulator and approved prior to the drilling of any wells. The WOMP outlines the well design and drilling practices that will be deployed to ensure compliance with the Code of Practice and protect underlying aquifers and the environment. Each well is anticipated to be constructed with multiple casing and cement strings, typically 4 casing strings (conductor casing, surface casing, intermediate casing and production casing). Once the well design is approved by the NTG, a rig package will be mobilised to site, which consists of a drilling rig (comprising rig matting, a rig floor, mast or derrick, rig engine, blow out preventor, catwalk, safety flare etc.), pipe racks, casing strings, drilling rods, rig fluid system (mud tanks, shakers, mud treatment system and pipework) storage trailers, bunded chemical storage areas, workshop portable onsite offices, crib huts, mini-rig camp and sewage treatment system and irrigation area), freshwater storage tanks, diesel power generation, cement trucks, bulk fuel storage, water transfer pumps, fork lifts, lighting towers, crane, etc. The rig will be constructed over the pre-installed stove pipe and cellar. Once functional, drilling will proceed down below the first encountered aquifer, where the first casing section of the well will be installed (either in the Anthony Lagoon Formation if present and saturated or the Gum Ridge formation (anticipated to be present). After the surface casing is set, a BOP will be installed, to ensure any influxes of gas, water or pressure are able to be safely managed during drilling of the remaining sections of the well. The drilling rig will continue to drill the other casing and cement sections. The integrity of each of these casing strings is tested through a combination of leak off tests, casing pressure tests, cement return tracking and cement bond logs. Upon completion of drilling, a barrier integrity verification report is	N/A located on proposed lease pad	<60 people	Pastoralist to be notified when drilling proposed	Typically 60 – 90 days per well	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
submitted to the regulator summarising the integrity of the well. Once each well is finished drilling, the well head is installed, and the rig is either “walked” to the next adjacent location with the process repeated or mobilised to a new location. A low toxicity water-based drilling mud is to be used as the base fluid for drilling, which primarily contain salts and polymers. Drilling mud is required to maintain well control, provide formation stability, lubricate and control the temperature of the drill bit and lift cuttings to the surface. The fluid system consists of water with a sodium or potassium-based salt (to prevent formation swelling) and a viscosifying agent such as bentonite. Other low toxicity chemicals such as barite, citric acid, sodium bicarbonate and loss circulation material (fibres such as coconut coir or nut hulls etc.) may also be used. The chemicals used for drilling are consistent with those used for water bore drilling. Waste drilling muds, fluids, cuttings and mineral waste (such as cement returns, sand etc.) brought to surface will be stored in the lined drilling sump. Drilling fluids will be evaporated and then removed from the sump and disposed of offsite. Solid waste within the drilling sump will be allowed to dry out and then either removed from site or disposed of onsite in accordance with the Code of Practice. Where onsite disposal is proposed, a risk assessment will be completed demonstrating that the activity can occur with no residual environmental harm. Onsite disposal can include encapsulation or mix bury cover, depending on the site-specific details and final composition of the drilling waste material. Subsurface diagnostic tools will be run on the well during and after drilling to understand the nature of the target reservoir. Some sections of the formation may be cored or have sidewall samples collected, which will add further analysis of the reservoir properties. To assist with determining the suitability and capacity of these formations for potential gas extraction activities, diagnostic fracture injection test (DFIT) may be conducted across several shale intervals to evaluate the geo-mechanical and reservoir properties of the targeted formation. Prior to a DFIT, a cement bond log and casing pressure test is completed to ensure the integrity of the cement and steel casing. A DFIT involves the injecting of small volumes of a water (approximately 30 barrels (5,000 L) per DFIT) at low pumping rates to create a small fracture in the target interval. The well is shut-in, and the pressure allowed to fall-off naturally. Monitoring the fall-off pressure over time allows information to be derived about the reservoir. The fluid does not contain proppant so that the fracture closes naturally when the fluid leaks off into formation. The analysis of pressure, during injection and after shut-in, provide powerful tools for understanding and subsequently informing the design for a future hydraulic fracturing process (not in this scope). Any returned fluid will be stored within double lined tanks and disposed of offsite at a licenced facility.					
Hydraulic Fracture Stimulation Upon completion of drilling activities, a frack spread will be mobilised to site to commence hydraulic fracture stimulation (HFS or stimulation) activities on each drilled well. A frack spread consists of: • Data van: On-site office to execute stimulation activities. • Water storage: Tanks will be constructed on-site, capable of managing both make-up water and flowback water. Tanks will be double lined with leak detection capable of monitoring any leaks between the primary and secondary liner. Tank number will depend on encountered flowback volume and can range between 5 – 12 tanks (the exact number may be more or less than the anticipated number). • Proppant trailer: A large sand storage and delivery trailer that holds the proppant. • Hydration unit: Used to add stimulation additives and viscosifying fluids. • Blender unit: Used to mix proppant and fluid additives, prior to its injection into the well. • High pressure pumps: Pumps which inject the hydraulic fracturing fluid mixtures from the blender unit down the well, via the surface lines and hydraulic fracturing wellhead or coiled tubing unit. • Coiled tubing unit: A large length of coiled steel pipe that can be temporarily installed in the well to perform various downhole operations. • Wireline unit: Plug and perforation deployment. • Ancillary support buildings: Offices, workshop, cranes, chemical storage area, equipment storage, power generation and all other activities required to support stimulation activities. Stimulation involves the injection of a slurry, primarily consisting of water and sand (proppant), plus a small percentage of chemicals at high pressure into the target section of the horizontal wellbore approximately 2000 m – 3000 m below ground level (depending on the depth of the target formation). Typically, 90% or higher of the total volume in stimulation fluids is a combination of fresh water and	N/A located on proposed lease pad	<50 people	Post exploration well drilling	2 – 8 weeks per well depending on stimulation size	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
sand (~6 – 8%), with the remainder as fluid-conditioning additives (~2 – 4%). Prior to the commencement of stimulation activities, the integrity of the well is tested with a cement bond log and pressure casing test. This integrity report is submitted to the regulator prior to the commencement of stimulation activities. The stimulation fluid is pressurised by the high-pressure pumping units and directed downhole via a manifold to the discrete target intervals along the horizontal wellbore (referred to as 'stages'). Each stage will be isolated and perforated using a plug and perforation gun assembly deployed via a wireline unit. As the pressure is sustained, the fractures propagate radially from the well, through the target rock. Once optimal fracture propagation has been achieved, the proppant (sand) is pumped down the well and into the open fractures. This process is repeated for each stage. The final number of stages pumped in each well is dependent on the useable length of the horizontal wellbore and in-situ geological conditions.					
Well completion Once each well has been stimulated, a completion rig will be mobilised to site to "complete" the well. This involves installing downhole equipment such as packers, plugs, production tubing, artificial lift required to enable the production testing.	N/A located on proposed lease pad	<12 people	Post stimulation	1 – 2 weeks	
Well testing Once each well has been completed, the well will be brought online and tested for a period of 3 to 24 months. To enable the testing, a well test package will be installed at the site consisting of: • separators (to separate gas, condensate and water) • flares (either a vertical or horizontal), • flare pit (if a horizontal flare is utilised • surface pipework, manifolds, and tanks • communication and generator shacks • workshops/ storerooms • bulk diesel tanks • wastewater storage tanks (converted freshwater storage tanks used for stimulation makeup water) • water transfer equipment • wastewater evaporation and treatment units • camp accommodation. Each of the exploration wells will be underbalanced (or "unloaded") to initiate production, either through its own energy or through artificial lift (such as through a Nitrogen lift or pump). The fluid and gas will be sent through a separator, with all hydrocarbon metered and either flared or beneficially used onsite (for power generation etc.). Flowback water will be discharged from the separator into	N/A located on proposed lease pad	<12 people during production testing	During exploration activities	Typically 1 to 24 months	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
designated wastewater storage tanks. Multiple well testing operations may be required to test the behaviour of the formation to determine whether extended shut ins can affect well productivity. After or during production testing operations the well/s may be shut in for a period to allow the pressure to naturally build up to assess reservoir pressure.					
Wastewater tank storage Flowback refers to water utilised for HFS that is "flowed-back" to surface. It typically is highly saline (saltier than seawater) and contains contaminants that require careful management to ensure they are not released to the environment. Flowback wastewater will be treated on site via evaporation (or other treatment technologies) and removed from site upon completion of activities. Evaporation is used to minimise the volume of wastewater required to be transported offsite, reducing the amount of truck movements. Double lined wastewater tanks will be utilised to store wastewater, with the volume and number of tanks installed dependent on the anticipated flowback return volume. Wastewater storage tanks have continuous level monitoring, with leak detection sensors located within the interstitial space between the primary and secondary liners. It is anticipated that up to 30 ML of tank storage may be installed onsite, with a combination of enclosed tanks and open treatment tanks. In accordance with the Code of Practice, sufficient enclosed tank capacity must be onsite to store all wastewater during the wet season. Flowback can only be stored within open tanks where undergoing treatment (such as evaporation). Open evaporation tanks must have a 1:1000 annual re-occurrence Interval (ARI) wet or dry season freeboard (i.e., available tank space to accommodate rainfall), which is typically 1.3 M or 0.3 M respectively. The lease pad or a specifically constructed wastewater storage areas will be bunded to contain 110% of the volume of the largest tank stored onsite. Wastewater storage tanks may be deployed for extended periods of time to allow ongoing evaporation or treatment. Treatment of wastewater may also be undertaken onsite, with water treatment options such as submerged combustion units, enhanced evaporation units etc. utilises to reduce wastewater volume onsite. Wastewater from other sites across the basin may also be used to stored onsite, to assist in wastewater treatment/ management.	N/A located on proposed lease pad	<4 persons	During wastewater storage activities	3 – 36 months	

Pastoralist Engagement Pack

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Flaring During well testing, all produced hydrocarbons (gas and liquids) will be flared onsite unless they can be beneficially used (for power generation etc.). Two flares may be installed, with a vertical flare used to manage gas and a horizontal flare used to manage condensate. The vertical flare will be an American Petroleum Industry (API) 537 and a US EPA AP 42 compliant unit, with a 98% combustion efficiency. The vertical flare (see figure) will have a constant pilot flame, with an autoignition system that provides electrical impulses to a spark plug continuously. If the flare was to go out, the spark would ignite the flare within 1.3 seconds. A horizontal flare may be used to combust condensate if produced during well testing. A horizontal flare will be equipped with 3 independent nozzles, located in a 20 m x 10 m clay lined flume. Flares will be located at least 45 m from the surrounding vegetation, with flaring not undertaken during total fire ban periods.	N/A located on proposed lease pad	<12 people during production testing	During exploration activities	During production testing	
Condensate management Where condensate (liquids rich gas that “condenses” when brought to the surface) is generated, it is separated and stored within double lined condensate tanks. Condensate may either then be trucked offsite or combusted in the horizontal flare. Condensate is not anticipated to be generated in sufficient quantities at the proposed locations.	N/A	1-2 trucks per day	During exploration activities	During production testing	
Drilling waste management All waste drilling fluids, muds, cuttings, DFIT return fluid and cement returns will be managed in a lined drilling sump on-site. Once drilling has been completed, this material will be sampled as per the Code of Practice and a detailed risk assessment completed to determine whether onsite encapsulation or mix bury cover can occur in an environmentally acceptable manner. In most cases, drilling wastes will be dewatered, blended with clean fill and encapsulated onsite within an impermeable liner. It will then be buried with capping material to enable vegetation re-establishment. To reduce the number of sites where material is mix-buried covered, multiple wells from other locations may be disposed of at the proposed location where the environmental risks as ALARP. An overview of the mix bury cover process is provided in Attachment B.	N/A- within proposed lease pad	< 6 people	Upon completion of drilling activities	7 days	

Pastoralist Engagement Pack

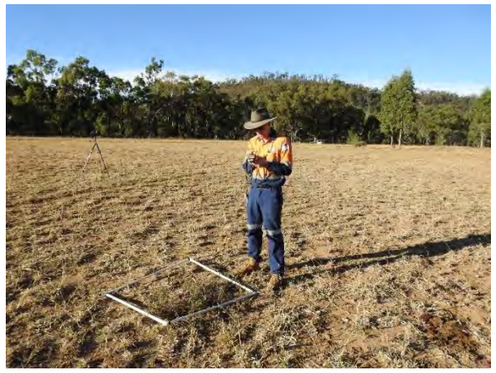
Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Wet season operations Exploration activities (including drilling, stimulation and well testing operations) may occur over the wet season. Where wet season operations are undertaken the following risk controls will be implemented: • All chemicals, fuels, equipment, tanks and materials required for ongoing operations will be stored on-site prior to the onset of the wet season. • All equipment required to respond to emergency situations will be on-site; this includes earth moving equipment, vacuum trucks, wireline rigs, cementing equipment etc. and equipment and material to deal with well control issues, spills and other emergency events. • All chemicals storage areas will be bunded, with covers used (where safe and appropriate) to prevent rain ingress and bund overflows. • Enclosed tanks will be utilised as the primary measure to store wastewater with enough enclosed tank capacity to store all wastewater on-site (see figure). • Enclosed wastewater storage volume will be sufficient to manage all wastewater stored onsite. • Open working evaporation tanks and mud sumps will have enough freeboard to manage an entire 1:1000 ARI wet season event (not just one (1) rainfall event but an entire season's rainfall total). • Helicopters will be used to transport people and supplies into and out of the site when access is restricted. • No transportation of wastewater or chemicals will be undertaken during the wet season unless a risk assessment is undertaken that demonstrates the risk is As Low as Reasonably Practicable (ALARP) and acceptable (as per the Code of Practice). • Wastewater storage area is bunded, which will prevent all off-site release of chemicals and stormwater practicable (ALARP). • During flowback wastewater stormwater will be retained on-site via the sediment retention pond prior to release. • Overland flow will be diverted around lease pads.	N/A	N/A	October - May	7 months of the year	
Site monitoring and inspections consisting of the following: • **Groundwater monitoring:** Groundwater monitoring bores are required to be installed on the lease pad before the commencement of hydraulic fracture stimulation activities. Groundwater monitoring is undertaken at the site commencing 6 months before stimulation and then quarterly for 3 years after. Groundwater monitoring involves purging a monitoring bore of water, measuring field parameters (level, electrical conductivity) and collecting laboratory samples and • **Site and exploration well monitoring:** An operator or contractor will access the site to perform checks on the exploration well and stability of the site. Checks include pressure readings and visual checks of valve integrity. In some cases, a helicopter may be utilised to complete the inspections. Surveys are completed fortnightly. • **Weed inspections:** Access to the site by several contractors/ Origin personnel in light vehicles to identify weeds. In some cases, a helicopter may be utilised. Contractors may perform spot sprays with a NTG recommended weed treatment. Surveys are completed pre and post wet season. • **Erosion and sediment control inspections:** Access to the site by several contractors/ Origin personnel in light vehicles to identify erosion or stability issues. Inspection will be used to schedule maintenance to repair any defects identified. In some cases, a helicopter may be utilised to complete the inspections. Surveys are completed pre and post wet season. • **Gas leak detection surveys:** Access to the site by 2 – 3 contractors / Origin personnel in light vehicles to perform mandatory gas testing using handheld gas meters. Surveys are completely.	N/A	<2 – 6 people	Fortnightly/ 6 monthly (depending on activity)	1 day per inspection	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Site maintenance (**lease pad, camp pad, access tracks and gravel pit):** Includes grading, erosion and sediment control repair, vegetation management, firebreak management, weed management, fence repair and all other ancillary activities required to maintain a site and associated with infrastructure. This includes maintenance of the access track interception with the Carpentaria Highway. The work will be undertaken by civil maintenance contractors and Origin personnel.	N/A	<10 people	6 monthly; pre and post wet season maintenance	<7 days per activity, depending on the nature of the activity	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Well head maintenance: Maintenance is completed annually on each well. Maintenance includes valve checking, testing, greasing and (in some cases) replacement, as well as any other activities required to maintain the integrity of the well.	N/A located on proposed lease pad	<20 people depending on activity	Annually	< 7 days per activity, depending on nature of maintenance	
Well intervention, data acquisition and testing: Subsurface activities may be undertaken periodically on each of the well to perform maintenance or collect additional information on the properties of the well or the reservoir. These type of well interventions typically include performing cement bond logs, casing pressure tests, running reservoir evaluation or production logging tools, cement and casing remediation activity (if required during the life of the well), setting downhole mechanical plugs and gauges, casing perforation, subsurface barrier maintenance/ installation and production tubing installation/repair or replacement. This generally involves the use of a variety of equipment dependent on the activity being completed. This typically may involve any of the following equipment: completion rig, coil tubing, wireline unit, data van, cement or pump truck, crane, trucks, power generation, support trucks and other support vehicles.	N/A located on proposed lease pad	<20 people depending on activity	Ad hoc requests, typically 2 interventions within the next 5 years	<10 days per activity	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Petroleum well plugging and decommissioning: Once a petroleum well is no longer required, each well will be decommissioning. Decommissioning involves the permanent removal of the well through the placement of cement plugs to isolate the target reservoir from overlying aquifers in accordance with the Code of Practice: Onshore Petroleum Activities within the Northern Territory (Code of Practice). Once plugs are installed, they are pressure tested to confirm the underlying formations have been adequately sealed off. The well head is then removed. A permanent marker is added to indicate the location of the plugged and abandoned well.	N/A located on proposed lease pad	<12 people	End of well life	<10 days	
Chemical and fuel storage: All chemicals and fuels (diesel) required to support exploration activities will be stored in accordance with the relevant regulatory requirements, including the use of secondary containment (bunding) onsite. The Code of Practice has implemented a range of additional controls, including requirements for routine inspections, emergency response procedures and spill management. Anticipated chemical and fuel volumes vary dependent on activity, but may involve the storage of the following types of chemicals and volumes: • Stimulation and drilling chemicals (friction reducers, surfactants, crosslinkers, breakers, buffers, acids, bases, biocides, scale inhibitors, corrosion inhibitors, clay stabilisers, loss of circulation material, drilling muds, salts etc.). Volumes typically less than 20 KL per chemical, with some chemicals stored at higher (such as pH control) or lower (such as biocides and corrosion inhibitors) volumes depending on their purpose and planned use. • Diesel – typically 100 KL stored but may be 500 KL if wet season activities are proposed. • Other chemicals and hydrocarbons: including oils and greases, lubricants, hydraulic fluid, cleaning chemicals, domestic chemicals etc. used to support operations.	N/A- located on existing area	N/A	During exploration activities	During exploration activities	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Waste management: Any waste generated during exploration activities will be stored onsite in accordance with the *Waste Management and Pollution Control Act 1998* and Code of Practice and transported offsite to a licenced waste management facility. All wastes (other than drilling mineral waste) will be stored within skips or equivalent and removed from site at the end of each activity.	N/A	1 -2 trucks during operations	During explorations activities	During explorations activities	
Groundwater extraction: Groundwater extractions from the purpose-built groundwater monitoring onsite or another approved extraction bore (which may include trucking water from adjacent properties) will be completed periodically to support exploration activities. All groundwater take will likely be from the Gum Ridge Formation and will licenced under Origin's existing Water Extraction Licence (WEL) GRF 10285. A new WEL may be submitted covering additional groundwater take and alternative groundwater formations, where required. It is anticipated that groundwater extraction volumes to support this program is anticipated to be less than 150 ML/year primarily used during the initial stimulation. Once drilling and stimulation has ceased, minimal ongoing water extraction from the site will be required.	N/A	N/A	Ongoing to support exploration activities	During exploration activities	
Traffic management: Access to of the proposed exploration sites is via the Carpentaria highway. Peak traffic volumes are anticipated to be associated with the drilling rig mobilisation and demobilisation. Traffic volumes may reach up to 44 vehicles per day spread over a 4-week period. During operations (drilling, stimulation or well testing), vehicle movements to the site are anticipated to be less than 10 movements per day. This period is likely to extend typically 60 days per exploration well, 45 days per stimulation and during the duration of a well test (30 – 365 days). Once the well is suspended or decommissioned, vehicle movements will reduce to 1 vehicle per fortnight or 1 vehicle per 6 months respectively.	N/A	N/A	During exploration activities	During large mobilisations or works within the road corridor	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Site rehabilitation: Within 6 months of the E&A wells at a site is plugged and decommissioned, the site will be rehabilitated. This involves: a) the removal of all surface facilities (e.g. well heads, fencing, water bores, tanks), b) deep ripping of compacted surfaces, c) recontouring landforms, d) respreading of topsoil from the topsoil stockpiles, e) re-seeding (if required), and f) ongoing monitoring and maintenance of the rehabilitation.	N/A		Within 6 months of the plugging and abandonment of all E&A wells	<14 days, with ongoing monitoring and maintenance	 

7. Environmental outcomes, impacts and risk

The environmental outcomes, potential impacts and risks associated with the ongoing exploration activities are summarised in Table 3. This information will also be provided in an EMP covering the proposed regulated activity, which will be submitted to the Department of Environment, Parks and Water Security (DEPWS) for formal assessment and approval.

Under the PER, an environmental outcome means an outcome that will be achieved if the environmental impacts and environmental risks of a regulated activity are reduced to a level that is as ALARP, and acceptable.

Environmental impacts are defined by the PER as any adverse change, or potential adverse change, to the environment resulting wholly or partly from a regulated activity.

Environmental risks are defined by the PER as the chance of something happening that will have an environmental impact, measured in terms of environmental consequences and the likelihood of those consequences happening.

Both the consequence and likelihood of a potential impact can be reduced through the adoption of controls, which must be applied to reduce a risk down to an ALARP and acceptable level.

Table 3 Environmental risks and controls of proposed variation

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
Groundwater use and quality	• To manage exploration activities to prevent unsustainable depletion of groundwater resources • Preserve groundwater quality to protect environmental and pastoral use	• No adverse changes to groundwater quantity are anticipated to be associated with exploration activities. • Impacts to aquifers levels anticipated to be minor, with rapid recharge observed from other Gum Ridge Formation bores utilised within the Basin. • No material changes to groundwater quality anticipated from exploration activities. • No impact to Groundwater Dependent Ecosystem's (GDE) or stygofauna from exploration activities (extraction and well construction). • No reduction in pastoral productivity through reduced groundwater volumes.	• Low risk of groundwater contamination from drilling fluids during construction of the conductor/ surface casing in the Cambrian Limestone Aquifers due to the selection of low toxicity drilling fluids • Low risk of cross flow of deep formations (such as the target shales) to shallow aquifers through inappropriate well barrier design and construction due to the presence of the Code of Practice controls and verification processes. • Low risk of crossflow through fracture growth into aquifer from stimulation activities allowing the migration of fluid and gas due to the controls within the Code of Practice and underlying separation distance between the target formation and Cambrian Limestone aquifers. • Low risk of stimulation activity inducing seismic activity that enables cross formational flow between shallow aquifers due to seismic stability of region and lack major faults or fracture zones. • Low risk of stimulated zones intersecting offset wells (including the adjacent horizontal wells) or intersecting an existing geohazard due to seismic control, pressure monitoring during stimulation and lack of older petroleum wells in proximity. • Low risk of crossflow/well integrity caused by the deviation of an E&A well into the adjacent well during drilling due to downhole GPS tracking tools and proximity alarms. • Low risk of leakage of either flowback,	• All petroleum wells are to be designed, constructed, operated and decommissioned in accordance with the mandatory controls within the Code of Practice. The Code of Practice outlines specific controls measures designed to protect underlying groundwater resources including: o Exploration wells designed with multiple cement and steel casing barriers to protect aquifers. o Drilling fluids and muds must have a low residual toxicity. o Groundwater monitoring must be completed before and after stimulation to detect contamination. o Well integrity confirmation to prove barrier performance aquifer isolation (casing pressure tests, formation leak off tests, cement bond logs, etc). o Separation between stimulated shale resources and aquifers must be sufficient to ensure the risk of fracture growth is ALARP. o Pressure monitoring completed to ensure maximum allowable operating pressure is not exceeded during stimulation. o Ongoing well integrity monitoring and maintenance throughout the life of each well to ensure aquifers are protected. o All wells are to be decommissioned in accordance with the Code of

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			produced water, or hydrocarbons (liquid and gaseous) from suspended or abandoned wells to groundwater due to well design and integrity management. • Low risk of surface contamination from storage and disposal of drilling fluids, additives, muds and cuttings on-site due to low toxicity of drilling muds and disposal risk assessment process. • Low risk of groundwater contamination from surface spills from storage, handling and transportation of flowback water due to the storage and spill management requirements outlined in the Code of Practice. • Low risk of groundwater contamination from the storage, handling and transportation of chemicals, fuels and wastes due to the mandatory code of practice controls (such as mandated use of secondary containment). • Low risk of groundwater contamination from overtopping of drilling sumps and flowback tanks (including during wet season) due to level alarms and use of enclosed tanks. • Low risk of groundwater contamination from a failure of flowback storage tank due to the design standards of the tank (cyclone rated steel tank structures) and routine integrity inspections. • Low risk from over extraction of groundwater for civils, drilling and stimulation activities due to limited nature of take (one off), yield of the Cambrian Limestone Aquifers and available allocation volumes (as assessed in the	Practice, with cement plugs utilised to separate aquifer units. • All surface storages of wastewater and chemicals to have secondary containment to prevent spills to the ground. • An emergency response plan must be implemented outlining how spills and emergencies will be responded to. • Drilling fluids and wastes to be stored within a lined sump. • Flowback wastewater must be stored in double lined tanks with leak detection and level monitoring. • Double lined enclosed wastewater tanks with leak detection and level monitoring utilised to store all wastewater, with open treatment tanks used to maximise evaporation and reduce wastewater volumes held onsite. • All open treatment tanks are to be operated with a 1:1000 ARI wet season or dry season (whichever is applicable) freeboard. • All wastewater to be transferred to enclosed tanks within 8 hours of a significant rainfall event occurring. • Groundwater monitoring from monitoring bores installed at the site must be completed prior to and after stimulation to detect any contamination. • All water take will be covered by an existing Water Extraction Licence (WEL) GRF 10285. • New extraction bores must model potential

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			WEL). • Low risk that seismic charges impact pastoralist groundwater bores or groundwater quality.	impact on adjacent pastoral bores prior to being added to WEL. • All water take will be metered and reported quarterly to the regulator. • Proposed site is not within 1 km of a pastoral bore. • Seismic surveys to have an industry standard buffer of typically 100 m from the nearest extraction bore. • Seismic charges are biodegradable, with any unexploded ordinance likely to rapidly degrade (weeks).
Soils	• Avoid, minimise and control soil erosion and discharge of sediment or soil into waterways or established drainage systems • Minimise disturbance of soil, vegetation and drainage during site activities • Prevent the contamination of soil to maintain the viability of soil resources • Minimise residual impacts to pastoralist usage of exploration areas	• Clearing of up to 34a to support exploration activities. • Soil compaction from access tracks and leases. • Increased sedimentation transportation from disturbed areas. • Loss of productivity of disturbed areas until final rehabilitation has been achieved.	• Medium risk of soil erosion from cleared areas (access tracks, lease pads, camp pads, gravel pits, seismic lines and laydown areas) occurring on disturbed sites due to high intensity wet seasons. Risk is a low consequence (minor impact), possible (<50% chance of occurring) event. • Low risk Reduction in land production through poor erosion and sediment control practices. • Low risk of spills/leaks from the on-site storing and handling of fuels. Condensate, hydrocarbons, drilling additives, stimulation additives, flowback fluid, solid wastes, storage and transportation of wastes causing soil contamination. • Low risk of drill sump and flowback tank overtopping due to mandatory freeboard and monitoring controls. • Low risk of chemical and waste	• Site is selected to avoid sensitive soil units and slopes which may increase erosion hazard. • Site selection to take on pastoralist feedback about existing site conditions (e.g. overland flow). • All land clearing to align with the requirements of the code of Practice and NT Land Clearing Guidelines (2019). • Seismic activities to: o Avoid vegetation clearing as much as practicable through use of seismic charges if possible. o In open woodlands, limit clearing to grasses and shrubs. o Maintain viable root stock to promote rapid rehabilitation. o Avoid seismic lines in water courses (unless co-located with an access track).

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			transportation accident, causing soil contamination due to licenced chemical/ waste provider use, spill response and emergency response requirements. • Low risk of contamination from on-site disposal of drill muds and cuttings with site specific assessment completed to ensure disposal is environmentally acceptable. • Low risk of contamination from a flowback wastewater tank failure due to the structural design of the tanks, site bunding, emergency response requirements and spill management requirements. • Low risk of wastewater evaporation mist transported offsite during wastewater treatment due to wind speed/direction cut offs and routine site inspections during operations. • Low risk of greywater and sewerage disposal from camp wastewater treatment plants due to the irrigation area being appropriately sized, fenced and quality aligning with the NT Department of Health requirements. • Medium risk of bushfire from accidental ignition by site activities (civil works, seismic, drilling, flaring, grinding) or personnel. The consequence of a fire is considered serious, with the likelihood 'unlikely'. • Low risk of reduction in land production through poor infrastructure placement as infrastructure is located along an	• Erosion and sediment control practices to be utilised at all disturbed sites to minimise erosion. • Sites (including gravel pits) maintained to minimise sediment releases, with erosion and sediment control plan in place. • Pre and post wet season monitoring completed on all disturbed areas to identify and repair erosion. • Construction within the wet season to be avoided to reduce the erosion risk. • No vegetation clearing in major watercourses proposed. • All chemicals and fuels to be stored with secondary containment as per code of Practice. • During wastewater storage, the site is to be fully bunded to contain the volume of an entire wastewater tank if a structural failure occurred. • Flowback wastewater must be stored in double lined tanks with leak detection and level monitoring. • Double lined enclosed wastewater tanks with leak detection and level monitoring used to store all wastewater, with open treatment tanks used to maximise evaporation and reduce wastewater volumes held onsite. • All open treatment tanks and sumps are to be operated with a 1:1000 ARI wet season or dry season (whichever is applicable) freeboard. • All wastewater to be transferred to

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			existing seismic line and no sensitive soil types are present in the immediate vicinity. • Low risk of reduction in land productivity from poor rehabilitation due to mandatory rehabilitation requirements and security bond requirements.	enclosed tanks within 8 hours of a significant rainfall event occurring. • Stormwater to be retained onsite during wastewater storage and tested prior to release. • All spills of chemicals and wastewater to be cleaned up upon detection. • Irrigation of greywater and treated effluent to be undertaken in accordance with DoH requirements. • Fire breaks to be utilised around all well sites, with minimum separation distances of 45m between flares and vegetation. • Grinding, welding and other higher risk fire activities to be undertaken away from vegetation/ in manners that avoid bushfire risk. • Vehicles to be equipped with fire extinguishers. • No flaring during total fire bans. • Fire response to be implemented during seismic program, with spotters and fire trailers utilised to put out spot fires during work • Seismic civils to be preferentially completed during either early wet or early dry. • Disposal of drilling muds, cuttings and mineral waste to be undertaken in accordance with Code of Practice, with onsite disposal only permitted where the potential harm to the environment can be demonstrated as ALARP and acceptable.

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
				• Site to be rehabilitated back to pre-existing/ agreed state with pastoralist input.
Emissions (dust, greenhouse and combustion emissions)	• Avoid environmental nuisance at sensitive receptors • Minimise impacts to pastoralists and surrounding ecological communities from dust • Minimise greenhouse gas emissions	• Dust on vegetation in the immediate vicinity of activities reduces plant palatability • Impacts of dust nuisance to birds and fauna in the immediate vicinity of activities, specifically access tracks and seismic lines • Emissions from the combustion of diesel. • Generation of Greenhouse gasses are anticipated to be approximately 70KTCO$_2$e- per year	• Low risk of dust impacts generated during Civil activities, drilling operations, well testing due to use of dust suppression and routine maintenance of access tracks and infrastructure. Productivity declines from dust impacts are anticipated to be temporal in nature • Low risk of reduction in regional air quality resulting from emissions from the combustion of diesel due to the temporal nature of the activities and selection of efficient equipment. • Low risk of reduction in regional air quality from gas and condensate flaring due to the combustion efficiency of the flare and operating procedures. • Low risk of air emissions from chemical releases during drilling and stimulation activities impacting livestock, fauna and people due to chemical handling procedures limiting emissions during mixing. • Medium risk of bushfire from accidental ignition by site activities (civil works, seismic, drilling, flaring, grinding) or personnel. The consequence of a fire is considered serious, with the likelihood 'unlikely'. • Low risk of uncontrolled release of gas impacting a receptor during drilling,	• Dust suppression to be used on access tracks, lease pads and gravel pits to minimise dust emissions. • Dust levels are anticipated to be temporal in nature- primarily during the dry season. • Venting of raw gas is tightly controlled under the Code of Practice, with no material volume of gas to be vented. • A reduced emission completion (flare) to be utilised to combust all hydrocarbons. • Flares to be compliant with USEPA design standards, including 98% flare efficiency. • Site located away from sensitive receptors, such as homesteads. • Stimulation chemical mixing procedures deployed (such as enclosed hoppers) that minimises dust emissions. • Fire breaks to be utilised around all well sites, with minimum separation distances of 45m between flares and vegetation. • Grinding, welding and other higher risk fire activities to be undertaken away from vegetation/ in manners that avoid bushfire risk. • Vehicles to be equipped with fire extinguishers.

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			stimulation, barrier failure, operator error or vehicle collision due to the well design, blow out prevention, well integrity and lack of sensitive receptors preventing impacts. • Low risk of leak of gas from wells due to the well design, routine leak detection and repair and separation distance from receptors.	• No flaring during total fire bans. • Fire response to be implemented during seismic program, with spotters and fire trailers utilised to put out spot fires during work • Seismic civils to be preferentially completed during either early wet or early dry. • 6 monthly gas leak detection on all exploration wells.
Surface Water	• Avoid and minimise the potential contamination caused by the discharge of sediment or contaminated storm water to waterways or established drainage systems. • Contain any potential contaminants for treatment or disposal.	• Increased sedimentation transportation from disturbed areas	• Low risk of contamination from a flowback wastewater tank failure due to the structural design of the tanks, site bunding, emergency response requirements and spill management requirements. • Low risk of drill sump and flowback tank overtopping due to mandatory freeboard and monitoring controls • Low risk of a transportation accident releasing chemical or wastewater (drilling fluid and flowback) due to the use of licenced wastewater/ chemical transportation providers, spill management and emergency response requirements. • Low risk of spills to surface water from chemicals and fuel storage and handling activities due to use of secondary containment and separation distance to watercourses. • Low risk of stormwater releases from activities contaminating surface water due to stormwater segregation and testing procedures.	• No take of surface water permitted or proposed. • Sites are not located within proximity of any mapped water courses. • Site maintained to minimise sediment releases, with erosion and sediment control plan in place. • Double lined enclosed wastewater tanks with leak detection and level monitoring utilised to store all wastewater, with open treatment tanks used to maximise evaporation and reduce wastewater volumes held onsite. • All wastewater tanks engineered to withstand failure; cyclone rated construction. • All open treatment tanks and sumps are to be operated with a 1:1000 ARI wet season or dry season (whichever is applicable) freeboard. • All wastewater to be transferred to enclosed tanks within 8 hours of a significant rainfall event occurring.

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			• Low risk of infrastructure changing surface hydrology and flow due to infrastructure design and avoidance of overland flow locations. • Low risk of changes to terrestrial ground surface levels associated with seismic activity due to the stability of the basin and geomechanical properties of the target and overlying formations.	• During wastewater storage, the site is to be fully bunded to contain the volume of an entire wastewater tank if a structural failure occurred. • All spills of chemicals and wastewater to be cleaned up upon detection. • Irrigation of greywater and treated effluent to be undertaken in accordance with DoH requirements. • No offsite releases of drilling or stimulation wastewater proposed or permitted. • Stormwater retained onsite during wastewater storage, with testing completed prior to offsite release. • Site selected to avoid major structural features, such as faults. • Basin is seismically stable, with low seismic activity reported. • Minimal disturbance seismic lines utilised where rootstock is maintained to increase stability and aid in vegetation recovery.

Flora and Fauna (including livestock)	• Minimise disturbance to flora and fauna
	• No disturbance to high conservation areas
	• Avoid the introduction of weeds
	• Avoid the spread of existing weeds
	• Minimise the loss of pastoral productivity
	• Minimise impacts to
		• Clearing of up to34 ha of regionally extension vegetation communities (such as Open Corymbia/Eucalypt woodland, Bullwaddy and/ or Lancewood) to support exploration activities.
		• Loss of fauna and flora habitat
		• Loss of livestock grazing area
		• Loss of productivity of
			• Low risk of threatened fauna mortality during clearing for seismic lines or well pad extension, with all sites to be inspected prior to clearing to avoid fauna.
			• Low risk of vehicle and machinery noise and lighting on well pads and access tracks causing material impacts to threatened fauna or livestock.
			• Low risk of contamination from a flowback wastewater tank failure due to the structural design of the tanks, site bunding, emergency response requirements and spill management
				• Vegetation to be walked down and inspected for fauna prior to clearing. Where fauna is identified, work shall stop in the immediate vicinity until they leave the area.
				• Seismic activities to:
				  • avoid vegetation clearing as much as practicable
				  • In open woodlands, limit clearing to grasses and shrubs
				  • Maintain viable root stock to

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
	livestock	disturbed areas until final rehabilitation has been achieved • Disturbance of flora, fauna and livestock from seismic charge noise and vibration	requirements. • Medium risk of introduction and spread of weeds in the area due to equipment washdowns, inspection and certification requirements. Monitoring and routine treatment completed on identified outbreaks. Impact from weed introductions/spread is considered moderate, with likelihood 'unlikely'. • Medium risk of bushfire from accidental ignition by site activities (civil works, drilling, flaring, grinding and seismic activities) or personnel on fauna, flora and land productivity. The consequence of a fire is considered serious, with the likelihood 'unlikely' (<30% chance of occurring). • Low risk of flora, fauna and livestock being trapped and drowning in storage tanks, sumps and pits due to the design of storages and fencing. • Low risk of contaminants in water and soil pass through the food chain and bioaccumulate in fauna causing detrimental impacts to local species and communities due to chemical storage and handling practices. Fences are utilised to restrict livestock access. • Low risk of vehicle collisions with fauna – fauna mortality results in a localised impact to listed threatened species, due to avoidance of night-time driving, speed limit restrictions and number of vehicle movements. • Low risk of reduction in land productivity from poor rehabilitation due to mandatory rehabilitation requirements and security	promote rapid rehabilitation • Avoid seismic lines in water courses (unless co-located with an access track) • Muster cattle away from seismic area in consultation with pastoralist • Lease pads to be fully fenced during operations. • Open pits to be fully fenced to prevent livestock access. • Sumps to have fauna ladders or liner material (such as Coletanche) with sufficient friction to allow fauna to escape. • Gravel pits to be left open to act as watering point for livestock when not in use. • Vehicle speed limit restricted to 60 km/hr. • Dust suppression used to limit dust impacts to vegetation. • Site to be rehabilitated back to pre-disturbance conditions as per the Code of Practice. • All equipment and loads to be inspected and certified weed free prior to entry • 6 monthly weed inspections to be completed with all identified weeds treated. • Weeds sprayed periodically to

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			bond requirements Reduction in land production through bushfire • Low risk of impacts to flora and fauna through the encouragement of feral animals and other pest species leading to competition with native species. This includes the introduction of cane toads. • Low risk of disturbance to livestock from seismic charges due to small nature of charges. Noise anticipated to be audible within 2 km and vibration felt typically <200 m. • Low risk of impacts to cattle/pastoralist productivity due to gates being left open and cattle escaping (consequence “moderate”, Likelihood unlikely)	restrict weed numbers. • Fire breaks to be utilised around all well sites, with minimum separation distances of 45m between flares and vegetation. • Grinding, welding and other higher risk fire activities to be undertaken away from vegetation/ in manners that avoid bushfire risk. • Vehicles to be equipped with fire extinguishers. • No flaring during total fire bans. • Fire response to be implemented during seismic program, with spotters and fire trailers utilised to put out spot fires during work • Seismic civils to be preferentially completed during either early wet or early dry. • Grids to be installed at areas with frequent access requirements • Gate ‘mates”, signage, inductions and gate monitoring programs implemented to ensure gates are not left open.
Environmental Nuisance and Amenity- including dust, noise, light, odour and vibration	• Minimise impacts to pastoralist operations	• Construction of exploration infrastructure onsite changes land use from pastoral to industrial. • Light and noise nuisance to fauna and livestock in immediate vicinity of activity	• Low of changes in property amenity through the construction and operation of exploration infrastructure due to location of activities and separation distance from receptors • Low risk of increased vehicle accident or traffic impacts through associated with no material traffic volumes anticipated and	• Site located >30 km from the closest pastoralist homestead. • Site is located away from pastoralist main access points. • Maximum peak traffic during mobilisation and demobilisation is likely to be typically <44 vehicle

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
		• Increased traffic to proposed exploration area • Noise, light, odour and dust emissions in the immediate vicinity of the lease pad. • A visible hue visible from the Carpentaria may be present at night during flaring or from activity lighting. • Noise impacts from helicopter movements	limited peak traffic periods. • Low risk of adverse impacts to fauna from traffic are not anticipated, with impact levels consistent with standard road traffic levels. • Low risk of helicopter movements causing impacts to receptors based on location of site away from homesteads • Low risk of disturbance to livestock from seismic charges due to small nature of charges- noise anticipated to be audible within 2 km and vibration felt typically <200 m.	movements per day for 2 weeks. • Speed limit restricted on the access tracks to <60 km/hr. • Dust suppression to be utilised to minimise dust emissions during major equipment moves. • Where helicopter movements are planned, the pastoralist to be engaged prior to ensure helicopter do not interfere with pastoral activities. • During seismic surveys, detonations will not occur when cattle are in proximity. Cattle will be mustered way from seismic area in consultation with pastoralist.

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8. Consequences for Stakeholder Rights and Activities

8.1 Stakeholders Rights

Pastoral Lessees within the Northern Territory have non-exclusive rights to conduct their pastoral activities on the land granted under the Northern Territory Pastoral Lands Act (2016). Origin respects these legal rights and seeks a sustainable relationship with Pastoral Lessees so that both parties can co-exist on the land. Origin proposes to achieve this via the following key principles:

1. Formal stakeholder engagement aligned with the requirements of Section 7.2 (a) of the Northern Territory Petroleum (Environment) Regulations 2016.
2. Structured and timely process for the execution of an access agreement and associated compensation under the Northern Territory Petroleum Regulations 2020.
3. Mutually agreed ongoing, regular engagement and communications.

Origin's impacts to stakeholder rights are limited to accessing and utilisation of defined sections of the pastoral lease for authorised petroleum exploration activities. Impacts to rights are restricted to a loss of pastoral productivity over the areas for which Origin has established infrastructure, such as lease pads, camp pads, gravel pits and access tracks. Access to demarcated zones around the well pad is also restricted, to ensure stakeholder and community safety.

8.2 Stakeholders Activities

In accordance with s.7.2 of the PER, Origin is required to provide the pastoralists information on the potential consequences of undertaking the regulated activities on a stakeholder's rights.

A summary of the potential consequences of the activity and mitigation controls are summarised in Table 3 Potential consequences and control measures.

Table 3 Potential consequences of the activity on stakeholders' activities

Pastoralist Activity	Potential Consequence to Activities	Mitigations
Pastoral time	• Impact to pastoralist time as they are required to engage with Origin as a part of the planning and approval for the proposed activity.	• Origin undertakes engagement in good faith, with information provided in a variety of formats to reduce time pressures as far as reasonably practicable.
Pastoralist site access	• Exploration vehicles along access track may interact with pastoralist activities- mustering and pastoralist vehicles. • Restricted access to exploration well and fenced area during the length of proposed activities. • Restricted access during seismic surveys.	• Pastoralist engaged throughout exploration activity planning to incorporate pastoralist feedback into activity to reduce impacts. • Camps with workers bussed to site (where possible) to minimise vehicle movements. • Hazardous areas to be fenced and signed to communicate potential safety hazards. • Compensation to be paid for loss of available grazing land and disturbance.
Pastoral activities- grazing and mustering	• Minor elevated levels of noise in the immediate vicinity of the well pad during exploration activities (limited noise at all other times). • Potential elevated noise and vibration within vicinity of seismic shoot (typically within 2-500m of activity).	• Pastoralist engaged throughout exploration activity planning to minimise impact on cattle and pastoral activities. • Compensation to be paid for loss of available grazing land and disturbance. • Full fencing of well pad to restrict cattle. • Speed limits restricted to 60 km/hr.

Pastoralist Activity	Potential Consequence to Activities	Mitigations
	• Disturbance of cattle in the immediate vicinity of the activity when works are undertaken. • Dust impacts on immediate adjacent vegetation has the potential to temporarily reduce yield, similar to existing pastoral tracks. • Reduction in pastoral productivity through poor rehabilitation. • Potential introduction or spread of weeds. • Helicopter movements in vicinity of pastoral activities may disturb cattle/ mustering operations. • Potential impacts on cattle and pastoral business where gates are left open.	• Dust control utilised to reduce dust emissions. • Site to be rehabilitated back to pre-existing state, with security bond in place if company fails to rehabilitate. • Weed management plan implemented, including requirements for weed hygiene inspections and certificates on all equipment and vehicles. • 6 monthly weed monitoring and spraying of weeds using a NT Government approved treatment. • Pastoralist to notified and engaged prior to commencing helicopter movements to mitigate interference. • Induction with all exploration contractors and staff in relation to pastoral operations. This induction to be developed with input from pastoralist. • Use of grids, gate signage, inductions and regular gate monitoring and reporting to pastoralist to minimise occurrence of gates being left open. • On-going liaising with pastoralist throughout on ground operations.
Pastoral activities- ongoing productivity of area post rehabilitation	• Reduction in productivity due to erosion and sediment releases. • Reduction in productivity due to wastewater, chemical/fuel spills. • Reduction in pastoral productivity through poor rehabilitation. • Potential introduction or spread of weeds.	• Routine site maintenance completed to ensure functioning of erosion and sediment control. • All fuels and chemicals to be stored within secondary containment, with no storage of hydraulic fracture stimulation flowback work drilling wastewater. • All spills remediated as required in the EMP/spill management plan. • End of life rehabilitation to return land back to pre-existing state or as agreed to with pastoralist. • Rehabilitation security with NTG retained. • Weed management plan implemented, including requirements for weed hygiene inspections and certificates on all equipment and vehicles. • 6 monthly weed monitoring and spraying of weeds using a NT Government approved treatment.
Pastoral access to groundwater	• No anticipated impacts as proposed groundwater take is to be covered under a WEL.	• All groundwater take to be authorised under a WEL. • Water extraction from pastoralist bores not proposed, unless specifically approved by pastoralist through an agreement.

Pastoralist Activity	Potential Consequence to Activities	Mitigations
Pastoral access to surface water	• No anticipated impacts as no surface water take, interference or wastewater discharges proposed.	• No surface water proposed to be taken.
Pastoralist's amenity	• Minor elevated levels of noise in the immediate vicinity of the well pad during activities consistent with the 2016 drilling campaign. • During seismic charge detonation, noise is infrequent and typically a dull thud. • Visual presence of infrastructure within pastoralist lease. • Potential visible hue form flare and night-time at distance.	• Site to be located away from main pastoralist entry points and homestead. • Noise and vibration from seismic surveys is typically a dull thud not felt outside of 200 m or heard outside of 2 km. • Site selection to avoid placing flares and exploration activities on regional high points.

9. Stakeholder Engagement Plan Feedback

All feedback on the proposed activities and their potential impacts, risks and proposed controls should be provided to Origin via the feedback form in Appendix A within the 28-day time period. Where no comments on contents relating to the requirements of the PER are received within the 28-day period, the PER Stakeholder Engagement requirements will be considered fulfilled. Ongoing stakeholder engagement will then proceed.

All lessee comments and associated Origin responses will be documented and provided to DEPWS as a part of the EMP approval process.

10. Ongoing Stakeholder Engagement

To keep the Shenandoah East Pastoral representatives informed of the status of the regulated activities, the following ongoing engagement is proposed:

- Quarterly engagement on the status of exploration activities
- Fortnightly engagement prior to the commencement of activities under this SEP
- Adhoc engagement as requested by the Beetaloo Pastoral Representative
- Future engagement on additional petroleum exploration activities (If and when proposed) which are not covered under this EMP

Alternative engagement frequencies can be accommodated at the request of the nominated representative.

Origin would also like to extend an invitation to the Pastoral lessees to attend any of the proposed exploration activities to further seek comfort in their understanding and to highlight the nature in which operations are conducted.

11. Commonly used Acronyms & Abbreviations

Acronym	Meaning
AAPA	Aboriginal Areas Protection Authority
ALARP	As Low as Reasonably Practicable
BMP	Bushfire Management Plan
CBL	Cement Bond Log
Code of Practice	Code of Practice: Onshore Petroleum Activities within the Northern Territory
DEPWS	Department of Environment, Parks and Water Security
DIPL	Department of Infrastructure, Planning and Logistics
DFIT	Diagnostic Fracture Injection Test
DoH	Department of Health
E&A	Exploration and Appraisal
EC	Electrical Conductivity
EPA	Environment Protection Authority (NT)
EP	Exploration Permit (e.g. EP76, EP98 and EP117)
EMP	Environmental Management Plan
ERP	Emergency Response Plan
ESCP	Erosion and Sediment Control Plan
GHG	Greenhouse Gas
Ha	hectare
HFS	Hydraulic Fracture Stimulation
JV	Joint Venture
Km	Kilometre
m	metre
NT	Northern Territory
NTG	Northern Territory Government
RWA	Restricted Work Area
SPMP	Spill Management Plan
TO	Traditional Owner
WEL	Water Extraction Licence
WMP	Weed management Plan

Acronym	Meaning
WOMP	Well Operations Management Plan
WWMP	Wastewater Management Plan

Appendix A – Stakeholder Feedback Form

Stakeholder Feedback Form NT-2050-95-AQ-0003

Stakeholder:	
Document Referenced:	
Controlled Doc Number:	

#	Ref	Comment	Date	Origin Feedback	Date

Appendix B Drilling sump mix bury cover

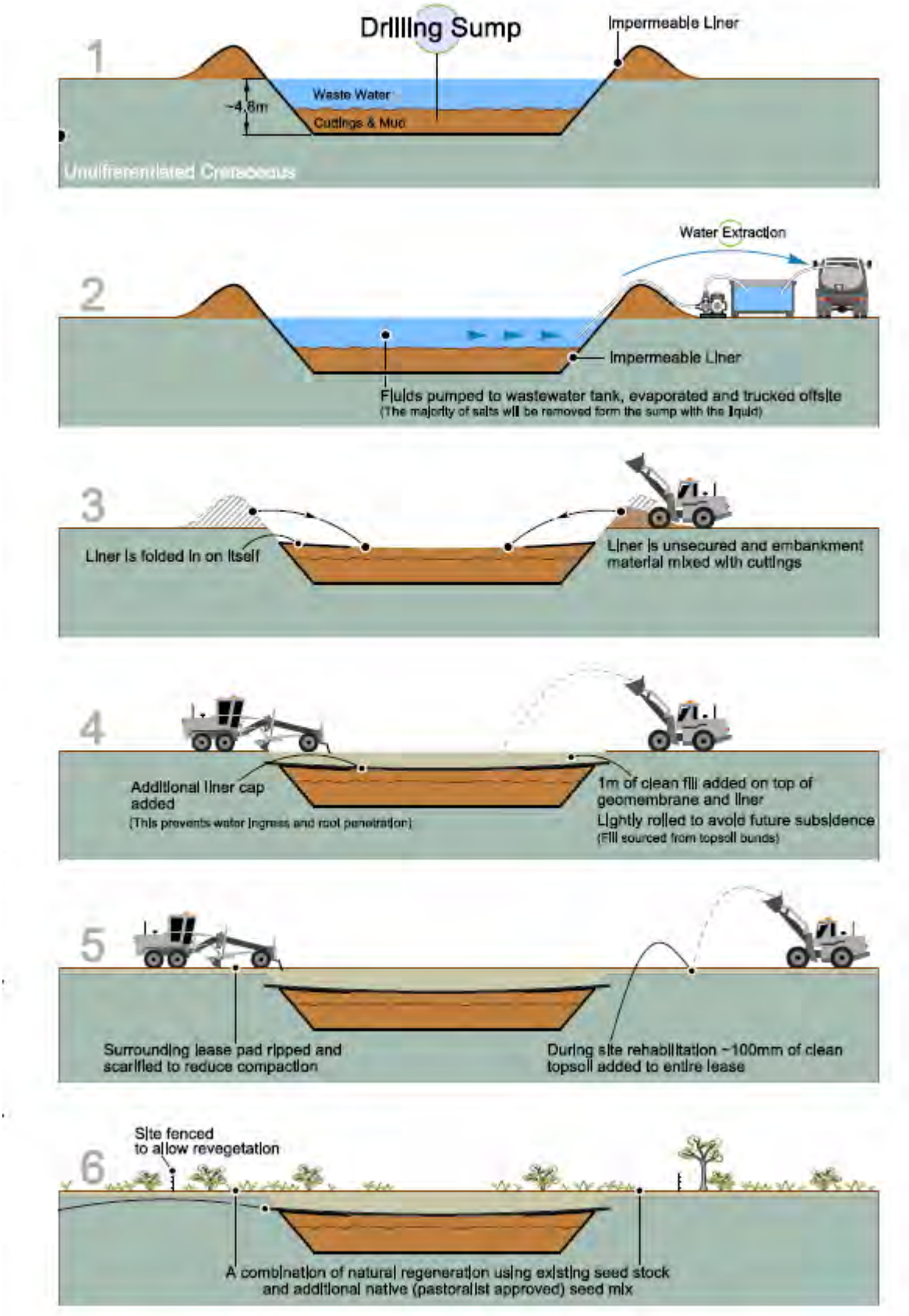
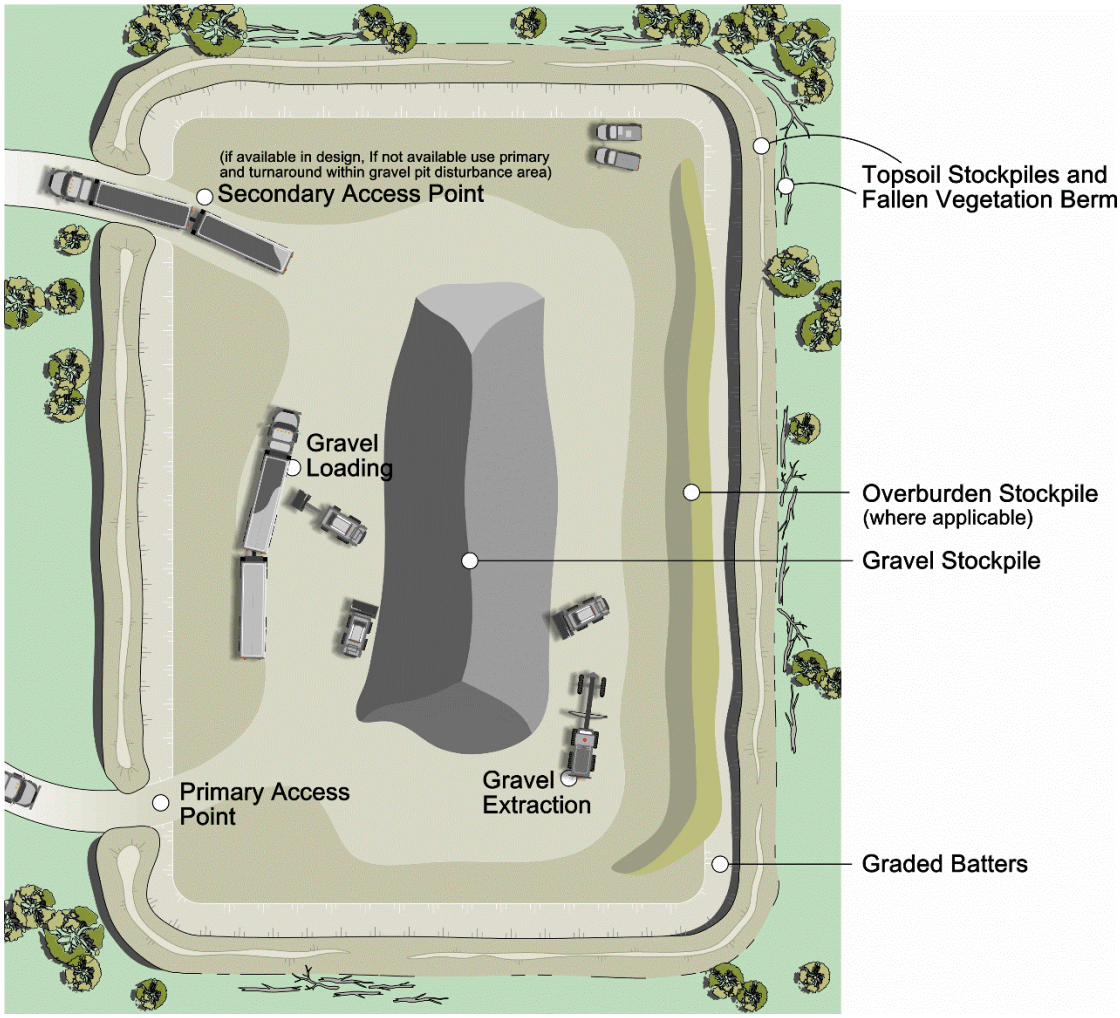
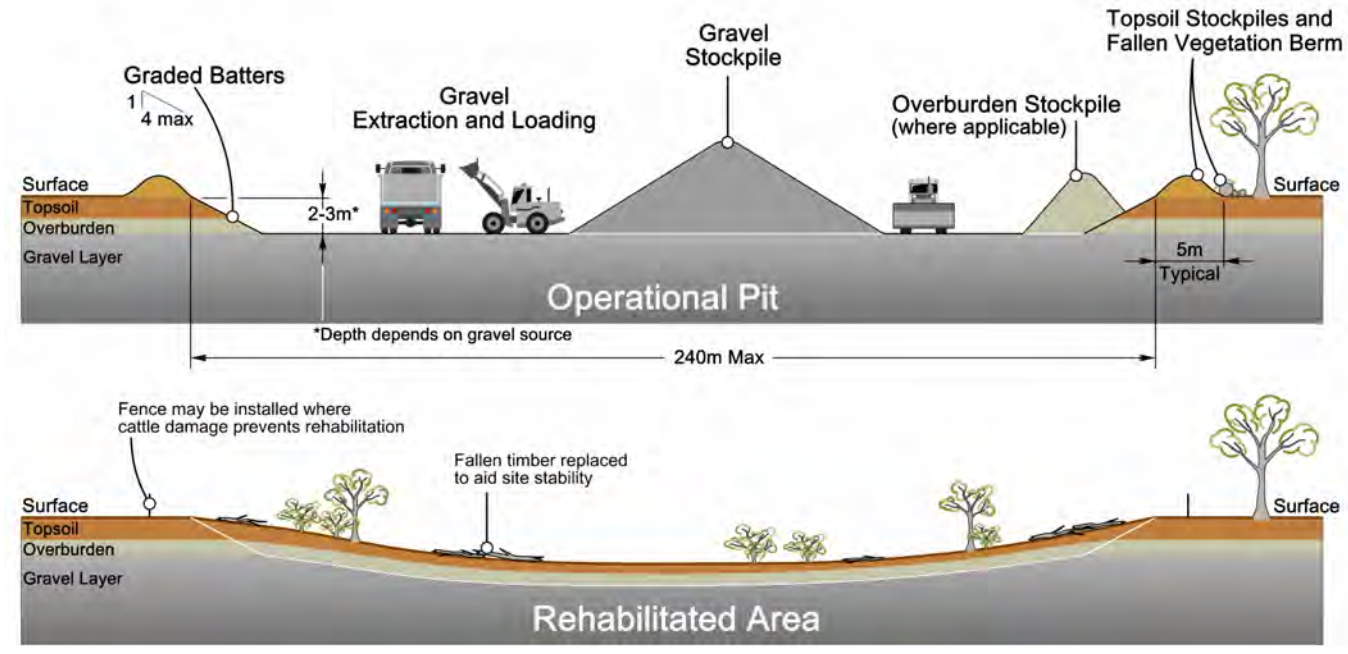


Figure 6 Illustration of the onsite burial of drilling waste at each location

Appendix C Gravel Pit Generic Layout, Operations and Rehabilitation





From:	David Armstrong
To:	Val Dyer
Cc:	Justin Dyer; Robbie Wear; Matthew Hanson; CharlieMartel@wardkeller.com.au; Nick Dyer
Subject:	Re: Stakeholder Engagement Pack (SEP) - Proposed Well location - Shenandoah East
Date:	Sunday, 26 June 2022 11:48:35 AM
Attachments:	image003.png Untitled attachment 00003.htm APN Pty Ltd Stakeholder Engagement Pack - Response to Feedback.pdf Untitled attachment 00006.htm

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Hi Val, hope your well

Please see attached answers from Origin to your questions from the SEP sent to you on May 23rd. I'll give you a call for a catch up regarding Origins operations. Robbie may have filled Justin in but there isn't a whole lot happening right now.

As always if you have any further questions on the SEP please let me know

Regards

Dave

DAVID ARMSTRONG

Managing Director

[redacted]

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APN Pty Ltd

Stakeholder Engagement Pack – Pastoralist Comments / Origin Feedback

#	Ref / Page	Comment	Date	Origin Feedback	Date
1	2, 10, 20	Variation in advice. Request greater/ clearer intentions of disposal of waste from drilling wells.	07/06/22	Disposal of drilling muds onsite. Similar to the proposal at Kyalla 117 N2, environment (including pastoral activities) are acceptable. Typically, this will be done by either encapsulating the material onsite within the existing sump footprint (i.e. using the existing bottom liner with a cap containing a separate liner and clean fill installed over it) or by removing the liners and mix-bury- covering the material (mixing the waste with embankment material at depth and then covering with clean fill to enable root growth). Origin would then monitor the site until it has been fully rehabilitated (i.e. vegetation has been established and the site is safe and stable). To minimise the number of sumps on each property and utilise the existing sump pit, waste cuttings and muds from multiple (typically 1-3) other wells may be disposed of on each of the well pads. This will allow Origin to move drilling cuttings and muds from unsuitable locations to suitable locations (i.e where soil types or other factors make it unsuitable to dispose of drilling waste at a site). Typically, drilling cuttings and waste will be disposed of at the site it is generated as this is the most economic option.	23/06/2022
2	2	Clarify location of gravel pit.	07/06/22	The gravel pit is located approximately 1.2km North West from the NW3 location centre adjacent to the Carpentaria Highway. It is located directly opposite to the DIPL pit (which is located within the Carpentaria Road corridor).	23/06/2022

3	6	NW3 access track could be 2km?	07/06/22	Correct, access track is anticipated to be approximately 2km with the final length determined by the location of the lease pad in the proposed area.	23/06/2022
4	10	'Beneficial' usage of the gas – a form of production? i.e commercial use.	07/06/22	Beneficial use of gas is designed to reduced Greenhouse gas emissions from flaring. Beneficial usage scenarios could include: 1. onsite power generation to support exploration and appraisal activities (such as power generation, water treatment etc.) 2. Sale into an adjacent pipeline during well testing activities (to reduce CO2 emissions from flaring)	23/06/2022
5	16, 23	Specifications for fencing? Further explanation of 'horizontal flare'.	07/06/22	Proposed fencing as per NTG stock fence design and details CS3310 drawing, 4 strand barbed wire cattle fence detail. As outlined in the SEP, Origin may use a horizontal flare to combust condensate if produced during well testing. The horizontal flare will be equipped with 3 independent nozzles, with a maximum flaring capacity of 3000 barrels/burner per day (see set-up example below). The horizontal flare will be located in a 20 mx 10 m lined pit. Flares will be located at least 45 m from the surrounding vegetation and a water curtain installed to dampen heat radiation.	23/06/2022

6	24, 27	Will there be water quality testing of bores up to 10km? Is there ongoing water quality testing of bores relating to Kyalla 117?	07/06/22	Groundwater quality testing: Yes- there will be groundwater quality of bores up to 10km away from a proposed location. Monitoring will be undertaken at a 6 monthly frequency (typically- based on accessibility) for a period of 3 years post stimulation. The bores within the vicinity of Kyalla 117 N2-1 well will continue to be monitored as a part of our regional monitoring program with data provided periodically. COVID has impacted monitoring rounds over the last 12 months and we are hopeful that the program will return to normal going forward.	23/06/2022
7	42 Table 3	Pastoral time: Compensation to be paid for time spent managing risk.	07/06/22	Compensation will be assessed in accordance with the Act and Regulations. Origin proposes to discuss compensation during the negotiation of the access agreement. Dave Armstrong will contact you initially to discuss this.	23/06/2022

Appendix N Rehabilitation Plan

Exploration Permit 98

Rehabilitation Plan 2022/25 - 2D Seismic

Located: Amungee Delineation Area (v1)

Rehabilitation Officer	Contact Details	Name
	[redacted]	Robert Wear

Location of EP98—Amungee Mungee PPL and Shenandoah East PPL

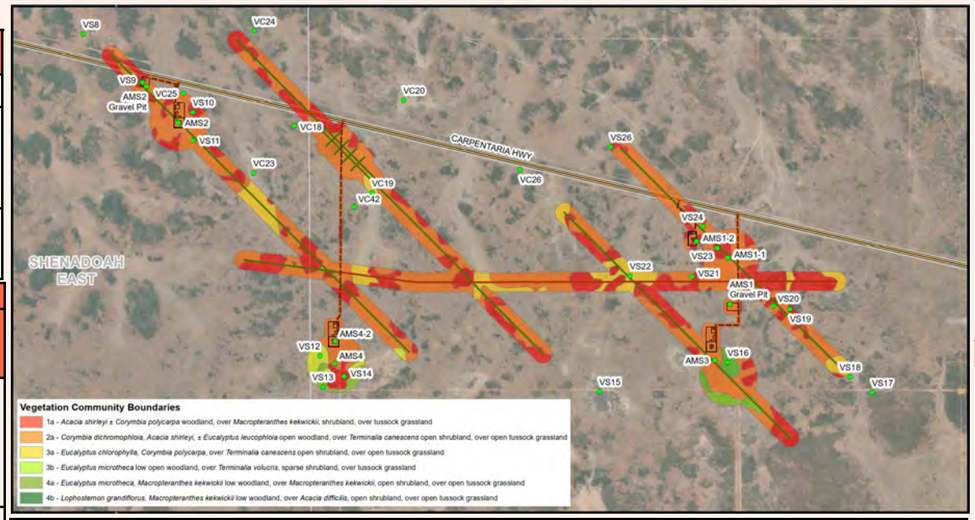
Property land uses	Gas exploration and cattle grazing
Climate	Amungee Delineation area is described as arid to semi-arid. Climate is influenced by the monsoon and there is a distinct wet and dry season. Most rainfall (90%) occurs during the summer months, between October and March. Annual rainfall varies across the permit area is around 680 mm, with rainfall totals show moderate
Site Description	The Amungee delineation area occurs within the Beetaloo Land System, which is classified as lateritic plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products, sandy and earth soils.

Site Environmental Summary

Vegetation community	Survey sites	Descriptions	Canopy cover (%)	Ground cover (%)
Acacia shirleyi, Corymbia polycarpa mid high woodland	VC6, VC7, VC24, VS9, VS10, VS14, VS17, VS19, VS23, VS26	*Acacia shirleyi ± Corymbia polycarpa* mid high woodland, over *Macropteranthes kekwickii*, *Terminalia* mid high shrubland, over *Chrysopogon sp.* mid high tussock grassland.	20-70	5-20
Corymbia dichromophloia, Erythrophleum chlorostachys, Eucalyptus chlorophylla mid high open woodland	VC5, VC8, VC18, VC21, VC25, VC26, VC42, VS8, VS11, VS20, VS21, VS24	*Corymbia dichromophloia*, *± Erythrophleum chlorostachys, ± Eucalyptus chlorophylla* mid high open woodland, over *Terminalia canescens, Petalostigma pubescens*, *Erythrophleum chlorostachys* mid high open shrubland, over *Chrysopogon fallax, ± Sorghum plumosum, Themeda triandra* mid high open tussock grassland	6-30	5-50
Eucalyptus chlorophylla, *Corymbia polycarpa*, and *C. dichromophloia* mid high open woodland	VC19, VC20, VC22, VC23, VS18, VS22	*Eucalyptus chlorophylla*, *Corymbia polycarpa*, *± C. dichromophloia* mid high open woodland, over *Eucalyptus chlorophylla*, *± C. ferruginea, ±Terminalia canescens*, mid high open shrubland, over *Chrysopogon fallax* mid high open tussock grassland	15-20	5-20
Eucalyptus microtheca low open woodland	VS12	*Eucalyptus microtheca* low open woodland, over *Terminalia volucris, Ehretia saligna,* mid high sparse shrubland, over *Aristida inaequiglumis, Eulalia aurea* mid high tussock grassland	5-20	5-40
Eucalyptus microtheca and *Macropteranthes kekwickii* low woodland	VS13, VS15	*Eucalyptus microtheca, Macropteranthes kekwickii* low woodland, over *Macropteranthes kekwickii*, *E. microtheca, Brachychiton diversifolius* mid high open shrubland, over *Chrysopogon fallax, Sorghum plumosum* mid high open tussock grassland	6	40
Lophostemon grandiflorus and Macropteranthes kekwickii low woodland	VS16	*Lophostemon grandiflorus, Macropteranthes kekwickii* low woodland, over *Acacia difficilis, Grewia retusifolia* mid high open shrubland, over *Chrysopogon fallax, Eulalia aurea, Themeda triandra* mid high open tussock grassland	20-35	2-40

Post Activity Rehabilitation Aim and Objectives

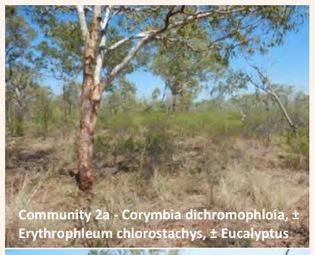
Site management aim	The aim is to rehabilitate any part of the land affected by the regulated petroleum activity to a safe condition consistent with industry standards. Existing tracks utilised for seismic surveys the Pastoral Stations are to be reinstated to a safe trafficable condition.
Rehabilitation objectives	The rehabilitation objective is to provide a stable land form, which supports a resilient self-sustaining vegetation community that can withstand impacts including fire and cattle grazing and is safe to humans and wildlife, whilst utilising appropriate site infrastructure for ongoing pastoral activities (i.e. access tracks, water bores, fencing and laydown areas).



Rehabilitation Strategy

Parameters	Methods	Objective
Vegetation	• Implement progressive rehabilitation of seismic lines as soon as data recording is completed to reduce exposed soils and minimise runoff from first flush events. • Implement rehabilitation of field camp upon cessation of use. • Disturbed areas to be allowed to naturally regenerate or revegetate on completion of regulated activity. • All compacted areas to be ripped and scarified to promote regeneration of vegetation, this may require assistance through spread of native seed stock. Where possible, native seed stock would be supplied by local indigenous suppliers.	• Establish vegetation similar to adjacent vegetation (species richness, structure and cover). • The type of ground cover applied to completed earthworks to be compatible with the anticipated long-term land use, environmental risk, and site rehabilitation measures.
Ground cover	• Previously removed vegetation and topsoil will be uniformly respread over disturbed area to assist with rehabilitation process through agencies of increased infiltration and return of seed-bearing topsoil, as well as reducing erosion. • If required, additional native seed mix from the area could be respread to speed up rehabilitation process.	
Landform stability	• All windrows and whoa boys are to be removed as soon as practicable after line stabilisation.	

Community 1a—*Acacia shirleyi ± Corymbia polycarpa* mid high woodland, over *Macropteranthes kekwickii* shrubland -


Community 2a - Corymbia dichromophloia, ± Erythrophleum chlorostachys, ± Eucalyptus

Community 3a— Eucalyptus chlorophylla, Corymbia polycarpa, ± Corymbia dichromo-

Community 3b (NVIS Code: T6r) - *Eucalyptus microtheca* low open woodland

Community 4a - *Eucalyptus microtheca, Macropteranthes kekwickii* low woodland

Community 4b—Lophostemon grandifloras, Macropteranthes kekwickii low woodland

Rehabilitation Risks

Key Risks	Controls
Drought — impacting the establishment of rehabilitated vegetation	• Time rehabilitation actions to coincide with the beginning of the wet season, to ensure access to the site and maximise the establishment period of vegetation over the wet season • Re-spread topsoil across the site to utilise the local seed bank • Ongoing monitoring to identify if further seed inputs are required • Collection of seed from the local area to ensure seed stock is suited to the climatic conditions of the site
Fire—impacting revegetation	• Establish a mix of perennial and annual grass species • Establish a mix of re-sprouter (e.g. *Eucalypt spp*. and *Corymbia spp*.) and re-seeder species (e.g. *Acacia spp*.) • Ongoing monitoring to determine fire impacts on revegetation. • Ongoing monitoring to determine if further seed inputs are required
Grazing —impacting revegetation	• Establish a mix of perennial and annual grass species • Re-spread timber with top soil • Ongoing monitoring to determine grazing impacts on revegetation. • Ongoing monitoring to determine if further seed inputs are required • Ongoing monitoring to determine if fencing is required
Exposed Ground — leading to an increase in weed establishment and/or erosion	• Remove windrows and topsoils • Respread of topsoil and vegetated matter across the site • Annual weed surveys of rehabilitated area once rehabilitation is established • Control of any weed incursions

Final Success Criteria

Canopy Cover (%)	• A minimum of 10-20% canopy cover for open woodland community • It is noted that Eucalypt woodlands will recover faster than the Lancewood/Bullwaddy community, however should have signs of regrowth following rehabilitation and within 12-18 months after rainfall
Ground Cover (%)	• Minimum 20% ground cover using locally available material including reserved topsoil/ cleared vegetation before the onset of the first wet season • A minimum of 20% ground foliage cover and 30% diversity to be achieved within the first 12 months and maintained for at least 3 years following rehabilitation. Success will be dependent on minimised cattle movements and rainfall
Creek Crossings	• All crossings are reinstated to the original topography of the bed following seismic survey
Erosion	• Less than 5 % erosion should be evident after the first 12 months and no subsidence or erosion should be evident for at least 5 years after completion
Weeds	• No establishment of weed species declared under the Northern Territory Weeds Management Act
Hazardous materials and waste	• All hazardous material and waste removed from site upon completion of works to licensed landfill facilities or recycling facilities.
Safety for humans and wildlife	• Rehabilitation of disturbance areas should be similar in landform to the surrounding area. No steep slopes or barriers to remain on site that endanger either wildlife or humans • Water bores and exploration wells to be sealed and isolated • Removal of all surface facilities including fencing (star pickets/fencing wire) • Remediation and backfilling of all sumps/ponds

Monitoring Program and Schedule

Rehabilitation Stage	Timing	Method	Measurable attributes
Progressive Rehabilitation (following data recording)	Within 2 weeks of completion of the survey	• Topsoil and cleared vegetation will be stockpiled to be respread following the works. • Refer to detail in Appendix G Erosion and Sediment Control Plan	• All disturbed areas must be suitably stabilised - as per IECA Table in the erosion and sediment control plan.
Preliminary Assessment	Post rehabilitation, end of wet season survey (February to June).	• Establish 14 permanent 100m x 4m woody species transects (one per hectare), with photo monitoring point/s, include 2 analogue sites in nearby undisturbed vegetation community. • Collect 1 x 1 m ground cover quadrats every 10 m along transect. • Transects to be randomly selected with start and end marked with star picket. • Edge effects (i.e. impacts from haul roads) minimised through reducing plot margins to <20 m.	Measurable attributes compared with analogue sites. • Indication of seed germination and plant establishment rates. • Vegetation cover (dominant species and abundance). • Land condition (e.g. erosion, canopy cover, ground cover, habitat quality). • Weed presence/absence (species and density). • Disturbance (fire frequency and intensity, evidence of feral animal/cattle) • Incidental observations from surrounding area.
Early Rehabilitation	Years 1, 2 and 3 post rehabilitation, end of wet season survey (February to June).	• Monitoring to be undertaken using permanent transects. • Collect data as per preliminary methods. • Compare results from previous assessment to determine if require additional management inputs (i.e. seeding, stabilisation). • Review success criteria.	• Early assessment of rehabilitation will determine attributes of woody plants in each 100 m x 4 m transect. • Including assessment of species, Diameter at Breast Height (DBH) (>1.5 cm) and height (>2 m), in addition to parameters described within the preliminary assessment.
Long-Term Rehabilitation	Annually until final success criteria has been met, end of wet season survey (February to June).	• Monitoring to be undertaken using permanent transects. • Collect data as per preliminary methods. • Compare results from previous assessment to determine if require additional management inputs (i.e. seeding, stabilisation). • Review success criteria.	• Long-term assessment will determine establishment, recruitment and growth rate attributes of plant species, in addition to parameters described during Early Rehabilitation stage.

Exploration Permit 98

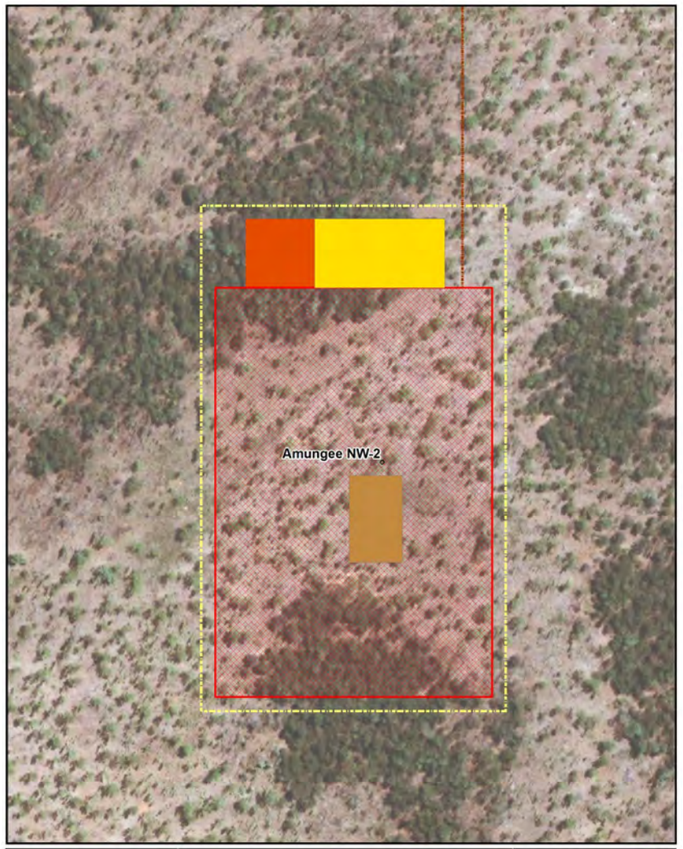
Rehabilitation Management Plan Rev 1.0

Amungee NW-2 Exploration Well Area

Origin Rehabilitation Officer	Contact Details	Name
	Mobile : 0467 679 003 Satellite phone : 0147 612 733 Robert.Wear@upstream.originenergy.com.au	Robert Wear

Location of Amungee NW-2 Exploration Well Area

Property land uses	Gas exploration and cattle grazing
Climate	The permit area is described as arid to semi-arid. Climate is influenced by the monsoon and there is a distinct wet and dry season. Most rainfall (90%) occurs during the summer months, between October and March. Annual rainfall varies across the permit area is around 680 mm, with rainfall totals show moderate variability and drought conditions are know to occur every 10 years.
Site Description (pre-disturbance)	Amungee NW-2 (GDA94, zone 53, 0389927E, 8190027N) is located in the EP98 tenement. The natural vegetation community that exists at Amungee NW-2 is *Corymbia dichromophloia* and *Eucalyptus chlorophylla* mid high open woodland, over *Erythrophleum chlorostachys, Acacia difficilis* and *Santalum lanceolatum* mid high open shrubland, over *Chrysopogon fallax and Sorghum plumosum* open tussock grassland. The Landform at Amungee NW-2 is characterised by plains and rises associated with deeply weathered lateritic profiles. Soils at this site are sandy loam soils containing around 50% fines, 50% ironstone gravels and has a high risk of loosing structural integrity under moist conditions. Habitat surrounding the site is considered to be in good condition. The habitat contains good refuge opportunities in the form of dense leaf litter, dense grass cover, large woody debris and smaller tree hollows.



Post Activity Rehabilitation Aim and Objectives

Site management aim	The aim is to rehabilitate any part of the land affected by the Regulated Petroleum Activity to a safe condition consistent with industry standards and in consultation with Landholder.
Rehabilitation objectives	The rehabilitation objective is to provide a stable land form, which supports a resilient self-sustaining vegetation community that can withstand impacts including fire and cattle grazing and is safe to humans and wildlife, whilst utilising appropriate site infrastructure for ongoing pastoral activities (i.e. access tracks, water bores, fencing and laydown areas).

Site Environment Summary

Infrastructure	Size (ha)	Soil Type / Slope Canopy/Ground Cover	Vegetation Community / Dominant Species
Drill Lease Pad	13.7	Lateritic silty Sand <1% Slope Canopy Cover 5-20% Ground Cover 5-30%	*Corymbia dichromophloia* and *Eucalyptus chlorophylla* mid high open woodland, over Erythrophleum chlorostachys, Acacia difficilis and Santalum lanceolatum mid high open shrubland, over Chrysopogon fallax and Sorghum plumosum open tussock grassland
Access Track	2.1		

Rehabilitation Strategy

Parameters	Methods	Objective
Vegetation	• Implement progressive rehabilitation within 12 months upon completion of petroleum activities. • Implement rehabilitation of lease pads upon cessation of use. • Disturbed areas to be allowed to naturally regenerate or revegetate on completion of Regulated Activity. • All compacted areas to be ripped and scarified to promote regeneration of vegetation, this may require assistance through spread of native seed stock. Where possible, native seed stock would be supplied by local indigenous suppliers.	• Establish vegetation similar to adjacent vegetation species richness, cover and structure), unless agreement with landowner and Regulator for alternative use. • The type of ground cover applied to completed earthworks to be compatible with the anticipated long-term land use, environmental risk, and site rehabilitation measures.
Ground cover	• Previously removed vegetation and topsoil will be uniformly re-spread over disturbed area to assist with rehabilitation process through agencies of increased infiltration and return of seed-bearing topsoil, as well as reducing erosion. • If required, additional native seed mix from the area could be respread to speed up rehabilitation process.	
Landform stability	• All windrows are to be removed as soon as practicable.	

Rehabilitation Risks

Key Risks	Controls
Drought — impacting the establishment of rehabilitated vegetation	• Time rehabilitation actions to coincide with the beginning of the wet season, to ensure access to the site and maximise the establishment period of vegetation over the wet season • Re-spread topsoil across the site to utilise the local seed bank • Ongoing monitoring to identify if further seed inputs are required • Collection of seed from the local area to ensure seed stock is suited to the climatic conditions of the site.
Fire—impacting revegetation	• Establish a mix of perennial and annual grass species • Establish a mix of re-sprouter (eg. *Eucalypt spp*. and *Corymbia spp.*) and re-seeder species (eg. *Acacia spp*.) • Ongoing monitoring to determine fire impacts on revegetation. • Ongoing monitoring to determine if further seed inputs are required
Grazing —impacting revegetation	• Establish a mix of perennial and annual grass species • Re-spread timber with top soil • Ongoing monitoring to determine grazing impacts on revegetation. • Ongoing monitoring to determine if further seed inputs are required • Ongoing monitoring to determine if fencing is required
Exposed Ground — leading to an increase in weed establishment and/or erosion	• Remove windrows and topsoils • Respread of topsoil and vegetated matter across the site • Annual weed surveys of rehabilitated area once rehabilitation is established • Control of any weed incursions

Final Success Criteria

Canopy Cover (%)	• A minimum of 10-20% canopy cover for open woodland community. • It is noted that Acacia shrublands will recover faster than Eucalypt and Bull-waddy communities, however should have signs of regrowth following rehabilitation and within 12-18 months after rainfall.
Ground Cover (%)	• Minimum 60% ground cover using locally available material including reserved topsoil/cleared vegetation before the onset of the first wet season resulting in a minimum of 40% bare ground. • A minimum of 40-60% ground foliage cover and diversity to be achieved within the first 12 months and maintained for at least 3 years following rehabilitation. Success will be dependent on minimised cattle movements and rainfall.
Erosion	• Less than 5 % erosion should be evident after the first 12 months and no subsidence or erosion should be evident for at least 5 years after completion.
Weeds	• No establishment of weed species declared under the Northern Territory Weeds Management Act 2001.
Hazardous materials and waste	• All hazardous material and waste removed from site upon completion of works to licensed landfill facilities or recycling facilities.
Safety for humans and wildlife	• Rehabilitation of disturbance areas should be similar in landform to the surrounding area. No steep slopes or barriers to remain on site that endanger either wildlife or humans • Water bores and exploration wells to be sealed and isolated • Removal of all surface facilities including fencing (star pickets/fencing wire) • Remediation and backfilling of all sumps/ponds.

Monitoring Program and Schedule

Rehabilitation Stage	Timing	Method	Measurable attributes
Preliminary Assessment	Post rehabilitation, end of wet season survey (February to June).	• Establish 5 permanent 100m x 4m woody species transects (one per hectare), with photo monitoring point/s, include 2 analogue sites in nearby undisturbed vegetation community. • Collect 1 x 1 m ground cover quadrats every 10 m along transect. • Transects to be randomly selected with start and end marked with star picket. • Edge effects (i.e. impacts from haul roads) minimised through reducing plot margins to <20m.	• All disturbed areas must be suitably stabilised – as per IECA Table in the erosion and sediment control plan. • Indication of seed germination and plant establishment rates. • Vegetation cover (species and abundance). • Land condition (e.g. erosion canopy cover, ground cover, habitat quality). • Weed presence (species and density). • Disturbance (fire and feral animal/cattle) • Incidental observations from surrounding area.
Early Rehabilitation	Years 1, 2 and 3 post rehabilitation, end of wet season survey (February to June).	• Monitoring to be undertaken using permanent transects. • Collect data as per preliminary methods. • Compare results from previous assessment to determine if require additional management inputs (i.e. seeding, stabilisation). • Review success criteria.	• Early assessment of rehabilitation will determine attributes of woody plants in each 100m x 4m transect. • Including assessment of species, Diameter at Breast Height (DBH) (>1.5cm) and height (>2m), in addition to parameters described within the preliminary assessment.
Long-Term Rehabilitation	Annually until final success criteria has been met, end of wet season survey (February to June).	• Monitoring to be undertaken using permanent transects. • Collect data as per preliminary methods. • Compare results from previous assessment to determine if require additional management inputs (i.e. seeding, stabilisation). • Review success criteria.	• Long-term assessment will determine establishment, recruitment and growth rate attributes of plant species, in addition to parameters described during Early Rehabilitation stage.

Amungee NW-2—Vegetation Community and Soil

Exploration Permit 98

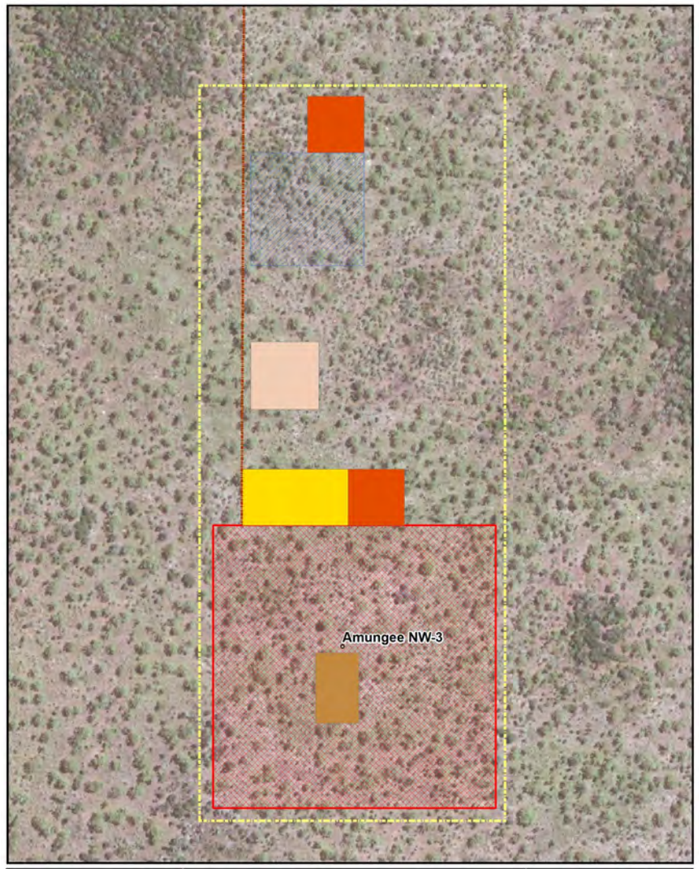
Rehabilitation Management Plan Rev 1.0

Amungee NW-3 Exploration Well Area

Origin Rehabilitation Officer	Contact Details	Name
	Mobile : 0467 679 003 Satellite phone : 0147 612 733 Robert.Wear@upstream.originenergy.com.au	**Robert Wear**

Location of Amungee NW-3 Exploration Well Area

Property land uses	Gas exploration and cattle grazing
Climate	The permit area is described as arid to semi-arid. Climate is influenced by the monsoon and there is a distinct wet and dry season. Most rainfall (90%) occurs during the summer months, between October and March. Annual rainfall varies across the permit area is around 680 mm, with rainfall totals show moderate variability and drought conditions are know to occur every 10 years.
Site Description (pre-disturbance)	Amungee NW-3 GDA94, zone 53, 0376604E, 8193091N 7N) is located in the EP98 tenement. The natural vegetation community that exists at Amungee NW-3 is *Corymbia dichromophloia* mid high open woodland, over *Terminalia canescens*, *Petalostigma pubescens* and *Hakea arborescens* mid high sparse shrubland, over *Chrysopogon fallax*, *Schizachyrium fragile* open tussock grassland. The Landform at Amungee NW-3 is characterised by plains and rises associated with deeply weathered lateritic profiles. Soils at this site are sandy loam soils containing around 50% fines, 50% ironstone gravels and has a high risk of loosing structural integrity under moist conditions. Habitat surrounding the site is considered to be in good condition. The habitat contains good refuge opportunities in the form of dense leaf litter, dense grass cover, large woody debris and smaller tree hollows.



Post Activity Rehabilitation Aim and Objectives

Site management aim	The aim is to rehabilitate any part of the land affected by the Regulated Petroleum Activity to a safe condition consistent with industry standards and in consultation with Landholder.
Rehabilitation objectives	The rehabilitation objective is to provide a stable land form, which supports a resilient self-sustaining vegetation community that can withstand impacts including fire and cattle grazing and is safe to humans and wildlife, whilst utilising appropriate site infrastructure for ongoing pastoral activities (i.e. access tracks, water bores, fencing and laydown areas).

Site Environment Summary

Infrastructure	Size (ha)	Soil Type / Slope Canopy/Ground Cover	Vegetation Community / Dominant Species
Drill Lease Pad	13.7	Lateritic silty Sand <1% Slope Canopy Cover 5-20% Ground Cover 5-30%	*Corymbia dichromophloia* and *Eucalyptus chlorophylla* mid high open woodland, over Erythrophleum chlorostachys, Acacia difficilis and Santalum lanceolatum mid high open shrubland, over Chrysopogon fallax and Sorghum plumosum open tussock grassland
Access Track	2.8		
Gravel Pit	3.5		

Rehabilitation Strategy

Parameters	Methods	Objective
Vegetation	• Implement progressive rehabilitation within 12 months upon completion of petroleum activities. • Implement rehabilitation of lease pads upon cessation of use. • Disturbed areas to be allowed to naturally regenerate or revegetate on completion of Regulated Activity. • All compacted areas to be ripped and scarified to promote regeneration of vegetation, this may require assistance through spread of native seed stock. Where possible, native seed stock would be supplied by local indigenous suppliers.	• Establish vegetation similar to adjacent vegetation species richness, cover and structure), unless agreement with landowner and Regulator for alternative use. • The type of ground cover applied to completed earthworks to be compatible with the anticipated long-term land use, environmental risk, and site rehabilitation measures.
Ground cover	• Previously removed vegetation and topsoil will be uniformly re-spread over disturbed area to assist with rehabilitation process through agencies of increased infiltration and return of seed-bearing topsoil, as well as reducing erosion. • If required, additional native seed mix from the area could be respread to speed up rehabilitation process.	
Landform stability	• All windrows are to be removed as soon as practicable.	

Rehabilitation Risks

Key Risks	Controls
Drought — impacting the establishment of rehabilitated vegetation	• Time rehabilitation actions to coincide with the beginning of the wet season, to ensure access to the site and maximise the establishment period of vegetation over the wet season • Re-spread topsoil across the site to utilise the local seed bank • Ongoing monitoring to identify if further seed inputs are required • Collection of seed from the local area to ensure seed stock is suited to the climatic conditions of the site.
Fire—impacting revegetation	• Establish a mix of perennial and annual grass species • Establish a mix of re-sprouter (eg. *Eucalypt spp*. and *Corymbia spp.*) and re-seeder species (eg. *Acacia spp*.) • Ongoing monitoring to determine fire impacts on revegetation. • Ongoing monitoring to determine if further seed inputs are required
Grazing —impacting revegetation	• Establish a mix of perennial and annual grass species • Re-spread timber with top soil • Ongoing monitoring to determine grazing impacts on revegetation. • Ongoing monitoring to determine if further seed inputs are required • Ongoing monitoring to determine if fencing is required
Exposed Ground — leading to an increase in weed establishment and/or erosion	• Remove windrows and topsoils • Respread of topsoil and vegetated matter across the site • Annual weed surveys of rehabilitated area once rehabilitation is established • Control of any weed incursions

Final Success Criteria

Canopy Cover (%)	• A minimum of 10-20% canopy cover for open woodland community. • It is noted that Acacia shrublands will recover faster than Eucalypt and Bullwaddy communities, however should have signs of regrowth following rehabilitation and within 12-18 months after rainfall.
Ground Cover (%)	• Minimum 60% ground cover using locally available material including reserved topsoil/cleared vegetation before the onset of the first wet season resulting in a minimum of 40% bare ground. • A minimum of 40-60% ground foliage cover and diversity to be achieved within the first 12 months and maintained for at least 3 years following rehabilitation. Success will be dependent on minimised cattle movements and rainfall.
Erosion	• Less than 5 % erosion should be evident after the first 12 months and no subsidence or erosion should be evident for at least 5 years after completion.
Weeds	• No establishment of weed species declared under the Northern Territory Weeds Management Act 2001.
Hazardous materials and waste	• All hazardous material and waste removed from site upon completion of works to licensed landfill facilities or recycling facilities.
Safety for humans and wildlife	• Rehabilitation of disturbance areas should be similar in landform to the surrounding area. No steep slopes or barriers to remain on site that endanger either wildlife or humans • Water bores and exploration wells to be sealed and isolated • Removal of all surface facilities including fencing (star pickets/fencing wire) • Remediation and backfilling of all sumps/ponds.

Monitoring Program and Schedule

Rehabilitation Stage	Timing	Method	Measurable attributes
Preliminary Assessment	Post rehabilitation, end of wet season survey (February to June).	• Establish 5 permanent 100m x 4m woody species transects (one per hectare), with photo monitoring point/s, include 2 analogue sites in nearby undisturbed vegetation community. • Collect 1 x 1 m ground cover quadrats every 10 m along transect. • Transects to be randomly selected with start and end marked with star picket. • Edge effects (i.e. impacts from haul roads) minimised through reducing plot margins to <20m.	• All disturbed areas must be suitably stabilised – as per IECA Table in the erosion and sediment control plan. • Indication of seed germination and plant establishment rates. • Vegetation cover (species and abundance). • Land condition (e.g. erosion canopy cover, ground cover, habitat quality). • Weed presence (species and density). • Disturbance (fire and feral animal/cattle) • Incidental observations from surrounding area.
Early Rehabilitation	Years 1, 2 and 3 post rehabilitation, end of wet season survey (February to June).	• Monitoring to be undertaken using permanent transects. • Collect data as per preliminary methods. • Compare results from previous assessment to determine if require additional management inputs (i.e. seeding, stabilisation). • Review success criteria.	• Early assessment of rehabilitation will determine attributes of woody plants in each 100m x 4m transect. • Including assessment of species, Diameter at Breast Height (DBH) (>1.5cm) and height (>2m), in addition to parameters described within the preliminary assessment.
Long-Term Rehabilitation	Annually until final success criteria has been met, end of wet season survey (February to June).	• Monitoring to be undertaken using permanent transects. • Collect data as per preliminary methods. • Compare results from previous assessment to determine if require additional management inputs (i.e. seeding, stabilisation). • Review success criteria.	• Long-term assessment will determine establishment, recruitment and growth rate attributes of plant species, in addition to parameters described during Early Rehabilitation stage.

Amungee NW-3—Vegetation Community and Soil

Exploration Permit 98

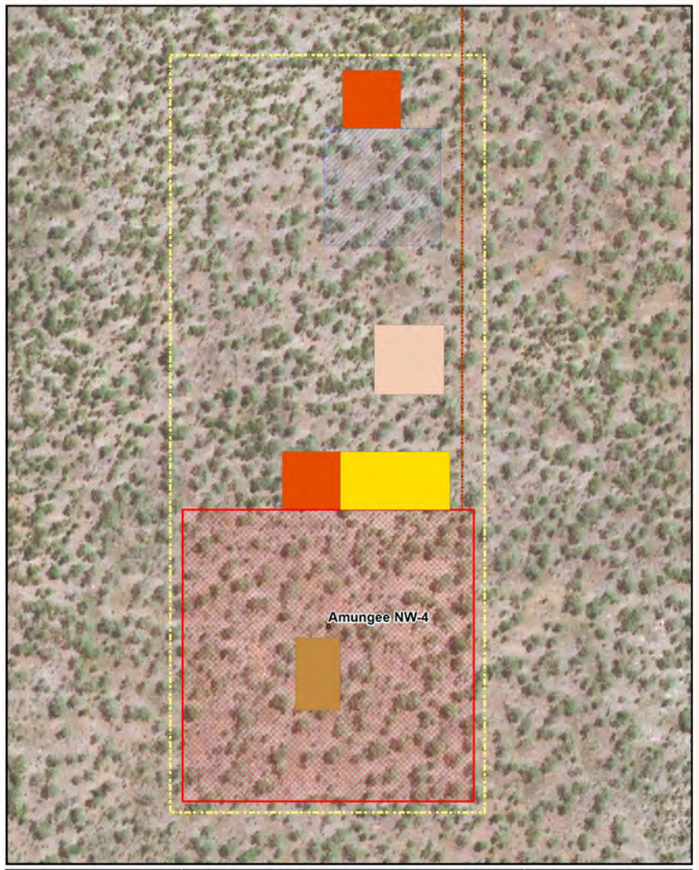
Rehabilitation Management Plan Rev 1.0

Amungee NW-4 Exploration Well Area

Origin Rehabilitation Officer	Contact Details	Name
	Mobile : 0467 679 003 Satellite phone : 0147 612 733 Robert.Wear@upstream.originenergy.com.au	Robert Wear

Location of Amungee NW-4 Exploration Well Area

Property land uses	Gas exploration and cattle grazing
Climate	The permit area is described as arid to semi-arid. Climate is influenced by the monsoon and there is a distinct wet and dry season. Most rainfall (90%) occurs during the summer months, between October and March. Annual rainfall varies across the permit area is around 680 mm, with rainfall totals show moderate variability and drought conditions are know to occur every 10 years.
Site Description (pre-disturbance)	Amungee NW-4 GDA94, zone 53, 0390418E, 8186954N) is located in the EP98 tenement. The natural vegetation community that exists at Amungee NW-4 is *Corymbia dichromophloia* and *Erythrophleum chlorostachys* mid high woodland, over *Acacia calligera*, *Grevillea parallela* and *Hakea arborescens* mid high open shrubland, over *Chrysopogon fallax* and *Triodia bitextura* open tussock grassland. The Landform at Amungee NW-4 is characterised by plains and rises associated with deeply weathered lateritic profiles. Soils at this site are sandy loam soils containing around 40% fines, 60% ironstone gravels and has a high risk of loosing structural integrity under moist conditions. Habitat surrounding the site is considered to be in good condition. The habitat contains good refuge opportunities in the form of dense leaf litter, dense grass cover, large woody debris and smaller tree hollows.



Post Activity Rehabilitation Aim and Objectives

Site management aim	The aim is to rehabilitate any part of the land affected by the Regulated Petroleum Activity to a safe condition consistent with industry standards and in consultation with Landholder.
Rehabilitation objectives	The rehabilitation objective is to provide a stable land form, which supports a resilient self-sustaining vegetation community that can withstand impacts including fire and cattle grazing and is safe to humans and wildlife, whilst utilising appropriate site infrastructure for ongoing pastoral activities (i.e. access tracks, water bores, fencing and laydown areas).

Site Environment Summary

Infrastructure	Size (ha)	Soil Type / Slope Canopy/Ground Cover	Vegetation Community / Dominant Species
Drill Lease Pad	13.7	Lateritic silty Sand <1% Slope Canopy Cover 7-20% Ground Cover 5-20%	*Corymbia dichromophloia* and *Erythrophleum chlorostachys* mid high woodland, over *Acacia calligera*, *Grevillea parallela* and *Hakea arborescens* mid high open shrubland, over *Chrysopogon fallax* and *Triodia bitextura* open tussock grassland.
Access Track	7.0		

Rehabilitation Strategy

Parameters	Methods	Objective
Vegetation	• Implement progressive rehabilitation within 12 months upon completion of petroleum activities. • Implement rehabilitation of lease pads upon cessation of use. • Disturbed areas to be allowed to naturally regenerate or revegetate on completion of Regulated Activity. • All compacted areas to be ripped and scarified to promote regeneration of vegetation, this may require assistance through spread of native seed stock. Where possible, native seed stock would be supplied by local indigenous suppliers.	• Establish vegetation similar to adjacent vegetation species richness, cover and structure), unless agreement with landowner and Regulator for alternative use. • The type of ground cover applied to completed earthworks to be compatible with the anticipated long-term land use, environmental risk, and site rehabilitation measures.
Ground cover	• Previously removed vegetation and topsoil will be uniformly re-spread over disturbed area to assist with rehabilitation process through agencies of increased infiltration and return of seed-bearing topsoil, as well as reducing erosion. • If required, additional native seed mix from the area could be respread to speed up rehabilitation process.	
Landform stability	• All windrows are to be removed as soon as practicable.	

Rehabilitation Risks

Key Risks	Controls
Drought — impacting the establishment of rehabilitated vegetation	• Time rehabilitation actions to coincide with the beginning of the wet season, to ensure access to the site and maximise the establishment period of vegetation over the wet season • Re-spread topsoil across the site to utilise the local seed bank • Ongoing monitoring to identify if further seed inputs are required • Collection of seed from the local area to ensure seed stock is suited to the climatic conditions of the site.
Fire—impacting revegetation	• Establish a mix of perennial and annual grass species • Establish a mix of re-sprouter (eg. *Eucalypt spp*. and *Corymbia spp.*) and re-seeder species (eg. *Acacia spp*.) • Ongoing monitoring to determine fire impacts on revegetation. • Ongoing monitoring to determine if further seed inputs are required
Grazing —impacting revegetation	• Establish a mix of perennial and annual grass species • Re-spread timber with top soil • Ongoing monitoring to determine grazing impacts on revegetation. • Ongoing monitoring to determine if further seed inputs are required • Ongoing monitoring to determine if fencing is required
Exposed Ground — leading to an increase in weed establishment and/or erosion	• Remove windrows and topsoils • Respread of topsoil and vegetated matter across the site • Annual weed surveys of rehabilitated area once rehabilitation is established • Control of any weed incursions

Final Success Criteria

Canopy Cover (%)	• A minimum of 10-20% canopy cover for open woodland community. • It is noted that Acacia shrublands will recover faster than Eucalypt and Bullwaddy communities, however should have signs of regrowth following rehabilitation and within 12-18 months after rainfall.
Ground Cover (%)	• Minimum 60% ground cover using locally available material including reserved topsoil/cleared vegetation before the onset of the first wet season resulting in a minimum of 40% bare ground. • A minimum of 40-60% ground foliage cover and diversity to be achieved within the first 12 months and maintained for at least 3 years following rehabilitation. Success will be dependent on minimised cattle movements and rainfall.
Erosion	• Less than 5 % erosion should be evident after the first 12 months and no subsidence or erosion should be evident for at least 5 years after completion.
Weeds	• No establishment of weed species declared under the Northern Territory Weeds Management Act 2001.
Hazardous materials and waste	• All hazardous material and waste removed from site upon completion of works to licensed landfill facilities or recycling facilities.
Safety for humans and wildlife	• Rehabilitation of disturbance areas should be similar in landform to the surrounding area. No steep slopes or barriers to remain on site that endanger either wildlife or humans • Water bores and exploration wells to be sealed and isolated • Removal of all surface facilities including fencing (star pickets/fencing wire) • Remediation and backfilling of all sumps/ponds.

Monitoring Program and Schedule

Rehabilitation Stage	Timing	Method	Measurable attributes
Preliminary Assessment	Post rehabilitation, end of wet season survey (February to June).	• Establish 5 permanent 100m x 4m woody species transects (one per hectare), with photo monitoring point/s, include 2 analogue sites in nearby undisturbed vegetation community. • Collect 1 x 1 m ground cover quadrats every 10 m along transect. • Transects to be randomly selected with start and end marked with star picket. • Edge effects (i.e. impacts from haul roads) minimised through reducing plot margins to <20m.	• All disturbed areas must be suitably stabilised – as per IECA Table in the erosion and sediment control plan. • Indication of seed germination and plant establishment rates. • Vegetation cover (species and abundance). • Land condition (e.g. erosion canopy cover, ground cover, habitat quality). • Weed presence (species and density). • Disturbance (fire and feral animal/cattle) • Incidental observations from surrounding area.
Early Rehabilitation	Years 1, 2 and 3 post rehabilitation, end of wet season survey (February to June).	• Monitoring to be undertaken using permanent transects. • Collect data as per preliminary methods. • Compare results from previous assessment to determine if require additional management inputs (i.e. seeding, stabilisation). • Review success criteria.	• Early assessment of rehabilitation will determine attributes of woody plants in each 100m x 4m transect. • Including assessment of species, Diameter at Breast Height (DBH) (>1.5cm) and height (>2m), in addition to parameters described within the preliminary assessment.
Long-Term Rehabilitation	Annually until final success criteria has been met, end of wet season survey (February to June).	• Monitoring to be undertaken using permanent transects. • Collect data as per preliminary methods. • Compare results from previous assessment to determine if require additional management inputs (i.e. seeding, stabilisation). • Review success criteria.	• Long-term assessment will determine establishment, recruitment and growth rate attributes of plant species, in addition to parameters described during Early Rehabilitation stage.

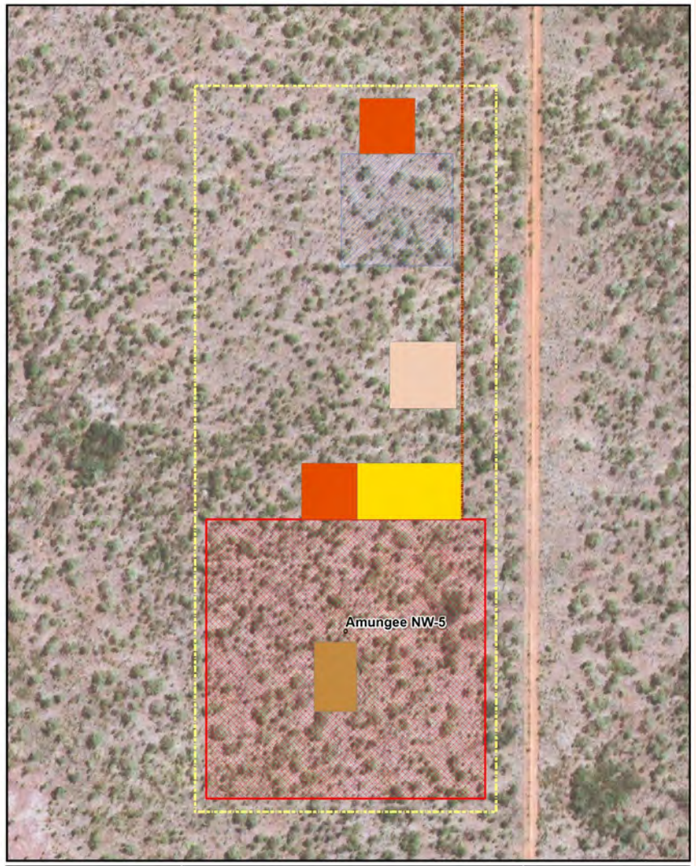
Amungee NW-4—Vegetation Community and Soil

Exploration Permit 98

Rehabilitation Management Plan Rev 1.0

Amungee NW-5 Exploration Well Area

Location of Amungee NW-5 Exploration Well Area	
Property land uses	Gas exploration and cattle grazing
Climate	The permit area is described as arid to semi-arid. Climate is influenced by the monsoon and there is a distinct wet and dry season. Most rainfall (90%) occurs during the summer months, between October and March. Annual rainfall varies across the permit area is around 680 mm, with rainfall totals show moderate variability and drought conditions are know to occur every 10 years.
Site Description (pre-disturbance)	Amungee NW-5 (GDA94, zone 53, 0380628E, 8186884N) is located in the EP98 tenement. The natural vegetation community that exists at Amungee NW-5 is *Corymbia dichromophloia* and *Eucalyptus chlorophylla* mid high open woodland, over *Erythrophleum chlorostachys, Petalostigma pubescens* and *Terminalia volucris* mid high open shrubland, over *Themeda triandra, Chrysopogon fallax* and *Schizachyrium fragile* tussock grassland. The Landform at Amungee NW-5 is characterised by plains and rises associated with deeply weathered lateritic profiles. Soils at this site are sandy loam soils containing around 80% fines, 20% ironstone gravels and has a high risk of loosing structural integrity under moist conditions. Habitat surrounding the site is considered to be in good condition. The habitat contains good refuge opportunities in the form of dense leaf litter, dense grass cover, large woody debris and smaller tree hollows.



Origin Rehabilitation Officer	Contact Details	Name
	Mobile : 0467 679 003 Satellite phone : 0147 612 733 Robert.Wear@upstream.originenergy.com.au	Robert Wear

Post Activity Rehabilitation Aim and Objectives	
Site management aim	The aim is to rehabilitate any part of the land affected by the Regulated Petroleum Activity to a safe condition consistent with industry standards and in consultation with Landholder.
Rehabilitation objectives	The rehabilitation objective is to provide a stable land form, which supports a resilient self-sustaining vegetation community that can withstand impacts including fire and cattle grazing and is safe to humans and wildlife, whilst utilising appropriate site infrastructure for ongoing pastoral activities (i.e. access tracks, water bores, fencing and laydown areas).

Site Environment Summary

Infrastructure	Size (ha)	Soil Type / Slope Canopy/Ground Cover	Vegetation Community / Dominant Species
Drill Lease Pad	13.7	Lateritic silty Sand <1% Slope Canopy Cover 5-35% Ground Cover 20-40%	*Corymbia dichromophloia* and *Eucalyptus chlorophylla* mid high open woodland, over *Erythrophleum chlorostachys*, *Petalostigma pubescens* and *Terminalia volucris* mid high open shrubland, over *Themeda triandra, Chrysopogon fallax* and *Schizachyrium fragile* tussock grassland
Access Track	9.1		

Rehabilitation Strategy

Parameters	Methods	Objective
Vegetation	• Implement progressive rehabilitation within 12 months upon completion of petroleum activities. • Implement rehabilitation of lease pads upon cessation of use. • Disturbed areas to be allowed to naturally regenerate or revegetate on completion of Regulated Activity. • All compacted areas to be ripped and scarified to promote regeneration of vegetation, this may require assistance through spread of native seed stock. Where possible, native seed stock would be supplied by local indigenous suppliers.	• Establish vegetation similar to adjacent vegetation species richness, cover and structure), unless agreement with landowner and Regulator for alternative use. • The type of ground cover applied to completed earthworks to be compatible with the anticipated long-term land use, environmental risk, and site rehabilitation measures.
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Erosion	• Less than 5 % erosion should be evident after the first 12 months and no subsidence or erosion should be evident for at least 5 years after completion.
Weeds	• No establishment of weed species declared under the Northern Territory Weeds Management Act 2001.
Hazardous materials and waste	• All hazardous material and waste removed from site upon completion of works to licensed landfill facilities or recycling facilities.
Safety for humans and wildlife	• Rehabilitation of disturbance areas should be similar in landform to the surrounding area. No steep slopes or barriers to remain on site that endanger either wildlife or humans • Water bores and exploration wells to be sealed and isolated • Removal of all surface facilities including fencing (star pickets/fencing wire) • Remediation and backfilling of all sumps/ponds.

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Early Rehabilitation	Years 1, 2 and 3 post rehabilitation, end of wet season survey (February to June).	• Monitoring to be undertaken using permanent transects. • Collect data as per preliminary methods. • Compare results from previous assessment to determine if require additional management inputs (i.e. seeding, stabilisation). • Review success criteria.	• Early assessment of rehabilitation will determine attributes of woody plants in each 100m x 4m transect. • Including assessment of species, Diameter at Breast Height (DBH) (>1.5cm) and height (>2m), in addition to parameters described within the preliminary assessment.
Long-Term Rehabilitation	Annually until final success criteria has been met, end of wet season survey (February to June).	• Monitoring to be undertaken using permanent transects. • Collect data as per preliminary methods. • Compare results from previous assessment to determine if require additional management inputs (i.e. seeding, stabilisation). • Review success criteria.	• Long-term assessment will determine establishment, recruitment and growth rate attributes of plant species, in addition to parameters described during Early Rehabilitation stage.

Amungee NW-5—Vegetation Community and Soil

Appendix O Environmental Commitment Register

Obligation Details	Accountability	When
Layout of the site and exact siting of infrastructure will be informed by the environmental sensitivities and mitigation measures identified in this EMP. This includes additional scouting as required, where infrastructure placement and 2D seismic lines need to be moved to accommodate pastoral or new / additional cultural heritage considerations.	**Project Manager**	Site establishment
Land clearance will not be undertaken as a part of this activity, unless authorised to do so.	**Civil Construction Superintendent**	Continuous
The monitoring and maintenance under the erosion and sediment control plan shall be implemented.	**Civil Construction Superintendent**	Pre and post wet season
The spill management plan will be implemented including spill prevention, detection, response and reporting measures.	**Drilling and Completions Lead** –	Throughout the activity
The wastewater management plan will be implemented including the use of covered tanks, wastewater characterisation, storage monitoring and appropriate disposal.	**Drilling and Completions Lead** –	Throughout the activity
The bushfire management plan will be implemented to reduce the risk of bushfires. This includes the use of appropriate separation distances between flares and the surrounding vegetation	**Drilling and Completions Lead** –	Throughout the activity
The methane emission management plan shall be implemented, including the strategies to prevent, detect, remediate and report potential leaks.	**Drilling and Completions Lead** –	Throughout the activity
Secondary containment will be implemented for all chemical storage and handling areas	**Drilling and Completions Lead** –	Throughout the activity
Origin and its sub-contractors will prioritise the use of local labour where such skill sets are available.	**Project Manager**	Activity planning
The weed management plan shall be implemented, including assuring all equipment and vehicles on-site have a valid weed hygiene certificate and routine monitoring is completed. All identified weeds associated with Origin's activities to be treated and managed in consultation with the DEPWS Weeds Officer.	**Project Manager/ Civil Construction Superintendent / Drilling and Completions Lead**	Throughout the activity
The site shall be fenced to prevent fauna and livestock access to wastewater	**Project Manager**	Site establishment and post drilling
Where monitoring confirms bird or bat mortality associated with on-site wastewater storages, Origin will implement additional controls to prevent such impacts from occurring. This may include netting or bird deterrents as appropriate.	**Drilling and Completions Lead**	During wastewater storage
The Well Operations Management Plan (WOMP) approved by DITT will be implemented to ensure the protection of aquifers and the environment. This includes protecting aquifers through multiple cement and casing barriers and performing the specified well integrity verification testing.	**Drilling and Completions Lead**	All E&A drilling, stimulation, well testing and decommissioning activities
All groundwater will be extracted, monitored and recorded in accordance with the Water extraction licence.	**Project Manager/ Civil Construction Superintendent / Drilling and Completions Lead**	Throughout the activity

Obligation Details	Accountability	When
All wastes will be transported and disposed of at licenced facilities in accordance with the *NT Waste Management and Pollution Control Act 1998*.	**Project Manager/ Civil Construction Superintendent / Drilling and Completions Lead**	Throughout the activity
Drilling muds and cuttings will be tested in accordance with the Code. Where an independent expert considers on-site disposal of muds and cuttings as being environmentally sound, a report will be submitted to DEPWS for approval a to the proposed disposal approach and potential risks.	**Health Safety and Environment Representative (HSE Representative)**	Prior to the disposal of muds
Where Origin's activities cause a material impact on the quality and quantity of a stock or domestic bore, Origin will make good such impacts in accordance with section 7.5.2.2 of the Inquiry Report. This may include adjusting pump heights, compensation or where appropriate, re-drilling/modifying the bore into an alternative water source.	**Project Manager**	Upon confirmation an activity has resulted in impairment to a water supply point
Each aquifer intersected will be isolated from overlying aquifers with a cemented casing string as per the WOMP.	**Drilling and Completions Lead**	During drilling of an E&A well
No material changes in the quality and quantity of aquifers will result from Origin's activities.	**Project Manager**	Throughout the activity
Surface water will not be used for any activities proposed in this EMP or future operations.	**Project Manager**	Throughout the activity
Stormwater flooding across the cleared site will be managed to minimise impacts from erosion and sedimentation.	**Project Manager**	Throughout the activity
Records of weed distribution will be maintained within Origin's GIS and if required provided to the Weeds Officer at DEPWS.	**Health Safety and Environment Representative (HSE Representative)**	Throughout the activity
Origin have committed to comply with conditions as prescribed by AAPA for the duration of the program.	**Project Manager**	Throughout the activity
Origin has committed resources and time to allow competent and experienced personnel to participate in educational and community information sessions from Darwin in the north, to Alice Springs in the south and across to Borroloola in the east.	**Project Manager**	Planning and implementation of activities
Appropriate housekeeping standards will be maintained, and the site will be maintained free of rubbish.	**Project Manager/ Civil Construction Superintendent / Drilling and Completions Lead**	Throughout the activity
Camps will be utilised to mitigate the impact on available accommodate and townships.	**Project Manager/ Civil Construction Superintendent / Drilling and Completions Lead**	Throughout the activity
Wastewater, sewage and sullage generated by the domestic camp activities will be managed by a Department of Health (DoH) approved sewage treatment system or captured and removed from site.	**Drilling and Completions Lead**	During wastewater (sewage) management
Monitor road conditions to ensure deterioration with possible increase in dust creation, does not occur and undertake road rehabilitation as required.	**Project Manager/ Civil Construction Superintendent /**	Daily during the activity

Obligation Details	Accountability	When
	Drilling and Completions Lead	
Origin will progressively implement a rehabilitation plan in consultation with DEPWS to rehabilitate all disturbed areas	**Health Safety and Environment Representative (HSE Representative)**	With 12 months of determining an asset is no longer required
Work instructions summarising the requirements of this EMP shall be prepared and submitted to contractors performing work under this EMP. Origin shall ensure all relevant hold points are enforced and signed off prior to commencing work.	**Health Safety and Environment Representative (HSE Representative)**	Prior to commencement of an activity.

Appendix P Emergency Response Plan

Integrated Gas

EMERGENCY RESPONSE PLAN
Beetaloo Asset (Northern Territory)

This document details the emergency response procedures for the Beetaloo Asset.

Revision	Date	Description	Originator	Checked	Approved
0	29/04/2019	Issued for use	L Fulford	B Baldwin M Hanson Ed Wong	T Boyes
1	19/07/2019	Update based on DENR feedback	L Fulford	M Hanson	T Boyes
2	03/12/2019	Update based on DENR feedback	L Fulford	M Kernke	L Fulford
3	18/02/2020	Stage 3 update	L Fulford	E Wong	L Fulford
4	17/01/2021	Updated with DEPWS comments	G. Bertini	M Hanson	M Kernke
5	29/05/2021	Issued for use	G Bertini	M Hanson E Wong	C White
6	1/10/2021	Issued for use	G Bertini	M Hanson E Wong	C White

Review due: 18/02/2023

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THE THREE WHATS

What can go wrong?
What could cause it to go wrong?
What can I do to prevent it?

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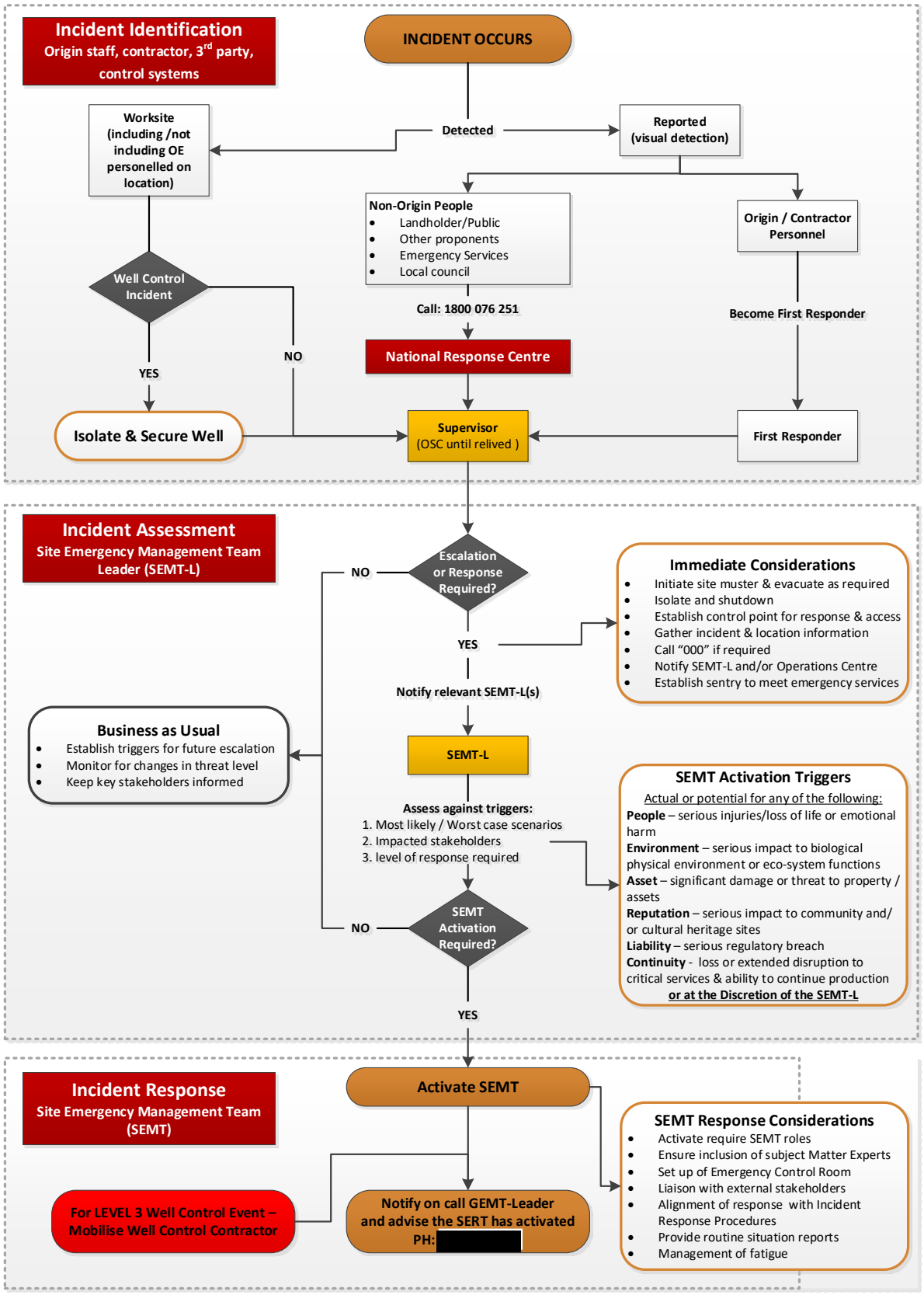
1. Site Emergency Response Plan (SERP) activation immediate actions

When a site level emergency is declared, this plan will be activated and escalated where appropriate.

Table 1: Activation immediate actions

Triggers for Activation			
Site Emergency Response Team activations (actual or potential) for impacts of any of the following and/or at the discretion of the Person in Charge (PIC).			
People	Serious temporary injury/illness or worse to any person		☐
Environment	Moderate effects on biological physical environment and serious short term effect to eco-system functions		☐
Asset	Serious damage or loss to production, property and/or infrastructure		☐
Reputation	Serious impact to community or cultural heritage		☐
Liability	Serious breach of law or regulation		☐
1 – Isolate and Evacuate			
Muster	Account for all personnel (upwind) whilst assessing the situation		☐
Isolate	Either through Emergency Shutdown Devices (ESD's) or remotely		☐
Evacuate	If required evacuate to designated evacuation points either upwind or at a safe distance as determined by event type or respective response guideline		☐
Control	Establish control points to coordinate response and restrict access		☐
Meeting Points	Nominate predetermined Emergency Services meeting points or establish meeting points near known landmarks or road intersections and establish sentry to meet Emergency Services upon their arrival		☐
2 – Communicate and Escalate			
Confirm	Confirm details of the emergency (type of emergency, injuries, contained or uncontained etc.) and response required.		☐
Activate	Activate ERT, SEMT, brief GEMT-L, contact Emergency Services, communicate with other Stakeholders		☐
Escalate	Consider likely impacts		☐
Impacts (actual & potential)	Most likely	What is realistically likely to happen and who / what is impacted?	☐
	Worst case	How bad could it really get and then who / what is impacted?	
SEMT-Leader: Brief On-Call GEMT Leader **0477 755 369** on situation, response and triggers for further activation.			☐
3 – Respond			
• Continually reassess situation		• Appoint OSC	☐
• Designate communication channels		• Establish exclusion zones	☐
• Activate appropriate resources		• Develop SMEACS briefing	☐
• Apply Incident Response Guidelines		• Provide regular updates	☐
4 – Response Management			
Personnel	Appropriate personnel in the ERT, SEMT and from outside resources		☐
Resources	Appropriate resources available to manage the incident		☐
Tools	Appropriate tools available for the ERT, SEMT, OSC and other responders		☐

Figure 1: Detection, Assessment, Response Flowchart



2. Introduction

This Emergency Response Plan (ERP) encompasses all Growth Asset's activities within the Beetaloo Basin (including both manned and unmanned scenarios) and will be activated to manage emergency events at site.

Locations / site specific information may be recorded either in a contractors emergency response plan (ERP), bridging document, or through another means of providing emergency information, e.g Emergency Response Notification (ERN) form.

The Site Emergency Response Plan (SERP) is designed to direct and guide the On Scene Commander (OSC) and Emergency Response Team (ERT) (if nominated) to respond effectively to site level emergencies and return the site to normal operations.

Further support is provided through the Origin Emergency Response Framework via the Group Emergency Management Plan (GEMP 6522903) and Crisis Management Plan (CMP ORG-RMS-PLA-001).

2.1 Purpose

The purpose of this plan is to describe how to effectively manage site emergencies for the Beetaloo Asset whilst in a manned and unmanned condition.

The plan will:

- Briefly describe the Origin emergency response structure
- Explain the notification and escalation paths for an emergency
- Identify key people and explain what they will do during an emergency
- Describe important information about site infrastructure including:
  - Location
  - Geographic area
  - Isolation points (if applicable)
  - Exclusion zones (if applicable)
  - Other technical information
- Provide tools and templates to use during an emergency.

2.2 Scope

This plan supports manned operations and also provides a response requirements for emergency scenarios on unmanned locations. Unmanned relates to periodic contractor service visits and occasional small team visits for inspections and maintenance.

This plan applies to all employees, contractors and visitors to the following Beetaloo Asset locations and activities:

- Asset locations details as described in Section 3.
- Activities included in scope are:
  - General travel activities (walking during scouting, land transport).
  - Activities such as visual inspections, routine low risk maintenance and monitoring tasks.
  - Accompanying or guiding contractors who are engaged in the above mentioned activities.
  - Laydown yards within tenure.
  - Construction work (such as access tracks, lease builds, site earthworks, remediation)
  - Drilling, well completion, intervention or abandonment activities.
  - Transport to and from work areas (not including chartered flights to Airfield)

This plan excludes:

- Chartered flights to airfield and commercial flights to Darwin
- Third line logistics freight and haulage from depots to laydown yards
- Accommodation in commercial establishments outside of the work areas

2.3 Compliance with Civil Legislation and Australian Standards

This plan meets the requirements as identified by legislation for emergency response plans including:

Australian Standards, Codes, Guidelines and Commonwealth Legislation

- Work Health and Safety Act 2011.

- Work Health and Safety Regulations 2011.
- Environment Protection and Biodiversity Conservation Act 1999.
- Australian Dangerous Goods Code.
- National Environment Protection (Assessment of Site Contamination) Measure (NEPM) 1999 as amended 2013.

Northern Territory

- *Work Health and Safety (National Uniform Legislation) Act 2011* and Regulations.
- *Petroleum Act 1984*.
- Petroleum Regulations 2020.
- Petroleum (Environment) Regulations 2016.
- Code of Practice for Petroleum Activities in the Northern Territory 2019
- Schedule of Onshore Petroleum Exploration and Production Requirements 2019
- *Bushfire Management Act 2016.*
- Bushfire Management (General) Regulations 2017.
- *Dangerous Goods Act 1998* and Regulations 2018.
- *Transport of Dangerous Goods by Road and Rail (National Uniform Legislation) Act 2020* and Regulations.
- *Waste Management and Pollution Control Act 1998.*
- Northern Territory Contaminated Land Guideline (June 2017).

2.4 Operator Details

Origin Energy B2 Limited (“Origin”)
Level 25, 180 Ann Street, Brisbane, QLD, 4000

2.5 Definition of a Site Emergency

An emergency is defined as an unplanned event within a specific site, facility, field or area, accidentally or deliberately caused, which requires a response to normalise the activity and which may result in an incident such as:

- Injury to people
- A near miss
- Loss of control of any health, safety environment or community related incident as part of the operation
- Damage to the environment
- An uncontrolled release of a substance to air, land and water
- Loss of reputation
- Loss of business
- Loss or damage to product or assets
- Loss of production
- The potential for any of the above

2.6 Project, Construction and Mobile Work Group Emergency Response Philosophy

These teams will have the ability to provide a basic response to: incipient fires, minor spills and basic medical emergencies in order to preserve life, contain incidents (if able) and reduce the impact on our people, the community, environment and assets.

Section 4, Appendix B and Appendix G identify where increased response capability has been introduced to mitigate the consequences of specific incident types, e,g, Loss of Well Control.

Depending on the magnitude of the scenario event, escalation could also include emergency services.

2.7 Site Emergency Management Team Activation/Escalation

This Site Emergency Response Plan (SERP) is activated for emergencies that cause or have the potential to cause SERIOUS or greater consequences. Consequence classification is based on Origins Risk Management Directive ORG- RMS-DIR-001

The Site Emergency Management Team Leader (SEMT-L) or On Scene Commander (OSC) has the authority to activate this SERP. Notification must occur to the Group Emergency Management Team (GEMT), however escalation and activation of the GEMT is determined by the GEMT on call leader.

Escalation to the GEMT is conducted by ringing the GEMT-L on call phone [redacted] The Origin Emergency Management Structure Escalation Chart shows the different escalation levels between the SERT, GEMT and Crisis Management Team (CMT).

Under certain circumstances the GEMT may be activated without the activation of the SERP / SERT. If required the GEMT-L may then require the activation of SERP's / SERT's to manage an incident/s.

2.8 Document Hierarchy

The Document Hierarchy for Origin Emergency response is identified in Figure 2 below.

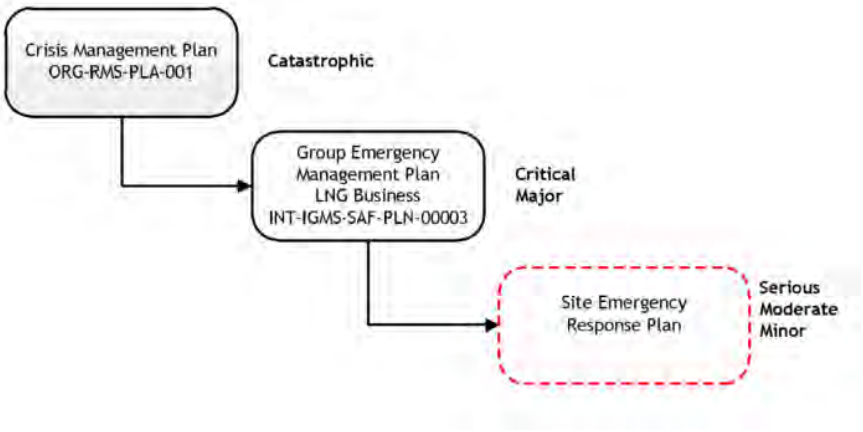


Figure 2 Hierarchy of Emergency Response documentation

2.8.1 Document Hierarchy for Contractors

The relationship of Origin Emergency Response documentation for the Beetaloo Assett, in conjunction with Contractor Emergency Response documentation is demonstrated in Figure 3 below.

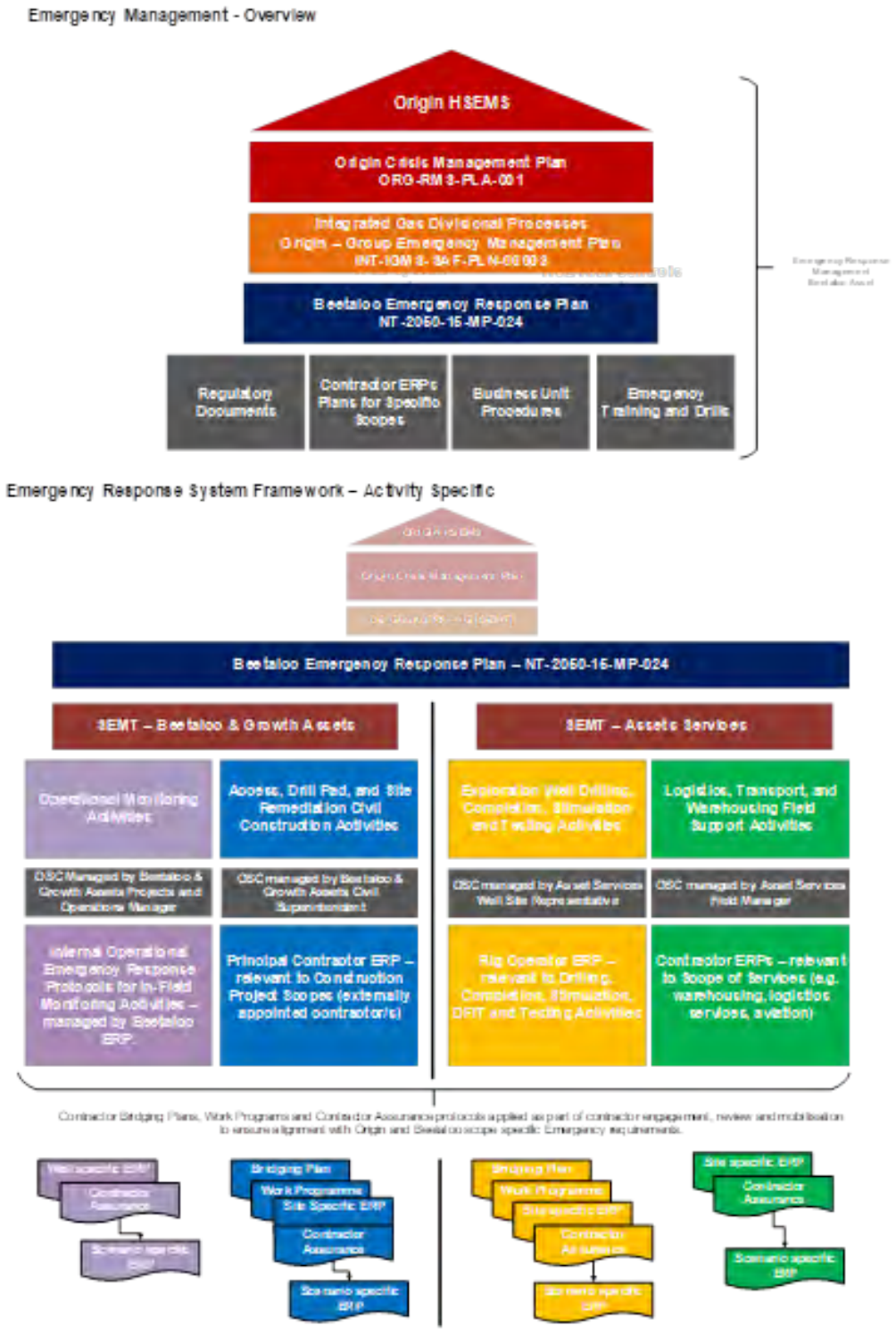


Figure 3 – Hierarchy of Emergency Response documentation

2.8.2 Emergency Management Structure

Figure 3 identifies the escalation pathways for each component in Beetaloo & Growth Assets including Asset Services. Figure 4 below identifies the Command and Control and escalation pathway for emergencies.

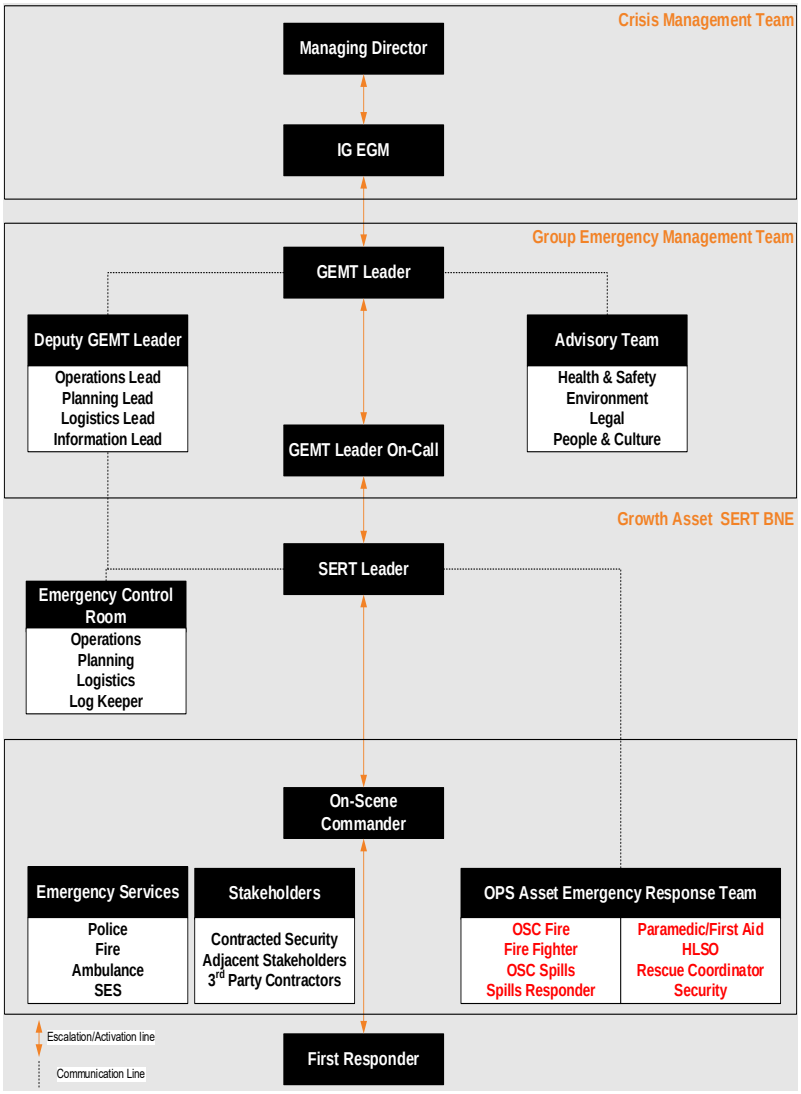


Figure 4 – Emergency Management Structure

3. Beetaloo Asset Locations and Field Activities

Origin (Growth Assets) conducts operations in the Northern Territory (NT) within the Beetaloo Basin. The activities conducted in this scope include the following areas:

3.1.1 Drilling, Hydraulic Fracturing Stimulation (HFS), Completion, Workover and Well Testing Activities

Works are executed by specialist contractors, and are overseen by an Origin Wellsite Representative (Operating Company Representative). Contractors undertaking these scopes of work operate under their own Safety Management System and Emergency Response Plans which can be bridged to Origin Energy requirements at designated locations. This scope is executed by Asset Services.

3.1.2 Civil construction and related activities

Civil works such as establishing lay down areas, construction and maintenance of access tracks and wellsites is executed by contractors operating under their own Safety Management System and Emergency Response Plans which can be bridged to Origin Energy requirements. This scope is executed by Growth Assets.

3.1.3 Projects

Ad-hoc works executed at varying locations to expand or support capability improvement to Origin Assets at Beetaloo including water monitoring bores, helicopter landing sites, or communication equipment. These Projects are usually delivered by contractors operating under their own Safety Management System and Emergency Response Plans bridged to Origin Energy requirements.

3.1.4 Field Support (logistics)

Where applicable, mobile camps will be executed by Principal Contractors. Warehousing and laydown activities will be managed by specific location ERP for the activity.

3.1.5 Existing well inspection monitoring

Well inspection monitoring activities are undertaken by local contractors working directly for Origin, these contractors report through the Beetaloo & Growth Assets Projects & Operations Manager and Beetaloo & Growth Assets Field Lead located within project areas during project duration. The process undertaken for existing wells is detailed within Appendix B.

3.2 Field Sites / Locations

Site specific details, include location, proximity to emergency services and townships can be found within Appendix C. The maps below (see fig 5 and 6) identify the location of the Beetaloo Project as well as specific Site locations referenced within this plan.

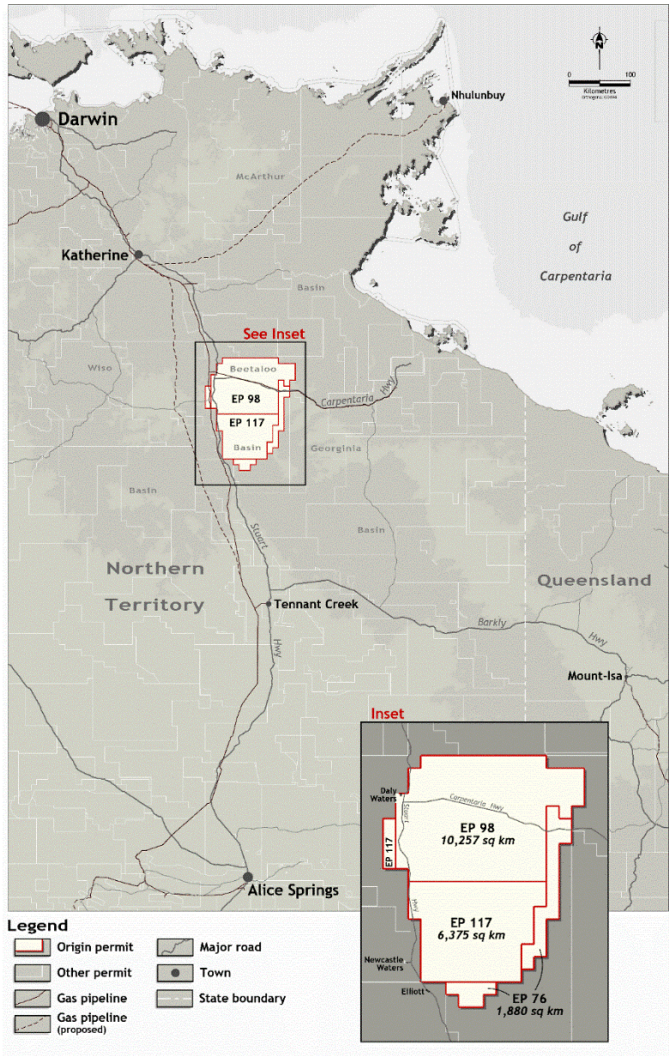


Figure 5: Location of Beetaloo Asset within Northern Territory

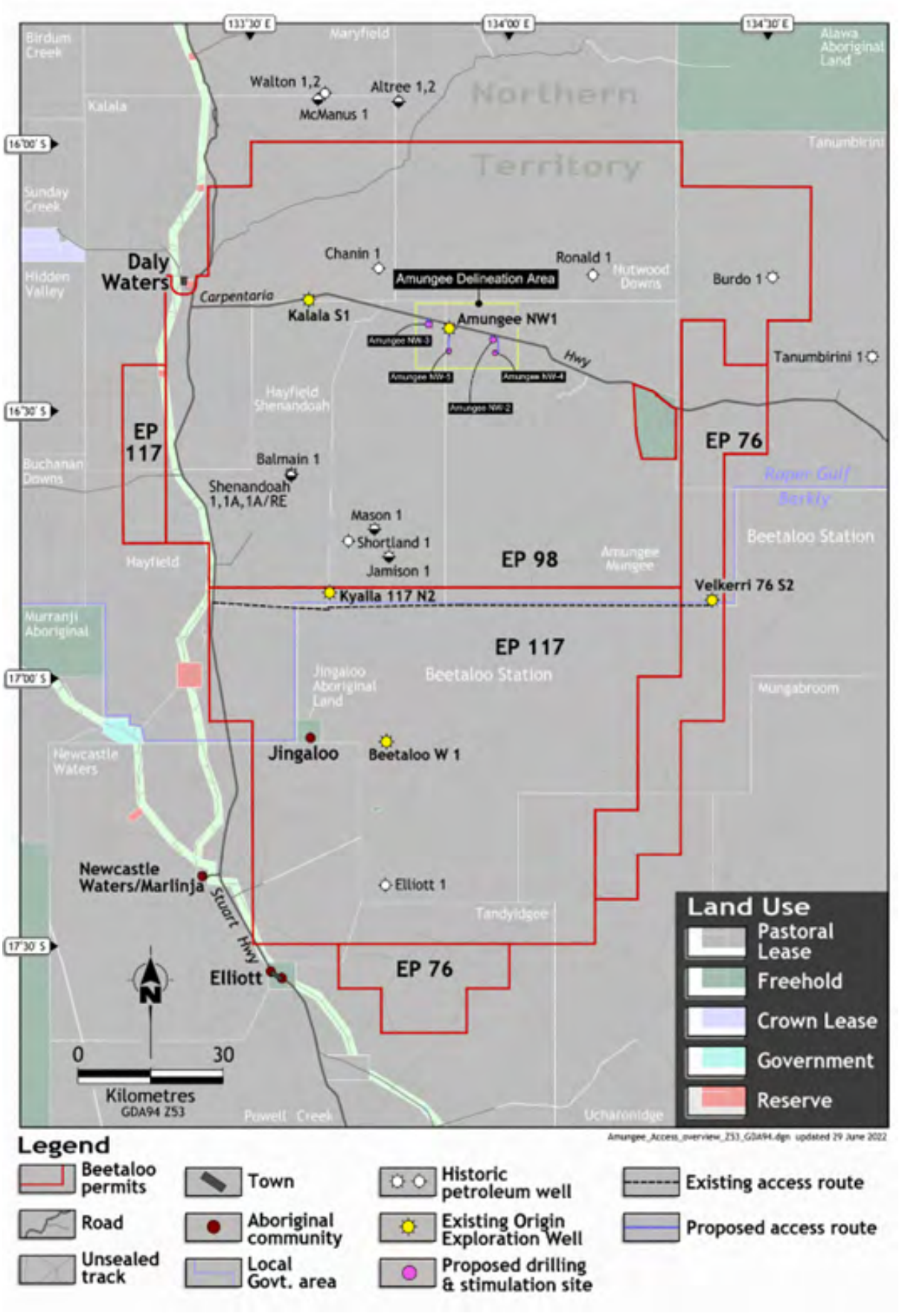


Figure 6 – Current Drilled and proposed wells locations

4. Emergency Scenario Responses

If an incident occurs, the designated Person in Charge will nominate the On Scene Commander and determine which Origin business unit Site Emergency Management Team (SEMT-L) will be initiated. These aspects are indicated within Figure 3 above.

The designated SEMT-L will liaise with the associated contractor and Growth Assets General Manager and notify the on-call GEMT (if deemed required).

If an emergency event exceeds the contractors capability, i.e. Loss of well control, then Origin will assume control of the incident and delegate management to internal expertise, i.e Asset Services, Drilling & Completions team. The Integrated Gas Asset Services team will then determine if external support is required.

Category	Response Procedures
GENERAL	▪ Evacuation and Alarms ▪ First Responder – Immediate Action Checklist ▪ Activate Emergency Shutdown Device ▪ Shift Change Over Checklist ▪ Termination of Emergency
FIRE	▪ Fire – (Plant, Building/Storage / Accommodation including mobile camps, electrical ▪ Bushfire
PERSONAL SAFETY	▪ Medical Emergency ▪ Vehicle Accident ▪ Missing Overdue worker ▪ Lone Worker ▪ Snakebite ▪ Rescue from Height ▪ Rescue from Confined space ▪ Rescue from Heights ▪ Communicable Disease ▪ Electrical Shock ▪ Man Down ▪ Aviation
ENVIRONMENT	▪ Environment Related Incident (Earthquake) ▪ Environment – Weather Related Incident – Storm and Lightning ▪ Loss of Containment / Spill ▪ Flood
FACILITY & EQUIPMENT	▪ Major Structural / Mechanical Damage ▪ HV / LV Electrical Fault
HAZMAT	▪ Diesel ▪ Nitrogen ▪ Loss of Well Control level 1 or 2
SECURITY	▪ Protest / Trespass ▪ Bomb Threat ▪ Armed Intruder ▪ Lockdown

4.1 Scenario Flip Charts

The Emergency Scenario Flip Charts (CDN 3676134) provide an easy to understand detailed response to identified emergency situations. The charts should be used in conjunction with this plan.

4.2 Contractor Scenarios

For some undertakings, for example a well control event, Origin will delegate its responsibility to a Contractor, or Sub-Contractor with suitable emergency response capability as Origin will have limited/if any field presence at times.

It will be the responsibility of the contractor to provide an initial emergency response and coordinate the emergency event. If an Origin employee is involved in an emergency event at a site under the control of a contractor it is expected that the Origin employee will conform to the contractors response requirements and support the contractor if willing and competent to do so.

Notification of the event will follow the established incident reporting procedure. The activation of the GEMT may be required for an incident involving a Contractor. While an Origin SEMT-L may be required to coordinate Origin aspects at the incident site, a nominated individual (Contract Owner or delegate) will liaise with the Contractor emergency management team.

Depending on location of works the Contractor may be able to call upon other nearby parties or State Emergency Services for assistance in responding or handling the incident; however the Contractor retains responsibility for managing the emergency event.

4.3 Well Monitoring and Control

Appendix B and Appendix C contain all information pertaining to the monitoring of remote wells, well control and classification of well control incidents.

A loss of well control is considered a Major Accident Event (MAE) which, while rare, requires additional controls and engineering assessments to mitigate potential consequences.

4.3.1 Potential Major Accident Events

A Major Accident Event is an uncontrolled incident, including fire, explosion or release of dangerous substance with the potential to lead to multiple fatalities or major environmental damage (potential for critical or catastrophic consequence as per Origin Risk Matrix).

For more information refer to MAE hazard assessment and risk reduction (ALARP & SFAIRP requirements) procedure (CDN/ID: 7983063) or contact the Process Safety Advisor at Origin (details in contact list).

5. Campaign Specific ERP Arrangements

5.1 Roles

The following roles and responsibilities are essential to ensure effective communication within Beetaloo Asset when responding to emergency events.

- First Responder (FR), located at the incident scene and may be a Contractor
- On Scene Commander (OSC) located at the incident scene
- Site Emergency Management Team Leader (SEMT-L), located at either:
  - the Field Emergency Control Room (ECR) ; or
  - The Brisbane ECR, 180 Ann Street, Level 29, Room 29:12

Individuals may undertake multiple roles depending on the nature of the emergency, its duration and complexity. The functional roles that will assist the SEMT-L are listed below and known as the Site Emergency Management Team (SEMT).

- Operations
- Planning
- Logistics
- Log Keeper

Additional roles such as Technical Engineering, Travel and Accommodation Services may supplement the SEMT depending on the type of incident.

If the SEMT-L is unable to undertake their responsibilities a competent alternate or delegate SEMT-L must be appointed to ensure the SEMT continues to function.

If required, depending on the nature and severity of the incident, the Group Emergency Management Team (GEMT) may be activated to support the response. The GEMT can be called upon to support such issues as Regulatory notifications, provide additional manning to site, or source assets required to support the site, such as Aviation.

For in-depth information regarding the above positions refer to the Duty cards in the OSC/SEMT toolkits

SEMT and OSC Toolkit (AUS-IGMS-SAF-GDL CDN 6893451)
http://im.originenergy.com.au/otcs/cs.exe/Open/6893451

5.2 Responsibilities

A summary of responsibilities are located below.

Roles and responsibilities	
Contractor work parties / First Responder	• Respond to the situation as per the contractors emergency response plan. • Actively participate in the risk management process to assist in the development of emergency action plans; • Check the notice boards for any recent updates to information; • Maintain a high level of awareness of actions to be taken in the event of an emergency situation; • Follow instructions from Emergency Controller, Emergency Services personnel, Fire Wardens, First Aiders and other designated emergency personnel as appropriate; and • Prior to commencing any work or entering a work area, sign on to prestart or JRA for the associated activity.
First Aiders	• Ensure their first aid competencies (minimum *Apply First Aid and CPR*) are maintained and advise the PM prior to the expiry; • Provide first aid treatment or assessment as needed, working within their skill level; • Determine need for medical assistance and provide information to Medical personnel or Emergency services as required; • Ensure that first aid kits are maintained and complete and items are in-date; and • Ensure that all treatments provided, regardless of the type or complexities are recorded.
Site Paramedic / Nurse Practioner	• Provide emergency health care on site. Available during the 12hr work day (on call 24/7 whilst on location) • Ensure that medical response emergency equipment is suitable and located appropriately; • Check that emergency action plans are appropriate for the activity/hazards identified; • Test communication and advises of any changes;
Origin work /travel team supervisor (Person in Charge) On Scene Commander	• Escalate to the Person in Charge, for Beetaloo & Growth Assets managed activities whom is the Beetaloo & Growth Assets Field Lead or delegate, • For Integrated Gas Asset Services (IGAS) managed activities (identified in Figure 3) to the Well Site Represenative. • Maintain a log of events • Escalate to Emergency Services, if required. • Act as On Scene Commander (OSC) and manage first response at site level • Ensure that emergency action plans are discussed on a regular basis at Pre-Start / Toolbox meetings, so that all persons under their control are aware of the project emergency procedures;

	• Ensure that emergency equipment is maintained in good working order (complete, clean and available for immediate use); • Advise the HSE Representative or Person in Charge (Field Lead or Wellsite Representative) of any operational issues that may impact with or affect the emergency action plans; • Ensure that emergency action plans are prominently displayed and available for use by all workers; and • Take role of on-scene commander especially in first response to an emergency incident. During first response, ensure safety of other team members and ensure that emergency situation is communicated to the Emergency Controller.
For civil and all existing operational (infrastructure,exploration wells)) activities managed by the Beetaloo & Growth Assets Team. Operations & Projects Manager Growth Assets	• Act as Site Emergency Management Team Leader (SEMT-L) (with respect to taking call from OSC and escalating to BGA General Manager as required. • Provide well monitoring trend analysis as required • Act as journey contact for field teams. • Escalate to GEMT-L as required. • Support field team with emergency service direction/calls as requested
For D&C activities managed by Integrated Gas Asset Services D&C Project Manager	• Act as Site Emergency Management Team Leader (SEMT-L) (with respect to taking call from OSC and escalating to IGAS General Manager and BGA General Manager as required. • Provide well monitoring trend analysis as required • Act as journey contact for field teams. • Escalate to GEMT-L as required. • Support field team with emergency service direction/calls as requested
General Manager Beetaloo & Growth Assets	• Receive call from Operations & Projects Manager / SEMT-L and support where required. • Participate in Group Emergency Management Team if activated.
General Manager Asset Services	• Receive call from D&C Project Manager / SEMT-L and support where required. • Participate in Group Emergency Management Team if activated.

5.3 Communications

The communication flow between contractors, external services and Origin is demonstrated in the flow chart below:

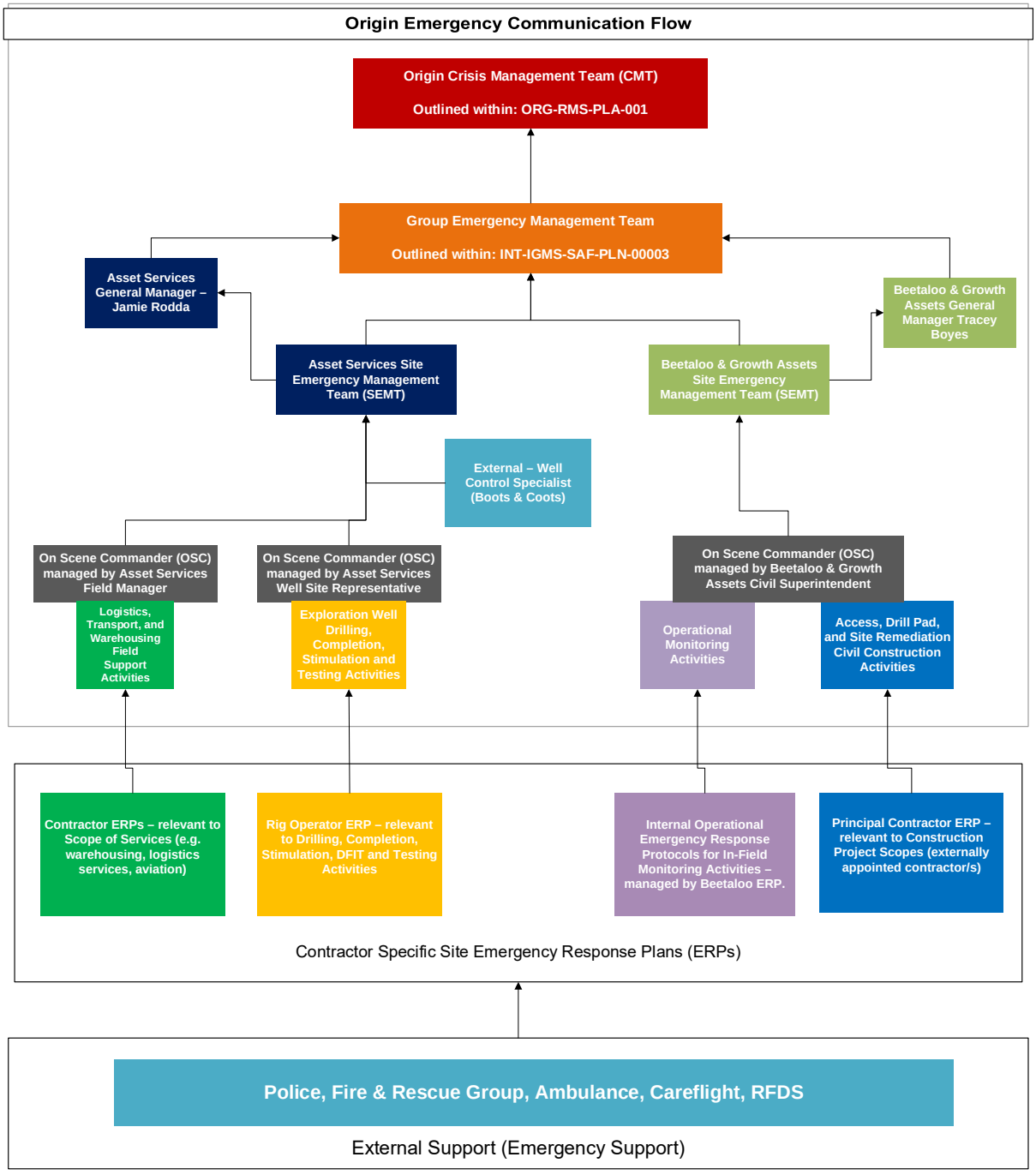


Figure 7: Communication flow

6. Emergency Management and Control

After an emergency is detected, the following emergency management stages will be used to control and contain the incident and return to business as usual.

- Raise the alarm
- Isolate and secure
- Communicate and Escalate
- Respond and Recover

6.1 Raise the alarm

One or more of the following methods can be used to raise the alarm:

- in person
- radio (Digital, UHF, VHF etc)
- phone (mobile, satellite or landline)
- emergency alarm

6.2 Isolate and Evacuate

- Stop all work and make sure the worksite is safe
  - Secure the well, or impacted area
  - stop vehicle and mobile plant operations

- If you need to abandon vehicles and mobile plant
  - pull over and park in a safe area
  - ensure access and egress to the site is not impeded
  - switch off and leave the keys in the ignition

- Plan a safe route to the muster point and avoid movement through unsafe areas
- Account for all people
- Stand by at the muster point until stood-down or instructed to evacuate

6.3 Communicate and Escalate

- Gather information – where is the emergency, what has happened, who is affected, is anyone missing, where are the safe areas etc
- Advise and update the Person in Charge
- Call Emergency Services (Police, Ambulance, Fire) if required
- Identify meeting points for responders (Origin Medical Providers, ERT etc) and Emergency Services
- SEMT activates if required

6.4 Respond and Recover

- Apply first aid to injured people (if safe to do so)
- Activate ERT
- Consider Simultaneous Operations (SIMOPS), advise nearby work groups and if on an IG Asset, the Asset SEMT-L
- Assist Emergency Services
- Follow response procedures

6.5 Meeting Emergency Services

Where Emergency Services such as Ambulance, Police and Fire are dispatched by road or air, an Origin employee or contractor representative will meet the Emergency Service at a designated location and guide them to the incident site.

Beetaloo Basin designated location - Daly Waters Hi-Way Inn (cnr Stuart and Carpentaria Highways).

Any additional meeting points will be identified and communicated on call out. These will be dependent on the type of emergency, access availability and exclusion zones.

At the beginning of each campaign of work, a copy of the worksite ERN (emergency response notification) shall be provided to NT Emergency Services in Mataranka and Katherine. This ERN provides site specific details; GPS co-ordinates, directions to site and contact phone numbers. This will enable emergency services to be familiar with the work location prior.

6.6 Hazard Awareness

Any person arriving at the emergency site (Origin responders, Origin medical providers, Emergency Services) will be made familiar with:

- Hazards generated by the incident (fire, heat radiation, chemical exposure etc)
- Known hazardous areas and exclusion zones
- Known safe locations and distances
- Appropriate PPE (if known)

6.7 Shift changeover during an emergency

Shift changeovers are required for continuity of emergency management. The SEMT-L is responsible for change over of personnel involved in the emergency. Effective changeover will be achieved by:

- Staggering changeover times
- Avoiding changeovers during critical periods
- Having changeovers in daylight, where possible
- Briefing incoming personnel

6.8 Termination of emergency and recovery actions

The SEMT-L will declare when the response phase will stop and determine the recovery strategy and resources required in consultation with the GEMT-L if GEMT is activated.

All activities required to terminate an emergency and conduct recovery operations are located in Paragraph 8 of this document.

7. Post Emergency Actions

The following post emergency actions must occur in order to ensure the Asset, and Business as a whole, successfully learns from the incident and returns to pre-incident state operations.

7.1 After Action Review

A debrief or After Action Review (AAR) is to be held after each emergency in accordance with the After Action Review Procedure CDN 8189619 and using the After Action Review Form CDN 13853829. An AAR is designed to discuss strengths and weaknesses and necessary improvements for this plan and related procedures. All AAR's shall be entered into OCIS along with any action items identified within the corresponding Incident tab.

7.2 Incident investigation

All incident investigations should be conducted in accordance with the Integrated Gas Manage Incidents and Learning Core Process found within ProMapp. The following steps should also be considered:

- Secure the incident site, restrict access and do not disturb anything until investigators have finished and handed back control of the site.
- Gather any evidence that may assist the investigations (list of people involved, response logs, situation boards, photographs etc).

The incident reporting system 'Origin Collective Intelligence System' (OCIS) will be used to record all incidents and actions arising from the emergency.

7.3 Recovery Actions

Prior to resuming work, develop a recovery plan that considers the following:

- Check plant and equipment for structural, physical and electrical/instrumentation integrity
- Ensure all active detection and protection systems are restored
- Replenish emergency response equipment as required
- Replace or return any third party emergency equipment

In addition, consider the following points:

- People who were involved may require counselling, depending on the nature of the incident
- People should be debriefed, with all relevant information captured for a 'lessons learnt'
- Conduct a tool box talk on specific start up activities before restarting work
- Consider the potential for loss of confidence or potential IR issues following the incident or the response to that incident
- Emergency response plans and training may need to be revised before resuming normal activities.

7.4 Post Incident Clean-Up

Post incident clean up must be done using the following guidelines:

- Conduct an initial inspection to identify the extent of equipment and plant damage

- Assess potential decontamination needs (removal of chemicals/oil/foam from plant/equipment, contaminated soil etc.)
- Store all contaminated material in proper containers, pending offsite disposal by licensed hazardous waste contractors
- Repair or replace damaged equipment and plant
- Inspect and test affected equipment
- Attend to commissioning and site reinstatement (where applicable to scope)

8. Training and Capability

IG emergency response competency-based training is managed by Organisational Capability. Training is captured in People Central on the Origin Intranet (Source). Managers and supervisors are responsible for identifying and organising training for people required to perform emergency response roles. All personnel must be given specific instructions and training on how to respond to emergencies and in the correct use of emergency equipment available.

Emergency training may be in the form of:

- Competency based training
- Simulated exercises
- Desktop exercises
- Toolboxes
- Practical drills
- Resource and equipment checks

8.1 Drills and Exercises

The Emergency Exercise Planning and Reporting Procedure AUS-1000-SAF-PRO-00010 CDN/ID 3674898 details the minimum requirements for the planning and conduct of exercises.

All drills and exercises require an After Action Review to determine what worked well and what requires improvement. All actions are to be recorded in OCIS and reviewed until close out.

Figure 8 details the Beetaloo Assets annual exercise schedule. The schedule can be dynamic and align with the operations and level of risk that exists on site.

In addition to this schedule the IG Well Control Standard (INT-1000-35-TS-001) mandates emergency response exercises to be conducted as follows:

- For continuous operations, IG D&C related activities shall conduct two Well Control Emergency response exercises per year to evaluate the effectiveness of the response of all stakeholders
- For projects that are campaign based, a Well Control Emergency Response Exercise shall be held at the start of the campaign involving all stakeholders. Subsequent exercises shall be conducted on a minimum twice annual basis if applicable.

		Jan	Feb	Mar	Apr	May	Jun
		1st Qtr			2nd Qtr		
Shift 1 and 2	Primary	Environmental	Fire	Environmental	Personnel safety	Structural failure	Personnel safety
	Secondary	Personnel safety	Personnel safety	HAZMAT	Security	Personnel safety	Personnel safety

		Jul	Aug	Sep	Oct	Nov	Dec
		3rd Qtr			4th Qtr		
Shift 1 and 2	Primary	Personnel safety	Personnel safety	Security	Structural / Equipment failure - Water	Fire	Personnel safety
	Secondary	Security	Personnel safety	Personnel safety	Environmental	Personnel safety	HAZMAT

Figure 8 – Exercise Schedule

8.2 Training Requirements

The site emergency response job task analysis and Site Supervisor/Wellsite Representative job task analysis identifies the minimum requirements for trained personnel for specific roles that comprise the

ERT and SEMT. It is the Contractor / Site Manager responsibility to maintain minimum levels of trained staff to meet their sites requirements.

8.3 Training and Competency

- All parties must be familiarised with the contents of this ERP.
- All personnel identified to fulfil emergency response roles within this ERP must be competent
- Minimum one remote first aid trained person per work party or travelling team.

9. Response Resources

The following response resources may aid in the preparation for, and management of, emergencies by the Beetaloo Asset.

9.1 Planning and Preparation

Enabling activities, such as ensuring minimum training and ensuring hardware maintenance, which are required to be carried out to support this plan are detailed in the:

- Beetaloo Basin Groundwater Monitoring Bore Installation Environmental Management Plan,
- Bushfire Management Plan
- Spill Management Plan
- Drilling, Completion, Hydraulic Fracture Stimulation and Well Testing Environmental Management Plan, in conjunction with the requirements of the Origin Integrated Gas HSEMS.

Dependent on workscope the relevant Person in Charge is responsible for ensuring that any staff mobilised to conduct work for Origin in the Beetaloo Basin have been appropriately briefed, completed appropriate inductions and completed the nominated minimum training as applicable to the work conducted.

9.2 Equipment and Unmanned Phase

During operations, emergency response equipment available at each site, and their layout, will be detailed and provided within contractor specific ERPs.

Emergency response escalation and assistance will be provided by Triple P Contracting on unmanned locations. This will only involve monitoring the infrastructure ie wellhead from a distance to ensure appropriate escalation can occur if required.

9.3 Incident Response Procedures Flip Charts

Emergency Scenario Flip Charts CDN 3676134 are intended to provide further assistance to each role in dealing with various pre–defined emergency scenarios. The charts define the key roles and responsibilities to ensure essential response actions are undertaken. The flip charts can be found in Core Process Manage Incidents and Learning.

9.4 Spill Response

The Beetaloo Spill Management Plan (NT-2050-15-MP-030) provides specific information on how to manage and handle spill response within the Beetaloo Asset (included spills located off tenure). This document should be referenced for all non emergency spill response scenarios. For managing spills, Emergency Scenario Flip Charts CDN 3676134 and Appendix H.

9.5 Chemical Response & Risk

The Chemical Response guidelines (QLD-1000-SAF-PRO CDN 4411922) provide specific information for specific chemicals that are used on Origin sites. The guidelines provide information on:

- PPE requirements
- Chemical details and description
- First aid requirements
- Evacuation considerations
- Fire and spill management

Any differences between the Chemical Response Procedures and the SDS must be risk assessed with appropriate controls adopted.

Additionally, an Hydraulic Fracturing Chemical Risk Assessments were completed for the activities. The fluid systems reviewed were:

- Hydraluic fracture stimulation fluids;
- Hydraulic fracture chemical tracers; and
- Drilling fluids

As part of the Chemical Risk Assessment an hazard assessment was undertaken with the evaluation of the environmental hazard of the chemical additives in the hydraulic fracturing fluid systems, based on their environmental persistence, bioaccumulation and aquatic toxicity properties.

Also included was an evaluation of human health effects (i.e.genotoxicity, carcinogenicity, reproductive toxicity, oral toxicity, inhalation toxicity, dermal toxicity, chronic repeated dose toxicity).

Chemical Response Procedures (CDN 4411922) **Beetaloo Chemical Risk Assessment (NT-2050-15-AR-0003)**

9.6 SEMT and OSC Toolkit

The link below identifies forms and procedures that can be used to help the OSC or SEMT in an emergency situation. These include:

SEMT and OSC Toolkit	
Duty Cards	SEMT Duty Cards
Initial Emergency Response Actions for All Incidents	Checklists
OSC Forms	SEMT Forms
OSC Worksheets	SEMT Worksheets
Checklists	ECR Equipment and Layout
Landing of Careflight Helicopter in The Field	ECR Status Boards

SEMT and OSC Toolkit (AUS-IGMS-SAF-GDL- CDN 6893451)

9.7 Bushfire Management

Specific wellsite Bushfire Managements Plans (BMPs) have been prepared for each wellsite location as per Code of Practice for Petroleum Activities requirements, these BMPs can be found in Appendix E.

The following link can provide technical advice in developing Bushfire Management processes as it provides access to prevention and response resources such as:

- IG Bushfire Standard
- Bushfire Preparedness Tool
- Generic Bushfire Asset Protection Zone (APZ) Guide
- Beetaloo Bushfire Management Plan
- https://www.pfes.nt.gov.au/incidentmap

Bushfire Management Source Bushfire Page Link

9.8 Flood Management

In the preparation and response to a flood event, the following resources have been developed to help the site prepare for and manage a flood response

- Camp Isolation Readiness Check sheet (Appendix I).
- Flood Mapping via OLIMAPS (where available)

Betaloo Assets teams can use the above tools to develop site Specific Flood Plans. The plan should take into consideration:

- Sources of flooding i.e. rivers, dam over flows etc.
- Fixed and temporary assets affected by flooding
- Access roads that are cut off and at what levels.
- Seasonal Preparedness – Activities at a minimum to prepare site for a flood
- Flood Warning or Watch
- Need to isolate equipment affected by flooding
- Flood Recovery requirements

9.9 Security Toolkits

In addition to the Emergency Response Flip Charts (CDN 6893451) the following documentation supports response to different security scenarios:

- IG Security Management Plan CDN 8278592
- Wellsite Safety and Security Level Classification Procedure
- Regional Protest Plan - CDN 7654911
- Beetaloo Security Plan – NT-2050-95-MN-001

Security Toolkits Source Security Page

9.10 Aviation Resources

Specific aviation resources can be sourced for use during an emergency. The Origin Aviation Management Plan (OT ID 28314649) outlines how aviation tasks must be managed.

The plan identifies
- Aviation tasking process
- Aviation bookings (fixed and rotary winged aircraft)
- Landing site management including approved Airfields and Helicopter landing site requirements.

Aviation Management Plan

Origin Aviation Managment Plan

In addition to the aviation management plan the below link provides details on the following:

- Helicopter Landing Sites technical inspection report form
- Helicopter Landing site design plate
- Helicopter Landing Site Officers
- Approved Helicopter Landing Site Register and requirements
- Aerial Firefighting
- Helicopter Landing Site Officer operators manual

Aviation Resources

Aviation Safety

9.10.1 Daly Waters Airstrip

Daly Waters Airstip is used frequently by CareFlight fixed wing aircraft when undertaking medical retrievials. Origin has supplied a set of emergency landing lights which must be deployed for night time landings. These lights are for use by both Origin and the Daly Waters community and are stored within the Origin storage shed at Daly Waters. Contact the Origin Field Lead for deployment or access to the lighting.

See Appendix I for Daly Waters Emergency Landing Lights Layout.

9.10.2 Helicopter Landing Site Officer (HLSO)

If a helicopter is required for an emergency situation a designated / trained Helicopter Landing Site Officer (HLSO) should be sourced (where available) to support ground activities. It is the responsibility

of the HLSO to ensure that they are familiar with the landing locations and the requirements associated with the Helicopter Landing Site Officer Operations Procedure – Integrated Gas (CDN/ID 7983075) .

Landing site coordinates are identified in Appendix D and in the Emergency Response Notification (ERN) document that is prefilled by the Origin Well Site Representative when moving to a new well location or if conducting a campaign then nominated in the campaign specific bridging document.

9.11 Emergency Control Room

The Emergency Control Room (ECR), manned by the Growth Assets SEMT, is the coordination centre and "communication hub" for Beetaloo Asset based emergency incidents. The ECR must be activated to help assist the affected site oversee the operational emergency response and well-being of personnel involved in, or affected by, the emergency. The Beetaloo Asset ECR is located in 180 Ann Street in room 29:12 and contains appropriate tools, documents and stationery to support a response.

Emergency Control Room ECR Tools

9.12 Emergency Equipment

A detailed list of emergency response equipment is below. Please note that this list is equipment supplied by Origin only.

Item	Location
Fire extingusher	All light vehicles 1 at each helicopter landing site
General first aid and snake bit kit	All site offices All light vehicles
Helicopter landing kit	1 at each wellsite office
Helicopter crash kit	1 at each wellsite office
Medical clinic (includes DEFIB, oxygen,	Designated well site (when in full operations only)
Runway landing lights	Daly Waters (Origin Shed)
Advanced first aid kit (including oxygen)	1 at Kyalla 117 wellsite office (during wet season)
Telehandler with bucket and forks	Kyalla 117
2 x trash pumps (waste fluid management)	Kyalla 117
7 x pond transfer pumps (waste fluid management)	Kyalla 117

10. Stakeholder Management

An emergency will be coordinated and supported by the SEMT at the ECR and SEMT at site. The bridging document or the ERN will contain site specific contacts that can be contacted in an emergency.

10.1 Group Emergency Management Team (GEMT)

The GEMT provides support to an emergency situation and manages the higher level requirements to assist the SEMT whilst dealing with regulators, media, legal and industry partners. For every activation of the SEMT, the SEMT-L must contact the on call GEMT-L and advise of the situation. The GEMT-L will determine whether the GEMT will be activated. The SEMTL and GEMTL must be familiar with the

levels of incident management categories located within the Emergency response Assessment and Escalation procedure (CDN 8629094)

When an incident has escalated to include the GEMT, the SEMT-L, having consulted with the OSC, will communicate regularly with the GEMT Operations Lead to provide updates and make requests for support.

Group Emergency Management Plan (INT-IGMS-SAF-PLN CDN 6522903)

10.2 Emergency Services

First Responders must notify the OSC and in turn the SEMT-L if they call Emergency Services. Once notified, the OSC is responsible for all communications back to the SEMT.

Upon arrival, Emergency Services may take control of the emergency or leave the control to Origin to manage, depending on the type of emergency and the assistance that is required. In most circumstances Emergency Services will require assistance from Origin for local and technical knowledge and for additional resources to manage the incident.

Where Emergency Services take control of the incident it must be remembered that they are not able to command Origin personnel or resources, this command must still be managed by an Origin representative such as the OSC. This same control over the Emergency Services personnel and resources must be managed by the Emergency Services representative, such as the Incident Controller or senior officer.

10.2.1 Emergency Health Care

In the event of a medical emergency, the medical clinician and onsite First Aiders (if required) will commence immediate treatment.

To initiate external medevac support for:

- Priority 1 – Life threatening / time critical
- Priority 2 – Urgent (early surgical intervention required)
- Priority 3 - Serious but not time critical (e.g. severe abdominal pain without compromise)

The onsite medical clinician is to contact Care Flight Direct Tasking on **1300 650 654** and provide accurate medical information to the CareFlight Medical Retrieval Consultant.

Care Flight will then facilitate the medivac operation should it be required, based on aircraft availability and they will also communicate with 000 to inform them they are undertaking a medevac response to the Beetaloo Asset and provide specific details of the location..

At the first available opportunity, the Aspen Duty Medical Officer will also be contacted by the medical clinician and informed of the incident, the patient’s condition and current treatment / medivac plan.

Depending on the situation, the Aspen Duty Medical Officer will assist with telehealth advice in consultation with the Care Flight and Top End Health Services Duty Medical Officers.

For Priority 3 patients alternate medivac options maybe available to the medical clinician and these need to be considered on a case by case basis in consultation with Beetaloo site leadership and Duty Medical Officers.

For example:

- Car transport to Katherine hospital
- Flight out on rostered charter flight
- Private Katherine helicopter transfer

In the event of a medical case Priority 4 which can be managed onsite, the medical clinician will commence treatment and will contact the Aspen Duty Medical Officer as required to discuss treatment strategies.

10.2.2 External Medical Resources for Medical Evacuation

Due to the remoteness of the Beetaloo Asset, there will be a delay to external medical resources responding should they be required to assist in the medivac of a patient.

External medical resources available for medivac include:

- CareFlight direct tasking via fixed wing or helicopter
- Triple 0 (000) Dispatcher and Top End Health Services (TEHS) Duty Medical Officer

- St Johns Ambulance (from Katherine)
- RFDS Fixed Wing Aircraft Response

10.2.3 Emergency Manifest

A hard copy Emergency Manifest, identifying notifiable quantities of hazardous substances, should be located on arrival at permanent field locations in an easily accessible and identifiable place. An Emergency Service Manifest template found in Open Text Templates (and CDN 5362370) can be used to develop the Emergency Manifest.

10.3 Next of Kin

In the event of a death, serious injury or other emergency, involving Origin personnel, advice to relatives about the condition of a person or about the incident will be coordinated by People and Culture (P&C) through the GEMT.

During or after an emergency, the SEMT-L will refer any queries or concerns from relatives to People and Culture. P&C may also activate Employee Assistance Program (EAP) providers to support site personnel or relatives affected by an incident.

Principal Contractors and Contractor companies are responsible for management of next of kin communication in consultation with Police services, and EAP management in accordance with their emergency response plans and relevant State obligations. Where Contractors do not maintain their own EAP provider, P&C may extend EAP services as determined by the GEMT-L and P&C GEMT representative.

10.4 Landowners / Pastoralists

Contact with local landowners can be initiated by the SEMT-L in extreme circumstances; however Land Relations Advisors are to be used in the first instance. When activated, stakeholder communications will be handled by the GEMT and are addressed in the Group Emergency Management Plan (INT-IGMS-SAF-PLN-00004). Refer to Appendix A for contact details.

10.5 Regulatory Notification

A regulatory notifiable incident is an incident or non-compliance with an External Mandatory Obligation or External Voluntary Obligation that requires notification or reporting to a Regulator as prescribed by applicable Laws and Regulations. HSE regulatory notifiable incidents required to be reported to a regulator are listed in Appendix A.1.

Any regulatory incident notification to joint venture parties must follow the contractual arrangements specified in the joint venture agreement.

The Origin Energy Joint Venture representative must be consulted to determine Origin Energy's contractual obligations for incident notification and reporting.

Any correspondence between Origin Energy and Joint Venture partners must be conducted through the Joint Venture representative unless other arrangements have been agreed.

10.6 Dealing with Media Enquires

During an emergency event, media attention may occur at the affected site. All communications with the media must be in accordance with the Origin Media Policy (ORG-CGOV-POL-005). If personnel receive an enquiry from a journalist or reporter, whether in person or by phone and are asked about Origin, they should say:

"I am not in a position to comment but if you give me your name and telephone number I will organise for the most appropriate person to call you."

Always ask for:

- the journalist / reporter's name;
- publication / media outlet;
- contact phone number and / or email, and
- publication deadline.

The SEMT-L will advise the GEMT-L on call and External Affairs managers at the earliest opportunity of any media contact or enquiry. Refer to Appendix A – Table 3 for External Affairs contact details.

It is important to remember that there is no such thing as “off the record”. Even if you are speaking informally, you could be quoted at any time.

11. Review and update

The ERP will be reviewed and updated as necessary in response to one or more of the following:

- annually
- when major changes have occurred, which may affect the Emergency Response coordination or capabilities
- following routine testing of the plan
- after an actual emergency or
- before installing and commissioning new plant and equipment.

During the review, the following aspects are also to be considered:

- lessons learned from an emergency
- changes in legal requirements
- improvements to effectiveness in terms of response strategy, management and communication
- developments in the latest techniques and technology in handling an emergency
- changes to, or movement of people within our organisation
- changes to contact numbers of internal and external organisations
- revisions to existing or availability of emergency management tools and equipment, resource suppliers or contractors

12. Associated Documents

Document	Document Reference
Incident Response Procedures	QLD-1000-SAF-PRO-00041
Chemical Response Procedures	QLD-1000-SAF-PRO-00095
SEMT Toolkit	AUS-IGMS-SAF-GDL-00002
Emergency Response Exercise Planning Form	AUS-1000-SAF-FRM-00012
IG Group Emergency Management Plan (GEMP)	INT-IGMS-SAF-PLN-00004
Crisis Management Plan	ORG-RMS-PLA-001
Emergency Response Exercise Planning and Reporting Procedure	AUS-1000-SAF-PRO-00010
Risk Management Directive	ORG-RMS-DIR-001

13. Document information and history

DOCUMENT CUSTODIAN GROUP

Title	Name/s
General Manager – Beetaloo & Growth Assets	Chris White

DOCUMENT AUTHOR

Position	Name
HSE Lead – Growth Assets	Gabrielle Bertini

STAKEHOLDERS AND OTHER CONTRIBUTORS

Position	Name
Emergency Response and Security SME – HSE, Risk and Compliance (RAC)	Bruce Baldwin
Operations & Projects Manager – Growth Assets	Matthew Hanson
D&C Project Manager – Growth Assets	Ed Wong
Logistics Manager – Asset Services	Peter Runge
Environmental Specialist – Growth Assets	Matt Kernke

DOCUMENT HISTORY

Rev	Date	Changes made in document	Reviewer/s	Consolidator	Approver
A	25/03/2019	Consolidation of previous Beetaloo campaign ER plans, unmanned ERP to align with Integrated Gas ERP requirements to form Asset ERP.	B Baldwin	L Fulford	
0	29/04/2019	Issued for Use	B Baldwin M Hanson Ed Wong	L Fulford	T Boyes
1	21/06/2019	- Update references around regulatory reporting requirements based on NT regulator DNER feedback. - Update from NT police comments. - Combined wells and lease pad locations into one location in Appendix C for ease of reference.	M Kernke	L Fulford	T Boyes
2	03/12/2019	Police contact details updated in Appendix A1.	M Kernke	L Fulford	L Fulford
3	08/01/2020	Update to Appendix C – Well control information, addition of Boots & Coots information. Addition of Appendix D – Bushfire Management Plans	E Wong	L Fulford	L Fulford
4	17/1/2021	Updated with DEPWS comments	G Bertini		M Kernke
5	29/5/2021	Update to include stage 2 specifics Changes to document custodian Update to contact lists Inclusion of emergency care requirements	E Wong M Hanson	G Bertini	C White
6	30/902021	Update to include detail around working with emergency services – DEPWS feedback Removed ER scenarios Included list of emergency response equipment Included Daly Waters runway lighting plan Included example ERN	E Wong	G Bertini	C White

Appendix A Contact lists

External Agencies		
Role	**Name**	**Primary**
Local Emergency Services	Police, Fire, Ambulance	000 (or 112 from mobile)
Hospital	Katherine Hospital	(08) 8973 9211 Kintore Clinic Katherine (08) 8972 1677
Field response contractor / initial inspections	Triple P Contracting (PPP)	[redacted]
Remote Well Monitoring Assistance	Vincent James Operations Support Manager MPC Kinetic	
Bushfires NT	Fire control officer	Katherine (08) 8973 8871 Darwin (08) 8922 0844
Volunteer Bushfire Brigade		(08) 8975 9936
Regional Shire Council	Roper Gulf Shire	08 8972 9000 or 1300 366 208
Regional Shire Council	Barkley Shire	
Police (non-emergency)	Police Link	131 444 Elliott - (08) 8969 2010 Katherine – (08) 8973 8000
Poisons Information Centre	n/a	13 11 26
Bureau of Meteorology	Cyclone Warnings Forecasts & Warnings	1300 659 211 08 8920 3826
NT DITT's Petroleum Operations Team	after-hours	+61 1300 935 250
NT DEPWS		08 8973 8871 or 08 8973 8872 or 08 8973 8870 **DEPWS** Note, also required to notify landholder
NT EPA Pollution Hotline	n/a	1800 064 567
NT WorkSafe	n/a	1800 019 115 ntworksafe@nt.gov.au
Department of Main roads	n/a	1300 654 628
NT power and water	n/a	1800 245 090
Well Control and Prevention (for level 3)	Boots & Coots Services	24 hr. hotline 1 800 BLOWOUT or + 1 281 931 8884

Origin Beetaloo Basin Contacts		
Role	**Name**	**Primary**
Group Emergency Management Team (GEMT) Leader On-Call	N/A roster system	[redacted]
Origin IG Compliance	N/A roster system	[redacted]
General Manager – Beetaloo & Growth Assets	Chris White	[redacted]
Field Lead - Beetaloo & Growth Assets	Robert Wear or Peter Thomas	[redacted]
Operations & Projects Manager – Beetaloo & Growth Assets	Matthew Hanson	[redacted]
Ed Wong – D&C Project Manager – Asset Services	Ed Wong	[redacted]
HSE Lead – Beetaloo & Growth Assets	Gabrielle Bertini	[redacted]
Environmental Specialist – Beetaloo & Growth Assets	Matt Kernke	[redacted]
Senior Petroleum Engineer – Beetaloo & Growth Assets	Alex Cote	[redacted]
Drilling Superintendent – Asset Services	James Boorman	[redacted]
External Affairs Manager – IG direct media enquires	Chris Zipf or Tony Hancox	[redacted]
Process Safety SME – HSE RAC – Origin	Liana Bonnette	[redacted]
Emergency Response and Security Specialist – HSE RAC – Origin	Bruce Baldwin	[redacted]

For contacting neighbouring properties/pastoralists, all escalation is to be undertaken by the Beetaloo & Growth Assets Project and Operations Manager – Matthew Hanson (or delegate).

Neighbouring Properties			
Property Name	**Contact Name**	**Phone**	**Direct Neighbouring Properties**
Amungee Mungee	Adrian Brown (owner)	[redacted]	Nutwood Downs –North Tanunbirini – East Hayfield – West Beetaloo – South
Beetaloo	Scotty & Jane Armstrong (son-in-law/ manager)	[redacted]	Amungee Mungee – North Hayfield/Shenandoah – N/W NCW – West NCW – South (Tandi/Uchar)
Sturt Plains Hayfield/Shenandoah	Brad & Lisa Dyer Justin & Sally Dyer (son)	[redacted]	Buchannan – West Kalala – North Amungee Mungee – East Beetaloo – East NCW – South
Hidden Valley	David & Jenny James	[redacted]	Sunday Creek – North Kalala – East Buchannan – South
Kalala	Des Carey	[redacted]	Sunday Creek – West Maryfield – North Nutwood Downs – East Hayfield/Shenan – South Hidden Valley - West
Newcastle Waters		[redacted]	Hayfield – North Beetaloo – North
Nutwood Downs	Rod & Rayna Dunbar	(08) 89 759 954	Kalala – West Amungee Mungee – South
Tanunbirini	Mick Tasker (Manager)	[redacted]	Amungee Mungee - West

A.1. Incident Notification Matrix – Northern Territory

As detailed in the IG Management of HSE Regulatory Notifiable Incidents procedure, incidents that may potentially be notifiable will be escalated via the various field team, through their functional lead (Field Manager / Operations and Projects Manager) and through to the IG RAC & Process Safety team who will provide guidance in interpreting notification requirements and guiding the external authority notification.

Integrated Gas Regulatory Incident Notification Guideline (NT regulatory notification matrix)				
Legislation	**Incident**	**Way report must be given**	**When report must be given**	**Contact Details**
Work Health and Safety (National Uniform Legislation) Act 2011 ***Sections 35 – 39***	A PCBU must notify the regulator as soon as they become aware of a death, serious injury or illness or dangerous incident that arises out of the conduct of the business or undertaking. A *dangerous incident* includes: • Uncontrolled escape, spillage or leakage of a substance, gas or pressurised substance • Uncontrolled implosion, explosion or fire • Electric shock • Fall or release from height of plant, substance or thing • Collapse, overturning, failure or malfunction of, or damage to, any plant/equipment/structure/excavation • In-rush of water, mud or gas in an underground excavation tunnel or interruption of ventilation in said tunnel A serious injury or illness means that results in: • work related injury • immediate hospital treatment as an in-patient • immediate treatment for serious injuries (for example amputation, scalping, a spinal injury, loss of a bodily function or a serious laceration, burn, head injury or eye injury), or • medical treatment within 48 hours of exposure to a substance.	By telephone	Immediately after becoming aware	1800 019 115 Worksafe ntworksafe@nt.gov.au
Schedule of Onshore Petroleum Exploration and Production Requirements 2019	An incident involving death or serious injury (reports shall be in addition to, and not take precedence over reports required by NT WorkSafe) A serious injury is one which requires immediate attention by a medical practitioner	by telephone AND in writing	immediately As soon as practicable	1300 935 250 DITT Petroleum.Operations@nt.gov.au
	An incident involving serious damage (other than Environmental Harm) including loss, destruction or damage to property exceeding $50k or when any person dies or suffers serious injury	by telephone AND in writing	immediately As soon as practicable	1300 935 250 DITT Petroleum.Operations@nt.gov.au
	An incident involving or could potentially involve the injury to a person or serious damage to property that is professionally considered to have been caused by an event that is not in the normal or ordinary course of an operation (Potentially Hazardous event)	by telephone AND in writing	immediately As soon as practicable	1300 935 250 DITT Petroleum.Operations@nt.gov.au
	An incident where damage to property occurs (<$50k) that is not serious damage to property, but which results in a significant loss of structural integrity or load bearing capacity in the property damaged or results in some other significant unsafe condition	by telephone AND in writing	immediately As soon as practicable	1300 935 250 DITT Petroleum.Operations@nt.gov.au
	An incident that is considered to be an emergency	by telephone	Immediately (after 000)	1300 935 250 DITT Petroleum.Operations@nt.gov.au

Integrated Gas Regulatory Incident Notification Guideline (NT regulatory notification matrix)				
Legislation	**Incident**	**Way report must be given**	**When report must be given**	**Contact Details**
Petroleum Act 1984 and associated Regulations	**Reportable Incident:** An incident, arising from a regulated activity, that has caused or has the potential to cause material environmental harm or serious environmental harm. *Material environmental harm* means harm that: (a) Is not trivial or negligible in nature; (b) Consists of an environmental nuisance of a high impact or on a wide scale; (c) Results, or is likely to result, in not more than $50k or the prescribed amount (whichever is greater) being spent in taking appropriate action to prevent or minimise the environmental harm or rehabilitate the environment; or (d) Results in actual or potential loss or damage to the value of not more than $50k or the prescribed amount (whichever is greater). *Serious environmental harm* means environmental harm that is more serious than material environmental harm and includes environmental harm that: (a) Is irreversible or otherwise of a high impact or on a wide scale; (b) Damages an aspect of the environment that is of a high conservation value, high cultural value or high community value or is of special significance; (c) Results or is likely to result in more than $50k or the prescribed amount (whichever is greater) being spent in taking appropriate action to prevent or minimise the environmental harm or rehabilitate the environment; or (d) Results in actual or potential loss or damage to the value of more than $50k or the prescribed amount (whichever is greater). **[Note: Applicable for on tenure Spills]**	by telephone OR in writing AND in writing	As soon as practicable (not later than 2 hours after the incident) <24 hours after oral notice (written notification) 3 days after the incident (initial report) 90 days intervals from the date of the initial report (interim reports) 30 days after clean up or rehabilitation (final)	1300 935 250 DITT Petroleum.Operations@nt.gov.au
	Recordable Incident: An incident that has resulted in an environmental impact or environmental risk not specified in the current plant for the activity; or has resulted in the contravention of an environmental performance standard specified in the current plan for the activity; or is inconsistent with an environmental outcome specified in the current plan for the activity; and is not a reportable incident.	In writing	15 days after each 90 day period after then day on which the environmental management plan is approved.	1300 935 250 DITT Petroleum.Operations@nt.gov.au
Environmental Protection Biodiversity Conservation Act 1999	Incidents considered to have an impact to Matters of National Environmental Significance	in writing	within 5 business days of becoming aware	Compliance@environment.gov.au
Energy Pipelines Act 1981 and associated Regulations	A reportable incident that involves: • Death or serious injury (or the potential to cause) • Significant damage to a pipeline (or potential to cause) • Immediate investigation	By telephone AND In writing	As soon as practicable As soon as practicable	1300 935 250 DITT Petroleum.Operations@nt.gov.au
	A significant pipeline accident event that: • Is connected with work carried out on or in relation to a pipeline • Causes, or has the potential to cause human death	By telephone AND in writing	As soon as practicable As soon as practicable	1300 935 250 DITT Petroleum.Operations@nt.gov.au
Environmental Assessment Act 1982 and associated Regulations	Alteration of action in such a manner that the environmental significance of the proposed action may be changed	in writing	As soon as practicable after the alteration	08 8924 4218 **NT EPA** ntepa@nt.gov.au
Bushfires Management Act 2016 and associated Regulations	Unable to control a fire on the land	All reasonable steps	Following the fact	08 8973 8871 or 08 8973 8872 or 08 8973 8870 **DEPWS** Note, also required to notify landholder

Integrated Gas Regulatory Incident Notification Guideline (NT regulatory notification matrix)				
Legislation	**Incident**	**Way report must be given**	**When report must be given**	**Contact Details**
Waste Management and Pollution Control Act 1998 and associated Regulations	An incident that causes, or is threatening or may threaten to cause, pollution resulting in material environmental harm or serious environmental harm. This includes road transport incidents and spills that may occur off the lease (spill response). Refer to the definition of *material* and *serious environmental harm* provided in *Petroleum Act* section above. *Pollution* means: (a) A contaminant or waste that is emitted, discharged, deposited or disturbed or that escapes, or (b) A contaminant, effect or phenomenon, that is present in the environment as a consequence of an emission, discharge, deposition, escape or disturbance of a contaminant or waste. Note: does not apply to incidents confined within petroleum activities land (including air and water above or below) – see the EMP for the area of petroleum activities land **[Note: Applicable for off tenure Spills]**	by telephone	Within 24 hours of becoming aware	1800 064 567 **NT EPA** Pollution@nt.gov.au
Heritage Act 2011 and associated Regulations	Discovery of archaeological places and objects	In writing	As soon as practicable (within 7 days of discovery)	08 8999 5039 **DTC - Heritage Branch** heritage@nt.gov.au
Weeds Management Act 2001	First becoming aware of a declared weed that has not previously been, or known to have been, present on the land.	Not specified	14 days of becoming aware	08 8999 4567 **DEPWS** weedinfo@nt.gov.au
Dangerous Goods Act 1998 and associated Regulations	Becoming aware of theft, loss of, or unauthorised interference with explosives.	Not specified	Immediately after becoming aware	Police Assistance Line 131 444

Internal Contacts	
The on-call phone number is 0475 813 986 and is monitored 24/7 by the Integrated Gas Regulatory Compliance Team	*integratedgascompliance@upstream.originenergy.com.au*
a. *Work Health & Safety Incident Notification form*	*http://www.worksafe.nt.gov.au/LawsAndCompliance/Pages/incident-reporting.aspx*
b. *Pollution Report Form*	*https://ntepa.nt.gov.au/waste-pollution/hotline/pollution-report-form* *http://im.originenergy.com.au/otcs/cs.exe/properties/7486053*
c. *Aviation Accident or Incident Notification Form*	*https://www.atsb.gov.au/mandatory/asair-form.aspx?*

Appendix B Well Inspection and Monitoring Protocol

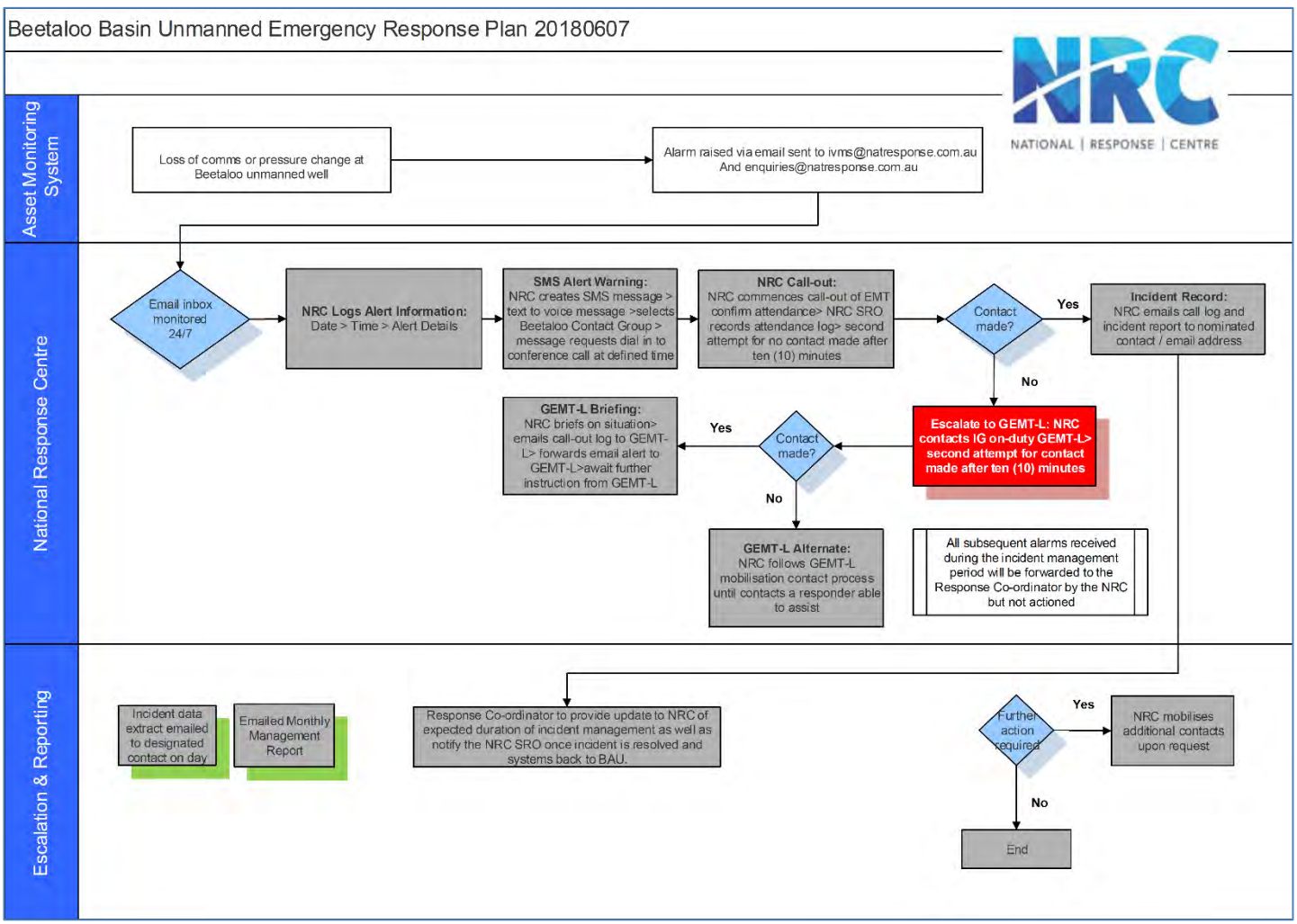
B.1. Well Pressure Remote Monitoring

The Amungee NW-1H well is suspended at surface for monitoring and recording of the reservoir pressure buildup. Real time pressure monitoring exists and a pressure anomaly or loss of communications to site will trigger an email alarm to a minimum of 7 people (listed below) and to a 24/7 monitored email at the Origin's National Response (NRC) centre. The NRC will send a further SMS and text to voice message to the notification list to alert the team of the alarm. The SMS will include time details to call into a conference call number at a set time (nominally 10 minutes time – but to be stated in the message). NRC will start the the conference call however if NRC was unable to contact any one on the list by phone before the call, and no one joins the conference call they escalate to GEMT.

The group on the conference call can then decide if the site requires inspection and agrees on the person (the nominated SERT-L) to deploy Triple P or other services to site. NRC will continue on the conference call maintaining notes of discussions. NRC will follow the below process flow when activated from an alarm.

Conference call number to be used.

1800 062 923
Host PIN 6700 4855 4873
Guest PIN 6700 4855 3024



Current list of people receiving notifications. All people on this list should have this list of people in their contacts to facilitate quick communications.

Role	Name	Primary
Beetaloo & Growth Assets Field Lead	Robert Wear Peter Thomas	[redacted]
Operations & Project Manager – Beetaloo & Growth Assets	Matthew Hanson	[redacted]
General Manager – Beetaloo & Growth Assets	Chris White	[redacted]
D&C Project Manager – Asset Services	Ed Wong	[redacted]
Senior Petroleum Engineer – Beetaloo & Growth Assets	Alex Cote	[redacted]
HSE Lead – Beetaloo & Growth Assets	Gabrielle Bertini	[redacted]

If it is determined there is an unexplained pressure change in the well or unrecoverable communications issue then Triple P is deployed to site to assess the situation. The site person shall only deploy to site if it is possible to do so and travel in daylight hours. The requirement is to be at site within 6 hours. This in practice means that they should only be deployed to site if the event occurs before noon. If the event occurs after noon they should notified so as to be on site as early as possible the next morning. Triple P will follow the procedure detailed in the “Well Control” Section B3.

Once on site Triple P will use the satellite phone to call back the person that deployed them to report the situation on site and received further instructions. If the information received from Triple P is that the situation on site is not normal then this triggers an emergency event and Triple P becomes the On Scene Command (OSC) and the Beetaloo & Growth Assets Operations and Project Manager (or the senior person in the group which has responded to the alarm) will be the SERT-L and notifies the General Manager Growth Assets).

Well control incidents may require the mobilisation of specialised response contractors information on this is listed within Appendix C4.

Appendix C Well Control

C.1. Unmanned

A specific standard operating procedure has been undertaken for well inspection monitoring where detailed instructions are provided to the worker undertaken the well inspection.

In the event of an uncontrolled release from a wellhead (being observed in the field):

- Move out of harm's way. Find safe upwind location (at least 50 metres away).

  Considerations:

  - Determine wind direction.
  - Always pay attention to Fire, fumes, electrical, ignition and Health Risks.
  - What is the type of Leak and source?
  - Monitor situation visually from distance.
  - Secure site and keep all non-essential personnel and ignition sources away from the hazardous area. (secure location)
- Alert others near-by
- Assess the situation – determine the level of the immediate threat.

If a report is received from any source (for instance tourists travelling along highway see the well on fire) that an incident has occurred then the response for a pressure change in the well, escalation is to be immediately initiated.

If the responding group are reasonably certain that loss of containment has occurred then Triple P should be sent to site to secure access from the highway and confirm the situation on site. Escalation through the General Manager – Beetaloo & Growth Assets to GEMT should occur with the recommendation to notify Asset Services to arrange third party Well Control Services to prepare to deploy, or deploy if the report is very credible (information on this process is located in Appendix C4).

If there is a high level of doubt about the information, Triple P contracting should be deployed to obtained reliable information from site (keeping a safe distance away with any potential ignition source).

Note: After consultation with the Project Manager and/or Well Integrity team representative - and you if are competent, confident – and i**f it is safe** to do so; **contain the incident** by shutting in the well – if flow is through wellbore; then activation of the self actuation UMV may be appropriate; of if escape is evident to be from an annular space, it may be possible to isolate via a manually operated valve.

Caution: Well control incidents may require the mobilisaiton of specialised response contractors.

Please refer to Appendix B for Well Inspection and alarm flow chart or NT-2050-35-MN-0001 Amungee NW-1H Remote Pressure Monitoring trouble shooting manual for well integrity monitoring and data transmission details.

C.2. Well Control Incident Classification

In the event that a Well Control Incident exceeds level 1 and 2, the Person in Charge will activate the SEMT who in turns, notifies the GEMT-L and the involvement of a contracted third party specialist to handle the well control integrity event.

The well control specific incident response plan is detailed the Origin Well Control Standard (INT-1000-35-TS-001) and the Asset Services Emergency Response Plan (QLD 1000 SAF PLN CDN/ID 19601361) for well control events these documents are to be followed.

The following information is guidance on different levels of well control. Additionally, Appendix G4 gives an basic overview on how Well Control events are managed.

Level 1 (an uncomplicated kick or a low risk production / well integrity event)	Level 2 (a kick with some complications or a low - moderate risk well integrity event)	Level 3 (complete loss of well control or a moderate - high risk well integrity event)
Generally, these are events that commonly occur during drilling and workover operations. Additionally covers low risk well integrity events during the production phase. Emergency interfacing is limited due to pressure and flow containment. Personnel and equipment are not threatened, and there are no injuries or fire involved. Thus, the situation can be handled using resources and procedures available on-site (or readily mobilisable in the case of a well integrity event). The situation is managed immediately by the Driller who will keep the rig manager informed of the situation. Caution: Level 1 incidents can escalate quickly to a more serious and threatening level if not handled properly.	A Level 2 event can be defined as an abnormal well control event during drilling and workover operations involving some sort of complication in which: • Well control has NOT been lost at the surface • Resources beyond the normal capabilities of the rig crew or production operations staff may be required • Outside well control consultation, materials, equipment or personnel may be required Includes low - moderate risk production events (e.g. noticeable leak or significant annular pressure). There are no injuries or fires associated with this incident level since control has not been totally lost. The situation is typically managed by the Rig with the OSC liaising. The SEMT is on Standby but not activated. The incident is generally not sufficiently threatening to activate the GEMT to deal with the situation.	A Level 3 emergency denotes a complete loss of well control at surface during drilling and workover operations with no opportunity to restore it using all the resources available on-site. Includes moderate – high risk well integrity events during the production phase. Level 3 Incidents require the SEMT to activate including notification to the GEMT to effectively deal with the situation. External Well Control support (i.e. Boots & Coots, Wild Well Control, Cudd, etc.) must be activated upon confirming that the well is out of control at surface and measures must be immediately taken to protect people, the environment and material assets. These emergencies, although serious at the outset, have the potential to escalate further during control attempts. Such escalation may cause serious structural damage or total loss of the facility, rig, BOP stack and wellhead due to explosion, fire, loss of buoyancy or location subsidence and could affect nearby wells & infrastructure.

In conjunction with the Well Control contractor, three levels of well control event have been defined in the Wellsite ERP and are mirrored in the Well Control Standard (INT-1000-35-TS-001).

Each level defines the level of escalation required including potential mobilisation of the Well Control contractor.

Well Control Incident Level 1 - Uncomplicated Kick	
Situation managed by:	WSR in consultation with Drilling Superintendent, Drilling/Completion Engineer
Support:	Usually none required
Communication:	Field Manager/Drilling Superintendent to liaise with Brisbane based D&C operations lead as required
Example situation:	Influx while drilling

Well Control Incident Level 2 – Kick with Complication	
Situation managed by:	WSR in consultation with Drilling Superintendent, Drilling/Completion Engineer SERT on standby
Support:	Technical Team as required Well control specialist as required
Communication:	WSR/Field Manager or Drilling Superintendent to liaise with Technical Team

	Technical team to liaise with IG D&C management as required
Example situation:	• Severe lost circulation combined with influx into wellbore • Kick taken with pipe out of hole • Leak or mechanical failure of well control equipment • Gain and loss situations • Plugged workstring • Influx taken while running casing or pumping cement • Loss of casing shoe integrity • Any complication experienced during live well operations

Well Control Incident Level 3 – Loss of Containment	
Situation managed by:	Onsite: SERT Office: GEMT
Support:	Technical Team to support SERT and GEMT as required Well control specialist onsite and in office as required
Communication:	SERT-L to liaise with GEMT-L Support functions to report to SERT-L or GEMT-L as required
Example situation:	• Severe lost circulation combined with influx into wellbore • Kick taken with pipe out of hole • Leak or mechanical failure of well control equipment • Gain and loss situations • Plugged workstring • Influx taken while running casing or pumping cement • Loss of casing shoe integrity • Any complication experienced during live well operations

C.3. Response to Level 3 Well Control Event

Human safety shall always be the highest priority in a well control event. Untrained personnel should never attempt to conduct well intervention activities due to the extreme risk for significant injury, fatality or event escalation. The primary focus immediately following a Level 3 well control event should consist of rig evacuation and care for injured parties. During drilling/completion operations the rig contractors evacuation procedures shall be the prevailing document(s). The senior contractor representative (Rig Manager) shall serve as the On Scene Commander (OSC) during evacuation and search and rescue operations. Upon completion and confirmation of a full muster, the Rig Manager shall be relieved of OSC duties by the Origin Energy Wellsite Representative.

Initial procedures as defined in the Wellsite ERP include, but are not limited to, the following:

- Evacuate and make sure everybody is safe and all personnel accounted for
- Isolate the area and restrict access
- Notify applicable groups (including well control specialists if required)
- Conduct initial assessments

C.3.1 Initial Assessment

In the event of a well control event, factually correct information is essential to aid in decision making. Once the site has been secured, personnel accounted for and appropriate notifications made, information should be gathered which aids the response to the incident. **Appendix C8 & C9** include templates to aid in gathering the information necessary in such an event.

C.3.2 Further Considerations for Initial Response

The response to a Well Control event will depend on situation. Hence, a specific plan would be made after the initial assessments are completed. For a loss of containment event where fire is an issue, then a suitable water source and storage capacity onsite will be one of the main issues with the

response. This should be addressed as a matter of urgency. Calculation of water requirements are outlined in **Appendix C13.**

Once the site has been secured, some hazards and potential solutions are outlined in **Appendix C10.** Information in this Appendix should be used to identify the site specific issues relevant to the event and mobilise services and materials that may be required to respond.

C.4. Well Control Contractor Mobilisation

The current primary well control contractor is Boots & Coots.

Although it will always be impossible to establish a plan that will be perfectly suited to a given loss of containment event, a well control package has been contracted to cover commonly required equipment for such occasions. To deal with a loss of containment event, regardless of the technical solution employed, requires mobilization of specific equipment and personnel, and more importantly proper engineering of any envisaged solution.

The Coalition Well Control Package shall only be mobilized upon request of the Operator (Origin) following declaration of a level 3 type event. Dispatch of the equipment shall only be authorized by the following Origin Energy representatives:

Position
General Manager – Asset Services
Drilling & Completions Manager – Asset Services

Table 2 - Origin Personnel Authorised to Mobilise Well Control Package

C.5. Well Control Contractor Contact details:

Alan Vick | Eastern Hemisphere – Technical Support - BD Manager

Well Control and Prevention| Boot and Coots

[redacted]

G-Tower 199 Jalan Tun Razak, Kuala Lumpur Malaysia 50450

[redacted]

[redacted]

24 Hr. Emergency Hotline 1 800 BLOWOUT (USA) or +1 281 931-8884 (International)

Appendix C9 has a well condition data sheet which should be completed and sent to Boots and Coots for their initial assessment of the situation.

C.6. Well Control Equipment Mobilisation

In addition to mobilising Boots and Coots personnel, preparation should commence to mobilise the Coalition Well Control package. The well control equipment package is stored and maintained at **Halliburton offices situated at 9 Roma Downs Road, Roma, Queensland Australia,4455**. The package consists of a total of eight (8) enclosed DMV type steel containers. An evaluation shall be conducted based on the scale of incident and a determination made as to the need to mobilize the full or partial equipment package.

The actual package would get mobilised to site once it was checked over by Boots and Coots personnel, but the trucks required to mobilise it site should be organised. Boots and Coots estimates that two road trains with a total of eight flatdeck trainers will be required to transport the well control equipment to site, along with a 25T crane to load and unload the trucks. **Appendix C11** provides information on the Boots and Coots Well Control Package.

In addition to the Boots and Coots well control package, a range of equipment and services may be required depending on actual event in question. Origin has existing contracts in place for the services that may be required. Primary contractors will be updated to ascertain equipment requirements, these

are listed in **Appendix C12** and a list of equipment and services that may be required to respond to a situation.

C.7. Level 3 Well Control Emergency Response Exercises

It is recommended that a Level 3 loss of containment event be simulated yearly as minimum to test the Emergency Management structure (SERT, GEMT, CMT) in line with the requirements set out in the Wellsite ERP. Scenarios should progress from level 1 to level 3 (blowout stage) to ensure that all Emergency Management leaders are provided an opportunity to participate. In addition, the drills should include the primary well control contractor and support contractors to test their state of readiness. The aim of the exercise is to simulate the loss containment event, test personnel's response to the event, test the mobilisation and function of the Emergency Management structures, and test the mobilisation of the contractors required to respond to the well control event. Any lessons learned from the exercise should be incorporated when appropriate to continually improve Origin's response to such an event.

C.8. Well Control Incident Questionnaire

Initial information to be obtained following well control incident.

Question	Answer
Are there any injuries and is immediate assistance required for evacuation of personnel?	
What assistance is currently underway for injured personnel?	
Has the rig been abandoned/evacuated?	
What are the weather conditions?	
Has the location been secured?	
When were applicable contingency plans put into effect?	
Determine the current status of the emergency:	
Is there a fire? If not, should ignition be considered?	
Is there any pollution?	
Can source of pollution be stopped?	
Are toxic gases present?	
What is the condition of the drilling/workover rig?	
Is the rig still on location?	
Should rig, or can rig, be moved off location?	
Are the BOP's operable?	
What is the current status of the well?	
Is the wellhead/tree intact?	
Pressure readings (annulus and drill pipe)?	
Previous casing size and depth?	
What is the well depth?	
Mud weight?	
Where is the drill pipe/tubing?	
Is an attempt to shut in the well feasible if not already done?	

C.9. Well Control Incident Call In Form

Date and time of incident:		Location:	
Contact name:		Contact number:	
Rig:		WC Incident Level:	

Injured parties:

	Name	Company	Type of Injury
1.			
2.			
3.			
4.			

Brief Summary (facts only):

What has been done so far to secure the site:

Who has been contacted so far:

Government/Regulatory Bodies Notified and Media Coverage:

Initial well conditions			
Shut In Drill pipe pressure (psi):		Shut In Casing pressure (psi):	
Pit gain volume (bbl):		Mud weight (ppg):	
Well depth (mMDRT): (mTVDRT if required)		Casing shoe depth (mMDRT): (mTVDRT if required)	
Last casing size (in):		Last FIT/LOT (ppg):	
Hole size (in):		Bit depth (mMDRT): (mTVDRT if required)	
Float in drill string: Ported?		If yes, drill pipe pressure to open float (psi):	
Operation in progress at time of kick:			
Actions since time of kick:			
Current conditions (if different from initial conditions reported above):			
Shut In Drill pipe pressure (psi):		Shut In Casing pressure (psi):	
BOPs closed (Y/N):			
Current operation and plans:			

C.10. Further Considerations for Initial Response – Possible Hazards and Solutions

Hazard	Services/Materials	Task
Security		
Visitors entering site	Self powered site office with toilet and fridge.	Secure entry to site (ie lock gate) Contact security contractor to mobilise personnel/equipment as required
Lack of communication	Digital radios	Supply digital radios for working party
Visibility at night	Light plants	Contact primary contractor to mobilise equipment as required
Landowner not informed of situation	N/A	Contact landholder access team to discuss how landholder is to be informed
People		
Fatigue	Additional SERT personnel	Ensure sufficient personnel at site location to man SERT 24hrs
Lease Preparation		
Fire – overgrown with grass	Slasher	Contact primary contractor to mobilise equipment as required
Uneven ground	Grader	Contact primary contractor to mobilise equipment as required Seek approval and blade fire break if safe to do so.
Removal ground soil	Excavator	Contact primary contractor to mobilise equipment as required
Ignition	N/A	Ensure any possibly ignition sources present at the wellsite are removed/disabled if safe to do so
Movement around well	Bobcat & Backhoe	Contact primary contractor to mobilise equipment as required Tentatively confirm work to remove fence around well pending well controls specialist advice upon arrival
Water used in well kill operations causing contamination	Bobcat and/or backhoe	Consider if application(s) of permits required to construct any in earth holding basin or water recovery trenches Contact primary contractor to mobilise equipment as required
Housekeeping – equipment on wellpad/lease	Crane/Forklift Truck	Contact primary contractor to mobilise equipment as required Clear lease as much as safely possible to allow access to wellhead considering equipment which may be required to solve well control situation
Loss of containment effecting nearby wells	Operations coordination	If other wells are nearby (ie on production pad), check wells are secure and check annuli on wells to ensure pressures haven't significantly changed
Water		
Insufficient water to respond to event - fire control and well kill	Water	Confirm an adequate water source close by See Appendix G for method to estimate water requirements

Inability to deliver sufficient water to site	Water trucks	Determine volume of water required for event See Appendix G for method to estimate water requirements Contact primary contractor to mobilise equipment as required
Inability to pump water required	Water pump(s) w/- suction & discharge hose	Contact primary contractor to mobilise equipment as required
Inability to store sufficient water at site	Onsite fluid storage tanks	Determine volume of water required for event See Appendix G for method to estimate water requirements Contract primary contractor to mobilise equipment as required
Logistics		
Inability to move heavy equipment around well	100 t Crane(s)	Contact primary contractor to mobilise equipment as required
Delay due to lack of road transport	Road transport	Contact primary contractor to mobilise equipment as required Sufficient road transport available to move required equipment (may need 24hr coverage)
Wellbore Fluids		
Gas	SCUF vent tank with generator to run same	Contact primary contractor to mobilise equipment as required
Return fluids	Storage tank	Contact primary contractor to mobilise equipment as required
Storage tank overflow	Vac trucks to remove fluid	Contact primary contractor to mobilise equipment as required
Well Kill/Isolation		
Inability to kill well	Mud or cementing pump with sufficient hard lines	Contact primary contractor to mobilise equipment as required
Inability to kill well	Fluid Storage/Mud Tank(s) with sufficient hard lines	Contact primary contractor to mobilise equipment as required
Hydrocarbon zone isolation	Cement unit, cement, additives and associated equipment	Contact primary contractor to mobilise equipment as required
Wellhead Equipment		
Isolation of well before side outlet valve removal	VR plug lubricator	Contact primary contractor to mobilise equipment as required
Surface facility isolations not in place	Origin Operator	Contact production operations to discuss situation
Specialised Services		
Inable to fabricate equipment	Machine shop	Contact primary contractor to mobilise equipment as required
Removal of equipment/fabrication	Welding services	Contact primary contractor to mobilise equipment as required
HSE		
HSE – hydrocarbon spill, uncontrolled release of well fluids into the air	Evaluate if any specialist HSE services are required (ie air sampling, radiation	Contact primary contractor to mobilise equipment as required

	assessment, noise assessment)	

C.11. Boots & Coots Well Control Package Specifications

The Boots & Coots Well Control Equipment package consists of eight (8) standardized and certified DMV steel containers. All containers are of the same standard size with a maximum weight of not more than 10,000 kg. The containers have been specially modified to meet the needs of the well control specialists and the equipment necessary to mitigate a reasonably forseeable well control event. Specifically the package consists of the following individual units.

The containers include the following equipment:

Container 1	**Workshop**
Container 2	**4000 gpm Water Pump #1**
Container 3	**4000 gpm Water Pump #2**
Container 4	**Pump Suction Piping**
Container 5	**Pump Discharge Piping/Nozzles**
Container 6	**Generator/ Casing Cutters**
Container 7	**Water Monitor Stands/ Tin**
Container 8	**Tool Shed**

Below are some photos of the equipment

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C.12. Sample Equipment List & Primary Support Contractors

Description	Qty	Contractor
Logistics support		
Trucking to transport 8 sea containers & support operation	8	
Crane, 25T to load/unload above sea containers	1	
D-8 or D-9 Caterpillar bulldozer w/ hydraulic winch	1	
D-8 or D-9 Caterpillar bulldozer w/ rippers	2	
Front end loader, large capacity rough terrain	1	
Track hoe, 235 Caterpillar or equivalent	1	
Bobcat	1	
Slasher	1	
Forklift	1	
150 ton Crawler crane w/ minimum of 100' boom (capping crane)	1	
40 – 60 ton hydraulic crane (for rigging up firefighting equipment)	2	
Tandem Rig up Truck/ Pole Truck	1	
Vacuum trucks (for hauling firewater or discharge from well)		
Water tankers	Calculate	
Refuelling/Lube truck (for refuelling heavy equipment, fire pumps)	1	
Road grader, Maintainer	1	
Transportation for workforce	1	
Self powered site office with toilet and fridge	1-2	
Digital radios	6	
Rental Equipment		
185 cfm air compressor	1	
Light plants, trailer mounted	4	
Generator	1	
Pressure washers	2	
4 wheelers, Kawasaki mules or alternative all-terrain vehicles		
Metal for Fabricating Support Equipment		
3' x 8' sheets corrugated tin	250	
Large diameter pipe for fire water supply line (12"-16")	1000 ft	
2" steel plate	1	
1" steel plate	2	
½" –5/8" steel plate	2	
2" x 2" x ¼" angle iron (Heat shields for bulldozers)	1500 ft	
3/16" or ¼" diamond plate, expanded metal or floor grating (flooring for monitor sheds, cutting sheds, etc.)	50	

2 3/8" or 2 7/8" junk tubing (structural for building monitor sheds, sheds, and heat shield)	2000 ft	
Casing for diverter lines	1	
General Oilfield Supplies		
8" Figure 100 hammer unions	6	
6" figure 100 hammer unions	6	
4" figure 100 hammer unions	12	
8" x12" pipe nipples, threaded both ends & collars	6	
6" x 12" pipe nipples, threaded both ends & collars	12	
4" x 12" pipe nipples, threaded both ends & collars	12	
4"wafer type butterfly valves	6	
4" 150# R.F. threaded flange	12	
5/8" x 6 ¼" studs w/ nuts both ends	50	
Tie wire	10 rolls	
3/8" x 15' high test chain w/ grab hooks (Crosby Brand & Load Binders)	20	
2" shackles, pinned	40	
1 ¾" shackles, pinned	40	
1 ½" shackles, pinned	40	
1 ¼" shackles, pinned	40	
1" shackles, pinned	40	
¾" shackles, pinned	40	
½" manila rope	1 roll	
¾" manila rope	1 roll	
200-psi liquid filled gauges	4	
600-psi liquid filled gauges	4	
1,000-psi liquid filled gauges	4	
3,000-psi liquid filled gauges	4	
5,000-psi liquid filled gauges	4	
10,000-psi liquid filled gauges	4	
Shop rags, Cotton Only (No Synthetic)	2 boxes	
Snatch blocks for 1 1/8" cable, shackled not hooked	2	
Heavy duty boards (to support pumps on water levy, scaffolding, etc.)	25	
Structural lumber (2 x 4's) for heat shields, road blocks, etc.		
Awning	1	
Specialised Oilfield Supplies		
Pit liner for fuel tank containment and potential water pits if utilized	1	
Tanks for water storage (frac tanks or the like), 450 bbl	Calculate	
Water pump with suction/discharge hose (one or two 4,000 gpm pumps)		

Mud or cementing pump(s) with hard lines		
SCUF vent tank with generator		
Tanks to store hydrocarbons		
VR plug lubricator		
500 ton travelling blocks (Used for rig removal)	2	
Mud charging pumps (to feed pump truck from frac tanks)	2	
Mud system, complete with mixing and circulating capabilities	1	
Cement		
Board mats	1	
High Pressure tubing, for pumping or cutting operation (to maintain good distance between well and pump trucks) size to be determined per requirement	1000 ft	
6" or 8" Drill Collars (Dead man to skid rig)	20	
Coil Tubing unit	1	
Snubbing Unit	1	
Cables, Slings & Clamps		
1 1/8" - 6 x 36-softlay cable (for rig removal)	2000 ft	
¾" - 6 x 36-softlay cable (slings for debris removal)	1000 ft	
5/8" - 6 x 36-softlay cable (slings for debris removal)	1000 ft	
1 1/8" cable clamps	100	
¾" cable clamps	100	
5/8" cable clamps	100	
1 ½" x 10' wire rope slings, 6 x 36 soft lay cable	10	
1 ¼" x 10' wire rope slings, 6 x 36 soft lay cable	20	
1 ¼" x 20' wire rope slings, 6 x 36 soft lay cable	20	
1" x 10' wire rope slings, 6 x 36 soft lay cable	20	
1" x 20' wire rope slings, 6 x 36 soft lay cable	20	
¾" x 10' wire rope slings, 6 x 36 soft lay cable	40	
¾" x 20' wire rope slings, 6 x 36 soft lay cable	40	
5/8" x 10' wire rope slings, 6 x 36 soft lay cable	40	
5/8" x 20' wire rope slings, 6 x 36 soft lay cable	40	
Welders, Machining and Associated Equipment		
Structural welders with helper and equipment	6	
Certified Welder with Helper and equipment	1	
Cutting torch complete with large supply of oxygen, acetylene and accessories, 250 ft. of hose per torch, strikers, tip cleaners and spare tips	4	
Long reach cutting torch, complete with large supply of oxygen, acetylene and accessories, 250 ft. of hose per torch, strikers, tip cleaners and spare tips	2	
Machine shop services for fabrication		

HSE		
HSE services (air sampling, heat radiation monitoring, noise monitoring)		

C.13. Water Requirements

The most important step when controlling a level 3 incident is establishing a water supply which is plentiful and consistent. Surface intervention of a blowout requires massive volumes of water. Well Control specialists will determine pumping, volume of water required onsite and ongoing water requirements.

If water cannot be stored in ground pits, water shall be stored on location utilizing multiple manifolded 450 barrel portable frac tank containers. Combined storage capacity up to 2,000,000 million gallons may be required (subject to confirmation). Origin shall consider the requirements for application(s) of any permits required to construct any in earth holding basin or water recovery trenches. It is critical to the safety of the well control crews and ultimate success of the well control mitigation that water supply remain uninterrupted. Water from the storage tanks will be piped to the fire pump(s) and distributed to fire monitor stands and hand lines as deemed appropriate by the well control specialist.

Water volume requirements vary from one blowout to another. For example, only one pump would be required for a minor fire (with backup pump circulating water as a redundant system) for a minor fire, whereas two or more pumps would be required for a major rig fire, thus doubling the water volume required. Typically, a benchmark of 2,000,000 gallons per day (48,000 bbls per day) is used in the Well Control Contingency Plan (WCCP) calculations.

A well on fire requires a tremendous volume of water. For example, the following calculations show how fast 1,000,000 gallon (24,000 bbls) pit would be emptied using various capacity fire pumps:

- 1,000,000 gallons/(4,000 gpm + 4,000 gpm) = 125 minutes

Water Supply Calculations – Using Tankers Only

Before mobilising water storage tanks and water to site, liaise with Boots and Coots to determine likely water requirements. Below are sample calculations only based on a worst case scenario.

The following calculations gives the number of tanker loads needed to replenish the pit with water:

- $1m^3$= 6.29 bbls
- $24m^3$ tanker capacity x 6.29 bbls/m^3=150 bbls
- 24,000 bbls/150 bbls per load= 160 tanker loads

The following calculation factors in a water recovery rate of 30%:

160 tanker loads x (1.0-.3) = 112 tanker loads.

Using the two minimum 4,000 gpm fire pumps, it would require 61 tanker loads per hour to maintain operations.

With a remote pit containing an additional 1,000,000 gallon capacity for a total of a 2,000,000 gallon capacity (48,000 bbls), operations could be maintained for four (4) hours using two 4,000 gpm pumps. The flowing calculations gives tanker load totals for 10 hours of winter time daylight operations:

- (10 hours operations) – (4 hours water supply on hand) = 6 hours additional water supply needed
- (6 hours) x (61 tanker loads per hour) = 366 tanker loads
- (366 tanker loads) / (10 hours) = 37 tanker loads per hour

37 tanker loads per hour, although cumbersome, is far more manageable than 61 tanker loads per hour. However, using the above calculation, at the end of 10 hours the pits will be dry. The following calculation gives the tanker loads per hour to overnight replenish the 2,000,000 gallons (48,000 bbls):

- 48,000 bbls / 150 per load = 320 tanker loads
- 24 hours – 10 hours daylight operations = 14 hours to refill pits
- 320 tanker loads / 14 hours = 23 tanker loads per hour overnight

C.14. Site Safety/Site Control

If a severe level 3 well control incident occurs, the OSC, SERT-L, HSE and Well Control Specialist will develop a Site Safety Plan and enforce it immediately.

The plan will identify the hazards present on site and will define Site Control boundaries, including SAFE AREA and HOT ZONE boundaries, and control access to the incident site. Common hazards to health and safety on a blowout include:

- Radiant Heat
- Explosive and/or toxic gas concentrations
- Explosive materials (perforating charges, prima cord, etc.)
- Compressed substances (acetylene, oxygen, aerosols, etc.)
- Hazardous chemicals
- Dangerous noise levels
- Structural damage
- Leaking gas or fluids

Such a plan would only be developed for Level 3 well control incidents where deemed necessary.

Appendix D Site Specific Lease Pads with Associated Wells

D.1. Location data – Existing Exploration Wells / Lease pads

Permit Area(s)	EP98
Exploration Well name	Kalala South (existing)
Associated Water Bores	N/A
Well/Lease location (Lat/Long)	-16° 17' 37.7" S / 133° 36' 44.3" E -16.2941, 133.6124 (GDA94) E: 351740, N: 8198023 (MGA Zone 53)
Nearest Town by Vehicle	Daly Waters
Nearest Major Road	Carpentaria Highway
Nearest Airports by Vehicle	Daly Waters: 25 min/25km Elliot: 2hrs / 165 km
Nearest Hospital by Vehicle	Katherine Hospital 3hrs drive (299km)
Permit Area(s)	EP117
Exploration Well name/s	Beetaloo West - 1 (existing) Kyalla 117 W1 (proposed second well on same lease)
Associated Wells on location	N/A
Well/Lease location (Lat/Long)	-17° 7'13.82"S / 133°45'43.63"E -17.12051, 133.7621 (GDA94) E: 368312, N: 8106689 (MGA Zone 53)
Nearest Town	Elliot
Nearest Major Road	Stuart Highway
Nearest Airport by Vehicle	Daly Waters: 1.5hrs/100km Elliot: 1.75hrs,110km
Nearest Hospital by Vehicle	Katherine Hospital: 4hrs drive (399km)
Permit Area(s)	EP98
Exploration Well name/s	Amungee North West-1H (existing) Velkerri 98 N1 (proposed second well on same lease)
Associated wells	VEL 98 N1 – CMB-G (RN40894)
Well/Lease location (Lat/Long)	-16°20'51.034"S / 133°53'4.403"E -16.34751, 133.8846 (GDA94) E: 380859, N: 8192292 (MGA Zone 53)
Nearest Town by Vehicle	Daly Waters
Nearest Major Road	Carptentaria Highway
Nearest Airport by Vehicle	Daly Waters: 1hr /61km Elliot 2.5hrs /202km
Nearest Hospital by Vehicle	Katherine Hospital: 3.5hrs drive (329km)
Permit Area(s)	EP117
Exploration Well name	Kyalla 117 N2 1H (existing)
	Kyalla 117 N2-2H and 3H- (proposed)

Associated Wells (water bores)	KYA117-N2 CMB (RN40895) KYA117-N2 CMB-AL (RN40896) KYA117-N2 CMB-G (RN41132) KYA117-N2 IMB-AL (R041137) KYA117-N2 IMB-G (RN041136)
Well/Lease location (Lat/Long)	-16°50' 29.01"S; 133°39' 0.16"E -16.84141, 133.6501 (GDA94) E: 356183, N: 8137492 (MGA Zone 53)
Helicopter Landing Pad	16.836500 S 133.658333 E Zone 53 K
Nearest Town by Vehicle	Daly Waters
Nearest Major Road	Stuart Highway
Nearest Airport by Vehicle	Daly Waters: 1hr /92 km Elliot: 1.5hrs /117 km
Nearest Hospital by Vehicle	Katherine Hospital: 4.5hrs drive (365km)
Permit Area(s)	EP76
Exploration Well name	Velkerri 76 S2 (to be drilled stage 2 in 2021)
Associated Wells (water bores)	VEL76-S2CMB-AL (RN41133) VEL76-S2CMB-G (RN41134) VEL98-N1 CMB-G (RN040894)
Well/Lease location (Lat/Long)	-16°51' 20.13"S; 134°23' 39.85"E -16.85571, 134.3939 (GDA94) E: 435432, N: 8136301 (MGA Zone 53)
Helicopter Landing Pad	16.856275S 134.395751 E Zone 53K
Nearest Town by Vehicle	Daly Waters
Nearest Major Road	Stuart Highway
Nearest Airports by Vehicle	Daly Waters: 2.5 hr /190 km Elliot: 3.0 hrs /198 km
Nearest Hospital by Vehicle	Katherine Hospital: 5.5 hrs drive (442km)

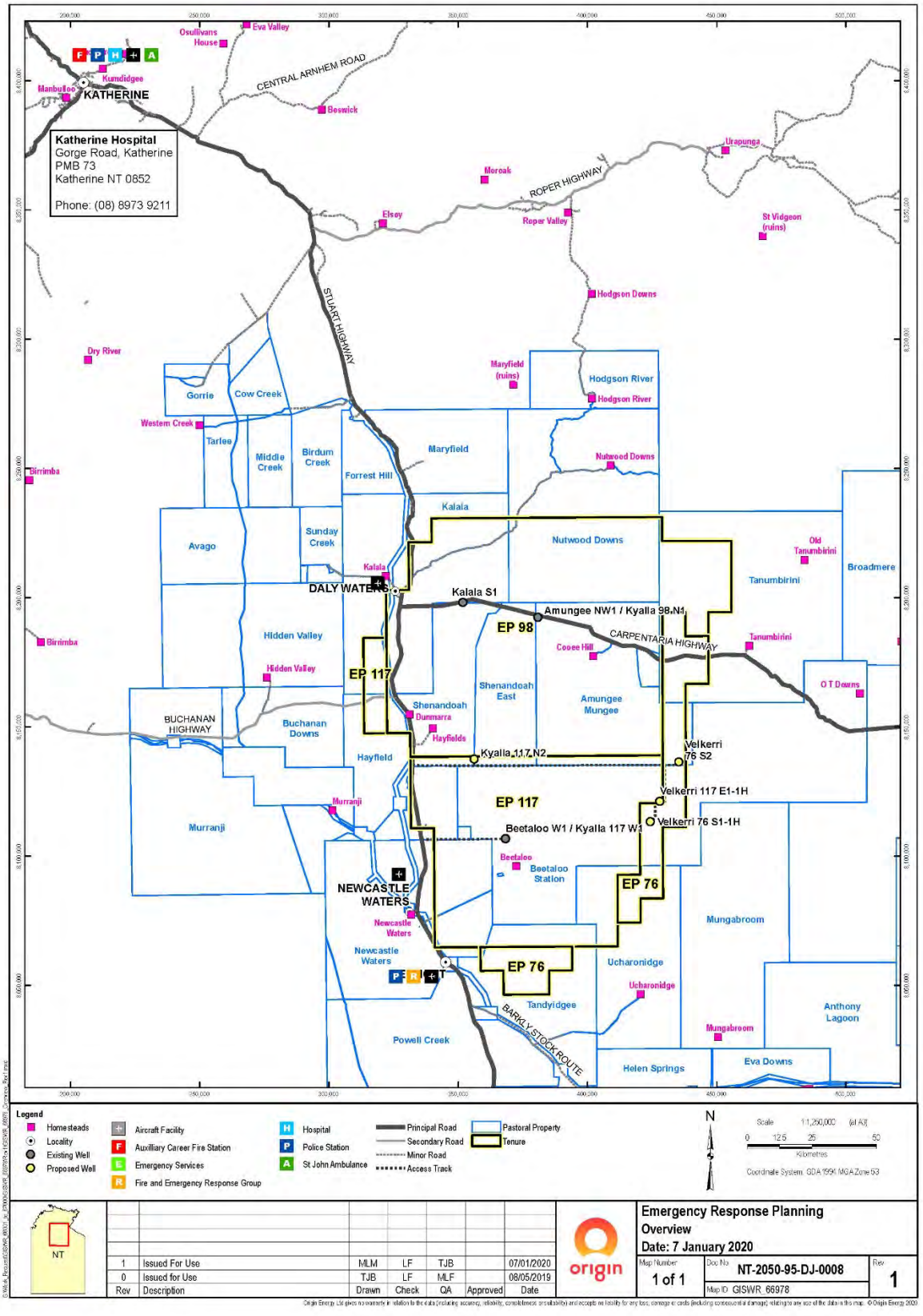
D.2. Location data – Proposed Exploration Wells / Lease pads

Permit Area(s)	EP117
Exploration Well name	Velkerri 117 E1 (proposed)
Associated Wells	TBD
Well/Lease location (Lat/Long)	-16°59' 35.50" S, 134°19' 26.21" E -16.993194, 134.323948 (GDA94) E: 428034.8, N: 8121074 (MGA Zone 53)
Nearest Town by Vehicle	Daly Waters
Nearest Major Road	Stuart Highway
Nearest Airports by Vehicle	Daly Waters: 3 hr / 190 km Elliot: 3.0 hrs /194 km
Nearest Hospital by Vehicle	Katherine Hospital: 5.5 hrs drive (452km)

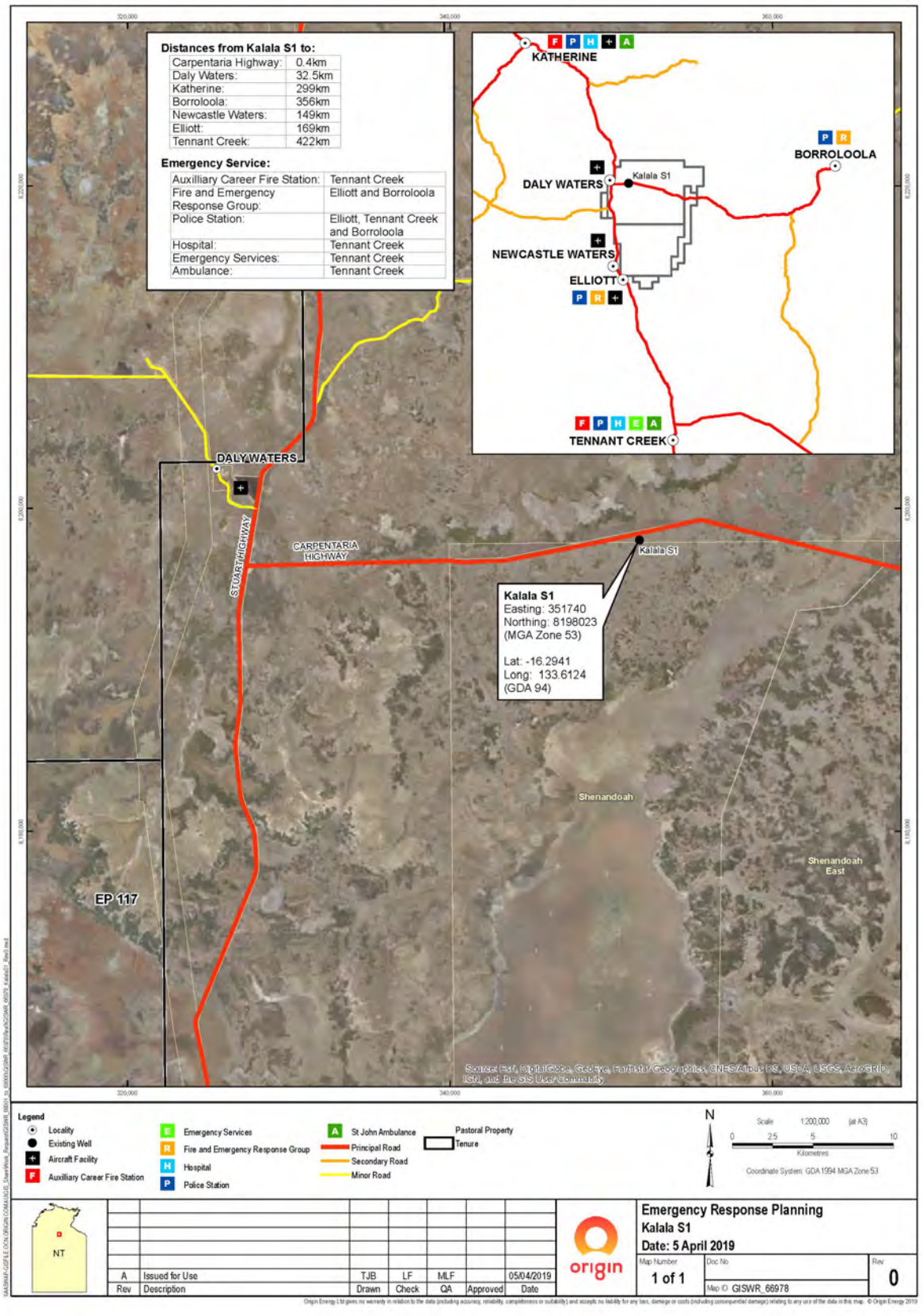
Permit Area(s)	EP 76
Exploration Well name	Velkerri 76 S1 (proposed)
Associated Wells	TBD
Well/Lease location (Lat/Long)	-17°3' 48.91" S, 134°17' 21.05" E -17.063587, 134.28918 (GDA94) E: 424362, N: 8113273 (MGA Zone 53)
Nearest Town by Vehicle	Daly Waters
Nearest Major Road	Stuart Highway
Nearest Airports by Vehicle	Daly Waters: 3.15 hr / 194 km Elliot: 3.15 hrs /204 km
Nearest Hospital by Vehicle	Katherine Hospital: 6 hr drive (462km)

D.3. Emergency Response Locality maps

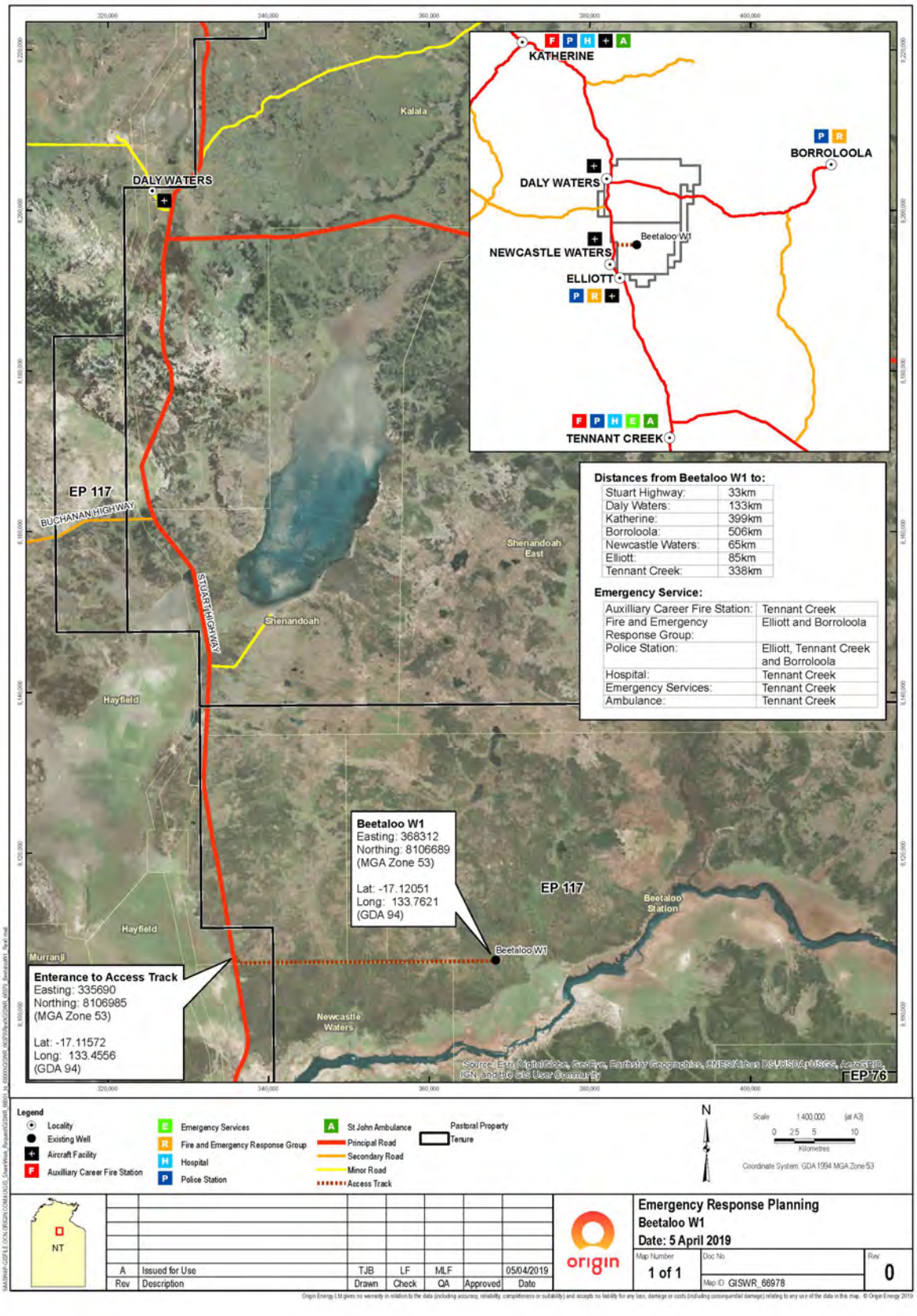
Overview maps for all existing and proposed petroleum wells



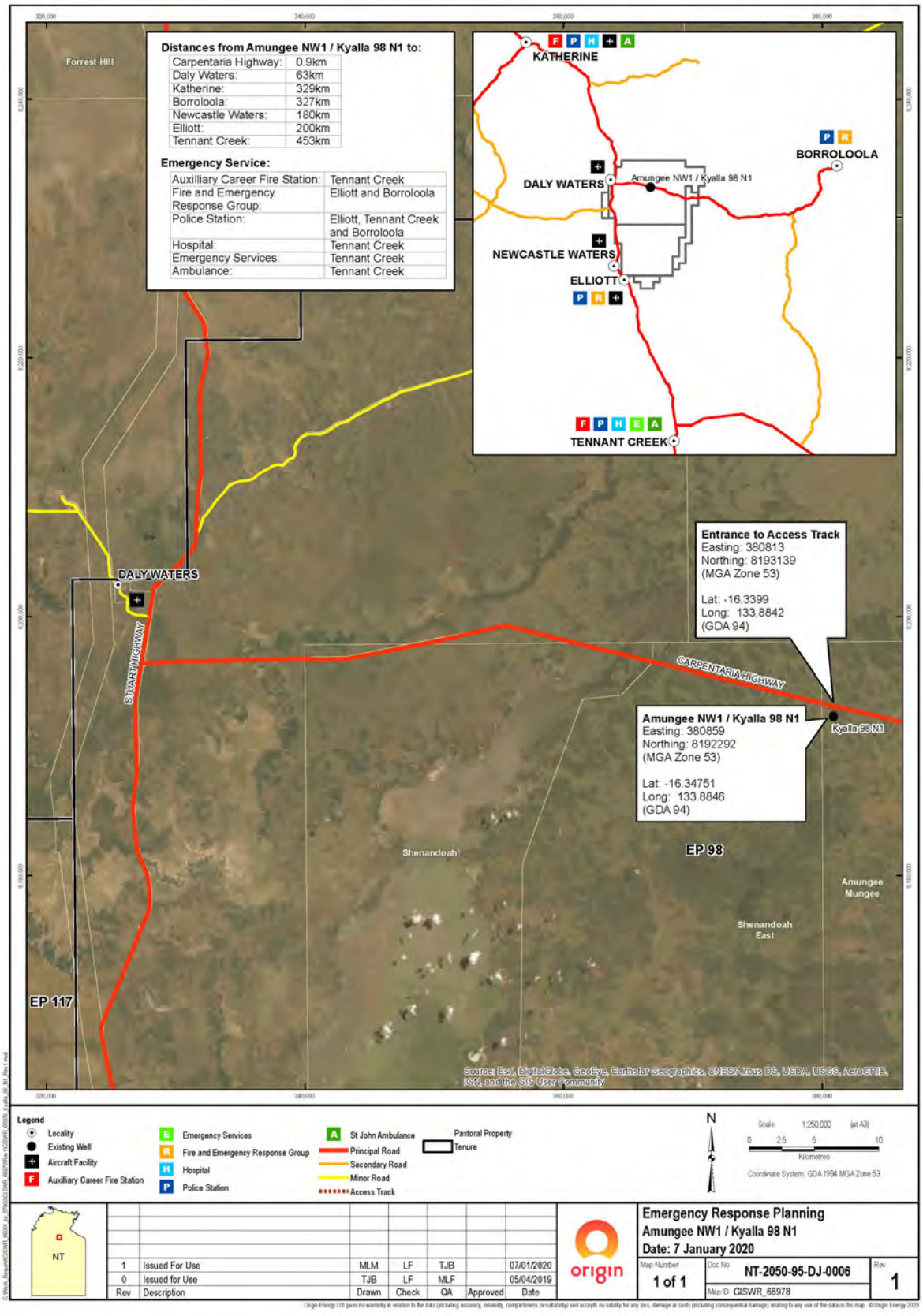
D.3.1 Kalala S1 – Emergency Response Planning Map



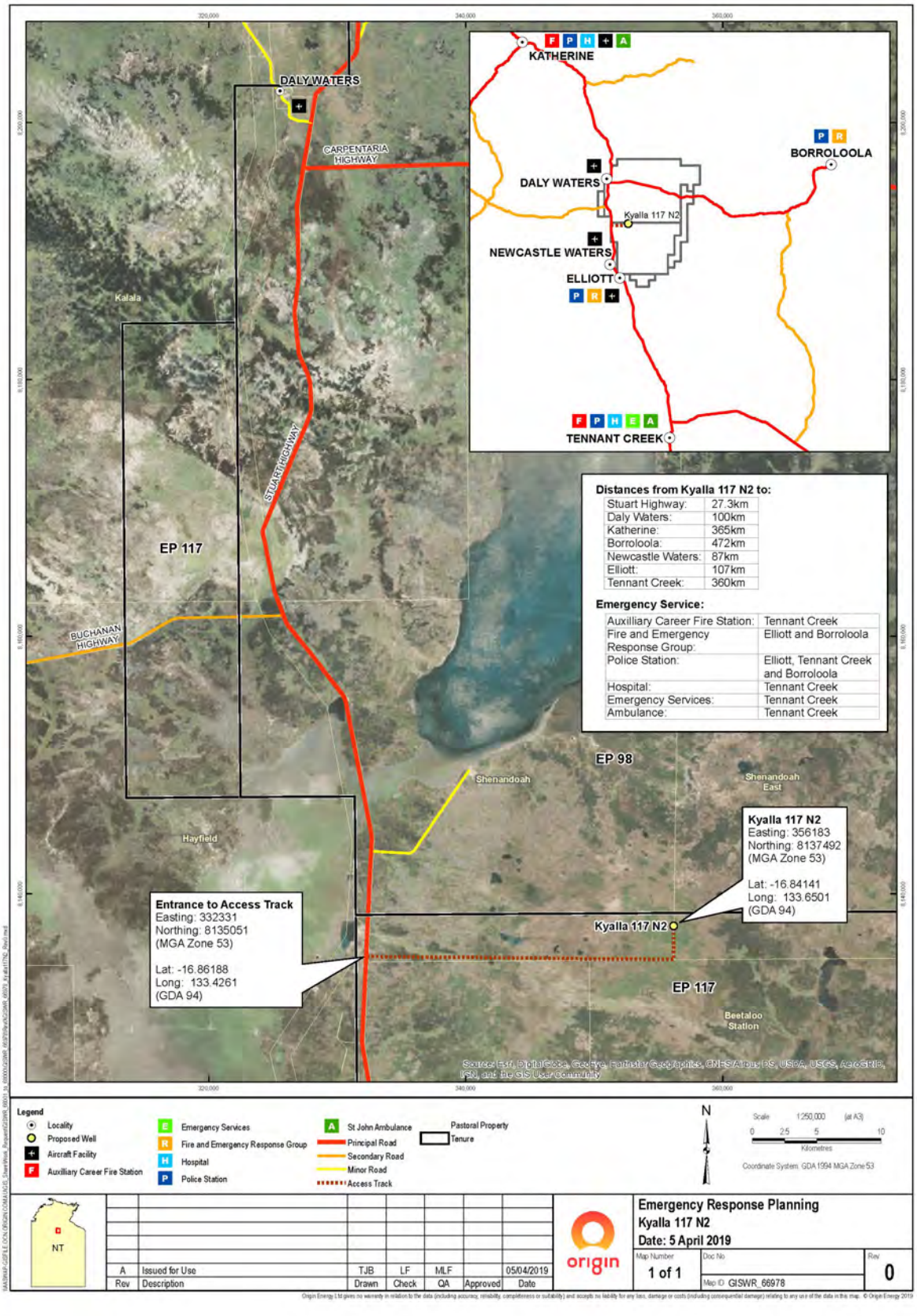
D.3.2 Beetaloo W1 – Emergency Response Planning Map



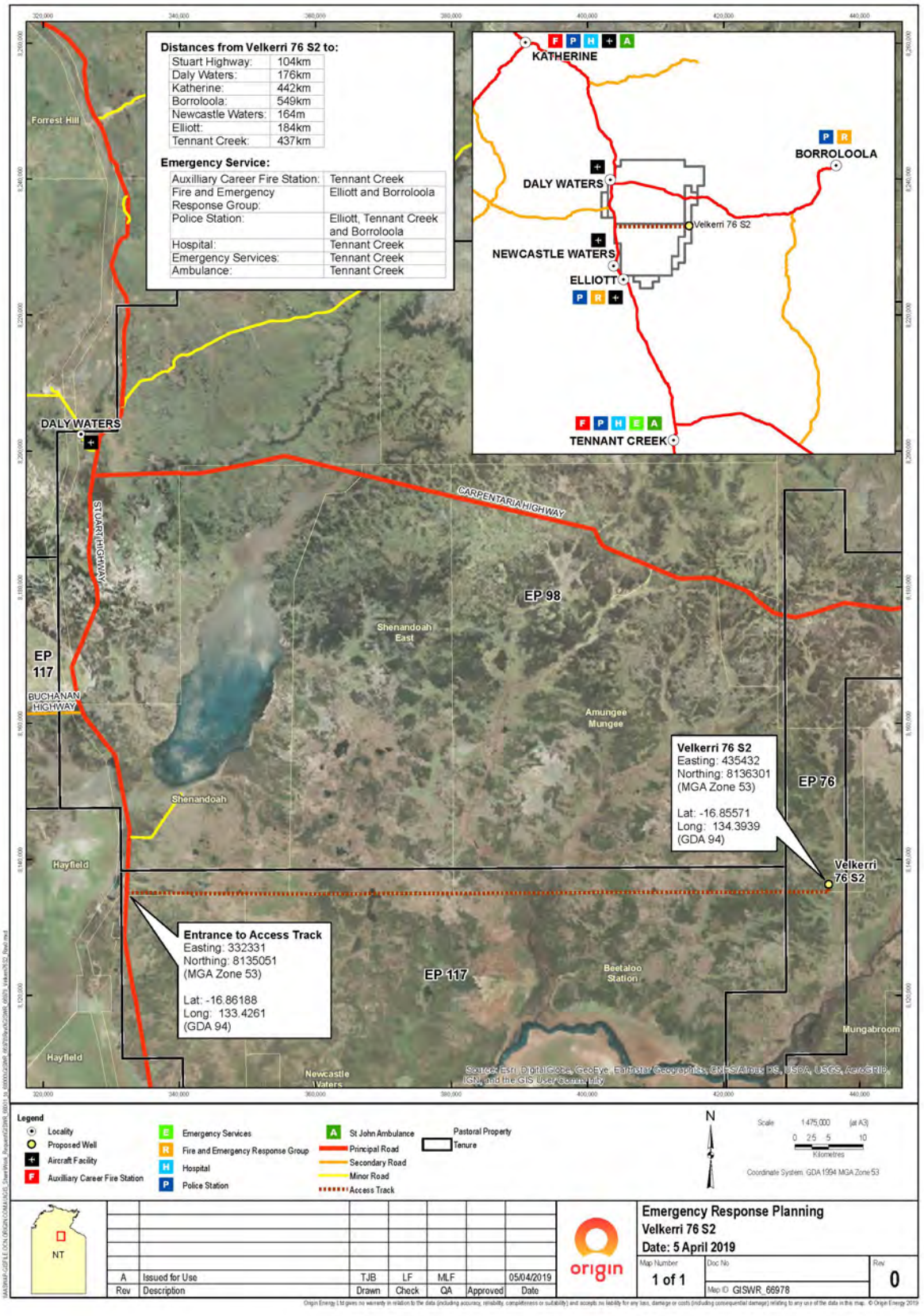
D.3.3 Amungee NW 1H / Kyalla 98 N1 – Emergency Response Planning Map



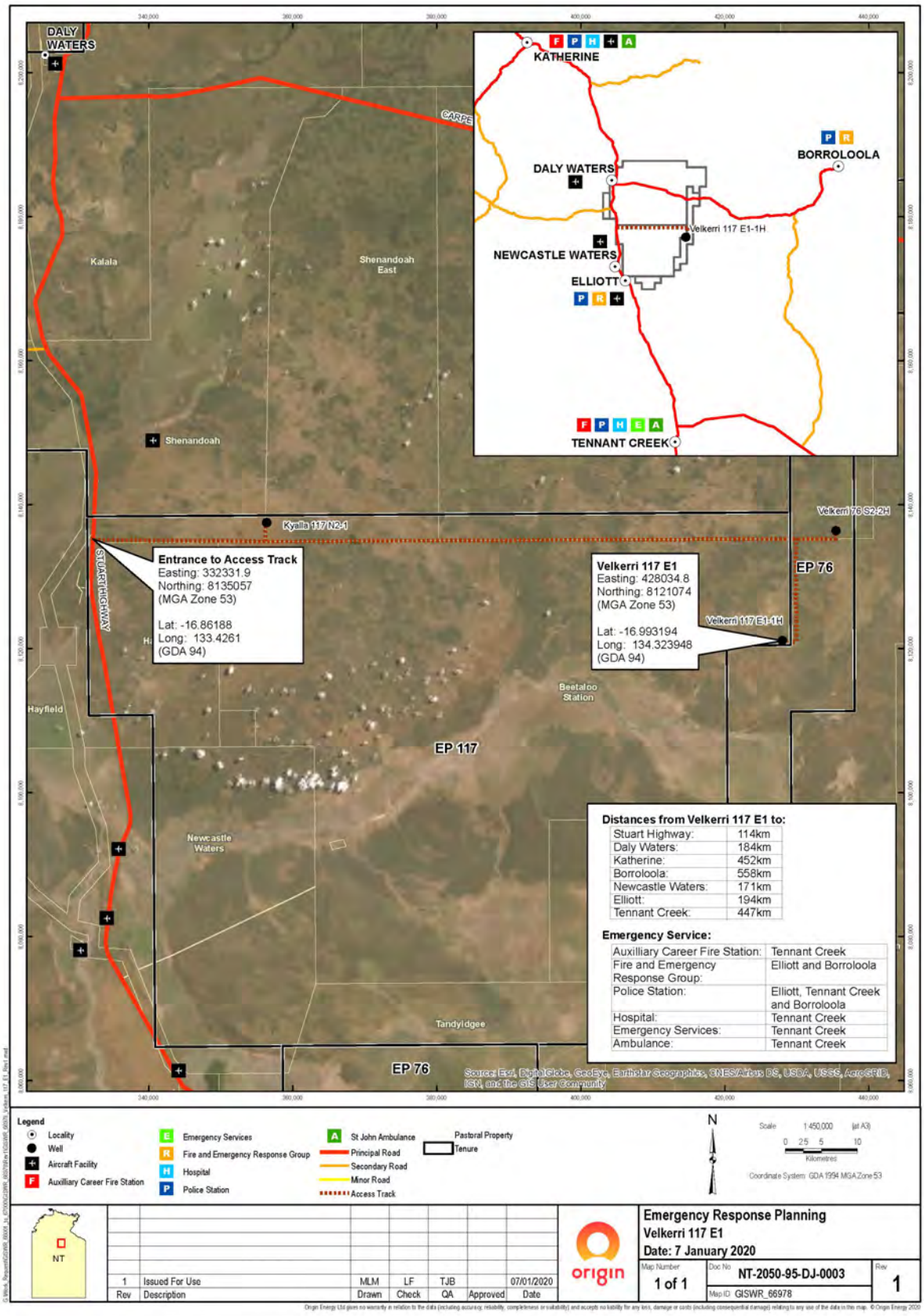
D.3.4 Kyalla 117 N2 – Emergency Response Planning Map



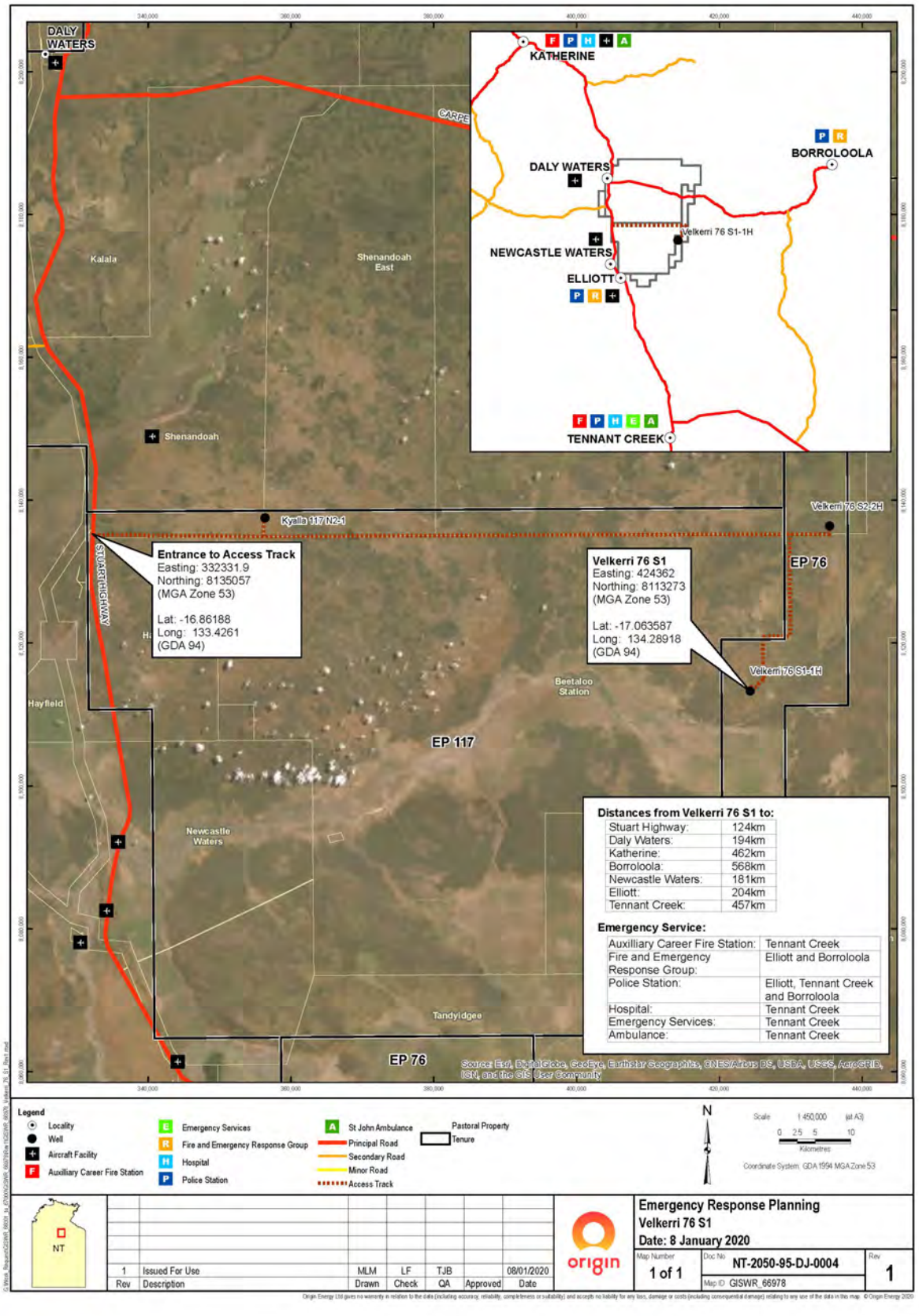
D.3.5 Velkerri 76 S2 – Emergency Response Planning Map



D.3.6 Velkerri 117 E1 – Emergency Response Planning Map



D.3.7 Velkerri 76 S1 – Emergency Response Planning Map



Appendix E Bushfire Management Plans (BMP) – Wellsites

E.1. Kyalla 117 N2 – Bushfire Management Plan

Exploration Permit 117

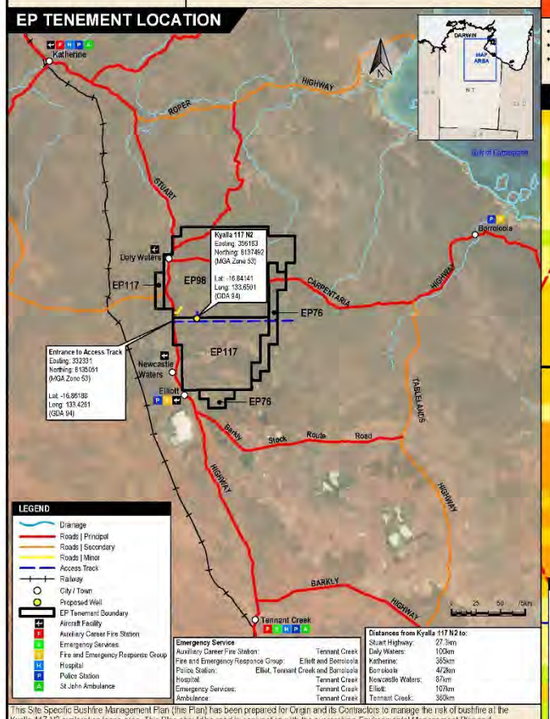
Bushfire Management Plan 2019/2020

Kyalla 117 N2 Lease

Location of Kyalla 117 N2

Property land uses	Gas exploration and cattle grazing
Site fire management aim	To reduce the occurrence of, and minimise the impact of bushfires, thereby reducing the threat to life, property, cultural values and the environment.
Site fire management objectives	Mitigate the potential impact of unplanned fires on Origin's people, assets and operations and neighbouring land uses.

EP TENEMENT LOCATION



This Site Specific Bushfire Management Plan (this Plan) has been prepared for Origin and its Contractors to manage the risk of bushfire at the Kyalla 117 N2 exploration lease area. The Plan should be read in conjunction with the overarching *Environmental Management Plan* and *Emergency Response Plans* for Origin's operations in the Beetaloo Basin.

Appendix A Site Specific Bushfire Management Plan (this plan) / Version 1/ 5 December 2019

Origin Fire Officer	Contact Details	Name
	[redacted]	Robert Wear

Properties	Contact Details	Name
Amungee Mungee Station	[redacted]	Adrian Brown
Kalala Station	[redacted]	Andrew Scott
Hayfield Station	[redacted]	Justin & Sally Dyer
Beetaloo Station	[redacted]	Scotty & Jane Armstrong

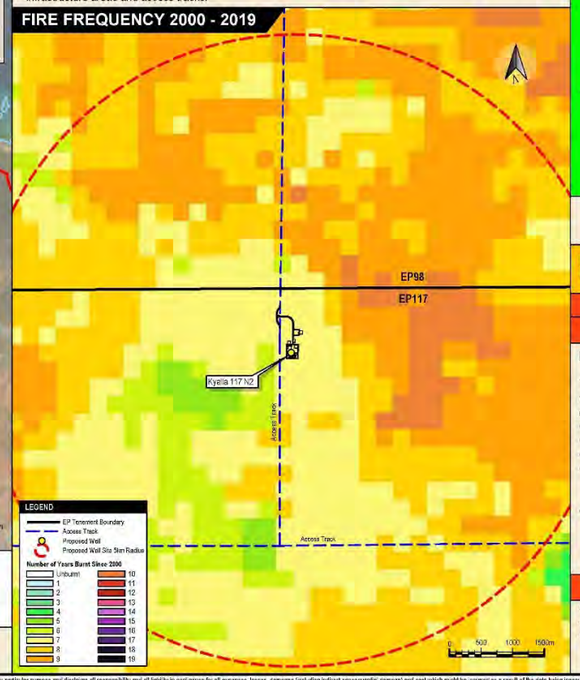
Offsite Stakeholders	Contact Details	Name
Volunteer Bushfire Brigades	08 8975 9936	
National Response Centre	1800 076 251	24/7 contract line
Emergency	000 or 112 mobile	
Bushfire NT Katherine office	08 8973 8873 08 8973 8871	Troy Munckton
Bushfire NT Head office	08 8922 0840 bushfires.nt@nt.gov.au 08 8922 0844	Mark Gardner
NAFI North	https://www.firenorth.org.au/nafi3/	
Secure NT (Fire Bans)	https://securent.nt.gov.au/alerts	
Fire incident map	https://www.pfes.nt.gov.au/incidentmap/	

Fire Frequency 2000-2019

Fire management risks

- Ignitions (humans and lightening) on or off site resulting in harm to workers and loss of equipment.
- Fire scar mapping indicates the exploration area burns approximately every 3 years.
- Spread of high fuel load grassy weeds could increase fire intensity, eg gamba, grader and buffel grass, adjacent infrastructure areas and access tracks.

FIRE FREQUENCY 2000 - 2019



Annual Works Calendar

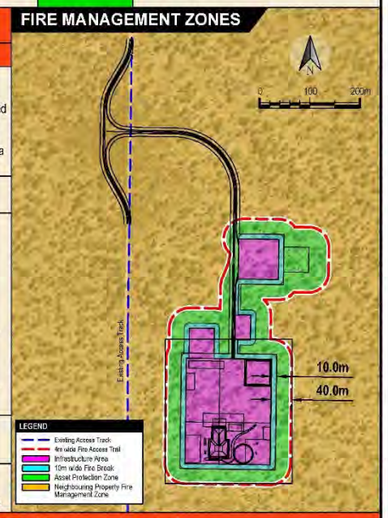
Month	Bushfire Risk	Action	Month	Bushfire Risk	Action
Jan	Low	• No fire management activity.	July	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Feb	Low	• Manage vegetation onsite including weeds.	Aug	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Mar	Low	• Planning meeting with neighbour. • Manage vegetation onsite including weeds. • Manage fire break and fire access trail.	Sept	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Apr	Low	• Manage vegetation onsite including weeds.	Oct	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
May	Low	• Manage vegetation onsite including weeds.	Nov	Medium	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
June	Medium	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.	Dec	Low	• No fire management activity.

Kyalla 117 N2 Fire Management Zones

Bushfire Management Actions

Infrastructure area	• Remove all vegetation. • Treat emerging vegetation with herbicide. • A permit for open flaring and hot works is required during a declared fire danger period. • Open flaring and hot works are not permitted on total fire ban days without written approval from a fire control officer or fire warden.
Fire management break	• Maintain a 10 m wide bare earth loop road around the infrastructure area.
Asset Protection Zone (APZ)	• During operations, establish a 40 m wide APZ around the infrastructure area by removing woody understorey vegetation and achieving a grass height of < 100 mm using the methods prescribed in the *Origin Generic bushfire asset protection zone guide*. • Maintain grass cover to a height < 100 mm. • Remove vegetation from the 10 m wide fire break around the infrastructure area. Monitor for grassy weeds and control where appropriate. • Ensure a 4m wide fire access trail around the perimeter of the asset protection zone is trafficable by fire fighting appliances. Monitor for grassy weeds and control where appropriate.
Fire access trails	• Create and maintain a 4m wide access trail around the perimeter of the asset protection zone by grading or spraying.
Neighbouring Property Fire Management Zone	• Annual fire management planning meeting with neighbouring properties. • Neighbour to advise proponent of planned burns.

FIRE MANAGEMENT ZONES



Bushfire Preparedness - refer to *IG Bushfire preparedness tool*

Preparedness Planning

Mandatory for all Severe, Extreme and Catastrophic FDI days

The following must be reviewed daily. If fire alerts are active or presenting with a known risk (fire in the area), personnel must execute their contingency plans which need to encompass the following:

- Procedure on identifying and notifying of a bushfire.
- Critical equipment to be removed / isolated / shut down.
- Safe evacuation routes from site and muster points.
- Communication methods:
  - Team channels and / or phone numbers.
  - Area channels and / or phone numbers.
- Closest 'Safe Havens' (Community or Origin permanent sites).

Monitoring Routine

- Provide timely advice on changes in level of fire risk as available.
- Monitor team and area common channels for bushfire early warning.
- Update changes in work location.

Bushfire First Responder Checklist

The following sequence must be followed by the first person responding to a fire:

1. **Danger** - Remove yourself and others from danger is safe to do so.
2. **Alarm** - Raise the Alarm either on common radio channel or other agreed process.
3. **Gather information**
   - **Location** - Direction from known reference points, eg roads and Origin infrastructure such as well numbers).
   - **Impacts** (actual and potential) - Life, property and the environment.
   - **Fire Characteristics** - Grass or woodlands, flame height, fire front and direction of travel.
   - **Weather** - Wind strength and direction.
   - **Response in Progress** - What response is underway and by who (Origin, Landowners or Emergency Services).
   - **Response required** - Origin and / or Emergency Services.
   - **Access** - Safe access and egress routes.
4. **Notify Origin** - Fire officer / Supervisor.
5. **Notify Pastoralists** - Refer to Property Contacts.
6. **Notify Emergency Services** - Call "000" or "112" (some mobiles) if Origin and Pastoralists unable to manage situation.
7. **Respond** - if safe to do so in consultation with Pastoralist.
8. **Handover** - to the Origin On-Scene Commander / Pastoralist of Emergency Services on arrival.
9. **Support** - provide ongoing support to the response as appropriate.

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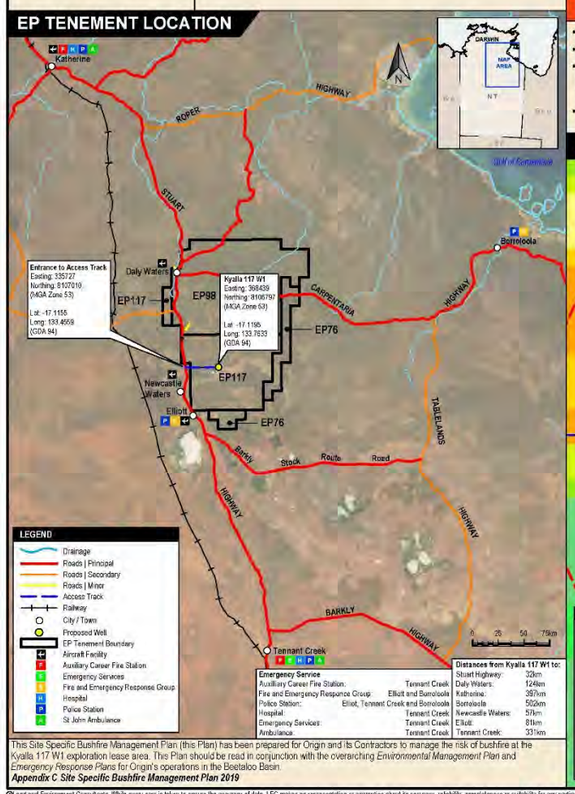
E.2. Beetaloo W1 / Kyalla 117 W1 – Bushfire Management Plan

Exploration Permit 117
Bushfire Management Plan 2019/2020
Kyalla 117 W1 Lease

Location of Kyalla 117 W1	
Property land uses	Gas exploration and cattle grazing
Site fire management aim	To reduce the occurrence of, and minimise the impact of bushfires, thereby reducing the threat to life, property, cultural values and the environment.
Site fire management objectives	Mitigate the potential impact of unplanned fires on Origin's people, assets and operations and neighbouring land uses.

EP TENEMENT LOCATION



Emergency Service	
Auxiliary Career Fire Station:	Tennant Creek
Fire and Emergency Response Group:	Elliott and Borroloola
Police Station:	Elliot, Tennant Creek and Borroloola
Hospital:	Tennant Creek
Emergency Services:	Tennant Creek
Ambulance:	Tennant Creek

Distances from Kyalla 117 W1 to:	
Stuart Highway:	32km
Daly Waters:	124km
Katherine:	397km
Borroloola:	502km
Newcastle Waters:	57km
Elliott:	81km
Tennant Creek:	331km

This Site Specific Bushfire Management Plan (this Plan) has been prepared for Origin and its Contractors to manage the risk of bushfire at the Kyalla 117 W1 exploration lease area. This Plan should be read in conjunction with the overarching *Environmental Management Plan* and *Emergency Response Plans* for Origin's operations in the Beetaloo Basin.
Appendix C Site Specific Bushfire Management Plan 2019

Origin Fire Officer	Contact Details	Name
	[redacted]	Robert Wear

Properties	Contact Details	Name
Amungee Mungee Station	[redacted]	Adrian Brown
Kalala Station	[redacted]	Andrew Scott
Hayfield Station	[redacted]	Justin & Sally Dyer
Beetaloo Station	[redacted]	Scotty & Jane Armstrong

Offsite Stakeholders	Contact Details	Name
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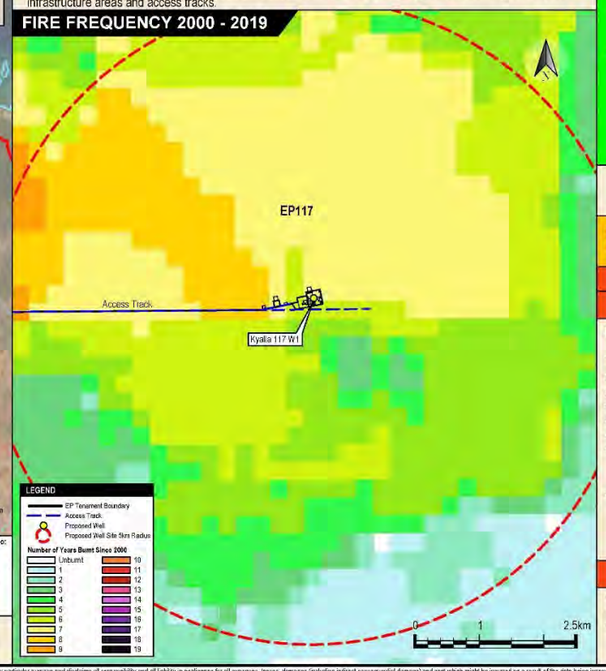
NAFI North	https://www.firenorth.org.au/nafi3/	
Secure NT (Fire Bans)	https://securent.nt.gov.au/alerts	
Fire incident map	https://www.pfes.nt.gov.au/incidentmap/	

Fire Frequency 2000-2019

Fire management risks

- Ignitions (humans and lightening) on or off site resulting in harm to workers and loss of equipment.
- Fire scar mapping indicates the exploration area burns approximately every 3 years.
- Bullwaddy and Lancewood vegetation communities occur within the vicinity of the infrastructure area and are fire sensitive. Hot fires have the ability to reduce habitat quality for both flora and fauna species which utilise these vegetation communities.
- Spread of high fuel load grassy weeds could increase fire intensity, eg gamba, grader and buffel grass, adjacent infrastructure areas and access tracks.

FIRE FREQUENCY 2000 - 1999



Annual Works Calendar

Month	Bushfire Risk	Action	Month	Bushfire Risk	Action
Jan	Low	• No fire management activity.	July	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Feb	Low	• Manage vegetation onsite including weeds.	Aug	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Mar	Low	• Planning meeting with neighbour. • Manage vegetation onsite including weeds. • Manage fire break and fire access trail.	Sept	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Apr	Low	• Manage vegetation onsite including weeds.	Oct	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
May	Low	• Manage vegetation onsite including weeds.	Nov	Medium	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
June	Medium	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.	Dec	Low	• No fire management activity.

Kyalla 117 W1 Fire Management Zones

Bushfire Management Actions	
Infrastructure area	• Remove all vegetation. • Treat emerging vegetation with herbicide. • A permit for open flaring and hot works is required during a declared fire danger period. • Open flaring and hot works are not permitted on total fire ban days without written approval from a fire control officer or fire warden.
Fire management break	• Maintain a 10 m wide bare earth loop road around the infrastructure area.
Asset Protection Zone (APZ)	• During operations, establish a 40 m wide APZ around the infrastructure area by removing woody understorey vegetation and achieving a grass height of < 100 mm using the methods prescribed in the *Origin Generic bushfire asset protection zone guide*. • Maintain grass cover to a height < 100 mm. • Remove vegetation from the 10 m wide fire break around the infrastructure area. Monitor for grassy weeds and control where appropriate. • Ensure a 4m wide fire access trail around the perimeter of the asset protection zone is trafficable by fire fighting appliances. Monitor for grassy weeds and control where appropriate.
Fire access trails	• Create and maintain a 4m wide access trail around the perimeter of the asset protection zone by grading or spraying.
Neighbouring Property Fire Management Zone	• Annual fire management planning meeting with neighbouring properties. • Neighbour to advise proponent of planned burns.

FIRE MANAGEMENT ZONES

Bushfire Preparedness - refer to *IG Bushfire preparedness tool*

Preparedness Planning

Mandatory for all Severe, Extreme and Catastrophic FDI days

The following must be reviewed daily. If fire alerts are active or presenting with a known risk (fire in the area), personnel must execute their contingency plans which need to encompass the following:
- Procedure on identifying and notifying of a bushfire.
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- Safe evacuation routes from site and muster points.
- Communication methods:
  - Team channels and / or phone numbers.
  - Area channels and / or phone numbers.
- Closest 'Safe Havens' (Community or Origin permanent sites).

Monitoring Routine

- Provide timely advice on changes in level of fire risk as available.
- Monitor team and area common channels for bushfire early warning.
- Update changes in work location.

Bushfire First Responder Checklist

The following sequence must be followed by the first person responding to a fire:
1. **Danger** - Remove yourself and others from danger is safe to do so.
2. **Alarm** - Raise the Alarm either on common radio channel or other agreed process.
3. **Gather information**
   - **Location** - Direction from known reference points, eg roads and Origin infrastructure such as well numbers).
   - **Impacts** (actual and potential) - Life, property and the environment.
   - **Fire Characteristics** - Grass or woodlands, flame height, fire front and direction of travel.
   - **Weather** - Wind strength and direction.
   - **Response in Progress** - What response is underway and by who (Origin, Landowners or Emergency Services).
   - **Response required** - Origin and / or Emergency Services.
   - **Access** - Safe access and egress routes.
4. **Notify Origin** - Fire officer / Supervisor.
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7. **Respond** - if safe to do so in consultation with Pastoralist.
8. **Handover** - to the Origin On-Scene Commander / Pastoralist of Emergency Services on arrival.
9. **Support** - provide ongoing support to the response as appropriate.

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E.3. Velkerri 76 S2 – Bushfire Management Plan

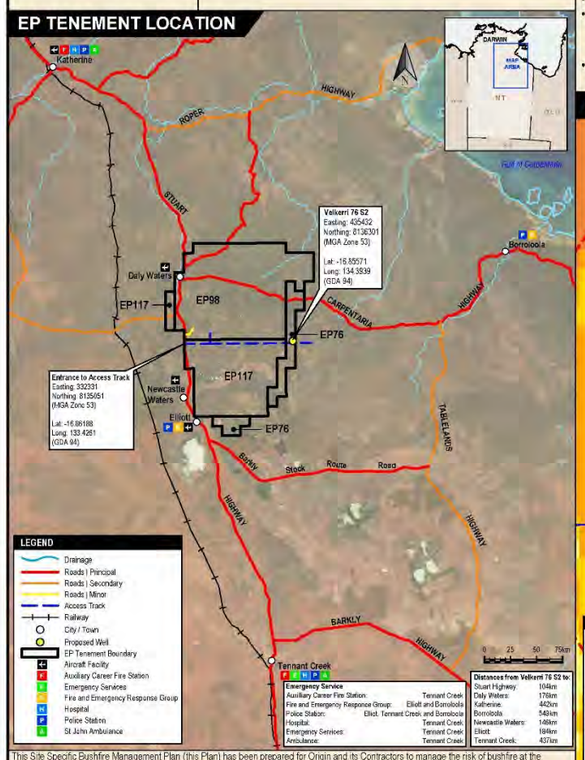
Exploration Permit 76

Bushfire Management Plan 2019/2020

Velkerri 76 S2 Lease

Location of Velkerri 76 S2	
Property land uses	Gas exploration and cattle grazing
Site fire management aim	To reduce the occurrence of, and minimise the impact of bushfires, thereby reducing the threat to life, property, cultural values and the environment.
Site fire management objectives	Mitigate the potential impact of unplanned fires on Origin's people, assets and operations and neighbouring land uses.

EP TENEMENT LOCATION



This Site Specific Bushfire Management Plan (this Plan) has been prepared for Origin and its Contractors to manage the risk of bushfire at the Velkerri 76 S2 exploration lease area. This Plan should be read in conjunction with the overarching *Environmental Management Plan* and *Emergency Response Plans* for Origin's operations in the Beetaloo Basin.

Appendix B Site Specific Bushfire Management Plan (this plan) / Version 1/ 5 December 2019

	Contact Details	Name
Origin Fire Officer	[redacted]	Robert Wear

Properties	Contact Details	Name
Amungee Mungee Station	[redacted]	Adrian Brown
Tanunbirini Station	[redacted]	Mick Tasker
Beetaloo Station	[redacted]	Scotty & Jane Armstrong

Offsite Stakeholders	Contact Details	Name
Volunteer Bushfire Brigades	08 8975 9936	
National Response Centre	1800 076 251	24/7 contract line
Emergency	000 or 112 mobile	
Bushfire NT Katherine office	08 8973 8873 08 8973 8871	Troy Munckton
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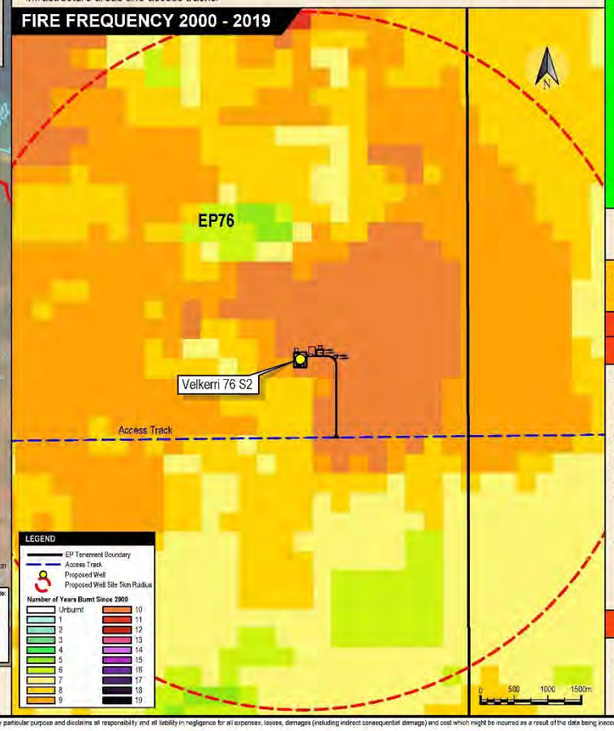
Secure NT (Fire Bans)	https://securent.nt.gov.au/alerts	
Fire incident map	https://www.pfes.nt.gov.au/incidentmap/	

Fire Frequency 2000-2019

Fire management risks

- Ignitions (humans and lightening) on or off site resulting in harm to workers and loss of equipment.
- Fire scar mapping indicates the exploration area burns approximately every 2 years.
- Bullwaddy and Lancewood vegetation communities occur to the south and west of the infrastructure area and are fire sensitive. Hot fires have the ability to reduce habitat quality for both flora and fauna species which utilise these vegetation communities.
- Spread of high fuel load grassy weeds could increase fire intensity, eg gamba, grader and buffel grass, adjacent infrastructure areas and access tracks.

FIRE FREQUENCY 2000 - 2019



Annual Works Calendar

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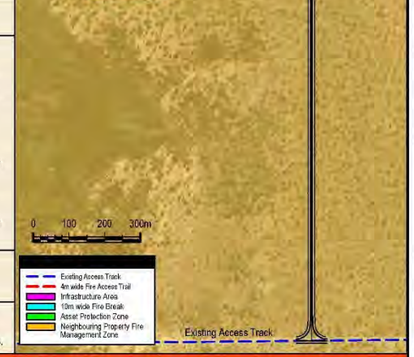
Feb	Low	• Manage vegetation onsite including weeds.	Aug	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Mar	Low	• Planning meeting with neighbour. • Manage vegetation onsite including weeds. • Manage fire break and fire access trail.	Sept	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Apr	Low	• Manage vegetation onsite including weeds.	Oct	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
May	Low	• Manage vegetation onsite including weeds.	Nov	Medium	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
June	Medium	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.	Dec	Low	• No fire management activity.

Velkerri 76 S2 Fire Management Zones

Bushfire Management Actions

Infrastructure area	• Remove all vegetation. • Treat emerging vegetation with herbicide. • A permit for open flaring and hot works is required during a declared fire danger period. • Open flaring and hot works are not permitted on total fire ban days without written approval from a fire control officer or fire warden.
Fire management break	• Maintain a 10 m wide bare earth loop road around the infrastructure area.
Asset Protection Zone (APZ)	• During operations, establish a 40 m wide APZ around the infrastructure area by removing woody understorey vegetation and achieving a grass height of < 100 mm using the methods prescribed in the *Origin Generic bushfire asset protection zone guide*. • Maintain grass cover to a height < 100 mm. • Remove vegetation from the 10 m wide fire break around the infrastructure area. Monitor for grassy weeds and control where appropriate. • Ensure a 4m wide fire access trail around the perimeter of the asset protection zone is trafficable by fire fighting appliances. Monitor for grassy weeds and control where appropriate.
Fire access trails	• Create and maintain a 4m wide access trail around the perimeter of the asset protection zone by grading or spraying.
Neighbouring Property Fire Management Zone	• Annual fire management planning meeting with neighbouring properties. • Neighbour to advise proponent of planned burns.

FIRE MANAGEMENT ZONES



Bushfire Preparedness - refer to *IG Bushfire preparedness tool*

Preparedness Planning

Mandatory for all Severe, Extreme and Catastrophic FDI days

The following must be reviewed daily. If fire alerts are active or presenting with a known risk (fire in the area), personnel must execute their contingency plans which need to encompass the following:

- Procedure on identifying and notifying of a bushfire.
- Critical equipment to be removed / isolated / shut down.
- Safe evacuation routes from site and muster points.
- Communication methods:
  - Team channels and / or phone numbers.
  - Area channels and / or phone numbers.
- Closest 'Safe Havens' (Community or Origin permanent sites).

Monitoring Routine

- Provide timely advice on changes in level of fire risk as available.
- Monitor team and area common channels for bushfire early warning.
- Update changes in work location.

Bushfire First Responder Checklist

The following sequence must be followed by the first person responding to a fire:

1. **Danger** - Remove yourself and others from danger is safe to do so.
2. **Alarm** - Raise the Alarm either on common radio channel or other agreed process.
3. **Gather information**
   - **Location** - Direction from known reference points, eg roads and Origin infrastructure such as well numbers).
   - **Impacts** (actual and potential) - Life, property and the environment.
   - **Fire Characteristics** - Grass or woodlands, flame height, fire front and direction of travel.
   - **Weather** - Wind strength and direction.
   - **Response in Progress** - What response is underway and by who (Origin, Landowners or Emergency Services).
   - **Response required** - Origin and / or Emergency Services.
   - **Access** - Safe access and egress routes.
4. **Notify Origin** - Fire officer / Supervisor.
5. **Notify Pastoralists** - Refer to Property Contacts.
6. **Notify Emergency Services** - Call "000" or "112" (some mobiles) if Origin and Pastoralists unable to manage situation.
7. **Respond** - If safe to do so in consultation with Pastoralist.
8. **Handover** - to the Origin On-Scene Commander / Pastoralist of Emergency Services on arrival.
9. **Support** - provide ongoing support to the response as appropriate.

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E.4. Velkerri 76 S1 – Bushfire Management Plan

Exploration Permit 76

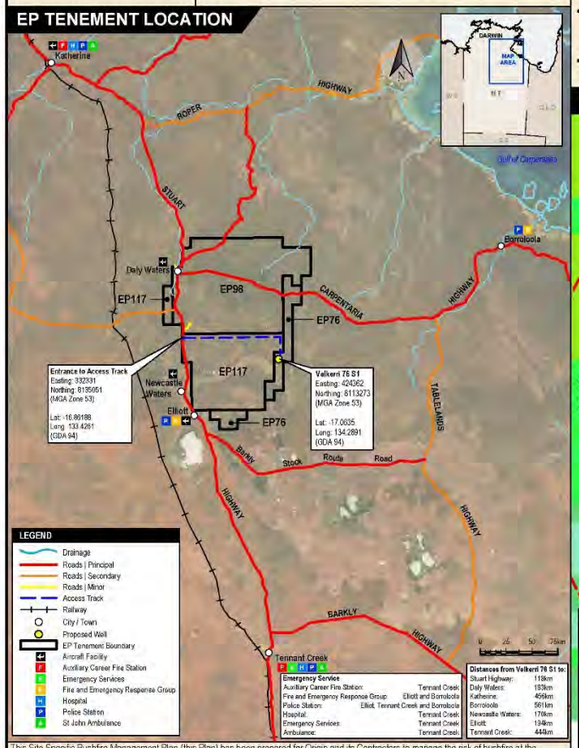
Bushfire Management Plan 2019/2020

Velkerri 76 S1 Lease

Location of Velkerri 76 S1

Property land uses	Gas exploration and cattle grazing
Site fire management aim	To reduce the occurrence of, and minimise the impact of bushfires, thereby reducing the threat to life, property, cultural values and the environment.
Site fire management objectives	Mitigate the potential impact of unplanned fires on Origin's people, assets and operations and neighbouring land uses.

EP TENEMENT LOCATION



This Site Specific Bushfire Management Plan (this Plan) has been prepared for Origin and its Contractors to manage the risk of bushfire at the Velkerri 76 S1 exploration lease area. This Plan should be read in conjunction with the overarching *Environmental Management Plan* and *Emergency Response Plans* for Origin's operations in the Beetaloo Basin.

Appendix A Site Specific Bushfire Management Plan 2019

Origin Fire Officer	Contact Details	Name
	[redacted]	Robert Wear

Properties	Contact Details	Name
Amungee Mungee Station	[redacted]	Adrian Brown
Tanunbirini Station	[redacted]	Mick Tasker
Beetaloo Station	[redacted]	Scotty & Jane Armstrong

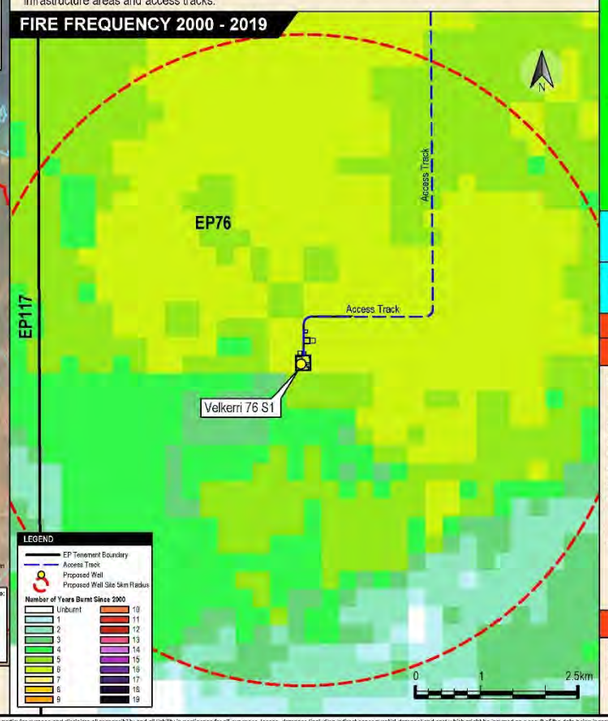
Offsite Stakeholders	Contact Details	Name
Volunteer Bushfire Brigades	08 8975 9936	
National Response Centre	1800 076 251	24/7 contract line
Emergency	000 or 112 mobile	
Bushfire NT Katherine office	08 8973 8873 08 8973 8871	Troy Munckton
Bushfire NT Head office	08 8922 0840 bushfires.nt@nt.gov.au 08 8922 0844	Mark Gardner
NAFI North	https://www.firenorth.org.au/nafi3/	
Secure NT (Fire Bans)	https://securent.nt.gov.au/alerts	
Fire incident map	https://www.pfes.nt.gov.au/incidentmap/	

Fire Frequency 2000-2019

Fire management risks

- Ignitions (humans and lightening) on or off site resulting in harm to workers and loss of equipment.
- Fire scar mapping indicates the exploration area burns approximately every 3 years.
- Bullwaddy and Lancewood vegetation communities occur within the vicinity of the infrastructure area and are fire sensitive. Hot fires have the ability to reduce habitat quality for both flora and fauna species which utilise these vegetation communities.
- Spread of high fuel load grassy weeds could increase fire intensity, eg gamba, grader and buffel grass, adjacent infrastructure areas and access tracks.

FIRE FREQUENCY 2000 - 2019



Annual Works Calendar

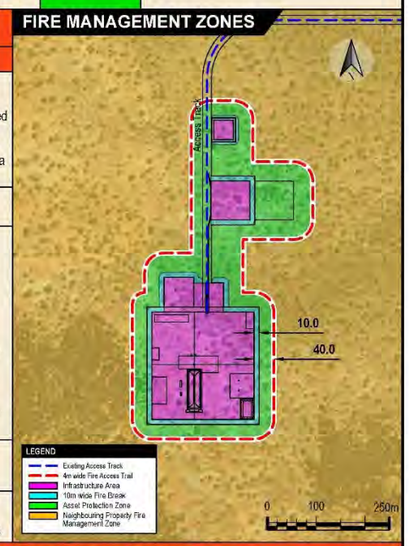
Month	Bushfire Risk	Action	Month	Bushfire Risk	Action
Jan	Low	• No fire management activity.	July	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Feb	Low	• Manage vegetation onsite including weeds.	Aug	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Mar	Low	• Planning meeting with neighbour. • Manage vegetation onsite including weeds. • Manage fire break and fire access trail.	Sept	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Apr	Low	• Manage vegetation onsite including weeds.	Oct	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
May	Low	• Manage vegetation onsite including weeds.	Nov	Medium	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
June	Medium	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.	Dec	Low	• No fire management activity.

Velkerri 76 S1 Fire Management Zones

Bushfire Management Actions

Infrastructure area	• Remove all vegetation. • Treat emerging vegetation with herbicide. • A permit for open flaring and hot works is required during a declared fire danger period. • Open flaring and hot works are not permitted on total fire ban days without written approval from a fire control officer or fire warden.
Fire management break	• Maintain a 10 m wide bare earth loop road around the infrastructure area.
Asset Protection Zone (APZ)	• During operations, establish a 40 m wide APZ around the infrastructure area by removing woody understorey vegetation and achieving a grass height of < 100 mm using the methods prescribed in the *Origin Generic bushfire asset protection zone guide*. • Maintain grass cover to a height < 100 mm. • Remove vegetation from the 10 m wide fire break around the infrastructure area. Monitor for grassy weeds and control where appropriate. • Ensure a 4m wide fire access trail around the perimeter of the asset protection zone is trafficable by fire fighting appliances. Monitor for grassy weeds and control where appropriate.
Fire access trails	• Create and maintain a 4m wide access trail around the perimeter of the asset protection zone by grading or spraying.
Neighbouring Property Fire Management Zone	• Annual fire management planning meeting with neighbouring properties. • Neighbour to advise proponent of planned burns.

FIRE MANAGEMENT ZONES



Bushfire Preparedness - refer to *IG Bushfire preparedness tool*

Preparedness Planning

Mandatory for all Severe, Extreme and Catastrophic FDI days

The following must be reviewed daily. If fire alerts are active or presenting with a known risk (fire in the area), personnel must execute their contingency plans which need to encompass the following:

- Procedure on identifying and notifying of a bushfire.
- Critical equipment to be removed / isolated / shut down.
- Safe evacuation routes from site and muster points.
- Communication methods:
  - Team channels and / or phone numbers.
  - Area channels and / or phone numbers.
- Closest 'Safe Havens' (Community or Origin permanent sites).

Monitoring Routine

- Provide timely advice on changes in level of fire risk as available.
- Monitor team and area common channels for bushfire early warning.
- Update changes in work location.

Bushfire First Responder Checklist

The following sequence must be followed by the first person responding to a fire:

1. **Danger** - Remove yourself and others from danger is safe to do so.
2. **Alarm** - Raise the Alarm either on common radio channel or other agreed process.
3. **Gather information**
   - **Location** - Direction from known reference points, eg roads and Origin infrastructure such as well numbers).
   - **Impacts** (actual and potential) - Life, property and the environment.
   - **Fire Characteristics** - Grass or woodlands, flame height, fire front and direction of travel.
   - **Weather** - Wind strength and direction.
   - **Response in Progress** - What response is underway and by who (Origin, Landowners or Emergency Services).
   - **Response required** - Origin and / or Emergency Services.
   - **Access** - Safe access and egress routes.
4. **Notify Origin** - Fire officer / Supervisor.
5. **Notify Pastoralists** - Refer to Property Contacts.
6. **Notify Emergency Services** - Call "000" or "112" (some mobiles) if Origin and Pastoralists unable to manage situation.
7. **Respond** - if safe to do so in consultation with Pastoralist.
8. **Handover** - to the Origin On-Scene Commander / Pastoralist of Emergency Services on arrival.
9. **Support** - provide ongoing support to the response as appropriate.

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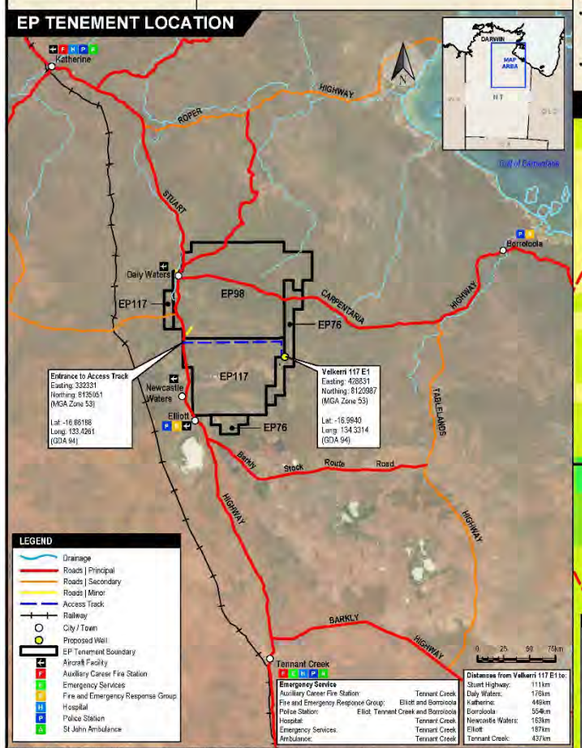
E.5. Velkerri 117 E1 – Bushfire Management Plan

Exploration Permit 117
Bushfire Management Plan 2019/2020
Velkerri 117 E1 Lease

Location of Velkerri 117 E1	
Property land uses	Gas exploration and cattle grazing
Site fire management aim	To reduce the occurrence of, and minimise the impact of bushfires, thereby reducing the threat to life, property, cultural values and the environment.
Site fire management objectives	Mitigate the potential impact of unplanned fires on Origin's people, assets and operations and neighbouring land uses.

EP TENEMENT LOCATION



This Site Specific Bushfire Management Plan (this Plan) has been prepared for Origin and its Contractors to manage the risk of bushfire at the Velkerri 117 E1 exploration lease area. This Plan should be read in conjunction with the overarching *Environmental Management Plan* and *Emergency Response Plans* for Origin's operations in the Beetaloo Basin.

Appendix B Site Specific Bushfire Management Plan 2019

Origin Fire Officer	Contact Details	Name
	[redacted]	Robert Wear

Properties	Contact Details	Name
Amungee Mungee Station	[redacted]	Adrian Brown
Tanunbirini Station	[redacted]	Mick Tasker
Beetaloo Station	[redacted]	Scotty & Jane Armstrong

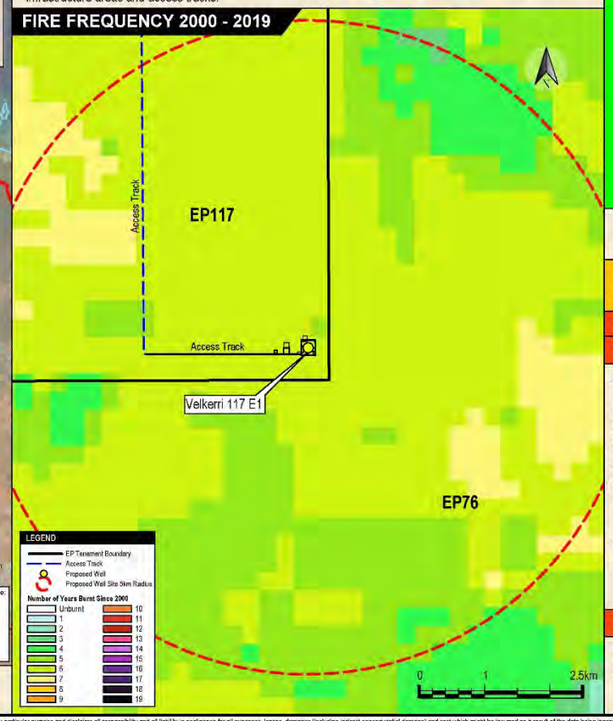
Offsite Stakeholders	Contact Details	Name
Volunteer Bushfire Brigades	08 8975 9936	
National Response Centre	1800 076 251	24/7 contract line
Emergency	000 or 112 mobile	
Bushfire NT Katherine office	08 8973 8873 08 8973 8871	Troy Munckton
Bushfire NT Head office	08 8922 0840 bushfires.nt@nt.gov.au 08 8922 0844	Mark Gardner
NAFI North	https://www.firenorth.org.au/nafi3/	
Secure NT (Fire Bans)	https://securent.nt.gov.au/alerts	
Fire incident map	https://www.pfes.nt.gov.au/incidentmap/	

Fire Frequency 2000-2019

Fire management risks

- Ignitions (humans and lightening) on or off site resulting in harm to workers and loss of equipment.
- Fire scar mapping indicates the exploration area burns approximately every 3 years.
- Bullwaddy and Lancewood vegetation communities occur within the vicinity of the infrastructure area and are fire sensitive. Hot fires have the ability to reduce habitat quality for both flora and fauna species which utilise these vegetation communities.
- Spread of high fuel load grassy weeds could increase fire intensity, eg gamba, grader and buffel grass, adjacent infrastructure areas and access tracks.

FIRE FREQUENCY 2000 - 2019



Annual Works Calendar

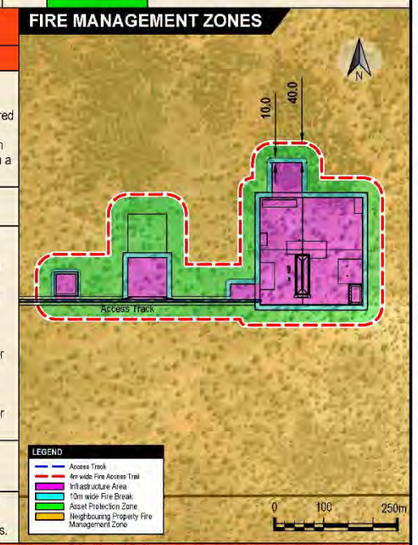
Month	Bushfire Risk	Action	Month	Bushfire Risk	Action
Jan	Low	• No fire management activity.	July	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Feb	Low	• Manage vegetation onsite including weeds.	Aug	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Mar	Low	• Planning meeting with neighbour. • Manage vegetation onsite including weeds. • Manage fire break and fire access trail.	Sept	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Apr	Low	• Manage vegetation onsite including weeds.	Oct	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
May	Low	• Manage vegetation onsite including weeds.	Nov	Medium	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
June	Medium	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.	Dec	Low	• No fire management activity.

Velkerri 117 E1 Fire Management Zones

Bushfire Management Actions

Infrastructure area	• Remove all vegetation. • Treat emerging vegetation with herbicide. • A permit for open flaring and hot works is required during a declared fire danger period. • Open flaring and hot works are not permitted on total fire ban days without written approval from a fire control officer or fire warden.
Fire management break	• Maintain a 10 m wide bare earth loop road around the infrastructure area.
Asset Protection Zone (APZ)	• During operations, establish a 40 m wide APZ around the infrastructure area by removing woody understorey vegetation and achieving a grass height of < 100 mm using the methods prescribed in the *Origin Generic bushfire asset protection zone guide*. • Maintain grass cover to a height < 100 mm. • Remove vegetation from the 10 m wide fire break around the infrastructure area. Monitor for grassy weeds and control where appropriate. • Ensure a 4m wide fire access trail around the perimeter of the asset protection zone is trafficable by fire fighting appliances. Monitor for grassy weeds and control where appropriate.
Fire access trails	• Create and maintain a 4m wide access trail around the perimeter of the asset protection zone by grading or spraying.
Neighbouring Property Fire Management Zone	• Annual fire management planning meeting with neighbouring properties. • Neighbour to advise proponent of planned burns.

FIRE MANAGEMENT ZONES



Bushfire Preparedness - refer to *IG Bushfire preparedness tool*

Preparedness Planning

Mandatory for all Severe, Extreme and Catastrophic FDI days

The following must be reviewed daily. If fire alerts are active or presenting with a known risk (fire in the area), personnel must execute their contingency plans which need to encompass the following:

- Procedure on identifying and notifying of a bushfire.
- Critical equipment to be removed / isolated / shut down.
- Safe evacuation routes from site and muster points.
- Communication methods:
  - Team channels and / or phone numbers.
  - Area channels and / or phone numbers.
- Closest 'Safe Havens' (Community or Origin permanent sites).

Monitoring Routine

- Provide timely advice on changes in level of fire risk as available.
- Monitor team and area common channels for bushfire early warning.
- Update changes in work location.

Bushfire First Responder Checklist

The following sequence must be followed by the first person responding to a fire:

1. **Danger** - Remove yourself and others from danger is safe to do so.
2. **Alarm** - Raise the Alarm either on common radio channel or other agreed process.
3. **Gather information**
   - **Location** - Direction from known reference points, eg roads and Origin infrastructure such as well numbers).
   - **Impacts** (actual and potential) - Life, property and the environment.
   - **Fire Characteristics** - Grass or woodlands, flame height, fire front and direction of travel.
   - **Weather** - Wind strength and direction.
   - **Response in Progress** - What response is underway and by who (Origin, Landowners or Emergency Services)
   - **Response required** - Origin and / or Emergency Services.
   - **Access** - Safe access and egress routes.
4. **Notify Origin** - Fire officer / Supervisor.
5. **Notify Pastoralists** - Refer to Property Contacts.
6. **Notify Emergency Services** - Call "000" or "112" (some mobiles) if Origin and Pastoralists unable to manage situation.
7. **Respond** - if safe to do so in consultation with Pastoralist.
8. **Handover** - to the Origin On-Scene Commander / Pastoralist of Emergency Services on arrival.
9. **Support** - provide ongoing support to the response as appropriate.

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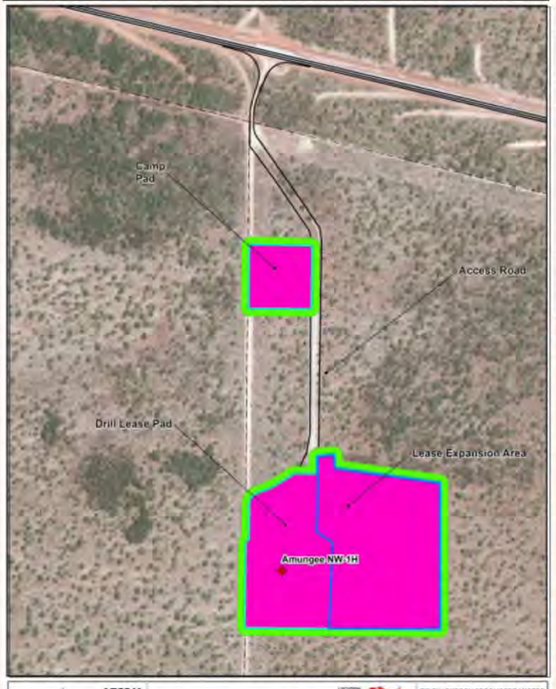
Exploration Permit 98
Bushfire Management Plan 2021/22 (Rev 3)
Amungee NW Lease

Location of Amungee NW-1H Lease	
Property land uses	Gas exploration and cattle grazing
Site fire management aim	To reduce the occurrence of, and minimise the impact of bushfires, thereby reducing the threat to life, property, cultural values and the environment.
Site fire management objectives	Mitigate the potential impact of unplanned fires on Origin's people, assets and operations and neighbouring land uses.

Fire Management Risks

- Ignitions (humans and lightening) on or off site resulting in harm to workers and loss of equipment.
- Fire scar mapping indicates the exploration area burns approximately every 3 to 5 years.
- Bullwaddy and Lancewood vegetation communities occur in areas across the permit and are fire sensitive. Hot fires have the ability to reduce habitat quality for both flora and fauna species which utilise these vegetation communities.
- Spread of high fuel load grassy weeds could increase fire intensity, e.g. gamba, grader and buffel grass, adjacent infrastructure areas and access tracks.



This Site Specific Bushfire Management Plan has been prepared for Origin to manage the risk from bushfire within the Amungee NW lease area. This Plan should be read in conjunction with the Overarching *Environmental Management Plan and Emergency Response Plans* for Origins operations in the Beetaloo Basin.

Bushfire Officer	Contact Details	Name
	[redacted]	Robert Wear

Properties	Contact Details	Name
Amungee Mungee Station	[redacted]	Adrian Brown Emma Brown

Offsite Stakeholders	Contact Details	Name
National Response Centre	1800 076 251	24/7 contract line
Emergency	000 or 112 mobile	
Bushfire NT Katherine office (Savanna)	(08) 8973 8876	
Bushfire NT - Alice Springs office (Barkly)	(08) 8952 3066	
NAFI North	https://www.firenorth.org.au/nafi3/	
Secure NT (Fire Bans)	https://securent.nt.gov.au/alerts	
Fire incident map	https://www.pfes.nt.gov.au/incidentmap/	

Origins's Amungee NW-1 Lease Area Management Zones—Bushfire Management Actions

Well Pads and Tank Pads	• Remove all vegetation within the lease pad area and implement erosion and sediment control plan. • Treat emerging vegetation with herbicide. • Hot works are not permitted on total fire ban days without written approval from a fire control officer or fire warden.
Fire management break	• A 10 m wide cleared perimeter around well pads and tank pads • An additional 10 m wide bare earth fire break incorporating a 4 m wide fire access trail
Fire access trails	• Create and maintain 4 m wide access trail by grading or spraying
Asset Protection Zone (APZ)	• Site Manager to assess fuel load prior to camp establishment and again at end of wet season if infrastructure is still in place. • Establish a 20 m low fuel zone around well pads and lease pads. • Monitor for grassy weeds and control where appropriate. • If deemed necessary, conduct controlled burns where other controls are not effective and in consultation with neighbouring properties. • Ensure 4 m wide fire access trail around the perimeter of the asset protection zone is trafficable by fire fighting appliances.
Neighbouring Property Fire Management Zone	• Fire management planning meeting with neighbouring properties prior to commencing activities, and reviewed annually. • Neighbour to advise proponent of planned burns.

Annual Works Calendar

Month	Bushfire Risk	Action	Month	Bushfire Risk	Action
Jan	Low	• No fire management activity	July	Medium	• Manage vegetation onsite including weeds • Manage fire break and fire access trail • Monitor NAFI • Liaise with neighbour regarding bushfires
Feb	Low	• No fire management activity	Aug	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
Mar	Low	• Weed survey • Planning meeting with neighbour • Annual fire mapping to monitor changes to fire frequency in the relevant area.	Sept	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
Apr	Low	• No fire management activity	Oct	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
May	Medium	• Manage vegetation onsite including weeds • Manage fire break and fire access trail • Monitor NAFI • Liaise with neighbour regarding bushfires	Nov	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
June	Medium	• Manage vegetation onsite including weeds • Manage fire break and fire access trail • Monitor NAFI • Liaise with neighbour regarding bushfires	Dec	Medium	• Manage vegetation onsite including weeds • Manage fire break and fire access trail • Monitor NAFI • Liaise with neighbour regarding bushfires

Bushfire Preparedness

Preparedness Planning

Mandatory for all Severe, Extreme and Catastrophic FDI days

The following must be reviewed daily. If fire alerts are active or presenting with a know risk (fire in the area), personnel must execute their contingency plans which need to encompass the following:

- ☐ Procedure on identifying and notifying of a bushfire.
- ☐ Critical equipment to be removed / isolated/ shut down.
- ☐ Safe evacuation routes from site and muster points.
- ☐ Communication methods:
  - ✓ Team channels and / or phone numbers
  - ✓ Area channels and/or phone numbers
- ☐ Closest 'Safe Havens' .

Monitoring

- ☐ Provide timely advice on changes in level of fire risk as available.
- ☐ Monitor team and area common channels for bushfire early warning.

Bushfire First Responder Checklist

The following sequence must be followed by the first person responding to a fire:

1. Danger – Remove yourself and others from danger is safe to do so.

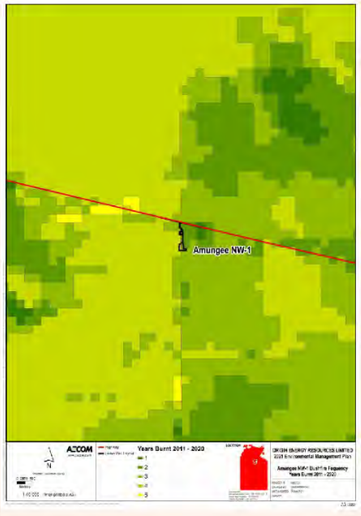
2. Alarm – Raise the alarm either on common radio channel or other agreed process.

3. Gather Information –

- ☐ **Location** – Direction from known reference points, (e.g. roads and Sweetpea's infrastructure such as lease pad location).
- ☐ **Impacts (actual and potential)** – Life, property and the environment.
- ☐ **Fire Characteristics** – Grass or woodlands, flame height, fire front and direction of travel.
- ☐ **Weather** – Wind strength and direction.
- ☐ **Response in Progress** – What response is underway and by who (Sweetpea Contractors, Pastoralist or Emergency Services).
- ☐ **Response required** – Sweetpea Contractors and / or Pastoralist and / or Emergency Services.
- ☐ **Access** – Safe access and egress routes.

4. Notify Origin – Fire Officer/Supervisor

5. Notify Pastoralists – Refer to Property Contacts



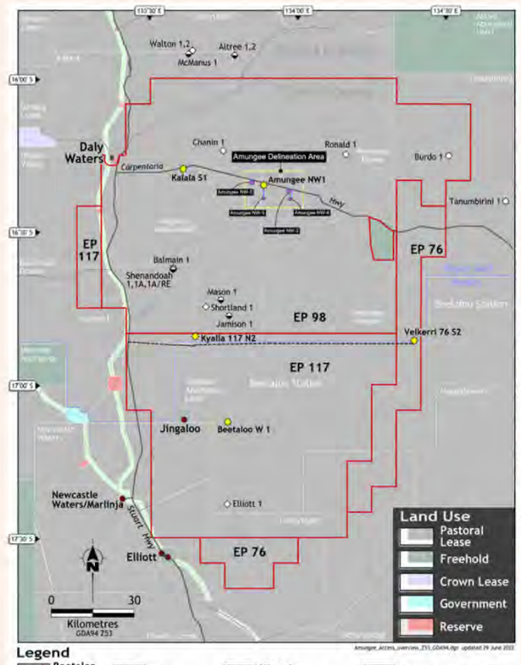
E.7. Amungee 98 NW 2D Seismic – Bushfire Management Plan

Exploration Permit 98
Bushfire Management Plan 2022/25 (Rev 1)
Amungee 2D Seismic Program

Location of Amungee NW-5 Lease	
Property land uses	Gas exploration and cattle grazing
Site fire management aim	To reduce the occurrence of, and minimise the impact of bushfires, thereby reducing the threat to life, property, cultural values and the environment.
Site fire management objectives	Mitigate the potential impact of unplanned fires on Origin's people, assets and operations and neighbouring land uses.

Fire Management Risks

- Ignitions (humans and lightening) on or off site resulting in harm to workers and loss of equipment.
- Fire scar mapping indicates the exploration area burns approximately every 3 to 5 years.
- Bullwaddy and Lancewood vegetation communities occur in areas across the permit and are fire sensitive. Hot fires have the ability to reduce habitat quality for both flora and fauna species which utilise these vegetation communities.
- Spread of high fuel load grassy weeds could increase fire intensity, e.g. gamba, grader and buffel grass, adjacent infrastructure areas and access tracks.

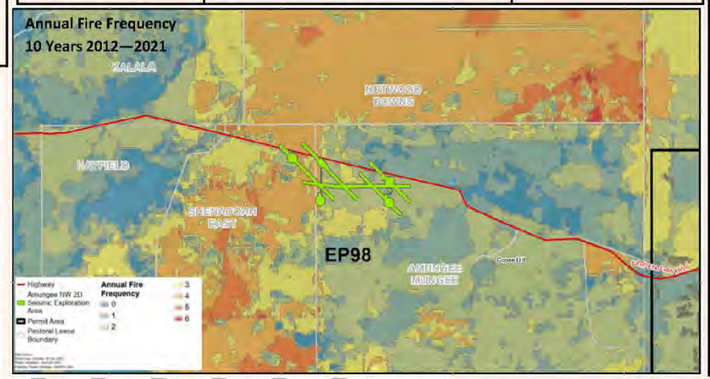


This Site Specific Bushfire Management Plan has been prepared for Origin to manage the risk from bushfire within the Amungee 2D Seismic Program (Rev 1). This Plan should be read in conjunction with the Overarching *Environmental Management Plan and Emergency Response Plans* for Origins operations in the Beetaloo Basin.

Bushfire Officer	Contact Details	Name
	[redacted]	Robert Wear

Properties	Contact Details	Name
Amungee Mungee Station	[redacted]	Adrian Brown Emma Brown
Hayfield Shenandoah Station		Justin Dyer Sally Dyer

Offsite Stakeholders	Contact Details	Name
National Response Centre	1800 076 251	24/7 contract line
Emergency	000 or 112 mobile	
Bushfire NT Katherine office (Savanna)	(08) 8973 8876	
Bushfire NT Alice Springs office (Barkly)	(08) 8952 3066	
NAFI North	https://www.firenorth.org.au/nafi3/	
Secure NT (Fire Bans)	https://securent.nt.gov.au/alerts	
Fire incident map	https://www.pfes.nt.gov.au/incidentmap/	



Amungee 2D Seismic Bushfire Management Actions

Seismic Acquisition, including line preparation	• Adequate fire protection equipment to be provided to prevent fires, the spread of fire, injury to personnel, and to ensure local bushfire and other fire regulations are observed. • Fire extinguishers to be fitted to all vehicles and key locations at camp. • Line preparation in grassed areas will be flattened to reduce the build-up of fuel within the vehicle's engine bays. Routine inspection of vehicles throughout day.
Neighbouring Property Fire Management Zone	• Fire management planning meeting with neighbouring properties prior to commencing activities, and reviewed annually. • Neighbour to advise proponent of planned burns.

Bushfire Preparedness

Preparedness Planning

Mandatory for all Severe, Extreme and Catastrophic FDI days

The following must be reviewed daily. If fire alerts are active or presenting with a know risk (fire in the area), personnel must execute their contingency plans which need to encompass the following:

- ☐ Procedure on identifying and notifying of a bushfire.
- ☐ Critical equipment to be removed / isolated/ shut down.
- ☐ Safe evacuation routes from site and muster points.
- ☐ Communication methods:
  - ✓ Team channels and / or phone numbers
  - ✓ Area channels and/or phone numbers
- ☐ Closest 'Safe Havens' .

Monitoring

- ☐ Provide timely advice on changes in level of fire risk as available.
- ☐ Monitor team and area common channels for bushfire early warning.

Bushfire First Responder Checklist

The following sequence must be followed by the first person responding to a fire:

1. Danger – Remove yourself and others from danger is safe to do so.

2. Alarm – Raise the alarm either on common radio channel or other agreed process.

3. Gather Information –

- ☐ **Location** – Direction from known reference points, (e.g. roads and Origin's infrastructure such as lease pad location).
- ☐ **Impacts (actual and potential)** – Life, property and the environment.
- ☐ **Fire Characteristics** – Grass or woodlands, flame height, fire front and direction of travel.
- ☐ **Weather** – Wind strength and direction.
- ☐ **Response in Progress** – What response is underway and by who (Origin Contractors, Pastoralist or Emergency Services).
- ☐ **Response required** – Origin Contractors and / or Pastoralist and / or Emergency Services.
- ☐ **Access** – Safe access and egress routes.

4. Notify Origin – Fire Officer/Supervisor

5. Notify Pastoralists – Refer to Property Contacts

6. Notify Emergency Services—Call 000 or 112 if Origin and Pastoralist unable to manage situation

7. Respond—If safe to do so in consultation with Pastoralist

8. Handover—To Pastoralist or Emergency Services as determined.

Annual Works Calendar

Month	Bushfire Risk	Action	Month	Bushfire Risk	Action
Jan	Low	• No fire management activity	July	High	• Manage vegetation onsite including weeds • Manage fire break and fire access trail • Monitor NAFI • Liaise with neighbour regarding bushfires
Feb	Low	• No fire management activity	Aug	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
Mar	Low	• Weed survey • Planning meeting with neighbour • Annual fire mapping to monitor changes to fire frequency in the relevant area.	Sept	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
Apr	Low	• No fire management activity	Oct	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
May	Low	• No fire management activity	Nov	Medium	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
June	Medium	• Manage vegetation onsite including weeds • Manage fire break and fire access trail • Monitor NAFI • Liaise with neighbour regarding bushfires	Dec	Low	• No fire management activity.

Exploration Permit 98
Bushfire Management Plan 2022/25 (Rev 1)
Amungee NW-2 Exploration Well

Location of Amungee NW-Lease	
Property land uses	Gas exploration and cattle grazing
Site fire management aim	To reduce the occurrence of, and minimise the impact of bushfires, thereby reducing the threat to life, property, cultural values and the environment.
Site fire management objectives	Mitigate the potential impact of unplanned fires on Origin's people, assets and operations and neighbouring land uses.

Fire Management Risks

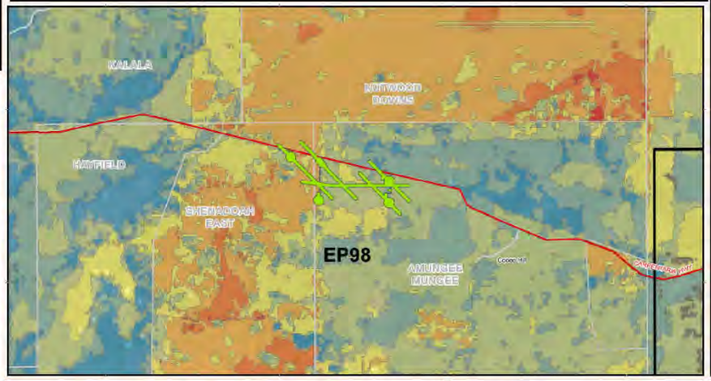
- Ignitions (humans and lightening) on or off site resulting in harm to workers and loss of equipment.
- Fire scar mapping indicates the exploration area burns approximately every 3 to 5 years.
- Bullwaddy and Lancewood vegetation communities occur in areas across the permit and are fire sensitive. Hot fires have the ability to reduce habitat quality for both flora and fauna species which utilise these vegetation communities.
- Spread of high fuel load grassy weeds could increase fire intensity, e.g. gamba, grader and buffel grass, adjacent infrastructure areas and access tracks.

This Site Specific Bushfire Management Plan has been prepared for Origin to manage the risk from bushfire within the Amungee NW-2 (Rev 1) lease area. This Plan should be read in conjunction with the Overarching *Environmental Management Plan and Emergency Response Plans* for Origins operations in the Beetaloo Basin.

Bushfire Officer	Contact Details	Name
	[redacted]	Robert Wear

Properties	Contact Details	Name
Amungee Mungee Station	[redacted]	Adrian Brown Emma Brown
Hayfield Shenandoah Station		Justin Dyer Sally Dyer

Offsite Stakeholders	Contact Details	Name
National Response Centre	1800 076 251	24/7 contract line
Emergency	000 or 112 mobile	
Bushfire NT Katherine office (Savanna)	(08) 8973 8876	
Bushfire NT Alice Springs office (Barkly)	(08) 8952 3066	
NAFI North	https://www.firenorth.org.au/nafi3/	
Secure NT (Fire Bans)	https://securent.nt.gov.au/alerts	
Fire incident map	https://www.pfes.nt.gov.au/incidentmap/	



Bushfire Preparedness

Preparedness Planning

Mandatory for all Severe, Extreme and Catastrophic FDI days

The following must be reviewed daily. If fire alerts are active or presenting with a know risk (fire in the area), personnel must execute their contingency plans which need to encompass the following:

- ☐ Procedure on identifying and notifying of a bushfire.
- ☐ Critical equipment to be removed / isolated/ shut down.
- ☐ Safe evacuation routes from site and muster points.
- ☐ Communication methods:
  - ✓ Team channels and / or phone numbers
  - ✓ Area channels and/or phone numbers
- ☐ Closest 'Safe Havens' .

Monitoring

- ☐ Provide timely advice on changes in level of fire risk as available.
- ☐ Monitor team and area common channels for bushfire early warning.
- ☐ Update changes in work location.

Bushfire First Responder Checklist

The following sequence must be followed by the first person responding to a fire:

1. **Danger** – Remove yourself and others from danger is safe to do so.
2. **Alarm** – Raise the alarm either on common radio channel or other agreed process.
3. **Gather Information** –
   - ☐ **Location** – Direction from known reference points, (e.g. roads and Origin's infrastructure such as lease pad location).
   - ☐ **Impacts (actual and potential)** – Life, property and the environment.
   - ☐ **Fire Characteristics** – Grass or woodlands, flame height, fire front and direction of travel.
   - ☐ **Weather** – Wind strength and direction.
   - ☐ **Response in Progress** – What response is underway and by who (Origin Contractors, Pastoralist or Emergency Services).
   - ☐ **Response required** – Origin Contractors and / or Pastoralist and / or Emergency Services.
   - ☐ **Access** – Safe access and egress routes.
4. **Notify Origin** – Fire Officer/Supervisor
5. **Notify Pastoralists** – Refer to Property Contacts
6. **Notify Emergency Services**—Call 000 or 112 if Origin and Pastoralist unable to manage situation
7. **Respond**—If safe to do so in consultation with Pastoralist

Amungee NW–2 Bushfire Management Actions	
Well Pads and Tank Pads	• Remove all vegetation within the lease pad area and implement erosion and sediment control plan. • Treat emerging vegetation with herbicide. • Hot works are not permitted on total fire ban days without written approval from a fire control officer or fire warden.
Fire management break	• A 10 m wide cleared perimeter around well pads and tank pads • An additional 10 m wide bare earth fire break incorporating a 4 m wide fire access trail
Fire access trails	• Create and maintain 4 m wide access trail by grading or spraying
Asset Protection Zone (APZ)	• Site Manager to assess fuel load prior to camp establishment and again at end of wet season if infrastructure is still in place. • Establish a 20 m low fuel zone around well pads and lease pads. • Monitor for grassy weeds and control where appropriate. • If deemed necessary, conduct controlled burns where other controls are not effective and in consultation with neighbouring properties. • Ensure 4 m wide fire access trail around the perimeter of the asset protection zone is trafficable by fire fighting appliances.
Neighbouring Property Fire Management Zone	• Fire management planning meeting with neighbouring properties prior to commencing activities, and reviewed annually. • Neighbour to advise proponent of planned burns.

Annual Works Calendar

Month	Bushfire Risk	Action	Month	Bushfire Risk	Action
Jan	Low	• No fire management activity	July	High	• Manage vegetation onsite including weeds • Manage fire break and fire access trail • Monitor NAFI • Liaise with neighbour regarding bushfires
Feb	Low	• No fire management activity	Aug	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
Mar	Low	• Weed survey • Planning meeting with neighbour • Annual fire mapping to monitor changes to fire frequency in the relevant area.	Sept	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
Apr	Low	• No fire management activity	Oct	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
May	Low	• No fire management activity	Nov	Medium	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
June	Medium	• Manage vegetation onsite including weeds • Manage fire break and fire access trail • Monitor NAFI • Liaise with neighbour regarding bushfires	Dec	Low	• No fire management activity.

E.9. Amungee 98 NW 3 – Bushfire Management Plan

Exploration Permit 98

Bushfire Management Plan 2022/25 (Rev 1)

Amungee NW-3 Exploration Well

Location of Amungee NW-3 Lease	
Property land uses	Gas exploration and cattle grazing
Site fire management aim	To reduce the occurrence of, and minimise the impact of bushfires, thereby reducing the threat to life, property, cultural values and the environment.
Site fire management objectives	Mitigate the potential impact of unplanned fires on Origin's people, assets and operations and neighbouring land uses.

Fire Management Risks

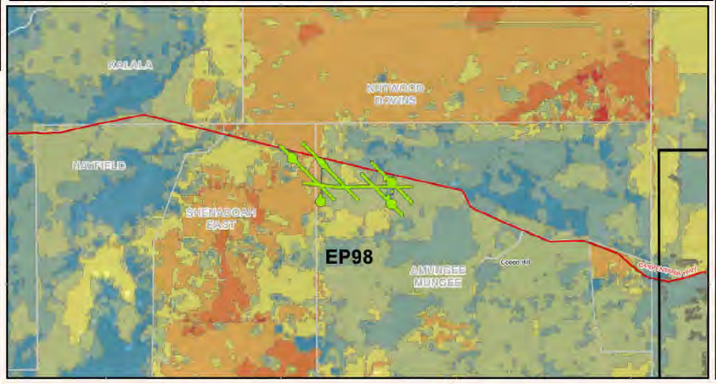
- Ignitions (humans and lightening) on or off site resulting in harm to workers and loss of equipment.
- Fire scar mapping indicates the exploration area burns approximately every 3 to 5 years.
- Bullwaddy and Lancewood vegetation communities occur in areas across the permit and are fire sensitive. Hot fires have the ability to reduce habitat quality for both flora and fauna species which utilise these vegetation communities.
- Spread of high fuel load grassy weeds could increase fire intensity, e.g. gamba, grader and buffel grass, adjacent infrastructure areas and access tracks.

This Site Specific Bushfire Management Plan has been prepared for Origin to manage the risk from bushfire within the Amungee NW-3 (Rev 1) lease area. This Plan should be read in conjunction with the Overarching *Environmental Management Plan and Emergency Response Plans* for Origins operations in the Beetaloo Basin.

Bushfire Officer	Contact Details	Name
	[redacted]	Robert Wear

Properties	Contact Details	Name
Amungee Mungee Station	[redacted]	Adrian Brown Emma Brown
Hayfield Shenandoah Station	[redacted]	Justin Dyer Sally Dyer

Offsite Stakeholders	Contact Details	Name
National Response Centre	1800 076 251	24/7 contract line
Emergency	000 or 112 mobile	
Bushfire NT Katherine office (Savanna)	(08) 8973 8876	
Bushfire NT Alice Springs office (Barkly)	(08) 8952 3066	
NAFI North	https://www.firenorth.org.au/nafi3/	
Secure NT (Fire Bans)	https://securent.nt.gov.au/alerts	
Fire incident map	https://www.pfes.nt.gov.au/incidentmap/	



Amungee NW–3 Bushfire Management Actions

Well Pads and Tank Pads	• Remove all vegetation withjn the lease pad area and implement erosion and sediment control plan. • Treat emerging vegetation with herbicide. • Hot works are not permitted on total fire ban days without written approval from a fire control officer or fire warden.
Fire management break	• A 10 m wide cleared perimeter around well pads and tank pads • An additional 10 m wide bare earth fire break incorporating a 4 m wide fire access trail
Fire access trails	• Create and maintain 4 m wide access trail by grading or spraying
Asset Protection Zone (APZ)	• Site Manager to assess fuel load prior to camp establishment and again at end of wet season if infrastructure is still in place. • Establish a 20 m low fuel zone around well pads and lease pads. • Monitor for grassy weeds and control where appropriate. • If deemed necessary, conduct controlled burns where other controls are not effective and in consultation with neighbouring properties. • Ensure 4 m wide fire access trail around the perimeter of the asset protection zone is trafficable by fire fighting appliances.
Neighbouring Property Fire Management Zone	• Fire management planning meeting with neighbouring properties prior to commencing activities, and reviewed annually. • Neighbour to advise proponent of planned burns.

Bushfire Preparedness

Preparedness Planning

Mandatory for all Severe, Extreme and Catastrophic FDI days

The following must be reviewed daily. If fire alerts are active or presenting with a know risk (fire in the area), personnel must execute their contingency plans which need to encompass the following:

- ☐ Procedure on identifying and notifying of a bushfire.
- ☐ Critical equipment to be removed / isolated/ shut down.
- ☐ Safe evacuation routes from site and muster points.
- ☐ Communication methods:
  - ✓ Team channels and / or phone numbers
  - ✓ Area channels and/or phone numbers
- ☐ Closest 'Safe Havens' .

Monitoring

- ☐ Provide timely advice on changes in level of fire risk as available.
- ☐ Monitor team and area common channels for bushfire early warning.
- ☐ Update changes in work location.

Bushfire First Responder Checklist

The following sequence must be followed by the first person responding to a fire:

1. Danger – Remove yourself and others from danger is safe to do so.

2. Alarm – Raise the alarm either on common radio channel or other agreed process.

3. Gather Information –

- ☐ **Location** – Direction from known reference points, (e.g. roads and Origin's infrastructure such as lease pad location).
- ☐ **Impacts (actual and potential)** – Life, property and the environment.
- ☐ **Fire Characteristics** – Grass or woodlands, flame height, fire front and direction of travel.
- ☐ **Weather** – Wind strength and direction.
- ☐ **Response in Progress** – What response is underway and by who (Origin Contractors, Pastoralist or Emergency Services).
- ☐ **Response required** – Origin Contractors and / or Pastoralist and / or Emergency Services.
- ☐ **Access** – Safe access and egress routes.

4. Notify Origin – Fire Officer/Supervisor

5. Notify Pastoralists – Refer to Property Contacts

6. Notify Emergency Services—Call 000 or 112 if Origin and Pastoralist unable to manage situation

7. Respond—If safe to do so in consultation with Pastoralist

8. Handover—To Pastoralist or Emergency Services as determined.

Annual Works Calendar

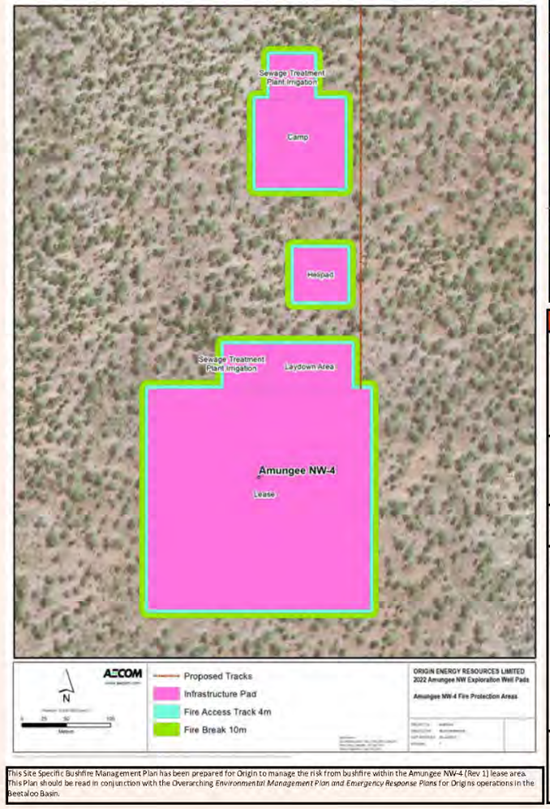
Month	Bushfire Risk	Action	Month	Bushfire Risk	Action
Jan	Low	• No fire management activity	July	High	• Manage vegetation onsite including weeds • Manage fire break and fire access trail • Monitor NAFI • Liaise with neighbour regarding bushfires
Feb	Low	• No fire management activity	Aug	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
Mar	Low	• Weed survey • Planning meeting with neighbour • Annual fire mapping to monitor changes to fire frequency in the relevant area.	Sept	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
Apr	Low	• No fire management activity	Oct	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
May	Low	• No fire management activity	Nov	Medium	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
June	Medium	• Manage vegetation onsite including weeds • Manage fire break and fire access trail • Monitor NAFI • Liaise with neighbour regarding bushfires	Dec	Low	• No fire management activity.

Exploration Permit 98
Bushfire Management Plan 2022/25 (Rev 1)
Amungee NW-4 Exploration Well

Location of Amungee NW-4 Lease	
Property land uses	Gas exploration and cattle grazing
Site fire management aim	To reduce the occurrence of, and minimise the impact of bushfires, thereby reducing the threat to life, property, cultural values and the environment.
Site fire management objectives	Mitigate the potential impact of unplanned fires on Origin's people, assets and operations and neighbouring land uses.

Fire Management Risks

- Ignitions (humans and lightening) on or off site resulting in harm to workers and loss of equipment.
- Fire scar mapping indicates the exploration area burns approximately every 3 to 5 years.
- Bullwaddy and Lancewood vegetation communities occur in areas across the permit and are fire sensitive. Hot fires have the ability to reduce habitat quality for both flora and fauna species which utilise these vegetation communities.
- Spread of high fuel load grassy weeds could increase fire intensity, e.g. gamba, grader and buffel grass, adjacent infrastructure areas and access tracks.

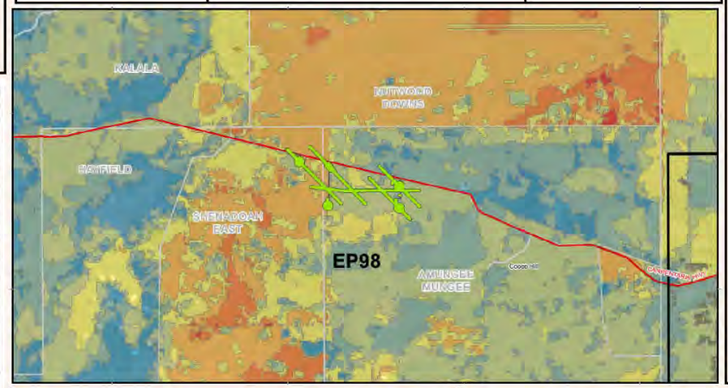


This Site Specific Bushfire Management Plan has been prepared for Origin to manage the risk from bushfire within the Amungee NW-4 (Rev 1) lease area. This Plan should be read in conjunction with the Overarching *Environmental Management Plan and Emergency Response Plans* for Origin's operations in the Beetaloo Basin.

Bushfire Officer	Contact Details	Name
	[redacted]	Robert Wear

Properties	Contact Details	Name
Amungee Mungee Station	[redacted]	Adrian Brown Emma Brown
Hayfield Shenandoah Station		Justin Dyer Sally Dyer

Offsite Stakeholders	Contact Details	Name
National Response Centre	1800 076 251	24/7 contract line
Emergency	000 or 112 mobile	
Bushfire NT Katherine office (Savanna)	(08) 8973 8876	
Bushfire NT Alice Springs office (Barkly)	(08) 8952 3066	
NAFI North	https://www.firenorth.org.au/nafi3/	
Secure NT (Fire Bans)	https://securent.nt.gov.au/alerts	
Fire incident map	https://www.pfes.nt.gov.au/incidentmap/	



Amungee NW–4 Bushfire Management Actions

Well Pads and Tank Pads	• Remove all vegetation within the lease pad area and implement erosion and sediment control plan. • Treat emerging vegetation with herbicide. • Hot works are not permitted on total fire ban days without written approval from a fire control officer or fire warden.
Fire management break	• A 10 m wide cleared perimeter around well pads and tank pads • An additional 10 m wide bare earth fire break incorporating a 4 m wide fire access trail
Fire access trails	• Create and maintain 4 m wide access trail by grading or spraying
Asset Protection Zone (APZ)	• Site Manager to assess fuel load prior to camp establishment and again at end of wet season if infrastructure is still in place. • Establish a 20 m low fuel zone around well pads and lease pads. • Monitor for grassy weeds and control where appropriate. • If deemed necessary, conduct controlled burns where other controls are not effective and in consultation with neighbouring properties. • Ensure 4 m wide fire access trail around the perimeter of the asset protection zone is trafficable by fire fighting appliances.
Neighbouring Property Fire Management Zone	• Fire management planning meeting with neighbouring properties prior to commencing activities, and reviewed annually. • Neighbour to advise proponent of planned burns.

Bushfire Preparedness

Preparedness Planning

Mandatory for all Severe, Extreme and Catastrophic FDI days

The following must be reviewed daily. If fire alerts are active or presenting with a know risk (fire in the area), personnel must execute their contingency plans which need to encompass the following:

- ☐ Procedure on identifying and notifying of a bushfire.
- ☐ Critical equipment to be removed / isolated/ shut down.
- ☐ Safe evacuation routes from site and muster points.
- ☐ Communication methods:
  - ✓ Team channels and / or phone numbers
  - ✓ Area channels and/or phone numbers
- ☐ Closest 'Safe Havens' .

Monitoring

- ☐ Provide timely advice on changes in level of fire risk as available.
- ☐ Monitor team and area common channels for bushfire early warning.

Bushfire First Responder Checklist

The following sequence must be followed by the first person responding to a fire:

1. **Danger** – Remove yourself and others from danger is safe to do so.
2. **Alarm** – Raise the alarm either on common radio channel or other agreed process.
3. **Gather Information** –
   - ☐ **Location** – Direction from known reference points, (e.g. roads and Origin's infrastructure such as lease pad location).
   - ☐ **Impacts (actual and potential)** – Life, property and the environment.
   - ☐ **Fire Characteristics** – Grass or woodlands, flame height, fire front and direction of travel.
   - ☐ **Weather** – Wind strength and direction.
   - ☐ **Response in Progress** – What response is underway and by who (Origin Contractors, Pastoralist or Emergency Services).
   - ☐ **Response required** – Origin Contractors and / or Pastoralist and / or Emergency Services.
   - ☐ **Access** – Safe access and egress routes.
4. **Notify Origin** – Fire Officer/Supervisor
5. **Notify Pastoralists** – Refer to Property Contacts
6. **Notify Emergency Services**—Call 000 or 112 if Origin and Pastoralist unable to manage situation
7. **Respond**—If safe to do so in consultation with Pastoralist
8. **Handover**—To Pastoralist or Emergency Services as determined.

Annual Works Calendar

Month	Bushfire Risk	Action	Month	Bushfire Risk	Action
Jan	Low	• No fire management activity	July	High	• Manage vegetation onsite including weeds • Manage fire break and fire access trail • Monitor NAFI • Liaise with neighbour regarding bushfires
Feb	Low	• No fire management activity	Aug	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
Mar	Low	• Weed survey • Planning meeting with neighbour • Annual fire mapping to monitor changes to fire frequency in the relevant area.	Sept	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
Apr	Low	• No fire management activity	Oct	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
May	Low	• No fire management activity	Nov	Medium	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
June	Medium	• Manage vegetation onsite including weeds • Manage fire break and fire access trail • Monitor NAFI • Liaise with neighbour regarding bushfires	Dec	Low	• No fire management activity.

E.11. Amungee 98 NW 5 – Bushfire Management Plan

Exploration Permit 98

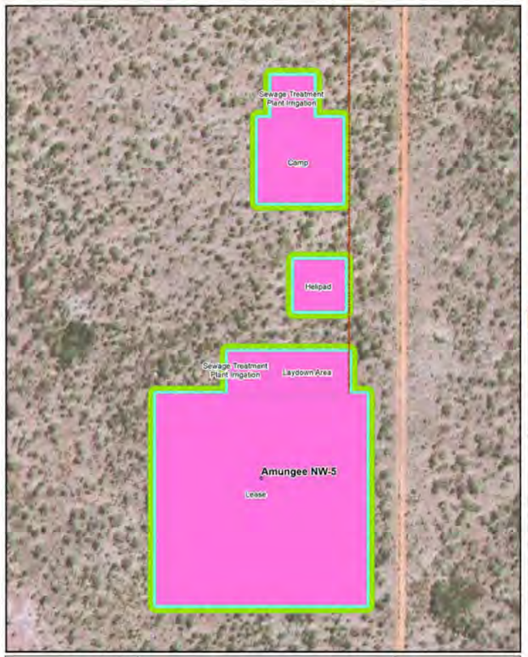
Bushfire Management Plan 2022/25 (Rev 1)

Amungee NW-5 Exploration Well

Location of Amungee NW-5 Lease	
Property land uses	Gas exploration and cattle grazing
Site fire management aim	To reduce the occurrence of, and minimise the impact of bushfires, thereby reducing the threat to life, property, cultural values and the environment.
Site fire management objectives	Mitigate the potential impact of unplanned fires on Origin's people, assets and operations and neighbouring land uses.

Fire Management Risks

- Ignitions (humans and lightening) on or off site resulting in harm to workers and loss of equipment.
- Fire scar mapping indicates the exploration area burns approximately every 3 to 5 years.
- Bullwaddy and Lancewood vegetation communities occur in areas across the permit and are fire sensitive. Hot fires have the ability to reduce habitat quality for both flora and fauna species which utilise these vegetation communities.
- Spread of high fuel load grassy weeds could increase fire intensity, e.g. gamba, grader and buffel grass, adjacent infrastructure areas and access tracks.

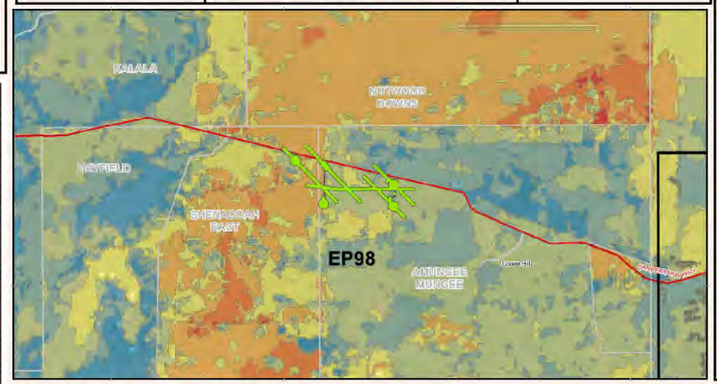


This Site Specific Bushfire Management Plan has been prepared for Origin to manage the risk from bushfire within the Amungee NW-5 (Rev 1) lease area. This Plan should be read in conjunction with the Overarching *Environmental Management Plan and Emergency Response Plans* for Origin's operations in the Beetaloo Basin.

Bushfire Officer	Contact Details	Name
	[redacted]	Robert Wear

Properties	Contact Details	Name
Amungee Mungee Station	[redacted]	Adrian Brown Emma Brown
Hayfield Shenandoah Station		Justin Dyer Sally Dyer

Offsite Stakeholders	Contact Details	Name
National Response Centre	1800 076 251	24/7 contract line
Emergency	000 or 112 mobile	
Bushfire NT Katherine office (Savanna)	(08) 8973 8876	
Bushfire NT Alice Springs office (Barkly)	(08) 8952 3066	
NAFI North	https://www.firenorth.org.au/nafi3/	
Secure NT (Fire Bans)	https://securent.nt.gov.au/alerts	
Fire incident map	https://www.pfes.nt.gov.au/incidentmap/	



Bushfire Preparedness

Preparedness Planning

Mandatory for all Severe, Extreme and Catastrophic FDI days

The following must be reviewed daily. If fire alerts are active or presenting with a know risk (fire in the area), personnel must execute their contingency plans which need to encompass the following:

- ☐ Procedure on identifying and notifying of a bushfire.
- ☐ Critical equipment to be removed / isolated/ shut down.
- ☐ Safe evacuation routes from site and muster points.
- ☐ Communication methods:
  - ✓ Team channels and / or phone numbers
  - ✓ Area channels and/or phone numbers
- ☐ Closest 'Safe Havens' .

Monitoring

- ☐ Provide timely advice on changes in level of fire risk as available.
- ☐ Monitor team and area common channels for bushfire early warning.

Bushfire First Responder Checklist

The following sequence must be followed by the first person responding to a fire:

1. Danger – Remove yourself and others from danger is safe to do so.

2. Alarm – Raise the alarm either on common radio channel or other agreed process.

3. Gather Information –

- ☐ **Location** – Direction from known reference points, (e.g. roads and Origin's infrastructure such as lease pad location).
- ☐ **Impacts (actual and potential)** – Life, property and the environment.
- ☐ **Fire Characteristics** – Grass or woodlands, flame height, fire front and direction of travel.
- ☐ **Weather** – Wind strength and direction.
- ☐ **Response in Progress** – What response is underway and by who (Origin Contractors, Pastoralist or Emergency Services).
- ☐ **Response required** – Origin Contractors and / or Pastoralist and / or Emergency Services.
- ☐ **Access** – Safe access and egress routes.

4. Notify Origin – Fire Officer/Supervisor

5. Notify Pastoralists – Refer to Property Contacts

6. Notify Emergency Services—Call 000 or 112 if Origin and Pastoralist unable to manage situation

7. Respond—If safe to do so in consultation with Pastoralist

8. Handover—To Pastoralist or Emergency Services as determined.

Amungee NW–5 Bushfire Management Actions

Well Pads and Tank Pads	• Remove all vegetation within the lease pad area and implement erosion and sediment control plan. • Treat emerging vegetation with herbicide. • Hot works are not permitted on total fire ban days without written approval from a fire control officer or fire warden.
Fire management break	• A 10 m wide cleared perimeter around well pads and tank pads • An additional 10 m wide bare earth fire break incorporating a 4 m wide fire access trail
Fire access trails	• Create and maintain 4 m wide access trail by grading or spraying
Asset Protection Zone (APZ)	• Site Manager to assess fuel load prior to camp establishment and again at end of wet season if infrastructure is still in place. • Establish a 20 m low fuel zone around well pads and lease pads. • Monitor for grassy weeds and control where appropriate. • If deemed necessary, conduct controlled burns where other controls are not effective and in consultation with neighbouring properties. • Ensure 4 m wide fire access trail around the perimeter of the asset protection zone is trafficable by fire fighting appliances.
Neighbouring Property Fire Management Zone	• Fire management planning meeting with neighbouring properties prior to commencing activities, and reviewed annually. • Neighbour to advise proponent of planned burns.

Annual Works Calendar

Month	Bushfire Risk	Action	Month	Bushfire Risk	Action
Jan	Low	• No fire management activity	July	High	• Manage vegetation onsite including weeds • Manage fire break and fire access trail • Monitor NAFI • Liaise with neighbour regarding bushfires
Feb	Low	• No fire management activity	Aug	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
Mar	Low	• Weed survey • Planning meeting with neighbour • Annual fire mapping to monitor changes to fire frequency in the relevant area.	Sept	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
Apr	Low	• No fire management activity	Oct	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
May	Low	• No fire management activity	Nov	Medium	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
June	Medium	• Manage vegetation onsite including weeds • Manage fire break and fire access trail • Monitor NAFI • Liaise with neighbour regarding bushfires	Dec	Low	• No fire management activity.

Appendix F Definitions

Term	Definition
CMP / T	Crisis Management Plan / Team
DEPWS	Department of Environment, Parks and Water Security
DITT	Department of Industry, Tourism and Trade
EPA	Environmental Protection Agency
SEMT	Site Emergency Management Team
ER/P/T	Emergency Response / Plan / Team
GEMP/T	Group Emergency Management Plan / Team
GEMT-L	Group Emergency Management Team Leader
SEMT-L	Site Emergency Management Team – Leader
OE BU	Origin Energy Business Unit
DA	Development Area
D&C	Drilling and Completions
ECR	Emergency Control Room
ER&S	Emergency Response and Security, Senior Advisor
PC ERT	Primary Contractor Emergency Response Team
PC IMT	Primary Contractor Incident Management Team
FR	First Responder
OE	Origin Energy
OSC	On scene Commander
PC	Primary Contractor

Appendix G Emergency Services Manifest

To be completed within 2 weeks of occupation of Site.

origin

Integrated Gas
Emergency Services Manifest
Insert Site Name

Purpose	A manifest of notifiable quantities of hazardous substances held at this site facility under section 347 of *'Work Health & Safety Regulation 2011, Queensland'*
Reference	Hazardous Materials Management - LNG Division - 3676149 Risk Management Directive - ORG-RISK-DVE-001
Records	Hard copy to be housed in the locked 'Hazmat' Red box located at the front of the site facility and electronic copy to be available on the Sharepoint H&S team site for monitoring of updates and future audit purposes.

Section 1 - General Site Information

Occupier of Facility: Origin Energy Pty Ltd
Site Address: <insert address>
<insert address>
<insert address>

Section 2 - Emergency Contacts

Name	Position	Contact Details			
		Business Hours	Mobile	UHF Radio	After Hours
Upstream Emergency Phone Number (24/7 After Hours) 1800 076 251					

Section 3 - Bulk Storage Locations

Note: Bulk storage includes vessels with a capacity of >500L. Gas tank capacity must be in Water Capacity (L), not gas capacity (m³).

Location / Equipment ID Number	Type	Capacity	Tank Diameter (Flammable liquids only)	Correct Shipping Name	UN Number	DG Class	Quantity
e.g. T3600-001	*Aboveground tank*	*20,000L*		*Petroleum distillates N.O.S*	*1268*	*3*	*20,000L*

Section 4 - Package and IBC Storage Locations

Note: Packages include containers with a capacity of <500L or IBCs of 1,000L capacity. Cylinder quantities must be in Water Capacity (L), not gas capacity (m³).

Storage Location	Correct Shipping Name	Package type	UN no.	Class	Max. Qty
e.g. Warehouse	*Hydrochloric Acid*	*Drum*	*1789*	*8*	*3,000L*

Appendix H Daly Waters Runway Lighting Plan

origin

Daly Waters Aerodrome
Emergency Landing Lights Layout Procedure

Activation from Emergency Services

CONFIRM who is in charge (for Origin this is the On Scene Commander)

CONFIRM the arrival time of the a/c and CTAF freq (126.7)

ACTIVATE other personnel to assist (refer to Daly Waters Aerodrome Plan for contact numbers)

COLLECT Eflare kit from the Origin Office at the Daly Waters Pub

MEET at Daly Waters Aerodrome apron gate

Purpose

This procedure describes how to layout the Eflare night landing lights for the safe arrival and departure of emergency aeroplanes such as Careflight and RFDS in under 60 minutes from the time of activation.

Scope

The Daly Waters community and any other stakeholders who may be able to assist in the lay out emergency landing lights in the event of an emergency.

Minimum Resources

Vehicles - to have UHF, amber flashing light / hazard lights and headlights on.

Personnel - to have torch, hi vis and reflective personal protective equipment.

Communications - UHF channel 16 is being monitored by all personnel in the aerodrome.

Key contacts

NT Careflight Operations
1300 650 654 or 0417 826 336

RFDS Alice Springs
For 24-hour medical and emergency assistance call:
NT (Central Australia) - 1800 733 768
HF Radio (4010kHz, 6890kHz or 8165kHz)
Satellite Telephone: 08 8648 9555 or +61 1800 733 772

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Set up and planning

1. Split into 2-3 teams each with 2 persons and 1 vehicle.
   Teams: Runway 14, Runway 32 and Taxiway / Apron
2. Prepare vehicle - conduct radio checks, check lights and clear our rear seat including footwells.
3. Secure the respective eflare kit in back right seat of the vehicle with the seatbelt.
   Each kit to include the following lights and rubber bases:
   Runway 14
   - 24 x White lights
   - 4 x Red threshold lights
   - 8 x Green displaced threshold lights

   Runway 32
   - 23 x White lights
   - 4 x Green/Red threshold lights

   Taxiway / Apron
   - 2 x Orange hold point lights
   - 22 x Blue lights
4. The On Scene Commander to monitor the time of arrival and monitor the CTAF frequency and provide updates and warning to personnel via UHF radio deploying eflares as necessary.
5. **CAUTION:** Where the aerodrome is delayed in setting up the eflares and leaving the aerodrome in an unsafe state for a landing, the pilot is to be notified on the CTAF 126.7 frequency advising on when the aerodrome will be available.
6. In the event an approaching aircraft is spotted either notify the aircraft directly or if unsuccessful notify personnel deploying the eflares on the UHF "Vacate runway immediately, aircraft on final, vacate runway immediately".
7. Where time permits a final runway inspection is conducted to identify any foreign objects or debris as part of the Eflare deployment. The vehicle should head on a 32 approach so approaching aircraft can be seen.

Placing and retrieving eflares

WARNING: When both deploying and retrieving eflares, the passenger needs to get out of the vehicle to place each light. Don't reach down from the vehicle as this risk over extension resulting in a back injury.

The driver must:
- Drive no faster than 25km/hr
- Drive on the right-hand side of the runway cones
- Stop in line with the rear left passenger door
- Wait for passenger to indicate they are ready before proceeding to the next light location

The person deploying the eflares must:
- Only remove the seatbelt on the runway when travelling less than 25km/hr
- Only set up 1 light at a time
- Avoid turning on the light in the vehicle
- Indicate to the driver when ready to go to next light location

Wait 10 minutes after aircraft has taken off before retrieving runway eflares.

Daly Waters Aerodrome Lighting Plan

Layout Procedures

Layout Runway 14

1. Start at the 14 end of runway (**turn left** from the taxiway).
2. 4 x Red lights - place evenly between the end cones. Locations are indicated with spray paint.
3. 4 x Green lights (each side) - placed each side on the white displaced threshold markers.
4. 8 x White runway lights – start on the East side or the **left side** if looking down the runway. Place a light between each cone so no more than 90m apart. Locations are indicated with spray paint markings.

Layout Runway 32

1. Start at the 32 end of runway (**turn right** from the taxiway).
2. 4 x Green/Red lights - place the Green side facing the away from the runway, evenly between the end cones. Locations are indicated with spray paint.
3. 23 x White runway lights – start on the East side or the **left side** if looking down the runway Place a light between each cone so no more than 90m apart. Locations are indicated with spray paint markings.

Layout apron / taxiway

1. Start on the runway and work back towards the apron.
2. 6 x Blue lights – 3 lights placed each side of the taxiway between the cones. Locations are indicated with spray paint.
3. 2 x Orange lights – place each side on the taxiway. Locations are indicated with spray paint.
4. 14 x Blue lights – placed between the cones along the taxiway. Remaining lights spaced approximately 60m apart.
5. 1 x Red light – placed near unserviceable marker in centre of apron.

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Appendix I Camp Isolation Checklist

Checklist for use can be found here: [the IG ER&S Flood Source Page]

Purpose	This checklist to be used to verify sustainability of camps in preparation for emergency events such as floods.
Reference	Area Flood Preparedness and Response Plans - http://source.originenergy.com.au/Business/lng/safety/emergency/Pages/FloodMgmt.aspx
Records	This checklist will be completed in October each year in preparation for the flood season. Additional requirements for completion will include forecasted severe storm or flood conditions.
Notes for use:	1. To be completed by the Camp Manager. 2. Additional sections critical supply items can be added in Sections 3 & 4 as required.

Date Checklist Completed	Click here to enter a date.	Prepared by	
Camp Name			
Location			
Type of Access	e.g. Dirt/Sealed Road Access or Single Point of access		
Camp Size	e.g. No of beds at full capacity		
Planning Assumptions	e.g. No of beds as the basis for determining supply/sustainment levels		
Camp Fire Fighting System	Choose an item.		

Section 1 - Food

Non Perishable		Perishables	
Current Holdings	Choose an item.	Current Holdings	Choose an item.
Frequency of Delivery	e.g. Twice Weekly - Mon & Thu	Frequency of Delivery	

Section 2 - Water & Waste Water

Water	Days' Supply	Storage Capacity	Current Holdings	Frequency of Delivery
		e.g. 90,000 Lt	Choose an item.	e.g. 2 Weekly - Mon/Thu
Waste Water	Days' Supply	Storage Capacity	Current Holdings	Frequency of Delivery
			Choose an item.	

Section 3 - Fuels & Chemicals

Diesel	Days' Supply	Storage Capacity	Current Holdings	Frequency of Delivery
			Choose an item.	
Other...	Days' Supply	Storage Capacity	Current Holdings	Frequency of Delivery
			Choose an item.	

Section 4 - Other

Linen	Days' Supply	Storage Capacity	Current Holdings	Frequency of Delivery
			Choose an item.	
Other...	Days' Supply	Storage Capacity	Current Holdings	Frequency of Delivery
			Choose an item.	

Section 5 - Exceptions/Comments

Appendix J Example ERN