APPENDIX N.1.2 NLC Stakeholder engagement

Appendix N.1.2 01 191205 NLC Clearance Request from Origin

From: Stonier, Stephanie
Sent: Thursday, 5 December 2019 3:30 PM
To: [redacted]
Cc: [redacted] David Armstrong [redacted]
Subject: Origin Work Program Submission to NLC requesting Sacred Site Clearance

Dear Greg

In accordance with the Exploration Agreement, please attached a Work Programme Submission from Origin in relation to ten future and potential well-site locations across our combined Exploration Permits, including the corresponding shape files.

We respectfully seek to have the clearance work carried out in the field as soon as possible in the New Year.

I will be on annual leave until Monday 20 January however if you have any questions or require additional information please feel free to reach out to Simon Nish and Cassie Bein who are ccd to this email.

We would also like to share a copy of this submission with the Aboriginal Areas Protection Authority and seek your endorsement to do so.

We look forward to hearing from you.

Regards

Stephanie Stonier
Corporate Affairs Manager (Northern Australia)
Head of Social Performance
Beetaloo and Growth Assets
Origin
[redacted]

Origin Energy acknowledges the Traditional Owners and Custodians of country throughout Australia and recognises their continuing connection to land, waters and community.

We pay our respects to them and their cultures, and to Elders past, present and future.

Origin shows its commitment to participating in Australia's reconciliation efforts through our Stretch Reconciliation Action Plan.

2019 Work Program Clearance Request

(For Potential Exploration Works from 2020)

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

Version:	**1.0**
Submitted:	
Presented by:	Origin Energy
Review Date:	December 2019

CONTENTS

1 OVERVIEW 3

2 PROPOSED WORK PROGRAM 3

2.1 Activities 4

2.2 Areas 4

2.3 Request 5

2.4 Figures 5

2.5 Tables 5

2.6 Appendices 5

2.7 Attachments 5

3 APPENDICES 10

1 OVERVIEW

- Since 2015, Origin has drilled four exploration wells (Kalala S1-V, Beetaloo W1-V, Amungee NW1-V and Amungee NW1-H) in the Beetaloo sub-basin (Beetaloo). The Aungee NW1-H well was hydraulic fracture stimulated (HFS) in 2016 (prior to the introduction of a moratorium in September 2016) as part of an exploration work program to assess the potential of natural gas in the Beetaloo (Figure 1).

- In 2018 the moratorium was lifted and in 2019, post the implementation of the NT Inquiry *Exploration Recommendations*, Origin resumed exploration activity in Exploration Permit 117 (EP117) drilling an exploration well targeting the Kyalla formation(s). Once the drilling of vertical and horizontal sections of the well is complete, the horizontal section of the well will be stimulated in early 2020.

- The approved budget to execute two (2) exploration wells in 2019 was approximately $120 million. We expect the cost for future exploration wells to be of a similar value.

- The full time period for drilling and stimulation is approximately:
  - Drilling: Two (2) km deep and two (2) km long: Twelve (12) weeks
  - Stimulation (of well with above specifications): Three (3) weeks
  - Production testing: Three (3) months (up to 12 months)
  - Maintenance and monitoring: Ongoing

- Origin's *Northern Territory Government permit commitments* across Exploration Permit 98 (EP), Exploration Permit 76 (EP76) and EP117 (the Permits) require Origin to complete a further four (4) additional exploration wells to be drilled and stimulated.

- Origin's exploration program is designed to identify areas of perspectivity for a potential, future gas development.

- Origin respectfully requests the Northern Land Council's assistance to facilitate a *Sacred Site Clearance Survey* of ten (10) potential future exploration locations and access routes (where necessary across the Permits) 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 (Figure 2).

2 PROPOSED WORK PROGRAM

- Origin is proposing to drill, HFS and production test four (4) horizontal wells across the Permits over 2019 and 2020. It is possible that vertical wells will be drilled prior to proposed horizontal wells (that is, a proposed horizontal well would be drilled from a vertical well as occurred for the Amungee NW-1H well).

- Origin may seek approvals to drill, HFS and production test from two (2) to four (4) additional horizontal wells (and associated vertical wells if required).

- Civil works activities to support the exploration program may be undertaken throughout 2020 (note this is likely to include the construction of roads to enable site access along with supporting activities such as accessing aggregate from identified gravel pits, water through registered water bores and the installation of additional water monitoring bores as per the requirements of the NT Inquiry).

- Civil works and associated activities are likely to be undertaken on all sites where NLC Clearance and AAPA certification is held to facilitate exploration activity beyond 2020.

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 Activities

The following activities would be required to complete work across the sites included in this request:

Activities, in approximate order of operation, include:

1. Scouting, surveying, and small-scale surface and shallow subsurface sampling of soils to support geotechnical studies and environmental evaluation.

2. Civil engineering activity to repair, improve and/or construct access tracks and/or unsealed roads and well pads (e.g. grading, excavation, fencing); note this activity may require borrow pits along access routes and close to well pads.

3. Drilling/installation of water bores as required.

4. Exploration drilling (vertical and horizontal wells).

5. HFS (horizontal wells and associated vertical wells if required) (including HFS monitoring equipment).

6. Production testing.

7. Follow-up testing, monitoring and work-over activity (as required).

8. Activities associated to the plugging, abandonment and/or remediation of wells after proper testing and monitoring has been conducted (as required).

9. Any other auxiliary works/activities required under good oilfield and/or environmental practice and accepted project commitments to support foregoing activities.

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 and digital GIS files detail the location of ten (10) potential sites, and associated access routes requested for Sacred Site Clearance surveying.

    - Sites - the initial clearance request is for an extended polygon providing a radius area area around the proposed location.

    - Access Routes - the initial clearance request is for a 100 m buffer zone either side of the access tracks; however, Origin will support a wider clearance area as needed by the NLC and cultural monitors and/or Traditional Owners.

- 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 2018 NLC cleared locations
Figure 3	Summary map of ten additional proposed locations, and associated access routes requested for Sacred Site Clearance survey

2.5 Tables

Table 1	Propose site locations for Sacred Site Clearance survey.

2.6 Appendices

Appendix 1	Indicative Activity Descriptions
Appendix 2	Minimising Environmental Impact

2.7 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

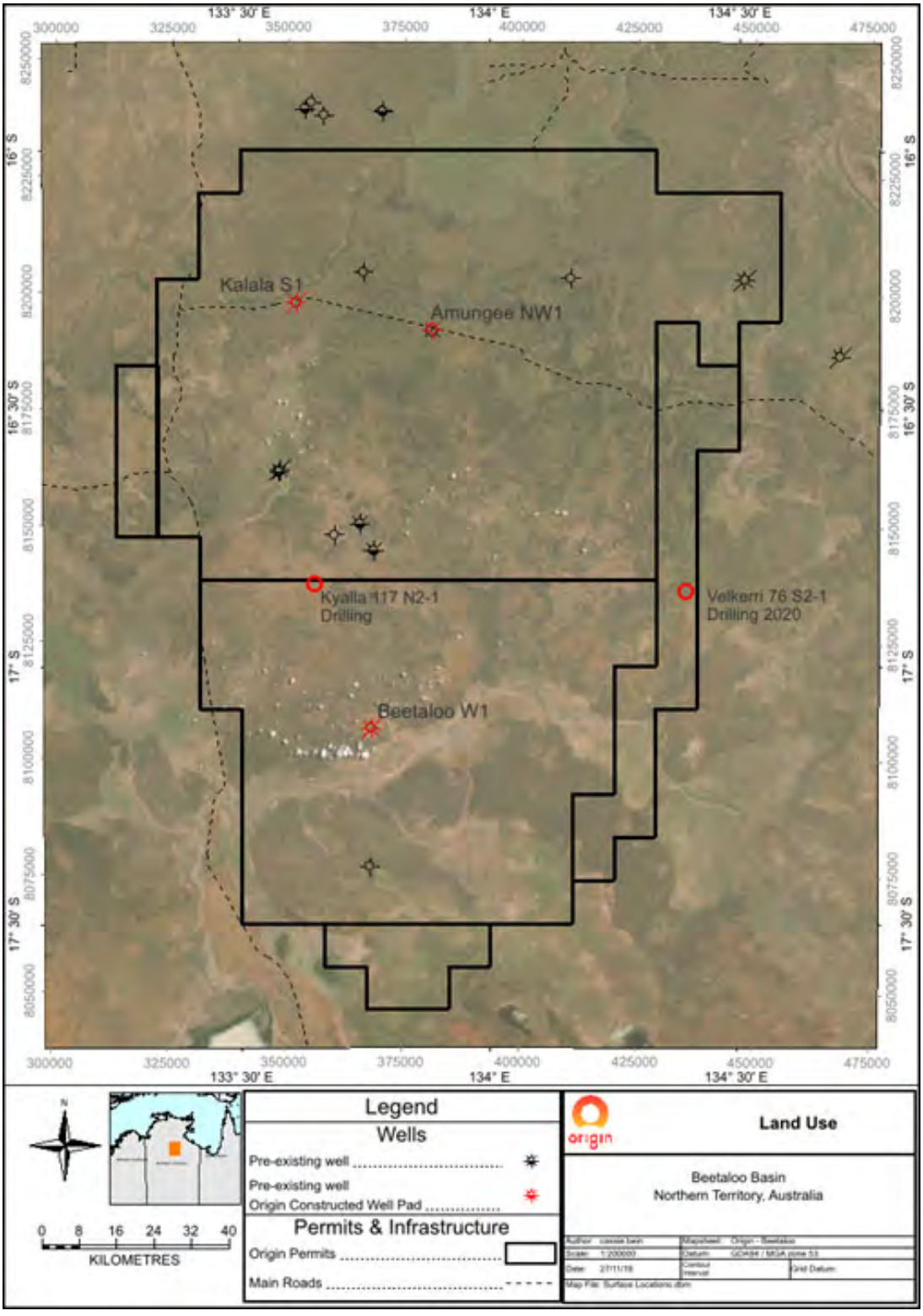


Figure 2 - Summary of wells and 2018 NLC cleared locations

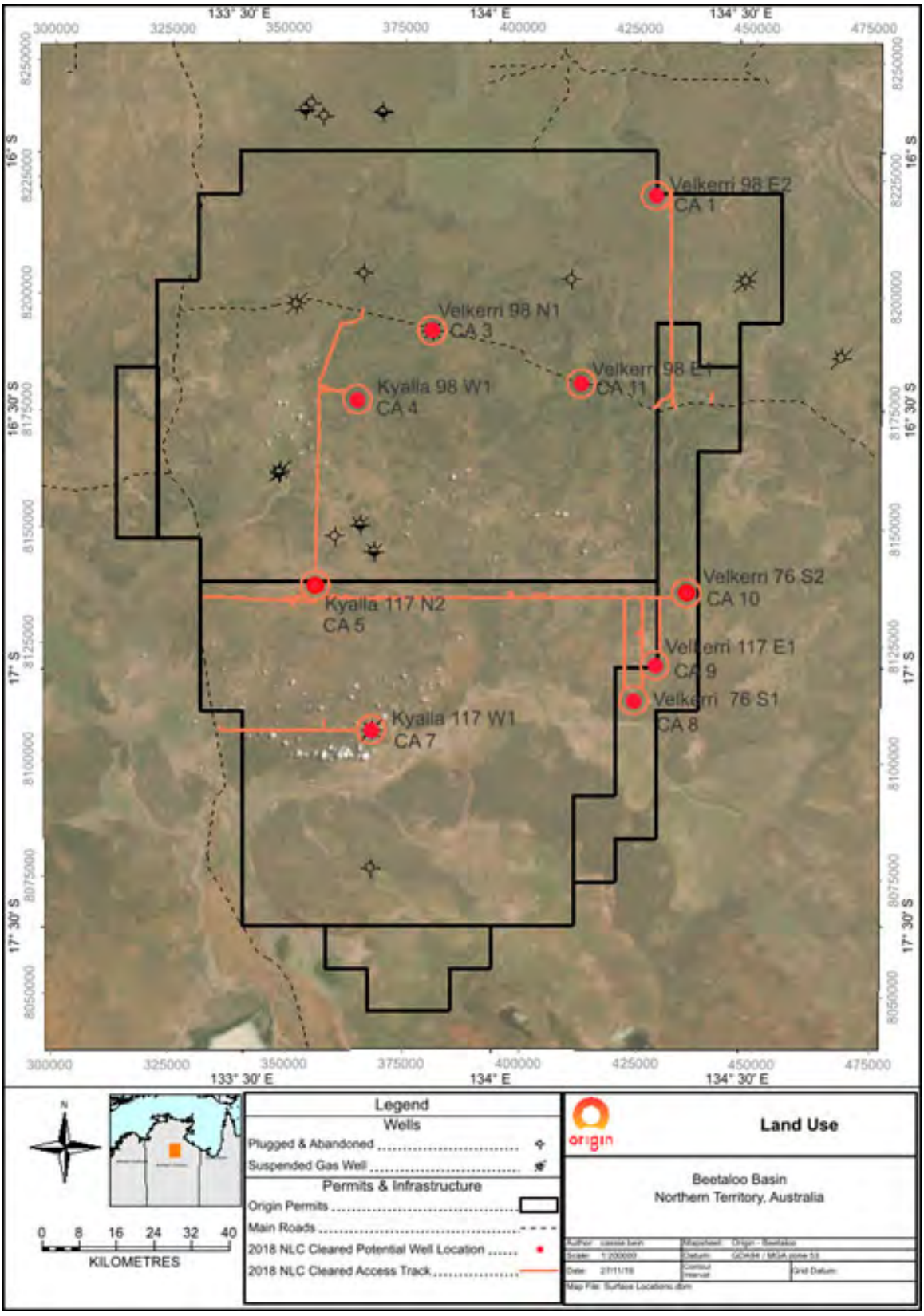


Figure 3 - Summary map of next ten additional proposed site locations for Sacred Site Clearance surveys

NOTE : New location denoted in blue/green and 2018 NLC Cleared locations denoted in pink

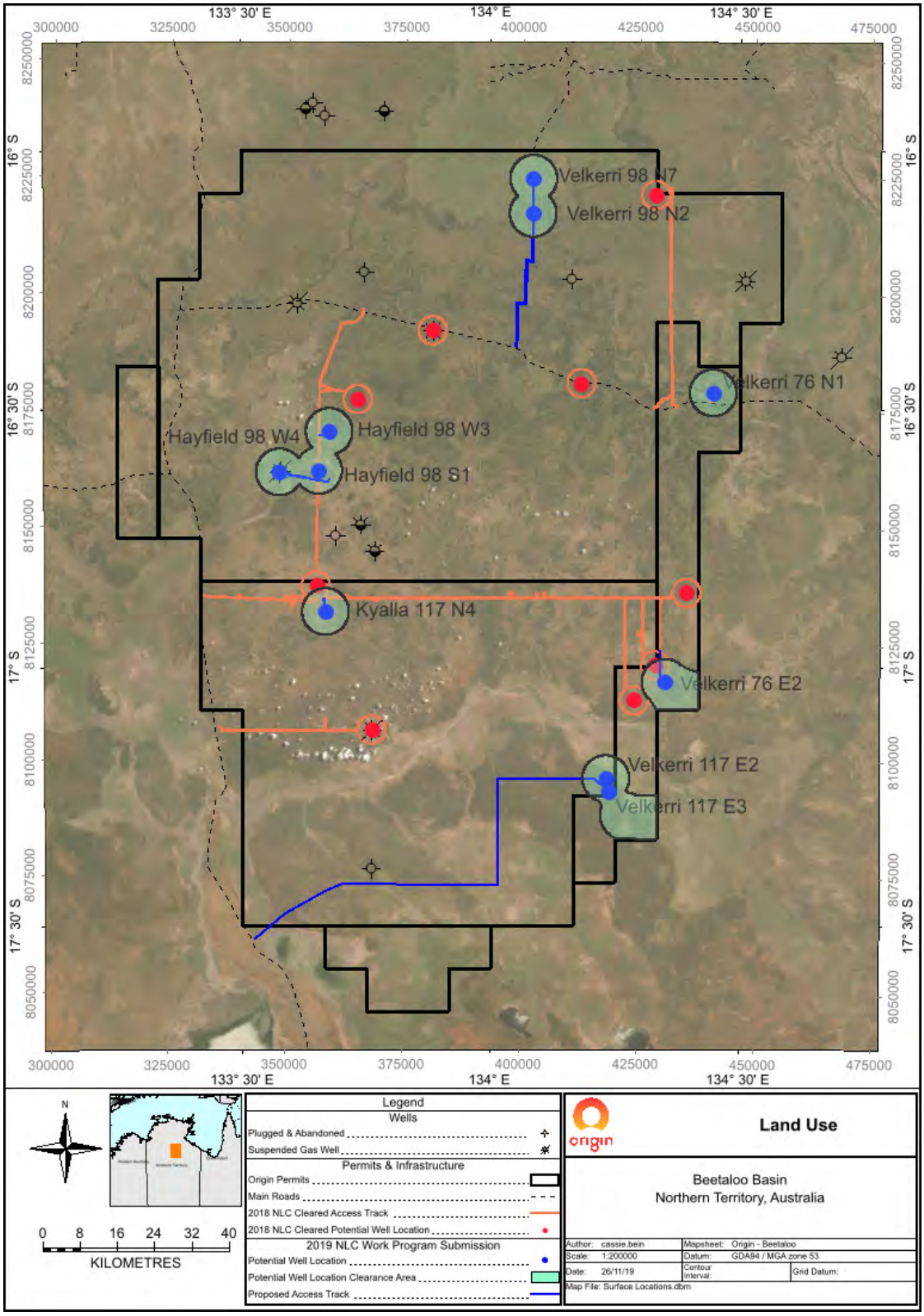


Table 1 - Proposed site locations for sacred site clearance surveys

Pad Name	Proposed Vertical Well Name	Pastoral Lease	Easting	Northing	Latitude	Longitude
Kyalla 117 N4	Kyalla 117 N4-1	Beetaloo	358268	8131930	16°53'30.6831"S	133°40'9.6037"E
Velkerri 76 N1	Velkerri 76 N1-1	Tanumbirini	440981	8179204	16°28'5.1647"S	134°26'49.4833"E
Velkerri 76 E2	Velkerri 76 E2-1	Beetaloo	431026	8117183	17°01'42.4343"S	134°21'6.9303"E
Velkerri 117 E2	Velkerri 117 E2 -1	Beetaloo	418443	8096497	17°12’54.573”	134°13’58.5737”
Velkerri 117 E3	Velkerri 117 E3-1	Ucharonidge	419089	8093753	17°14’23.4266”	134°14’20.0796”
Velkerri 98 N7	Velkerri 98 N7-1	Nutwood Downs	402329.21	8224916.6	16°03'13.0854"S	134°05'12.8614"E
Velkerri 98 N2	Velkerri 98 N2-1	Nutwood Downs	402256	8217405	16°07’17.5100”	134°05’9.2801”
Hayfield 98 W4	Hayfield 98 W4-1	Hayfield / Shenandoah	348255	8161760.9	16°37'17.9164"S	133°34'38.4656"E
Hayfield 98 S1	Hayfield 98 S1-1	Hayfield / Shenandoah	356661	8162146	16°37'7.2767"S	133°39'22.2048"E
Hayfield 98 W3	Hayfield 98 W3-1	Hayfield / Shenandoah	358854	8170505.1	16°32'35.7887"S	133°40'38.0644"E

3 APPENDICES

3.1 Appendix 1

The following information and table details the typical activities associated with drilling and hydraulic fracture stimulation operations of vertical and/or horizontal exploration well as proposed in the Beetaloo. These descriptions are indicative and general in nature, minor departures from such descriptions are likely to occur and we propose that such departures are covered by the content of this application.

The first step in the exploration well process includes the construction of access roads and where necessary, land clearance to allow access to the potential well-site location. The drilling lease pad itself (ie. the area of land that would be occupied by the drilling rig and support equipment) would consist of approximately one (1) hectare of cleared and site engineered compacted earth. This area would host the drilling rig and all associated equipment as well as a mud sump (i.e. a pit where used drilling fluids would be stored while the operation is in process) and a flare pit (i.e. a pit that can be used to burn any gas or oil encountered while drilling in a safe manner, although it is unlikely to be used). The rig camp would be located within the vicinity of the drilling rig on a cleared area of approximately 100 m x 100 m. A rig camp for this type of exploration activity typically accommodate approximately 50 to 100 people.

All of the above areas would be connected to existing roads with unsealed tracks built specifically for the activity, approximately 6m wide tracks in an 18m wide corridor.

Once the surface infrastructure is in place, a drilling rig and camp would be brought in to undertake the drilling activity. A drilling rig package consists of the main rig package as well as supporting vehicles and pieces of equipment. Origin's host Traditional Owners have visited these types of facilities both at the Beetaloo well pad as well as the Amungee well pad. Generally, some, or all, of 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.
- 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.
- A work/welding shop.
- Portable onsite offices.
- Third party equipment such as cementing trucks and wireline evaluation units would also be required on site intermittently as per operational requirements.

Trucks delivering equipment and consumables (e.g. 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, 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

regional aquifer (depth varies regionally). 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 would then be set and cemented at this depth.

The drilling rig would then be set up to drill through the aquifers and the Antrim Plateau Volcanics (assuming they are present). At this point a further string of 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 may 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.

A KCl/Polymer 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 potassium 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)).

The final hole section (referred to as the “production hole section”) covers the hydrocarbon reservoir section(s) and it is drilled to the well total depth (TD). TD is likely to reach a measured depth (the length of both the vertical and horizontal sections of the well) between 1400-3200m below the surface (horizontal wells will have substantially greater measured depths as after reaching the target vertical depth they are drilled laterally for a further 500m-3000m), depending on the stratigraphic depth and thickness of the zone of interest at a particular location. Drilling of the production hole section could also include coring activities, a process in which a drill bit with a cylindrical opening is used to cut-out rock cores for geological, geochemical and geomechanical studies.

In horizontal wells, 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 500-3000m.

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, such as their natural radiation signature. 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 be hydraulically fracture stimulated (HFS), a separate set of specialised equipment, trailers or skid mounted equipment is mobilised to the well location. This equipment mainly consists of high volume/high pressure pumps, mixing equipment, water storage tanks (enclosed and open), and control and monitoring equipment. This equipment was inspected by host NLC representatives and host

Traditional Owners prior to the HFS activities at the Amungee well. HFS involves the injection of large quantities of water and sand plus a small percentage of chemicals at high pressure down and across horizontally drilled wellbores as far as 3000m below the surface. The pressurised mixture causes the rock (i.e. shale) to crack. The small cracks or fractures created are held open by the sand/proppant allowing gas to flow from the shale to the wellbore and up the well. The fractures created are separated from surface aquifers by over 1000m of mainly impermeable rock. Other formations (including surface aquifers) are also isolated behind several layers of steel casing and cement preventing contamination.

After the completion of HFS operations, a production test is typically carried out for a period required to assess the potential of the well and acquire important reservoir and hydrocarbon data (Origin proposes to test wells for a minimum of three (3) months, and may seek to extend this for the final wells in the 2019 and 2020 work program to up to 12 months).

Once all drilling, wireline and testing operations are completed a decision is made to either safely suspend the well (e.g. for further testing 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 maintaining and conditioning the surface well pad, as well as site rehabilitation after well decommissioning and ongoing monitoring.

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.

The drilling rig and all associated temporary equipment would be then removed from the site. If the well has been plugged and decommissioned, all disturbed areas (e.g. lease pad, pits, camp area) would be rehabilitated and re-vegetated. 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.

Table A - Summary of Exploration activities.

Activity	Description	Equipment	Duration
Water Bore / Civil Works	Installation of a water bore and water tanks, levelled areas for rig and camp, pits for fluid storage and roads for access.	Earth moving equipment and water bore drilling unit.	Approximately 1-2 months and potentially completed some months prior to drilling activity.
Exploration Drilling	Drilling with air/water to install progressively smaller cemented casing strings to ultimately reach the target rock formations and well TD	A drilling rig package (described above) as well as associated heavy and light vehicles.	Approximately 30-90 days (highly variable, especially in exploration phase and will depend on whether a horizontal section is required).

Evaluation	Running wireline tools to tests various properties of the reservoir rocks once they have been drilled into.	As well as the drilling package, there would be a wireline logging truck and a variety of industry standard tools.	Approximately 2-3 days, depending on success of testing.
DFIT	The DFIT involves injecting small volumes of water at low rates to create small fractures in the rock and then allow the pressure to fall naturally.	Specialised truck, trailer or skid mounted equipment mainly consisting of high volume/high pressure pumps and control, and monitoring equipment.	Approximately 2-3 days.
HFS	Hydraulic Fracture Stimulation involves the injection of large quantities of water and sand plus a small percentage of chemicals at high pressure down and across horizontal drilled wellbores causing the shale to crack. The cracks or fractures created are held open by the sand/proppant allowing gas from the shale to flow into and up the well.	Specialised truck, trailer or skid mounted equipment mainly consisting of high volume/high pressure pumps, mixing equipment, water storage tanks and control and monitoring equipment.	Approximately 10-30 days depending on the number of stages to be fracture stimulated.
Completions Activity	Equipment installation inside the wellbore, typically steel tubing to assist the well's ability to lift fluids/gas up the wellbore to surface.	A completions rig package and wireline units when required	Approximately 2-5 days
Production Test	Measuring the productivity of the wellbore after it has been HFS. Flow rates (gas/fluids), pressures, solids, and gas/fluid analysis are typically assessed.	Well test package, typically consisting of a 3 phase test separator, choke manifolds, flowback tanks, flare stacks and emergency shutdown valves. Wells that require artificial lift to initiate flow may also have a coiled tubing unit on location to conduct a Nitrogen (N_2) lift.	Approximately 1-12 months.
Plug and Decommissioning (activity	Setting and testing cement plugs to ensure permeable zones have been isolated	A drilling rig package.	Approximately 2 days.

delayed if well is suspended)	from each other to prevent cross flow and/or flow communication to surface.		
Site Rehabilitation (after Plug and Decommissioning)	Earth works rehabilitation to original condition. Re-vegetation as required. Note that any water bore and some road access are likely to remain.	Earth moving equipment.	Approximately 1 week (TBA) and then sufficient time to re-establish vegetation. May be completed several months post drilling activity.

3.2 Appendix 2

Origin is required to obtain approval of the *Environmental Management Plan* and *Well Operations Management Plan*. Included in submissions are comprehensive data and information detailing processes and procedures that will be followed during implementation and execution of all aspects of exploration activity. An EMP and associated documentation, assessed by the Regulators, may include:

- Management of Sacred Site / Cultural Heritage, heritage, bushfire, weed control and management, erosion and sediment control, protection of Surface water and groundwater water, dust, traffic, biodiversity, and waste) - these plans will cover both the general exploration activity plus specific environmental requirements for each well site and its associated activities
- Oil Spill Contingency Plan (OSCP)
- Emergency Response Plan (ERP)
- Well Integrity Management Plan
- Water Management Plans for regular testing of local water bores before, during, and after the project
- Chemicals disclosure – a list all chemicals to be used during the project
- Environment Rehabilitation Security Bond - submission of security bond calculation that covers all the rehabilitation management areas and evidence of final payment
- Archaeological, Sacred Site and Heritage clearance
- Aboriginal Areas Protection Authority Certification
- Access Agreement with host Pastoralist

Copies of all documentation including all plans and documentation provided to Northern Territory regulatory agencies will also be provided to the NLC. All activities carried out by Origin as operator are also governed by stringent internal environmental policies and directives which are referenced when preparing environmental plans and undertaking work programs.

If hydraulic fracture stimulation is to be undertaken, the following additional environmental controls are also applied:

- Further validation of cement placement and its integrity
- Further pressure testing
- Continuation of baseline water monitoring and testing
- Submission of fracture modelling (maximum propagation height), confirming safe separation between any natural aquifers and the fracture zone
- Submission of all MSDS for public disclosure on the department's website
- BTEX (Benzene, Toluene, Ethyl-benzene, Xylene) products will not be accepted nor utilised as they are prohibited for use in the Northern Territory.

Origin has in place an HSE Policy that states:

At Origin, we value the wellbeing of our employees, contractors, customers, the communities in which we operate and the environment. We are committed to responsible management practices that minimise any adverse health, safety or environmental impacts, and enhance benefits associated with our activities, products or services.

We have in place a Health, Safety and Environment management system for our activities that drives continual improvement. The HSE Management System outlines accountabilities to implement this Policy and requires that we:

- Identify hazards and reduce risks so far as is reasonably practicable where there is potential to cause injury or illness to people, or to adversely impact the environment or the community
- Provide safe work places and systems of work, empower employees and contractors to address unsafe or hazardous situations and carry out their work in a manner that does not present a risk to themselves, others or the environment
- Support the recovery and rehabilitation of employees in the event of work related injury or illness
- Set objectives and targets which promote the efficient use of energy and resources, the minimisation of wastes and emissions and the prevention of pollution
- Comply with relevant HSE legal requirements and other commitments
- Require Contractors to manage HSE using standards and practices that accord with this Policy
- Regularly review and report HSE performance.

In implementing this Policy, we will engage with our employees, contractors, suppliers, business partners, customers and Government and communicate expectations to all persons working with or on behalf of Origin.

Origin field activities are also covered by a series of Environmental Directives which include the following:

- The Air Emissions directive outlines Origin's requirement for identification and management of emissions with potential to affect air quality and/or regulatory compliance.
- The Biodiversity Management directive describes requirements for identification and assessment of impacts on terrestrial and aquatic flora, fauna and ecosystems; controls for managing biodiversity-related risks; and methods for enhancing biodiversity values.
- The Cultural Heritage directive covers identification and assessment of cultural heritage values and sites, compliance with legal obligations and voluntary commitments, development of plans, and effective stakeholder engagement.
- The Environmental Noise directive describes requirements for identifying, assessing, monitoring and minimising noise emitted during normal operations as well as during construction, commissioning and decommissioning activities.
- The Greenhouse Gas and Energy Efficiency directive sets out requirements for managing greenhouse gas (GHG) emissions and energy efficiency, including identification and monitoring of energy consumption, energy production and GHG emissions.

- The Land Management directive describes requirements for identifying and assessing impacts to land, and implementing controls to manage erosion, visual amenity, contaminated sites, site closure and rehabilitation.

- The Materials and Waste directive outlines requirements for identifying, assessing and managing impacts associated with use of materials, and storage, handling, treatment and disposal of wastes.

- The Water Management directive outlines requirements for managing water extraction and consumption, water quality and controlling wastewater treatment and discharges.

Proposed Water, Gravel or other Resource Use

It is proposed that water bores to provide water for civil construction, well drilling and completion operations are to be installed adjacent to the well site pad and along access tracks within the clearance area of the well sites and access tracks. The bores will be constructed to the minimum construction requirements of the NT Government.

Gravel from existing gravel pits and new borrow pits may be required for access road sheeting and well site pad sheeting. Any new borrow pits would be located within the clearance area along the access tracks or lease pads.

Appendix N.1.2 02 200904 email and map attachments

From: Stonier, Stephanie [redacted]
Sent: Friday, September 4, 2020 4:44 PM
To: [redacted]
Subject: Updated Sacred Site Clearance Survey Submission / Information

Dear [redacted]
Thank you to the NLC Team for their time this week to discuss the scaled back location amendments to the forthcoming Sacred Site Clearance Survey field work. As discussed I provide the following update(s):

UPDATES

1. The SSC Survey field work will now likely commence sometime during the week commencing Monday 21 September 2020 (pending confirmation from the NLC that they will be able to have the necessary information / maps etc ready in time). This commencement date sometime during this week remains preferable to allow the opportunity for Native Title holders to potentially be able to visit the Kyalla 117 wellsite location during fracture stimulation operations (currently scheduled to commence on or about 16 September and will likely take place for about approximately 10 to 14 days).

2. The team are updating the submission as discussed and agreed this week and I will forward by separate email once I get the final copy.

3. Here is the link to the example we looked at of the activity involved with the 3D seismic survey. The priority area for this activity is the polygon area around CA5 (Kyalla 117) and CA10 (Velkerri 76). Given its low impact it would also be helpful to discuss this for the other areas. https://www.youtube.com/watch?v=DaX4krPTeJs

4. We have attached the revised maps in the event that you require them independently of the submission documentation.

5. Attached is an updated copy of Origin's COVID19 Safety Management Plan approved by the NT Chief Health Officer.

Kind regards
Stephanie

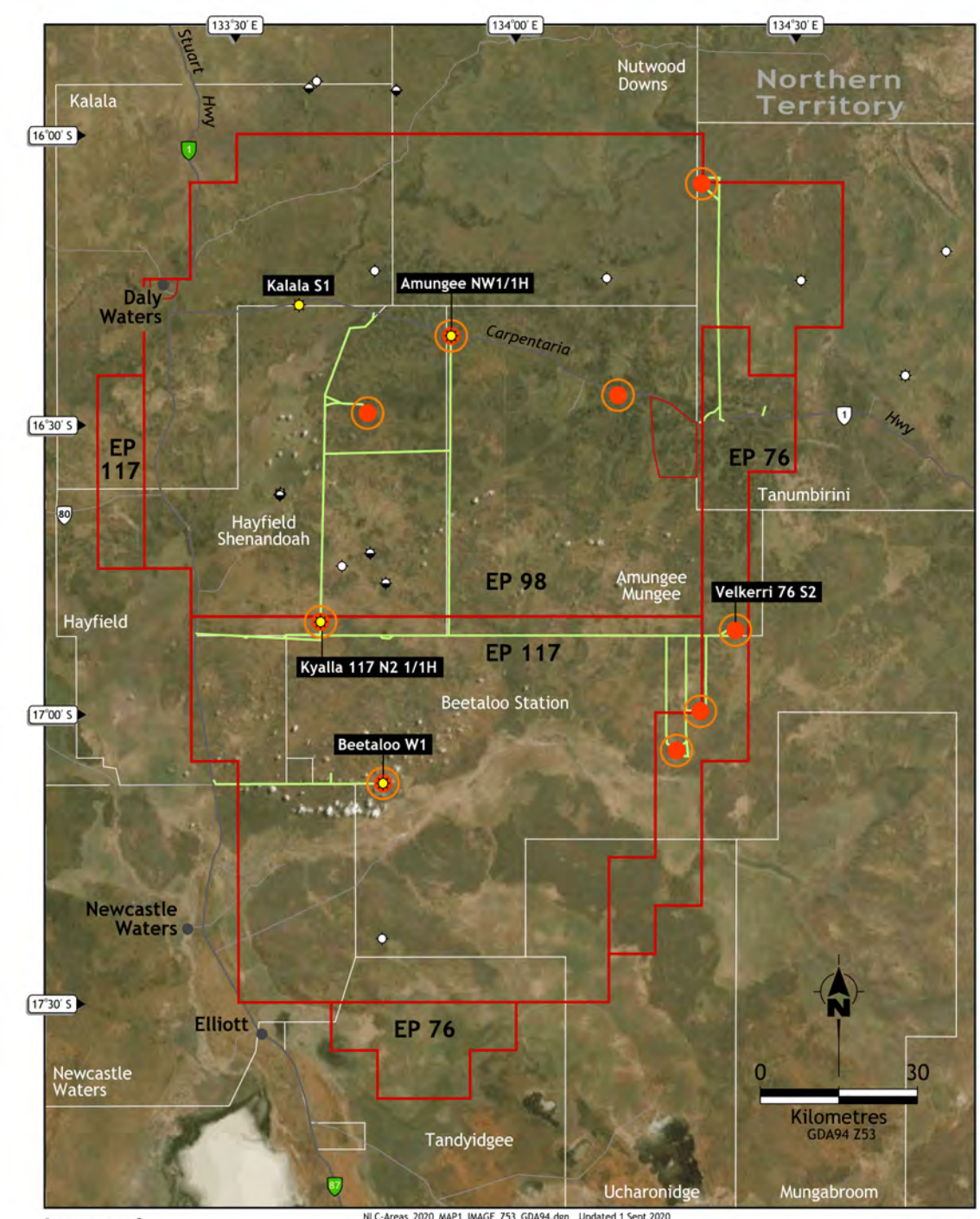
Stephanie Stonier
Corporate Affairs Manager (Northern Australia)
Head of Social Performance

Beetaloo and Growth Assets
Origin
[redacted]

Origin Energy acknowledges the Traditional Owners and Custodians of country throughout Australia and recognises their continuing connection to land, waters and community.

We pay our respects to them and their cultures, and to Elders past, present and future.

Origin shows its commitment to participating in Australia's reconciliation efforts through



NLC-Areas_2020_MAP1_IMAGE_Z53_GDA94.dgn Updated 1 Sept 2020

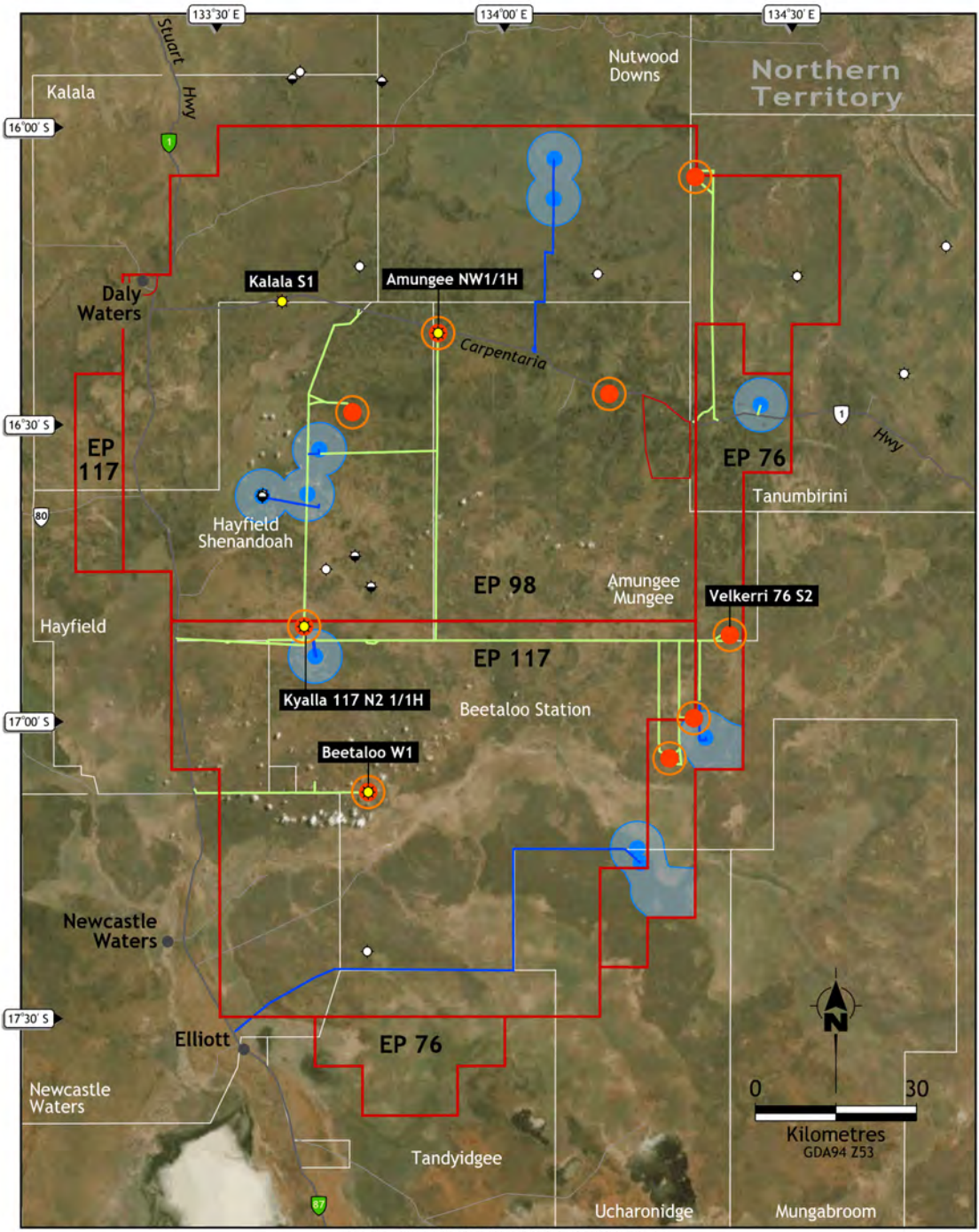
Legend

- Beetaloo JV permits
- Road
- Town
- Pastoral lease
- Pre existing well
- Pre existing well
  Origin constructed well pad
- NLC
  cleared access track
- NLC
  cleared potential well location

Beetaloo Basin
EP 75, EP 98, EP 117
origin

NLC Clearance Areas

Sept. 2020



NLC-Areas_2020_MAP2_IMAGE_Z53_GDA94.dgn Updated 1 Sept 2020

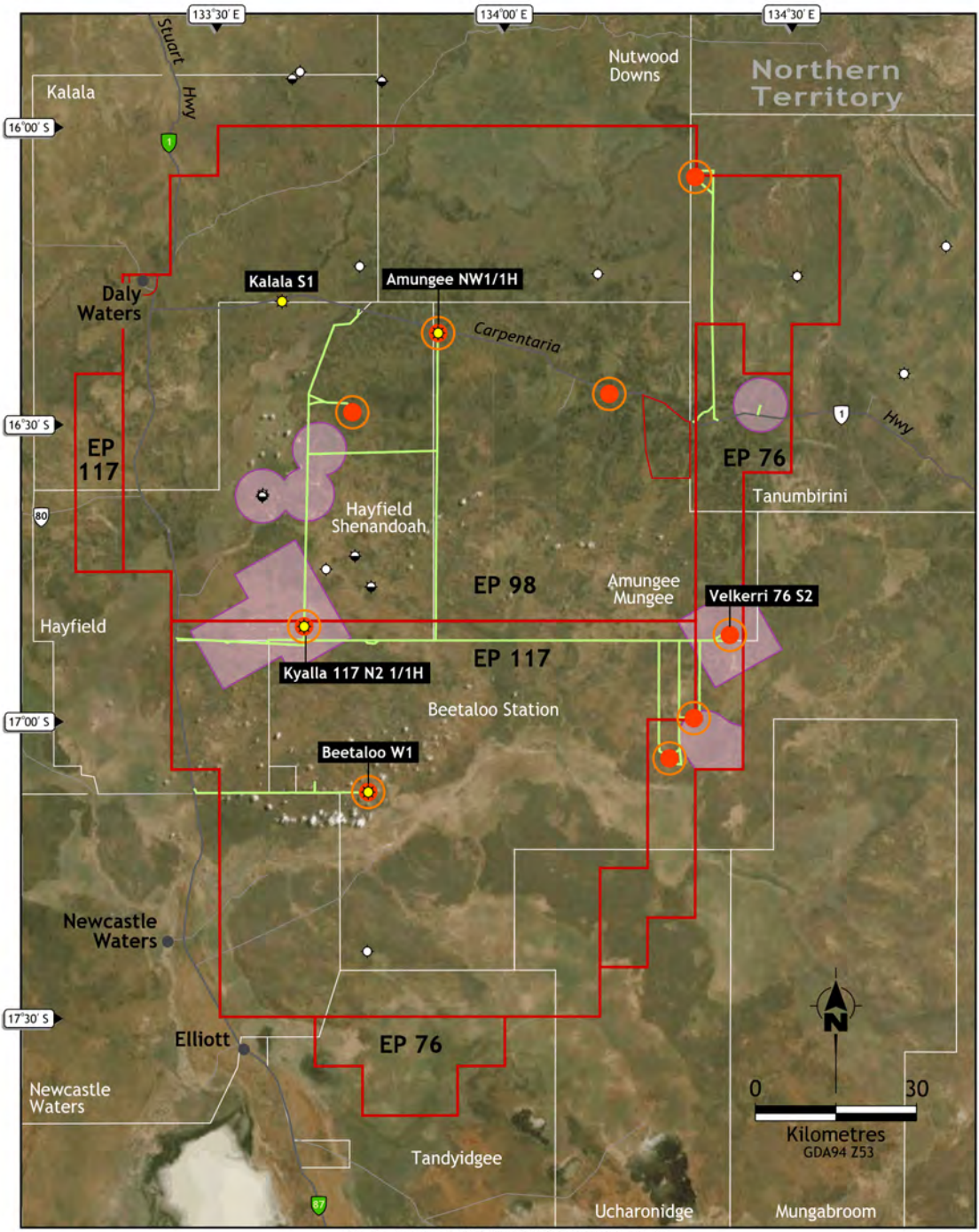
Legend

- Beetaloo JV permits
- Road
- Town
- Pastoral lease
- Pre existing well
- Pre existing well
  Origin constructed well pad
- NLC
  cleared access track
- NLC
  cleared potential well location
- 2019 NLC
  potential well location
- 2019 NLC
  previously provided well clearance areas
- 2019 NLC
  previously provided access route clearance areas

Beetaloo Basin
EP 75, EP 98, EP 117
origin

NLC Clearance Areas

Sept. 2020



NLC-Areas_2020_MAP3_IMAGE_Z53_GDA94.dgn Updated 1 Sept 2020

Legend

- Beetaloo JV permits
- Road
- Town
- Pastoral lease
- Pre existing well
- Pre existing well, Origin constructed well pad
- NLC cleared access track
- NLC cleared potential well location
- NLC areas for clearance

Beetaloo Basin
EP 75, EP 98, EP 117
origin

NLC Clearance Areas

Sept. 2020

Appendix N.1.2 03 200904 email attachment

From:	Stonier, Stephanie
Sent:	Thursday, 3 September 2020 12:07 PM
To:	Altmann, Carl; Aurisch, Karen; Baruch Jurado, Lisa; Bein, Cassie; Clarke, Brendan; Davis, Daniel; DL IG Beetaloo and Growth Assets LT; Dolan, Rebekah; Dunne, Michael; Freeman, Amanda; Jeffrey, Russell; Jenkinson, Les; Mitchell, Brendon; Napier, Casey; Nish, Simon; Pedler, Adam; Pollock, Meg; Rhimes, Andrew; Richards, Brenton; Richards, Tegan; Roll, Mitch; Taylor, Matthew; Thomas, Peter; Wear, Robert
Cc:	Williams, Gary
Subject:	IMPORTANT INFORMATION and INSTRUCTIONS - Approved COVID19 Safety Management Plan - NT Chief Health Officer Approved (Reference Number CHOE-7852 APPROVED)
Attachments:	NT COVID-19 Management Plan_Origin_att.pdf

Good afternoon everyone

I am pleased to share with you that the NT Chief Health Officer yesterday approved our NT COVID19 Management Plan (copy attached) which carries the reference number CHOE-7852.

In order to make travelling (by road or air) to the Northern Territory as easy as possible, please ensure that all personnel have a copy of this Plan with them as well as a copy of this email.

This NT specific plan been put in place to assist all personnel (employees, contractors, service providers etc) with 'NT Quarantine Exemption' (NTQE) applications for **critical / essential workers** coming from NT Government declared 'hotspots'. This Plan is not an overarching approval for persons to enter the NT from declared hot spots and not have to do quarantine, rather it is in place for individual exemption applications to be assessed and approved more efficiently.

NTQE applications need to be made for each individual travelling from a NTG declared hotspot. At the moment we do not have any Beetaloo personnel coming from hotspots though, if new ones are declared, and we have people from those areas, Leads / Managers will need to be notified immediately so myself and Matthew Hanson can make plans for the person to be replaced and / or assist with an NTQE application.

We currently have two NTQE applications in for our international team mates. Cody Nelson has completed his mandatory quarantine in Sydney and is now in Cairns QLD awaiting confirmation to enter the NT. Devin Walker will finish quarantine in Sydney on 6 September. Cody and Devin have to test negative to three tests before they are authorised to leave quarantine and then they are issued a Police Clearance and a Health Clearance. If and when you get to meet Cody and Devin please extend a warm welcome to them, especially as they are a long way from home and quarantine is pretty tough going.

If you have any questions please don't hesitate to reach out.

Kindest regards

Stephanie Stonier
Corporate Affairs Manager (Northern Australia)

Head of Social Performance
Beetaloo and Growth Assets

Origin
[redacted]

Origin Energy acknowledges the Traditional Owners and Custodians of country throughout Australia and recognises their continuing connection to land, waters and community.

We pay our respects to them and their cultures, and to Elders past, present and future.

Origin shows its commitment to participating in Australia's reconciliation efforts through our Stretch Reconciliation Action Plan.

From: CHO_Exemption@nt.gov.au <CHO_Exemption@nt.gov.au>
Sent: Wednesday, 2 September 2020 2:11 PM
To: Stonier, Stephanie [redacted]
Subject: CHOE-7852 APPROVED - Origin Energy - Management Plan - 02/09/2020

Dear Stephanie Stonier

Dear Stephanie,

Your COVID-19 Management Plan is approved.

An employee covered by the approved COVID-19 Management Plan can now apply for an exemption from mandatory supervised quarantine.

On the application, the employee must reference **CHOE - 7852** when prompted.

Important: it is your responsibility to provide this information to your employees. They must carry a copy of the approved COVID-19 Management Plan and this email with them at all times, particularly when crossing the border or they may be placed into mandatory quarantine.

For more information:

NT Border Restriction Exemptions

1800 490 484 (available 8am to 5pm every day)

Coronavirus (COVID-19) in the Northern Territory

- https://coronavirus.nt.gov.au/

For more information regarding this request, reply via email.

Regards,

Border Restriction Exemptions
Phone: 1800 490 484
Email: CHO_Exemption@nt.gov.au

Our Vision: To exceed our clients' expectations with high quality corporate services
Our Values: Honest | Professional | Respectful | Accountable | Innovative

NT COVID-19 Management Plan

This document must be used by you or your company to develop a COVID-19 management plan which is required as part of your application for an exemption. This template has been developed in line with the legal requirements under the Directions of the Chief Health Officer, NT Health.

Please write **N/A** where questions / fields do not apply to you.

You can find more information about crossing the border into the Northern Territory at https://coronavirus.nt.gov.au/

For further assistance please call the Border Restrictions Call Centre on 1800 490 484.

Your name or the name of your organisation	Origin Energy
Key contact	Matthew Hanson
Contact phone number	[redacted]
Contact email address	Matthew.hanson@originenrgy.com.au
Date of travel Please provide an explanation if you have no defined date of travel.	**Travel planned during the period 31-Sep-20 through to 1-Feb-21**
Provide details of the goods you are carrying or the service you intend to provide AND why it is *"essential, critical or urgent"* This is a mandatory field – you must complete this section for your application to be considered.	Origin's activity in the NT includes the drilling, stimulation and extended production testing of exploration wells within Origin's exploration tenure (EP117, 98 and 76). These activities are specialist in nature requiring expertise that is not readily available throughout Australia. To deliver these activities safely and without incident it is critical that these specialists are utilised in Origin's operations. In addition, there is existing infrastructure that Origin must maintain, within the permit areas to ensure ongoing safe and compliant operation.

Travel and accommodation

The majority of interstate personnel travel from Brisbane, Adelaide and Perth to Darwin on commercial flights, then on arrival, transfer to an Origin-provided private aeroplane or bus charter service,

If an individual is required to stay in Darwin overnight to meet connecting flights, the individual will transfer via taxi directly to the Origin designated accommodation in Darwin and undertake self-isolation, eating only delivered meals. Individuals will practice social distancing throughout their transfers through Darwin and will be required to utilise a face mask where they cannot ensure the prescribed social distancing requirements.

A dedicated Origin aeroplane or bus charter service transfers personnel from Darwin to Daly Waters (and return). Once in Daly Waters a dedicated 4WD bus transfers personnel to the Kyalla 117 Wellsite location.

Origin staff and their contractors are accommodated in a dedicated camp at the Kyalla 117 wellsite location which is approximately 30kms off the Stuart Highway in a remote location on the Hayfield Pastoral property

International Workers

- In the event that international workers are required, Federal and NT government requirements will be implemented (which currently requires a 14-day quarantine period).

Origin Dedicated Charter Flight:

- A dedicated charter service operates from Darwin to Daly Waters (and return) (currently provided by Hardys Aviation), the planes utilised are:
  - Nine (9) seater King Air with no more than four (7) passengers per flight; or
  - 18-seater Metroliner with no more than eight (14) passengers per flight.
- Members of the public are not able to purchase seats on charter services.

Origin Dedicated Bus Charter:

- Dedicated bus service from Darwin to Daly Waters (and return) (to be provided by Greyhound):
  - Standard charter of a 52 seat bus with maximum 26 passengers.
- Members of the public are not able to purchase seats on this service.
- A specific Journey Management Plan has been developed for this service which limits stops and exposure of passengers to Northern Territory Residents.

Kyalla 117 Camp

- All workers receive an induction in COVID-19 camp management plan practices including hygiene and social distancing by the Camp Manager and Nurse Practioner / Paramedic.
- Camp provider (OICS) has implemented their COVID-19 management plan to ensure robust hygiene practices are implemented
- All rooms are independent and not interconnected. Rooms are ensuited with individual air-conditioners.

• Segregation of local NT based personnel being allocated their accommodation in dedicated sleeping modules (bed and ensuite rooms) within a set area of the camp.

Physical distancing requirements

Origin is focused on increased social distancing to ensure limited interaction between all personnel, in particular being NT and interstate personnel. Origin have limited all travel into the Northern Territory to critical operations personnel only.

Origin has reconfigured its work crews to achieve separation into:

a) Interstate personnel

c) NT-based personnel, and

d) mixed teams where this is unavoidable.

There are a small number of activities where interstate personnel will be working alongside NT-based personnel. These team members will be educated on the additional risks that this poses and are required to comply with social distancing; and PPE requirements.

Origin Dedicated Charters

- All charters have capacities set to ensure social distancing and where not possible provide masks to be worn.
- The scheduling of Origin's charter flights has been adjusted to allow quick transfer and connection to minimise time periods in between transfers.
- Designated waiting and boarding areas have been defined in Daly Waters for the Daly Waters to Darwin sector and Darwin for the Darwin to Daly Waters sector to ensure social distancing can be maintained.

Kyalla 117 Camp

- Individual ensuited rooms are provided in the camp.
- Rostering of mealtimes has been set up to provide separate sittings for NT based personnel and interstate personnel.
- The camp mess has been modified to accommodate social distancing requirements.
- Rostering of mealtimes has been set up to provide separate sittings for NT based personnel and interstate personnel.
- Meals are plated and served by staff wearing appropriate PPE and workers can collect their meal and eat it away from others to increase social distancing.
- Camp residents leave clothes in their rooms in individual bags.
- Clothing is segregated by each camp resident for cleaning and then returned to the resident's room to avoid non-essential interaction between residents.

Work Areas:

Social distancing is being practiced wherever possible within work groups. In the event that social distancing would prohibit the safe execution of an activity, personnel may be required to wear additional PPE (such as face masks) within the requirements of the approved activity risk assessment.

The small number of workstations within offices have been spread out to meet social distancing requirements.

Essential Goods and Services Transportation / Deliveries

Where deliveries are made to site the driver then returns to cabin to ensure minimal interaction with site personnel. Site personnel load / unload the vehicle and then leave the designated zone. Driver can then be escorted to a dedicated room for personal use and rest prior to leaving site or will immediately leave site.

Workplace hygiene requirements

Origin is focused on increased hygiene to reduce the potential of indirect interaction of workers, in particular between NT and interstate personnel.

Origin has reconfigured its work crews to achieve separation into:

a) Interstate personnel
c) NT-based personnel, and
d) mixed teams where this is unavoidable.

There are a small number of activities where interstate personnel will be working alongside NT-based personnel. These team members will be educated on the additional risks that this poses and are required to comply with hygiene and PPE requirements.

Origin Dedicated Charters

- Hand sanitiser and masks will be made available to all travellers and pilots both of which are recommended to be used.
- Planes and buses are cleaned and sanitised prior to boarding and after disembarking to mitigate secondary exposure.
- The charter company terminal is sanitised and disinfected regularly, including the check-in counter and waiting room facilities.

Kyalla 117 Camp

- All rooms are independent and not interconnected. Rooms are ensuited with individual air-conditioners.
- Room cleans are undertaken daily under a documented safe operating procedure utilising appropriate PPE (Gloves/Mask).
- Cleaning staff are trained and competent and only undertake cleaning activities.
- Segregation of local NT based personnel being allocated their accommodation in dedicated sleeping modules (bed and ensuite rooms) within a set area of the camp.

- The camp mess has been modified to accommodate increased hygiene controls. In accordance with Government recommendations.
- Hand Sanitiser located at designated point prior to entry. Wash basins to clean hands located close to, and prior to, entry point.
- Buffet services are prohibited.
- General waste is regularly collected by local NT service provider and disposed at authorised facility. The contractor follows clear protocols during these collections and if stay in camp do so in designated rooms that are cleaned and sanitised prior to and after each use.
- All common areas have cleaning regimes in place in accordance with the National Health guidelines.

Work Areas

- Personal hygiene practices (i.e. washing hands regularly) are in place in all work areas.
- General / common use activities are operated with PPE (e.g. gloves)
- Workstations are cleaned before and after shift changes.

Management of staff coming from a COVID-19 'hotspot'

Travelling from Hot stop under an NT Exemption

In the event that interstate workers are required from a declared hot spot, NT government requirements will be implemented (which currently require a 14-day quarantine period). Where the individual is in a critical or safety role, then Origin or its contractors will apply for exemption with the NT Government, supported by the following additional controls to those stated within this plan:

- COVID testing to be completed no more than 72 hrs prior to departure
- Post-COVID test personnel to enter quarantine at an Origin-nominated hotel location until travel to the Northern Territory.
- COVID test results to be verified prior to travel.
- Statutory declaration to be completed by the person stating that they do not have symptoms and have complied with the controls and quarantine.
- Personnel will not be allowed to overnight stay in Darwin and will be immediately transferred from commercial flights to Daly Waters and the Origin camp.
- Either bus or aeroplane Charters will be limited to 25% capacity when travelling from Darwin to Daly Waters.

Monitoring and identification of COVID-19 symptoms

- Origin have a designated Nurse Practitioner (Aspen Medical) on location at the Kyalla 117 Camp This is supported by a fully stocked medical facility with adequate supplies.
- Daily health and temperature screening are conducted.
- Health and temperature screening is also conducted prior to authorisation of entry to site.
- Anyone exhibiting a temperature above 38^{o}C and / or COVID-19 like symptoms is excluded from the workplace and quarantined in their room, with their health monitored.
- In this scenario the Aspen Nurse Practitioner has COVID-19 swabs on location and would immediately complete a swab for testing.
- This swab would be sent to Pathology (S&N in Katherine or Darwin) for processing within 48hrs. The person would remain in quarantine until results were received.
- If the result was positive Aspen medical would confirm this with the NT Center for Disease Control and depending on the patient advise next steps for isolation and treatment.
- Origin have private medivac support (Careflight) which could be arranged if necessary.

I declare that all the information I have provided in this document is true and correct to the best of my knowledge and belief. I understand that it is an offence to make a declaration that is false in any way.

Signature

Name Matthew Hanson

Position: Operations and Projects Manager

Date 30-Aug-20

Management Plan

NT-2050-15-MP-0050

Integrated Gas

PANDEMIC (COVID-19) MANAGEMENT PLAN

Beetaloo - Northern Territory

Rev	Date	Reason for issue	Reviewer/s	Consolidator	Approver
0	31/03/2020	Issued for Use	L Fulford E Wong S Stonier C Zipf M Kernke G Williams A Woehrle	M Hanson	T Boyes
1	25/07/2020	Issued for Use	L Fulford E Wong S Stonier	M Hanson	T Boyes

Table of Contents

1. Overview 3
   - 1.1 Purpose 3
   - 1.2 Objectives 4
   - 1.3 Beetaloo Workforce 4
   - 1.4 Operations and Maintenance Activities Only 4
   - 1.5 Contractors supporting Beetaloo Operations 5
   - 1.6 Essential Services 6
   - 1.7 Ongoing Community Support 7
2. Beetaloo Pandemic Management Plan 8
   - 2.1 Workforce fluctuations 8
   - 2.2 Travel to site 8
     - 2.2.1 Implemented Controls 8
   - 2.3 Camp and Accommodation at site 10
     - 2.3.1 Implemented Controls 10
   - 2.4 Working Areas 12
     - 2.4.1 Implemented Controls 12
   - 2.5 Protocols for Personnel travelling under an Exemption 13
     - 2.5.1 Additional Controls 13
   - 2.6 Mental health support 13
     - 2.6.1 Implemented Controls 13
3. Local Community 14
   - 3.1 Public Areas in nearby townships 14
     - 3.1.1 Implemented Controls 14
   - 3.2 Indigenous Communities 14
   - 3.3 Emergency Event 14
     - 3.3.1 Implemented Controls 14
4. Escalation and case management 14
   - 4.1 Resources implemented to oversee effectiveness of response 14

Table of Figures

Figure 1 - Location of Project 3

List of Appendices

Appendix A Beetaloo CoVID-19 response flowchart 15

Appendix B Origin – Exemption Declaration Form 16

1. Overview

1.1 Purpose

The purpose of this document is to describe Origin's plan for its Beetaloo operations in the Northern Territory (NT), to manage the risk of the spread of COVID-19.

Origin's activity in the NT includes the drilling, stimulation and extended production testing of exploration wells within Origin's exploration tenure (EP117, 98 and 76). In addition, there is existing infrastructure that Origin must maintain, within those permit areas to ensure their ongoing safe and compliant operation.

Origin holds three petroleum exploration permits in the Barkly region under the Beetaloo Joint Venture with Falcon Oil and Gas. These permits are EP76, EP98 and EP117 which cover 18,512 square kilometres (km2) of largely pastoral leases on the Sturt Plain, part of the Barkly Tableland, within the NT (Figure 1).

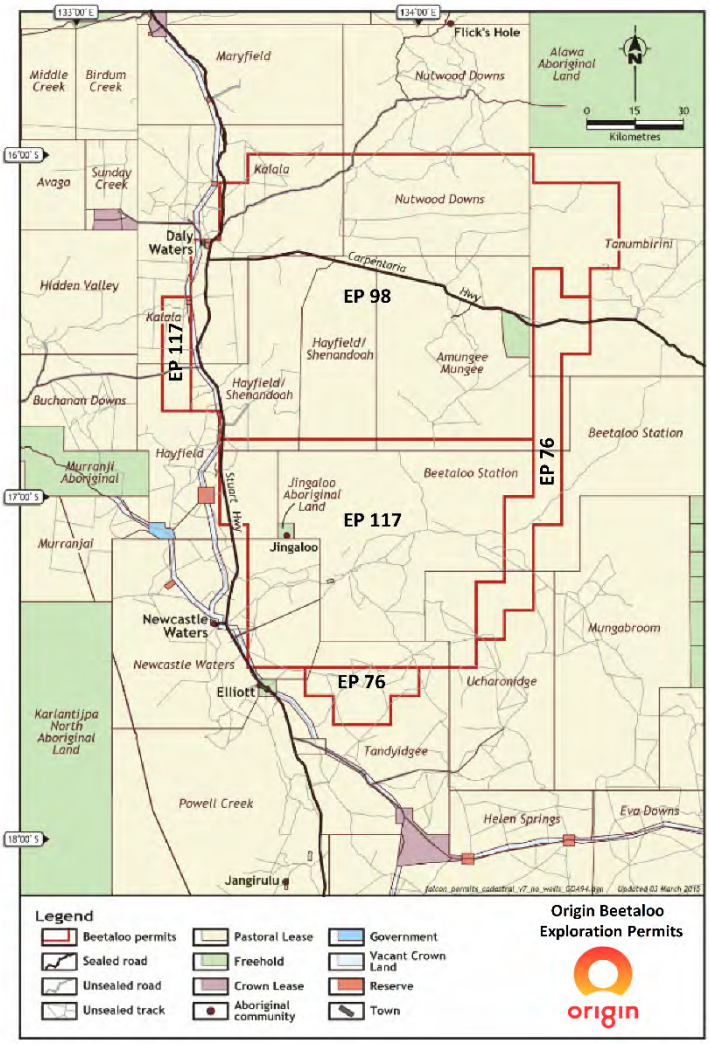


Figure 1 - Location of Project

1.2 Objectives

To continue safe and compliant operations in the Beetaloo, Origin needs to achieve the following objectives:

1. Protect the health and wellbeing of our workforce and communities
2. Achieve separation between interstate FIFO personnel, NT based personnel and local communities to reduce the risk of the spread of COVID-19
3. Continue to work with the NT Government to apply suitable controls.

This document describes the protocols implemented to ensure that all activities conducted at Origin's exploration locations, by both Origin personnel and their contractors, are compliant with:

- NT guidance / requirements for COVID-19 management;
- the requirements of the National Guidelines developed in consultation with the Communicable Diseases Network Australia and endorsed by the Australian Health Protection Principle Committee; and
- Australian Petroleum Production and Exploration Association (APPEA) COVID-19 industry protocols.

As the situation evolves, Origin will ensure its protocols are adapted to ensure they continue to be effective and meet the expectations and standards established by the Chief Health Officer and the NT Government.

Origin has a standing Group Emergency Management Team (GEMT), who oversee and monitor the effectiveness of all COVID-19 management plans in place across Origin's Integrated Gas business.

1.3 Beetaloo Workforce

The controls defined within this management plan are applicable to all types of operations conducted by Origin and their contractors in the Beetaloo. These operations are as below:

Operation	Details
Operations and Maintenance	To conduct ongoing operations and maintenance of existing infrastructure, support compliance monitoring and where required, complete preservation activities of drilling and completions equipment stored at the wellsite. Workforce of up to eight (8) interstate FIFO personnel and twelve (12) NT based personnel.
Civil and Water Bore Drilling	To complete civils construction (e.g. access roads, well pads), and install water monitoring bores. Up to 40 NT based personnel and no more than four (4) interstate FIFO personnel.
Drilling and Completions	Undertaking drilling and completions activities conducted in accordance with approved Environmental Management Plans and Well Operations Management Plans. These activities include drilling, hydraulic fracture stimulation, well testing plus all associated services and activities. Workforce intensity during resumption of these activities is approximately 130 interstate personnel and approximately 25 NT based personnel. See Section 1.3.2 for details around the resumption of these works.

1.4 Operations and Maintenance Activities Only

When neither Drilling and Completions, or civil and water bore activities are being conducted then limited activities will be undertaken to support Operations and Maintenance.

To meet regulatory obligations through Operations and Maintenance periods, Origin is required to undertake the following activities.

Activity	NTG Requirement
Fluid monitoring	Code of Practice for Onshore Petroleum Activities (NT) / Well Operations Management Plan requirement *(Department of Primary Industries and Resources, DPIR) – frequency - daily*
Well monitoring	Code of Practice for Onshore Petroleum Activities (NT) / Well Operations Management Plan requirement *(DPIR)* - frequency - daily.
Water sampling/monitoring	Code of Practice: Onshore Petroleum Activities in the NT/ Environmental Management Plan occurring every 3 months. *(Department of Environment and Natural Resources, DENR)*
Weed Monitoring	Environmental Management Plan / Weed Management Planning guide: Onshore Petroleum Projects - surveys are conducted both pre and post wet season September / May each year (*DENR*).
Gas leak detection	Code of Practice for Onshore Petroleum Activities (NT) – six (6) monthly gas leak detection undertaken in September / May every year (*DENR*).
Sump Sampling	Environmental Management Plan Approvals notice - within three (3) months of the completion of a well being drilled (*DENR*)

Where possible, Origin will utilise NT-based companies and personnel to provide these services. Where this is not possible, and specialist personnel from jurisdictions other than the NT are required, the controls described in the remainder of this management plan will be operational.

1.5 Contractors supporting Beetaloo Operations

To support Origin's Beetaloo operations, the below contract personnel will operate under this management plan while working in service of Origin's operation in the Beetaloo.

Where contract companies and their personnel operate in multiple jurisdictions, and have their own company Pandemic Management plans, their plans will at a minimum meet the controls described in this plan.

Contractor Name	Work Scope
AECOM	Environmental Support services
Allwell NT	Waterbore drilling
Arnhem Earthmoving & Mechanical (AEM)	Civil activities and maintenance support.
Aspen Medical	Onsite medical support.
Baker Hughes GE	Drilling and Completion services
Boots & Coots	Drilling and Completion Services
Careflight	Emergency Medical support
Cedrent	Vehicle hire and camp supply.
Daly Waters Wayside Inn (Pub)	Provision of fuel and consumables and bus transfer service Normal operations supply dedicated accommodation and meals.
Elemental Group	Drilling services

Contractor Name	Work Scope
Ensign	Drilling services
Fendley Consulting	Wellsite Representative support (Site supervision)
Firetail	Drilling services
Greyhound	Bus Charter (Darwin to Daly Waters and return)
Halliburton	Drilling and Completion services
Hardys Aviation	Aviation services (Charter flight - Darwin to Daly Waters)
Hi Way Inn (Daly Waters)	Provision of fuel and consumables and water (when required) Normal operations supply dedicated accommodation and meals.
Jayrow	Helicopter services
MPC Kinetic	Fluid management support
Oceania Geo	Drilling and Completion services
Oil Industry Catering Services (OICS)	Camp and logistical services.
Protechnics / Core Labs	Completion services
Petrolabs	Completion services
Savanna	Completion services
Schlumberger	Drilling and Completion services
SGS	Completion Services
Tango	Drilling and Completions services
Toll	Logistics
Triple P Contracting (Triple P)	Waste removal and Daly Waters airport maintenance.
Tropwater	Water monitoring activities
Weatherford	Drilling services

1.6 Essential Services

Origin utilises the following essential services to maintain operations in the Beetaloo.

Service	Details
Accommodation	The majority of Origin personnel and contractors reside at the wellsite camps. The Kyalla camp is approximately 30kms from the Stuart Highway.
Emergency Management	Origin's emergency response services are contracted through Careflight (Darwin based operations)
Food	Food is separately ordered and supplied to Origin through its camp contractor (OICS) with provisions primarily sourced from NT businesses and delivered to site on a frequency of approximately once per week from Katherine.
Fuel	Fuel is supplied by Caltex from Katherine and Darwin and is transported to field locations, via NT based contractors – AEM (Humpty Doo-based) and JKH Transport (Daly Waters-based)

Service	Details
Medical	Nurse Practitioners / Paramedics are based at the wellsite and these services are contracted through Aspen Medical (interstate FIFO personnel).
Waste Removal	General waste is collected from the wellsite camp locations 30-100kms from the Stuart Highway utilising Elliot-based contractor Triple P Contracting.

1.7 Ongoing Community Support

Origin is an active community member within the Barkly region and Northern Territory. Origin will continue to support the local community where possible, including via:

1. Daly Waters Airfield - provision of inspection services, maintenance and equipment to support the ongoing safe operations of the airfield for the community.
2. Emergency Management - provision of first responder support in the event of an incident.
3. Medical Support - through Origin's Nurse Practitioner / Paramedic presence at the wellsite, providing medical support to the local community when required.
4. Food and consumables - sourcing the majority of food and consumables via NT providers.
5. Local and NT employment as described in sections 1.3 – 1.6 above

2. Beetaloo Pandemic Management Plan

The controls defined within this management plan are applicable to all levels of operations being conducted by Origin and their contractors in the Beetaloo. These levels of operations are as below.

2.1 Workforce fluctuations

Remobilisation of workers required for the resumption of drilling and completions activities is currently planned for Q3 2020. From this time the workforce supporting Origin's Beetaloo Operations will fluctuate (as described in Section 1.3) based on the works being conducted. Throughout these fluctuations Origin and its Contractors will comply with the controls defined within this plan.

2.2 Travel to site

There are a number of avenues for site travel into the Beetaloo:

1. Travel for crew change and a small number of personnel for initial mobilization will be facilitated by a private charter flight (provided by Hardy Aviation) from Darwin to Daly Waters, connected by commercial flights from Brisbane, Perth and Adelaide. This charter flight lands at the Daly Waters Airfield where a private bus collects the workers and transports them directly to either of the worksites 80km and 130 km south east of Daly Waters.
2. In addition, a dedicated chartered bus service will be in place from Darwin to Daly Waters for any smaller crew changes who are not transferred by private charter flight. This will connect to a further private bus service in Daly Waters and transport workers to the worksites.
3. A number of personnel are required to drive into work locations with the mobilization of specialised equipment either from within the Northern Territory or interstate.

2.2.1 Implemented Controls

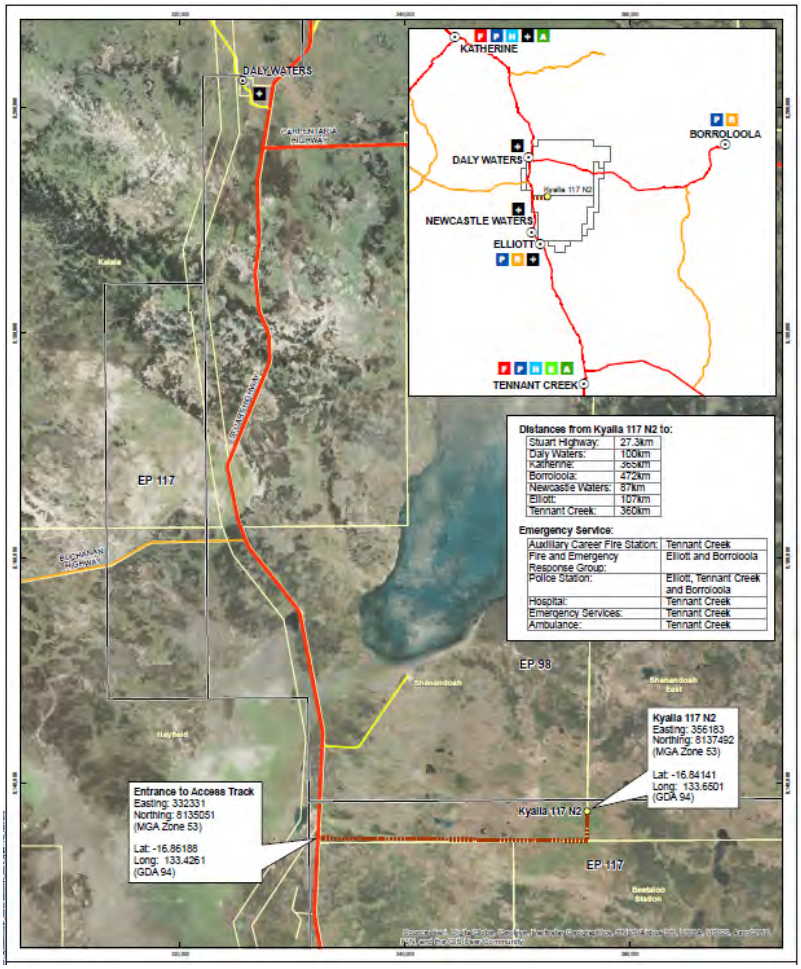
Risk Exposure	Control
Pre-mobilisation	• A NT Government border arrival / COVID-19 Declaration Form (NT COVID Declaration Form) must be completed by all travellers no earlier than 72 hours prior to their anticipated arrival date. This is to be provided to Origin by contractors 48 hours prior to departure - without this travel will be cancelled. • These declarations are obtained by an Origin representative prior to authorisation of company booked travel (commercial and charter) and if the requirements are not met, the individual will be prohibited from travelling and will be required to self-isolate in line with Federal government recommendations.
Domestic Flights	• The majority of interstate personnel travel from Brisbane, Adelaide and Perth to Darwin on commercial flights, then on arrival, transfer to an Origin-provided private aeroplane or bus charter service. • Social distancing on commercial flights cannot be guaranteed however wearing the masks that are provided on flights is recommended. • If an individual is required to stay in Darwin overnight to meet connecting flights, the individual will transfer via taxi directly to the Origin designated accommodation in Darwin and undertake self-isolation, eating only delivered meals. Individuals will practice social distancing throughout their transfers through Darwin and will be

Risk Exposure	Control
	required to utilise a face mask where they cannot ensure the prescribed social distancing requirements.
Charter Flight(s) - Darwin / Daly Waters RETURN	• Dedicated charter service from Darwin to Daly Waters (and return) (currently provided by Hardy Aviation): - Nine (9) seater King Air with no more than four (7) passengers per flight; or - 18-seater Metroliner with no more than eight (14) passengers per flight. • Members of the public are not able to purchase seats on charter services. • Hand sanitiser and masks will be made available to all travellers and pilots both of which are recommended to be used. • Planes are cleaned and sanitised prior to boarding and after disembarking to mitigate secondary exposure. • The charter company terminal is sanitised and disinfected regularly, including the check-in counter and waiting room facilities. • The scheduling of Origin's charter flights has been adjusted to allow quick transfer and connection to minimise time periods in between transfers. • Designated waiting and boarding area in Daly Waters for the Daly Waters to Darwin sector which follows the same protocols as the Darwin to Daly Waters sector
Charter Bus – Darwin / Daly Waters RETURN	• Dedicated bus service from Darwin to Daly Waters (and return): - Standard charter of a 52 seat bus with maximum 26 passengers. • Members of the public are not able to purchase seats on this service. • Hand sanitiser is available for all travellers and drivers. • Buses are cleaned and sanitised prior to boarding and after disembarking to mitigate secondary exposure. • The scheduling of Origin's bus transfers has been adjusted to allow quick transfer and connection to minimise time periods in between transfers. • Designated waiting and boarding area in Daly Waters for the Daly Waters to Darwin sector which follows the same protocols as the Darwin to Daly Waters sector • A specific Journey Management Plan has been developed for this service which limits stops and exposure of passengers to Northern Territory Residents.
International personnel	• In the event that international workers are required, Federal and NT government requirements will be implemented (which currently require a 14-day quarantine period, up to 28 days if arriving in Australia to another port other than Darwin).
Interstate personnel	• In the event that interstate workers are required from a classified hot spot, NT government requirements will be implemented (which currently require a 14-day quarantine period). Where the individual is in a critical or safety role, then Origin or its contractors will apply for exemption with the NT Government, supported by additional controls defined in Section 2.5.
Essential Goods and Services Transportation	• Drivers arrive and the vehicle is parked in a designated zone which has been demarcated to ensure social distancing in accordance with government and health advice. • Driver alights the vehicle to lash / unlash the load. • Driver then returns to cabin to ensure minimal interaction with site personnel.

Risk Exposure	Control
	• Site personnel load / unload the vehicle and then leave the designated zone. • Driver can then alight vehicle and secure the load. • Driver can then be escorted to a dedicated room for personal use and rest prior to leaving site. • Designated rooms are cleaned and sanitised prior to and after each use. • Drivers are instructed to follow NT government advice regarding social distancing at all times.

2.3 Camp and Accommodation at site

Origin's camp at the Kyalla 117 wellsite location is approximately 30kms off the Stuart Highway in a remote location on the Hayfield Pastoral property.



2.3.1 Implemented Controls

Risk Exposure	Control
Member of the public interacting with workers at camp	• Fully self-sufficient camp accommodation at Kyalla 117 (~80km from Daly Waters), is closed to members of the public. Only approved personnel who are booked into the remote wellsite camp can enter the camp.
Daly Waters accommodation	• The majority of Origin personnel will be accommodated at wellsite camp(s). There may be circumstances where Origin personnel will be required to work out of the Daly Waters office. During these times personnel will be restricted to the Origin office and designated accommodation areas only.

Risk Exposure	Control
	• In the event a worker is required to utilise local accommodation, social distancing, meal delivery / takeaway meals, and hygiene practices will be implemented.
Camp Accommodation	• All workers receive an induction in COVID-19 camp management plan practices including hygiene and social distancing by the Camp Manager and Nurse Practioner / Paramedic. • Camp provider (OICS) has implemented their COVID-19 management plan to ensure robust hygiene practices are implemented • All rooms are independent and not interconnected. Rooms are ensuited with individual air-conditioners. • Room cleans are undertaken daily under a documented safe operating procedure utilising appropriate PPE (Gloves/Mask). • Cleaning staff are trained and competent and only undertake cleaning activities. • Segregation of local NT based personnel being allocated their accommodation in dedicated sleeping modules (bed and ensuite rooms) within a set area of the camp.
Food Service	• Only kitchen staff undertake cooking activities. • Camp Mess is cleaned and sanitised between meal services. • The camp mess has been modified to accommodate increased social distancing and hygiene controls. In accordance with Government recommendations. • Rostering of mealtimes has been set up to provide separate sittings for NT based personnel and interstate personnel. • Meals are plated and served by staff wearing appropriate PPE and workers can collect their meal and eat it away from others to increase social distancing. • Hand Sanitiser located at designated point prior to entry. Wash basins to clean hands located close to, and prior to, entry point. • Buffet services are prohibited.
Laundry	• Camp residents leave clothes in their rooms in individual bags. • Clothing is segregated by each camp resident for cleaning and then returned to the resident's room to avoid non-essential interaction between residents.
Medical Support	• Designated Nurse Practitioner on location (Aspen Medical). • Fully stocked medical facility with adequate supplies. • Daily health and temperature screening are conducted. • Health and temperature screening is also conducted prior to authorisation of entry to site. • Anyone exhibiting a temperature above 38°C and / or COVID-19 like symptoms is excluded from the workplace and quarantined in their room, with their health monitored. • Private medivac will be arranged if necessary.
Common Areas (recreational area and gym).	• The camp gym and recreation room will be open to camp occupants however social distancing requirements are in place and cleaning regime in place in accordance with National Health guidelines. • Workers are encouraged to use open-air recreational areas to ensure physical and mental wellbeing while maintaining social distancing.
Waste removal	• General waste collected by local NT service provider and disposed at authorised facility.

Risk Exposure	Control
	• Origin COVID-19 Declaration Form completed for drivers (Pre-mobilisation) • Drivers arrive and the vehicle is parked in a designated zone which has been demarcated to ensure social distancing in accordance with government and health advice. • Driver alights the vehicle to lash / unlash the load. • Driver then returns to cabin to ensure minimal interaction with site personnel. • Site personnel load / unload the vehicle and then leave the designated zone. • Driver can then alight vehicle and secure the load. • Driver can then be escorted to a dedicated room for personal use and rest prior to leaving site. • Designated rooms are cleaned and sanitised prior to and after each use. • Drivers are instructed to follow NT government advice regarding social distancing at all times.

2.4 Working Areas

Origin is focused on increased hygiene controls and social distancing to ensure limited interaction between the interstate personnel and NT-based personnel.

Hygiene protocols and education sessions will be rolled out to all work groups with additional supplies of cleaning and sanitiser product available to crews.

Origin has reconfigured its work crews to achieve separation into:

a) Interstate personnel

c) NT-based personnel, and

d) mixed teams where this is unavoidable.

There are a small number of activities where interstate personnel will be working alongside NT-based personnel. These team members will be educated on the additional risks that this poses and are required to comply with social distancing; hygiene and PPE requirements.

2.4.1 Implemented Controls

Risk Exposure	Control
Working as a group (more than one person completing tasks)	• Social distancing is being practiced wherever possible within work groups. In the event that social distancing would prohibit the safe execution of an activity, personnel may be required to wear additional PPE (such as face masks) within the requirements of the approved activity risk assessment. • Personal hygiene practices (i.e. washing hands regularly) are in place.
Safety (Prestart/Debrief meetings).	• Pre-start briefings are conducted in areas large enough to facilitate appropriate levels of social distance
Handovers	• Undertaken as per government recommendations to limit face to face handovers.
Aboriginal camp personnel	• There are two Aboriginal workers who are NT residents, who undertake cleaning activities at the camp – they are accommodated in the NT resident wings / pods only.

2.5 Protocols for Personnel travelling under an Exemption

To protect NT residents, the NT government may define hot stops at locations around Australia where cases of COVID are prevalent. If a nominated hotspot is home base for any critical or safety critical personnel then the safety of Origin's Beetaloo operations could be compromised. In this circumstance an exemption will be requested by Origin or its Contractors with the NT government. To support this exemption the following controls will be implemented in addition to those stated through Section 2:

2.5.1 Additional Controls

Risk Exposure	Control
Pre-mobilisation	• COVID testing to be completed no more than 72 hrs prior to departure • Post-COVID test personnel to enter quarantine at an Origin-nominated hotel location until travel to the Northern Territory. • COVID test results to be verified prior to travel. • Statutory declaration to be completed by the person stating that they do not have symptoms and have complied with the controls and quarantine.
Travel	• Personnel will not be allowed to overnight stay in Darwin and will be immediately transferred from commercial flights to Daly Waters and the Origin camp. • Either bus or aeroplane Charters will be limited to 25% capacity when travelling from Darwin to Daly Waters.

2.6 Mental health support

Origin recognises the impact that this may have on our workforce so additional controls have been put in place to support our workforce in accessing wellbeing and mental health support during this challenging time.

Social distancing presents a unique set of challenges and Origin is working closely with our Employee Assistance Provider to develop strategies to support our workforce.

2.6.1 Implemented Controls

Risk Exposure	Control
Mental health support	• Nurse Practitioner on site • 24/7 support via Converge International - **1300 687 327** Beetaloo Emergency Response Hotline / Injury Assist Hotline **1300 229 902** • Internal People and Culture support

3. Local Community

3.1 Public Areas in nearby townships

Food provisions are managed by Origin's third-party camp provider (OICS). Origin personnel have no requirement to access public areas in nearby townships.

3.1.1 Implemented Controls

Risk Exposure	Control
General personal consumables.	• A weekly order facilitated to ensure no need to interact in local NT populations (i.e. Daly Waters). Orders can be placed via email or telephone and paid electronically prior to pick up. • Social distancing maintained during pick up.

3.2 Indigenous Communities

All Beetaloo personnel are prohibited from entering Aboriginal communities without prior approval and discussion with the Northern Land Council. The exception to this is where stops are required in townships as part of travel through the NT. In these cases journey management plan will be adhered to which minimises this interaction with social distancing required at all times.

3.3 Emergency Event

In the event of an unexpected emergency occurring during operations, Origin will revert to its approved Emergency Response Plan under its Environmental Management Plan and Well Operations Management Plan. Should these plans be activated, likely interactions are set out below.

3.3.1 Implemented Controls

Risk Exposure	Control
Emergency event occurs during operations – Darwin-based Careflight response required	• Helicopter Landing Site at each wellsite • Trained staff in emergency response • Nurse Practitioner on location • Tasking agreement with Careflight.
Well Control	• Well Control specialist on standby. • Application for international exemptions as determined by the Commissioner of the Australian Border Force for persons with critical skills such as Boots & Coots as per the guidance on the Home Affairs website.

4. Escalation and case management

Response Plans have been developed to support the operational team with prevention and preparedness (See Appendix A).

Should there be a confirmed case, additional controls are ready to be enacted to ensure further quarantining of work groups, isolation of individual cases and the private medivac of the individual off location - if advised by medical professionals

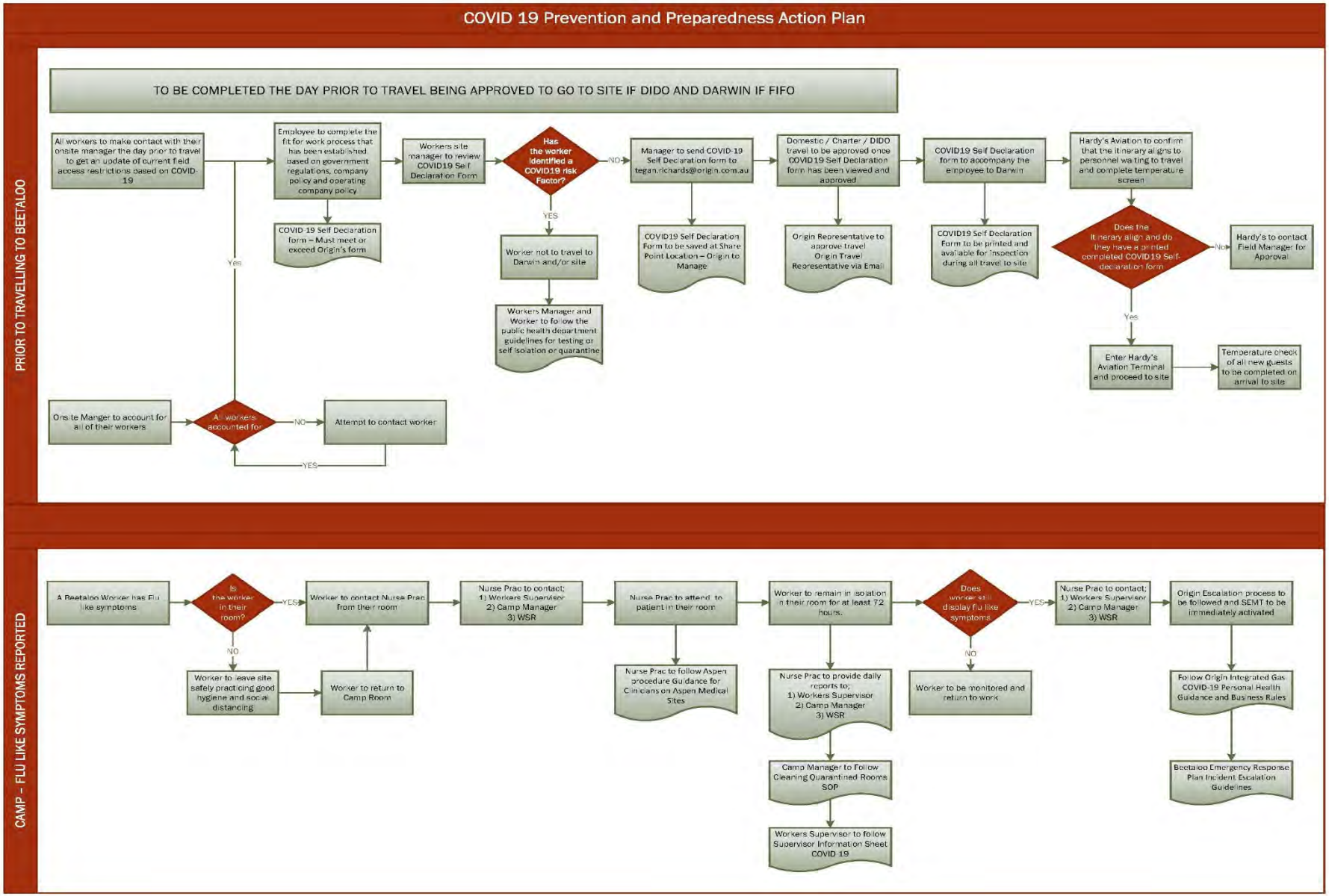
4.1 Resources implemented to oversee effectiveness of response

The site team is directly supported by an overarching emergency management and response structure and adequate resources are available to support where required.

Origin has a standing Group Emergency Management Team, who oversee and monitor the effectiveness of all COVID-19 management plans in place across Origin's Integrated Gas business.

Origin has also implemented its Crisis Management Team (CMT) who oversee and monitor the situation across all Origin's operations for the duration of the CoVID-19 threat.

Appendix A Beetaloo CoVID-19 response flowchart



Appendix B Origin – Exemption Declaration Form

Coronavirus (COVID-19) Declaration

origin

Our principle of due care

At Origin, we care about the health and wellbeing of our people and the communities in which we operate. This declaration is for workers critical to the ongoing safe operations of Origin's Beetaloo activities, who are travelling from declared NT Government declared Coronavirus (COVID-19) hotspots (*Declared hotspots*). To protect our employees, contractors and visitors from the potential of contracting COVID-19, we ask that you answer the following questions:

Q1: Have you completed and received a negative COVID-19 Test within the last 72 hrs?

YES ☐ NO ☐

Q2: Since completing the COVID-19 Test have you been in individual self-isolation at the nominated hotel?

YES ☐ NO ☐

Q3: On your transit will you practice social distancing and where not possible wear a mask?

YES ☐ NO ☐

Q4: Are you aware of and will you compile with all controls defined in the Origin Beetaloo COVID Management Plan?

YES ☐ NO ☐

Q5: Have you completed your NT border declaration form and printed off for entry?

https://coronavirus.nt.gov.au/travel/quarantine

YES ☐ NO ☐

If you have answered **NO** to above questions 1-5, you are **not** permitted to travel to the Northern Territory.

This form should be filled in no more than 72 hours prior to travelling

If you require assistance, please speak with the person supplying this form.

First name:_____ **Surname:**_____

Company:_____ **Contact number:**_____

Signature:_____ **Date:**____/____/____

COMPLETED BY ORIGIN OR A NOMINATED REPRESENTATIVE

Witness name:_____

Witness signature:_____

Date:_____/_____/_____

Form to be retained by IG: Site Administration V9/ 05082020

Appendix N.1.2 04 ORIGIN_2019 Request 28 Sept 202

Annexure A:

2019 Work Program Document provided to the NLC (28 September 2020)

2019 Work Program Clearance Request

(For Potential Exploration Works from 2020)

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

Version:	**1.0**
Submitted:	
Presented by:	Origin Energy
Review Date:	November 2019

CONTENTS

EP98, 117, 76 – Beetaloo Joint Venture (Origin / Falcon) 1

CONTENTS 2

1 OVERVIEW 3

2 PROPOSED WORK PROGRAM 3

2.1 Activities 4

2.2 Areas 4

2.3 Request 5

2.4 Figures 5

2.5 Tables 5

2.6 Appendices 5

2.7 Attachments 5

3 APPENDICES 10

1 OVERVIEW

- 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). The Amungee NW 1H well was hydraulically fracture stimulated (HFS) in 2016 (prior to the introduction of a moratorium in September 2016) as part of an exploration work program to assess the potential of hydrocarbons in the Beetaloo (Figure 1).

- In 2018 the moratorium was lifted and in 2019, post the implementation of the NT Inquiry *Exploration Recommendations*, Origin resumed exploration activity in Exploration Permit 117 (EP117) drilling a vertical exploration well, and a horizonal appraisal well targeting the Kyalla formation. HFS is scheduled to be undertaken at Kyalla 117 N2 1H beginning in Q4 2020.

- The approved budget to execute two (2) exploration wells in 2019 was approximately $120 million.

- The full time period for drilling and stimulation is approximately:
  - Drilling: Two (1-4) km deep and two (2-3) km long: Twelve (12) weeks
  - Stimulation (of well with above specifications): Three (3) weeks
  - Production testing: Three (3) months (up to 12 months)
  - Maintenance and monitoring: Ongoing

- Origin's *Northern Territory Government permit commitments* across Exploration Permit 98 (EP), Exploration Permit 76 (EP76) and EP117 (the Permits) require Origin to complete a further four (4) additional exploration wells to be drilled and stimulated.

- Origin's exploration program is designed to identify areas of perspectivity for a potential, future hydrocarbon development.

- Origin respectfully requests the Northern Land Council's assistance to facilitate a *Sacred Site Clearance Survey* of eight (8) potential future exploration locations and access routes (where necessary across the Permits) 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 (Figure 2).

2 PROPOSED WORK PROGRAM

- Origin is proposing to drill, HFS and production test four (4) horizontal wells across the Permits over 2019-2022. It is possible that vertical wells will be drilled prior to proposed horizontal wells (that is, a proposed horizontal well would be drilled from a vertical well as occurred for the Amungee NW 1H well).

- Origin may seek approvals to drill, HFS and production test from two (2) to four (4) additional horizontal wells (and associated vertical wells if required).

- Civil works activities to support the exploration program may be undertaken throughout 2020 (note this is likely to include the construction of roads to enable site access along with supporting activities such as accessing aggregate from identified gravel pits, water through registered water bores and the installation of additional water monitoring bores as per the requirements of the NT Inquiry).

- Civil works and associated activities are likely to be undertaken on sites where NLC Clearance and AAPA certification is held to facilitate exploration activity beyond 2020.

- 3D or 2D seismic activity

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 Activities

The following activities would be required to complete work across the sites included in this request:

Activities, in approximate order of operation, include:

1. Scouting, surveying, and small-scale surface and shallow subsurface sampling of soils to support geotechnical studies and environmental evaluation.

2. Civil engineering activity to repair, improve and/or construct access tracks and/or unsealed roads and well pads (e.g. grading, excavation, fencing); note this activity may require borrow pits along access routes and close to well pads.

3. Drilling/installation of water bores as required.

4. Exploration drilling (vertical and horizontal wells).

5. HFS (horizontal wells and associated vertical wells if required) (including HFS monitoring equipment).

6. Production testing.

7. Follow-up testing, monitoring and work-over activity (as required).

8. 2D or 3D seismic data collection activity

8. Activities associated to the plugging, abandonment and/or remediation of wells after proper testing and monitoring has been conducted (as required).

9. Any other auxiliary works/activities required under good oilfield and/or environmental practice and accepted project commitments to support foregoing activities.

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 and digital GIS files detail the location of eight (8) potential sites, and associated access routes requested for Sacred Site Clearance surveying.

    - Sites - the initial clearance request is for an extended polygon providing a radius area area around the proposed location.

- Access Routes - the initial clearance request is for a 100 m buffer zone either side of the access tracks; however, Origin will support a wider clearance area as needed by the NLC and cultural monitors and/or Traditional Owners.

• 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 current NLC cleared locations
Figure 3 Summary map of additional proposed locations, clearance areas and associated access routes requested for Sacred Site Clearance survey

2.5 Tables

Table 1 Propose site locations for Sacred Site Clearance survey.

2.6 Appendices

Appendix 1 Indicative Activity Descriptions
Appendix 2 Minimising Environmental Impact

2.7 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

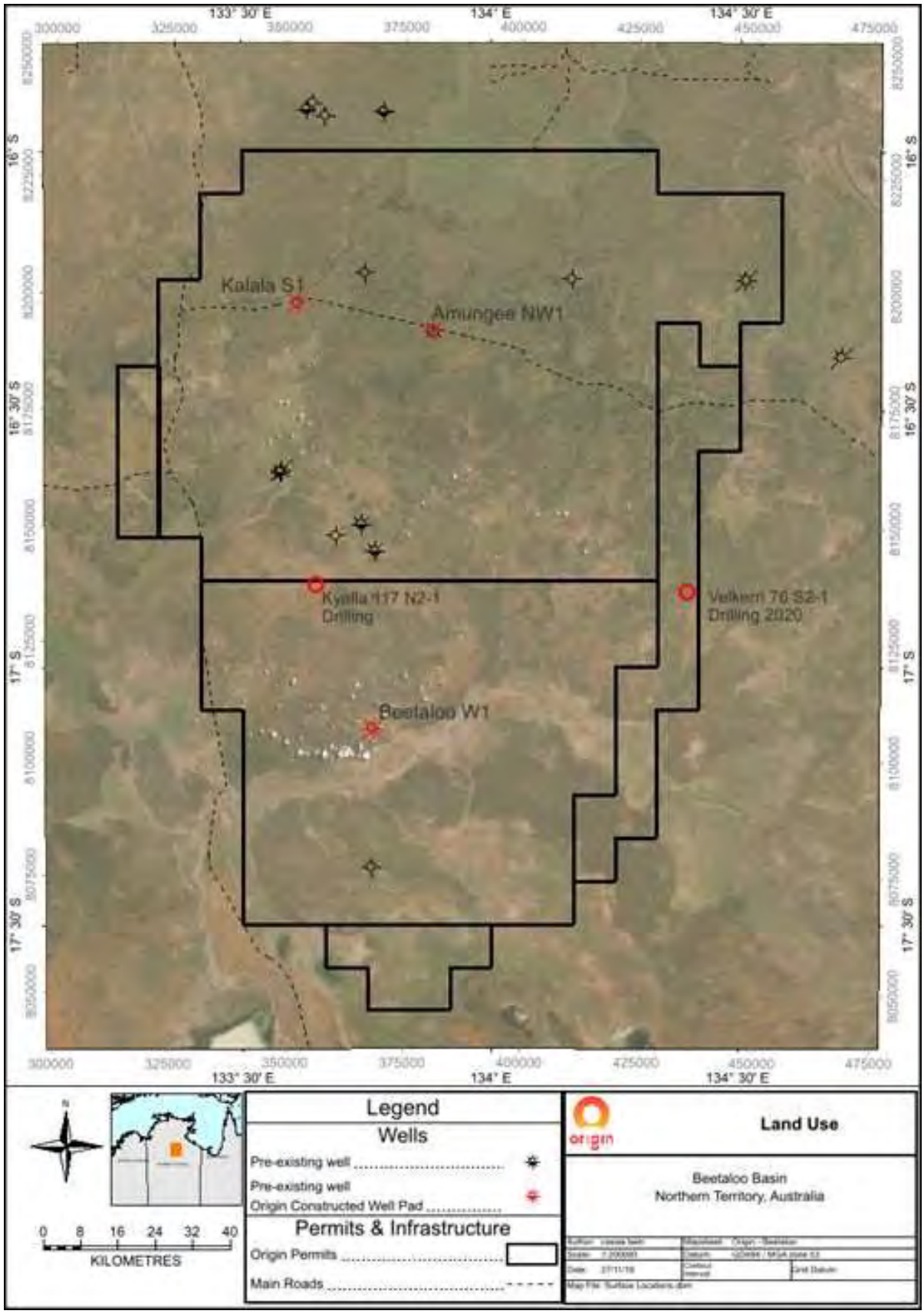

133° 30' E
134° E
134° 30' E
300000
325000
350000
375000
400000
425000
450000
475000
8250000
8225000
8200000
8175000
8150000
8125000
8100000
8075000
8050000
16° S
16° 30' S
17° S
17° 30' S
Kalala S1
Amungee NW1
Kyalla 117 N2-1
Drilling
Velkern 76 S2-1
Drilling 2020
Beetaloo W1
N
0 8 16 24 32 40
KILOMETRES
Legend
Wells
Pre-existing well
Pre-existing well
Origin Constructed Well Pad
Permits & Infrastructure
Origin Permits
Main Roads
origin
Land Use
Beetaloo Basin
Northern Territory, Australia

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

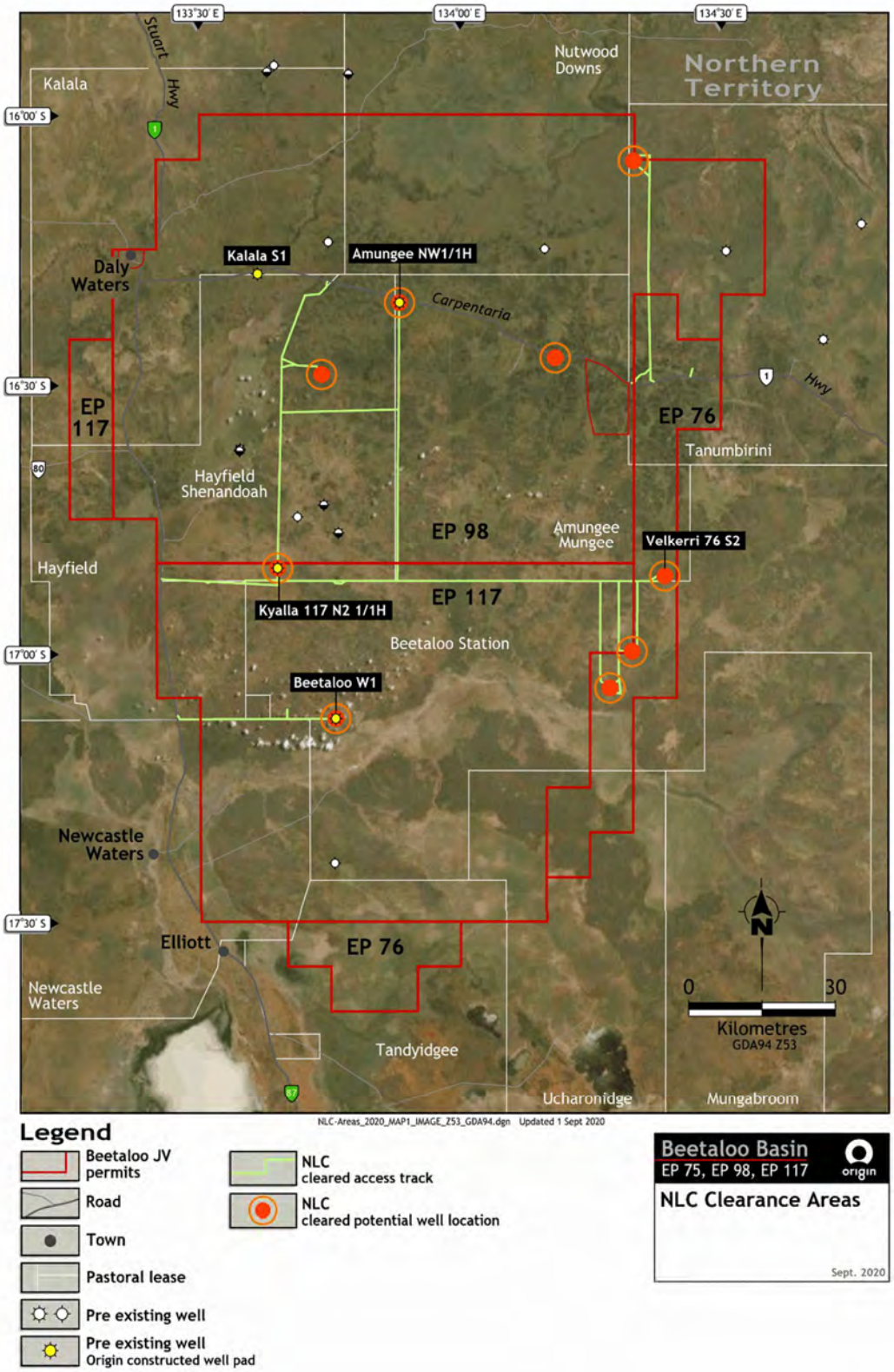


Figure 3 - Summary map of additional proposed locations, clearance areas and associated access routes requested for Sacred Site Clearance survey

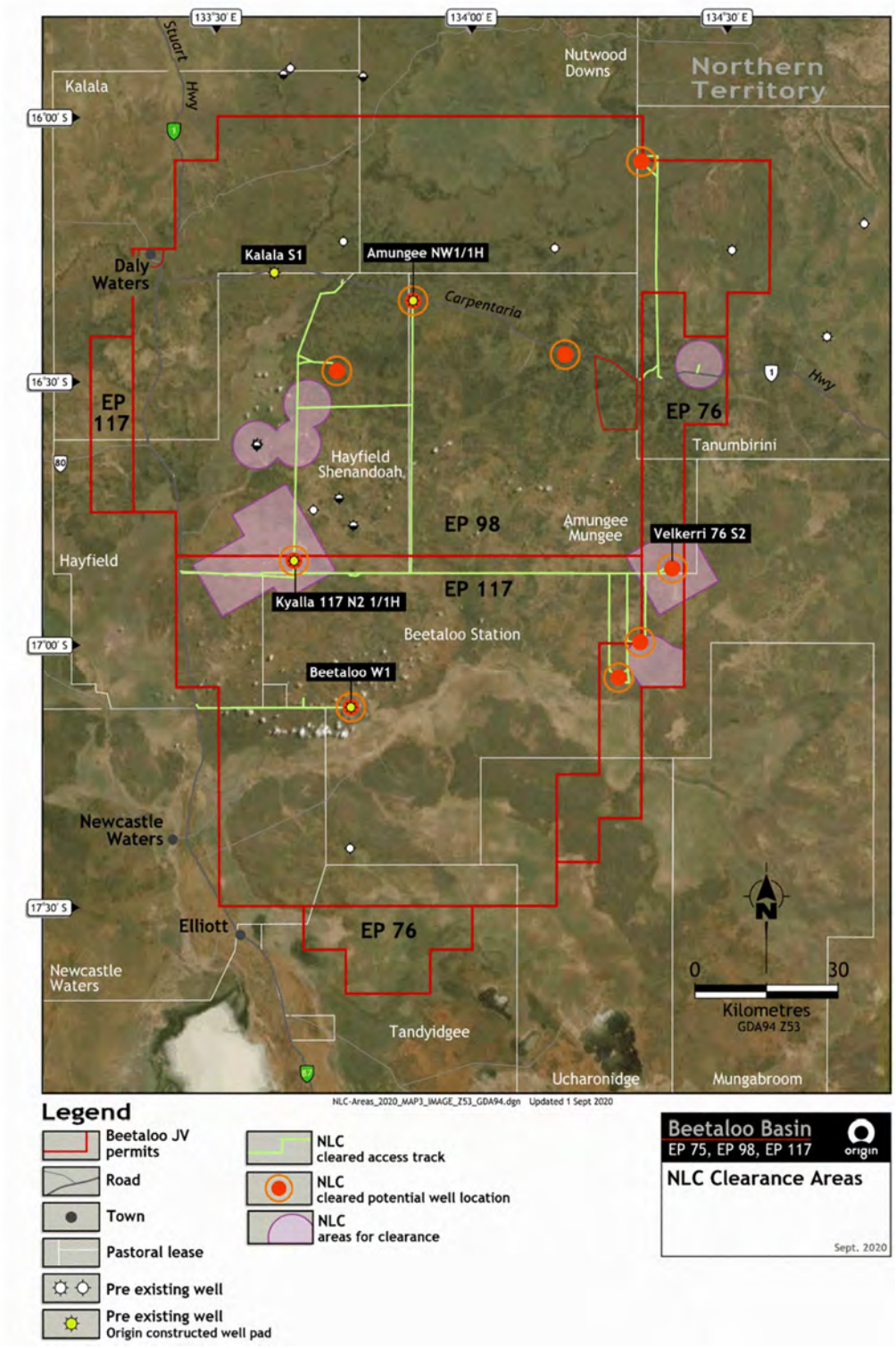


Figure 4

Table 1 - Proposed site locations proximity for sacred site clearance surveys

Proposed Well Pad Name	Pastoral Lease	Easting	Northing	Latitude	Longitude
Kya l la 117 N1	Hayfield / Shenandoah	344283	8134178	16°52'14.3287"S	133°32'17.5948"E
Kya l la 98 S1	Hayfield / Shenandoah	355907	8142955	16°47'31.4756"S	133°38'52.3682"E
Kya l la 98 S2	Hayfield / Shenandoah	353457	8143874	16°47'1.0291"S	133°37'29.8366"E
Velkerri 76 N1	Tanumbirini	440981	8179204	16°28'5.1647"S	134°26'49.4833"E
Velkerri 76 S3	Beetaloo	431026	8117183	17°01'42.4343"S	134°21'6.9303"E
Hayfield 98 W4	Hayfield / Shenandoah	348255	8161760.9	16°37'17.9164"S	133°34'38.4656"E
Hayfield 98 S1	Hayfield / Shenandoah	356661	8162146	16°37'7.2767"S	133°39'22.2048"E
Hayfield 98 W3	Hayfield / Shenandoah	358854	8170505.1	16°32'35.7887"S	133°40'38.0644"E

3 APPENDICES

3.1 Appendix 1

The following information and table details the typical activities associated with drilling and hydraulic fracture stimulation operations of vertical and/or horizontal exploration well as proposed in the Beetaloo. These descriptions are indicative and general in nature, minor departures from such descriptions are likely to occur and we propose that such departures are covered by the content of this application.

The first step in the exploration well process includes the construction of access roads and where necessary, land clearance to allow access to the potential well-site location. The drilling lease pad itself (ie. the area of land that would be occupied by the drilling rig and support equipment) would consist of approximately one (1) hectare of cleared and site engineered compacted earth. This area would host the drilling rig and all associated equipment as well as a mud sump (i.e. a pit where used drilling fluids would be stored while the operation is in process) and a flare pit (i.e. a pit that can be used to burn any gas or oil encountered while drilling in a safe manner, although it is unlikely to be used). The rig camp would be located within the vicinity of the drilling rig on a cleared area of approximately 100 m x 100 m. A rig camp for this type of exploration activity typically accommodate approximately 50 to 100 people.

All of the above areas would be connected to existing roads with unsealed tracks built specifically for the activity, approximately 6m wide tracks in an 18m wide corridor.

Once the surface infrastructure is in place, a drilling rig and camp would be brought in to undertake the drilling activity. A drilling rig package consists of the main rig package as well as supporting vehicles and pieces of equipment. Origin's host Traditional Owners have visited these types of facilities both at the Beetaloo well pad as well as the Amungee well pad. Generally, some, or all, of 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.
- 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.
- A work/welding shop.
- Portable onsite offices.
- Third party equipment such as cementing trucks and wireline evaluation units would also be required on site intermittently as per operational requirements.

Trucks delivering equipment and consumables (e.g. 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, 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 regional aquifer (depth varies regionally). 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 would then be set and cemented at this depth.

The drilling rig would then be set up to drill through the aquifers and the Antrim Plateau Volcanics (assuming they are present). At this point a further string of 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 may 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.

A KCl/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 potassium 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)). A synthetic based fluid system consists of a non-aqueous fluid base.

The final hole section (referred to as the “production hole section”) covers the hydrocarbon reservoir section(s) and it is drilled to the well total depth (TD). TD is likely to range between 1000-4000 m below the ground surface, with the potential for a lateral section to be drilled horizontally for 1000-3000 m within a target reservoir,depending on the stratigraphic depth and thickness of the zone of interest at a particular location. 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.

In horizontal wells, 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.

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 be hydraulically fracture stimulated (HFS), a separate set of specialised equipment, trailers or skid mounted equipment is mobilised to the well location. This equipment mainly consists of high volume/high pressure pumps, mixing equipment, water storage tanks (enclosed and open), and

control and monitoring equipment. This equipment was inspected by host NLC representatives and host Traditional Owners prior to the HFS activities at the Amungee NW 1H well. HFS involves the injection of large quantities of water and sand plus a small percentage of chemicals at high pressure down and across horizontally drilled wellbores. The pressurised mixture causes the rock (i.e. shale) to crack. The small cracks or fractures created are held open by the sand/proppant allowing hydrocarbons to flow from the shale to the wellbore and up the well. The fractures created are separated from surface aquifers by impermeable rock. Other formations (including surface aquifers) are also isolated behind several layers of steel casing and cement preventing contamination.

After the completion of HFS operations, a production test is typically carried out for a period required to assess the potential of the well and acquire important reservoir and hydrocarbon data (Origin proposes to test wells for a minimum of three (3) months, and may seek to extend this for the final wells in the 2021 and 2022 work program to up to 12 months).

Once all drilling, wireline and testing operations are completed a decision is made to either safely suspend the well (e.g. for further testing 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 maintaining and conditioning the surface well pad, as well as site rehabilitation after well decommissioning and ongoing monitoring.

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.

The drilling rig and all associated temporary equipment would be then removed from the site. If the well has been plugged and decommissioned, all disturbed areas (e.g. lease pad, pits, camp area) would be rehabilitated and re-vegetated. 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.

Table A - Summary of Exploration activities.

Activity	Description	Equipment	Duration
Water Bore / Civil Works	Installation of a water bore and water tanks, levelled areas for rig and camp, pits for fluid storage and roads for access.	Earth moving equipment and water bore drilling unit.	Approximately 1-2 months and potentially completed some months prior to drilling activity.
Exploration Drilling	Drilling with air/water to install progressively smaller cemented casing strings to ultimately reach the target rock formations and well TD	A drilling rig package (described above) as well as associated heavy and light vehicles.	Approximately 30-90 days (highly variable, especially in exploration phase and will depend on whether a horizontal section is required).

Evaluation	Running wireline tools to tests various properties of the reservoir rocks once they have been drilled into.	As well as the drilling package, there would be a wireline logging truck and a variety of industry standard tools.	Approximately 2-3 days, depending on success of testing.
DFIT	The DFIT involves injecting small volumes of water at low rates to create small fractures in the rock and then allow the pressure to fall naturally.	Specialised truck, trailer or skid mounted equipment mainly consisting of high volume/high pressure pumps and control, and monitoring equipment.	Approximately 2-3 days.
HFS	Hydraulic Fracture Stimulation involves the injection of large quantities of water and sand plus a small percentage of chemicals at high pressure down and across horizontal drilled wellbores causing the shale to crack. The cracks or fractures created are held open by the sand/proppant allowing gas from the shale to flow into and up the well.	Specialised truck, trailer or skid mounted equipment mainly consisting of high volume/high pressure pumps, mixing equipment, water storage tanks and control and monitoring equipment.	Approximately 10-30 days depending on the number of stages to be fracture stimulated.
Completions Activity	Equipment installation inside the wellbore, typically steel tubing to assist the well's ability to lift fluids/gas up the wellbore to surface.	A completions rig package and wireline units when required	Approximately 2-5 days
Production Test	Measuring the productivity of the wellbore after it has been HFS. Flow rates (gas/fluids), pressures, solids, and gas/fluid analysis are typically assessed.	Well test package, typically consisting of a 3 phase test separator, choke manifolds, flowback tanks, flare stacks and emergency shutdown valves. Wells that require artificial lift to initiate flow may also have a coiled tubing unit on location to conduct a Nitrogen (N_2) lift.	Approximately 1-12 months.

Plug and Decommissioning (activity delayed if well is suspended)	Setting and testing cement plugs to ensure permeable zones have been isolated from each other to prevent cross flow and/or flow communication to surface.	A drilling rig package.	Approximately 2 days.
Site Rehabilitation (after Plug and Decommissioning)	Earth works rehabilitation to original condition. Re-vegetation as required. Note that any water bore and some road access are likely to remain.	Earth moving equipment.	Approximately 1 week (TBA) and then sufficient time to re-establish vegetation. May be completed several months post drilling activity.
2D or 3D seismic	Collection of seismic data by placing seismic nodes on the ground surface and then creating pulse energy into the subsurface which reflects off changes in rock layers 'hardness' and are detected by the nodes when the reach surface again. This allows an 'image' of the subsurface to be collected which allows predictions on what rocks occur underneath the exploration area	Vibroseis trucks, Seismic nodes and associated cables	2 - 12 weeks

3.2 Appendix 2

Included in submissions are comprehensive environmental management plans (EMP) detailing processes and procedures that will be followed during implementation and execution of all aspects of exploration activity. These plans are also assessed and reviewed as part of the ATD process to ensure field activities are carried out in a way that meets all applicable environmental legislation and regulation. An EMP and associated documentation, assessed as part of the ATD approval, may include:

- Management of Sacred Site / Cultural Heritage, heritage, bushfire, weed control and management, erosion and sediment control, protection of Surface water and groundwater water, dust, traffic, biodiversity, and waste) - these plans will cover both the general exploration activity plus specific environmental requirements for each well site and its associated activities
- Oil Spill Contingency Plan (OSCP)
- Emergency Response Plan (ERP)
- Water Management Plans for regular testing of local water bores before, during, and after the project
- Chemicals disclosure – a list all chemicals to be used during the project
- Environment Rehabilitation Security Bond - submission of security bond calculation that covers all the rehabilitation management areas and evidence of final payment
- Archaeological, Sacred Site and Heritage clearance
- Pastoralist's consent

Copies of all documentation including all Environmental plans and documentation provided to Northern Territory regulatory agencies will also be provided to the NLC. All activities carried out by Origin as operator are also governed by stringent internal environmental policies and directives which are referenced when preparing environmental plans and undertaking work programs.

If hydraulic fracture stimulation is to be undertaken, the following additional environmental controls are also applied:

- Further validation of cement placement and its integrity
- Further pressure testing
- Continuation of baseline water monitoring and testing
- Submission of fracture modelling (maximum propagation height), confirming safe separation between any natural aquifers and the fracture zone
- Submission of all MSDS for public disclosure on the department's website
- BTEX (Benzene, Toluene, Ethyl-benzene, Xylene) products will not be accepted nor utilised as they are prohibited for use in the Northern Territory.

Origin has in place an HSE Policy that states:

At Origin, we value the wellbeing of our employees, contractors, customers, the communities in which we operate and the environment. We are committed to responsible management practices that minimise any adverse health, safety or environmental impacts, and enhance benefits associated with our activities, products or services.

We have in place a Health, Safety and Environment management system for our activities that drives continual improvement. The HSE Management System outlines accountabilities to implement this Policy and requires that we:

- Identify hazards and reduce risks so far as is reasonably practicable where there is potential to cause injury or illness to people, or to adversely impact the environment or the community
- Provide safe work places and systems of work, empower employees and contractors to address unsafe or hazardous situations and carry out their work in a manner that does not present a risk to themselves, others or the environment
- Support the recovery and rehabilitation of employees in the event of work related injury or illness
- Set objectives and targets which promote the efficient use of energy and resources, the minimisation of wastes and emissions and the prevention of pollution
- Comply with relevant HSE legal requirements and other commitments
- Require Contractors to manage HSE using standards and practices that accord with this Policy
- Regularly review and report HSE performance.

In implementing this Policy, we will engage with our employees, contractors, suppliers, business partners, customers and Government and communicate expectations to all persons working with or on behalf of Origin.

Origin field activities are also covered by a series of Environmental Directives which include the following:

- The Air Emissions directive outlines Origin's requirement for identification and management of emissions with potential to affect air quality and/or regulatory compliance.
- The Biodiversity Management directive describes requirements for identification and assessment of impacts on terrestrial and aquatic flora, fauna and ecosystems; controls for managing biodiversity-related risks; and methods for enhancing biodiversity values.
- The Cultural Heritage directive covers identification and assessment of cultural heritage values and sites, compliance with legal obligations and voluntary commitments, development of plans, and effective stakeholder engagement.
- The Environmental Noise directive describes requirements for identifying, assessing, monitoring and minimising noise emitted during normal operations as well as during construction, commissioning and decommissioning activities.
- The Greenhouse Gas and Energy Efficiency directive sets out requirements for managing greenhouse gas (GHG) emissions and energy efficiency, including identification and monitoring of energy consumption, energy production and GHG emissions.

- The Land Management directive describes requirements for identifying and assessing impacts to land, and implementing controls to manage erosion, visual amenity, contaminated sites, site closure and rehabilitation.

- The Materials and Waste directive outlines requirements for identifying, assessing and managing impacts associated with use of materials, and storage, handling, treatment and disposal of wastes.

- The Water Management directive outlines requirements for managing water extraction and consumption, water quality and controlling wastewater treatment and discharges.

Proposed Water, Gravel or other Resource Use

It is proposed that water bores to provide water for civil construction, well drilling and completion operations are to be installed adjacent to the well site pad and along access tracks within the clearance area of the well sites and access tracks. The bores will be constructed to the minimum construction requirements of the NT Government.

Gravel from existing gravel pits and new borrow pits may be required for access road sheeting and well site pad sheeting. Any new borrow pits would be located within the clearance area along the access tracks or lease pads.

Appendix N.1.2 05 210924 Email

Linda Pugh

From: Nish, Simon
Sent: Friday, 24 September 2021 4:48 PM
To: Michael Egan
Cc: [redacted]
Subject: RE: Beetaloo - Seismic site avoidance and clearance survey
Attachments: 210924 NLC Clearance Request Origin 2021 (work program extension) .pdf

And again in pdf format

Kind regards,

Simon Nish
Lead Negotiator – Indigenous Land Use Agreements
Beetaloo and Growth Assets

Origin
Level 28, 180 Ann Street, Brisbane QLD 4000
[redacted]

Connect with us

originenergy.com.au

I acknowledge the Traditional Owners and Custodians of country throughout Australia and recognise their continuing connection to land, waters and community.

I pay my respects to them and their cultures, and to Elders past, present and future.

Origin shows its commitment to participating in Australia's reconciliation efforts through our Stretch Reconciliation Action Plan.

From: Nish, Simon
Sent: Friday, 24 September 2021 5:12 PM
To: [redacted]
Cc: [redacted]
Subject: RE: Beetaloo - Seismic site avoidance and clearance survey

Hello Michael,

Please find attached the work program, with explanatory information in the Appendixes.

Kind regards,

Simon Nish
Lead Negotiator – Indigenous Land Use Agreements
Beetaloo and Growth Assets

Origin
Level 28, 180 Ann Street, Brisbane QLD 4000
[redacted]

Connect with us

originenergy.com.au

I acknowledge the Traditional Owners and Custodians of country throughout Australia and recognise their continuing connection to land, waters and community.

I pay my respects to them and their cultures, and to Elders past, present and future.

Origin shows its commitment to participating in Australia's reconciliation efforts through our Stretch Reconciliation Action Plan.

From: [redacted]
Sent: Wednesday, 22 September 2021 12:59 PM
To: Nish, Simon [redacted]
Cc: [redacted]
Subject: Beetaloo - Seismic site avoidance and clearance survey

Hello Simon

Could we please confirm the scope of the site clearance work prior to Walter's planned trip next week as we must be able to describe the proposed works to the Native Title Holders during the clearance consultations.

- As we understand it, the yellow polygons on the attached map around the Amungee NW1/1H well and around the proposed well pad on EP76 just north of the Carpentaria Highway on Tinumbirini Station represent the **proposed areas for 3D seismic surveys in 2022** (marked 'NLC Extension areas for clearance' in the legend), is this correct?

- Do you know what the line spacing for the surveys will be?

- Do you have any other relevant information that would assist Walter in his consultations?

- If you have any work program documentation that you could share, that would also be appreciated, but we will need at least the basic information as above by COB Friday at the latest for Walter's use next week.

As an aside, we are still awaiting a work program for the potential consultations in November. We are not able to start the planning process until we have the work program so it may be that these consultations move into the start of next year if necessary.

Regards

Mike

[redacted]
Acting Petroleum Manager
Minerals and Energy
Northern Land Council

NORTHERN
LAND COUNCIL
Our Land, Our Sea, Our Life

[redacted] | Website: www.nlc.org.au

Disclaimer

The information contained in this communication from the sender is confidential. It is intended solely for use by the recipient and others authorized to receive it. If you are not the recipient, you are hereby notified that any disclosure, copying, distribution or taking action in relation of the contents of this information is strictly prohibited and may be unlawful.

This email has been scanned for viruses and malware, and may have been automatically archived by **Mimecast Ltd**, an innovator in Software as a Service (SaaS) for business. Providing a **safer** and **more useful** place for your human generated data. Specializing in; Security, archiving and compliance. To find out more Click Here.

Appendix N.1.2 06 NLC Clearance Request Origin 2021

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

CONTENTS

EP98, 117, 76 – Beetaloo Joint Venture (Origin / Falcon) 1

CONTENTS 2

1 OVERVIEW 3

2 PROPOSED WORK PROGRAM 3

2.1 Detailed Activity List 3

2.2 Areas 4

2.3 Request 5

2.4 Figures 5

2.5 Appendices 5

2.6 Attachments 5

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

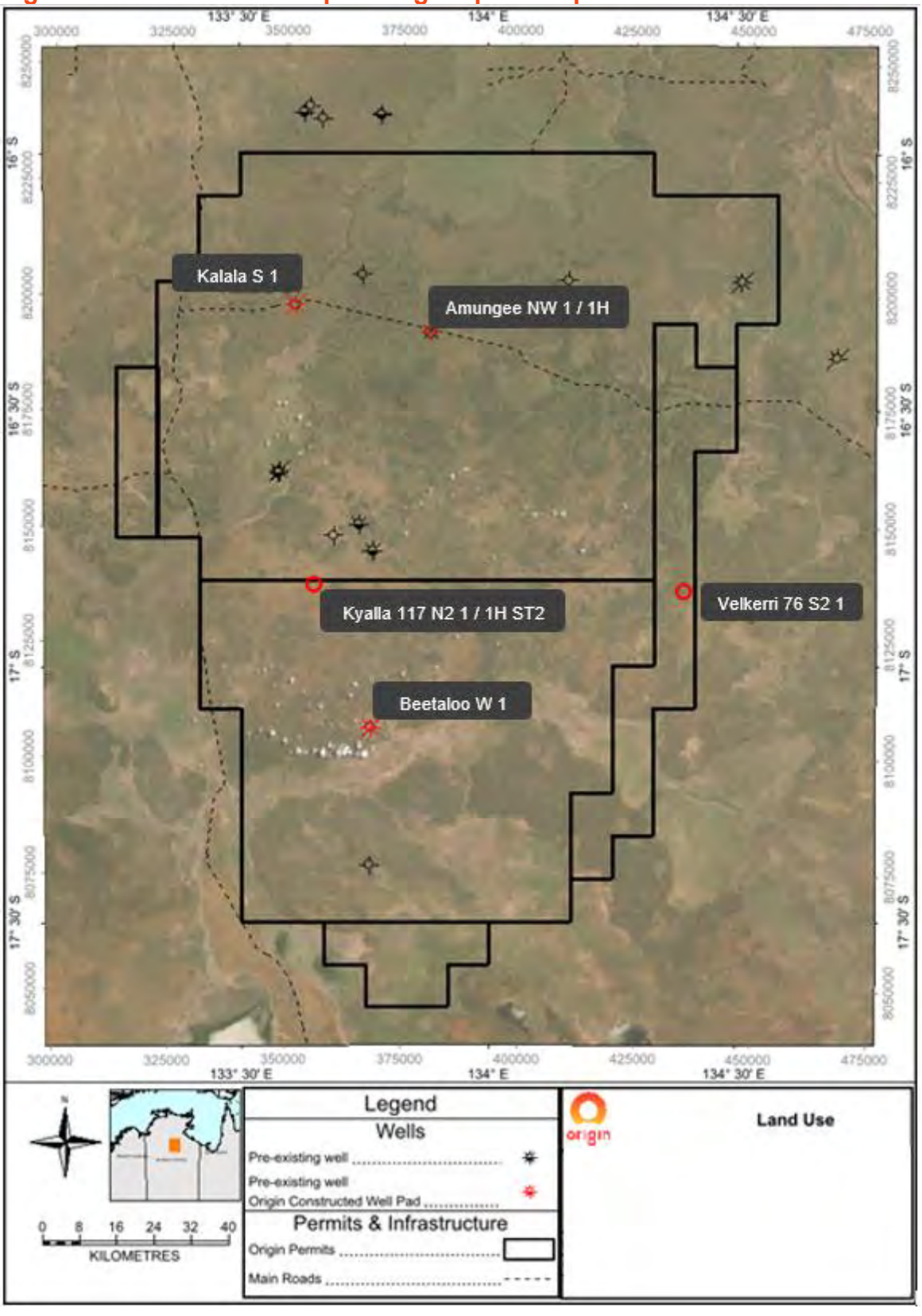


Figure 1 - Overview of Origins Beetaloo Basin Exploration permits and existing wells drilled to date

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

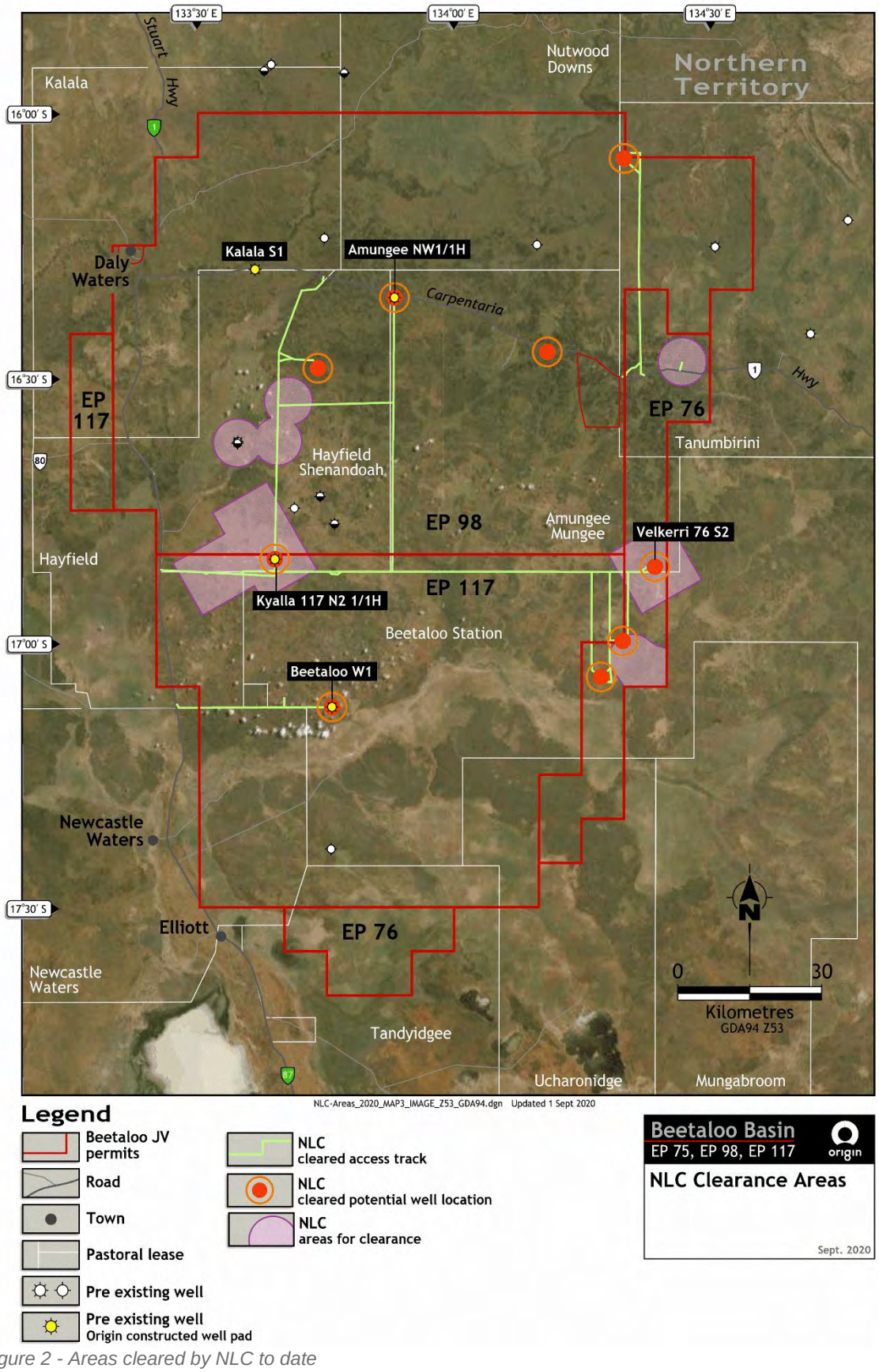


Figure 2 - Areas cleared by NLC to date

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

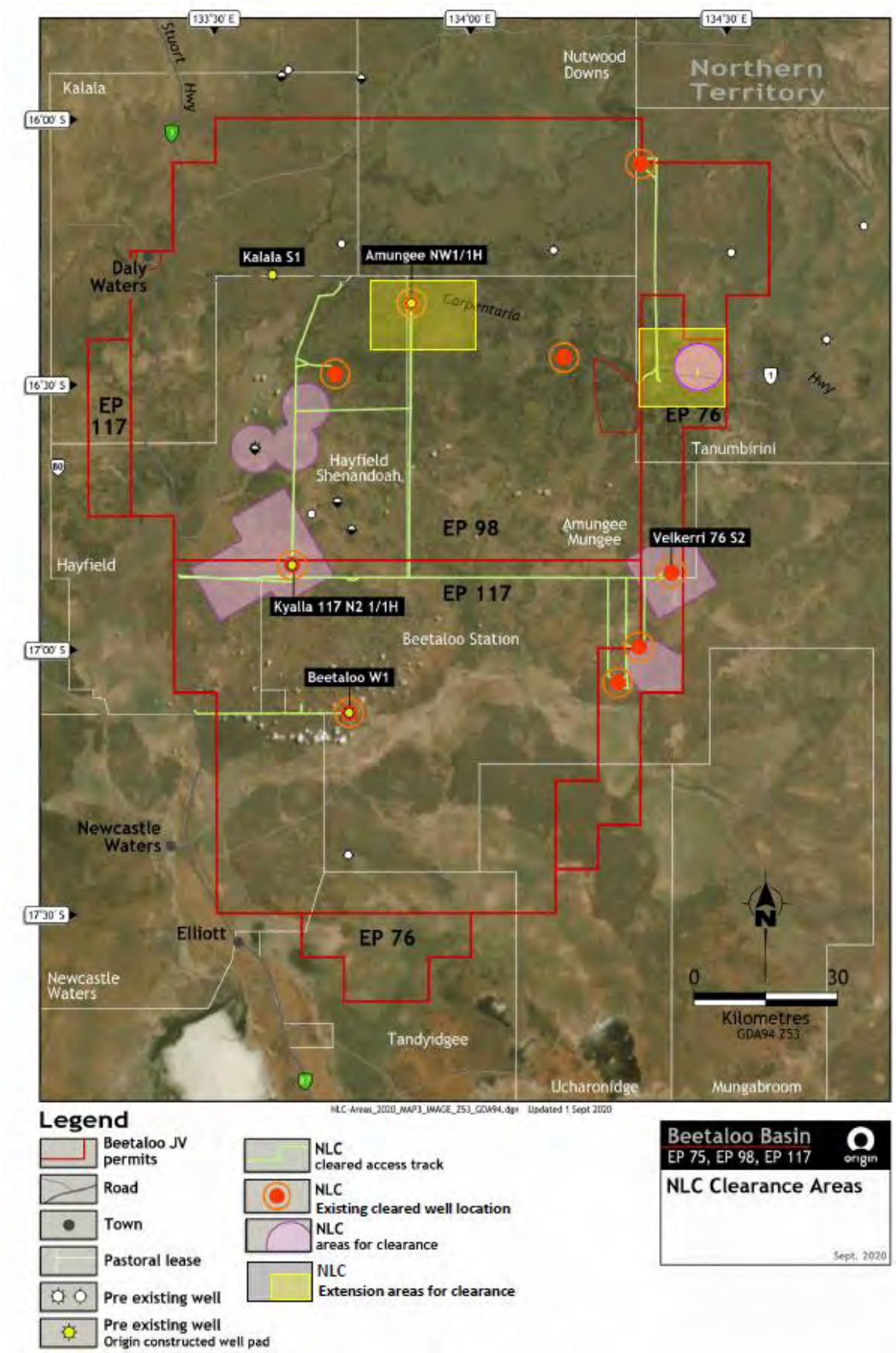


Figure 3 - Extension areas requested for NLC clearance (yellow polygons)

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.

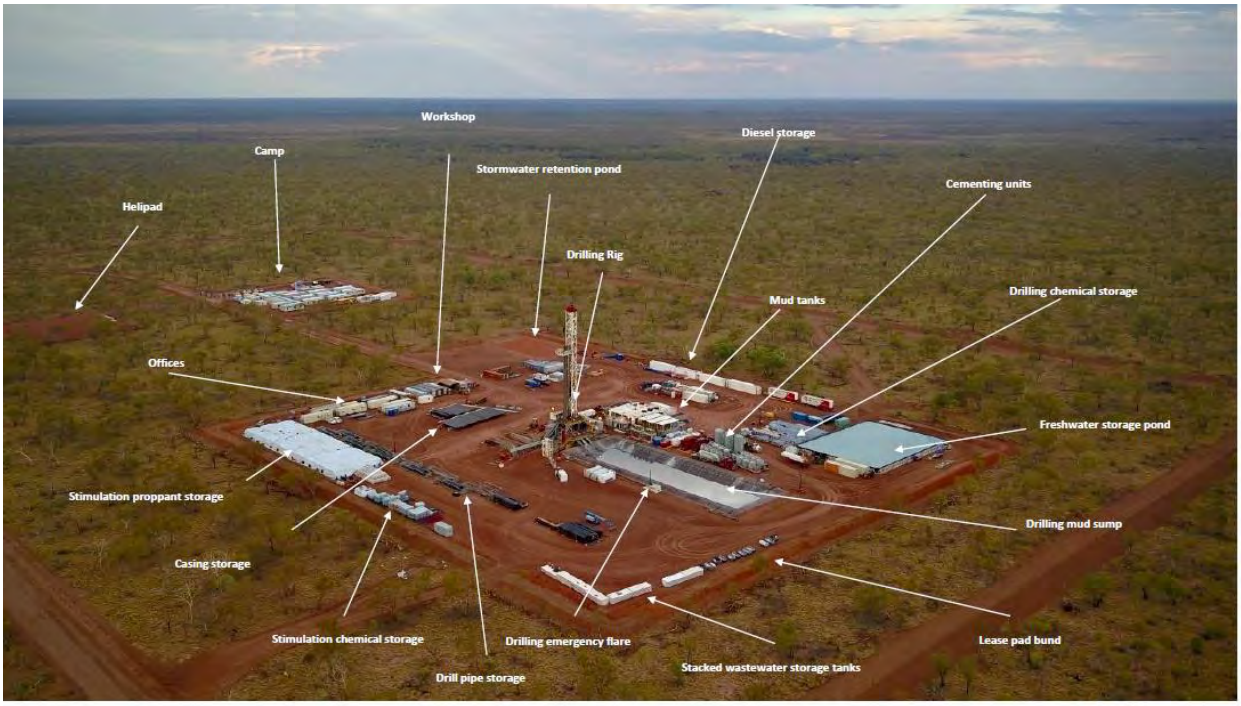


Figure 10 Typical well site layout during drilling. This site is the existing Kyalla 117 N2 site.

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.

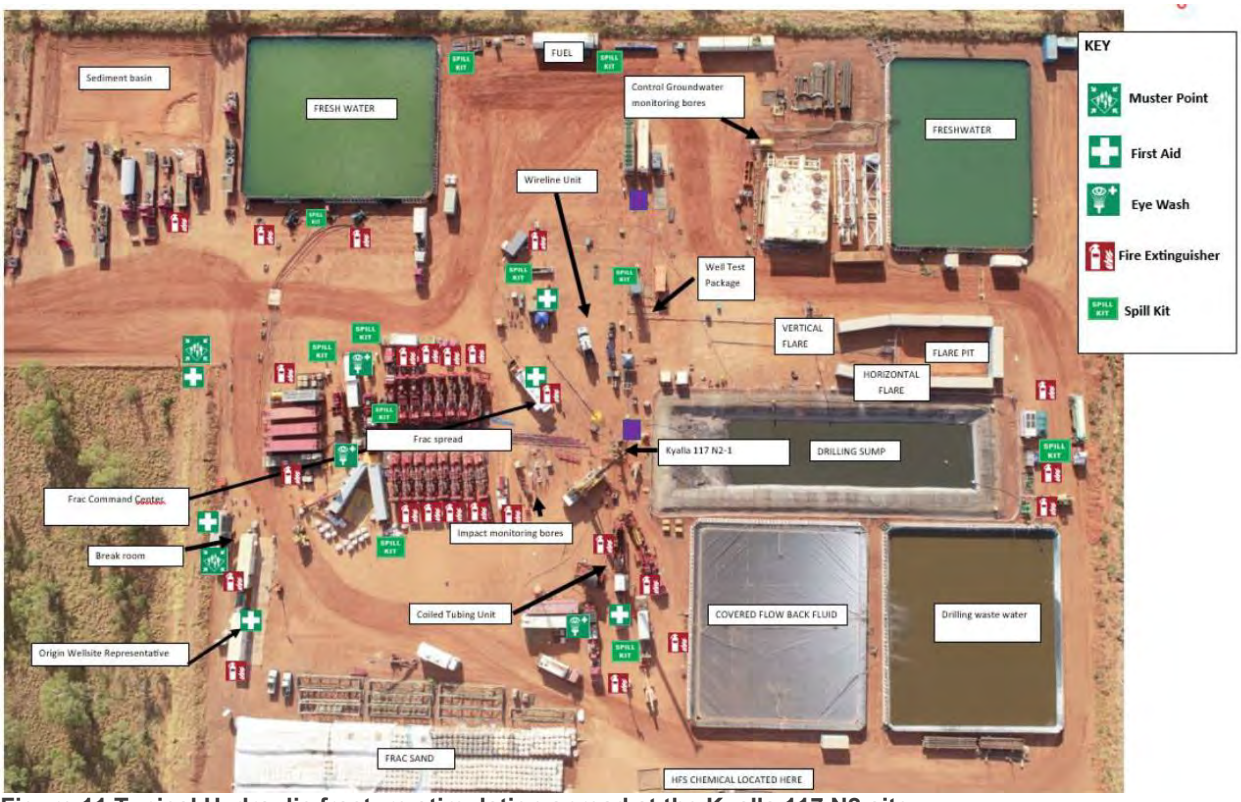


Figure 11 Typical Hydraulic fracture stimulation spread at the Kyalla 117 N2 site.

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: 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, 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: 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) • 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: o avoid clearing of mature trees and protected flora o 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 o Maintain viable root stock to promote rapid rehabilitation o No seismic lined in riparian o 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.

Appendix N.1.2 07 211130 Email

[redacted]

From: Belford, Jim
Sent: Tuesday, 30 November 2021 7:56 AM
To: origin_nt_beetaloo
Subject: FW: Conditions of Work Report re 2020 and 2021 Sacred Site Avoidance Surveys
Attachments: NLC Conditions of Works Report to Operator ORIGIN_211129_Final.pdf

Jim Belford
Social Performance Manager
Beetaloo and Growth Assets
Integrated Gas

Origin
[redacted]

originenergy.com.au

I acknowledge the Traditional Owners and Custodians of country throughout Australia and recognise their continuing connection to land, waters and community.

I pay my respects to them and their cultures, and to Elders past, present and future.

Origin shows its commitment to participating in Australia's reconciliation efforts through our Stretch Reconciliation Action Plan.

From: [redacted]
Sent: Tuesday, 30 November 2021 8:09 AM
To: Nish, Simon [redacted]
Cc: [redacted]
Subject: RE: Conditions of Work Report re 2020 and 2021 Sacred Site Avoidance Surveys

Hello Simon

I attempted to send this report yesterday but it appears that it was too big. I have reduced the file size. If this does not work I will save it to a shared OneDrive location and send you the link.

Mike

Michael Egan
Manager Petroleum Unit
Resources & Energy Branch
Northern Land Council

NORTHERN LAND COUNCIL
Our Land, Our Sea, Our Life

[redacted] | Website: www.nlc.org.au

From: [redacted]
Sent: Monday, 29 November 2021 4:50 PM
To: Nish, Simon [redacted]
Cc: [redacted]
Subject: Conditions of Work Report re 2020 and 2021 Sacred Site Avoidance Surveys

Hello Simon

Please find attached the Conditions of Work Report for the 2020 and 2021 sacred site avoidance surveys.

Regards

[redacted]
Manager Petroleum Unit
Resources & Energy Branch
Northern Land Council

NORTHERN LAND COUNCIL
Our Land, Our Sea, Our Life

[redacted] | Website: www.nlc.org.au

Disclaimer

The information contained in this communication from the sender is confidential. It is intended solely for use by the recipient and others authorized to receive it. If you are not the recipient, you are hereby notified that any disclosure, copying, distribution or taking action in relation of the contents of this information is strictly prohibited and may be unlawful.

This email has been scanned for viruses and malware, and may have been automatically archived by **Mimecast Ltd**, an innovator in Software as a Service (SaaS) for business. Providing a **safer** and **more useful** place for your human generated data. Specializing in; Security, archiving and compliance. To find out more Click Here.

Appendix N.1.2 08 NLC Conditions of Works Report to Operator ORIGIN_211129_Final

ORIGIN ENERGY

(Beetaloo Joint Venture: Origin Energy / Falcon Oil & Gas)

2020/2021 WORK PROGRAM CLEARANCE REQUEST
(FOR POTENTIAL EXPLORATION WORKS FROM 2020)
OVER EP98, EP117 AND EP76

A 'CONDITIONS OF WORKS' REPORT TO THE OPERATOR

2020 – 2021 SACRED SITES AVOIDANCE SURVEYS

NORTHERN
LAND COUNCIL

© Copyright, August 2013, Northern Land Council, All rights reserved.

Northern Land Council

October 2021

Annexure A:

2019 Work Program Document provided to the NLC (28 September 2020)

2019 Work Program Clearance Request

(For Potential Exploration Works from 2020)

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

Version:	**1.0**
Submitted:	
Presented by:	Origin Energy
Review Date:	November 2019

CONTENTS

EP98, 117, 76 – Beetaloo Joint Venture (Origin / Falcon) 1

CONTENTS 2

1 OVERVIEW 3

2 PROPOSED WORK PROGRAM 3

2.1 Activities 4

2.2 Areas 4

2.3 Request 5

2.4 Figures 5

2.5 Tables 5

2.6 Appendices 5

2.7 Attachments 5

3 APPENDICES 10

1 OVERVIEW

- 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). The Amungee NW 1H well was hydraulically fracture stimulated (HFS) in 2016 (prior to the introduction of a moratorium in September 2016) as part of an exploration work program to assess the potential of hydrocarbons in the Beetaloo (Figure 1).

- In 2018 the moratorium was lifted and in 2019, post the implementation of the NT Inquiry *Exploration Recommendations*, Origin resumed exploration activity in Exploration Permit 117 (EP117) drilling a vertical exploration well, and a horizonal appraisal well targeting the Kyalla formation. HFS is scheduled to be undertaken at Kyalla 117 N2 1H beginning in Q4 2020.

- The approved budget to execute two (2) exploration wells in 2019 was approximately $120 million.

- The full time period for drilling and stimulation is approximately:
  - Drilling: Two (1-4) km deep and two (2-3) km long: Twelve (12) weeks
  - Stimulation (of well with above specifications): Three (3) weeks
  - Production testing: Three (3) months (up to 12 months)
  - Maintenance and monitoring: Ongoing

- Origin's *Northern Territory Government permit commitments* across Exploration Permit 98 (EP), Exploration Permit 76 (EP76) and EP117 (the Permits) require Origin to complete a further four (4) additional exploration wells to be drilled and stimulated.

- Origin's exploration program is designed to identify areas of perspectivity for a potential, future hydrocarbon development.

- Origin respectfully requests the Northern Land Council's assistance to facilitate a *Sacred Site Clearance Survey* of eight (8) potential future exploration locations and access routes (where necessary across the Permits) 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 (Figure 2).

2 PROPOSED WORK PROGRAM

- Origin is proposing to drill, HFS and production test four (4) horizontal wells across the Permits over 2019-2022. It is possible that vertical wells will be drilled prior to proposed horizontal wells (that is, a proposed horizontal well would be drilled from a vertical well as occurred for the Amungee NW 1H well).

- Origin may seek approvals to drill, HFS and production test from two (2) to four (4) additional horizontal wells (and associated vertical wells if required).

- Civil works activities to support the exploration program may be undertaken throughout 2020 (note this is likely to include the construction of roads to enable site access along with supporting activities such as accessing aggregate from identified gravel pits, water through registered water bores and the installation of additional water monitoring bores as per the requirements of the NT Inquiry).

- Civil works and associated activities are likely to be undertaken on sites where NLC Clearance and AAPA certification is held to facilitate exploration activity beyond 2020.

- 3D or 2D seismic activity

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 Activities

The following activities would be required to complete work across the sites included in this request:

Activities, in approximate order of operation, include:

1. Scouting, surveying, and small-scale surface and shallow subsurface sampling of soils to support geotechnical studies and environmental evaluation.

2. Civil engineering activity to repair, improve and/or construct access tracks and/or unsealed roads and well pads (e.g. grading, excavation, fencing); note this activity may require borrow pits along access routes and close to well pads.

3. Drilling/installation of water bores as required.

4. Exploration drilling (vertical and horizontal wells).

5. HFS (horizontal wells and associated vertical wells if required) (including HFS monitoring equipment).

6. Production testing.

7. Follow-up testing, monitoring and work-over activity (as required).

8. 2D or 3D seismic data collection activity

8. Activities associated to the plugging, abandonment and/or remediation of wells after proper testing and monitoring has been conducted (as required).

9. Any other auxiliary works/activities required under good oilfield and/or environmental practice and accepted project commitments to support foregoing activities.

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 and digital GIS files detail the location of eight (8) potential sites, and associated access routes requested for Sacred Site Clearance surveying.

    - Sites - the initial clearance request is for an extended polygon providing a radius area area around the proposed location.

- Access Routes - the initial clearance request is for a 100 m buffer zone either side of the access tracks; however, Origin will support a wider clearance area as needed by the NLC and cultural monitors and/or Traditional Owners.

• 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 current NLC cleared locations
Figure 3 Summary map of additional proposed locations, clearance areas and associated access routes requested for Sacred Site Clearance survey

2.5 Tables

Table 1 Propose site locations for Sacred Site Clearance survey.

2.6 Appendices

Appendix 1 Indicative Activity Descriptions
Appendix 2 Minimising Environmental Impact

2.7 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

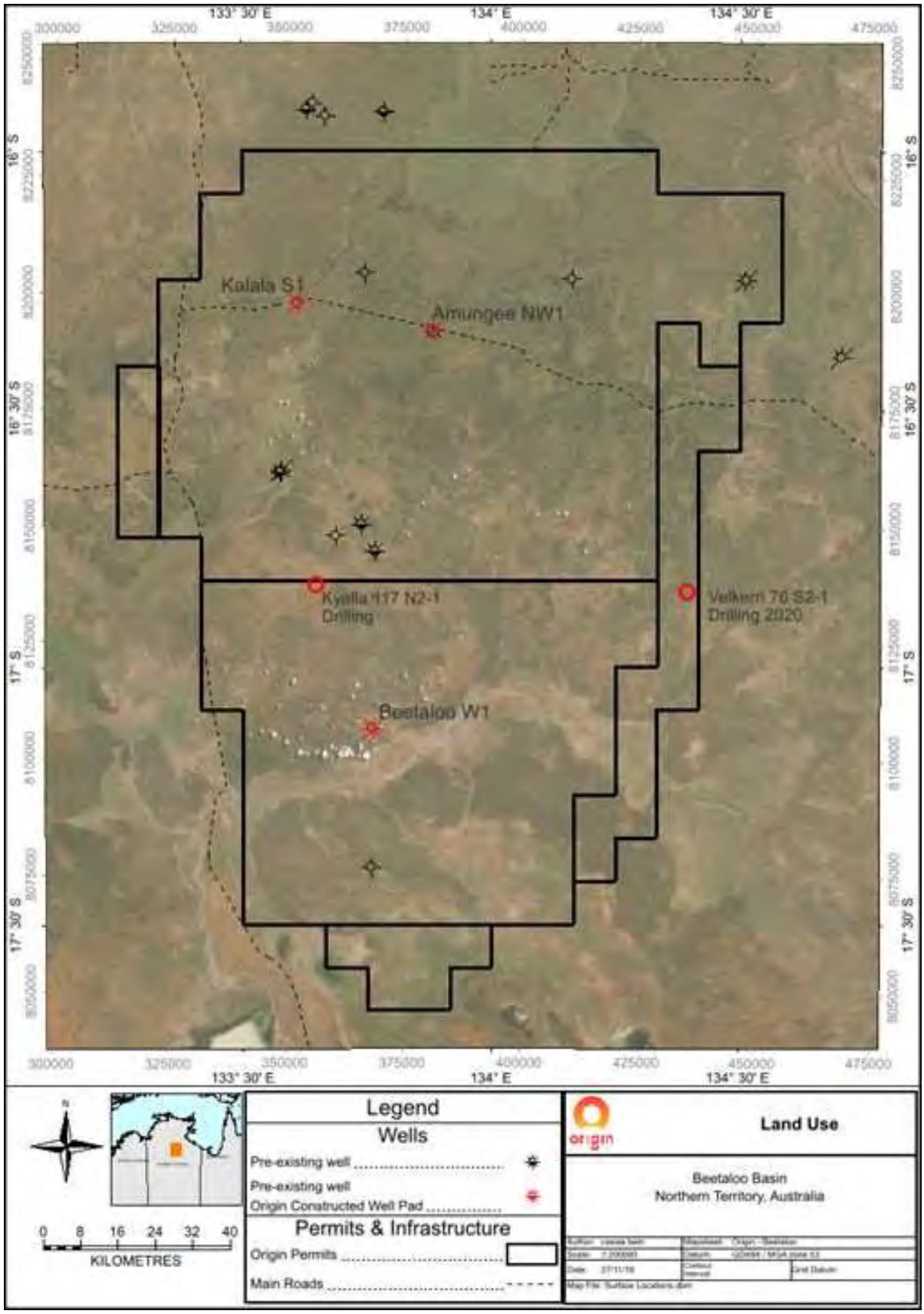

133° 30' E
134° E
134° 30' E
300000
325000
350000
375000
400000
425000
450000
475000
8250000
8225000
8200000
8175000
8150000
8125000
8100000
8075000
8050000
16° S
16° 30' S
17° S
17° 30' S
Kalala S1
Amungee NW1
Kyalla 117 N2-1
Drilling
Velkern 76 S2-1
Drilling 2020
Beetaloo W1
N
0 8 16 24 32 40
KILOMETRES
Legend
Wells
Pre-existing well
Pre-existing well
Origin Constructed Well Pad
Permits & Infrastructure
Origin Permits
Main Roads
origin
Land Use
Beetaloo Basin
Northern Territory, Australia

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

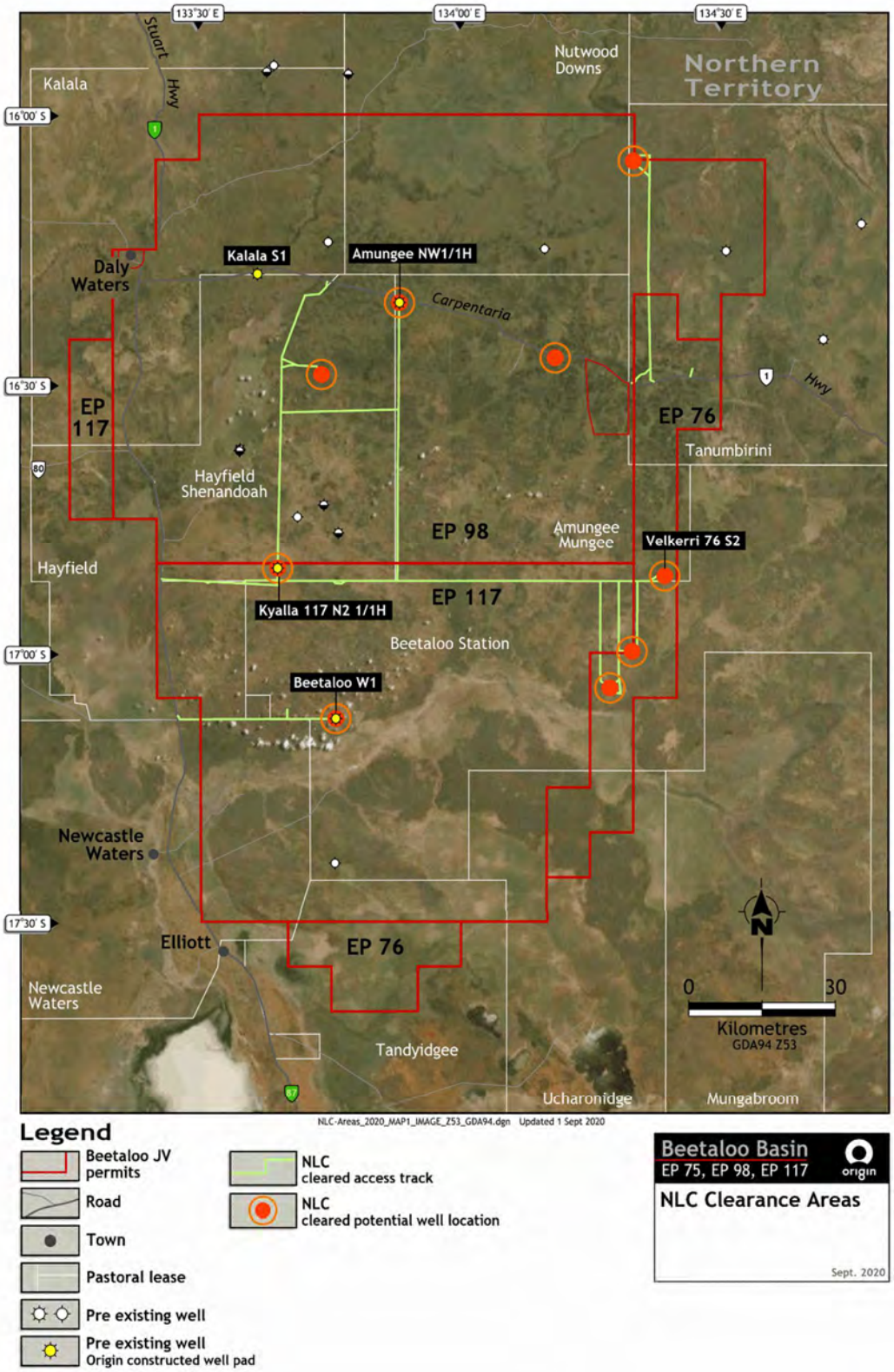


Figure 3 - Summary map of additional proposed locations, clearance areas and associated access routes requested for Sacred Site Clearance survey

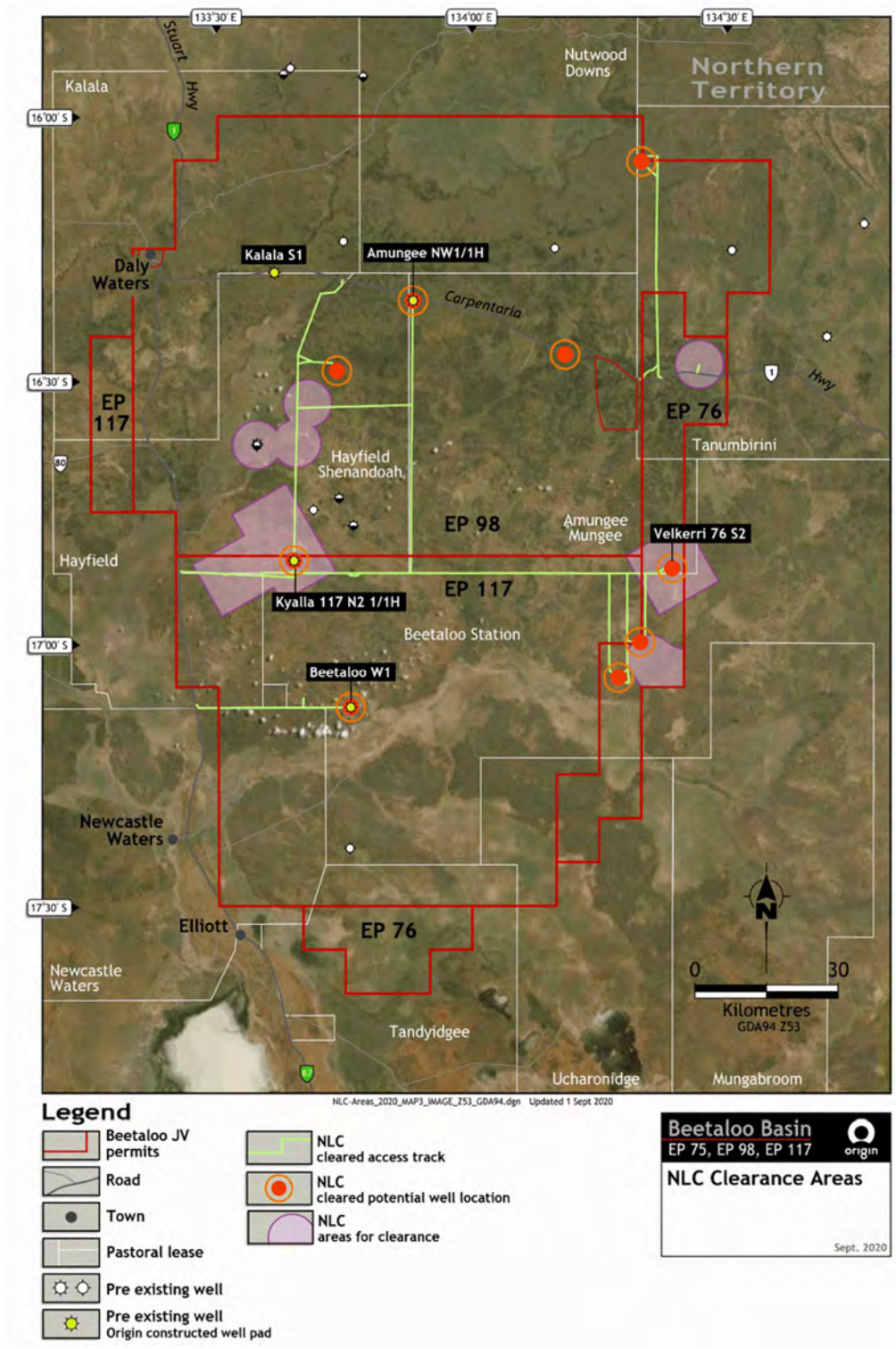


Figure 4

Table 1 - Proposed site locations proximity for sacred site clearance surveys

Proposed Well Pad Name	Pastoral Lease	Easting	Northing	Latitude	Longitude
Kya l la 117 N1	Hayfield / Shenandoah	344283	8134178	16°52'14.3287"S	133°32'17.5948"E
Kya l la 98 S1	Hayfield / Shenandoah	355907	8142955	16°47'31.4756"S	133°38'52.3682"E
Kya l la 98 S2	Hayfield / Shenandoah	353457	8143874	16°47'1.0291"S	133°37'29.8366"E
Velkerri 76 N1	Tanumbirini	440981	8179204	16°28'5.1647"S	134°26'49.4833"E
Velkerri 76 S3	Beetaloo	431026	8117183	17°01'42.4343"S	134°21'6.9303"E
Hayfield 98 W4	Hayfield / Shenandoah	348255	8161760.9	16°37'17.9164"S	133°34'38.4656"E
Hayfield 98 S1	Hayfield / Shenandoah	356661	8162146	16°37'7.2767"S	133°39'22.2048"E
Hayfield 98 W3	Hayfield / Shenandoah	358854	8170505.1	16°32'35.7887"S	133°40'38.0644"E

3 APPENDICES

3.1 Appendix 1

The following information and table details the typical activities associated with drilling and hydraulic fracture stimulation operations of vertical and/or horizontal exploration well as proposed in the Beetaloo. These descriptions are indicative and general in nature, minor departures from such descriptions are likely to occur and we propose that such departures are covered by the content of this application.

The first step in the exploration well process includes the construction of access roads and where necessary, land clearance to allow access to the potential well-site location. The drilling lease pad itself (ie. the area of land that would be occupied by the drilling rig and support equipment) would consist of approximately one (1) hectare of cleared and site engineered compacted earth. This area would host the drilling rig and all associated equipment as well as a mud sump (i.e. a pit where used drilling fluids would be stored while the operation is in process) and a flare pit (i.e. a pit that can be used to burn any gas or oil encountered while drilling in a safe manner, although it is unlikely to be used). The rig camp would be located within the vicinity of the drilling rig on a cleared area of approximately 100 m x 100 m. A rig camp for this type of exploration activity typically accommodate approximately 50 to 100 people.

All of the above areas would be connected to existing roads with unsealed tracks built specifically for the activity, approximately 6m wide tracks in an 18m wide corridor.

Once the surface infrastructure is in place, a drilling rig and camp would be brought in to undertake the drilling activity. A drilling rig package consists of the main rig package as well as supporting vehicles and pieces of equipment. Origin's host Traditional Owners have visited these types of facilities both at the Beetaloo well pad as well as the Amungee well pad. Generally, some, or all, of 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.
- 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.
- A work/welding shop.
- Portable onsite offices.
- Third party equipment such as cementing trucks and wireline evaluation units would also be required on site intermittently as per operational requirements.

Trucks delivering equipment and consumables (e.g. 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, 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 regional aquifer (depth varies regionally). 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 would then be set and cemented at this depth.

The drilling rig would then be set up to drill through the aquifers and the Antrim Plateau Volcanics (assuming they are present). At this point a further string of 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 may 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.

A KCl/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 potassium 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)). A synthetic based fluid system consists of a non-aqueous fluid base.

The final hole section (referred to as the “production hole section”) covers the hydrocarbon reservoir section(s) and it is drilled to the well total depth (TD). TD is likely to range between 1000-4000 m below the ground surface, with the potential for a lateral section to be drilled horizontally for 1000-3000 m within a target reservoir,depending on the stratigraphic depth and thickness of the zone of interest at a particular location. 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.

In horizontal wells, 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.

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 be hydraulically fracture stimulated (HFS), a separate set of specialised equipment, trailers or skid mounted equipment is mobilised to the well location. This equipment mainly consists of high volume/high pressure pumps, mixing equipment, water storage tanks (enclosed and open), and

control and monitoring equipment. This equipment was inspected by host NLC representatives and host Traditional Owners prior to the HFS activities at the Amungee NW 1H well. HFS involves the injection of large quantities of water and sand plus a small percentage of chemicals at high pressure down and across horizontally drilled wellbores. The pressurised mixture causes the rock (i.e. shale) to crack. The small cracks or fractures created are held open by the sand/proppant allowing hydrocarbons to flow from the shale to the wellbore and up the well. The fractures created are separated from surface aquifers by impermeable rock. Other formations (including surface aquifers) are also isolated behind several layers of steel casing and cement preventing contamination.

After the completion of HFS operations, a production test is typically carried out for a period required to assess the potential of the well and acquire important reservoir and hydrocarbon data (Origin proposes to test wells for a minimum of three (3) months, and may seek to extend this for the final wells in the 2021 and 2022 work program to up to 12 months).

Once all drilling, wireline and testing operations are completed a decision is made to either safely suspend the well (e.g. for further testing 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 maintaining and conditioning the surface well pad, as well as site rehabilitation after well decommissioning and ongoing monitoring.

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.

The drilling rig and all associated temporary equipment would be then removed from the site. If the well has been plugged and decommissioned, all disturbed areas (e.g. lease pad, pits, camp area) would be rehabilitated and re-vegetated. 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.

Table A - Summary of Exploration activities.

Activity	Description	Equipment	Duration
Water Bore / Civil Works	Installation of a water bore and water tanks, levelled areas for rig and camp, pits for fluid storage and roads for access.	Earth moving equipment and water bore drilling unit.	Approximately 1-2 months and potentially completed some months prior to drilling activity.
Exploration Drilling	Drilling with air/water to install progressively smaller cemented casing strings to ultimately reach the target rock formations and well TD	A drilling rig package (described above) as well as associated heavy and light vehicles.	Approximately 30-90 days (highly variable, especially in exploration phase and will depend on whether a horizontal section is required).

Evaluation	Running wireline tools to tests various properties of the reservoir rocks once they have been drilled into.	As well as the drilling package, there would be a wireline logging truck and a variety of industry standard tools.	Approximately 2-3 days, depending on success of testing.
DFIT	The DFIT involves injecting small volumes of water at low rates to create small fractures in the rock and then allow the pressure to fall naturally.	Specialised truck, trailer or skid mounted equipment mainly consisting of high volume/high pressure pumps and control, and monitoring equipment.	Approximately 2-3 days.
HFS	Hydraulic Fracture Stimulation involves the injection of large quantities of water and sand plus a small percentage of chemicals at high pressure down and across horizontal drilled wellbores causing the shale to crack. The cracks or fractures created are held open by the sand/proppant allowing gas from the shale to flow into and up the well.	Specialised truck, trailer or skid mounted equipment mainly consisting of high volume/high pressure pumps, mixing equipment, water storage tanks and control and monitoring equipment.	Approximately 10-30 days depending on the number of stages to be fracture stimulated.
Completions Activity	Equipment installation inside the wellbore, typically steel tubing to assist the well's ability to lift fluids/gas up the wellbore to surface.	A completions rig package and wireline units when required	Approximately 2-5 days
Production Test	Measuring the productivity of the wellbore after it has been HFS. Flow rates (gas/fluids), pressures, solids, and gas/fluid analysis are typically assessed.	Well test package, typically consisting of a 3 phase test separator, choke manifolds, flowback tanks, flare stacks and emergency shutdown valves. Wells that require artificial lift to initiate flow may also have a coiled tubing unit on location to conduct a Nitrogen (N_2) lift.	Approximately 1-12 months.

Plug and Decommissioning (activity delayed if well is suspended)	Setting and testing cement plugs to ensure permeable zones have been isolated from each other to prevent cross flow and/or flow communication to surface.	A drilling rig package.	Approximately 2 days.
Site Rehabilitation (after Plug and Decommissioning)	Earth works rehabilitation to original condition. Re-vegetation as required. Note that any water bore and some road access are likely to remain.	Earth moving equipment.	Approximately 1 week (TBA) and then sufficient time to re-establish vegetation. May be completed several months post drilling activity.
2D or 3D seismic	Collection of seismic data by placing seismic nodes on the ground surface and then creating pulse energy into the subsurface which reflects off changes in rock layers 'hardness' and are detected by the nodes when the reach surface again. This allows an 'image' of the subsurface to be collected which allows predictions on what rocks occur underneath the exploration area	Vibroseis trucks, Seismic nodes and associated cables	2 - 12 weeks

3.2 Appendix 2

Included in submissions are comprehensive environmental management plans (EMP) detailing processes and procedures that will be followed during implementation and execution of all aspects of exploration activity. These plans are also assessed and reviewed as part of the ATD process to ensure field activities are carried out in a way that meets all applicable environmental legislation and regulation. An EMP and associated documentation, assessed as part of the ATD approval, may include:

- Management of Sacred Site / Cultural Heritage, heritage, bushfire, weed control and management, erosion and sediment control, protection of Surface water and groundwater water, dust, traffic, biodiversity, and waste) - these plans will cover both the general exploration activity plus specific environmental requirements for each well site and its associated activities
- Oil Spill Contingency Plan (OSCP)
- Emergency Response Plan (ERP)
- Water Management Plans for regular testing of local water bores before, during, and after the project
- Chemicals disclosure – a list all chemicals to be used during the project
- Environment Rehabilitation Security Bond - submission of security bond calculation that covers all the rehabilitation management areas and evidence of final payment
- Archaeological, Sacred Site and Heritage clearance
- Pastoralist's consent

Copies of all documentation including all Environmental plans and documentation provided to Northern Territory regulatory agencies will also be provided to the NLC. All activities carried out by Origin as operator are also governed by stringent internal environmental policies and directives which are referenced when preparing environmental plans and undertaking work programs.

If hydraulic fracture stimulation is to be undertaken, the following additional environmental controls are also applied:

- Further validation of cement placement and its integrity
- Further pressure testing
- Continuation of baseline water monitoring and testing
- Submission of fracture modelling (maximum propagation height), confirming safe separation between any natural aquifers and the fracture zone
- Submission of all MSDS for public disclosure on the department's website
- BTEX (Benzene, Toluene, Ethyl-benzene, Xylene) products will not be accepted nor utilised as they are prohibited for use in the Northern Territory.

Origin has in place an HSE Policy that states:

At Origin, we value the wellbeing of our employees, contractors, customers, the communities in which we operate and the environment. We are committed to responsible management practices that minimise any adverse health, safety or environmental impacts, and enhance benefits associated with our activities, products or services.

We have in place a Health, Safety and Environment management system for our activities that drives continual improvement. The HSE Management System outlines accountabilities to implement this Policy and requires that we:

- Identify hazards and reduce risks so far as is reasonably practicable where there is potential to cause injury or illness to people, or to adversely impact the environment or the community
- Provide safe work places and systems of work, empower employees and contractors to address unsafe or hazardous situations and carry out their work in a manner that does not present a risk to themselves, others or the environment
- Support the recovery and rehabilitation of employees in the event of work related injury or illness
- Set objectives and targets which promote the efficient use of energy and resources, the minimisation of wastes and emissions and the prevention of pollution
- Comply with relevant HSE legal requirements and other commitments
- Require Contractors to manage HSE using standards and practices that accord with this Policy
- Regularly review and report HSE performance.

In implementing this Policy, we will engage with our employees, contractors, suppliers, business partners, customers and Government and communicate expectations to all persons working with or on behalf of Origin.

Origin field activities are also covered by a series of Environmental Directives which include the following:

- The Air Emissions directive outlines Origin's requirement for identification and management of emissions with potential to affect air quality and/or regulatory compliance.
- The Biodiversity Management directive describes requirements for identification and assessment of impacts on terrestrial and aquatic flora, fauna and ecosystems; controls for managing biodiversity-related risks; and methods for enhancing biodiversity values.
- The Cultural Heritage directive covers identification and assessment of cultural heritage values and sites, compliance with legal obligations and voluntary commitments, development of plans, and effective stakeholder engagement.
- The Environmental Noise directive describes requirements for identifying, assessing, monitoring and minimising noise emitted during normal operations as well as during construction, commissioning and decommissioning activities.
- The Greenhouse Gas and Energy Efficiency directive sets out requirements for managing greenhouse gas (GHG) emissions and energy efficiency, including identification and monitoring of energy consumption, energy production and GHG emissions.

- The Land Management directive describes requirements for identifying and assessing impacts to land, and implementing controls to manage erosion, visual amenity, contaminated sites, site closure and rehabilitation.

- The Materials and Waste directive outlines requirements for identifying, assessing and managing impacts associated with use of materials, and storage, handling, treatment and disposal of wastes.

- The Water Management directive outlines requirements for managing water extraction and consumption, water quality and controlling wastewater treatment and discharges.

Proposed Water, Gravel or other Resource Use

It is proposed that water bores to provide water for civil construction, well drilling and completion operations are to be installed adjacent to the well site pad and along access tracks within the clearance area of the well sites and access tracks. The bores will be constructed to the minimum construction requirements of the NT Government.

Gravel from existing gravel pits and new borrow pits may be required for access road sheeting and well site pad sheeting. Any new borrow pits would be located within the clearance area along the access tracks or lease pads.

Annexure B:
2021 Work program Document provided to the NLC (24 September 2021)

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

CONTENTS

EP98, 117, 76 – Beetaloo Joint Venture (Origin / Falcon) 1

CONTENTS 2

1 OVERVIEW 3

2 PROPOSED WORK PROGRAM 3

2.1 Detailed Activity List 3

2.2 Areas 4

2.3 Request 5

2.4 Figures 5

2.5 Appendices 5

2.6 Attachments 5

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

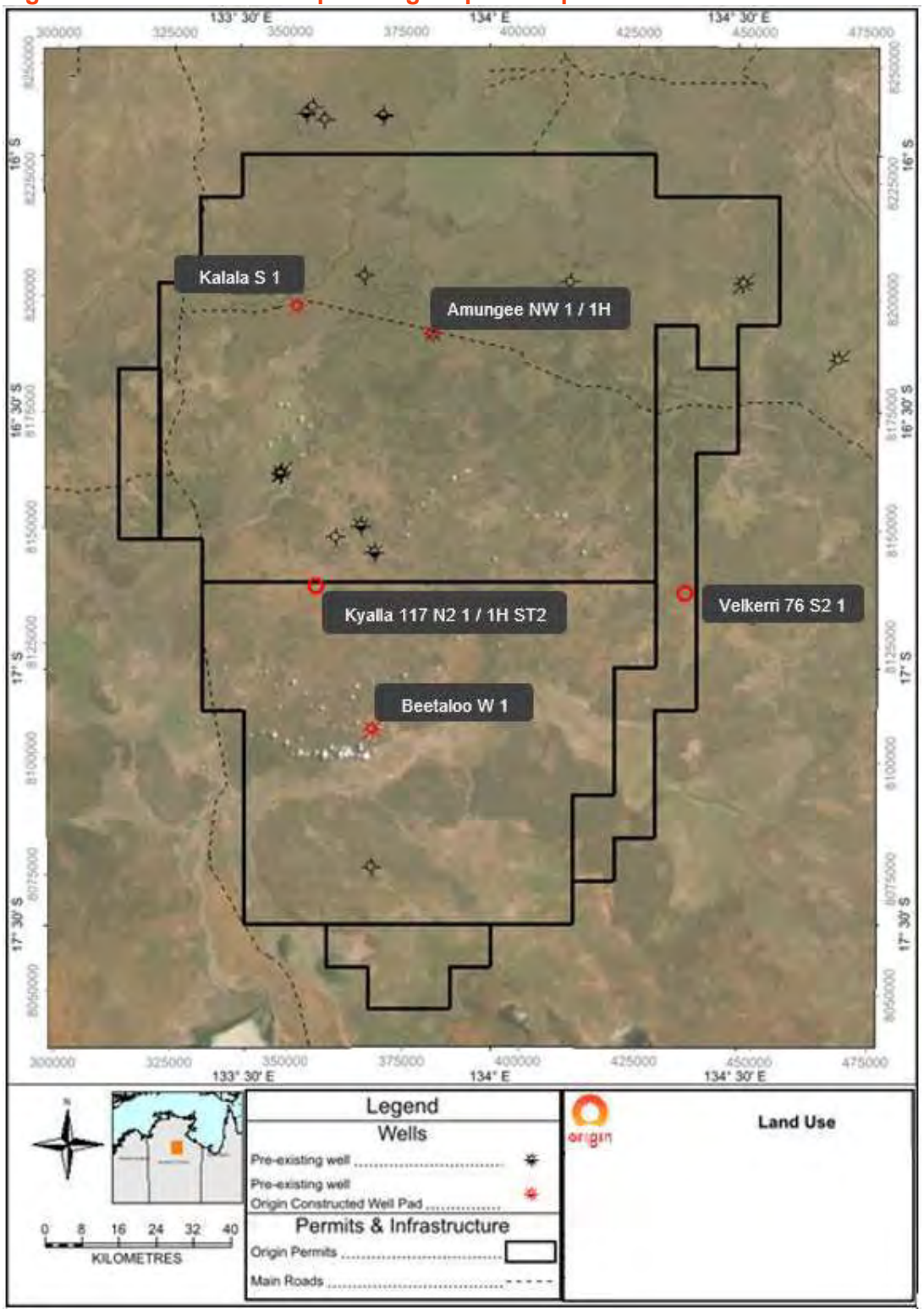


Figure 1 - Overview of Origins Beetaloo Basin Exploration permits and existing wells drilled to date

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

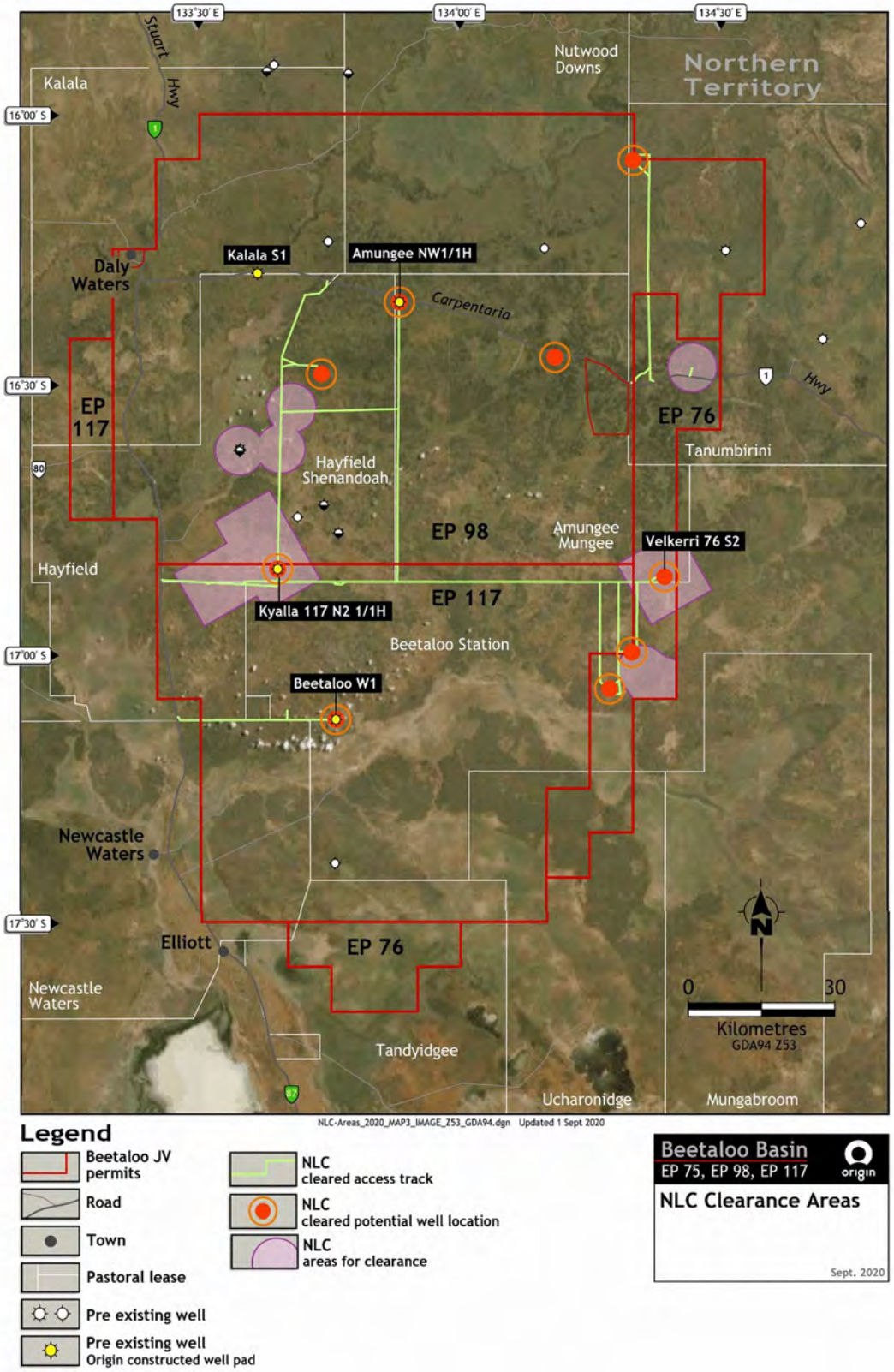


Figure 2 - Areas cleared by NLC to date

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

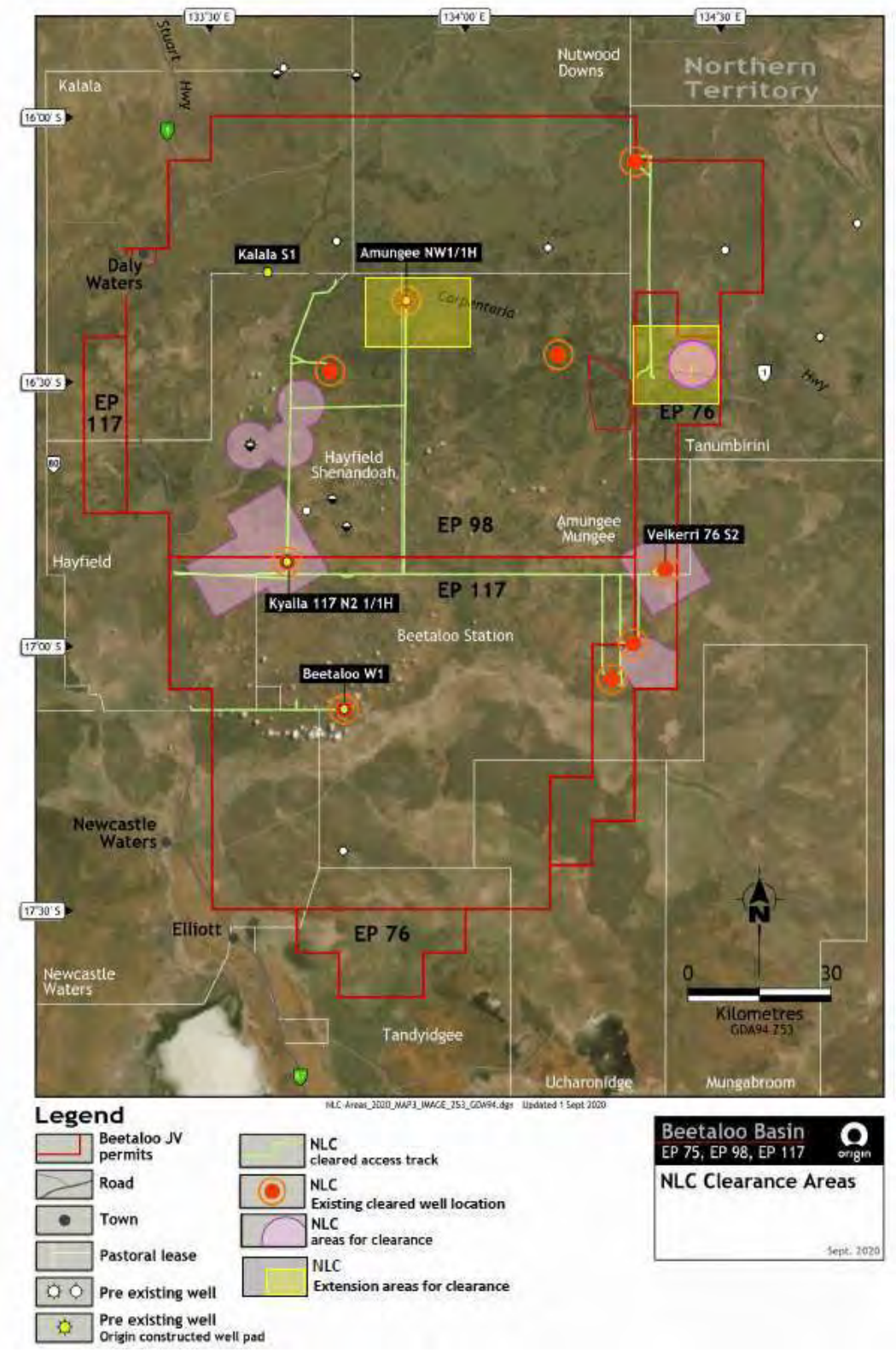


Figure 3 - Extension areas requested for NLC clearance (yellow polygons)

3 APPENDICES

3.1 Appendix 1

The following information and table details of the proposed exploration activties proposed **w** **ithin 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.

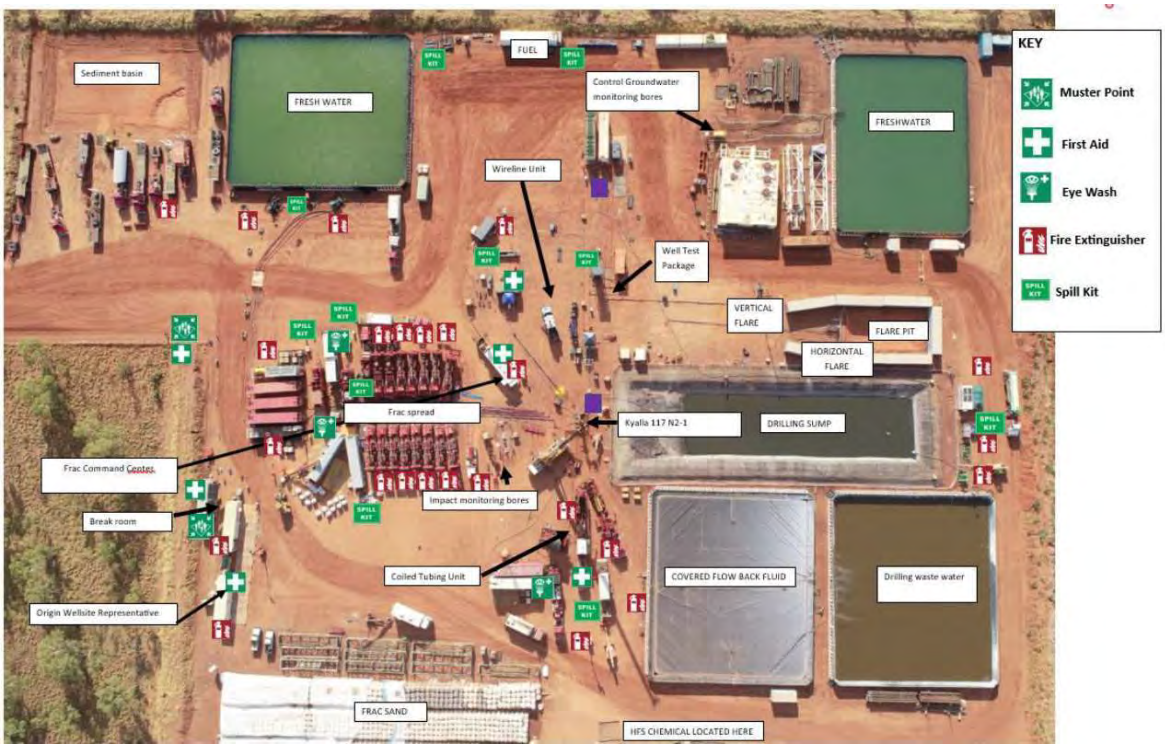


Figure 11 Typical Hydraulic fracture stimulation spread at the Kyalla 117 N2 site.

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 thelife 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 smallearthen 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 abandonmen t 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, produced water, or hydrocarbons (liquid	• 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 being added to separate aquifer units.

			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 WEL).	• 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
				• .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 environmentally acceptable.	• 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 code of Practice.

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			• 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	• 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 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	• 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 –	○ 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.

Appendix N.1.2 09 211129 EMAIL

[redacted]

Subject: Conditions of Work Report re 2020 and 2021 Sacred Site Avoidance Surveys

Hello Simon

Please find attached the Conditions of Work Report for the 2020 and 2021 sacred site avoidance surveys.

Regards

[redacted]
Manager Petroleum Unit
Resources & Energy Branch
Northern Land Council

NORTHERN LAND COUNCIL
Our Land, Our Sea, Our Life

[redacted] | Website: www.nlc.org.au

Disclaimer

The information contained in this communication from the sender is confidential. It is intended solely for use by the recipient and others authorized to receive it. If you are not the recipient, you are hereby notified that any disclosure, copying, distribution or taking action in relation of the contents of this information is strictly prohibited and may be unlawful.

This email has been scanned for viruses and malware, and may have been automatically archived by **Mimecast Ltd**, an innovator in Software as a Service (SaaS) for business. Providing a **safer** and **more useful** place for your human generated data. Specializing in; Security, archiving and compliance. To find out more Click Here.

Appendix N.1.2 10 Tamboran priorities CY23

From: Simon Nish
To: [redacted]; Gibson Porkime
Cc: Tamboran Contact
Subject: Tamboran priorities CY23
Date: Friday, 16 December 2022 7:20:55 AM
Attachments: 221216 Work Programme CY2023.pdf
image001.png

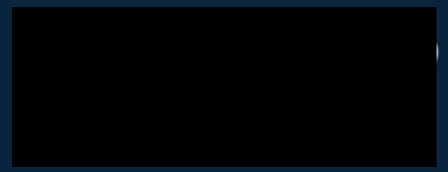
Dear all

Please find attached the updated presentation that Matt stepped through at the Operations meeting yesterday.

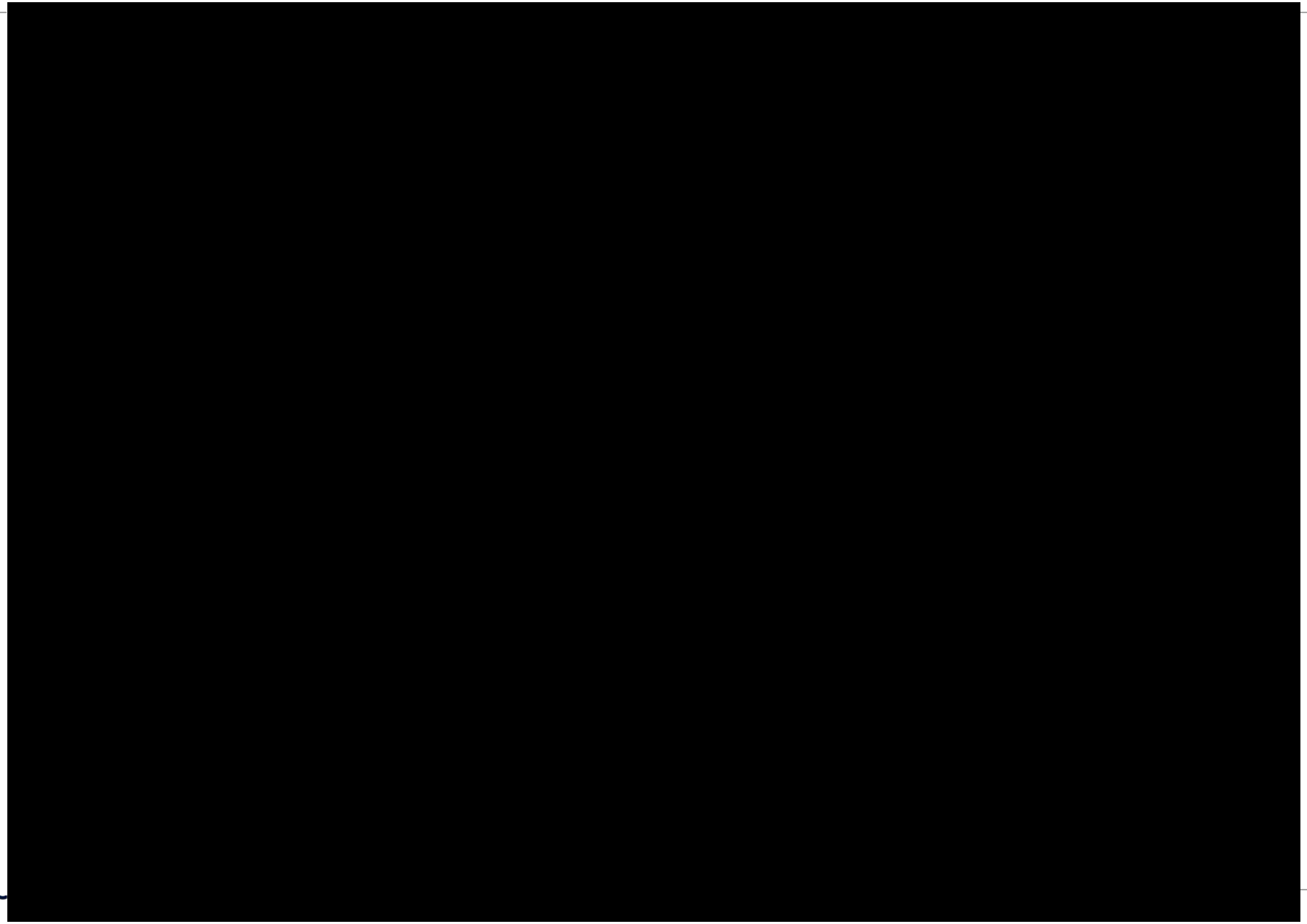
Kind regards,
Simon Nish
Lead Negotiator Beetaloo ILUA
[redacted]
tamboran
RESOURCES

Tamboran
Work Program Summary CY2023

NLC Update Dec 2022



Current scouting underway



2023 Exploration Operations Summary Map

[redacted]

2 Option for 2023 On-The-Ground Exploration Operations

1

Firm
- Pad civil works – existing Kyalla 117 N2 & Step-out Pad #2
- Drilling 2 Velkerri wells at existing Kyalla 117 N2 and Step-out Pad #2
- Frac and test 2 wells

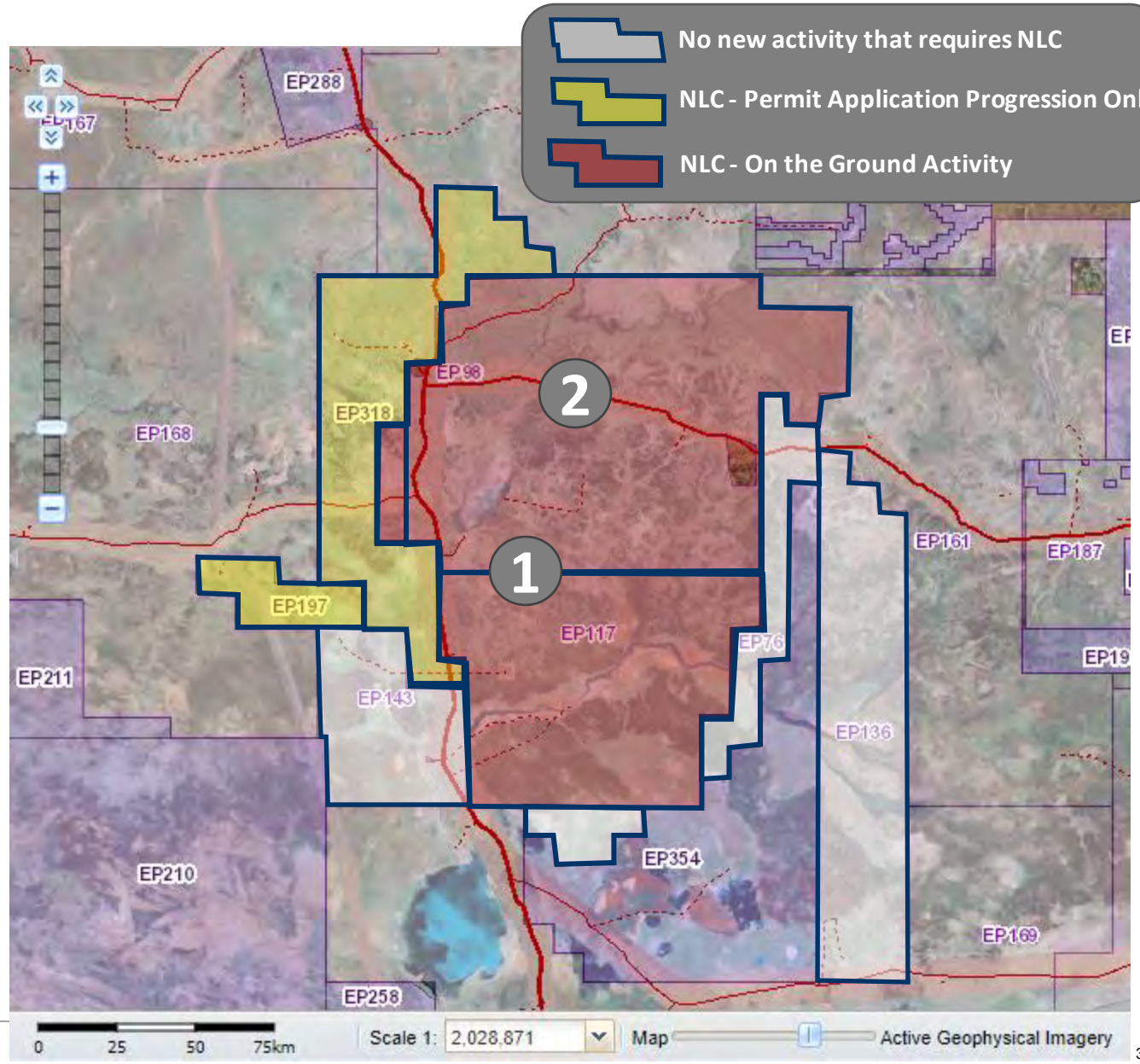
Contingent
- Pad civil works Step-out Pad #3
- 2D Seismic
- Drilling 1 well
- Frac and test 1 well

Or

2

Firm
- Pad civil works – Amungee Step Out Pad (TBD)
- Drilling 1 well
- Frac and test 1 well

Contingent
- Drilling 2 wells
- Frac and test 2 wells



2023 Exploration Operations Summary- High priorities

Highest Priority to support 23 work program:

[redacted]

High Priority

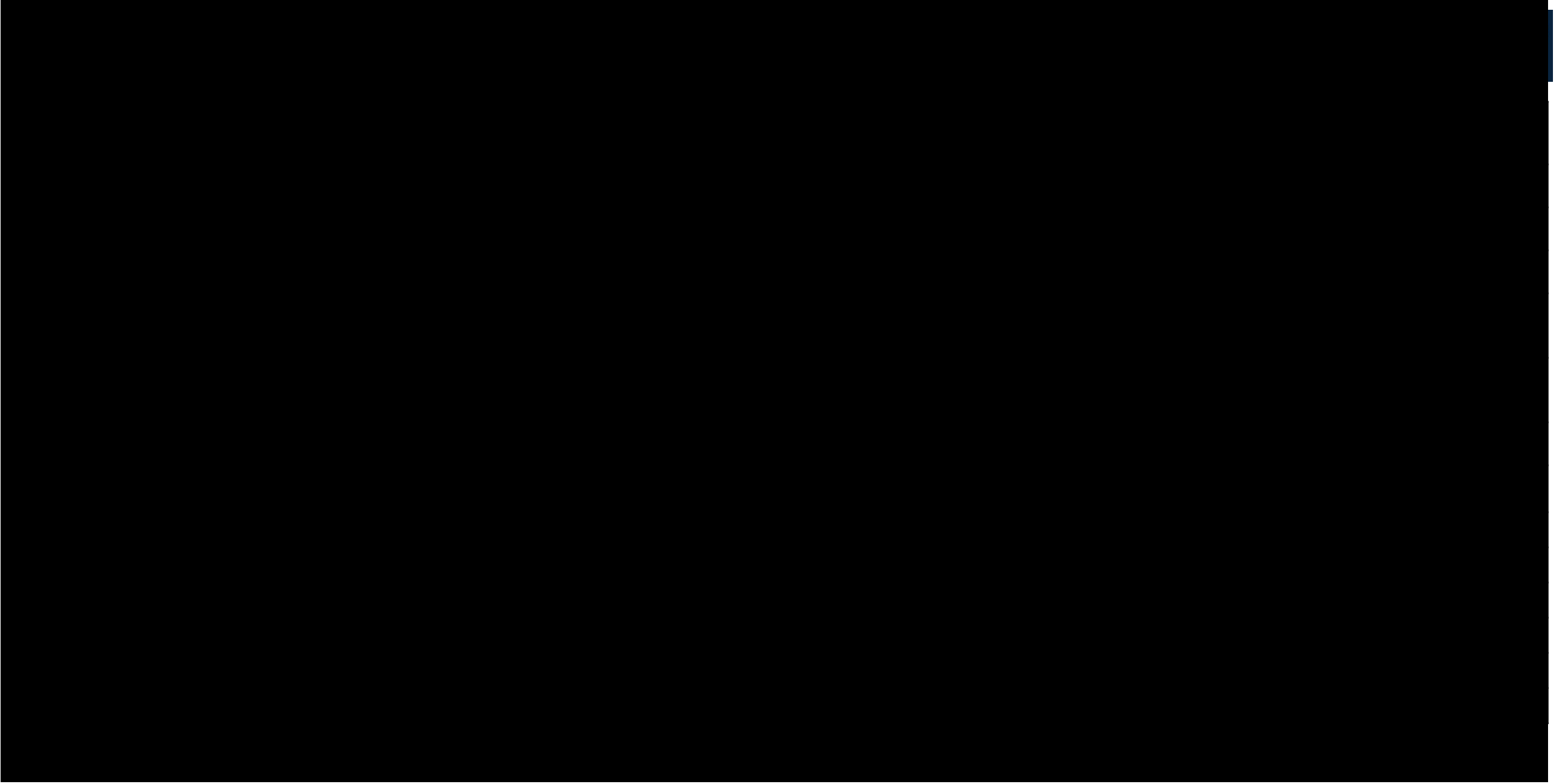
[redacted]

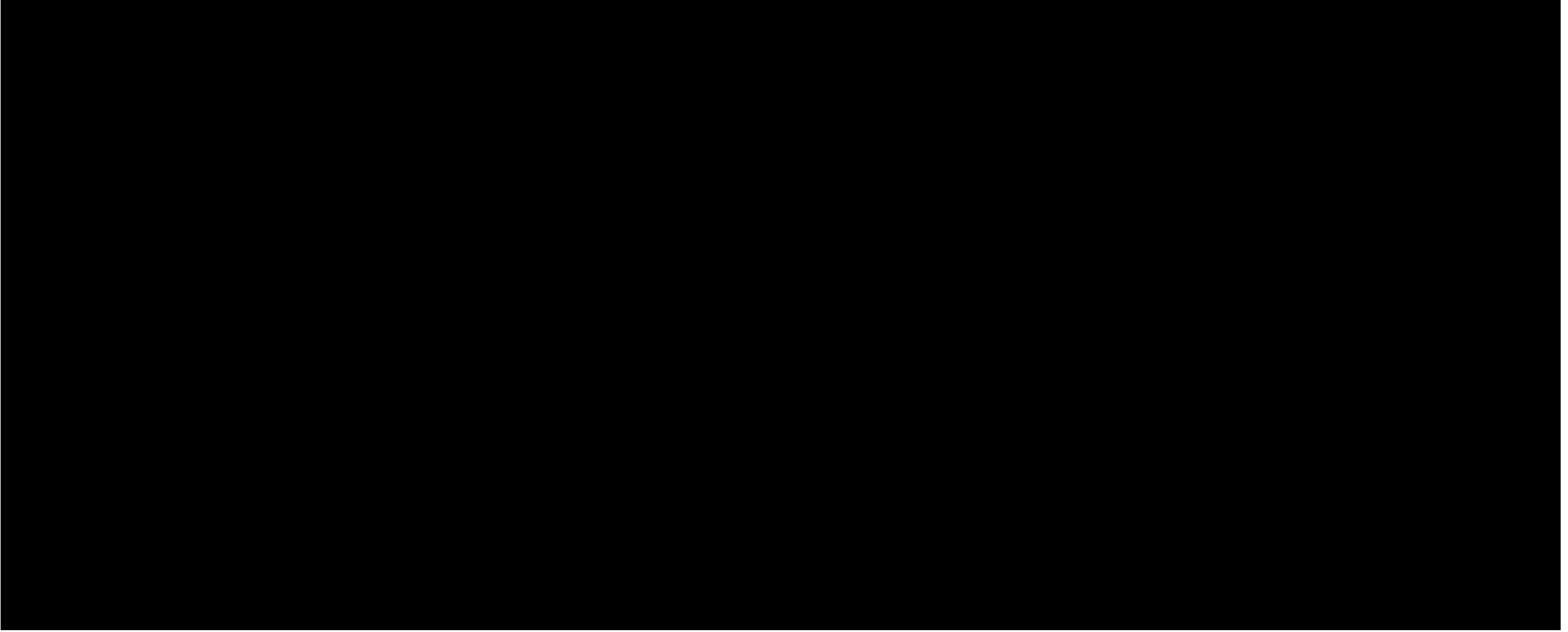
[redacted]

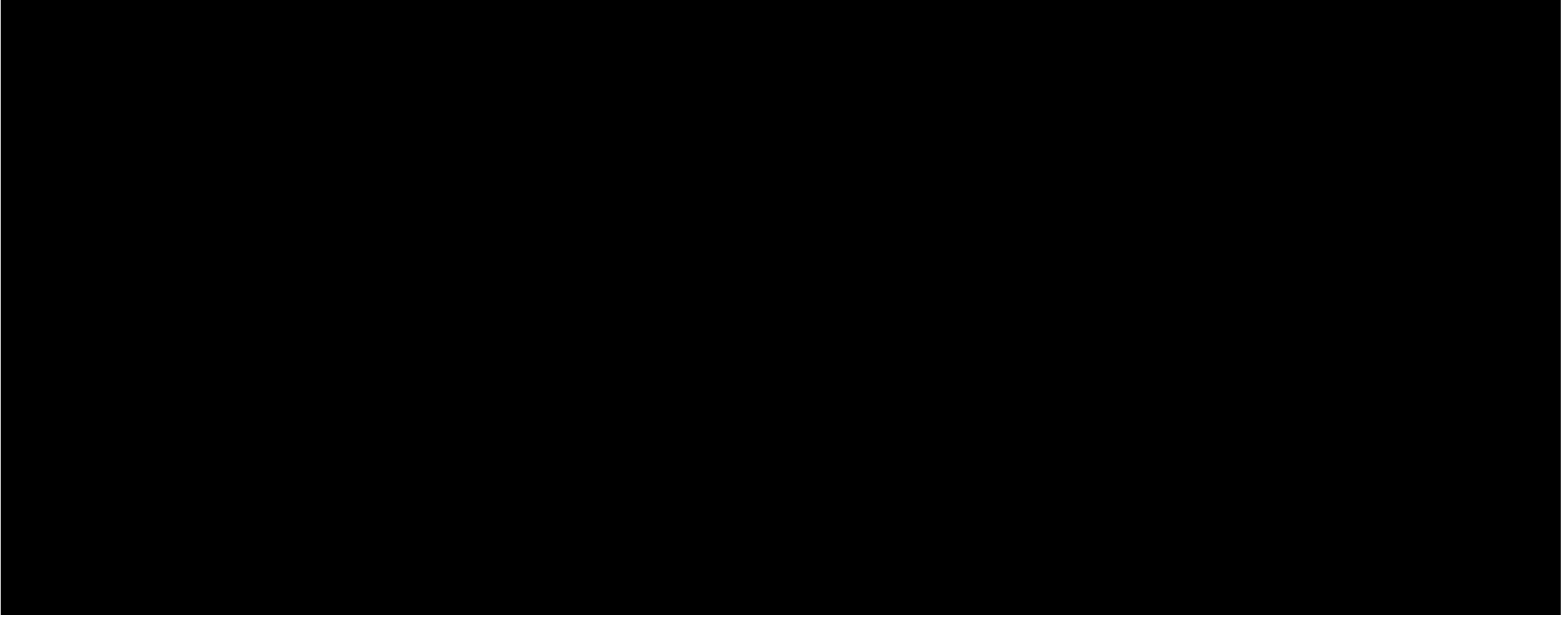
[redacted]

- Tamboran looking to expand activities around the Kyalla 117 N2 site
- Indicative scope:
  - Clearance to increase cleared well pads within expanded subject land 2 from 4 (currently cleared) up to 7- predominantly focused around the existing Kyalla 117 N2 location
  - Seismic lines 200-300km2 of 3D/2D seismic lines
  - Access tracks
  - Gravel pits
  - Water storages (fresh and flowback)
  - Water extraction and monitoring bores
  - Appraisal gas sale
  - Onsite compression and gas processing
  - Pipelines- potential gathering and high pressure sales
- Seeking [redacted]

[redacted]







tamboran
RESOURCES

Appendix N.1.2 11 Tamboran Annual Work Program update and Clearance Request Report

From:	Matt Kernke
To:	[redacted]
Cc:	Tamboran Contact; Gibson Porkime; David Close; Simon Nish; Emily Beresford-Cane
Subject:	Tamboran Annual Work Program update and Clearance Request Report
Date:	Thursday, 16 February 2023 10:34:27 AM
Attachments:	160223 Tamboran NLC Work Program 2023 Final .pdf New NLC Clearance Spatial files.zip

---

Dear All,

Please find attached Tamboran's annual work program update and clearance request report. This report provides an overview of the Calendar Year 2023 Work program and proposed sacred site clearance areas.

The spatial files for the new sacred site clearance area are also attached and form part of this submission.

If you require any additional information or clarification, please do not hesitate to contact me.

Kind Regards
Matt

2023 Work Program update and Clearance Request

EP 98, 117, 76 – Beetaloo Joint Venture (Tamboran / Falcon)

Version:	1.0
Submitted:	Matt Kernke
Presented by:	Tamboran
Review Date:	16 February 2023

2023 Work Program Update and Sacred Site Clearance Request

CONTENTS

1 OVERVIEW 3

2 Exploration and appraisal program strategy - the bigger picture 3

3 Proposed 2023 work program 5

4 Calendar Year 2023 NLC Requests 7

4.1 AAPA certificate application - existing cleared areas 12

4.2 New Clearance Area request 12

APPENDIX A Detailed description of regulated activity 19

Appendix B Summary of Environmental outcomes, impacts, risk and controls 41

2023 Work Program Update and Sacred Site Clearance Request

1 OVERVIEW

In November 2022, Tamboran (B1) Pty Ltd (ABN 39 662 327 237) (*Tamboran (B1)*) executed a transaction to purchase Origin B2 Pty Ltd (ABN 42 105 431 525) (A subsidiary of Origin Energy;) in its entirety. The transaction resulted in Tamboran (B1) acquiring Origin B2's 77.5% interest in Exploration Permits (EP) 76, 98 and 117 (the Permits) under the Beetaloo Joint Venture (JV) with Falcon Oil and Gas (the Beetaloo JV). Tamboran (B1) is a jointly owned subsidiary (in equal proportions) of Tamboran (West) Pty Limited (ACN 661 967 077) ("Tamboran West") and Daly Waters Energy, LP ("Daly Waters"). Tamboran West is ultimately owned by Tamboran Resources and Daly Waters is ultimately owned by Sheffield Holdings, LP.

Origin Energy B2 Pty Ltd continues to operate as Tamboran B2 Pty Ltd (*Tamboran B2*), having formally changed company name with the Australian Securities and Investment Commission (ASIC). For the purposes of this document and going forward, all previous references to *Origin* will be replaced by *Tamboran B2* or the *Beetaloo JV.* Tamboran B2 remains as operator of the Permits.

Northern Territory Government permit commitments across the Permits require Tamboran B2 to complete ongoing exploration and appraisal (E&A) activities. Since 2015, the Beetaloo JV has drilled eight (8) wells in the Beetaloo Sub-basin (Beetaloo). These include Kalala S 1, Beetaloo W 1, Amungee NW 1, Amungee NW 1H, Kyalla 117 N2 1, Kyalla 117 N2 1H, Velkerri 76 S2 1 and the recently drilled Amungee NW 2H (December 2022).

Results collected from the Beetaloo E&A program have highlighted that the various shales within the Beetaloo are potentially suitable for a future onshore gas development. Tamboran B2 has identified two main areas where larger scale pilot projects may be completed in the coming years pending approvals and E&A success; The Amungee Delineation Area and the Shenandoah South Pilot Area. These areas are the focus of the forward E&A campaign and subsequent sacred site clearance requests.

Tamboran B2 respectfully requests the Northern Land Council's assistance to facilitate a *Sacred Site Clearance Survey* to comply with the obligations of the Exploration Agreement(s) and to support an application for Aboriginal Areas Protection Authority (AAPA) Authority Certificate for activity as described below.

This application is designed to provide coverage for Tamboran B2's proposed activities within these area over the next 1-5 years, with all or a subset of the proposed activities likely to occur. Annual work program updates will continue to communicate any refinement of Tamboran B2's E&A strategy.

2 Exploration and appraisal program strategy - the bigger picture

Tamboran B2's development strategy is focused on bringing gas to the domestic market as soon as practicable. Well testing during the Exploration and appraisal (E&A) phase is a crucial step in assessing the commercial viability of the Beetaloo Basin shale resources. Hydrocarbons produced during this phase are typically flared; which is a significant source of Greenhouse Gasses (GHG). Tamboran B2 is seeking to beneficially use produced hydrocarbons, rather than dispose of them via an onsite flare. This will achieve multiple objectives such as:

- Minimising GHG generation
- Increasing domestic gas supply at a time of domestic and international scarcity
- de-risking future shale developments through longer term gas production information
- providing near-term benefits to Native Title Holders (NTH), local stakeholders and the people of the Northern Territory through increased gas supply, and greater potential for local employment opportunities and compensation/royalty payments.

Similar to Origin's previous strategy, Tamboran B2 will begin increasing E&A activities around specific areas that could support future production activities. Tamboran is focusing its E&A efforts around the Amungee Delineation Area (around the existing Amungee NW location) and the Shenandoah South Pilot Area (around the existing Kyalla 117 N2 location). An overview of the proposed focused areas is provided in Figure 1.

The E&A work program for calendar year (CY) 2023 includes a new E&A wells at the existing Kyalla 117 N2 location (within the Shenandoah South Pilot Area) and a new step out location adjacent to Amungee

2023 Work Program Update and Sacred Site Clearance Request

NW (within the Amungee NW Delineation Area). New well pads will be constructed progressively over the CY 2023-25 period, with additional E&A wells drilled stimulated and tested within both the proposed areas (subject to approvals and appraisal results). As the number of wells drilled and tested increase over the next 1- 3 years, it is anticipated that the gas production volumes could be sufficient to warrant the construction of compression and pipeline infrastructure. This infrastructure will allow for the temporary sale of appraisal gas, subject to agreement with NTHs and the Northern Territory Government (NTG). Sale of appraisal gas is anticipated to commence in 2024.

Previous work program progress from operators within the Beetaloo has been slowed by the lack of availability of suitable drilling rigs in Australia. To alleviate this constraint and prioritise the near-term delivery of gas to the domestic market, Tamboran B2 has entered a partnership with Helmerich & Payne (H&P) to import a dedicated drilling rig in country to support Tamboran B2's E&A program. H&P is one of the largest global onshore drilling rig providers, with over 40% of the "Super Spec" American land drilling market share. This strategic move is anticipated to increase the delivery of E&A program results and drive down drilling costs. It is anticipated that the H&P rig will be in country, ready for spud by July 1st 2023.

In parallel with the E&A program, Tamboran B2 will continue to progress the Production ILUA, other critical approvals and front-end engineering design (FEED) for a larger development. A larger development will be focused on both domestic and potentially export markets, with the upstream component (i.e. extraction of gas) anticipated to be Scope 1 and 2 net zero. The design of a larger development and subsequent approvals will be underpinned by information collected from the CY 2023 to CY 2025 E&A program.

3 Proposed 2023 work program

There are two potential work program areas for Tamboran B2's CY 2023 work program, which are subject to environmental, land access and sacred site clearance approvals. Tamboran is prioritising activities within two areas as summarised below:

Area 1 Shenandoah South Pilot Area

- Expansion of the existing Kyalla 117 N2 location and construction of a step out location (Shenandoah South Pad #2 - naming to be confirmed)
- Drilling, hydraulic fracture stimulation (HFS) and testing of a deeper well targeting the Velkerri Formation shales on the existing Kyalla 117 N2 location
- 52km of 2D seismic
- Maintenance of existing sites and associated infrastructure.
- Environmental and heritage surveys required for future production environmental approvals.

Area 2. Amungee Delineation Area

- Stimulation and testing of Amungee NW 2H (nominally a 180 day well test);
- Civil construction of the Amungee NW 3 step out location, including lease pad, camp pad and access tracs;
- Drilling, HFS and testing of up to 3 additional wells on either the existing Amungee NW, new Amungee NW3 location or a combination of both
- Maintenance of existing sites and associated infrastructure.
- Environmental and heritage surveys required for future production environmental approvals

The full 2023 work program for EP 76, 98 and 117 is detailed in Table 1 covering the existing and proposed new locations required to support the proposed work program.

Table 1 EP 76, 98 and 117 Work Program Summary (including contingent scope)

Exploration Permit	Location	Location type	Pastoral Stations/ NT Portions	2023 work program overview
EP 76	Velkerri 76 S2	Existing	Amungee station (NT Por 1079)	• Ongoing access track, gravel pit, camp pad and lease pad maintenance and monitoring • Ongoing Velkerri 76 S2-1 well maintenance
EP 98	Amungee NW	Existing	Amungee station (NT Por 1079)	• Ongoing access track, camp pad and lease pad use, maintenance and monitoring • Hydraulic fracturing and well testing (~180 days) of the Amungee NW 2H well • Well testing of the Amungee NW 1H well • Drilling, hydraulic fracturing and testing of up to 2 additional E&A wells • *Contingent*: approximately 40km of 2D seismic
EP 98	Amungee NW2	Existing	Amungee station (NT Por 1079)	• Periodic inspection and ad hoc maintenance of existing access track, water bore, and lease pad

2023 Work Program Update and Sacred Site Clearance Request

Exploration Permit	Location	Location type	Pastoral Stations/ NT Portions	2023 work program overview
EP 98	Amungee NW3	New proposed location	Shenandoah East (NT Por 7027)	• Construction of new access track, gravel pit, lease pad and camp pad to ~15-20 hectares • Construction of groundwater extraction bores • Drilling, hydraulic fracturing and well testing of up to 3 additional E&A wells
EP 98	Kalala S	Existing	Kalala Station (NT Por 697)	• Periodic inspection and ad hoc maintenance of existing access track, camp pad, and lease pad • Ongoing Kalala S-1 well maintenance • Groundwater monitoring and extraction • Potential well abandonment • Potential site rehabilitation
EP 117	Kyalla 117 N2	Existing	Shenandoah (NT Por 7026)	• Ongoing access track, gravel pit and lease pad maintenance and monitoring • Civil construction works to maintain and expand the existing well pad to accommodate multiwell drilling and centralised wastewater treatment / storage- ~ 10 hectares • Drilling, hydraulic fracturing and testing of up to 2 new exploration and appraisal (E&A) wells • Ongoing maintenance and data collection from the existing Kyalla 117 N2-1H exploration well • Operation of a temporary camp • Groundwater extraction and monitoring • Long-term wastewater storage and treatment
EP 117	Shenandoah step out pad #1– naming convention to be confirmed	New proposed location	Shenandoah (NT Por 7026)	• Construction of new E&A location consisting of access track, camp pad, lease pad, laydowns, firebreak to ~15-20 hectares • Construction and operation of groundwater extraction bores • drilling, hydraulic fracturing and well testing of up to 2 additional E&A wells

2023 Work Program Update and Sacred Site Clearance Request

Exploration Permit	Location	Location type	Pastoral Stations/ NT Portions	2023 work program overview
				• acquisition of ~52km of 2D seismic[1]
EP 117	Shenandoah step out pad # 2 – naming convention to be confirmed	New proposed location	Shenandoah (NT Por 7026)	• *Contingent:* Construction of new access track, lease pad and camp pad to ~15-20 hectares • *Contingent:* Construction and operation of groundwater extraction and monitoring bores
EP 117	Beetaloo W	Existing	Beetaloo Station (NT Por (702) Access track: Hayfield (NT Por 1077) Access Track: Jingaloo (NT Por 5416)	• Periodic inspection and ad hoc maintenance of existing access track, gravel pits, camp pad and lease pad • Ongoing Beetaloo W-1 well maintenance • Diagnostic fracture injection test and monitoring • Groundwater monitoring and extraction • Potential well abandonment • Potential site rehabilitation

4 Calendar Year 2023 NLC Requests

To support the proposed E&A strategy and work program, Tamboran B2 seeks NLC support for a range of NTH engagement as summarised in *Table* 2. This can be summarised as the following ranked on priority:

1) **Highest:**

a) [redacted]

2) **High Priority:**

[redacted]

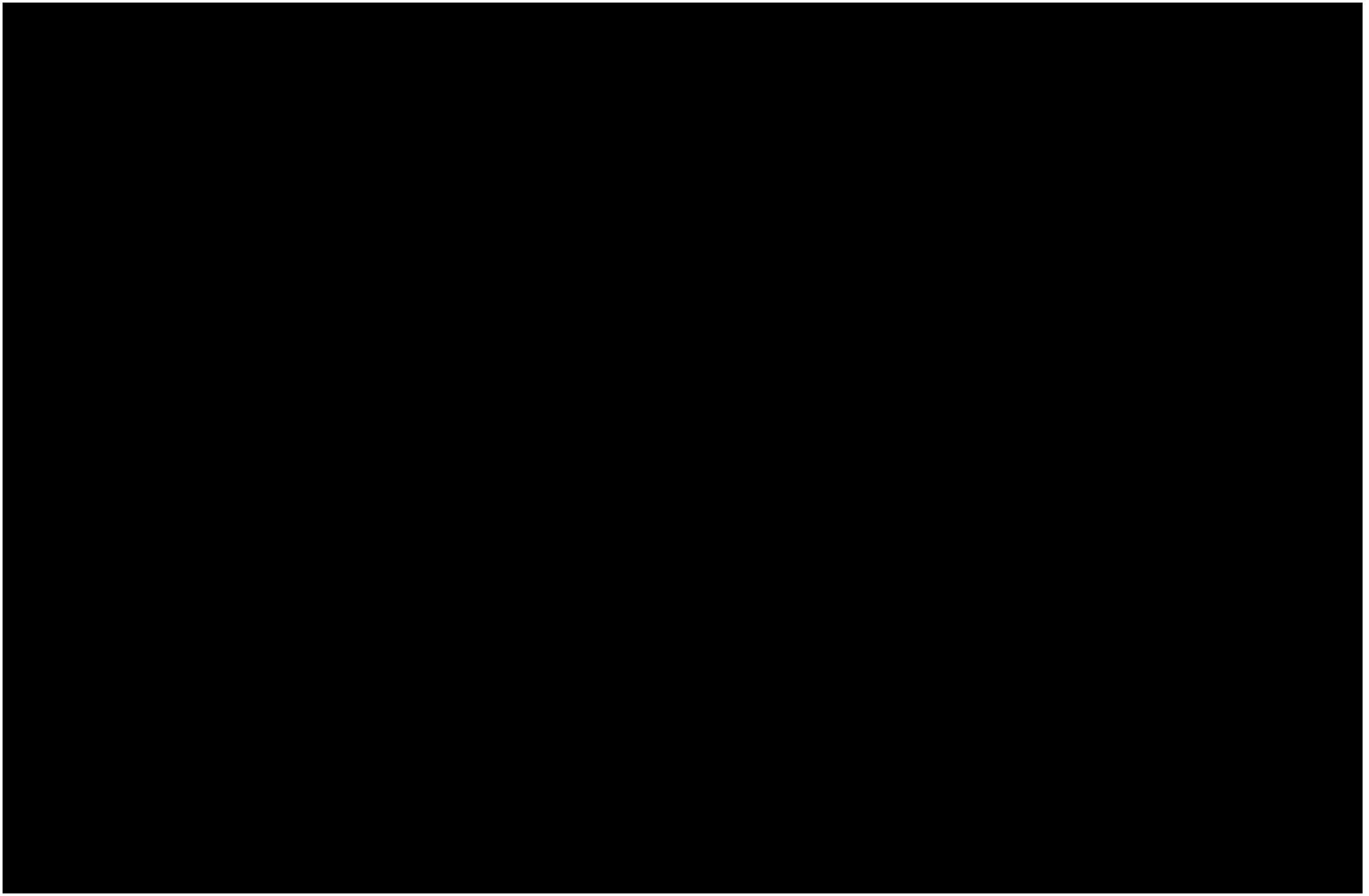
[1] An approved activity under the Amungee NW Delineation Program EMP Exploration Permit 98 EMP(ORI11-3) and a subset of a larger 200 km^2 2D/3D seismic surveys (refer Section 4).

g) [redacted]

3) Moderate/BAU priority:

a) [redacted]

2023 Work Program Update and Sacred Site Clearance Request



2023 Work Program Update and Sacred Site Clearance Request

4.1 AAPA certificate application - existing cleared areas

To accommodate future work program scope, Tamboran requests the following new clearances covering the proposed E&A scope:

1. **Appraisal gas within “Subject Land 5”**

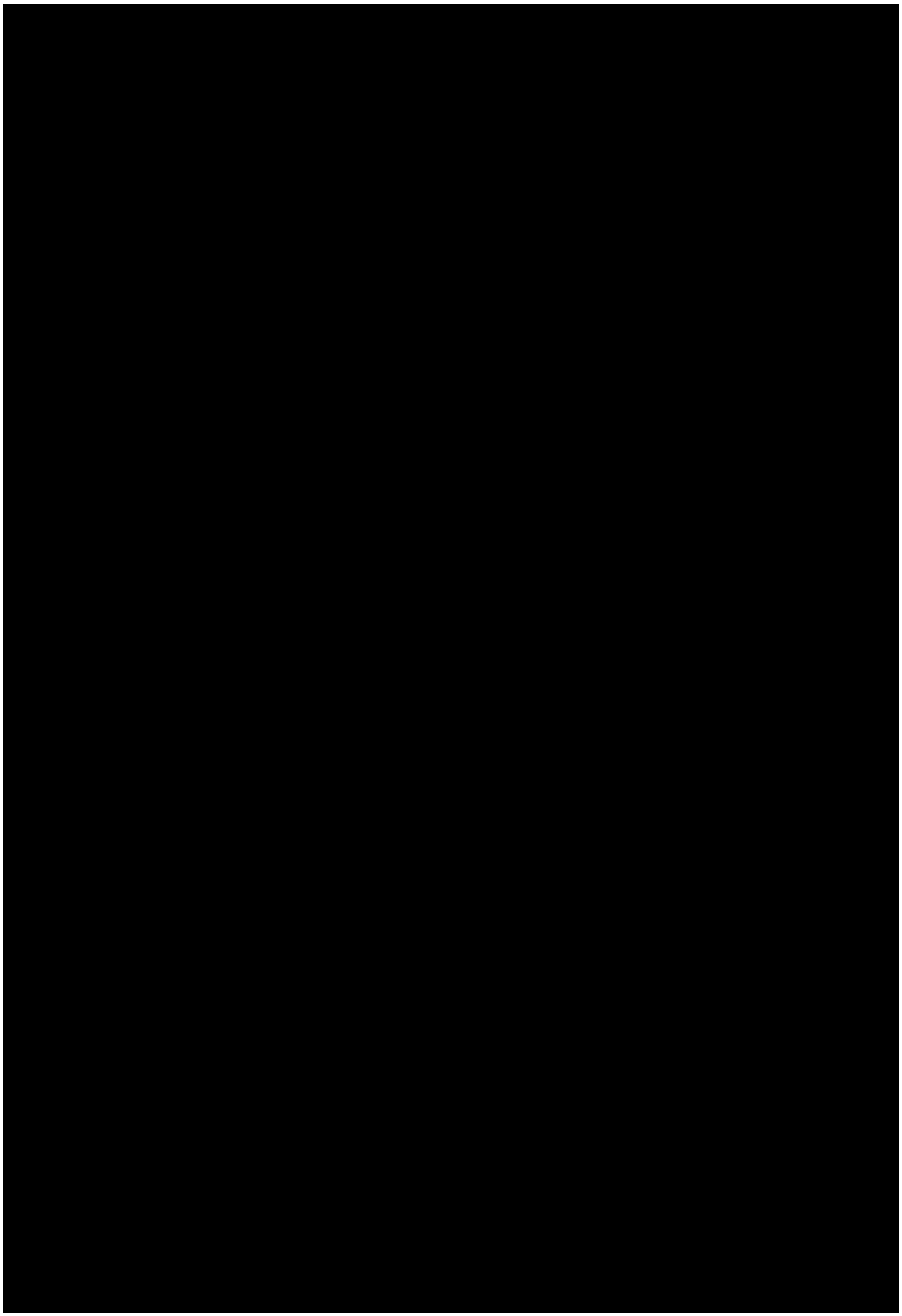
2023 Work Program Update and Sacred Site Clearance Request

[redacted]

2. **New Clearances for Shenandoah South and Amungee NW Extension Area**

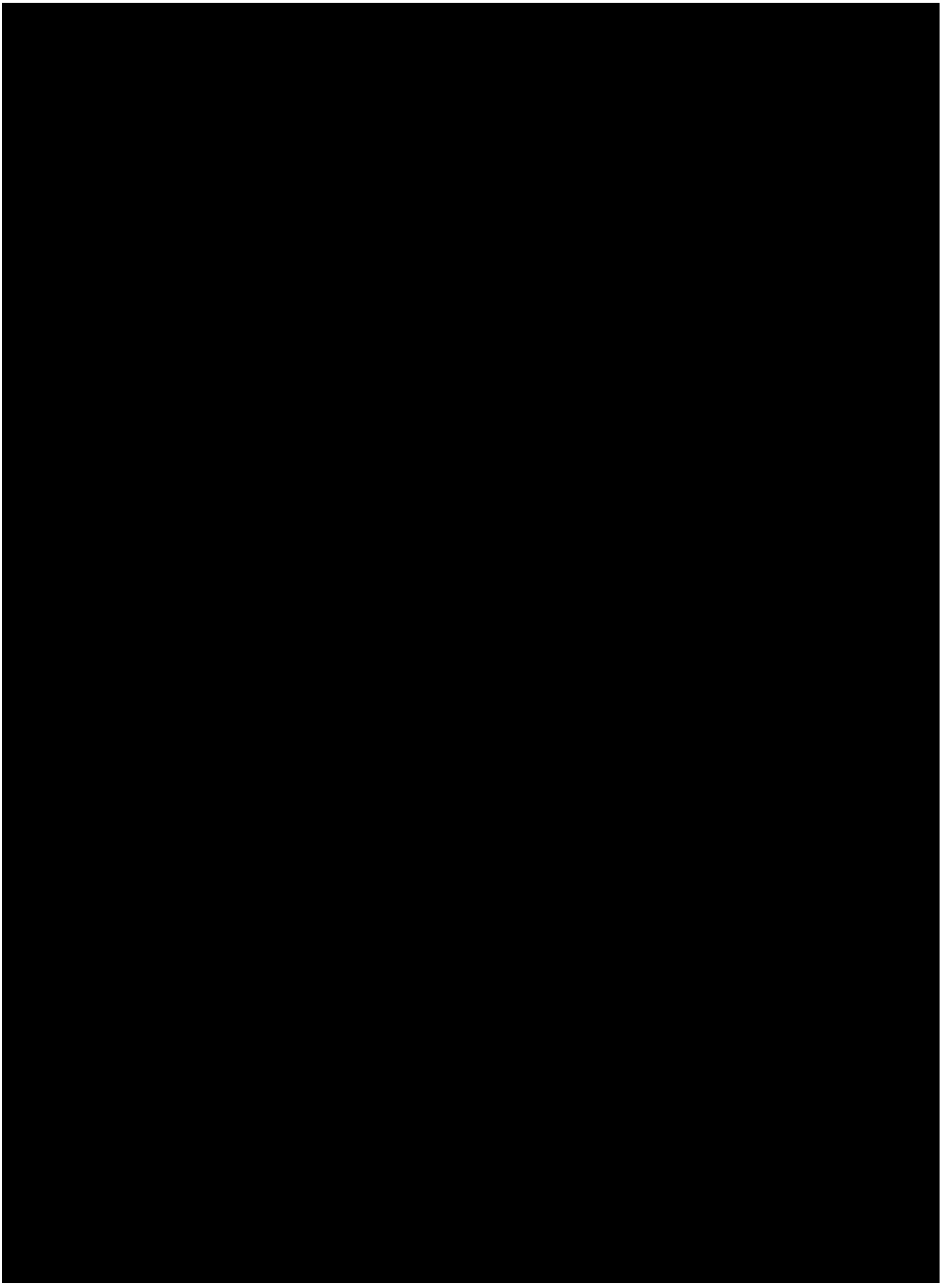
[redacted]

2023 Work Program Update and Sacred Site Clearance Request



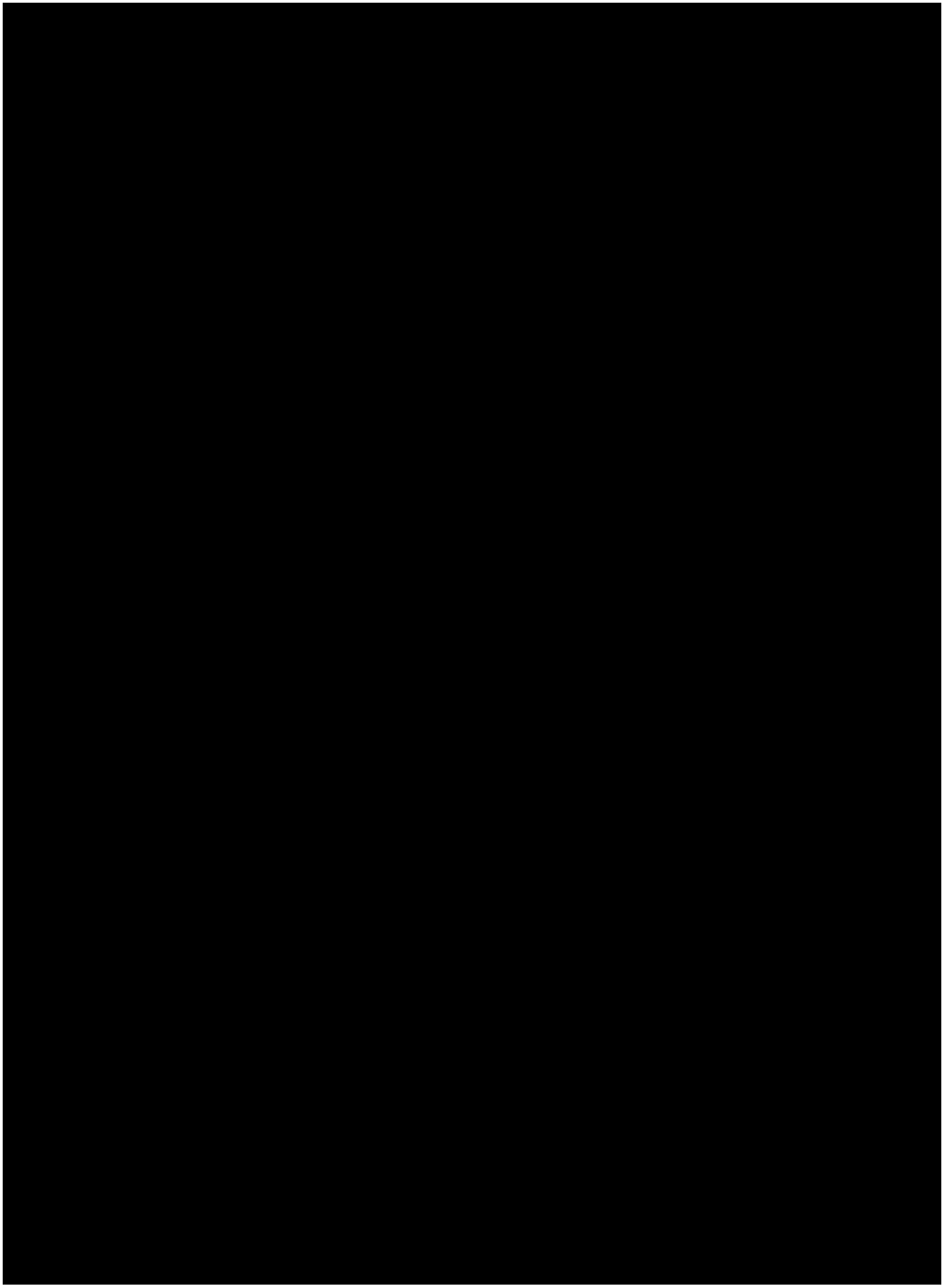
2023 Work Program Update and Sacred Site Clearance Request

2023 Work Program Update and Sacred Site Clearance Request



2023 Work Program Update and Sacred Site Clearance Request

2023 Work Program Update and Sacred Site Clearance Request



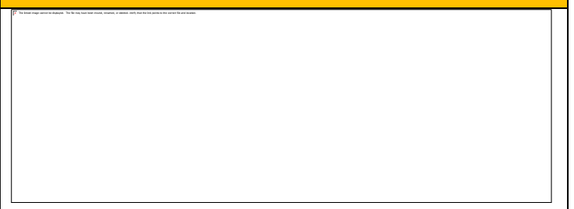
APPENDIX A Detailed description of regulated activity

The following table provides details of the proposed exploration activities proposed **within the requested clearance areas**. These descriptions are indicative and general in nature, minor departures from such descriptions are likely to occur and such departures are covered as much as practicably possible by the content of this activity description.

Table 3 Description of proposed regulated activity details within the clearance areas

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Site selection and scouting The first step of the process when undertaking exploration activities is site selection. Proposed E&A 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 (including for other infrastructure such as pipelines, access tracks, gravel pits etc.), each site is assessed for suitability using a multi-criteria analysis. This analysis covers several 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 several different specialists with a “scouting party”. Scouting activities include: • NLC field clearance: Tamboran B2 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/areas 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,	N/A	2-6	During activity planning.	<4 weeks	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
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.					
Access track construction Access tracks will be constructed to connect the proposed infrastructure to existing roads. Tracks will generally be constructed to at least NT Standard Drawings (CS3003) for Typical Cross Section for Rural Environment – Pastoral Access Road 2. Where possible access tracks will align with the existing seismic lines or other clearances/disturbances to minimise vegetation clearing. Access tracks 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 access tracks in places to enable all weather access. Where access tracks intersect with main roads (such as the Stuart Highway), intersections 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	First activity required to enable civil construction and drilling.	Access tracks are likely to be continually maintained and surfaced throughout the life of the activity	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Seismic consists of the following: 650km^2 of seismic acquisition will be undertaken. **Dynamite charges - minimal disturbance approach** Where possible surveys will be undertaken using dynamite to minimise the clearing of vegetation. In such surveys, vegetation clearing will be restricted to extremely dense vegetation where site access is otherwise prevented. Charges are typically 0.5-2kg and are installed to a depth of approximately 10-15m underground using a small ATV/4WD mounted auger. All charges and detonators are handled by licensed shotfirers. The charges are tamped and secured into place to prevent surface blow-outs and unlicensed interference. During the seismic recording the charges are detonated by a licensed shotfirer with no surface disturbance occurring. The detonated charge generates a “dull thud sound” which can be heard within 2-4km radius and felt within a 200m radius (typically) **Low Impact Source – AWD (Accelerated Weight Drop) or similar** A low impact source, such as an AWD, may be utilised as a standalone source option in suitable locations, or in combination with dynamite, or as infill in areas of restricted access. This type of source has a small surface footprint generally requiring no vegetation clearing for access. Source points are more densely spaced than larger sources such as dynamite and vibroseis trucks and may be in the order of 5-10m along a line. **Vibroseis or similar** If the seismic energy source is Vibroseis truck(s) then line clearing will be required so that the vehicles can drive and operate over the survey area. Source lines will need to be cleared every 200-400m for a 3D survey or on a sparser grid for a 2D survey. Existing cleared areas will be utilised where possible to reduce disturbance. line location tolerances utilised for avoiding vegetation, cultural heritage sights and infrastructure.. Seismic lines will be planned 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:** When required for access or source points in tough terrain surveyors mark the ground with either biodegradable paint or temporary stakes . Line detours may also be marked with temporary biodegradable flagging. A survey team in a light 4WD vehicle, ATV, or on foot 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. Recording is generally restricted to daylight hours. Geophones are deployed at regular intervals along lines perpendicular to the source lines for a 3D survey and along the source line for a 2D survey. The geophones are autonomous nodal receivers that can be readily carried by hand or small ATV and as such no line preparation is generally required for the deployment of the geophones. Once the required number of geophones are deployed each source point is activated in a pre-defined sequence and the energy generated is recorded by the geophones. The activation methodology of the source point will differ depending on the source energy type i.e. dynamite, AWD, vibroseis. After the energy source is finished the geophones are collected and line rehabilitation and data analysis commence.	up to 500ha (noting minimal disturbance seismic will be prioritised to minimise clearaing with target clearing below 50ha)	6 to 35	Before or after exploration well drilling with the final time to be finalised.	3 – 12 weeks per campaign	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
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 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 control and impact groundwater monitoring bores 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 and tested at least 6 months prior to drilling (except for exceptional circumstances) and 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 typically utilise a water bore drilling rig to construct the bores, similar to the rigs 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 other viable water bearing formations if encountered.. 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 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	
Lease pad construction Each proposed lease pad will be constructed to accommodate exploration well drilling, stimulation, testing and ongoing wastewater storage and treatment; typically such pads will be less than 12 hectares. 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, well cellars, sediment ponds, bunds and other necessary earthworks 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.	7.5-12ha	<24 people	Prior to exploration drilling	2-8 weeks	

<table>
<tr><th>Activity description</th><th>Disturbance area</th><th>Typical personnel numbers</th><th>Timing</th><th>Duration</th><th>Activity example pictures</th></tr>
<tr>
<td>The well cellars will be constructed on the proposed lease to accommodate the wellhead equipment and blow-out preventer (BOP). The cellars are typically concrete- or steel-lined and prefabricated off-site. The cellars are typically 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..</td>
<td></td><td></td><td></td><td></td>
<td> </td>
</tr>
<tr>
<td>Gathering and main pipeline Construction

Each lease pad may be connected to a centralised processing facility via a gathering pipeline. The gathering pipeline will be constructed to transport both gas and water to/and from a pad. Gathering pipelines will be constructed in a cleared right of way of approximately 25m wide.

If the beneficial use of gas is approved, to allow the avoidance of the majority of flaring, appraisal gas would likely be sold into the domestic gas market via a high-pressure main pipeline constructed to connect processing facilities to the existing Amadeus Gas Pipeline or McArthur River Mine Pipeline (MMRP). Pipeline corridors will be typically up to 50m, with the exact route and length dependent on final site selection.

Construction for the gathering and main pipelines generally include the following activities:

Pipeline Construction
<table>
<tr><th>Stage</th><th>Description</th></tr>
<tr><td>Location</td><td>An initial route selection study will be conducted for the pipeline in order to optimise the pipeline route to connect to the Amadeus pipeline. Further fine-tuning and route refinement will continue throughout the planning phase of the project to ensure the route does not interfere with any sacred sites, cultural heritage or environmentally sensitive features.</td></tr>
<tr><td>Pipe</td><td>The gas transmission pipeline will be a buried, high pressure steel pipeline. It will be designed and constructed in accordance with the requirements of AS 2885 Pipelines – Gas and Liquid Petroleum. The pipeline will be buried for its entire length and will be deep enough so current land use activities can continue after the pipe has been installed. The minimum depth of cover over the pipeline will be 750mm. For road crossings the depth of cover will be increased to ensure protection of the pipeline and the asset or feature being crossed by the pipeline.</td></tr>
<tr><td>Early Works</td><td>In order to support the approvals and detailed design activities a number of activities take place prior to the main construction phases. Generally known as ‘early works’ , these activities include a range of field-based activities. These activities inform the Approvals and Design teams about field conditions and are often iterative, as additional identified information results in changes to aspects of the project scope requiring revisiting and rework of the project scope. These activities include but are not limited to general investigations, surveys for the pipeline, sacred sites, cultural heritage, environmental and soil & geotechnical.</td></tr>
<tr><td>Survey</td><td>The limits of the right of way (ROW) working width shall be marked with stakes at visible intervals.
A survey crew will work ahead of the initial clearance of vegetation from the ROW. This survey crew will utilise the project benchmarks to check</td></tr>
</table>
</td>
<td>25m to 50m wide</td>
<td>~15-50</td>
<td>Main Pipeline construction expected to start dry season 2024</td>
<td>3-6 months</td>
<td> </td>
</tr>
</table>

Activity description		Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
	and re-establish all agreed intersection points (IPs), mark the right of way boundaries and place offset/recovery pegs.					
Clear and Grade	To allow construction activities to commence, the pipeline alignment needs to be cleared of vegetation, rocks, trees, etc to provide mainline construction vehicles access. Clearing and grading shall be minimised to the extent necessary for the safe construction of the pipeline and shall in any event not exceed the maximum permissible width of the ROW except where additional working areas are defined and agreed. Light vegetation removed during clearing shall be stockpiled outside of the stripped ROW working area and will be respread during restoration unless the property owner requests that the vegetation be left as stockpiles.					
Pipe Transport and Stringing	Stockpiled pipe will be delivered to the ROW along the identified access tracks using prime movers and trailers. The specific logistics of the pipe haulage will be developed during the planning phase. The pipe trucks will only utilise specific access tracks which will be constructed (or upgraded) to allow them to pass. Pipe will be strung (placed on the ROW) directly from trailers onto saw dust filled bags or equivalent using a Vacuum lift pipe handler mounted on a hydraulic excavator, end hooks or slings depending on the pipe length and size, terrain. Strung pipe shall be supported clear of the ground and in a manner that will not damage the pipe or coating.					
Trenching	A trench is formed to accommodate the welded pipe strings and achieve the required depth of cover in accordance with the pipeline design. The trench shall be excavated along the surveyed and pegged centreline, in accordance with the minimum cover specified. Trenching operations are carried out utilising a combination of bucket wheel trenchers, rocksaws & 30T excavators. Accordingly, excavation plant, equipment and techniques will be selected to accommodate the anticipated conditions and required production rates. In areas of hard rock, controlled blasting using explosives may be required to break the rock to permit removal by excavator.					
Welding	Line pipe ends will be welded together (butt welded) to form pipe strings up to a typical length of 1km. The mainline welding crew is the engine room for the project's welding and sets the pace for mainline construction. The very agile and mobile poor boy crew carries out all difficult mainline welding sections and provides start joints for the mainline crew. Additional welding resources carry out all tie-ins and special crossings.					
Lower in, padding and backfill	The coated pipe shall be lowered-in using a series of side booms so the pipeline has adequate and properly distributed slack, the pipe is not unduly stressed, and the pipe coating is not damaged. Where the excavated material and the bottom of trench are free of material that could damage the pipe, the pipe shall be laid directly on the trench bottom. The excavated material shall be used directly for bedding and padding. Where excavated material does not meet the specification, padding machines (screening machines) or similar will be used to produce bedding and padding. The trench will be back filled using the remaining trench spoil (excavated material) following the padding operation. The trench is compacted by wheel and/or track rolling with the backfilling equipment. Areas requiring higher compaction, such as road crossings, will be undertaken with an excavator mounted vibrating plate or other suitable manually operated or driven compaction equipment.					
Reinstatement	The pipeline ROW will be reinstated which includes replacement of previously stripped topsoil and rootstock, installation of contour banks, reinstatement of fencing & install new gates and revegetation as necessary.					

Activity description		Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
	Restoration of the ROW shall be completed in accordance with any easement agreements, Environmental Impact Statement, Construction Environmental Management Plan and regulatory requirements.					
Pipeline testing	The pipeline will be hydrostatic pressure tested to prove the strength and leak tightness of the installed pipeline. The hydrostatic testing will be conducted by a certified mechanical testing laboratory and all test reports are to be certified.					
Commissioning	The commissioning phase of the works can be broken into two components, pre-commissioning and commissioning. Pre-commissioning is the exercise of manually proving each component of the pipeline/facility system prior to the introduction of gas. Example testing includes: • Verification that all parts are installed as detailed on engineering drawings, including position, orientation, part numbers, etc • Hydrostatic testing (confirming the system is leak tight), cleaning (blow through with air and cleanliness checks), drying and blow-through of piping • Bolt torquing of flanged connections • Functional testing of all manual valves through full extent of travel • Functional testing of all actuators and control valves through full extent of travel • Earthing compliance checks • Instrument calibration and installation checks • Insulation, continuity and point to point testing of all circuits installed by the Contractor Following the pre-commissioning phase, the asset becomes ready for the introduction of gas.					
Camp pad construction and camp operation A camp pad will be constructed adjacent to each proposed lease pad to accommodate a temporary 70-100 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 (for 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. 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. 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 handling and irrigation will occur in accordance with the NT Department of Health requirements.		1.2-2.5ha	Typically <100 people (including housed staff)	For duration of activity	For duration of activity	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
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 tracks to store materials, wastes, wastewater, equipment and other material as required. The laydown yard will be fenced to prevent access. These are typically 2.5- 5ha in size, with allowance up to 25 hectares for multiple laydowns. Laydowns may also be utilised for temporary offices/workshops/field camps or warehouse infrastructure support E&A and construction activities. 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).	25ha	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) may 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). 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.	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
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 Multiple petroleum exploration wells are proposed to be drilled at each site (typically 6-8 but potentially more where multiple formations are targeted). Wells may be drilled in stages (i.e. 1 or 2 at a time) or progressively (i.e. 8 wells drilled over a single campaign). Each well will be drilled into an underlying prospective petroleum reservoir (such as the Velkerri shale, Kyalla shale or other formation) to a typical depth of 1500m-4000m. Each well will be deviated into the horizontal position, with a lateral drilled up to 5000m (please note the depth and lateral length may change based on operational requirements and technological advances). 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 as per NT drilling regulations. 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, formation integrity 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	N/A located on proposed lease pad	<60 people	Post civil construction	Typically 45 - 90 days per well	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
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 (or equivalent tanks or fit-for-purpose containers). Once drilling has been completed, this material will be sampled and tested as per the code of practice and a 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 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, hydraulic fracturing stimulation (HFS) plant and equipment (commonly referred to as a “frac spread”) will be mobilised to site to commence HFS (or stimulation) activities on each of the drilled wells. A frac spread typically 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 (for frac fluids) 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 to 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	N/A located on proposed lease pad	<50 people	Post E&A well drilling	2- 8 weeks per well depending on stimulation size	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
perforation deployment • Ancillary support equipment and 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 (raw water or a mixture of raw water and recycled flowback wastewater) and sand (proppant), plus a small percentage of chemicals at high pressure into the target section of the horizontal wellbore. Typically, >90% of the total volume of stimulation fluids is a combination of water (fresh and recycled wastewater) 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 tests and an integrity report generated, which is submitted to and assessed by the regulator prior to the commencement of stimulation activities. The stimulation fluid is generated through mixing freshwater, recycled flowback, chemicals and sand in blenders. Stimulation fluid is then 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	

<table>
<tr><th>Activity description</th><th>Disturbance area</th><th>Typical personnel numbers</th><th>Timing</th><th>Duration</th><th>Activity example pictures</th></tr>
<tr>
<td>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

The E&A 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 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 either flared, sold (piped or compressed/liquified and trucked) or beneficially used onsite to reduce greenhouse gas emissions where possible.</td>
<td>N/A located on proposed lease pad</td>
<td><12 people during production testing</td>
<td>During exploration activities</td>
<td>Typically 30 days to 24 months.</td>
<td> </td>
</tr>
<tr>
<td>Appraisal gas sale

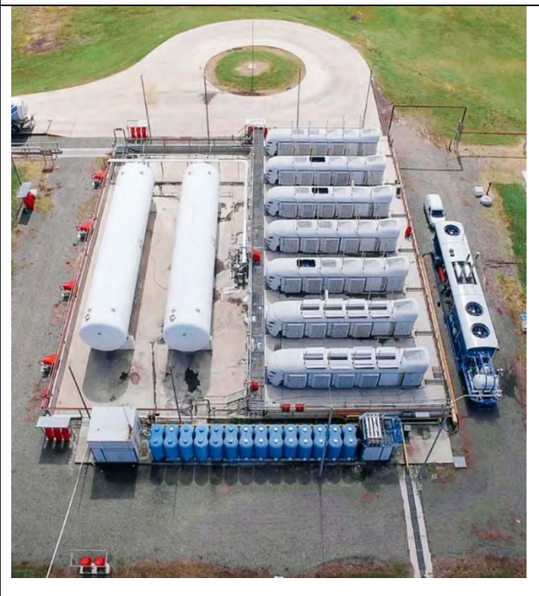
To minimise flaring during the production testing phase of the wells Tamboran will be developing facilities and a pipeline to enable this gas to be captured rather than flared. This is anticipated to reduce appraisal emissions by approximately 90%.

Options are currently being assessed with a priority on speed of installation to limit flaring and economic affordability.

The initial solution is likely to be a Compressed Natural Gas (CNG) or mini Liquified Natural Gas (LNG) facility to enable gas treatment, compression and truck loading of the CNG or LNG so the gas can be delivered to and injected into either the AGP or the McArthur River Mine Pipeline and to any customers seeking truck deliveries of CNG/LNG as a fuel or diesel alternative. This approach is commonly used around the world for initial production gas or virtual pipeline supply, however it is limited in the amount of gas it can capture. Local generation and power consumption for a data centre on site is another possibility for this initial gas but again will be limited in capacity.

In parallel, initial treatment and compression facilities will be developed to compress the gas into a new pipeline connection to the AGP. This will enable all the extended production gas to be captured and flaring stopped.

Appraisal gas facility construction

Stage | Description</td>
<td>9 Ha</td>
<td>< 10 people operating and <50 people during construction</td>
<td>Upon completion of well testing- potential 2024.</td>
<td>Until Production Licence</td>
<td>  </td>
</tr>
</table>

Activity description		Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Mobilisation	Establishment of access track into site and site offices and amenities, laydown areas, erosion and sediment controls installation as per the requirements of the approval management plans, site communications links and construction set out survey.					**Figure 3 Example facility – the Buquebus LNG Facility in Buenos Aires Argentina**
Earthworks and Civil Works	Preparation of top soils and sub-fill for establishment of foundation – including excavation and removal of unsuitable fill materials from site, import of required sub-grade fill materials, grading and levelling of the facility pad and final capping and import of road base materials to design specification. Works **may** also include **ongoing up**grading of **existing** access track**s**.					
Underground Services	Trenching of facility pad as required to install buried services and piping, backfill and compaction of trenches, including installation of crossing reinforcement for protection of buried services in trafficable areas.					**Figure 4 A truck mounted compression facility**
Piling	Installation of steel pile foundations by driving into the prepared facility pad and/or pre-drilling as required and welding of pile caps onto piles in preparation for skids to be landed.					
Structural Mechanical and Piping	Installation of pre-assembled skidded pipe rack modules onto foundations requiring lifting onto pile caps and welding in place, bolting flanges to connect interfacing skids and equipment packages, installation of site run utilities piping, lifting and welding in place of skidded equipment packages.					
Electrical and Instrumentation	Installation of cables and cable supports, ladders and trays, termination of cables into relevant panels (control and low voltage), installation of tubing and glanding of instruments, mounting instruments onto piping or instrument stands.					
Plant Commissioning	**This stage involves the testing and commissioning of all equipment on the site, in preparation for operations.**					

A range of temporary facilities will be required during construction. These may include work areas for equipment and pipe, storage and lay down areas, and a site office.

The location of the temporary facilities will be primarily based on logistical requirements. This will include ensuring facilities are located at a suitable distance from watercourses, are not endangered by threat of flood, do not require clearing of sensitive vegetation and are managed in such a way as to ensure no long-term land contamination issues.

Typical manning during operations is <10 people. During construction, ~50 people may be required. These are indicative numbers with the final manning levels will be finalised during the activity planning.

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Wastewater tank storage Flowback and drilling wastewater will be stored one each location or piped to a centralised location for storage via gathering lines. Wastewater will be recycled within the drilling or stimulation process to reduce raw groundwater volumes. Wastewater not earmarked for recycling will be treated on site via evaporation within open tanks (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. Wastewater storage tanks may be deployed for extended periods of time (potentially several years) 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 Tamboran infrastructure footprint (such as lease pads or laydown yard) to reduce the amount of offsite wastewater trucking.	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
Flaring During well testing and where gas cannot be beneficially used or sold (such as during facility downtime etc.) , produced hydrocarbons (gas and liquids) will be flared onsite, 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.	
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.	N/A- within proposed lease pad	< 6 people	Upon completion of drilling activities	7 days	

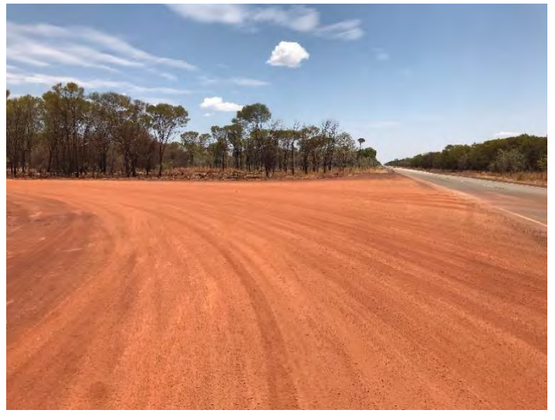
Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Wet season operations Exploration activities (including drilling, stimulation and well testing operations) may occur over the wet season. Where wet season operations are undertaken the following 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 wet season significant rains (notionally December or as predicted) • 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 the access to the site is safe. • Wastewater storage area is bunded, which will prevent all off-site release of chemicals and stormwater. • During flowback wastewater storage, stormwater will be retained on-site via the sediment retention pond prior to release. • Overland flow will be diverted around lease pads as far as reasonably practicable.	N/A	N/A	October – May	7 months of the year	
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.	Minimal	3-9 personnel.	Deployment of Geophones before stimulation. Retrieval of Geophones after stimulation.	1 month (one week deployment, two weeks Stimulation, one week collection)	

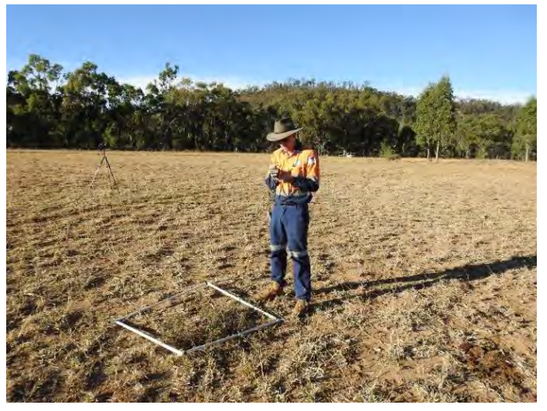
Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Induced Seismic Monitoring will be undertaken at the same time as the Microseismic monitoring. A temporary seismic receiver is installed ~1km from the well site, with a small amount of other equipment 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. Minimal clearing or heavy machinery is required for either activity, and the activities are considered to have a minimal impact, like that of scouting activities.					
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/ Tamboran 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/ Tamboran 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 Tamboran 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 Tamboran 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 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	
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.	

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 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 per day 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 be licenced under Tamboran's existing Water Extraction Licence (WEL) GRF 10285. A new WEL may be submitted to increase the water take and/or covering take an alternative formation where present. It is anticipated that groundwater extraction volumes to support this program will be in the order of 250-600ML per year (conservatively) , primarily used for civil construction, drilling and to stimulate the E&A wells. Once drilling and stimulation has ceased, minimal ongoing water extraction from the site will be required. Where possible, recycled flowback will be utilised within stimulation to reduce raw water usage.	N/A	N/A	Ongoing to support exploration activities.	During exploration activities	
Traffic management Access to the site will be via a combination of existing and new access tracks, located approximately 15-20km South of Dunmarra on the Stuart Highway. Minor traffic disruptions may occur during the construction of the access track intersection with the Stuart 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/appraisal gas sale (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	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Site rehabilitation Within 6 months of the E&A wells being plugged and decommissioned, a 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	 

Appendix B 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 4 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, produced water, or hydrocarbons (liquid and gaseous) from suspended or abandoned wells to groundwater due to well design and integrity management. • Low risk of leaks from gathering lines, with gathering lines constructed as per Australian Standard, leak detection in place to identify pipeline failures and routine inspections completed. • 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	• 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, 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 • Gathering lines and pipelines constructed as per Australian standard, leak detection in place to identify pipeline failures and routine inspections completed. • 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 being added to WEL. • All water take to be metered and reported quarterly to the regulator • No pastoralists groundwater bores within 1 km of each proposed site • Flowback to be preferentially used in stimulation fluid to reduce raw water usage.

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			• 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 WEL).	
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 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 preferentially located in existing disturbed area, with no sensitive soil types present in the immediate vicinity. • Low risk of reduction in land productivity from poor rehabilitation due to mandatory rehabilitation requirements and security bond requirements • Low risk of pipeline subsidence creating erosion	• 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 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 demonstrated as ALARP and acceptable. • Site to be rehabilitated back to pre-existing/ agreed state with pastoralist input. • Pipeline monitoring and repair work to minimise/ respond to pipeline subsidence

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
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 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, • Low risk of air emissions created by gas fired compression • Low risk of greenhouse gas emission impacts from appraisal gas sale/ well testing (climate change)	• 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 where practicable • Outside of high intensity activities (such a s civil construction, drilling and stimulation) 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, 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 and equipment, with annual inspections on pipelines • Low NOx and Low CO gas fired compression/ power generation utilised to minimise air emissions. • Appraisal gas will be beneficially used through sale of CNG/LNG/ piped natural gas to reduce flaring and minimise flaring to reduce scope 1 and 2 emissions.
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 gathering pipeline failure and release of flowback • 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	• No take of surface water permitted or proposed • Lease pad located away from watercourses- typically 1km or greater • 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) • 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 be operated with a 1:1000Annual re-occurrence interval (ARI) wet season or dry season (whichever is

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			contaminating surface water due to stormwater segregation and testing procedures. • Low risk of infrastructure (including pipeline) 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. • Low risk of gathering line failure releasing flowback fluid to the environment	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 gathering lines to be welded as per Australian Standards, hydrotested during construction to verify integrity prior to being brought into service • Gathering lines to utilise flowmeters/ pressure monitoring to identify leaks (such as flow/ pressure drops) • Gathering lines to be inspected 6 monthly to identify subsidence/ potential integrity issues. 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 • Avoid the introduction of weeds • Avoid the spread of existing weeds • Minimise the loss of pastoral productivity	• Clearing of vegetation communities (such as Open Corymbia/eucalypt woodland, Bullwaddy and/ or Lancewood) to support 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	• 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 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 – fauna mortality	• Seismic activities to: o avoid clearing of mature trees and protected flora o In open woodlands, limit clearing to grasses and shrubs o Maintain viable root stock to promote rapid rehabilitation o No seismic lined in riparian o 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 inspected and certified weed free prior to entry • 6 monthly weed inspections to be completed with all identified weeds treated.

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			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.	• 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 night during flaring or from activity lighting. • Noise impacts from helicopter movements • Noise and vibration impacts during seismic activities.	• 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 noise, dust, light and vibration impacts associated with temporary appraisal gas facility	• Sites located away from homesteads and local communities • Flaring to be minimised to avoid light generation • 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. • Compression/ power generation/ CNG/ LNG facilities to be designed to minimise aesthetic impacts and located away from homesteads and local communities. • Lighting of infrastructure designed to minimise aesthetic impacts during the evening •

Appendix N.1.2 12 Email & presentation

From: Emily Beresford-Cane [redacted]
Sent: Tuesday, March 28, 2023 3:48 PM
To: Tamboran Contact [redacted]
Subject: Fwd: Draft Tamboran Presentation

Begin forwarded message:

From: Emily Beresford-Cane [redacted]
Subject: Draft Tamboran Presentation
Date: 25 March 2023 at 3:11:13 pm AEDT
To: [redacted]
Cc: [redacted]

Dear Rory

[redacted].

We intend to have larger Story Board images of a number of key images to speak to during the meeting.

Let me know if you have any comments, questions or feedback about including additional information.

Kind regards

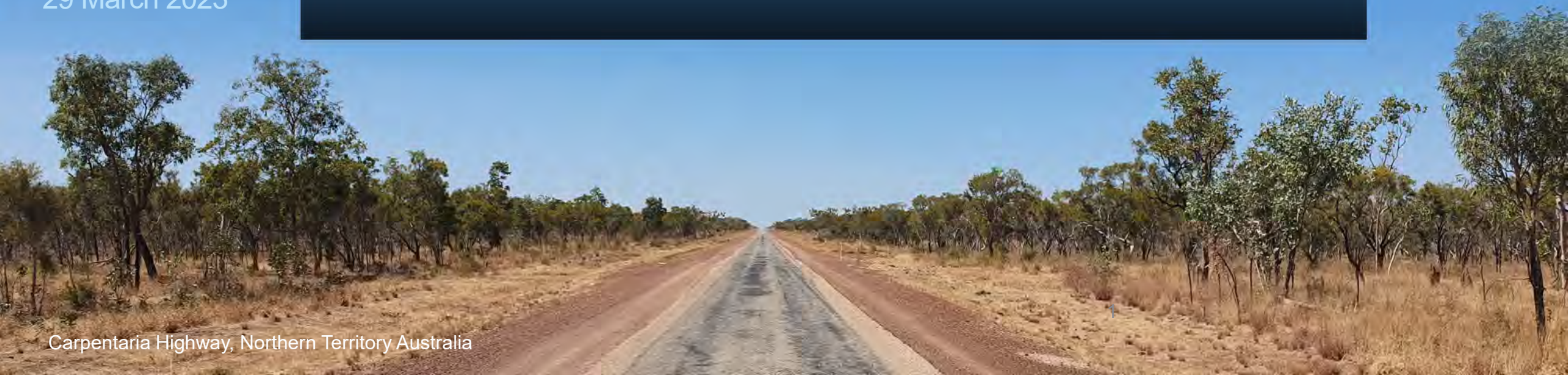
Emily
[redacted]

tamboran

RESOURCES

[redacted]

29 March 2023



Carpentaria Highway, Northern Territory Australia

Agenda [redacted]

- Introduction
- About Tamboran
- Beetaloo Exploration
- Beetaloo Project [redacted]
- Exploration and Production activities
- Protecting Water
- Looking after Country
- [redacted]
- Next steps

About Tamboran

Introducing Tamboran

We are a publicly listed Australian company with our headquarters in Sydney and staff across Australia and the USA. We are committed to creating value for our shareholders, communities, Territorians and Australians by appraising and developing the gas resources of the Beetaloo Basin. We strive to follow and exceed the example set by Origin in community engagement since 2014 and will continue to focus on economic, development and employment opportunities for Native Title Holders and local communities.

Our Vision

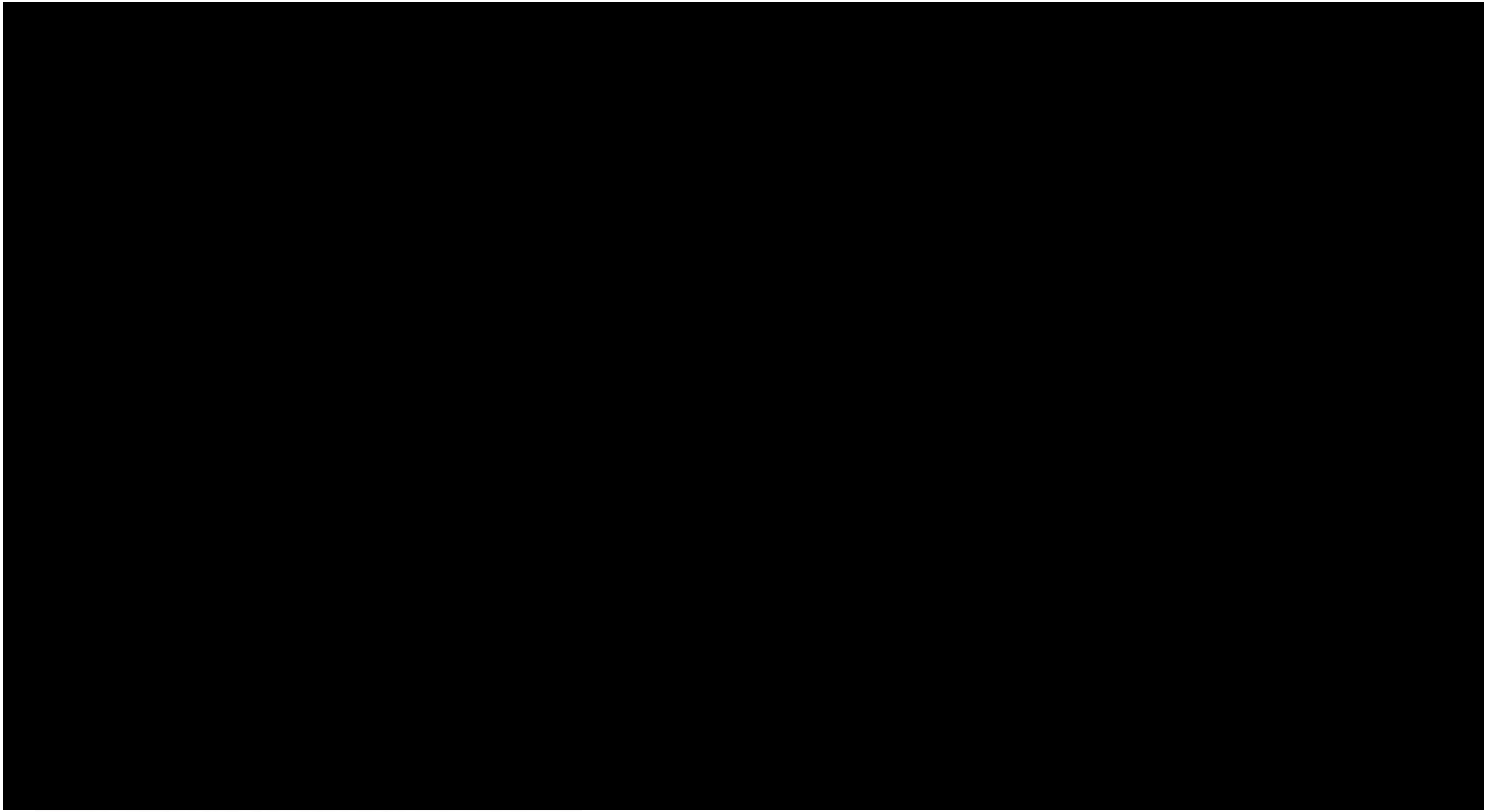
To play a role in the global energy transition by investing in the development of low CO2 unconventional natural gas resources in the Beetaloo Sub-basin of the Northern Territory of Australia and to become a Net Zero carbon emissions gas producer for our equity share of Scope 1 and Scope 2 emissions when the Company achieves commercial gas sales.

Strategy

- Target is to become a Net Zero equity Scope 1 & 2 emissions producer
- Focused, high growth Beetaloo strategy
- High quality assets with significant scale
- Low-cost development targeting multiple markets, premium pricing
- Expertise in unconventional E&P development

Sustainability

- Health & Safety
- Climate Change
- Environment
- People
- Community
- Economic Sustainability



Beetaloo Exploration Project

tamboran RESOURCES

Tamboran Resources, together with joint venture partner Falcon Oil and Gas, is exploring for gas in the Northern Territory's Beetaloo Basin.

The Resource Potential

Our exploration project in the Beetaloo Basin is a multi-year, nine well shale gas project that started in mid-2014.

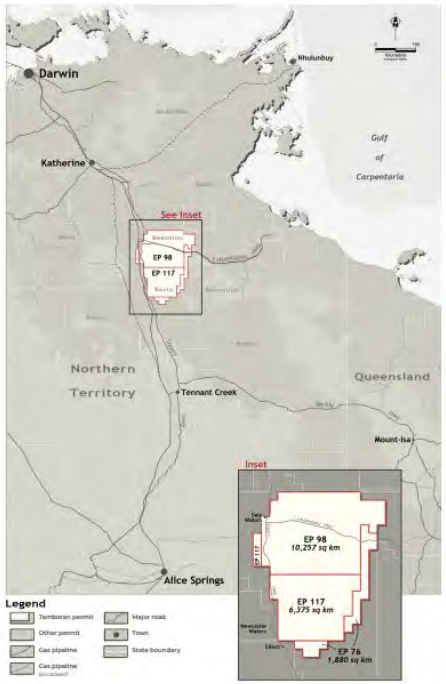
So far, we've drilled six wells. All within regulations and with the consent of the pastoralists and Native Title holders. We plan to drill one more this year (2021) and two more in 2022.

We think there's a very large gas resource underneath the ground with outstanding potential.

Today our project has as much as 61 trillion cubic feet of gas, with 6.6 trillion cubic feet of that already recognised as a contingent resource*.

Just how big is this? The Inpex project is 12 trillion cubic feet and the Mereenie gas fields have produced around 240 billion cubic feet since the mid 1980's.

* Amungee well estimate



Our Permit Commitments

EP	2014	2015	2016	Moratorium 2017 - 2018	2019 - 2021	2022
98	Geological and geophysical studies	2 vertical wells 1 horizontal well	1 HFS horizontal well Extended production test		Extended production test	
117	Geological and geophysical studies	Geological and geophysical studies	1 vertical well		1 vertical well 1 HFS horizontal well Extended production test	2 HFS horizontal wells Extended production tests
76	Geological and geophysical studies	Geological and geophysical studies	Geological and geophysical studies		1 vertical well	
Permit Year	1	2	3		4	5

The Benefits

If successful, and development goes ahead, the project means:

- more work for and jobs with local companies, including Aboriginal companies
- the opportunity to supply goods and services to the project
- financial payment for host pastoralists and Native Title holders
- taxes and royalties – providing government with more money that can go to improving community services, infrastructure and telecommunications
- energy security (delivering gas to the Eastern Australia)

Beetaloo Project

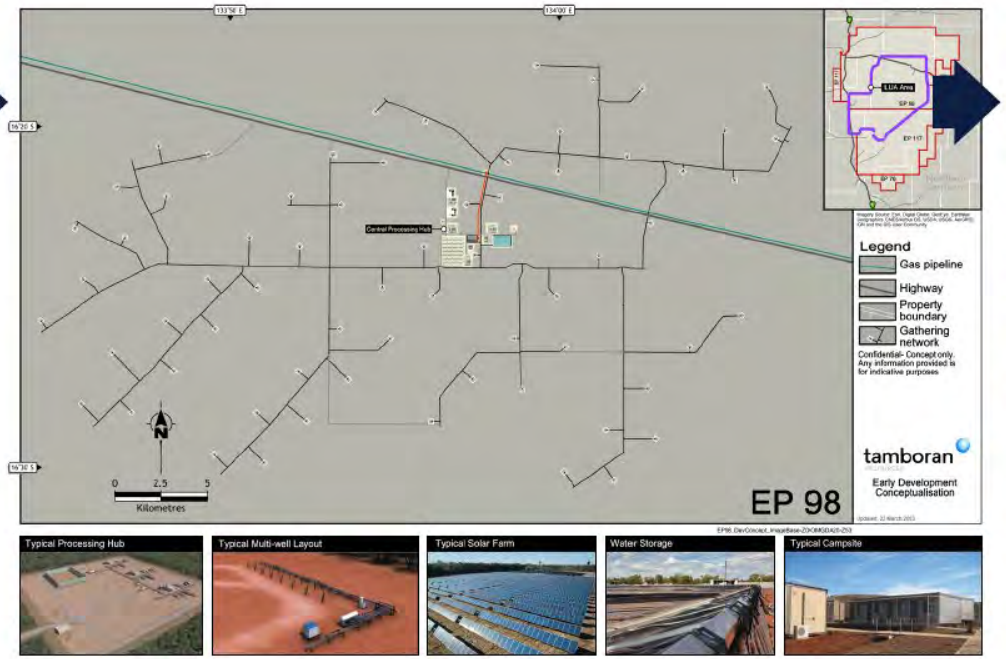
tamboran RESOURCES

Moving from Exploration through to Development and Rehabilitation

Exploration, appraisal and piloting
Several individual sites spread over a large area

Development and production
Concentration of sites and supporting infrastructure over a smaller area

Rehabilitation
Progressive fixing of country back to pre-existing state



Exploration

- Is there gas?
- 1-2 wells per year
- typically smaller sites with vertical wells with no fracking or gas produced
- 2D seismic used to assess whether rocks are continuous

Appraisal and Piloting

- What type of gas and how much?
- Increasing number of wells- typically 2-6 per year.
- Larger sites to store more equipment with multiple wells per site
- Horizontal wells drilled which are fracked and tested to see how much gas can be produced

Development and production

- Extract gas from target formations to supply for both domestic and international customers
- Construction and operation of infrastructure required to support production, including gathering pipelines , multiple gas processing facilities, warehouses, laydowns, camps, wastewater treatment areas, renewable and gas fired energy generators
- increasing number of wells drilled and stimulated per year to maintain production ranging from ~ 6 to 60 depending on size of project and demand
- Small lease pads with centralized infrastructure
- All gas sold, with minimal Greenhouse gas emissions during production
- Progressive rehabilitation of wells and wellsite's once production has finished
- Typically 30+ years

Rehabilitation

- Country progressively rehabilitated as activities finish
- Production wells plugged with cement and rehabilitated
- Infrastructure remove, with topsoil and vegetation reinstated
- Multiple years of rehabilitation

Conventional and Unconventional

tamboran
RESOURCES

Conventional and Unconventional are industry terms used to define where gas is found underground and how it's extracted.

It's the same gas (natural gas reserves are mostly methane with some propane, butane and light condensates) - the main difference is how it occurs in nature today.

Conventional gas has typically migrated from where it formed millions of years ago to a sandstone reservoir where it's trapped between porous grains under a denser layer of rock that acts as a cap or seal.

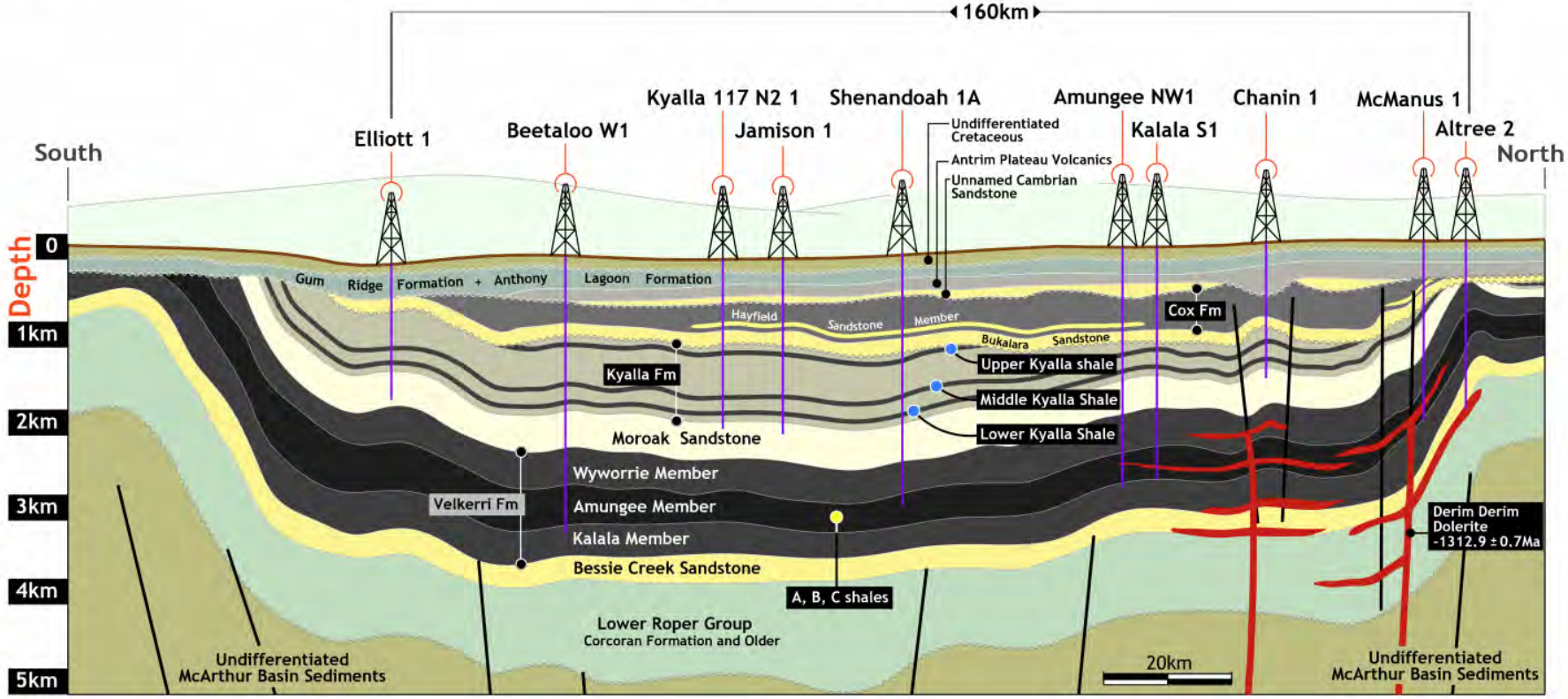
Unconventional gas is typically extracted from where it formed, in coal seams or shale formations that can be less porous and are sometimes described as tighter.

Extracting gas from either source can require a range of different techniques and processes

It's a common misunderstanding that conventional reserves do not require fracture stimulation and unconventional reserves do.

For example, around a third of conventional wells in the Mereenie field near Alice Springs have been fracced.

Less than a quarter of Tamboran's unconventional coal seam gas wells in Queensland are fracced.



Drilling For Shale Gas

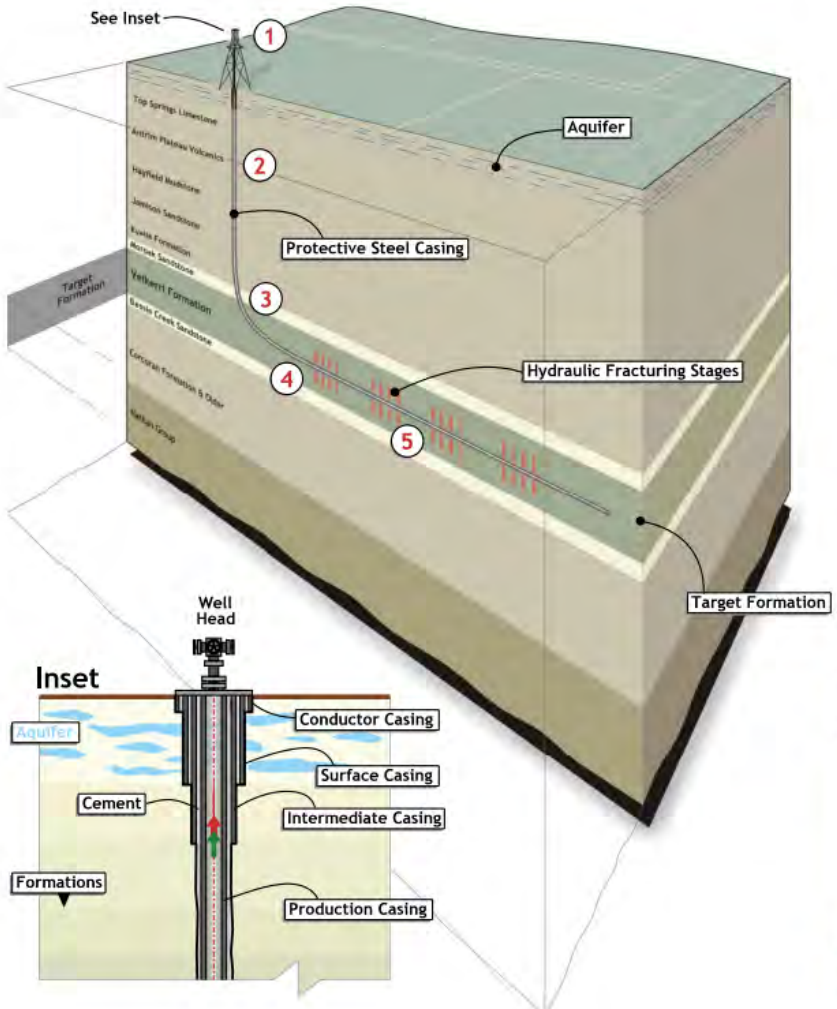
tamboran
RESOURCES

Our exploration program includes drilling both vertical and horizontal wells that target the underground shale rock formations in the Beetaloo Basin.

Long Reach Horizontal Drilling

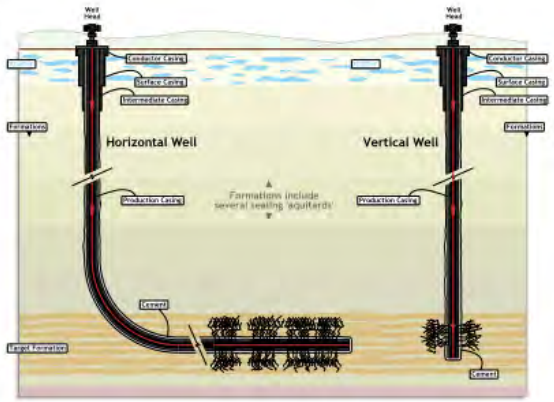
Steps in Horizontal Drilling:

1. Negotiate and agree access, obtain approval and bring in drilling rig and equipment
2. Drill vertical section of well using conventional methods
3. Drill kick-off (curved) section, with the use of a downhole motor mounted directly above the bit, in order to make the turn from vertical to horizontal. Downhole instruments called MWD (measuring while drilling) packages transmit sensor readings upward, allowing operators at the surface to build the angle
4. Drill horizontal wellbore, still using MWD to hold the angle and direction
5. Case off the well with steel casing and cement to allow for completion and fracture stimulation, preparing the well for production



Vertical Wells and Long Reach Horizontal Wells

- Tamboran will drill both vertical and horizontal wells during the Exploration Phase/s
- Vertical wells allow a more cost effective assessment of the potential for gas and liquids in the target zones and provide some information on production capability
- Horizontal wells will be required to assess the potential for economic gas and liquid recovery rates
- Horizontal wells are most likely to be required for field development



Hydraulic Fracture Stimulation (Fracking)

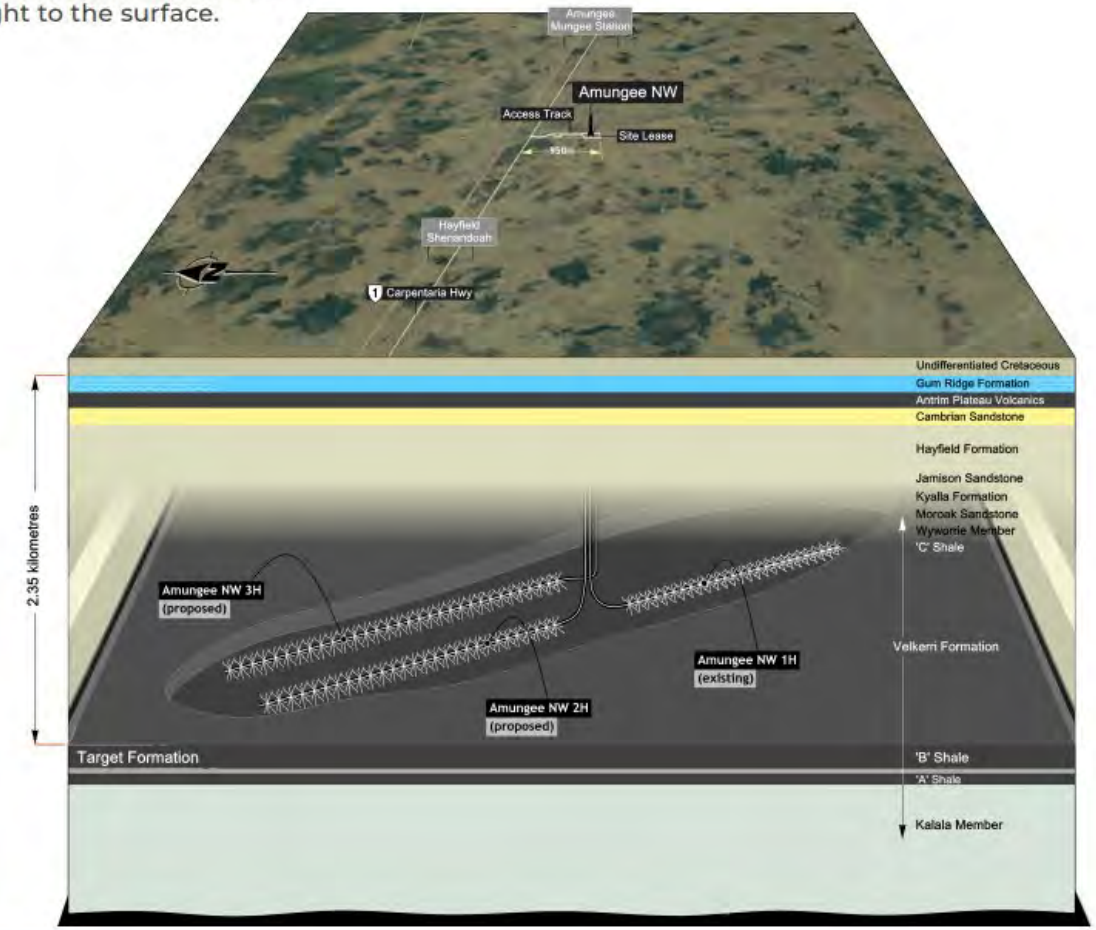
tamboran RESOURCES

Fracking is the technical process designed to release the gas trapped in the dense shale rocks deep underground.

It involves pumping water mixed with sand and some chemical additives in low concentrations under pressure to fracture the shale, creating tiny pathways in the rock that allow the gas to flow into the well and be brought to the surface.

Key facts about fracking in the Beetaloo

- Distance offers initial protection – 1-2km between the shallower aquifers and the deeper rocks where gas is found.
- Both zones are effectively sealed off by several thick geological layers in between called aquatards.
- It's not physically possible for a fracture to extend upwards into the aquifer. Because of the distance, and because the amount of energy and pressure used in fracking isn't enough to connect and create pathways outside of the rock formation where gas is found.
- Any natural vertical fractures or discontinued bores are extremely unlikely to provide a pathway for fracking fluids to reach a fresh water zone due to the greater weight (what's called hydrostatic head pressure) pushing down from above.
- Seismic work allows us to map the geology and avoid any large structures or faults.



Hydraulic Fracture Stimulation (Fracking)

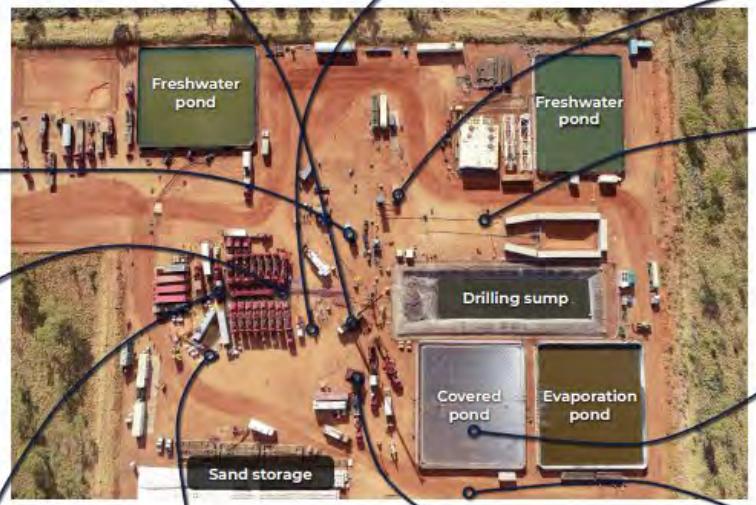
tamboran RESOURCES

Wireline command centre

Well head and crane

Groundwater monitoring bores

Gas and condensate separators



Flare

Pump trucks

Covered ponds

Mixing unit

Sand hopper

Coil tubing unit

Chemical storage

Production Testing

tamboran
RESOURCES

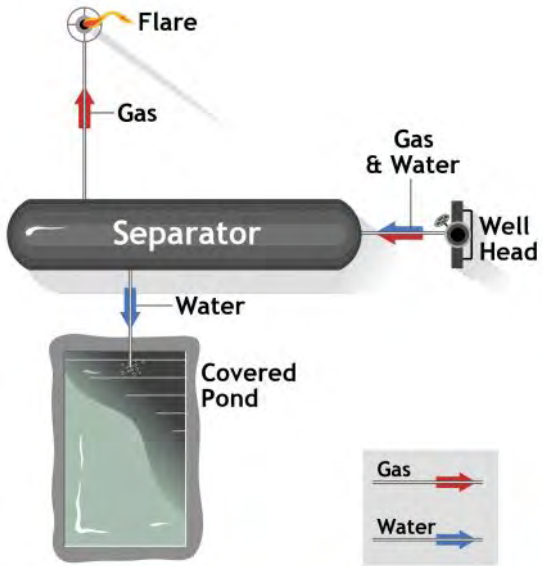
Production testing occurs after a well is successfully drilled and fracture stimulated, and sufficient volumes of fluids pumped down during these stages is returned to surface to allow the well to flow on its own.

The purpose of production testing is to understand the deliverability of the well.

Gas flow from the well is directed to a separator. From there any water is sent to on site ponds. The gas produced is sent to a flare where it is combusted. During exploration, flaring is a better environmental outcome than venting.

Data is gathered about the composition, the rate and how much gas the well is able to flow over a period of time. This information allows estimations to be made about how much of the resource is recoverable.

Production testing, often called extended production testing, can occur over a number of months. The longer the test the greater the confidence that can be gained about the extent of the resource.



Vertical flare

Covered flow back pond

Separator

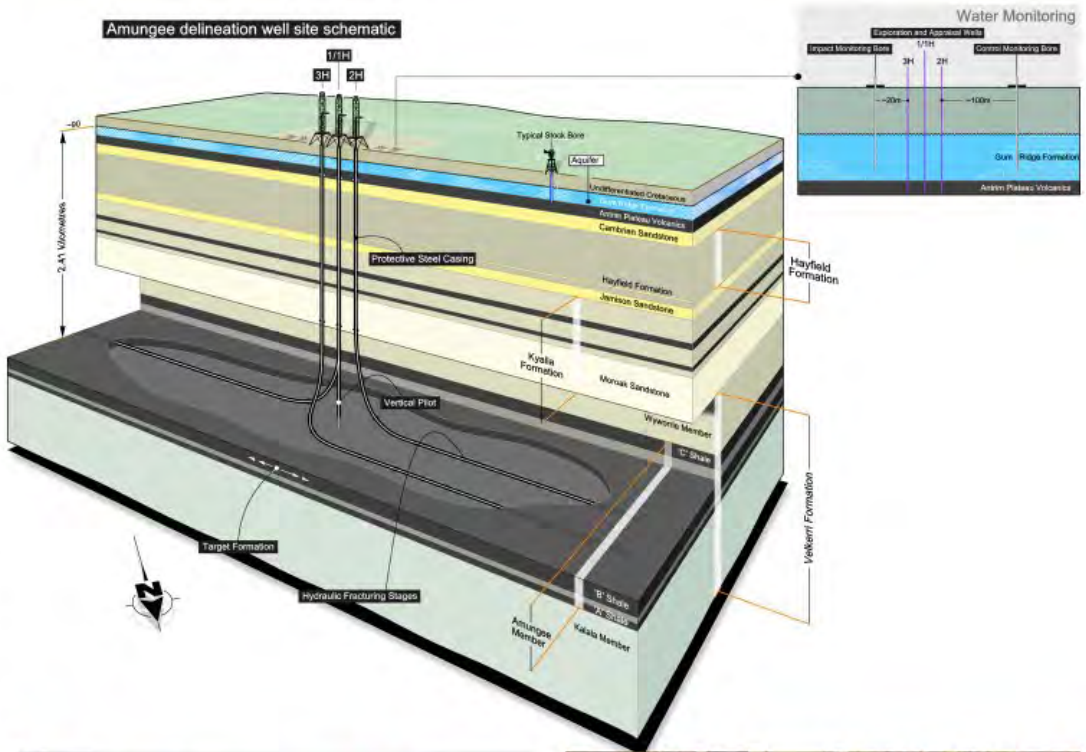
Horizontal flare

Protecting Groundwater

tamboran
RESOURCES

We understand how important groundwater resources are to Traditional Owners, pastoralists and the community. Both engineered and natural geological barriers isolate and protect underground water sources.

Multiple controls are put in place to protect the environment and groundwater. If these controls aren't successfully met when we drill - we don't frack.



Protecting Groundwater

The Beetaloo Basin where Tamboran operates is underlain by two limestone aquifers in the area - the Anthony Lagoon Beds, which lies between 60 and 200 metres below surface, and the Gum Ridge formation, which lies between 200 and 400 metres below the surface. The horizontal section of Tamboran's existing and proposed wells are located in the Velkerri shale formation, separated by the deepest aquifer by approximately two Groundwater monitoring is a regulatory requirement that allows us to detect any potential groundwater impacts that may occur from exploration activities.

Monitoring bores are completed in the Anthony Lagoons Formation(where present) and Gum Ridge Formation on well pads where wells have been hydraulically fractured. The monitoring of groundwater level and quality is required to be completed before, during and after a well is fracture stimulated to ensure any impacts are promptly identified. As well integrity is a major design feature of our wells- groundwater contamination is not anticipated to occur.

It also improves our understanding of the natural variability of water volumes and quality, and broader hydrogeological system in the Beetaloo sub-Basin.

Groundwater monitoring of the broader aquifers within the Beetaloo commenced in 2014 originally by Origin. Tamboran has continued this program and is planning on expanding it in the future. This will ensure all of Tamboran's proposed activities can occur sustainably, with no impacts on surrounding water users.

Well Integrity and protecting groundwater

tamboran RESOURCES

Engineering standards, steel and cement ensure the drilling and fracking of gas wells do not create a pathway between the underground layers of rock or deteriorate over time.

Built Strong - To Last The Test Of Time

A gas well has three main parts – the steel casing, the above ground well head, and cement which is engineered to be as strong as the rock that it will live in.

Casing and cement hold the hole open and protect or prevent any cross flow between the surrounding underground formations. The cement is pumped down the inside and back up the outside of the casing.

An x-ray device sent down the well (a technique called logging) combined with pressure testing confirm the quality of the job.

The casing is designed to ensure its strong enough to withstand the most extreme loads it could be subjected to.

Added to this is a program of regulatory control and oversight, and the requirement to appropriately decommission every well at the end of its operational life.

Engineering Standards And Performance Data

Category	Description	Risk
1	Shallow surface casing + top of production casing cement below over pressured hydrocarbon reservoir	High
2	Shallow surface casing + top of production casing cement below under pressured hydrocarbon reservoir	
3	Shallow surface casing + top of production casing cement above top of gas	
4	Shallow surface casing + top of production casing cement above surface casing shoe	
5	Deep surface casing + top of production casing cement below under pressured hydrocarbon reservoir	
6	Deep surface casing + top of production casing cement above top of gas	
7	Deep surface casing + top of production casing cement above surface casing shoe	
8	Deep surface casing + 1 intermediate casing + top of production casing cement below top of gas	
9	Shallow surface casing + 1 intermediate casing + top of production casing cement above casing shoe	
10	Deep surface casing + 1 intermediate casing + top of production casing cement above top of gas	
11	Deep surface casing + 1 intermediate casing + top of production casing cement above casing shoe	
12	Deep surface casing + 2 intermediate casing strings + top of production casing cement above casing shoe	Low

Tamboran's minimum design requirement for a producing well

Tamboran's minimum design requirement for a P&A well

Tamboran's Beetaloo wells

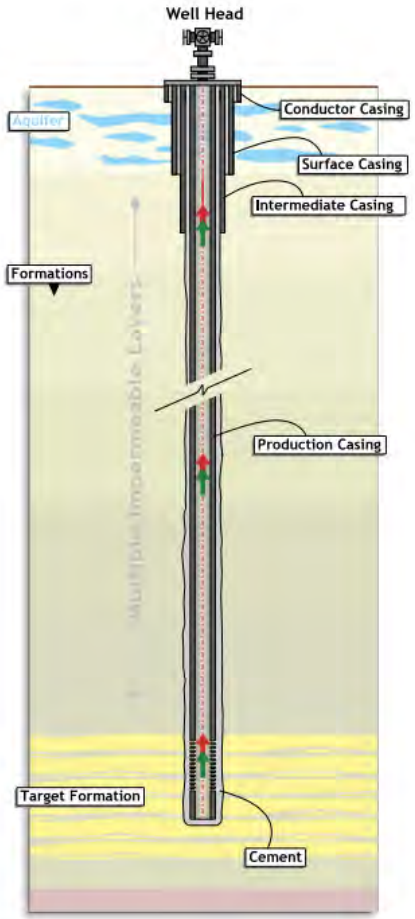
(a) Vertical and deviated wells

CATEGORY	ORIGINAL WELL COUNT	POTENTIAL BARRIER FAILURES	POTENTIAL BARRIER FAILURES %	CATASTROPHIC BARRIER FAILURES	CATASTROPHIC BARRIER FAILURES %	AVG COMPLETION DATE	P&A WELL COUNT	CURRENT WELL COUNT	ORIGINAL AVG SURFACE CASING DEPTH (FT)	ORIGINAL AVG TOP OF PRODUCTION CEMENT (FT)
Category 1	166	100	60.24%	3	1.81%	1979	57	15	253	7,334
Category 2	621	219	35.27%	5	0.81%	1983	138	301	306	6,566
Category 3	46	16	34.78%	1	2.17%	1987	14	31	321	4,008
Category 4	7	0	0.00%	0	0.00%	1982	1	15	222	125
Category 5	8,789	77	0.88%	1	0.01%	1995	782	6,140	559	6,111
Category 6	5,433	6	0.11%	0	0.00%	2007	105	7,181	712	2,816
Category 7	1,766	0	0.00%	0	0.00%	2009	8	2,040	719	534
TOTAL	16,828	418	2.48%	10	0.06%		1,105	15,723		
D&A	147									

(b) Horizontal wells

CATEGORY	ORIGINAL WELL COUNT	POTENTIAL BARRIER FAILURES	POTENTIAL BARRIER FAILURES %	CATASTROPHIC BARRIER FAILURES	CATASTROPHIC BARRIER FAILURES %	AVG COMPLETION DATE	P&A WELL COUNT	CURRENT WELL COUNT	ORIGINAL AVG SURFACE CASING DEPTH (FT)	ORIGINAL AVG TOP OF PRODUCTION CEMENT (FT)
Category 1	0	0	0.00%	0	0.00%	NA	0	0	NA	NA
Category 2	0	0	0.00%	0	0.00%	NA	0	0	NA	NA
Category 3	0	0	0.00%	0	0.00%	NA	0	0	NA	NA
Category 4	0	0	0.00%	0	0.00%	NA	0	0	NA	NA
Category 5	0	0	0.00%	0	0.00%	NA	0	0	NA	NA
Category 6	269	0	0.00%	0	0.00%	2012	1	268	789	2,153
Category 7	704	0	0.00%	0	0.00%	2012	2	702	929	442
TOTAL	973	0	0.00%	0	0.00%		3	970		
D&A	0									

Well Construction - Protecting Aquifers



Include protecting country and sacred sites slide

Beetaloo Project

tamboran
RESOURCES

[redacted]

Protect Country

Protect Sacred Sites

Training and Jobs

Fixing the Country

Aboriginal Business

Working Together

[redacted]

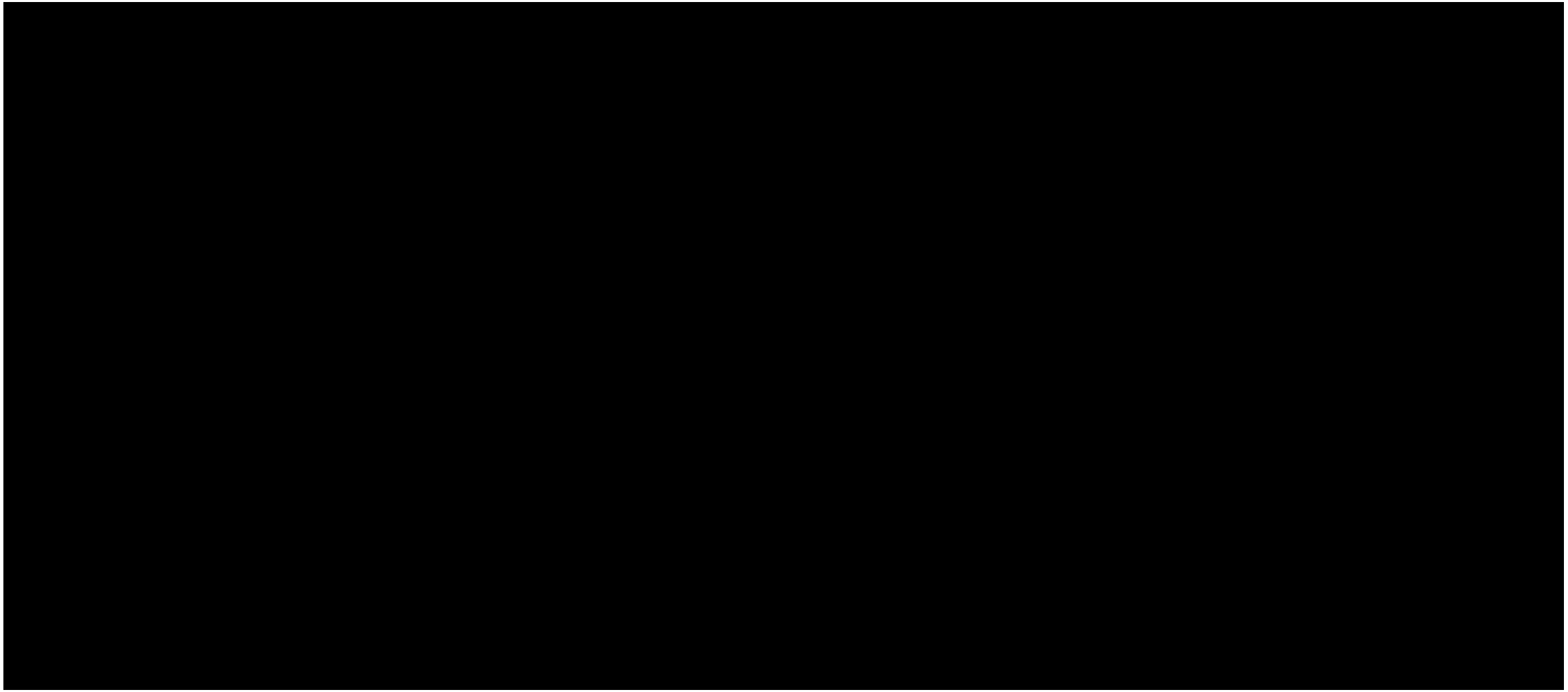
Emergency Services

Managing Native Title Holder Money

Beetaloo Project

tamboran
RESOURCES

Next Steps



Appendix N.1.2 13 230327 NLC Revised 2023 work program

From:	Matt Kernke
To:	[redacted]
Cc:	Tamboran Contact; Emily Beresford-Cane; David Close; Gibson Porkime; Scott Crabtree
Subject:	Revised 2023 work program- inclusion of Shenandoah Nth A
Date:	Monday, 27 March 2023 10:36:59 AM
Attachments:	Shenandoah Nth A (revised additional location).kmz New NLC Clearance Spatial files.zip image001.png NLC Work Program 2023 Revised.pdf

Dear Jeremy and Rory,

As discussed during last week's operators meeting, please find attached a copy of the revised work program with the inclusion of Shenandoah North A within the 2023 proposed activities. I have also provided an updated map within the document which illustrates the locations of the proposed activities (figure 1).

Shenandoah North A is located on the Shenandoah East Pastoral Station, approximately 25km North of the existing Kyalla 117 N2 site.

The new location is within Subject land 1- which has a conditions of work report completed. The proposed new clearances remain unchanged.

Please let me know if you require any further information.

Kind Regards
Matt

Matt Kernke
Environment and Approvals Manager

tamboran
RESOURCES

[redacted]

2023 Work Program update and Clearance Request

EP 98, 117, 76 – Beetaloo Joint Venture (Tamboran / Falcon)

Version:	2.0
Submitted:	Matt Kernke
Presented by:	Tamboran
Review Date:	16 February 2023

2023 Work Program Update and Sacred Site Clearance Request

CONTENTS

1 OVERVIEW 3

2 Exploration and appraisal program strategy - the bigger picture 3

3 Proposed 2023 work program 5

4 Calendar Year 2023 NLC Requests 9

4.1 AAPA certificate application - existing cleared areas 13

4.2 New Clearance Area request 13

APPENDIX A Detailed description of regulated activity 20

Appendix B Summary of Environmental outcomes, impacts, risk and controls 42

2023 Work Program Update and Sacred Site Clearance Request

1 OVERVIEW

In November 2022, Tamboran (B1) Pty Ltd (ABN 39 662 327 237) (*Tamboran (B1)*) executed a transaction to purchase Origin B2 Pty Ltd (ABN 42 105 431 525) (A subsidiary of Origin Energy;) in its entirety. The transaction resulted in Tamboran (B1) acquiring Origin B2's 77.5% interest in Exploration Permits (EP) 76, 98 and 117 (the Permits) under the Beetaloo Joint Venture (JV) with Falcon Oil and Gas (the Beetaloo JV). Tamboran (B1) is a jointly owned subsidiary (in equal proportions) of Tamboran (West) Pty Limited (ACN 661 967 077) ("Tamboran West") and Daly Waters Energy, LP ("Daly Waters"). Tamboran West is ultimately owned by Tamboran Resources and Daly Waters is ultimately owned by Sheffield Holdings, LP.

Origin Energy B2 Pty Ltd continues to operate as Tamboran B2 Pty Ltd (*Tamboran B2*), having formally changed company name with the Australian Securities and Investment Commission (ASIC). For the purposes of this document and going forward, all previous references to *Origin* will be replaced by *Tamboran B2* or the *Beetaloo JV.* Tamboran B2 remains as operator of the Permits.

Northern Territory Government permit commitments across the Permits require Tamboran B2 to complete ongoing exploration and appraisal (E&A) activities. Since 2015, the Beetaloo JV has drilled eight (8) wells in the Beetaloo Sub-basin (Beetaloo). These include Kalala S 1, Beetaloo W 1, Amungee NW 1, Amungee NW 1H, Kyalla 117 N2 1, Kyalla 117 N2 1H, Velkerri 76 S2 1 and the recently drilled Amungee NW 2H (December 2022).

Results collected from the Beetaloo E&A program have highlighted that the various shales within the Beetaloo are potentially suitable for a future onshore gas development. Tamboran B2 has identified two main areas where larger scale pilot projects may be completed in the coming years pending approvals and E&A success; The Amungee Delineation Area and the Shenandoah South Pilot Area. These areas are the focus of the forward E&A campaign and subsequent sacred site clearance requests.

Tamboran B2 respectfully requests the Northern Land Council's assistance to facilitate a *Sacred Site Clearance Survey* to comply with the obligations of the Exploration Agreement(s) and to support an application for Aboriginal Areas Protection Authority (AAPA) Authority Certificate for activity as described below.

This application is designed to provide coverage for Tamboran B2's proposed activities within these area over the next 1-5 years, with all or a subset of the proposed activities likely to occur. Annual work program updates will continue to communicate any refinement of Tamboran B2's E&A strategy.

2 Exploration and appraisal program strategy - the bigger picture

Tamboran B2's development strategy is focused on bringing gas to the domestic market as soon as practicable. Well testing during the Exploration and appraisal (E&A) phase is a crucial step in assessing the commercial viability of the Beetaloo Basin shale resources. Hydrocarbons produced during this phase are typically flared; which is a significant source of Greenhouse Gasses (GHG). Tamboran B2 is seeking to beneficially use produced hydrocarbons, rather than dispose of them via an onsite flare. This will achieve multiple objectives such as:

- Minimising GHG generation
- Increasing domestic gas supply at a time of domestic and international scarcity
- de-risking future shale developments through longer term gas production information
- providing near-term benefits to Native Title Holders (NTH), local stakeholders and the people of the Northern Territory through increased gas supply, and greater potential for local employment opportunities and compensation/royalty payments.

Similar to Origin's previous strategy, Tamboran B2 will begin increasing E&A activities around specific areas that could support future production activities. Tamboran is focusing its E&A efforts around the Amungee Delineation Area (around the existing Amungee NW location) and the Shenandoah South Pilot Area (around the existing Kyalla 117 N2 location). An overview of the proposed focused areas is provided in Figure 2.

The E&A work program for calendar year (CY) 2023 includes a new E&A wells at the existing Kyalla 117 N2 location (within the Shenandoah South Pilot Area) and a new step out location adjacent to Amungee

NW (within the Amungee NW Delineation Area). New well pads will be constructed progressively over the CY 2023-25 period, with additional E&A wells drilled stimulated and tested within both the proposed areas (subject to approvals and appraisal results). As the number of wells drilled and tested increase over the next 1- 3 years, it is anticipated that the gas production volumes could be sufficient to warrant the construction of compression and pipeline infrastructure. This infrastructure will allow for the temporary sale of appraisal gas, subject to agreement with NTHs and the Northern Territory Government (NTG). Sale of appraisal gas is anticipated to commence in 2024.

A single exploration well is proposed for the new Shenandoah South A location, which is located in Subject land 1. The Shenandoah north A well is designed to assess the Velkerri shale continuity between the Amungee NW Delineation are and the Shenandoah South Pilot Area. This exploration well will not be hydraulically stimulated or tested and will be plugged and rehabilitated upon activity completion.

Previous work program progress from operators within the Beetaloo has been slowed by the lack of availability of suitable drilling rigs in Australia. To alleviate this constraint and prioritise the near-term delivery of gas to the domestic market, Tamboran B2 has entered a partnership with Helmerich & Payne (H&P) to import a dedicated drilling rig in country to support Tamboran B2's E&A program. H&P is one of the largest global onshore drilling rig providers, with over 40% of the "Super Spec" American land drilling market share. This strategic move is anticipated to increase the delivery of E&A program results and drive down drilling costs. It is anticipated that the H&P rig will be in country, ready for spud by July 1st 2023.

In parallel with the E&A program, Tamboran B2 will continue to progress the Production ILUA, other critical approvals and front-end engineering design (FEED) for a larger development. A larger development will be focused on both domestic and potentially export markets, with the upstream component (i.e. extraction of gas) anticipated to be Scope 1 and 2 net zero. The design of a larger development and subsequent approvals will be underpinned by information collected from the CY 2023 to CY 2025 E&A program.

3 Proposed 2023 work program

There are three potential work program areas for Tamboran B2's CY 2023 work program, which are subject to environmental, land access and sacred site clearance approvals. Tamboran is prioritising activities within the nominated areas as summarised below:

Area 1 Shenandoah South Pilot Area (subject land 2)

- Expansion of the existing Kyalla 117 N2 location and construction of a step out location (Shenandoah South Pad #2 - naming to be confirmed)
- Drilling, hydraulic fracture stimulation (HFS) and testing of a deeper well targeting the Velkerri Formation shales on the existing Kyalla 117 N2 location
- 52km of 2D seismic
- Maintenance of existing sites and associated infrastructure.
- Environmental and heritage surveys required for future production environmental approvals.

Area 2. Amungee Delineation Area (**subject land 5**)

- Stimulation and testing of Amungee NW 2H (nominally a 180 day well test);
- Civil construction of the Amungee NW 3 step out location, including lease pad, camp pad and access tracs;
- Drilling, HFS and testing of up to 3 additional wells on either the existing Amungee NW, new Amungee NW3 location or a combination of both
- Maintenance of existing sites and associated infrastructure.
- Environmental and heritage surveys required for future production environmental approvals

Area 3. Shenandoah North A within subject land 1

- Drilling of water bores
- Civil construction of a new ~3 hectare lease pad, 1 ha camp pad and 1km access track
- Drilling of a vertical exploration wells
- Plug and abandonment of the exploration well
- Rehabilitation of exploration site

The full 2023 work program for EP 76, 98 and 117 is summarised in Figure 1 and detailed in Table 1. Table 1 includes a summary covering the existing and proposed new locations required to support the proposed work program.

2023 Work Program Update and Sacred Site Clearance Request

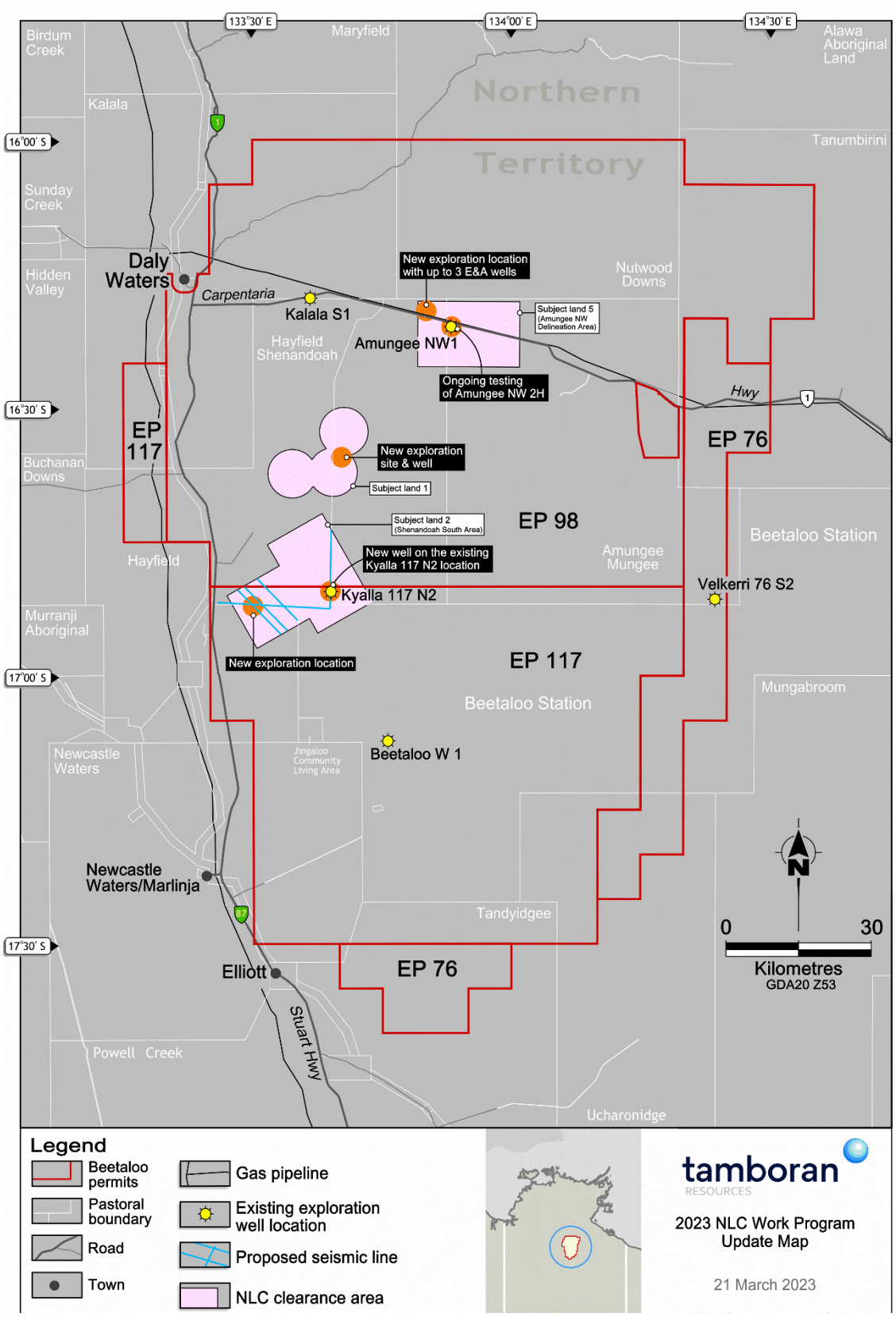


Figure 1 Overview of Tamboran's proposed 2023 work program

2023 Work Program Update and Sacred Site Clearance Request

Table 1 EP 76, 98 and 117 Work Program Summary (including contingent scope)

Exploration Permit	Location	Location type	Pastoral Stations/ NT Portions	2023 work program overview
EP 76	Velkerri 76 S2	Existing	Amungee station (NT Por 1079)	• Ongoing access track, gravel pit, camp pad and lease pad maintenance and monitoring • Ongoing Velkerri 76 S2-1 well maintenance
EP 98	Amungee NW	Existing	Amungee station (NT Por 1079)	• Ongoing access track, camp pad and lease pad use, maintenance and monitoring • Hydraulic fracturing and well testing (~180 days) of the Amungee NW 2H well • Well testing of the Amungee NW 1H well • Drilling, hydraulic fracturing and testing of up to 2 additional E&A wells • *Contingent*: approximately 40km of 2D seismic
EP 98	Amungee NW2	Existing	Amungee station (NT Por 1079)	• Periodic inspection and ad hoc maintenance of existing access track, water bore, and lease pad
EP 98	Amungee NW3	New proposed location	Shenandoah East (NT Por 7027)	• Construction of new access track, gravel pit, lease pad and camp pad to ~15-20 hectares • Construction of groundwater extraction bores • Drilling, hydraulic fracturing and well testing of up to 3 additional E&A wells
EP 98	Kalala S	Existing	Kalala Station (NT Por 697)	• Periodic inspection and ad hoc maintenance of existing access track, camp pad, and lease pad • Ongoing Kalala S-1 well maintenance • Groundwater monitoring and extraction • Potential well abandonment • Potential site rehabilitation
EP 98	Shenandoah North A	New	Shenandoah East (NT Por 7027)	• Drilling of water bores • Civil construction of a new ~3 hectare lease pad, 1 ha camp pad and 1km access track • Drilling of a vertical exploration wells • Plug and abandonment of the exploration well • Rehabilitation of site
EP 117	Kyalla 117 N2	Existing	Shenandoah (NT Por 7026)	• Ongoing access track, gravel pit and lease pad maintenance and monitoring

2023 Work Program Update and Sacred Site Clearance Request

Exploration Permit	Location	Location type	Pastoral Stations/ NT Portions	2023 work program overview
				• Civil construction works to maintain and expand the existing well pad to accommodate multiwell drilling and centralised wastewater treatment / storage- ~ 10 hectares • Drilling, hydraulic fracturing and testing of up to 2 new exploration and appraisal (E&A) wells • Ongoing maintenance and data collection from the existing Kyalla 117 N2-1H exploration well • Operation of a temporary camp • Groundwater extraction and monitoring • Long-term wastewater storage and treatment
EP 117	Shenandoah step out pad #1– naming convention to be confirmed	New proposed location	Shenandoah (NT Por 7026)	• Construction of new E&A location consisting of access track, camp pad, lease pad, laydowns, firebreak to ~15-20 hectares • Construction and operation of groundwater extraction bores • drilling, hydraulic fracturing and well testing of up to 2 additional E&A wells • acquisition of ~52km of 2D seismic[1]
EP 117	Shenandoah step out pad # 2 – naming convention to be confirmed	New proposed location	Shenandoah (NT Por 7026)	• *Contingent:* Construction of new access track, lease pad and camp pad to ~15-20 hectares • *Contingent:* Construction and operation of groundwater extraction and monitoring bores
EP 117	Beetaloo W	Existing	Beetaloo Station (NT Por (702) Access track: Hayfield (NT Por 1077) Access Track: Jingaloo (NT Por 5416)	• Periodic inspection and ad hoc maintenance of existing access track, gravel pits, camp pad and lease pad • Ongoing Beetaloo W-1 well maintenance • Diagnostic fracture injection test and monitoring • Groundwater monitoring and extraction • Potential well abandonment • Potential site rehabilitation

[1] An approved activity under the Amungee NW Delineation Program EMP Exploration Permit 98 EMP(ORI11-3) and a subset of a larger 200 km^2 2D/3D seismic surveys (refer Section 4).

4 Calendar Year 2023 NLC Requests

To support the proposed E&A strategy and work program, Tamboran B2 seeks NLC support for a range of NTH engagement as summarised in Table 2. This can be summarised as the following ranked on priority:

1) **Highest:**

2) **High Priority:**

consultation with NTHs on formation of ILUA Steering Committee and the NTH nominees.

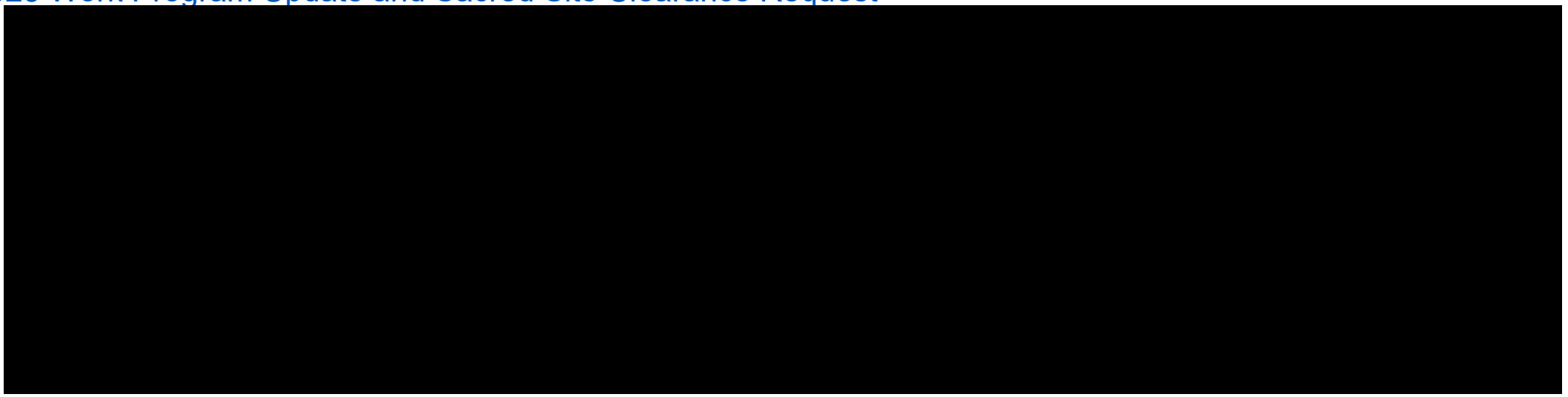
3) **Moderate/BAU priority:**

2023 Work Program Update and Sacred Site Clearance Request

Table 2 Summary of NTH engagements requested for CY 2023, with indicative, tentative timing assumptions or preferences.

2023 Work Program Update and Sacred Site Clearance Request

2023 Work Program Update and Sacred Site Clearance Request



2023 Work Program Update and Sacred Site Clearance Request

4.1 AAPA certificate application - existing cleared areas

4.2 New Clearance Area request

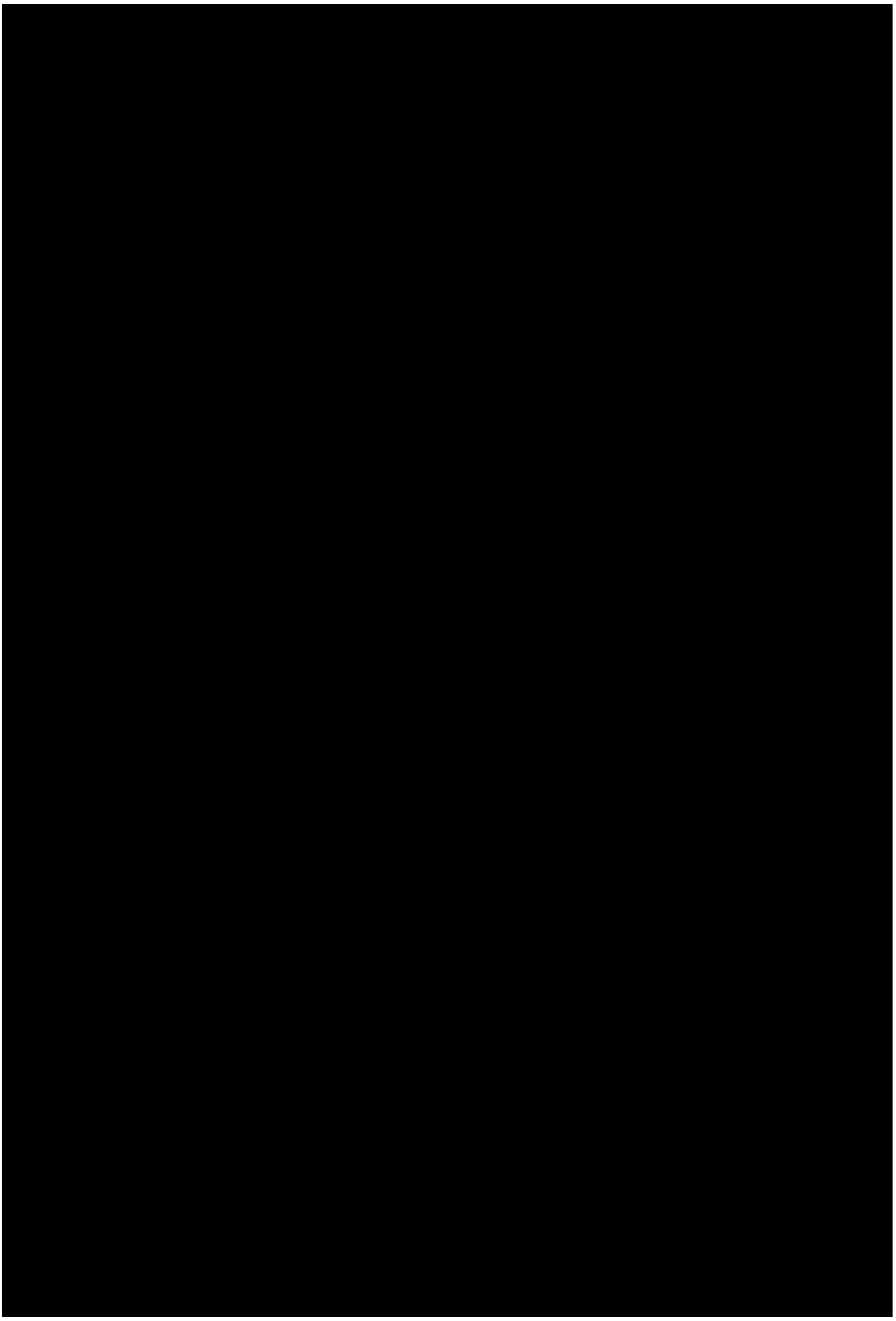
2023 Work Program Update and Sacred Site Clearance Request

[redacted]

2. **New Clearances for Shenandoah South and Amungee NW Extension Area**

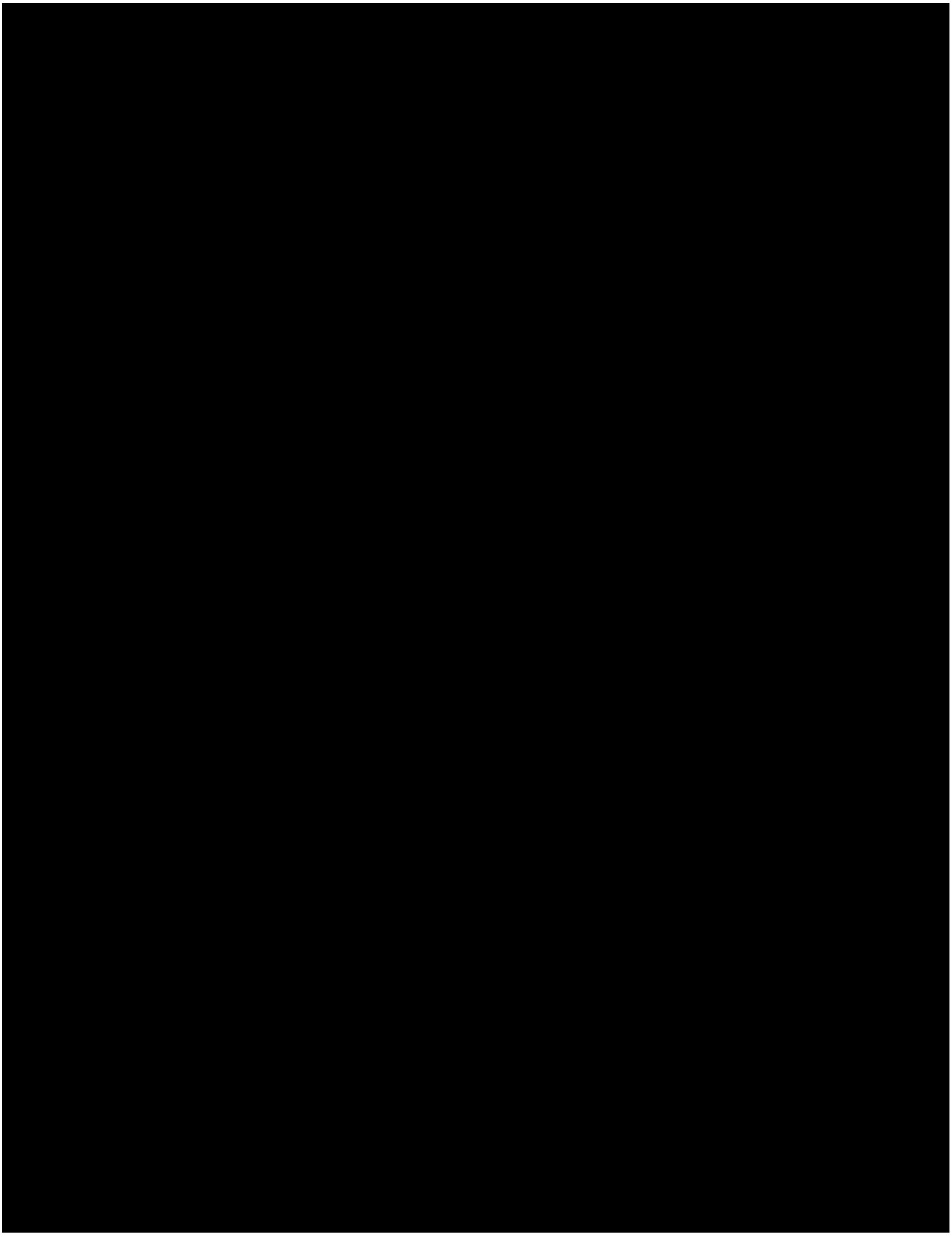
[redacted]

2023 Work Program Update and Sacred Site Clearance Request



2023 Work Program Update and Sacred Site Clearance Request

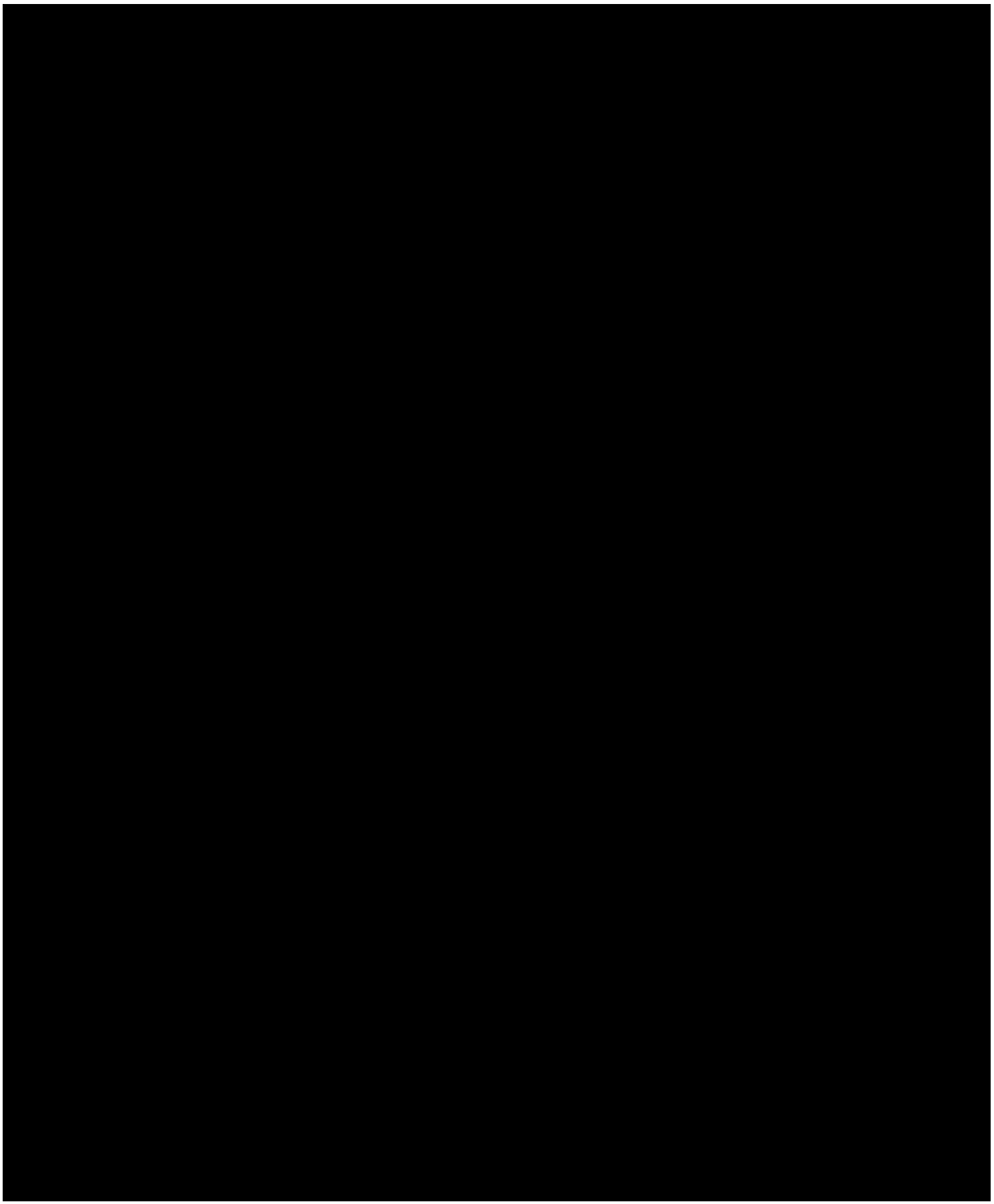
2023 Work Program Update and Sacred Site Clearance Request



2023 Work Program Update and Sacred Site Clearance Request

[redacted]

2023 Work Program Update and Sacred Site Clearance Request



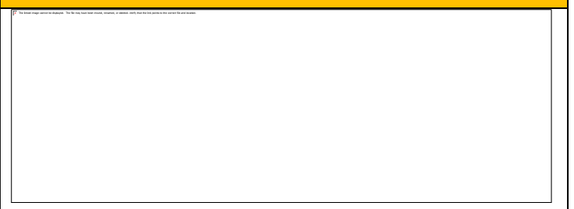
APPENDIX A Detailed description of regulated activity

The following table provides details of the proposed exploration activities proposed **within the requested clearance areas**. These descriptions are indicative and general in nature, minor departures from such descriptions are likely to occur and such departures are covered as much as practicably possible by the content of this activity description.

Table 3 Description of proposed regulated activity details within the clearance areas

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Site selection and scouting The first step of the process when undertaking exploration activities is site selection. Proposed E&A 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 (including for other infrastructure such as pipelines, access tracks, gravel pits etc.), each site is assessed for suitability using a multi-criteria analysis. This analysis covers several 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 several different specialists with a “scouting party”. Scouting activities include: • NLC field clearance: Tamboran B2 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/areas 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,	N/A	2-6	During activity planning.	<4 weeks	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
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.					
Access track construction Access tracks will be constructed to connect the proposed infrastructure to existing roads. Tracks will generally be constructed to at least NT Standard Drawings (CS3003) for Typical Cross Section for Rural Environment – Pastoral Access Road 2. Where possible access tracks will align with the existing seismic lines or other clearances/disturbances to minimise vegetation clearing. Access tracks 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 access tracks in places to enable all weather access. Where access tracks intersect with main roads (such as the Stuart Highway), intersections 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	First activity required to enable civil construction and drilling.	Access tracks are likely to be continually maintained and surfaced throughout the life of the activity	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Seismic consists of the following: 650km^2 of seismic acquisition will be undertaken. **Dynamite charges - minimal disturbance approach** Where possible surveys will be undertaken using dynamite to minimise the clearing of vegetation. In such surveys, vegetation clearing will be restricted to extremely dense vegetation where site access is otherwise prevented. Charges are typically 0.5-2kg and are installed to a depth of approximately 10-15m underground using a small ATV/4WD mounted auger. All charges and detonators are handled by licensed shotfirers. The charges are tamped and secured into place to prevent surface blow-outs and unlicensed interference. During the seismic recording the charges are detonated by a licensed shotfirer with no surface disturbance occurring. The detonated charge generates a “dull thud sound” which can be heard within 2-4km radius and felt within a 200m radius (typically) **Low Impact Source – AWD (Accelerated Weight Drop) or similar** A low impact source, such as an AWD, may be utilised as a standalone source option in suitable locations, or in combination with dynamite, or as infill in areas of restricted access. This type of source has a small surface footprint generally requiring no vegetation clearing for access. Source points are more densely spaced than larger sources such as dynamite and vibroseis trucks and may be in the order of 5-10m along a line. **Vibroseis or similar** If the seismic energy source is Vibroseis truck(s) then line clearing will be required so that the vehicles can drive and operate over the survey area. Source lines will need to be cleared every 200-400m for a 3D survey or on a sparser grid for a 2D survey. Existing cleared areas will be utilised where possible to reduce disturbance. line location tolerances utilised for avoiding vegetation, cultural heritage sights and infrastructure.. Seismic lines will be planned 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:** When required for access or source points in tough terrain surveyors mark the ground with either biodegradable paint or temporary stakes . Line detours may also be marked with temporary biodegradable flagging. A survey team in a light 4WD vehicle, ATV, or on foot 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. Recording is generally restricted to daylight hours. Geophones are deployed at regular intervals along lines perpendicular to the source lines for a 3D survey and along the source line for a 2D survey. The geophones are autonomous nodal receivers that can be readily carried by hand or small ATV and as such no line preparation is generally required for the deployment of the geophones. Once the required number of geophones are deployed each source point is activated in a pre-defined sequence and the energy generated is recorded by the geophones. The activation methodology of the source point will differ depending on the source energy type i.e. dynamite, AWD, vibroseis. After the energy source is finished the geophones are collected and line rehabilitation and data analysis commence.	up to 500ha (noting minimal disturbance seismic will be prioritised to minimise clearaing with target clearing below 50ha)	6 to 35	Before or after exploration well drilling with the final time to be finalised.	3 – 12 weeks per campaign	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
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 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 control and impact groundwater monitoring bores 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 and tested at least 6 months prior to drilling (except for exceptional circumstances) and 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 typically utilise a water bore drilling rig to construct the bores, similar to the rigs 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 other viable water bearing formations if encountered.. 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 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	
Lease pad construction Each proposed lease pad will be constructed to accommodate exploration well drilling, stimulation, testing and ongoing wastewater storage and treatment; typically such pads will be less than 12 hectares. 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, well cellars, sediment ponds, bunds and other necessary earthworks 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.	7.5-12ha	<24 people	Prior to exploration drilling	2-8 weeks	

<table>
<tr><th>Activity description</th><th>Disturbance area</th><th>Typical personnel numbers</th><th>Timing</th><th>Duration</th><th>Activity example pictures</th></tr>
<tr>
<td>The well cellars will be constructed on the proposed lease to accommodate the wellhead equipment and blow-out preventer (BOP). The cellars are typically concrete- or steel-lined and prefabricated off-site. The cellars are typically 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..</td>
<td></td><td></td><td></td><td></td>
<td> </td>
</tr>
<tr>
<td>Gathering and main pipeline Construction

Each lease pad may be connected to a centralised processing facility via a gathering pipeline. The gathering pipeline will be constructed to transport both gas and water to/and from a pad. Gathering pipelines will be constructed in a cleared right of way of approximately 25m wide.

If the beneficial use of gas is approved, to allow the avoidance of the majority of flaring, appraisal gas would likely be sold into the domestic gas market via a high-pressure main pipeline constructed to connect processing facilities to the existing Amadeus Gas Pipeline or McArthur River Mine Pipeline (MMRP). Pipeline corridors will be typically up to 50m, with the exact route and length dependent on final site selection.

Construction for the gathering and main pipelines generally include the following activities:

Pipeline Construction
<table>
<tr><th>Stage</th><th>Description</th></tr>
<tr><td>Location</td><td>An initial route selection study will be conducted for the pipeline in order to optimise the pipeline route to connect to the Amadeus pipeline. Further fine-tuning and route refinement will continue throughout the planning phase of the project to ensure the route does not interfere with any sacred sites, cultural heritage or environmentally sensitive features.</td></tr>
<tr><td>Pipe</td><td>The gas transmission pipeline will be a buried, high pressure steel pipeline. It will be designed and constructed in accordance with the requirements of AS 2885 Pipelines – Gas and Liquid Petroleum. The pipeline will be buried for its entire length and will be deep enough so current land use activities can continue after the pipe has been installed. The minimum depth of cover over the pipeline will be 750mm. For road crossings the depth of cover will be increased to ensure protection of the pipeline and the asset or feature being crossed by the pipeline.</td></tr>
<tr><td>Early Works</td><td>In order to support the approvals and detailed design activities a number of activities take place prior to the main construction phases. Generally known as ‘early works’ , these activities include a range of field-based activities. These activities inform the Approvals and Design teams about field conditions and are often iterative, as additional identified information results in changes to aspects of the project scope requiring revisiting and rework of the project scope. These activities include but are not limited to general investigations, surveys for the pipeline, sacred sites, cultural heritage, environmental and soil & geotechnical.</td></tr>
<tr><td>Survey</td><td>The limits of the right of way (ROW) working width shall be marked with stakes at visible intervals.
A survey crew will work ahead of the initial clearance of vegetation from the ROW. This survey crew will utilise the project benchmarks to check</td></tr>
</table>
</td>
<td>25m to 50m wide</td>
<td>~15-50</td>
<td>Main Pipeline construction expected to start dry season 2024</td>
<td>3-6 months</td>
<td> </td>
</tr>
</table>

Activity description		Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
	and re-establish all agreed intersection points (IPs), mark the right of way boundaries and place offset/recovery pegs.					
Clear and Grade	To allow construction activities to commence, the pipeline alignment needs to be cleared of vegetation, rocks, trees, etc to provide mainline construction vehicles access. Clearing and grading shall be minimised to the extent necessary for the safe construction of the pipeline and shall in any event not exceed the maximum permissible width of the ROW except where additional working areas are defined and agreed. Light vegetation removed during clearing shall be stockpiled outside of the stripped ROW working area and will be respread during restoration unless the property owner requests that the vegetation be left as stockpiles.					
Pipe Transport and Stringing	Stockpiled pipe will be delivered to the ROW along the identified access tracks using prime movers and trailers. The specific logistics of the pipe haulage will be developed during the planning phase. The pipe trucks will only utilise specific access tracks which will be constructed (or upgraded) to allow them to pass. Pipe will be strung (placed on the ROW) directly from trailers onto saw dust filled bags or equivalent using a Vacuum lift pipe handler mounted on a hydraulic excavator, end hooks or slings depending on the pipe length and size, terrain. Strung pipe shall be supported clear of the ground and in a manner that will not damage the pipe or coating.					
Trenching	A trench is formed to accommodate the welded pipe strings and achieve the required depth of cover in accordance with the pipeline design. The trench shall be excavated along the surveyed and pegged centreline, in accordance with the minimum cover specified. Trenching operations are carried out utilising a combination of bucket wheel trenchers, rocksaws & 30T excavators. Accordingly, excavation plant, equipment and techniques will be selected to accommodate the anticipated conditions and required production rates. In areas of hard rock, controlled blasting using explosives may be required to break the rock to permit removal by excavator.					
Welding	Line pipe ends will be welded together (butt welded) to form pipe strings up to a typical length of 1km. The mainline welding crew is the engine room for the project's welding and sets the pace for mainline construction. The very agile and mobile poor boy crew carries out all difficult mainline welding sections and provides start joints for the mainline crew. Additional welding resources carry out all tie-ins and special crossings.					
Lower in, padding and backfill	The coated pipe shall be lowered-in using a series of side booms so the pipeline has adequate and properly distributed slack, the pipe is not unduly stressed, and the pipe coating is not damaged. Where the excavated material and the bottom of trench are free of material that could damage the pipe, the pipe shall be laid directly on the trench bottom. The excavated material shall be used directly for bedding and padding. Where excavated material does not meet the specification, padding machines (screening machines) or similar will be used to produce bedding and padding. The trench will be back filled using the remaining trench spoil (excavated material) following the padding operation. The trench is compacted by wheel and/or track rolling with the backfilling equipment. Areas requiring higher compaction, such as road crossings, will be undertaken with an excavator mounted vibrating plate or other suitable manually operated or driven compaction equipment.					
Reinstatement	The pipeline ROW will be reinstated which includes replacement of previously stripped topsoil and rootstock, installation of contour banks, reinstatement of fencing & install new gates and revegetation as necessary.					

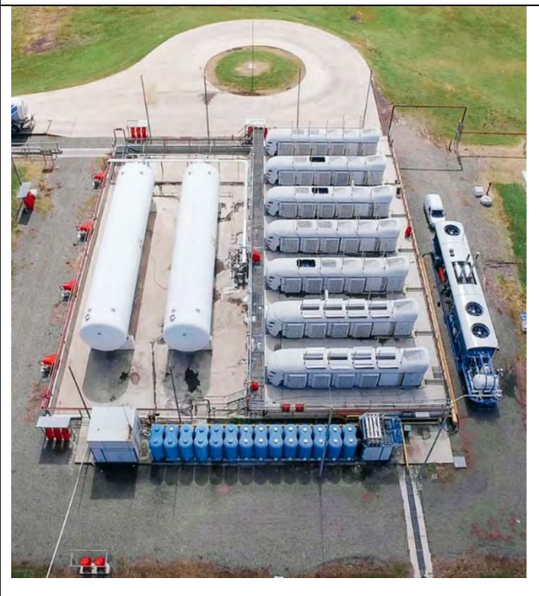
Activity description		Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
	Restoration of the ROW shall be completed in accordance with any easement agreements, Environmental Impact Statement, Construction Environmental Management Plan and regulatory requirements.					
Pipeline testing	The pipeline will be hydrostatic pressure tested to prove the strength and leak tightness of the installed pipeline. The hydrostatic testing will be conducted by a certified mechanical testing laboratory and all test reports are to be certified.					
Commissioning	The commissioning phase of the works can be broken into two components, pre-commissioning and commissioning. Pre-commissioning is the exercise of manually proving each component of the pipeline/facility system prior to the introduction of gas. Example testing includes: • Verification that all parts are installed as detailed on engineering drawings, including position, orientation, part numbers, etc • Hydrostatic testing (confirming the system is leak tight), cleaning (blow through with air and cleanliness checks), drying and blow-through of piping • Bolt torquing of flanged connections • Functional testing of all manual valves through full extent of travel • Functional testing of all actuators and control valves through full extent of travel • Earthing compliance checks • Instrument calibration and installation checks • Insulation, continuity and point to point testing of all circuits installed by the Contractor Following the pre-commissioning phase, the asset becomes ready for the introduction of gas.					
Camp pad construction and camp operation A camp pad will be constructed adjacent to each proposed lease pad to accommodate a temporary 70-100 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 (for 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. 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. 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 handling and irrigation will occur in accordance with the NT Department of Health requirements.		1.2-2.5ha	Typically <100 people (including housed staff)	For duration of activity	For duration of activity	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
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 tracks to store materials, wastes, wastewater, equipment and other material as required. The laydown yard will be fenced to prevent access. These are typically 2.5- 5ha in size, with allowance up to 25 hectares for multiple laydowns. Laydowns may also be utilised for temporary offices/workshops/field camps or warehouse infrastructure support E&A and construction activities. 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).	25ha	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) may 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). 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.	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
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 Multiple petroleum exploration wells are proposed to be drilled at each site (typically 6-8 but potentially more where multiple formations are targeted). Wells may be drilled in stages (i.e. 1 or 2 at a time) or progressively (i.e. 8 wells drilled over a single campaign). Each well will be drilled into an underlying prospective petroleum reservoir (such as the Velkerri shale, Kyalla shale or other formation) to a typical depth of 1500m-4000m. Each well will be deviated into the horizontal position, with a lateral drilled up to 5000m (please note the depth and lateral length may change based on operational requirements and technological advances). 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 as per NT drilling regulations. 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, formation integrity 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	N/A located on proposed lease pad	<60 people	Post civil construction	Typically 45 - 90 days per well	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
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 (or equivalent tanks or fit-for-purpose containers). Once drilling has been completed, this material will be sampled and tested as per the code of practice and a 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 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, hydraulic fracturing stimulation (HFS) plant and equipment (commonly referred to as a “frac spread”) will be mobilised to site to commence HFS (or stimulation) activities on each of the drilled wells. A frac spread typically 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 (for frac fluids) 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 to 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	N/A located on proposed lease pad	<50 people	Post E&A well drilling	2- 8 weeks per well depending on stimulation size	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
perforation deployment • Ancillary support equipment and 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 (raw water or a mixture of raw water and recycled flowback wastewater) and sand (proppant), plus a small percentage of chemicals at high pressure into the target section of the horizontal wellbore. Typically, >90% of the total volume of stimulation fluids is a combination of water (fresh and recycled wastewater) 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 tests and an integrity report generated, which is submitted to and assessed by the regulator prior to the commencement of stimulation activities. The stimulation fluid is generated through mixing freshwater, recycled flowback, chemicals and sand in blenders. Stimulation fluid is then 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	

<table>
<tr><th>Activity description</th><th>Disturbance area</th><th>Typical personnel numbers</th><th>Timing</th><th>Duration</th><th>Activity example pictures</th></tr>
<tr>
<td>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
The E&A 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 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 either flared, sold (piped or compressed/liquified and trucked) or beneficially used onsite to reduce greenhouse gas emissions where possible.</td>
<td>N/A located on proposed lease pad</td>
<td><12 people during production testing</td>
<td>During exploration activities</td>
<td>Typically 30 days to 24 months.</td>
<td> </td>
</tr>
<tr>
<td>Appraisal gas sale
To minimise flaring during the production testing phase of the wells Tamboran will be developing facilities and a pipeline to enable this gas to be captured rather than flared. This is anticipated to reduce appraisal emissions by approximately 90%.
Options are currently being assessed with a priority on speed of installation to limit flaring and economic affordability.
The initial solution is likely to be a Compressed Natural Gas (CNG) or mini Liquified Natural Gas (LNG) facility to enable gas treatment, compression and truck loading of the CNG or LNG so the gas can be delivered to and injected into either the AGP or the McArthur River Mine Pipeline and to any customers seeking truck deliveries of CNG/LNG as a fuel or diesel alternative. This approach is commonly used around the world for initial production gas or virtual pipeline supply, however it is limited in the amount of gas it can capture. Local generation and power consumption for a data centre on site is another possibility for this initial gas but again will be limited in capacity.
In parallel, initial treatment and compression facilities will be developed to compress the gas into a new pipeline connection to the AGP. This will enable all the extended production gas to be captured and flaring stopped.
Appraisal gas facility construction
<table><tr><th>Stage</th><th>Description</th></tr></table></td>
<td>9 Ha</td>
<td>< 10 people operating and <50 people during construction</td>
<td>Upon completion of well testing- potential 2024.</td>
<td>Until Production Licence</td>
<td>  </td>
</tr>
</table>

Activity description		Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Mobilisation	Establishment of access track into site and site offices and amenities, laydown areas, erosion and sediment controls installation as per the requirements of the approval management plans, site communications links and construction set out survey.					**Figure 4 Example facility – the Buquebus LNG Facility in Buenos Aires Argentina**
Earthworks and Civil Works	Preparation of top soils and sub-fill for establishment of foundation – including excavation and removal of unsuitable fill materials from site, import of required sub-grade fill materials, grading and levelling of the facility pad and final capping and import of road base materials to design specification. Works **may** also include **ongoing up**grading of **existing** access track**s**.					
Underground Services	Trenching of facility pad as required to install buried services and piping, backfill and compaction of trenches, including installation of crossing reinforcement for protection of buried services in trafficable areas.					**Figure 5 A truck mounted compression facility**
Piling	Installation of steel pile foundations by driving into the prepared facility pad and/or pre-drilling as required and welding of pile caps onto piles in preparation for skids to be landed.					
Structural Mechanical and Piping	Installation of pre-assembled skidded pipe rack modules onto foundations requiring lifting onto pile caps and welding in place, bolting flanges to connect interfacing skids and equipment packages, installation of site run utilities piping, lifting and welding in place of skidded equipment packages.					
Electrical and Instrumentation	Installation of cables and cable supports, ladders and trays, termination of cables into relevant panels (control and low voltage), installation of tubing and glanding of instruments, mounting instruments onto piping or instrument stands.					
Plant Commissioning	**This stage involves the testing and commissioning of all equipment on the site, in preparation for operations.**					

A range of temporary facilities will be required during construction. These may include work areas for equipment and pipe, storage and lay down areas, and a site office.

The location of the temporary facilities will be primarily based on logistical requirements. This will include ensuring facilities are located at a suitable distance from watercourses, are not endangered by threat of flood, do not require clearing of sensitive vegetation and are managed in such a way as to ensure no long-term land contamination issues.

Typical manning during operations is <10 people. During construction, ~50 people may be required. These are indicative numbers with the final manning levels will be finalised during the activity planning.

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Wastewater tank storage Flowback and drilling wastewater will be stored one each location or piped to a centralised location for storage via gathering lines. Wastewater will be recycled within the drilling or stimulation process to reduce raw groundwater volumes. Wastewater not earmarked for recycling will be treated on site via evaporation within open tanks (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. Wastewater storage tanks may be deployed for extended periods of time (potentially several years) 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 Tamboran infrastructure footprint (such as lease pads or laydown yard) to reduce the amount of offsite wastewater trucking.	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
Flaring During well testing and where gas cannot be beneficially used or sold (such as during facility downtime etc.) , produced hydrocarbons (gas and liquids) will be flared onsite, 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.	
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.	N/A- within proposed lease pad	< 6 people	Upon completion of drilling activities	7 days	

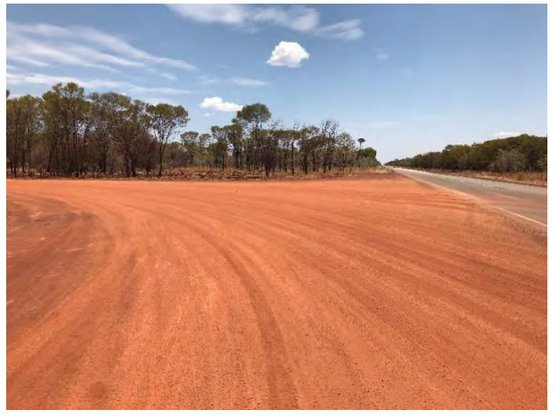
Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Wet season operations Exploration activities (including drilling, stimulation and well testing operations) may occur over the wet season. Where wet season operations are undertaken the following 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 wet season significant rains (notionally December or as predicted) • 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 the access to the site is safe. • Wastewater storage area is bunded, which will prevent all off-site release of chemicals and stormwater. • During flowback wastewater storage, stormwater will be retained on-site via the sediment retention pond prior to release. • Overland flow will be diverted around lease pads as far as reasonably practicable.	N/A	N/A	October – May	7 months of the year	
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.	Minimal	3-9 personnel.	Deployment of Geophones before stimulation. Retrieval of Geophones after stimulation.	1 month (one week deployment, two weeks Stimulation, one week collection)	

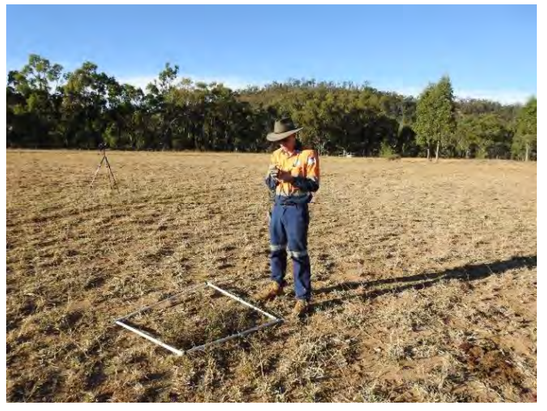
Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Induced Seismic Monitoring will be undertaken at the same time as the Microseismic monitoring. A temporary seismic receiver is installed ~1km from the well site, with a small amount of other equipment 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. Minimal clearing or heavy machinery is required for either activity, and the activities are considered to have a minimal impact, like that of scouting activities.					
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/ Tamboran 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/ Tamboran 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 Tamboran 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 Tamboran 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 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	
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.	

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 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 per day 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 be licenced under Tamboran's existing Water Extraction Licence (WEL) GRF 10285. A new WEL may be submitted to increase the water take and/or covering take an alternative formation where present. It is anticipated that groundwater extraction volumes to support this program will be in the order of 250-600ML per year (conservatively) , primarily used for civil construction, drilling and to stimulate the E&A wells. Once drilling and stimulation has ceased, minimal ongoing water extraction from the site will be required. Where possible, recycled flowback will be utilised within stimulation to reduce raw water usage.	N/A	N/A	Ongoing to support exploration activities.	During exploration activities	
Traffic management Access to the site will be via a combination of existing and new access tracks, located approximately 15-20km South of Dunmarra on the Stuart Highway. Minor traffic disruptions may occur during the construction of the access track intersection with the Stuart 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/appraisal gas sale (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	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Site rehabilitation Within 6 months of the E&A wells being plugged and decommissioned, a 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	 

Appendix B 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 4 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, produced water, or hydrocarbons (liquid and gaseous) from suspended or abandoned wells to groundwater due to well design and integrity management. • Low risk of leaks from gathering lines, with gathering lines constructed as per Australian Standard, leak detection in place to identify pipeline failures and routine inspections completed. • 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	• 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, 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 • Gathering lines and pipelines constructed as per Australian standard, leak detection in place to identify pipeline failures and routine inspections completed. • 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 being added to WEL. • All water take to be metered and reported quarterly to the regulator • No pastoralists groundwater bores within 1 km of each proposed site • Flowback to be preferentially used in stimulation fluid to reduce raw water usage.

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			• 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 WEL).	
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 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 preferentially located in existing disturbed area, with no sensitive soil types present in the immediate vicinity. • Low risk of reduction in land productivity from poor rehabilitation due to mandatory rehabilitation requirements and security bond requirements • Low risk of pipeline subsidence creating erosion	• 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 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 demonstrated as ALARP and acceptable. • Site to be rehabilitated back to pre-existing/ agreed state with pastoralist input. • Pipeline monitoring and repair work to minimise/ respond to pipeline subsidence

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
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 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, • Low risk of air emissions created by gas fired compression • Low risk of greenhouse gas emission impacts from appraisal gas sale/ well testing (climate change)	• 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 where practicable • Outside of high intensity activities (such a s civil construction, drilling and stimulation) 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, 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 and equipment, with annual inspections on pipelines • Low NOx and Low CO gas fired compression/ power generation utilised to minimise air emissions. • Appraisal gas will be beneficially used through sale of CNG/LNG/ piped natural gas to reduce flaring and minimise flaring to reduce scope 1 and 2 emissions.
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 gathering pipeline failure and release of flowback • 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	• No take of surface water permitted or proposed • Lease pad located away from watercourses- typically 1km or greater • 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) • 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 be operated with a 1:1000Annual re-occurrence interval (ARI) wet season or dry season (whichever is

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			contaminating surface water due to stormwater segregation and testing procedures. • Low risk of infrastructure (including pipeline) 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. • Low risk of gathering line failure releasing flowback fluid to the environment	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 gathering lines to be welded as per Australian Standards, hydrotested during construction to verify integrity prior to being brought into service • Gathering lines to utilise flowmeters/ pressure monitoring to identify leaks (such as flow/ pressure drops) • Gathering lines to be inspected 6 monthly to identify subsidence/ potential integrity issues. 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 • Avoid the introduction of weeds • Avoid the spread of existing weeds • Minimise the loss of pastoral productivity	• Clearing of vegetation communities (such as Open Corymbia/eucalypt woodland, Bullwaddy and/ or Lancewood) to support 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	• 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 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 – fauna mortality	• Seismic activities to: o avoid clearing of mature trees and protected flora o In open woodlands, limit clearing to grasses and shrubs o Maintain viable root stock to promote rapid rehabilitation o No seismic lined in riparian o 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 inspected and certified weed free prior to entry • 6 monthly weed inspections to be completed with all identified weeds treated.

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			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.	• 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 night during flaring or from activity lighting. • Noise impacts from helicopter movements • Noise and vibration impacts during seismic activities.	• 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 noise, dust, light and vibration impacts associated with temporary appraisal gas facility	• Sites located away from homesteads and local communities • Flaring to be minimised to avoid light generation • 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. • Compression/ power generation/ CNG/ LNG facilities to be designed to minimise aesthetic impacts and located away from homesteads and local communities. • Lighting of infrastructure designed to minimise aesthetic impacts during the evening •

Appendix N.1.2 14 230327 Updated Draft NLC ILUA Presentation

From: Emily Beresford-Cane [redacted]
Sent: Tuesday, March 28, 2023 3:47 PM
To: Tamboran Contact [redacted]
Subject: Fwd: Updated Draft NLC ILUA Presentation

Begin forwarded message:

From: Emily Beresford-Cane [redacted]
Subject: Updated Draft NLC ILUA Presentation
Date: 27 March 2023 at 4:51:03 pm AEDT
To: [redacted]
Cc: Scott Crabtree [redacted]

Dear Rory

Please see updated presentation for the meeting on Wednesday 29th. Can you please let me now as soon as possible if you have any suggestions or amendments?

Are you also able to confirm who from the NLC will be in attendance at the meeting - and assume its all systems go for Wednesday?

Kind regards

Emily
[redacted]

tamboran

RESOURCES

NLC-Tamboran [redacted]

29 March 2023

Carpentaria Highway, Northern Territory Australia

Agenda – ILUA Meeting

- Introduction
- About Tamboran
- [redacted]
- Beetaloo Exploration
- Beetaloo Project
- Exploration and Production activities
- Protecting Water
- Looking after Country
- [redacted]
- Next steps

About Tamboran

Introducing Tamboran

We are a publicly listed Australian company with our headquarters in Sydney and staff across Australia and the USA. We are committed to creating value for our shareholders, communities, Territorians and Australians by appraising and developing the gas resources of the Beetaloo Basin. We strive to follow and exceed the example set by Origin in community engagement since 2014 and will continue to focus on economic, development and employment opportunities for Native Title Holders and local communities.

Our Vision

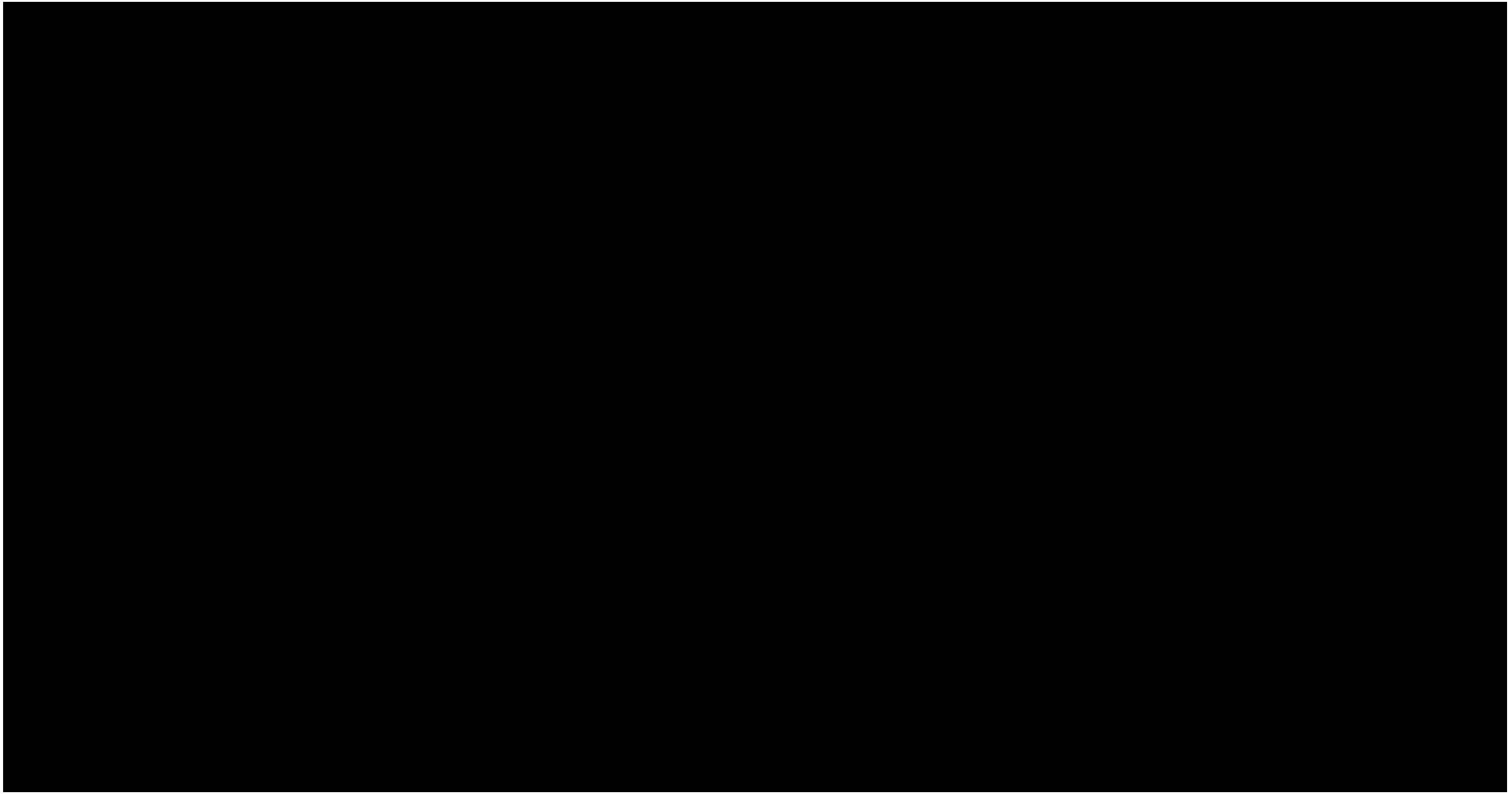
To play a role in the global energy transition by investing in the development of low CO2 unconventional natural gas resources in the Beetaloo Sub-basin of the Northern Territory of Australia and to become a Net Zero carbon emissions gas producer for our equity share of Scope 1 and Scope 2 emissions when the Company achieves commercial gas sales.

Strategy

- Target is to become a Net Zero equity Scope 1 & 2 emissions producer
- Focused, high growth Beetaloo strategy
- High quality assets with significant scale
- Low-cost development targeting multiple markets, premium pricing
- Expertise in unconventional E&P development

Sustainability

- Health & Safety
- Climate Change
- Environment
- People
- Community
- Economic Sustainability



Beetaloo Exploration Project

tamboran RESOURCES

Tamboran Resources, together with joint venture partner Falcon Oil and Gas, is exploring for gas in the Northern Territory's Beetaloo Basin.

The Resource Potential

Our exploration project in the Beetaloo Basin is a multi-year, nine well shale gas project that started in mid-2014.

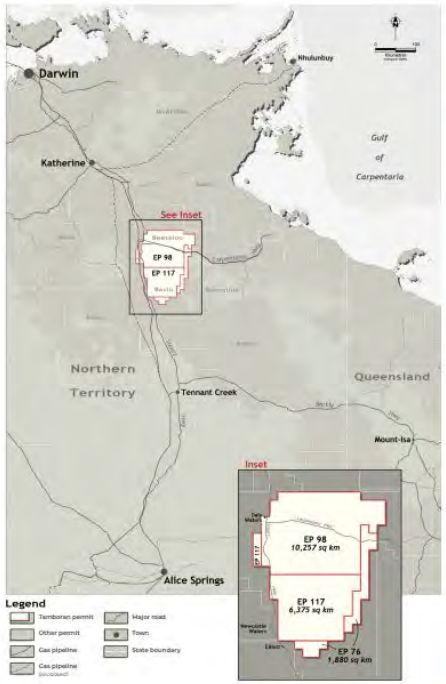
So far, we've drilled six wells. All within regulations and with the consent of the pastoralists and Native Title holders. We plan to drill one more this year (2021) and two more in 2022.

We think there's a very large gas resource underneath the ground with outstanding potential.

Today our project has as much as 61 trillion cubic feet of gas, with 6.6 trillion cubic feet of that already recognised as a contingent resource*.

Just how big is this? The Inpex project is 12 trillion cubic feet and the Mereenie gas fields have produced around 240 billion cubic feet since the mid 1980's.

* Amungee well estimate



Our Permit Commitments

EP	2014	2015	2016	Moratorium 2017 - 2018	2019 - 2021	2022
98	Geological and geophysical studies	2 vertical wells 1 horizontal well	1 HFS horizontal well Extended production test		Extended production test	
117	Geological and geophysical studies	Geological and geophysical studies	1 vertical well		1 vertical well 1 HFS horizontal well Extended production test	2 HFS horizontal wells Extended production tests
76	Geological and geophysical studies	Geological and geophysical studies	Geological and geophysical studies		1 vertical well	
Permit Year	1	2	3		4	5

The Benefits

If successful, and development goes ahead, the project means:

- more work for and jobs with local companies, including Aboriginal companies
- the opportunity to supply goods and services to the project
- financial payment for host pastoralists and Native Title holders
- taxes and royalties – providing government with more money that can go to improving community services, infrastructure and telecommunications
- energy security (delivering gas to the Eastern Australia)

Beetaloo Project

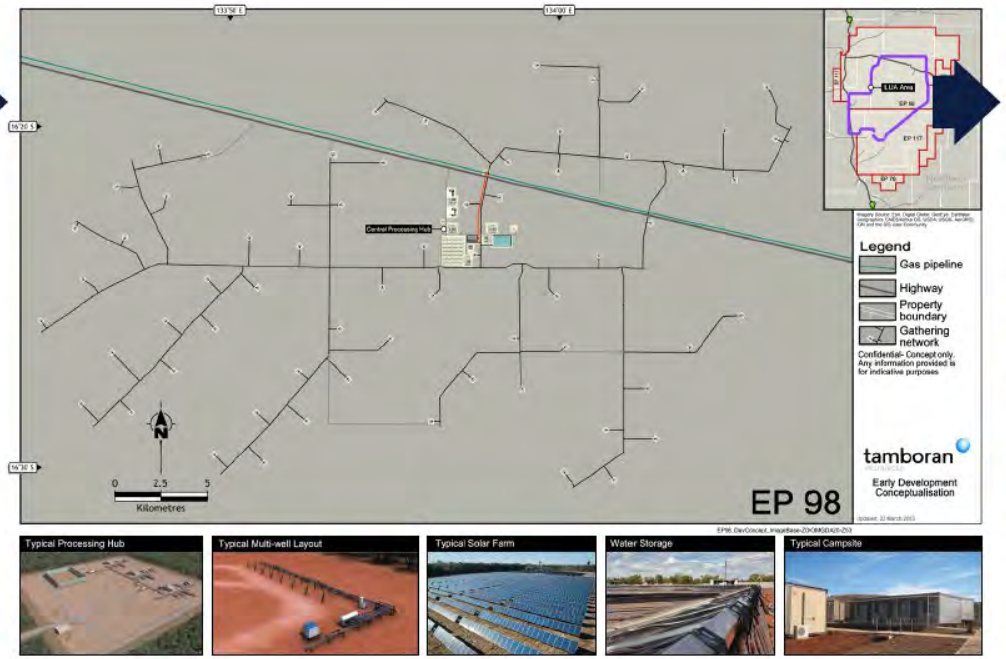
tamboran RESOURCES

Moving from Exploration through to Development and Rehabilitation

Exploration, appraisal and piloting
Several individual sites spread over a large area

Development and production
Concentration of sites and supporting infrastructure over a smaller area

Rehabilitation
Progressive fixing of country back to pre-existing state



Exploration

- Is there gas?
- 1-2 wells per year
- typically smaller sites with vertical wells with no fracking or gas produced
- 2D seismic used to assess whether rocks are continuous

Appraisal and Piloting

- What type of gas and how much?
- Increasing number of wells- typically 2-6 per year.
- Larger sites to store more equipment with multiple wells per site
- Horizontal wells drilled which are fracked and tested to see how much gas can be produced

Development and production

- Extract gas from target formations to supply for both domestic and international customers
- Construction and operation of infrastructure required to support production, including gathering pipelines , multiple gas processing facilities, warehouses, laydowns, camps, wastewater treatment areas, renewable and gas fired energy generators
- increasing number of wells drilled and stimulated per year to maintain production ranging from ~ 6 to 60 depending on size of project and demand
- Small lease pads with centralized infrastructure
- All gas sold, with minimal Greenhouse gas emissions during production
- Progressive rehabilitation of wells and wellsite's once production has finished
- Typically 30+ years

Rehabilitation

- Country progressively rehabilitated as activities finish
- Production wells plugged with cement and rehabilitated
- Infrastructure remove, with topsoil and vegetation reinstated
- Multiple years of rehabilitation

Conventional and Unconventional

tamboran
RESOURCES

Conventional and Unconventional are industry terms used to define where gas is found underground and how it's extracted.

It's the same gas (natural gas reserves are mostly methane with some propane, butane and light condensates) - the main difference is how it occurs in nature today.

Conventional gas has typically migrated from where it formed millions of years ago to a sandstone reservoir where it's trapped between porous grains under a denser layer of rock that acts as a cap or seal.

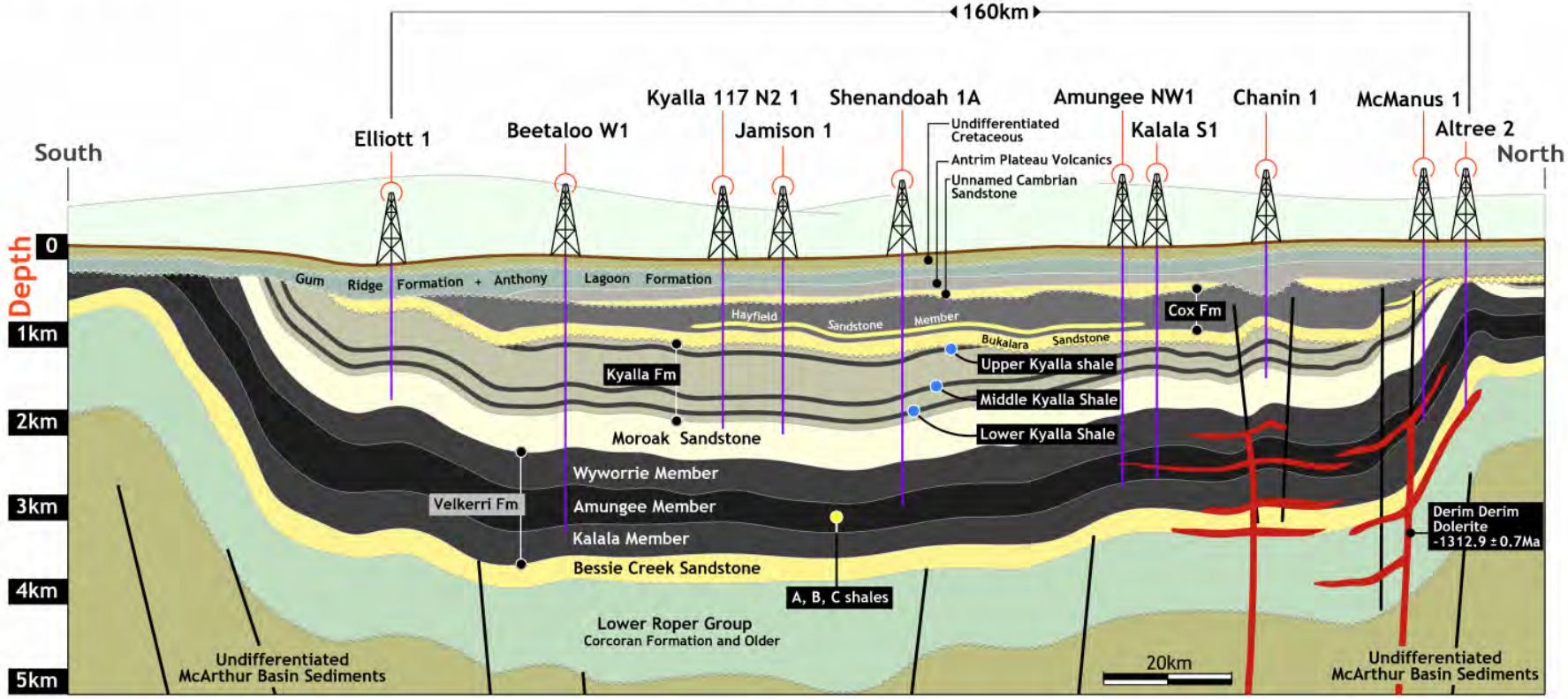
Unconventional gas is typically extracted from where it formed, in coal seams or shale formations that can be less porous and are sometimes described as tighter.

Extracting gas from either source can require a range of different techniques and processes

It's a common misunderstanding that conventional reserves do not require fracture stimulation and unconventional reserves do.

For example, around a third of conventional wells in the Mereenie field near Alice Springs have been fracced.

Less than a quarter of Tamboran's unconventional coal seam gas wells in Queensland are fracced.



Drilling For Shale Gas

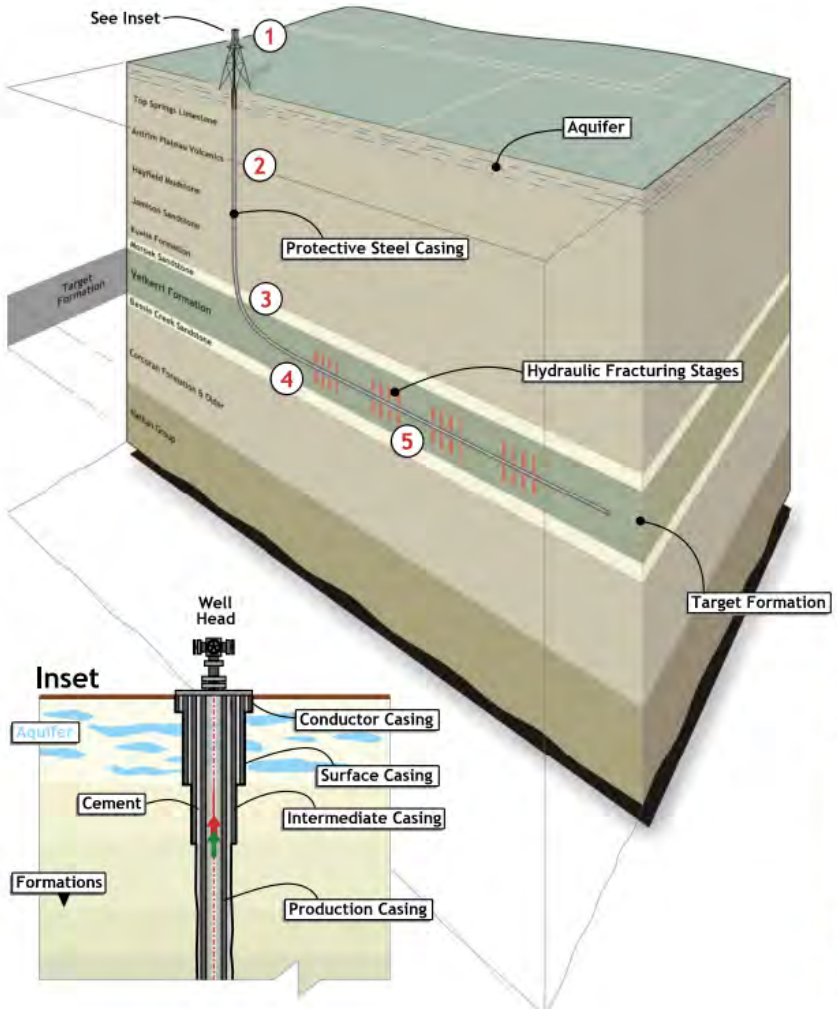
tamboran
RESOURCES

Our exploration program includes drilling both vertical and horizontal wells that target the underground shale rock formations in the Beetaloo Basin.

Long Reach Horizontal Drilling

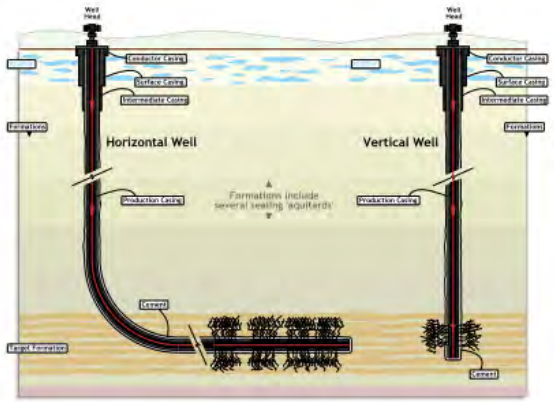
Steps in Horizontal Drilling:

1. Negotiate and agree access, obtain approval and bring in drilling rig and equipment
2. Drill vertical section of well using conventional methods
3. Drill kick-off (curved) section, with the use of a downhole motor mounted directly above the bit, in order to make the turn from vertical to horizontal. Downhole instruments called MWD (measuring while drilling) packages transmit sensor readings upward, allowing operators at the surface to build the angle
4. Drill horizontal wellbore, still using MWD to hold the angle and direction
5. Case off the well with steel casing and cement to allow for completion and fracture stimulation, preparing the well for production



Vertical Wells and Long Reach Horizontal Wells

- Tamboran will drill both vertical and horizontal wells during the Exploration Phase/s
- Vertical wells allow a more cost effective assessment of the potential for gas and liquids in the target zones and provide some information on production capability
- Horizontal wells will be required to assess the potential for economic gas and liquid recovery rates
- Horizontal wells are most likely to be required for field development



Hydraulic Fracture Stimulation (Fracking)

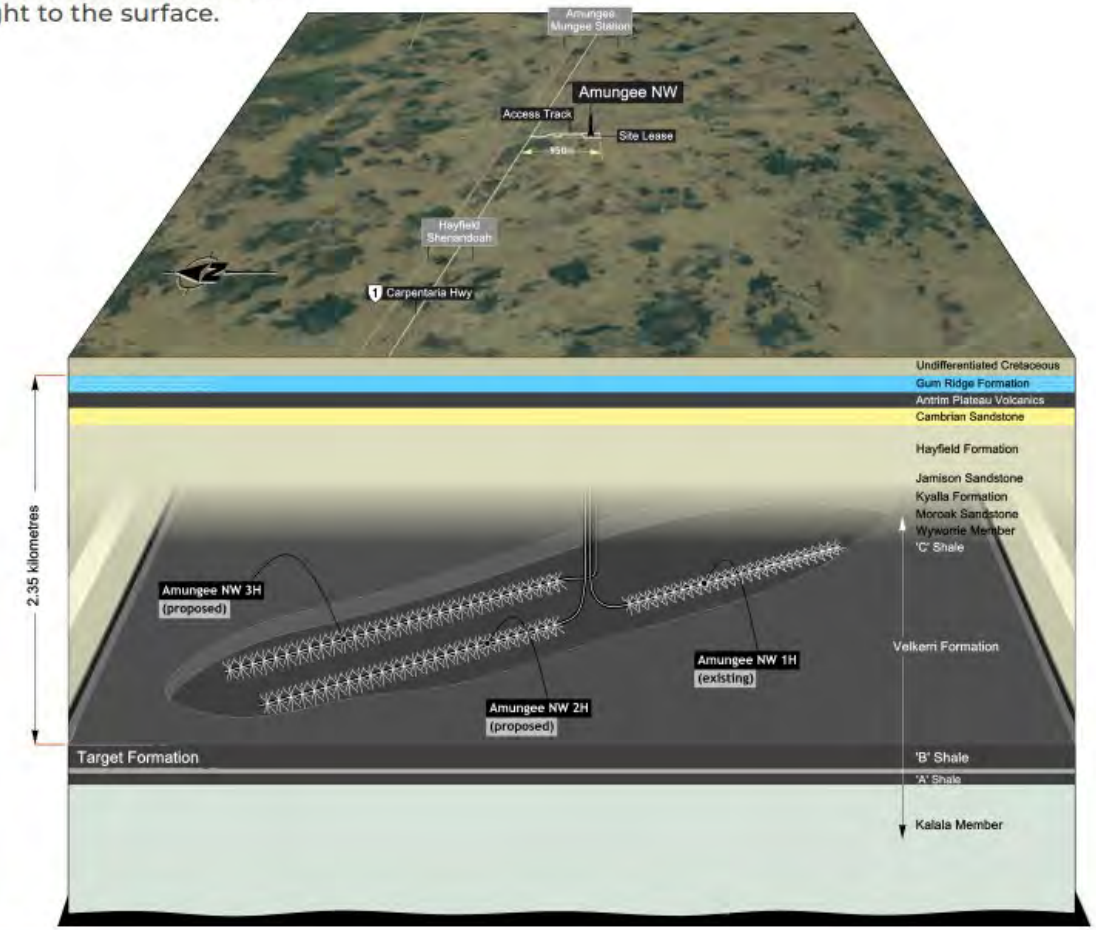
tamboran RESOURCES

Fracking is the technical process designed to release the gas trapped in the dense shale rocks deep underground.

It involves pumping water mixed with sand and some chemical additives in low concentrations under pressure to fracture the shale, creating tiny pathways in the rock that allow the gas to flow into the well and be brought to the surface.

Key facts about fracking in the Beetaloo

- Distance offers initial protection – 1-2km between the shallower aquifers and the deeper rocks where gas is found.
- Both zones are effectively sealed off by several thick geological layers in between called aquatards.
- It's not physically possible for a fracture to extend upwards into the aquifer. Because of the distance, and because the amount of energy and pressure used in fracking isn't enough to connect and create pathways outside of the rock formation where gas is found.
- Any natural vertical fractures or discontinued bores are extremely unlikely to provide a pathway for fracking fluids to reach a fresh water zone due to the greater weight (what's called hydrostatic head pressure) pushing down from above.
- Seismic work allows us to map the geology and avoid any large structures or faults.



Hydraulic Fracture Stimulation (Fracking)

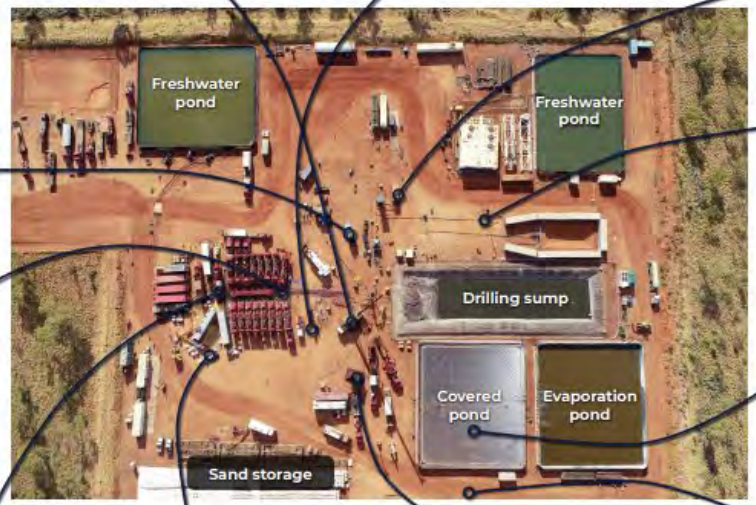
tamboran RESOURCES

Wireline command centre

Well head and crane

Groundwater monitoring bores

Gas and condensate separators



Flare

Pump trucks

Covered ponds

Mixing unit

Sand hopper

Coil tubing unit

Chemical storage

Production Testing

tamboran
RESOURCES

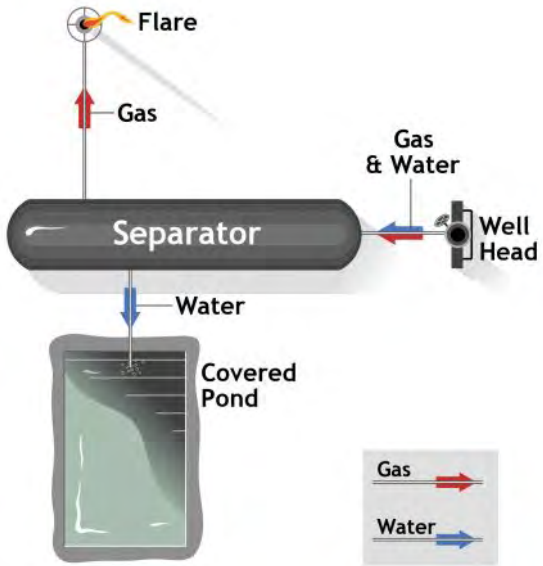
Production testing occurs after a well is successfully drilled and fracture stimulated, and sufficient volumes of fluids pumped down during these stages is returned to surface to allow the well to flow on its own.

The purpose of production testing is to understand the deliverability of the well.

Gas flow from the well is directed to a separator. From there any water is sent to on site ponds. The gas produced is sent to a flare where it is combusted. During exploration, flaring is a better environmental outcome than venting.

Data is gathered about the composition, the rate and how much gas the well is able to flow over a period of time. This information allows estimations to be made about how much of the resource is recoverable.

Production testing, often called extended production testing, can occur over a number of months. The longer the test the greater the confidence that can be gained about the extent of the resource.



Vertical flare

Covered flow back pond

Separator

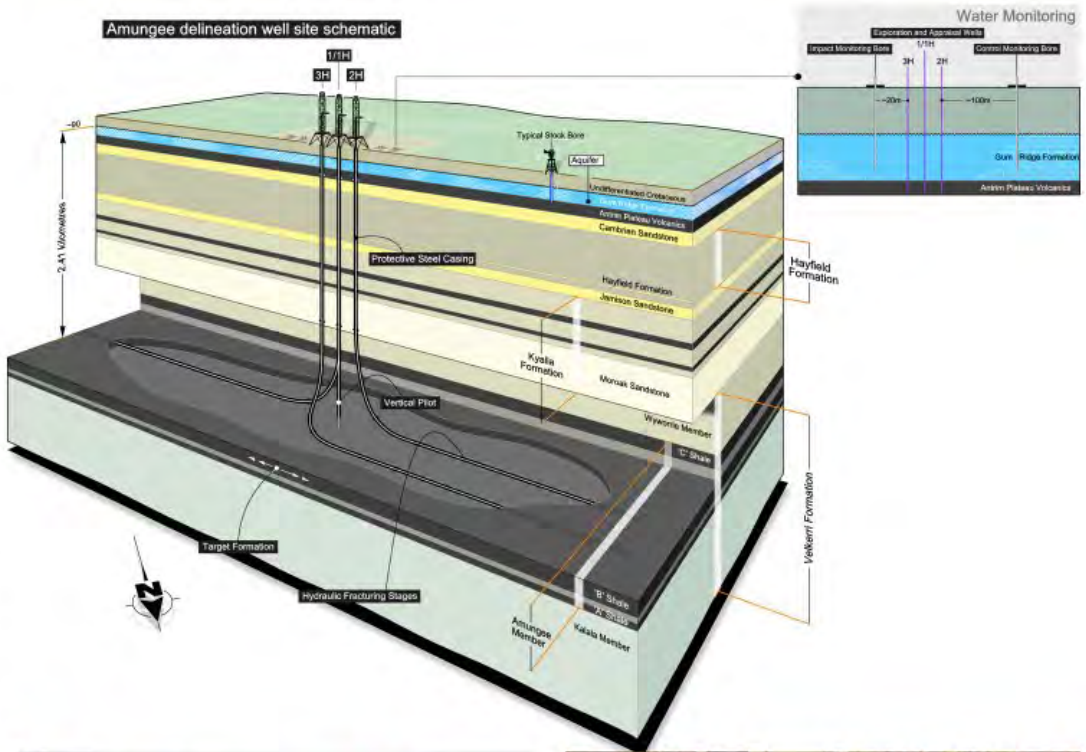
Horizontal flare

Protecting Groundwater

tamboran
RESOURCES

We understand how important groundwater resources are to Traditional Owners, pastoralists and the community. Both engineered and natural geological barriers isolate and protect underground water sources.

Multiple controls are put in place to protect the environment and groundwater. If these controls aren't successfully met when we drill - we don't frack.



Protecting Groundwater

The Beetaloo Basin where Tamboran operates is underlain by two limestone aquifers in the area - the Anthony Lagoon Beds, which lies between 60 and 200 metres below surface, and the Gum Ridge formation, which lies between 200 and 400 metres below the surface. The horizontal section of Tamboran's existing and proposed wells are located in the Velkerri shale formation, separated by the deepest aquifer by approximately two Groundwater monitoring is a regulatory requirement that allows us to detect any potential groundwater impacts that may occur from exploration activities.

Monitoring bores are completed in the Anthony Lagoons Formation(where present) and Gum Ridge Formation on well pads where wells have been hydraulically fractured. The monitoring of groundwater level and quality is required to be completed before, during and after a well is fracture stimulated to ensure any impacts are promptly identified. As well integrity is a major design feature of our wells- groundwater contamination is not anticipated to occur.

It also improves our understanding of the natural variability of water volumes and quality, and broader hydrogeological system in the Beetaloo sub-Basin.

Groundwater monitoring of the broader aquifers within the Beetaloo commenced in 2014 originally by Origin. Tamboran has continued this program and is planning on expanding it in the future. This will ensure all of Tamboran's proposed activities can occur sustainably, with no impacts on surrounding water users.

Well Integrity and protecting groundwater

tamboran RESOURCES

Engineering standards, steel and cement ensure the drilling and fracking of gas wells do not create a pathway between the underground layers of rock or deteriorate over time.

Built Strong - To Last The Test Of Time

A gas well has three main parts – the steel casing, the above ground well head, and cement which is engineered to be as strong as the rock that it will live in.

Casing and cement hold the hole open and protect or prevent any cross flow between the surrounding underground formations. The cement is pumped down the inside and back up the outside of the casing.

An x-ray device sent down the well (a technique called logging) combined with pressure testing confirm the quality of the job.

The casing is designed to ensure its strong enough to withstand the most extreme loads it could be subjected to.

Added to this is a program of regulatory control and oversight, and the requirement to appropriately decommission every well at the end of its operational life.

Engineering Standards And Performance Data

Category	Description	Risk
1	Shallow surface casing + top of production casing cement below over pressured hydrocarbon reservoir	High
2	Shallow surface casing + top of production casing cement below under pressured hydrocarbon reservoir	
3	Shallow surface casing + top of production casing cement above top of gas	
4	Shallow surface casing + top of production casing cement above surface casing shoe	
5	Deep surface casing + top of production casing cement below under pressured hydrocarbon reservoir	
6	Deep surface casing + top of production casing cement above top of gas	
7	Deep surface casing + top of production casing cement above surface casing shoe	
8	Deep surface casing + 1 intermediate casing + top of production casing cement below top of gas	
9	Shallow surface casing + 1 intermediate casing + top of production casing cement above casing shoe	
10	Deep surface casing + 1 intermediate casing + top of production casing cement above top of gas	
11	Deep surface casing + 1 intermediate casing + top of production casing cement above casing shoe	
12	Deep surface casing + 2 intermediate casing strings + top of production casing cement above casing shoe	Low

Tamboran's minimum design requirement for a producing well

Tamboran's minimum design requirement for a P&A well

Tamboran's Beetaloo wells

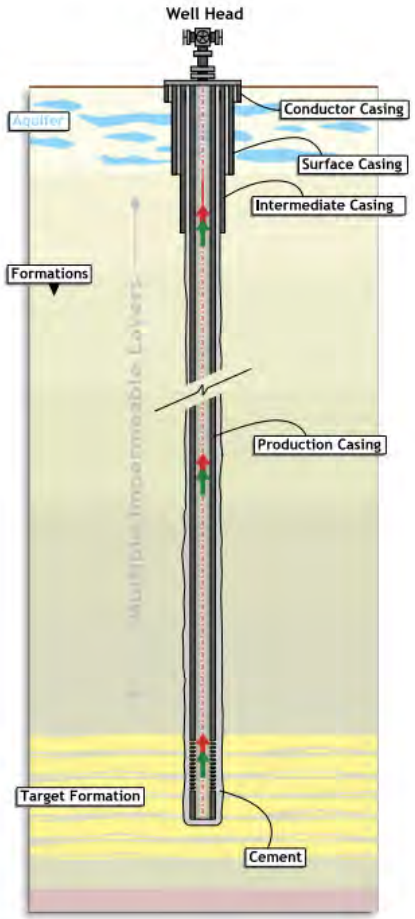
(a) Vertical and deviated wells

CATEGORY	ORIGINAL WELL COUNT	POTENTIAL BARRIER FAILURES	POTENTIAL BARRIER FAILURES %	CATASTROPHIC BARRIER FAILURES	CATASTROPHIC BARRIER FAILURES %	AVG COMPLETION DATE	P&A WELL COUNT	CURRENT WELL COUNT	ORIGINAL AVG SURFACE CASING DEPTH (FT)	ORIGINAL AVG TOP OF PRODUCTION CEMENT (FT)
Category 1	166	100	60.24%	3	1.81%	1979	57	15	253	7,334
Category 2	621	219	35.27%	5	0.81%	1983	138	301	306	6,566
Category 3	46	16	34.78%	1	2.17%	1987	14	31	321	4,008
Category 4	7	0	0.00%	0	0.00%	1982	1	15	222	125
Category 5	8,789	77	0.88%	1	0.01%	1995	782	6,140	559	6,111
Category 6	5,433	6	0.11%	0	0.00%	2007	105	7,181	712	2,816
Category 7	1,766	0	0.00%	0	0.00%	2009	8	2,040	719	534
TOTAL	16,828	418	2.48%	10	0.06%		1,105	15,723		
D&A	147									

(b) Horizontal wells

CATEGORY	ORIGINAL WELL COUNT	POTENTIAL BARRIER FAILURES	POTENTIAL BARRIER FAILURES %	CATASTROPHIC BARRIER FAILURES	CATASTROPHIC BARRIER FAILURES %	AVG COMPLETION DATE	P&A WELL COUNT	CURRENT WELL COUNT	ORIGINAL AVG SURFACE CASING DEPTH (FT)	ORIGINAL AVG TOP OF PRODUCTION CEMENT (FT)
Category 1	0	0	0.00%	0	0.00%	NA	0	0	NA	NA
Category 2	0	0	0.00%	0	0.00%	NA	0	0	NA	NA
Category 3	0	0	0.00%	0	0.00%	NA	0	0	NA	NA
Category 4	0	0	0.00%	0	0.00%	NA	0	0	NA	NA
Category 5	0	0	0.00%	0	0.00%	NA	0	0	NA	NA
Category 6	269	0	0.00%	0	0.00%	2012	1	268	789	2,153
Category 7	704	0	0.00%	0	0.00%	2012	2	702	929	442
TOTAL	973	0	0.00%	0	0.00%		3	970		
D&A	0									

Well Construction - Protecting Aquifers



Protecting Country and Cultural Heritage

Protect Country

Protect Sacred Sites

Fixing the Country

Beetaloo Project

[redacted]

tamboran RESOURCES

Protect Country

Protect Sacred Sites

Training and Jobs

Fixing the Country

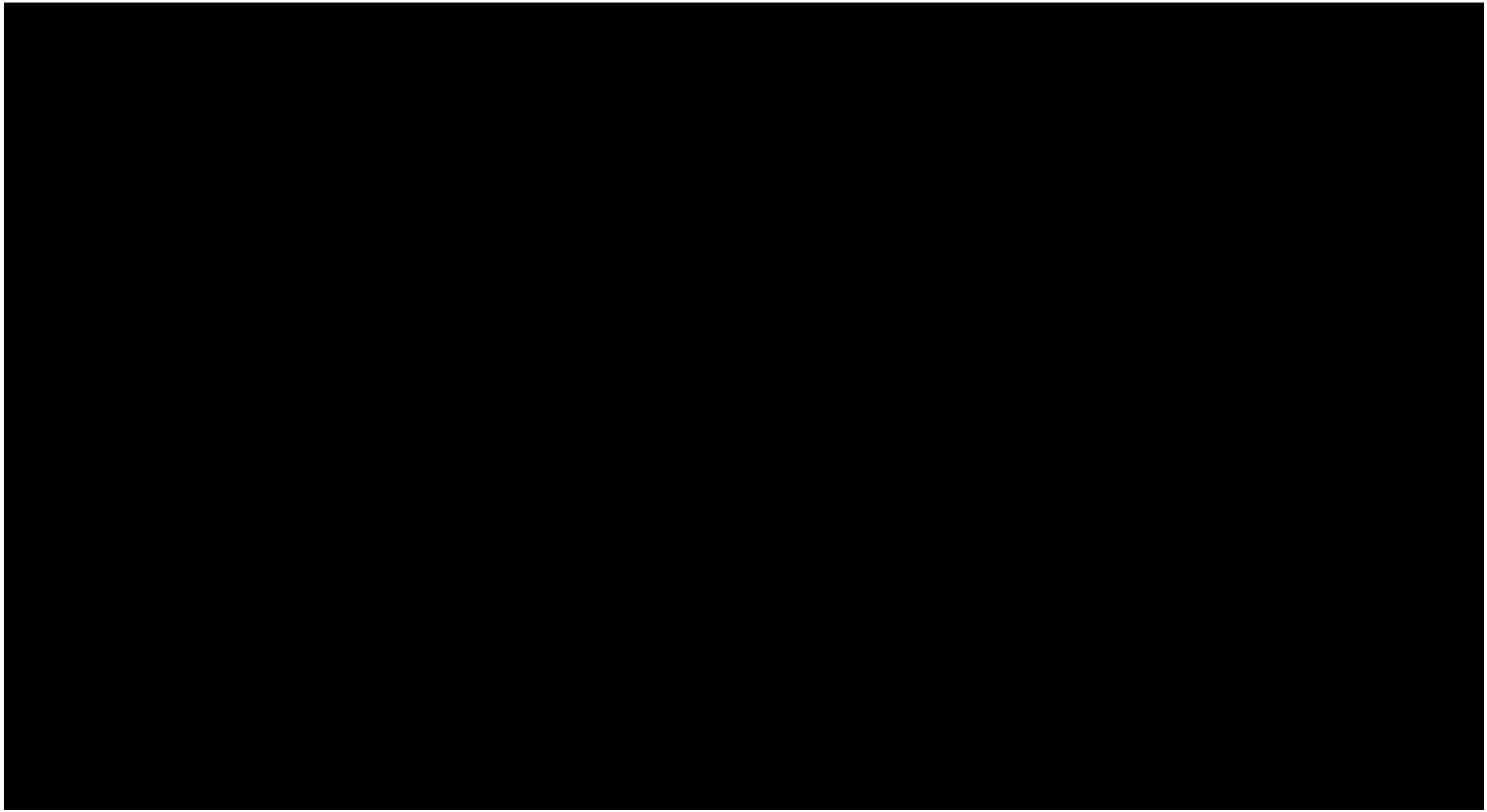
Aboriginal Business

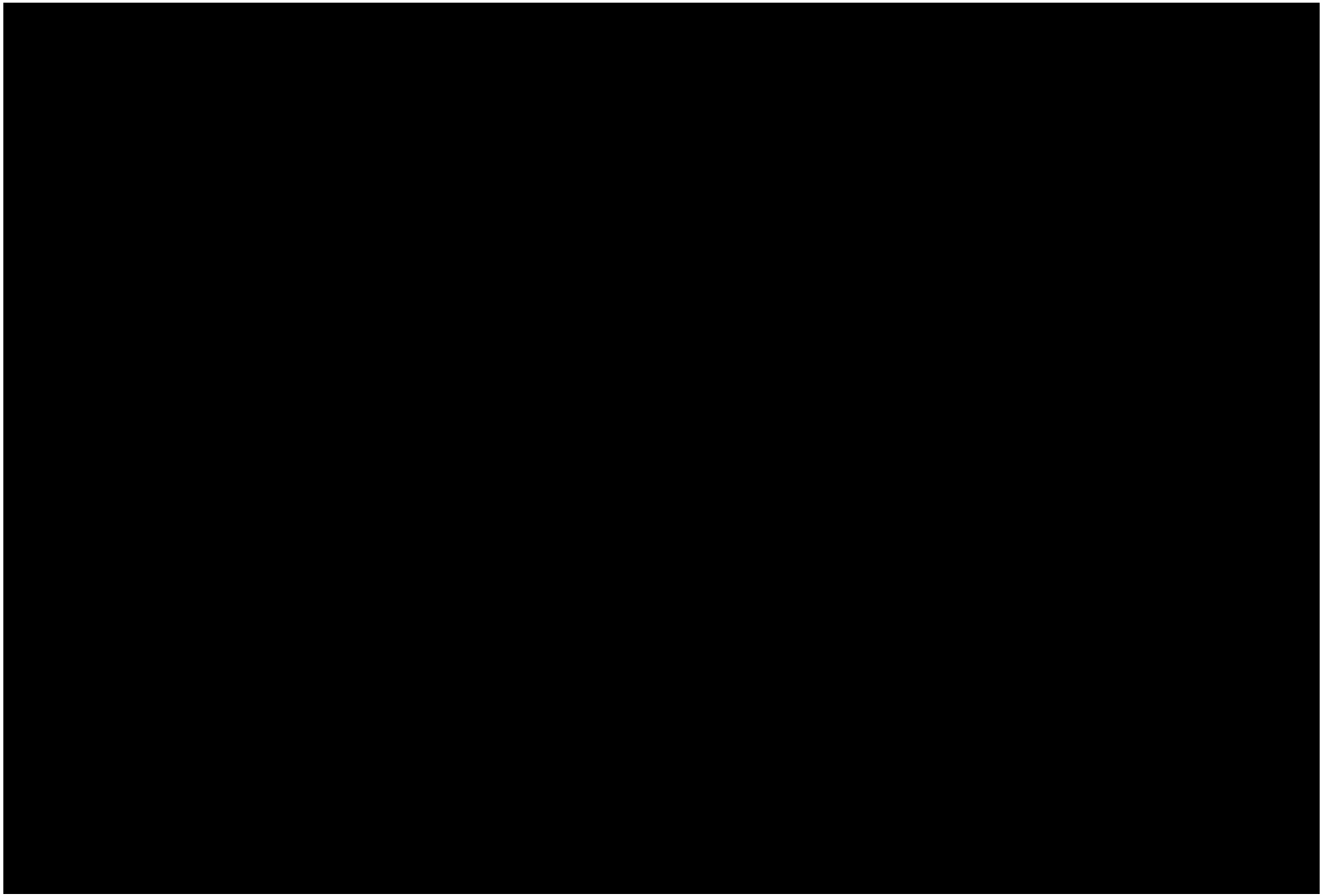
Working Together

[redacted]

Emergency Services

Managing Native Title Holder Money





Next Steps

[redacted]

Appendix N.1.2 15 230427 Revised 2023 work program- inclusion of Shenandoah Nth A

From: Emily Beresford-Cane [redacted]
Sent: Thursday, April 27, 2023 11:22 AM
To: [redacted]
Cc: [redacted]
Subject: Re: Revised 2023 work program- inclusion of Shenandoah Nth A [NLC-NLC.FID2713]

Hi [redacted]

Please find attached updated document with Figures 2 and 3 included.

Kind regards

Emily

> On 21 Apr 2023, at 5:44 pm, [redacted] wrote:
>
> Hi Emily
>
> Figures 2 and 3 appear to be missing from the revised work program that Matt Kernke emailed me (see attached).
>
> Would you be able to include those figures and resend.
>
> Regards
>
> [redacted]
> **Senior Lawyer (Resources & Energy)**
> Northern Land Council
>
> [redacted]

M: +61429511180
Email: RossRo@nlc.org.au | Website: www.nlc.org.au

From: Matt Kernke [redacted]
Sent: Monday, 27 March 2023 10:37 AM
To: [redacted]
Cc: Tamboran Contact [redacted]
Subject: Revised 2023 work program- inclusion of Shenandoah Nth A

Dear [redacted]

As discussed during last week's operators meeting, please find attached a copy of the revised work program with the inclusion of Shenandoah North A within the 2023 proposed activities. I have also provided an updated map within the document which illustrates the locations of the proposed activities (figure 1).

Shenandoah North A is located on the Shenandoah East Pastoral Station, approximately 25km North of the existing Kyalla 117 N2 site.

The new location is within Subject land 1- which has a conditions of work report completed. The proposed new clearances remain unchanged.

Please let me know if you require any further information.

Kind Regards
Matt

Matt Kernke
Environment and Approvals Manager

[redacted]

Disclaimer

The information contained in this communication from the sender is confidential. It is intended solely for use by the recipient and others authorized to receive it. If you are not the recipient, you are hereby notified that any disclosure, copying, distribution or taking action in relation of the contents of this information is strictly prohibited and may be unlawful.

This email has been scanned for viruses and malware, and may have been automatically archived by **Mimecast Ltd**, an innovator in Software as a Service (SaaS) for business. Providing a **safer** and **more useful** place for your human generated data. Specializing in; Security, archiving and compliance. To find out more Click Here.

2023 Work Program update and Clearance Request

EP 98, 117, 76 – Beetaloo Joint Venture (Tamboran / Falcon)

Version:	2.0
Submitted:	Matt Kernke
Presented by:	Tamboran
Review Date:	16 February 2023

2023 Work Program Update and Sacred Site Clearance Request

CONTENTS

1 OVERVIEW 3

2 Exploration and appraisal program strategy - the bigger picture 3

3 Proposed 2023 work program 5

4 Calendar Year 2023 NLC Requests 9

4.1 AAPA certificate application - existing cleared areas 13

4.2 New Clearance Area request 13

APPENDIX A Detailed description of regulated activity 20

Appendix B Summary of Environmental outcomes, impacts, risk and controls 42

2023 Work Program Update and Sacred Site Clearance Request

1 OVERVIEW

In November 2022, Tamboran (B1) Pty Ltd (ABN 39 662 327 237) (*Tamboran (B1)*) executed a transaction to purchase Origin B2 Pty Ltd (ABN 42 105 431 525) (A subsidiary of Origin Energy;) in its entirety. The transaction resulted in Tamboran (B1) acquiring Origin B2's 77.5% interest in Exploration Permits (EP) 76, 98 and 117 (the Permits) under the Beetaloo Joint Venture (JV) with Falcon Oil and Gas (the Beetaloo JV). Tamboran (B1) is a jointly owned subsidiary (in equal proportions) of Tamboran (West) Pty Limited (ACN 661 967 077) ("Tamboran West") and Daly Waters Energy, LP ("Daly Waters"). Tamboran West is ultimately owned by Tamboran Resources and Daly Waters is ultimately owned by Sheffield Holdings, LP.

Origin Energy B2 Pty Ltd continues to operate as Tamboran B2 Pty Ltd (*Tamboran B2*), having formally changed company name with the Australian Securities and Investment Commission (ASIC). For the purposes of this document and going forward, all previous references to *Origin* will be replaced by *Tamboran B2* or the *Beetaloo JV.* Tamboran B2 remains as operator of the Permits.

Northern Territory Government permit commitments across the Permits require Tamboran B2 to complete ongoing exploration and appraisal (E&A) activities. Since 2015, the Beetaloo JV has drilled eight (8) wells in the Beetaloo Sub-basin (Beetaloo). These include Kalala S 1, Beetaloo W 1, Amungee NW 1, Amungee NW 1H, Kyalla 117 N2 1, Kyalla 117 N2 1H, Velkerri 76 S2 1 and the recently drilled Amungee NW 2H (December 2022).

Results collected from the Beetaloo E&A program have highlighted that the various shales within the Beetaloo are potentially suitable for a future onshore gas development. Tamboran B2 has identified two main areas where larger scale pilot projects may be completed in the coming years pending approvals and E&A success; The Amungee Delineation Area and the Shenandoah South Pilot Area. These areas are the focus of the forward E&A campaign and subsequent sacred site clearance requests.

Tamboran B2 respectfully requests the Northern Land Council's assistance to facilitate a *Sacred Site Clearance Survey* to comply with the obligations of the Exploration Agreement(s) and to support an application for Aboriginal Areas Protection Authority (AAPA) Authority Certificate for activity as described below.

This application is designed to provide coverage for Tamboran B2's proposed activities within these area over the next 1-5 years, with all or a subset of the proposed activities likely to occur. Annual work program updates will continue to communicate any refinement of Tamboran B2's E&A strategy.

2 Exploration and appraisal program strategy - the bigger picture

Tamboran B2's development strategy is focused on bringing gas to the domestic market as soon as practicable. Well testing during the Exploration and appraisal (E&A) phase is a crucial step in assessing the commercial viability of the Beetaloo Basin shale resources. Hydrocarbons produced during this phase are typically flared; which is a significant source of Greenhouse Gasses (GHG). Tamboran B2 is seeking to beneficially use produced hydrocarbons, rather than dispose of them via an onsite flare. This will achieve multiple objectives such as:

- Minimising GHG generation
- Increasing domestic gas supply at a time of domestic and international scarcity
- de-risking future shale developments through longer term gas production information
- providing near-term benefits to Native Title Holders (NTH), local stakeholders and the people of the Northern Territory through increased gas supply, and greater potential for local employment opportunities and compensation/royalty payments.

Similar to Origin's previous strategy, Tamboran B2 will begin increasing E&A activities around specific areas that could support future production activities. Tamboran is focusing its E&A efforts around the Amungee Delineation Area (around the existing Amungee NW location) and the Shenandoah South Pilot Area (around the existing Kyalla 117 N2 location). An overview of the proposed focused areas is provided in Figure 2.

The E&A work program for calendar year (CY) 2023 includes a new E&A wells at the existing Kyalla 117 N2 location (within the Shenandoah South Pilot Area) and a new step out location adjacent to Amungee

NW (within the Amungee NW Delineation Area). New well pads will be constructed progressively over the CY 2023-25 period, with additional E&A wells drilled stimulated and tested within both the proposed areas (subject to approvals and appraisal results). As the number of wells drilled and tested increase over the next 1- 3 years, it is anticipated that the gas production volumes could be sufficient to warrant the construction of compression and pipeline infrastructure. This infrastructure will allow for the temporary sale of appraisal gas, subject to agreement with NTHs and the Northern Territory Government (NTG). Sale of appraisal gas is anticipated to commence in 2024.

A single exploration well is proposed for the new Shenandoah South A location, which is located in Subject land 1. The Shenandoah north A well is designed to assess the Velkerri shale continuity between the Amungee NW Delineation are and the Shenandoah South Pilot Area. This exploration well will not be hydraulically stimulated or tested and will be plugged and rehabilitated upon activity completion.

Previous work program progress from operators within the Beetaloo has been slowed by the lack of availability of suitable drilling rigs in Australia. To alleviate this constraint and prioritise the near-term delivery of gas to the domestic market, Tamboran B2 has entered a partnership with Helmerich & Payne (H&P) to import a dedicated drilling rig in country to support Tamboran B2's E&A program. H&P is one of the largest global onshore drilling rig providers, with over 40% of the "Super Spec" American land drilling market share. This strategic move is anticipated to increase the delivery of E&A program results and drive down drilling costs. It is anticipated that the H&P rig will be in country, ready for spud by July 1st 2023.

In parallel with the E&A program, Tamboran B2 will continue to progress the Production ILUA, other critical approvals and front-end engineering design (FEED) for a larger development. A larger development will be focused on both domestic and potentially export markets, with the upstream component (i.e. extraction of gas) anticipated to be Scope 1 and 2 net zero. The design of a larger development and subsequent approvals will be underpinned by information collected from the CY 2023 to CY 2025 E&A program.

3 Proposed 2023 work program

There are three potential work program areas for Tamboran B2's CY 2023 work program, which are subject to environmental, land access and sacred site clearance approvals. Tamboran is prioritising activities within the nominated areas as summarised below:

Area 1 Shenandoah South Pilot Area (subject land 2)

- Expansion of the existing Kyalla 117 N2 location and construction of a step out location (Shenandoah South Pad #2 - naming to be confirmed)
- Drilling, hydraulic fracture stimulation (HFS) and testing of a deeper well targeting the Velkerri Formation shales on the existing Kyalla 117 N2 location
- 52km of 2D seismic
- Maintenance of existing sites and associated infrastructure.
- Environmental and heritage surveys required for future production environmental approvals.

Area 2. Amungee Delineation Area (**subject land 5**)

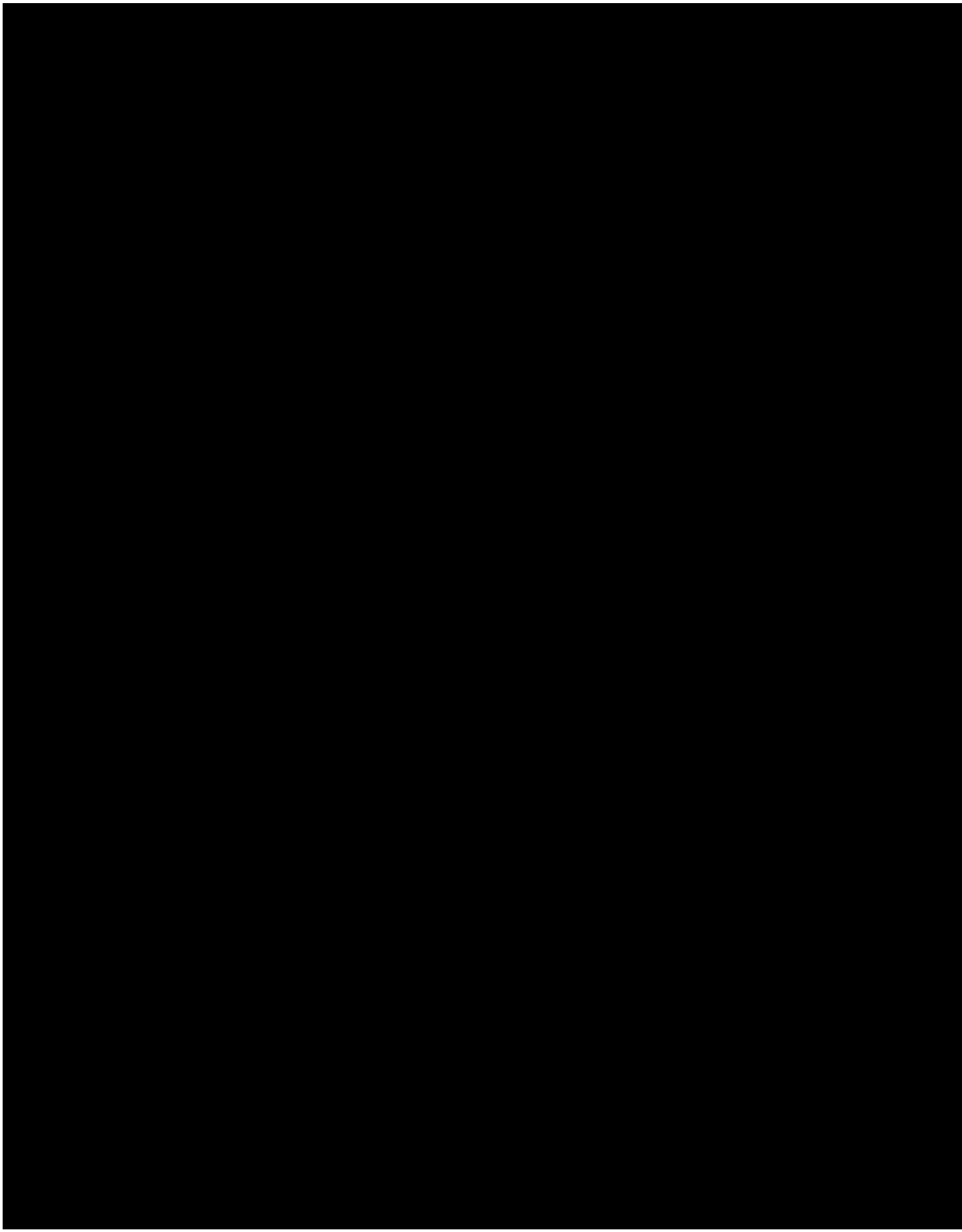
- Stimulation and testing of Amungee NW 2H (nominally a 180 day well test);
- Civil construction of the Amungee NW 3 step out location, including lease pad, camp pad and access tracs;
- Drilling, HFS and testing of up to 3 additional wells on either the existing Amungee NW, new Amungee NW3 location or a combination of both
- Maintenance of existing sites and associated infrastructure.
- Environmental and heritage surveys required for future production environmental approvals

Area 3. Shenandoah North A within subject land 1

- Drilling of water bores
- Civil construction of a new ~3 hectare lease pad, 1 ha camp pad and 1km access track
- Drilling of a vertical exploration wells
- Plug and abandonment of the exploration well
- Rehabilitation of exploration site

The full 2023 work program for EP 76, 98 and 117 is summarised in Figure 1 and detailed in Table 1. Table 1 includes a summary covering the existing and proposed new locations required to support the proposed work program.

2023 Work Program Update and Sacred Site Clearance Request



2023 Work Program Update and Sacred Site Clearance Request

Table 1 EP 76, 98 and 117 Work Program Summary (including contingent scope)

Exploration Permit	Location	Location type	Pastoral Stations/ NT Portions	2023 work program overview
EP 76	Velkerri 76 S2	Existing	Amungee station (NT Por 1079)	• Ongoing access track, gravel pit, camp pad and lease pad maintenance and monitoring • Ongoing Velkerri 76 S2-1 well maintenance
EP 98	Amungee NW	Existing	Amungee station (NT Por 1079)	• Ongoing access track, camp pad and lease pad use, maintenance and monitoring • Hydraulic fracturing and well testing (~180 days) of the Amungee NW 2H well • Well testing of the Amungee NW 1H well • Drilling, hydraulic fracturing and testing of up to 2 additional E&A wells • *Contingent*: approximately 40km of 2D seismic
EP 98	Amungee NW2	Existing	Amungee station (NT Por 1079)	• Periodic inspection and ad hoc maintenance of existing access track, water bore, and lease pad
EP 98	Amungee NW3	New proposed location	Shenandoah East (NT Por 7027)	• Construction of new access track, gravel pit, lease pad and camp pad to ~15-20 hectares • Construction of groundwater extraction bores • Drilling, hydraulic fracturing and well testing of up to 3 additional E&A wells
EP 98	Kalala S	Existing	Kalala Station (NT Por 697)	• Periodic inspection and ad hoc maintenance of existing access track, camp pad, and lease pad • Ongoing Kalala S-1 well maintenance • Groundwater monitoring and extraction • Potential well abandonment • Potential site rehabilitation
EP 98	Shenandoah North A	New	Shenandoah East (NT Por 7027)	• Drilling of water bores • Civil construction of a new ~3 hectare lease pad, 1 ha camp pad and 1km access track • Drilling of a vertical exploration wells • Plug and abandonment of the exploration well • Rehabilitation of site
EP 117	Kyalla 117 N2	Existing	Shenandoah (NT Por 7026)	• Ongoing access track, gravel pit and lease pad maintenance and monitoring

2023 Work Program Update and Sacred Site Clearance Request

Exploration Permit	Location	Location type	Pastoral Stations/ NT Portions	2023 work program overview
				• Civil construction works to maintain and expand the existing well pad to accommodate multiwell drilling and centralised wastewater treatment / storage- ~ 10 hectares • Drilling, hydraulic fracturing and testing of up to 2 new exploration and appraisal (E&A) wells • Ongoing maintenance and data collection from the existing Kyalla 117 N2-1H exploration well • Operation of a temporary camp • Groundwater extraction and monitoring • Long-term wastewater storage and treatment
EP 117	Shenandoah step out pad #1– naming convention to be confirmed	New proposed location	Shenandoah (NT Por 7026)	• Construction of new E&A location consisting of access track, camp pad, lease pad, laydowns, firebreak to ~15-20 hectares • Construction and operation of groundwater extraction bores • drilling, hydraulic fracturing and well testing of up to 2 additional E&A wells • acquisition of ~52km of 2D seismic[1]
EP 117	Shenandoah step out pad # 2 – naming convention to be confirmed	New proposed location	Shenandoah (NT Por 7026)	• *Contingent:* Construction of new access track, lease pad and camp pad to ~15-20 hectares • *Contingent:* Construction and operation of groundwater extraction and monitoring bores
EP 117	Beetaloo W	Existing	Beetaloo Station (NT Por (702) Access track: Hayfield (NT Por 1077) Access Track: Jingaloo (NT Por 5416)	• Periodic inspection and ad hoc maintenance of existing access track, gravel pits, camp pad and lease pad • Ongoing Beetaloo W-1 well maintenance • Diagnostic fracture injection test and monitoring • Groundwater monitoring and extraction • Potential well abandonment • Potential site rehabilitation

[1] An approved activity under the Amungee NW Delineation Program EMP Exploration Permit 98 EMP(ORI11-3) and a subset of a larger 200 km^2 2D/3D seismic surveys (refer Section 4).

4 Calendar Year 2023 NLC Requests

To support the proposed E&A strategy and work program, Tamboran B2 seeks NLC support for a range of NTH engagement as summarised in Table 2. This can be summarised as the following ranked on priority:

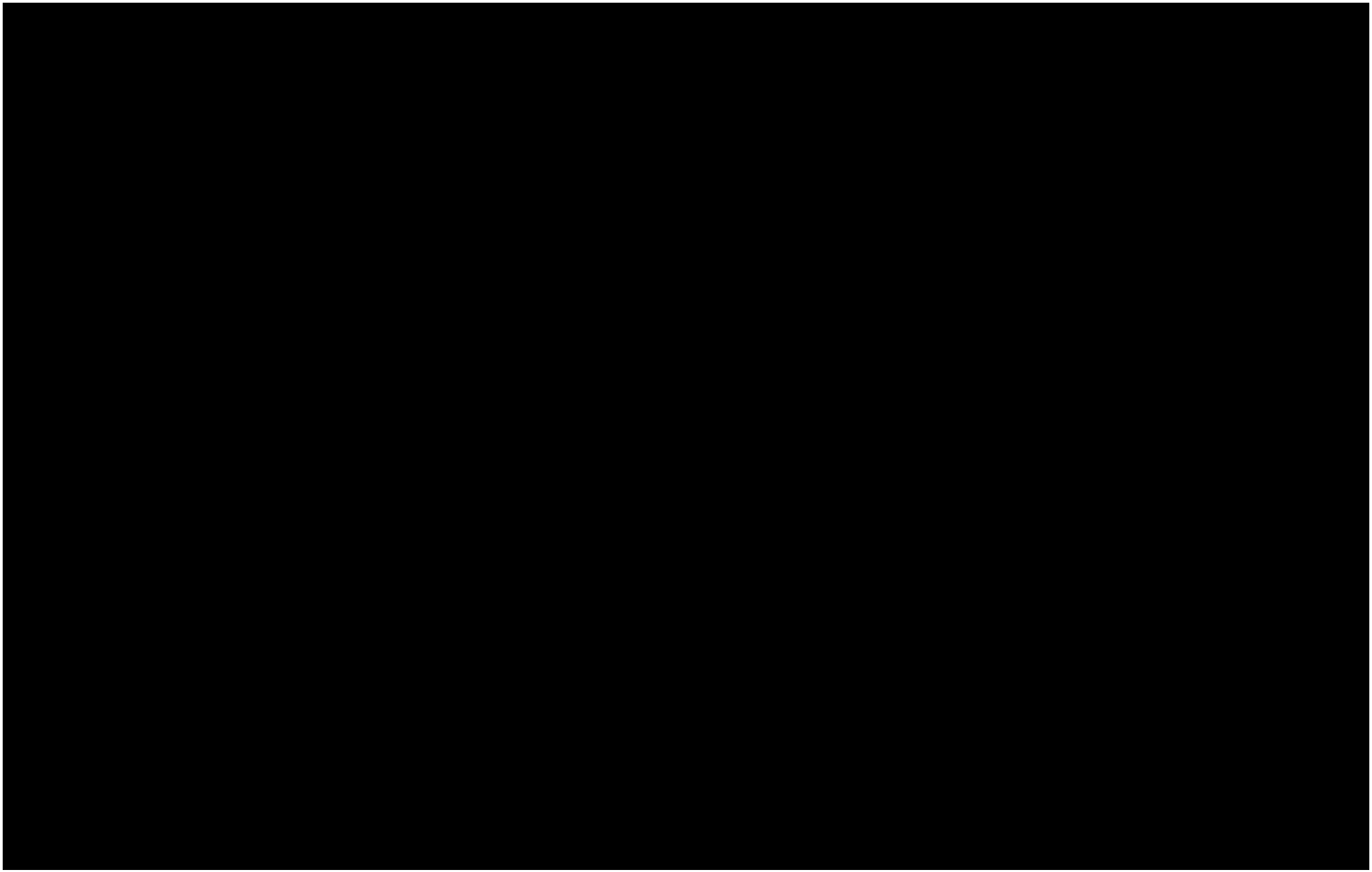
1) **Highest:**
   a) [redacted]

2) **High Priority:**
   a) New AAPA submission covering proposed activities within the existing cleared "Subject Land 2" [redacted]

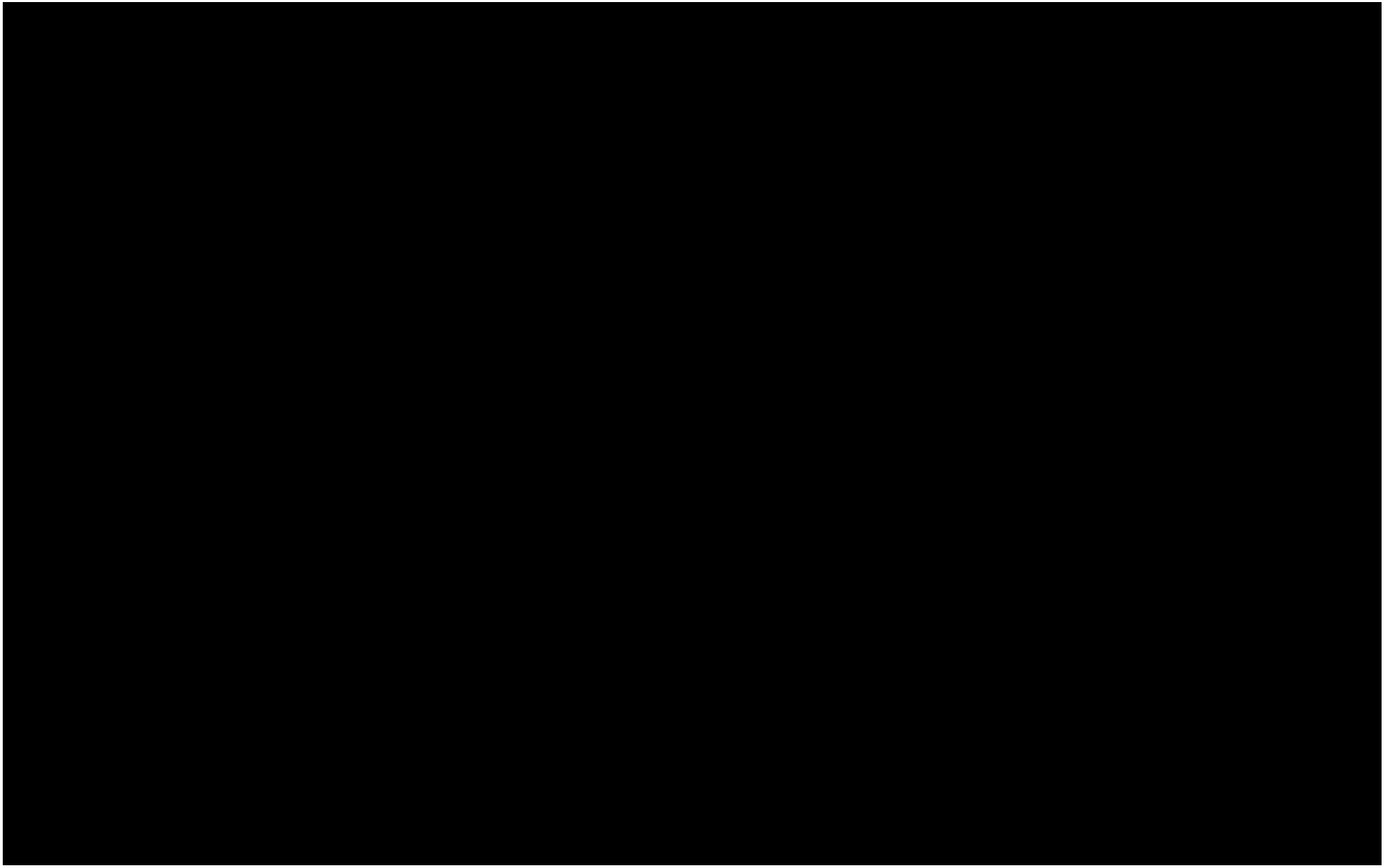
3) **Moderate/BAU priority:** [redacted]

2023 Work Program Update and Sacred Site Clearance Request

Table 2 Summary of NTH engagements requested for CY 2023, with indicative, tentative timing assumptions or preferences.



2023 Work Program Update and Sacred Site Clearance Request



2023 Work Program Update and Sacred Site Clearance Request

2023 Work Program Update and Sacred Site Clearance Request

4.1 AAPA certificate application - existing cleared areas

[redacted]

4.2 New Clearance Area request

[redacted]

1. **Appraisal gas within "Subject Land 5"**

The proposed 2023 sacred site clearance request within Subject Land 5 is designed to allow the future

[redacted]

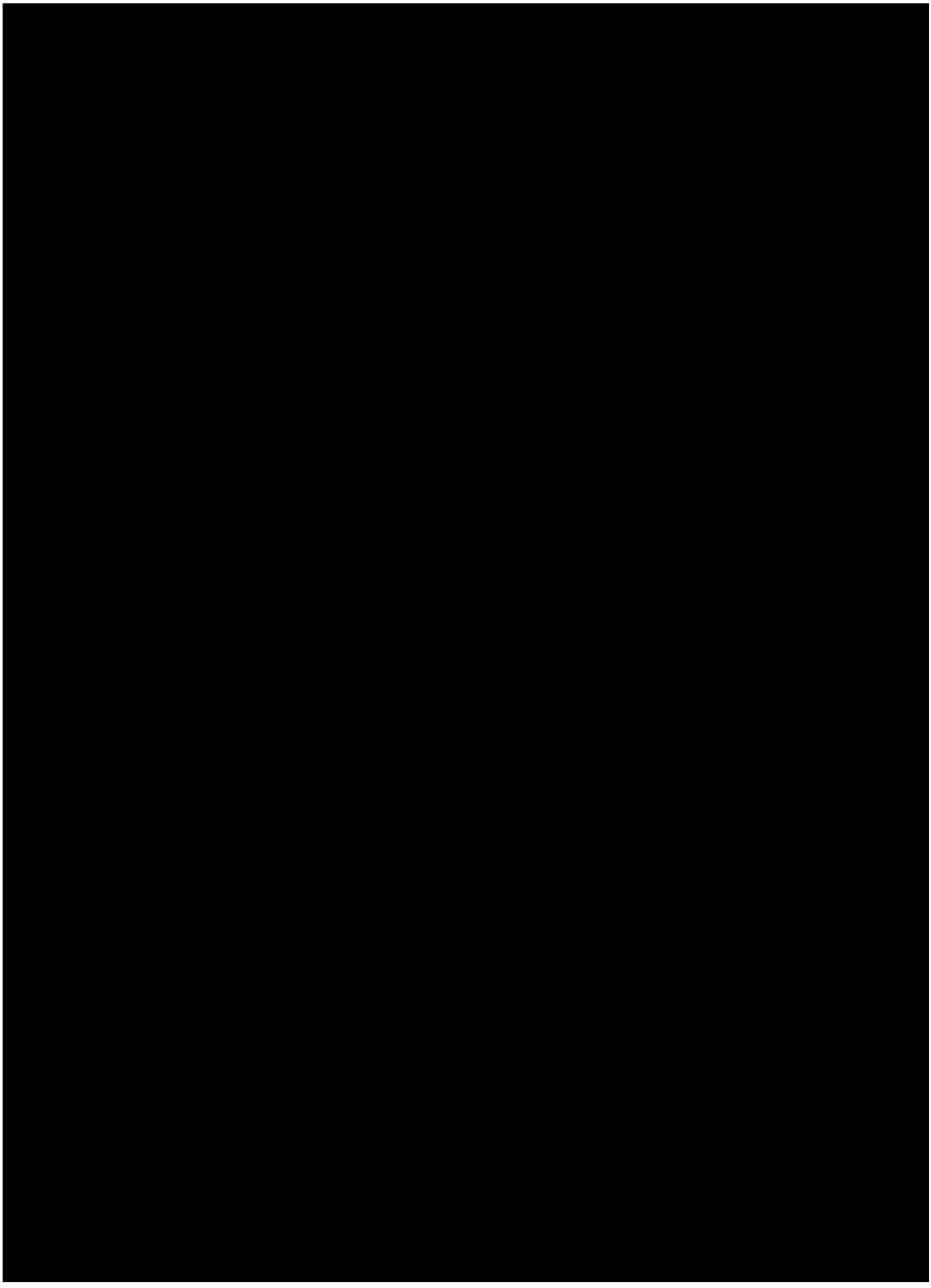
2023 Work Program Update and Sacred Site Clearance Request

[redacted]

2. **New Clearances for Shenandoah South and Amungee NW Extension Area**

[redacted]

2023 Work Program Update and Sacred Site Clearance Request



2023 Work Program Update and Sacred Site Clearance Request

2023 Work Program Update and Sacred Site Clearance Request

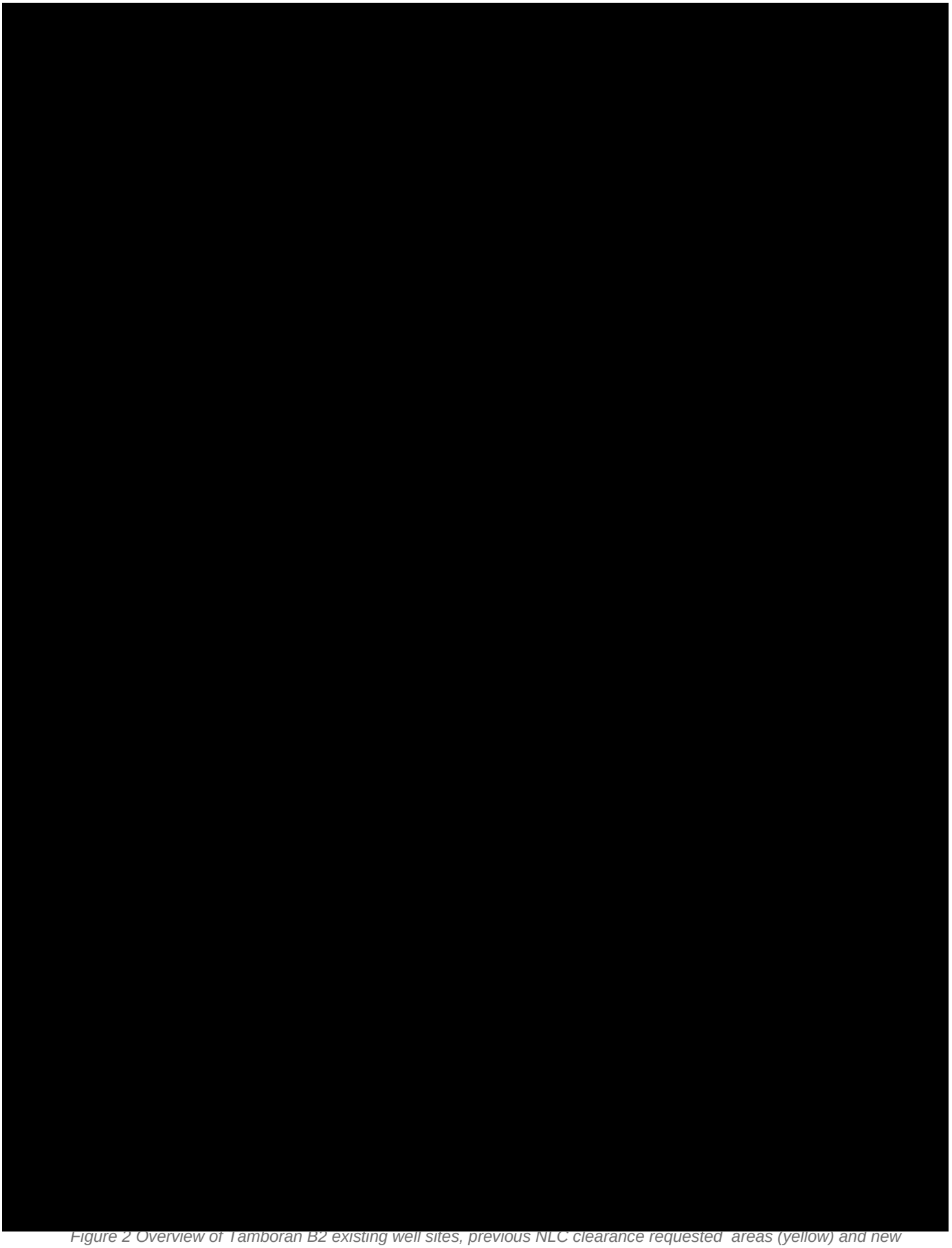
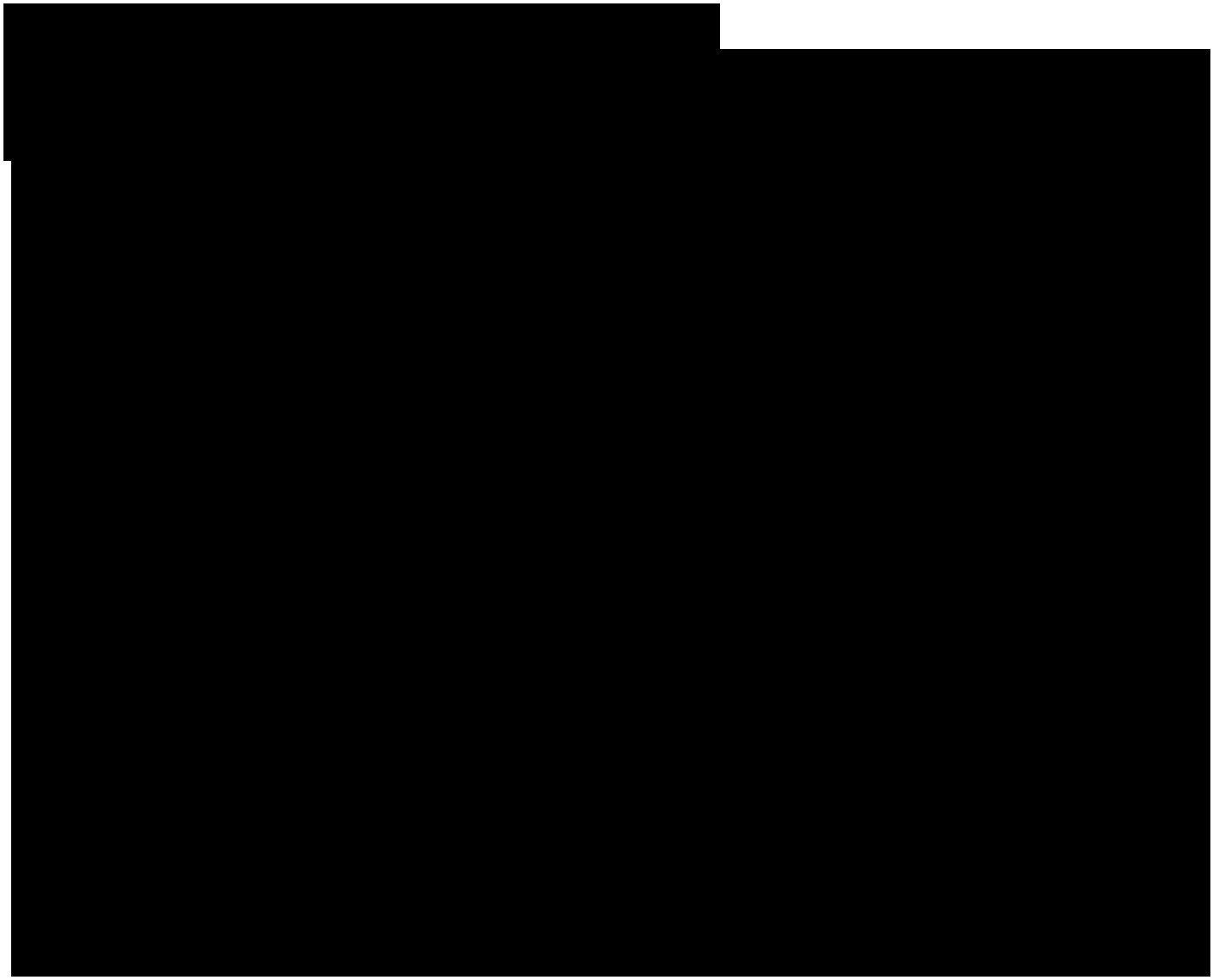
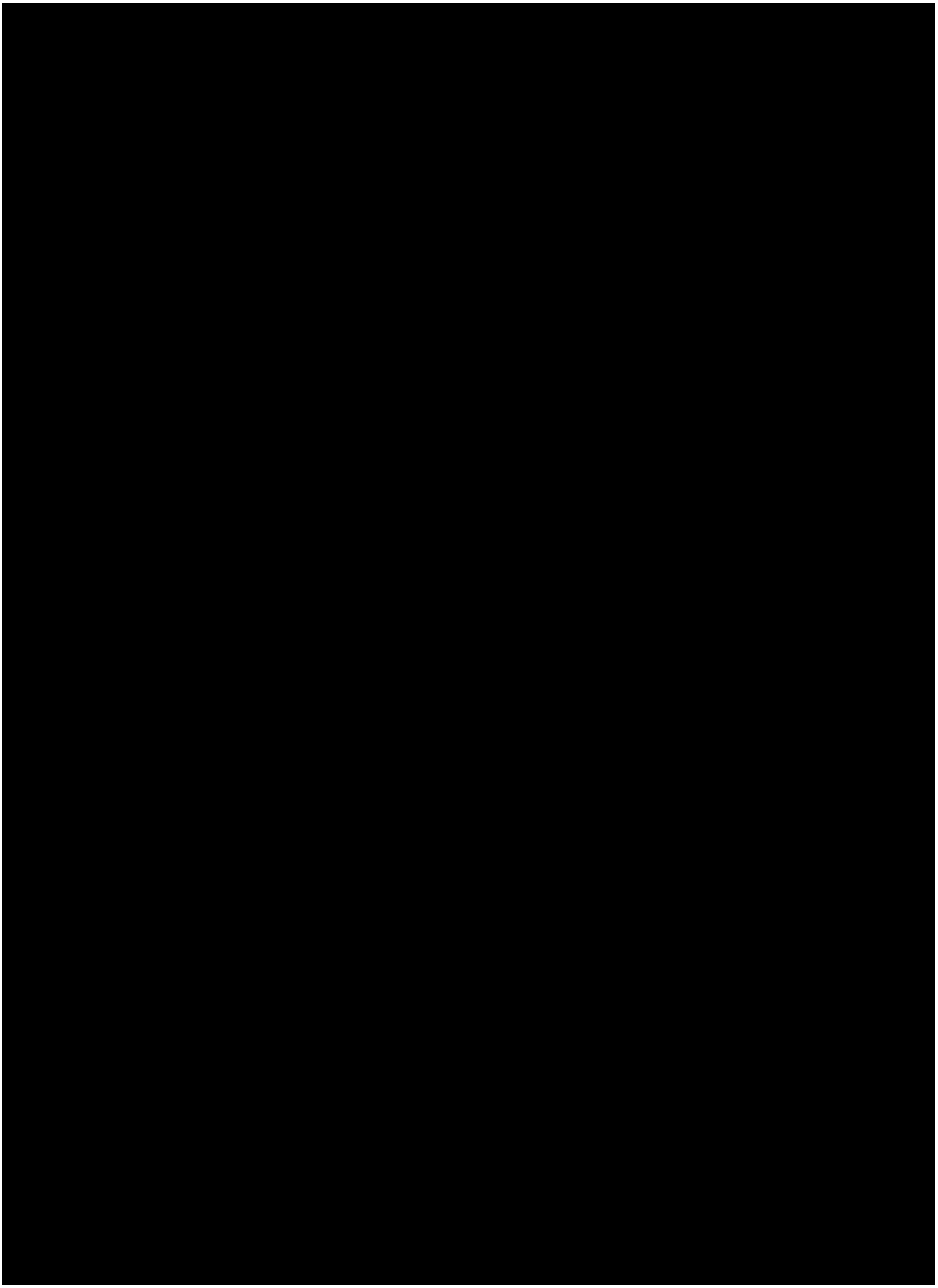


Figure 2 Overview of Tamboran B2 existing well sites, previous NLC clearance requested areas (yellow) and new request areas

2023 Work Program Update and Sacred Site Clearance Request



2023 Work Program Update and Sacred Site Clearance Request



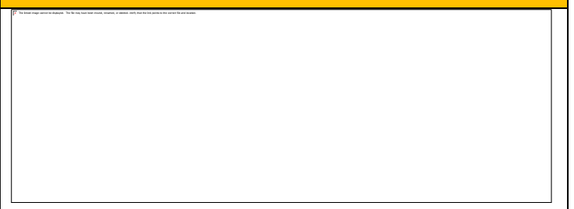
APPENDIX A Detailed description of regulated activity

The following table provides details of the proposed exploration activities proposed **within the requested clearance areas**. These descriptions are indicative and general in nature, minor departures from such descriptions are likely to occur and such departures are covered as much as practicably possible by the content of this activity description.

Table 3 Description of proposed regulated activity details within the clearance areas

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Site selection and scouting The first step of the process when undertaking exploration activities is site selection. Proposed E&A 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 (including for other infrastructure such as pipelines, access tracks, gravel pits etc.), each site is assessed for suitability using a multi-criteria analysis. This analysis covers several 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 several different specialists with a “scouting party”. Scouting activities include: • NLC field clearance: Tamboran B2 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/areas 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,	N/A	2-6	During activity planning.	<4 weeks	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
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.					
Access track construction Access tracks will be constructed to connect the proposed infrastructure to existing roads. Tracks will generally be constructed to at least NT Standard Drawings (CS3003) for Typical Cross Section for Rural Environment – Pastoral Access Road 2. Where possible access tracks will align with the existing seismic lines or other clearances/disturbances to minimise vegetation clearing. Access tracks 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 access tracks in places to enable all weather access. Where access tracks intersect with main roads (such as the Stuart Highway), intersections 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	First activity required to enable civil construction and drilling.	Access tracks are likely to be continually maintained and surfaced throughout the life of the activity	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Seismic consists of the following: 650km^2 of seismic acquisition will be undertaken. **Dynamite charges - minimal disturbance approach** Where possible surveys will be undertaken using dynamite to minimise the clearing of vegetation. In such surveys, vegetation clearing will be restricted to extremely dense vegetation where site access is otherwise prevented. Charges are typically 0.5-2kg and are installed to a depth of approximately 10-15m underground using a small ATV/4WD mounted auger. All charges and detonators are handled by licensed shotfirers. The charges are tamped and secured into place to prevent surface blow-outs and unlicensed interference. During the seismic recording the charges are detonated by a licensed shotfirer with no surface disturbance occurring. The detonated charge generates a “dull thud sound” which can be heard within 2-4km radius and felt within a 200m radius (typically) **Low Impact Source – AWD (Accelerated Weight Drop) or similar** A low impact source, such as an AWD, may be utilised as a standalone source option in suitable locations, or in combination with dynamite, or as infill in areas of restricted access. This type of source has a small surface footprint generally requiring no vegetation clearing for access. Source points are more densely spaced than larger sources such as dynamite and vibroseis trucks and may be in the order of 5-10m along a line. **Vibroseis or similar** If the seismic energy source is Vibroseis truck(s) then line clearing will be required so that the vehicles can drive and operate over the survey area. Source lines will need to be cleared every 200-400m for a 3D survey or on a sparser grid for a 2D survey. Existing cleared areas will be utilised where possible to reduce disturbance. line location tolerances utilised for avoiding vegetation, cultural heritage sights and infrastructure.. Seismic lines will be planned 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:** When required for access or source points in tough terrain surveyors mark the ground with either biodegradable paint or temporary stakes . Line detours may also be marked with temporary biodegradable flagging. A survey team in a light 4WD vehicle, ATV, or on foot 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. Recording is generally restricted to daylight hours. Geophones are deployed at regular intervals along lines perpendicular to the source lines for a 3D survey and along the source line for a 2D survey. The geophones are autonomous nodal receivers that can be readily carried by hand or small ATV and as such no line preparation is generally required for the deployment of the geophones. Once the required number of geophones are deployed each source point is activated in a pre-defined sequence and the energy generated is recorded by the geophones. The activation methodology of the source point will differ depending on the source energy type i.e. dynamite, AWD, vibroseis. After the energy source is finished the geophones are collected and line rehabilitation and data analysis commence.	up to 500ha (noting minimal disturbance seismic will be prioritised to minimise clearaing with target clearing below 50ha)	6 to 35	Before or after exploration well drilling with the final time to be finalised.	3 – 12 weeks per campaign	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
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 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 control and impact groundwater monitoring bores 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 and tested at least 6 months prior to drilling (except for exceptional circumstances) and 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 typically utilise a water bore drilling rig to construct the bores, similar to the rigs 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 other viable water bearing formations if encountered.. 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 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	
Lease pad construction Each proposed lease pad will be constructed to accommodate exploration well drilling, stimulation, testing and ongoing wastewater storage and treatment; typically such pads will be less than 12 hectares. 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, well cellars, sediment ponds, bunds and other necessary earthworks 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.	7.5-12ha	<24 people	Prior to exploration drilling	2-8 weeks	

<table>
<tr><th>Activity description</th><th>Disturbance area</th><th>Typical personnel numbers</th><th>Timing</th><th>Duration</th><th>Activity example pictures</th></tr>
<tr>
<td>The well cellars will be constructed on the proposed lease to accommodate the wellhead equipment and blow-out preventer (BOP). The cellars are typically concrete- or steel-lined and prefabricated off-site. The cellars are typically 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..</td>
<td></td><td></td><td></td><td></td>
<td> </td>
</tr>
<tr>
<td>Gathering and main pipeline Construction

Each lease pad may be connected to a centralised processing facility via a gathering pipeline. The gathering pipeline will be constructed to transport both gas and water to/and from a pad. Gathering pipelines will be constructed in a cleared right of way of approximately 25m wide.

If the beneficial use of gas is approved, to allow the avoidance of the majority of flaring, appraisal gas would likely be sold into the domestic gas market via a high-pressure main pipeline constructed to connect processing facilities to the existing Amadeus Gas Pipeline or McArthur River Mine Pipeline (MMRP). Pipeline corridors will be typically up to 50m, with the exact route and length dependent on final site selection.

Construction for the gathering and main pipelines generally include the following activities:

Pipeline Construction
<table>
<tr><th>Stage</th><th>Description</th></tr>
<tr><td>Location</td><td>An initial route selection study will be conducted for the pipeline in order to optimise the pipeline route to connect to the Amadeus pipeline. Further fine-tuning and route refinement will continue throughout the planning phase of the project to ensure the route does not interfere with any sacred sites, cultural heritage or environmentally sensitive features.</td></tr>
<tr><td>Pipe</td><td>The gas transmission pipeline will be a buried, high pressure steel pipeline. It will be designed and constructed in accordance with the requirements of AS 2885 Pipelines – Gas and Liquid Petroleum. The pipeline will be buried for its entire length and will be deep enough so current land use activities can continue after the pipe has been installed. The minimum depth of cover over the pipeline will be 750mm. For road crossings the depth of cover will be increased to ensure protection of the pipeline and the asset or feature being crossed by the pipeline.</td></tr>
<tr><td>Early Works</td><td>In order to support the approvals and detailed design activities a number of activities take place prior to the main construction phases. Generally known as ‘early works’ , these activities include a range of field-based activities. These activities inform the Approvals and Design teams about field conditions and are often iterative, as additional identified information results in changes to aspects of the project scope requiring revisiting and rework of the project scope. These activities include but are not limited to general investigations, surveys for the pipeline, sacred sites, cultural heritage, environmental and soil & geotechnical.</td></tr>
<tr><td>Survey</td><td>The limits of the right of way (ROW) working width shall be marked with stakes at visible intervals.
A survey crew will work ahead of the initial clearance of vegetation from the ROW. This survey crew will utilise the project benchmarks to check</td></tr>
</table>
</td>
<td>25m to 50m wide</td>
<td>~15-50</td>
<td>Main Pipeline construction expected to start dry season 2024</td>
<td>3-6 months</td>
<td> </td>
</tr>
</table>

Activity description		Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
	and re-establish all agreed intersection points (IPs), mark the right of way boundaries and place offset/recovery pegs.					
Clear and Grade	To allow construction activities to commence, the pipeline alignment needs to be cleared of vegetation, rocks, trees, etc to provide mainline construction vehicles access. Clearing and grading shall be minimised to the extent necessary for the safe construction of the pipeline and shall in any event not exceed the maximum permissible width of the ROW except where additional working areas are defined and agreed. Light vegetation removed during clearing shall be stockpiled outside of the stripped ROW working area and will be respread during restoration unless the property owner requests that the vegetation be left as stockpiles.					
Pipe Transport and Stringing	Stockpiled pipe will be delivered to the ROW along the identified access tracks using prime movers and trailers. The specific logistics of the pipe haulage will be developed during the planning phase. The pipe trucks will only utilise specific access tracks which will be constructed (or upgraded) to allow them to pass. Pipe will be strung (placed on the ROW) directly from trailers onto saw dust filled bags or equivalent using a Vacuum lift pipe handler mounted on a hydraulic excavator, end hooks or slings depending on the pipe length and size, terrain. Strung pipe shall be supported clear of the ground and in a manner that will not damage the pipe or coating.					
Trenching	A trench is formed to accommodate the welded pipe strings and achieve the required depth of cover in accordance with the pipeline design. The trench shall be excavated along the surveyed and pegged centreline, in accordance with the minimum cover specified. Trenching operations are carried out utilising a combination of bucket wheel trenchers, rocksaws & 30T excavators. Accordingly, excavation plant, equipment and techniques will be selected to accommodate the anticipated conditions and required production rates. In areas of hard rock, controlled blasting using explosives may be required to break the rock to permit removal by excavator.					
Welding	Line pipe ends will be welded together (butt welded) to form pipe strings up to a typical length of 1km. The mainline welding crew is the engine room for the project's welding and sets the pace for mainline construction. The very agile and mobile poor boy crew carries out all difficult mainline welding sections and provides start joints for the mainline crew. Additional welding resources carry out all tie-ins and special crossings.					
Lower in, padding and backfill	The coated pipe shall be lowered-in using a series of side booms so the pipeline has adequate and properly distributed slack, the pipe is not unduly stressed, and the pipe coating is not damaged. Where the excavated material and the bottom of trench are free of material that could damage the pipe, the pipe shall be laid directly on the trench bottom. The excavated material shall be used directly for bedding and padding. Where excavated material does not meet the specification, padding machines (screening machines) or similar will be used to produce bedding and padding. The trench will be back filled using the remaining trench spoil (excavated material) following the padding operation. The trench is compacted by wheel and/or track rolling with the backfilling equipment. Areas requiring higher compaction, such as road crossings, will be undertaken with an excavator mounted vibrating plate or other suitable manually operated or driven compaction equipment.					
Reinstatement	The pipeline ROW will be reinstated which includes replacement of previously stripped topsoil and rootstock, installation of contour banks, reinstatement of fencing & install new gates and revegetation as necessary.					

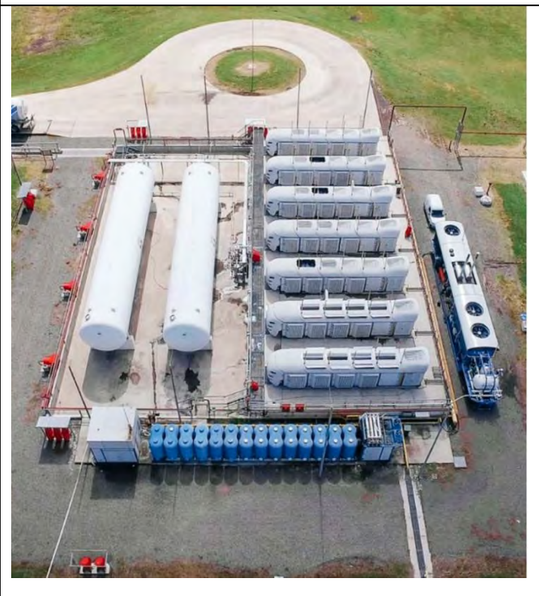
Activity description		Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
	Restoration of the ROW shall be completed in accordance with any easement agreements, Environmental Impact Statement, Construction Environmental Management Plan and regulatory requirements.					
Pipeline testing	The pipeline will be hydrostatic pressure tested to prove the strength and leak tightness of the installed pipeline. The hydrostatic testing will be conducted by a certified mechanical testing laboratory and all test reports are to be certified.					
Commissioning	The commissioning phase of the works can be broken into two components, pre-commissioning and commissioning. Pre-commissioning is the exercise of manually proving each component of the pipeline/facility system prior to the introduction of gas. Example testing includes: • Verification that all parts are installed as detailed on engineering drawings, including position, orientation, part numbers, etc • Hydrostatic testing (confirming the system is leak tight), cleaning (blow through with air and cleanliness checks), drying and blow-through of piping • Bolt torquing of flanged connections • Functional testing of all manual valves through full extent of travel • Functional testing of all actuators and control valves through full extent of travel • Earthing compliance checks • Instrument calibration and installation checks • Insulation, continuity and point to point testing of all circuits installed by the Contractor Following the pre-commissioning phase, the asset becomes ready for the introduction of gas.					
Camp pad construction and camp operation A camp pad will be constructed adjacent to each proposed lease pad to accommodate a temporary 70-100 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 (for 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. 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. 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 handling and irrigation will occur in accordance with the NT Department of Health requirements.		1.2-2.5ha	Typically <100 people (including housed staff)	For duration of activity	For duration of activity	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
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 tracks to store materials, wastes, wastewater, equipment and other material as required. The laydown yard will be fenced to prevent access. These are typically 2.5- 5ha in size, with allowance up to 25 hectares for multiple laydowns. Laydowns may also be utilised for temporary offices/workshops/field camps or warehouse infrastructure support E&A and construction activities. 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).	25ha	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) may 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). 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.	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
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 Multiple petroleum exploration wells are proposed to be drilled at each site (typically 6-8 but potentially more where multiple formations are targeted). Wells may be drilled in stages (i.e. 1 or 2 at a time) or progressively (i.e. 8 wells drilled over a single campaign). Each well will be drilled into an underlying prospective petroleum reservoir (such as the Velkerri shale, Kyalla shale or other formation) to a typical depth of 1500m-4000m. Each well will be deviated into the horizontal position, with a lateral drilled up to 5000m (please note the depth and lateral length may change based on operational requirements and technological advances). 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 as per NT drilling regulations. 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, formation integrity 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	N/A located on proposed lease pad	<60 people	Post civil construction	Typically 45 - 90 days per well	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
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 (or equivalent tanks or fit-for-purpose containers). Once drilling has been completed, this material will be sampled and tested as per the code of practice and a 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 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, hydraulic fracturing stimulation (HFS) plant and equipment (commonly referred to as a “frac spread”) will be mobilised to site to commence HFS (or stimulation) activities on each of the drilled wells. A frac spread typically 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 (for frac fluids) 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 to 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	N/A located on proposed lease pad	<50 people	Post E&A well drilling	2- 8 weeks per well depending on stimulation size	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
perforation deployment • Ancillary support equipment and 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 (raw water or a mixture of raw water and recycled flowback wastewater) and sand (proppant), plus a small percentage of chemicals at high pressure into the target section of the horizontal wellbore. Typically, >90% of the total volume of stimulation fluids is a combination of water (fresh and recycled wastewater) 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 tests and an integrity report generated, which is submitted to and assessed by the regulator prior to the commencement of stimulation activities. The stimulation fluid is generated through mixing freshwater, recycled flowback, chemicals and sand in blenders. Stimulation fluid is then 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	

<table>
<tr><th>Activity description</th><th>Disturbance area</th><th>Typical personnel numbers</th><th>Timing</th><th>Duration</th><th>Activity example pictures</th></tr>
<tr>
<td>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
The E&A 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 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 either flared, sold (piped or compressed/liquified and trucked) or beneficially used onsite to reduce greenhouse gas emissions where possible.</td>
<td>N/A located on proposed lease pad</td>
<td><12 people during production testing</td>
<td>During exploration activities</td>
<td>Typically 30 days to 24 months.</td>
<td> </td>
</tr>
<tr>
<td>Appraisal gas sale
To minimise flaring during the production testing phase of the wells Tamboran will be developing facilities and a pipeline to enable this gas to be captured rather than flared. This is anticipated to reduce appraisal emissions by approximately 90%.
Options are currently being assessed with a priority on speed of installation to limit flaring and economic affordability.
The initial solution is likely to be a Compressed Natural Gas (CNG) or mini Liquified Natural Gas (LNG) facility to enable gas treatment, compression and truck loading of the CNG or LNG so the gas can be delivered to and injected into either the AGP or the McArthur River Mine Pipeline and to any customers seeking truck deliveries of CNG/LNG as a fuel or diesel alternative. This approach is commonly used around the world for initial production gas or virtual pipeline supply, however it is limited in the amount of gas it can capture. Local generation and power consumption for a data centre on site is another possibility for this initial gas but again will be limited in capacity.
In parallel, initial treatment and compression facilities will be developed to compress the gas into a new pipeline connection to the AGP. This will enable all the extended production gas to be captured and flaring stopped.
Appraisal gas facility construction
<table><tr><th>Stage</th><th>Description</th></tr></table></td>
<td>9 Ha</td>
<td>< 10 people operating and <50 people during construction</td>
<td>Upon completion of well testing- potential 2024.</td>
<td>Until Production Licence</td>
<td>  </td>
</tr>
</table>

Activity description		Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Mobilisation	Establishment of access track into site and site offices and amenities, laydown areas, erosion and sediment controls installation as per the requirements of the approval management plans, site communications links and construction set out survey.					**Figure 4 Example facility – the Buquebus LNG Facility in Buenos Aires Argentina**
Earthworks and Civil Works	Preparation of top soils and sub-fill for establishment of foundation – including excavation and removal of unsuitable fill materials from site, import of required sub-grade fill materials, grading and levelling of the facility pad and final capping and import of road base materials to design specification. Works **may** also include **ongoing up**grading of **existing** access track**s**.					
Underground Services	Trenching of facility pad as required to install buried services and piping, backfill and compaction of trenches, including installation of crossing reinforcement for protection of buried services in trafficable areas.					**Figure 5 A truck mounted compression facility**
Piling	Installation of steel pile foundations by driving into the prepared facility pad and/or pre-drilling as required and welding of pile caps onto piles in preparation for skids to be landed.					
Structural Mechanical and Piping	Installation of pre-assembled skidded pipe rack modules onto foundations requiring lifting onto pile caps and welding in place, bolting flanges to connect interfacing skids and equipment packages, installation of site run utilities piping, lifting and welding in place of skidded equipment packages.					
Electrical and Instrumentation	Installation of cables and cable supports, ladders and trays, termination of cables into relevant panels (control and low voltage), installation of tubing and glanding of instruments, mounting instruments onto piping or instrument stands.					
Plant Commissioning	**This stage involves the testing and commissioning of all equipment on the site, in preparation for operations.**					

A range of temporary facilities will be required during construction. These may include work areas for equipment and pipe, storage and lay down areas, and a site office.

The location of the temporary facilities will be primarily based on logistical requirements. This will include ensuring facilities are located at a suitable distance from watercourses, are not endangered by threat of flood, do not require clearing of sensitive vegetation and are managed in such a way as to ensure no long-term land contamination issues.

Typical manning during operations is <10 people. During construction, ~50 people may be required. These are indicative numbers with the final manning levels will be finalised during the activity planning.

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Wastewater tank storage Flowback and drilling wastewater will be stored one each location or piped to a centralised location for storage via gathering lines. Wastewater will be recycled within the drilling or stimulation process to reduce raw groundwater volumes. Wastewater not earmarked for recycling will be treated on site via evaporation within open tanks (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. Wastewater storage tanks may be deployed for extended periods of time (potentially several years) 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 Tamboran infrastructure footprint (such as lease pads or laydown yard) to reduce the amount of offsite wastewater trucking.	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
Flaring During well testing and where gas cannot be beneficially used or sold (such as during facility downtime etc.) , produced hydrocarbons (gas and liquids) will be flared onsite, 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.	
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.	N/A- within proposed lease pad	< 6 people	Upon completion of drilling activities	7 days	

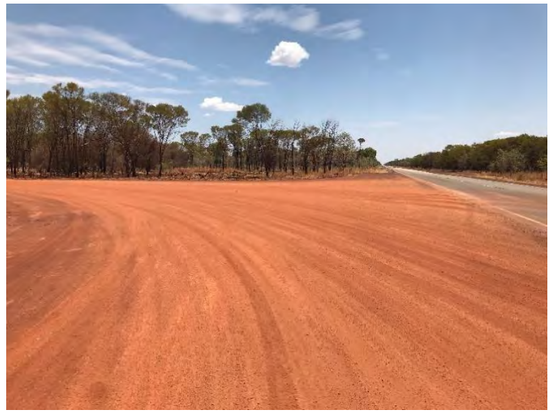
Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Wet season operations Exploration activities (including drilling, stimulation and well testing operations) may occur over the wet season. Where wet season operations are undertaken the following 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 wet season significant rains (notionally December or as predicted) • 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 the access to the site is safe. • Wastewater storage area is bunded, which will prevent all off-site release of chemicals and stormwater. • During flowback wastewater storage, stormwater will be retained on-site via the sediment retention pond prior to release. • Overland flow will be diverted around lease pads as far as reasonably practicable.	N/A	N/A	October – May	7 months of the year	
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.	Minimal	3-9 personnel.	Deployment of Geophones before stimulation. Retrieval of Geophones after stimulation.	1 month (one week deployment, two weeks Stimulation, one week collection)	

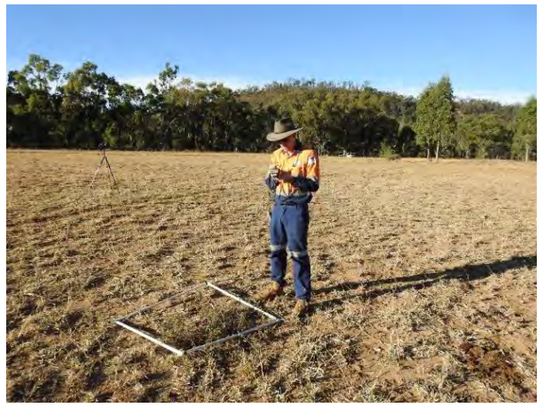
Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Induced Seismic Monitoring will be undertaken at the same time as the Microseismic monitoring. A temporary seismic receiver is installed ~1km from the well site, with a small amount of other equipment 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. Minimal clearing or heavy machinery is required for either activity, and the activities are considered to have a minimal impact, like that of scouting activities.					
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/ Tamboran 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/ Tamboran 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 Tamboran 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 Tamboran 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 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	
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.	

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 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 per day 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 be licenced under Tamboran's existing Water Extraction Licence (WEL) GRF 10285. A new WEL may be submitted to increase the water take and/or covering take an alternative formation where present. It is anticipated that groundwater extraction volumes to support this program will be in the order of 250-600ML per year (conservatively) , primarily used for civil construction, drilling and to stimulate the E&A wells. Once drilling and stimulation has ceased, minimal ongoing water extraction from the site will be required. Where possible, recycled flowback will be utilised within stimulation to reduce raw water usage.	N/A	N/A	Ongoing to support exploration activities.	During exploration activities	
Traffic management Access to the site will be via a combination of existing and new access tracks, located approximately 15-20km South of Dunmarra on the Stuart Highway. Minor traffic disruptions may occur during the construction of the access track intersection with the Stuart 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/appraisal gas sale (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	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Site rehabilitation Within 6 months of the E&A wells being plugged and decommissioned, a 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	 

Appendix B 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 4 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, produced water, or hydrocarbons (liquid and gaseous) from suspended or abandoned wells to groundwater due to well design and integrity management. • Low risk of leaks from gathering lines, with gathering lines constructed as per Australian Standard, leak detection in place to identify pipeline failures and routine inspections completed. • 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	• 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, 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 • Gathering lines and pipelines constructed as per Australian standard, leak detection in place to identify pipeline failures and routine inspections completed. • 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 being added to WEL. • All water take to be metered and reported quarterly to the regulator • No pastoralists groundwater bores within 1 km of each proposed site • Flowback to be preferentially used in stimulation fluid to reduce raw water usage.

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			• 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 WEL).	
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 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 preferentially located in existing disturbed area, with no sensitive soil types present in the immediate vicinity. • Low risk of reduction in land productivity from poor rehabilitation due to mandatory rehabilitation requirements and security bond requirements • Low risk of pipeline subsidence creating erosion	• 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 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 demonstrated as ALARP and acceptable. • Site to be rehabilitated back to pre-existing/ agreed state with pastoralist input. • Pipeline monitoring and repair work to minimise/ respond to pipeline subsidence

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
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 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, • Low risk of air emissions created by gas fired compression • Low risk of greenhouse gas emission impacts from appraisal gas sale/ well testing (climate change)	• 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 where practicable • Outside of high intensity activities (such a s civil construction, drilling and stimulation) 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, 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 and equipment, with annual inspections on pipelines • Low NOx and Low CO gas fired compression/ power generation utilised to minimise air emissions. • Appraisal gas will be beneficially used through sale of CNG/LNG/ piped natural gas to reduce flaring and minimise flaring to reduce scope 1 and 2 emissions.
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 gathering pipeline failure and release of flowback • 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	• No take of surface water permitted or proposed • Lease pad located away from watercourses- typically 1km or greater • 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) • 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 be operated with a 1:1000Annual re-occurrence interval (ARI) wet season or dry season (whichever is

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			contaminating surface water due to stormwater segregation and testing procedures. • Low risk of infrastructure (including pipeline) 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. • Low risk of gathering line failure releasing flowback fluid to the environment	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 gathering lines to be welded as per Australian Standards, hydrotested during construction to verify integrity prior to being brought into service • Gathering lines to utilise flowmeters/ pressure monitoring to identify leaks (such as flow/ pressure drops) • Gathering lines to be inspected 6 monthly to identify subsidence/ potential integrity issues. 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 • Avoid the introduction of weeds • Avoid the spread of existing weeds • Minimise the loss of pastoral productivity	• Clearing of vegetation communities (such as Open Corymbia/eucalypt woodland, Bullwaddy and/ or Lancewood) to support 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	• 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 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 – fauna mortality	• Seismic activities to: o avoid clearing of mature trees and protected flora o In open woodlands, limit clearing to grasses and shrubs o Maintain viable root stock to promote rapid rehabilitation o No seismic lined in riparian o 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 inspected and certified weed free prior to entry • 6 monthly weed inspections to be completed with all identified weeds treated.

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			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.	• 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 night during flaring or from activity lighting. • Noise impacts from helicopter movements • Noise and vibration impacts during seismic activities.	• 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 noise, dust, light and vibration impacts associated with temporary appraisal gas facility	• Sites located away from homesteads and local communities • Flaring to be minimised to avoid light generation • 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. • Compression/ power generation/ CNG/ LNG facilities to be designed to minimise aesthetic impacts and located away from homesteads and local communities. • Lighting of infrastructure designed to minimise aesthetic impacts during the evening •

Appendix N.1.2 16 230421 Email

On 21 Apr 2023, at 5:44 pm, [redacted] wrote:

Hi Emily

Figures 2 and 3 appear to be missing from the revised work program that Matt Kernke emailed me (see attached).

Would you be able to include those figures and resend.

Regards

[redacted]
Senior Lawyer (Resources & Energy)
Northern Land Council

NORTHERN LAND COUNCIL
Our Land, Our Sea, Our Life

[redacted] | Website: www.nlc.org.au

From: Matt Kernke [redacted]
Sent: Monday, 27 March 2023 10:37 AM
To: [redacted]
Cc: Tamboran Contact [redacted]
Subject: Revised 2023 work program- inclusion of Shenandoah Nth A

Dear [redacted],

As discussed during last week's operators meeting, please find attached a copy of the revised work program with the inclusion of Shenandoah North A within the 2023 proposed activities. I have also provided an updated map within the document which illustrates the locations of the proposed activities (figure 1).

Shenandoah North A is located on the Shenandoah East Pastoral Station, approximately 25km North of the existing Kyalla 117 N2 site.

The new location is within Subject land 1- which has a conditions of work report completed. The proposed new clearances remain unchanged.

Please let me know if you require any further information.

Kind Regards
Matt

Matt Kernke
Environment and Approvals Manager

tamboran
RESOURCES

[redacted]

Disclaimer

The information contained in this communication from the sender is confidential. It is intended solely for use by the recipient and others authorized to receive it. If you are not the recipient, you are hereby notified that any disclosure, copying, distribution or taking action in relation of the contents of this information is strictly prohibited and may be unlawful.

This email has been scanned for viruses and malware, and may have been automatically archived by **Mimecast Ltd**, an innovator in Software as a Service (SaaS) for business. Providing a **safer** and **more useful** place for your human generated data. Specializing in; Security, archiving and compliance. To find out more Click Here.

Appendix N.1.2 17 230509 AAPA application document

From: Emily Beresford-Cane [redacted]
Sent: Tuesday, May 9, 2023 2:53 PM
To: [redacted]
Cc: Matt Kernke [redacted]
Subject: AAPA application document

Dear [redacted]

Further to our recent meeting, please see attached AAPA Application for Subject Land -1 (Shenandoah A and E&A site).

Tamboran submitted this application to AAPA in April and we are anticipating AAPA will send the NLC correspondence in the coming days/weeks - similar to the recent correspondence on the Kyalla 117 application.

We will also be in a position to get back to the NLC shortly on Tamboran's preferred clearance schedule.

Please let Matt or I know if you have any questions.

Kind regards

Emily
[redacted]

AAPA Authority Certificate Request- Subject Land 1 (Shenandoah North A)

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

Version:	**1.0**
Submitted:	April 6 2023
Presented by:	Tamboran

CONTENTS

1	Introduction	3
2	AAPA Certificate Request Scope	3
3	Request Area	4
4	Supporting information	4

1 Introduction

Tamboran B2 Pty Ltd (ABN 42 105 431 525) (*Tamboran*) holds a 77.5% ownership interest in Exploration Permits (EP) 76, 98 and 117 (the Permits) under the Beetaloo Joint Venture (JV) with Falcon Oil and Gas (the Beetaloo JV). Tamboran B2's *Northern Territory Government work program commitments* require the completion of ongoing exploration and appraisal (E&A) activities as a condition of approval. Since 2015, the Beetaloo JV has drilled eight (8) wells in the Beetaloo Sub-basin (Beetaloo). These include Kalala S 1, Beetaloo W 1, Amungee NW 1, Amungee NW 1H, Kyalla 117 N2 1, Kyalla 117 N2 1H, Velkerri 76 S2 1 and the recently drilled Amungee NW 2H (December 2022).

As a part of its Calendar Year 2023 work program (***work program)***, Tamboran B2 is proposing to undertake a range of additional exploration and appraisal activities across its tenure to test the technical and commercial viability of the Velkerri formation. This includes the civil construction of a new exploration location and the drilling of a vertical exploration well on EP 98, within the "Subject Land 1".

In 2019, Origin Energy B2 Pty Ltd (which was acquired by Tamboran B1 Pty Ltd in 2022 and renamed to Tamboran B2 Pty Ltd) submitted a clearance request for 3 proposed well sites within "Subject Land 1". The Northern Land Council (NLC) issued a Conditions of Work report for the proposed activities in October 2021.This application proposes to seek an Aboriginal Area Protection Authority (AAPA) clearance certificate for a subset of exploration activities within "Subject Land 1" to support Tamboran's ongoing exploration program.

Tamboran requests that an Authority Certificate is obtained via agreement in accordance with s22(1)(b) of the Northern Territory Sacred Sites Act. The agreement forming the basis of this Authority Certificate application are:

- Exploration Agreement: Exploration Permit Application 117 - Borroloola Barkly Region, Northern Territory between Sweetpea Corporation Pty. Ltd. and the Local Aboriginal Groups and the Northern Land Council, as executed by tripartite deed on 23 November 2005;
- Exploration Agreement: Exploration Permit Applications 98 & 99 and Exploration Permit 76 - Borroloola Barkly Region, Northern Territory between Sweetpea Corporation Pty. Ltd. and the Local Aboriginal Groups and the Northern Land Council; as executed by tripartite deed on 24 November 2003.

2 AAPA Certificate Request Scope

Tamboran is submitting this application for an AAPA certificate to cover all works associated with the following exploration scope within the defined clearance area:

a) Upgrade, use and maintenance of existing pastoralist tracks
b) Construction of up to approximately 5 hectares of gravel pits within cleared area to support civil construction and maintenance activities (including preliminary excavation activities at potential locations to determine appropriate material can be extracted)
c) The civil construction of a single exploration well pad, including construction and use of access tracks, exploration well lease pads, camp pads, storage yards, fence lines and firebreaks.
d) Construction of groundwater monitoring and extraction bores, including the utilisation of water to support exploration activities.
e) Drilling- vertically to a depth of no greater than approximately 4000 metres (4 kilometres), including formation logging, coring, diagnostic fracture injectivity testing (DFIT), and all activities associated with the collection of formation data and maintenance of well integrity
f) Plugging, abandonment and/or remediation of wells after data acquisition and monitoring has been conducted
g) Rehabilitation and remediation of site
h) Any other minor works ancillary to the abovementioned works including operation of camps, laydown areas, chemical and fuel storage, waste management, routine ongoing maintenance and repair of any infrastructure and/or services.

3 Request Area

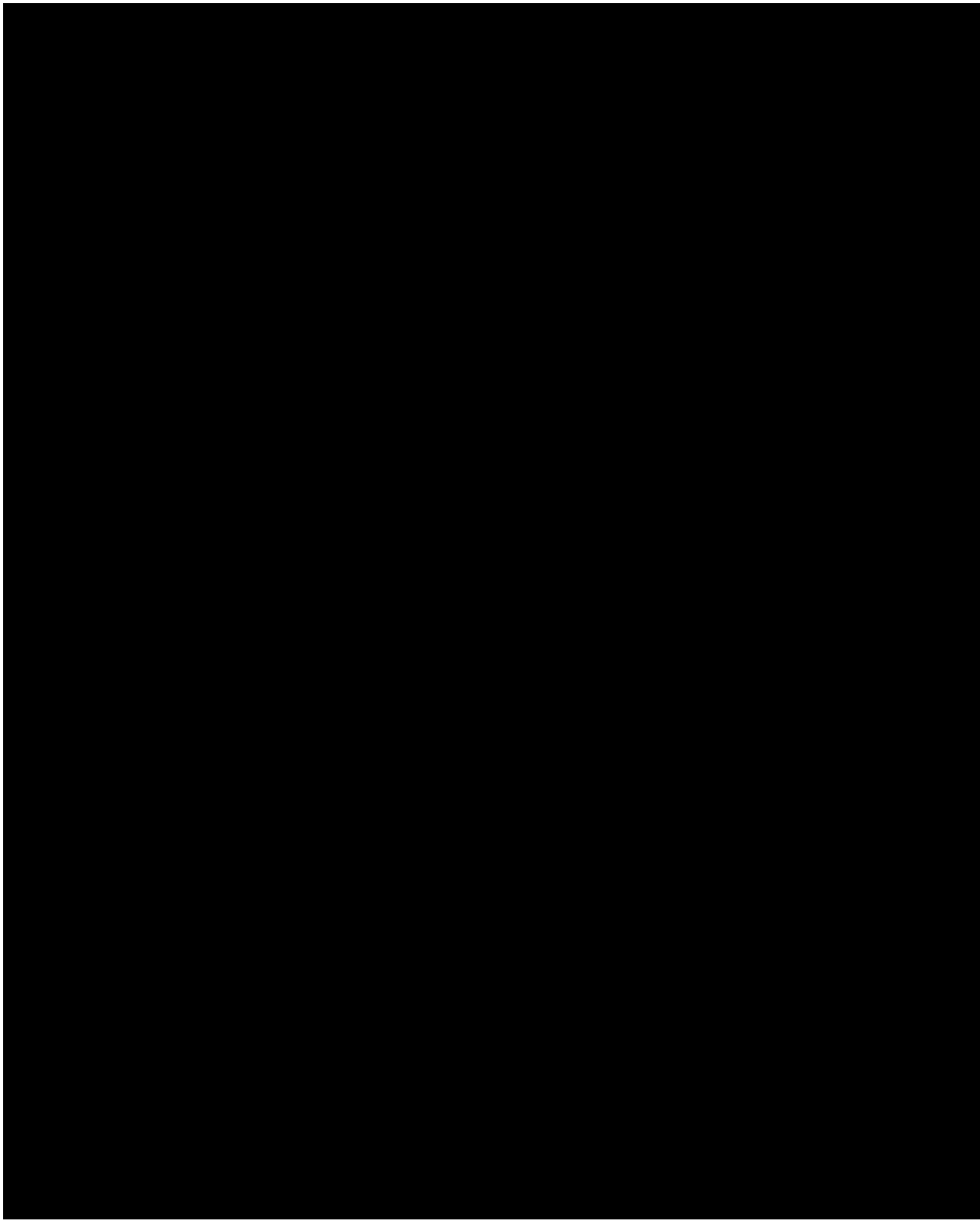
The spatial files for the requested area are provided with this application.

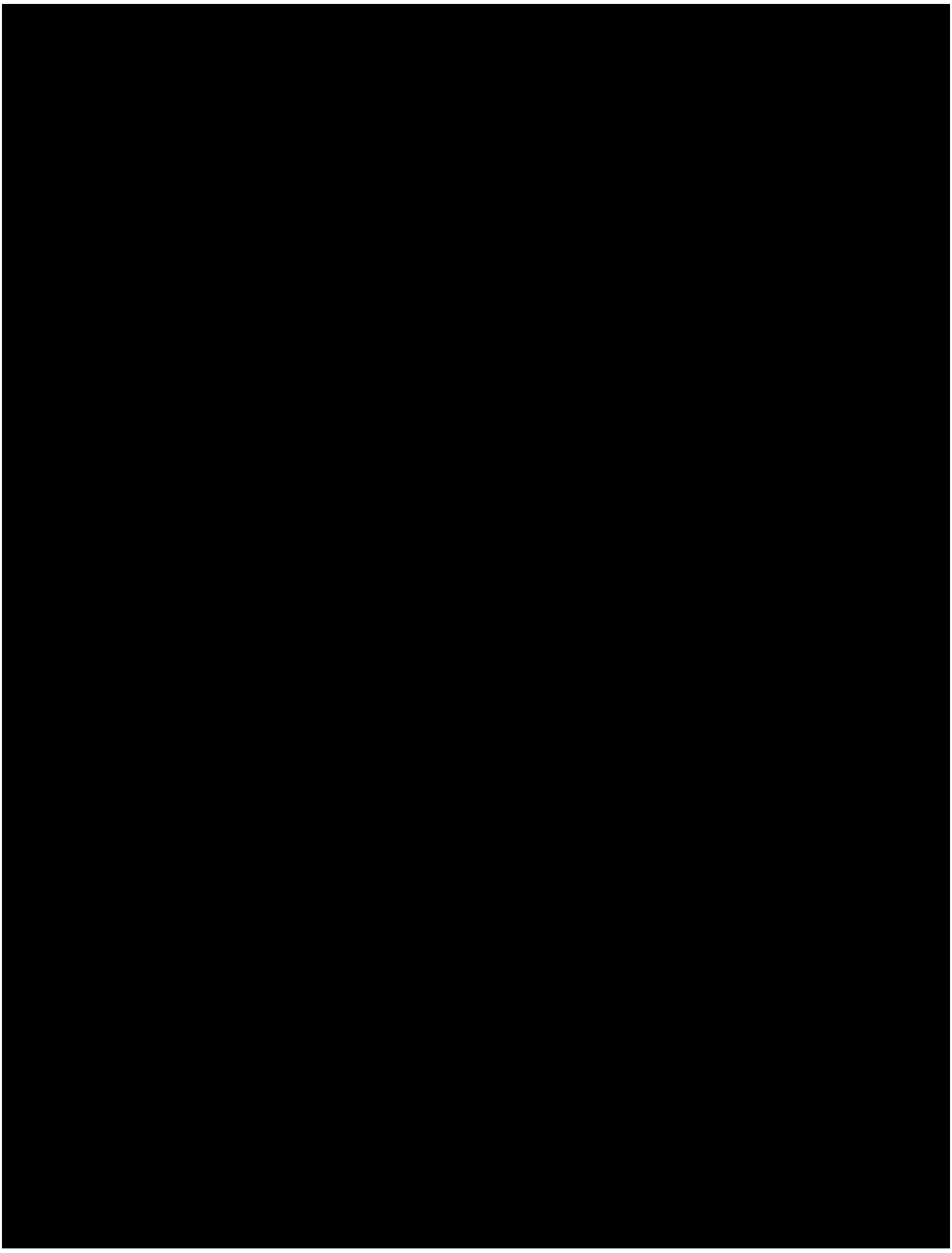
4 Supporting information

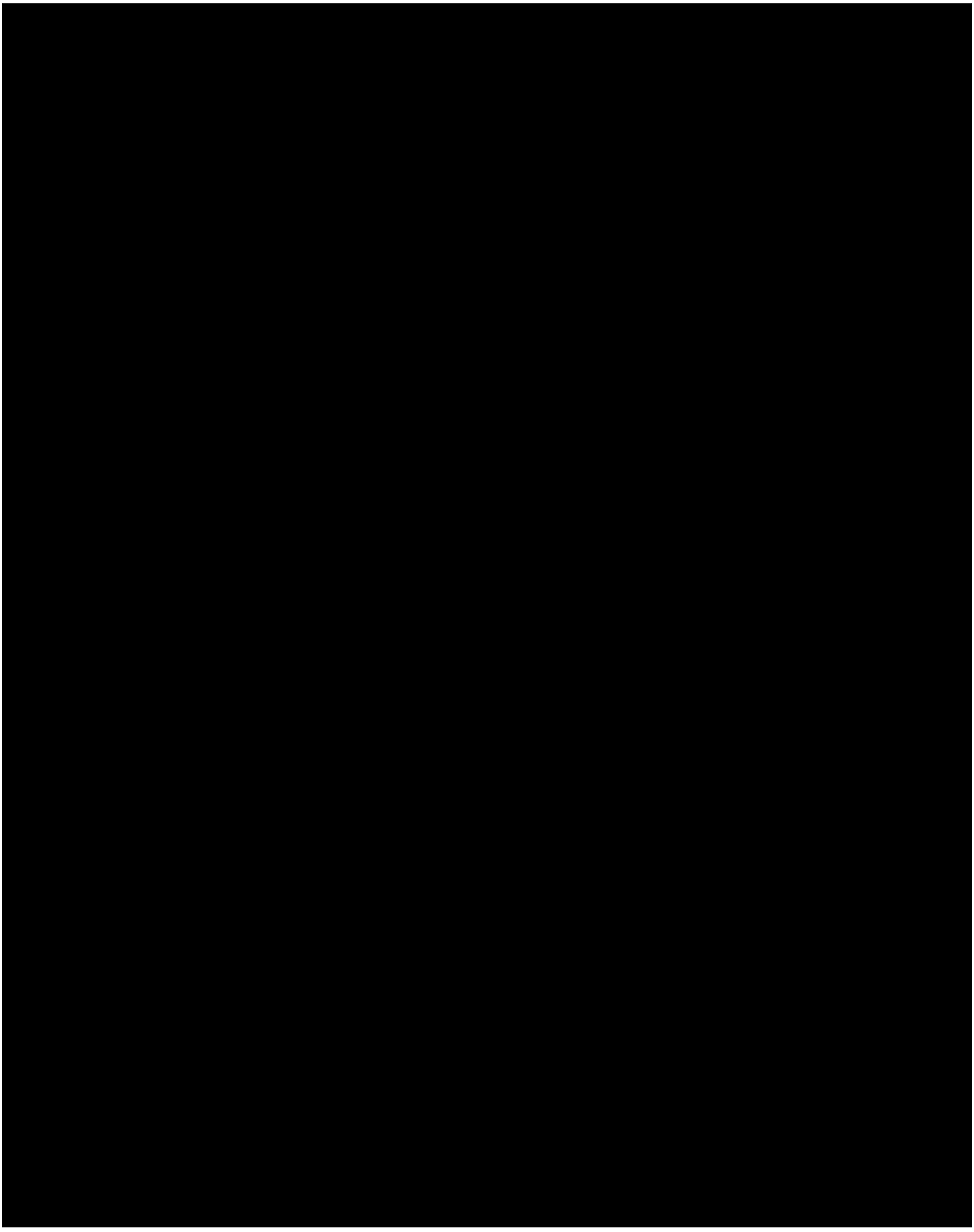
The Beetaloo JV has previously completed engagement with Native Title Holder's covering the proposed scope within the broader "Subject Land 1" area. This scope is covered under the October 2021 NLC Conditions of Work report issued to Origin Energy B2 Pty Ltd (which was acquired by Tamboran B1 Pty Ltd in 2022 and renamed to Tamboran B2 Pty Ltd). The October 2021 condition of Work Report has been provided in Appendix A.

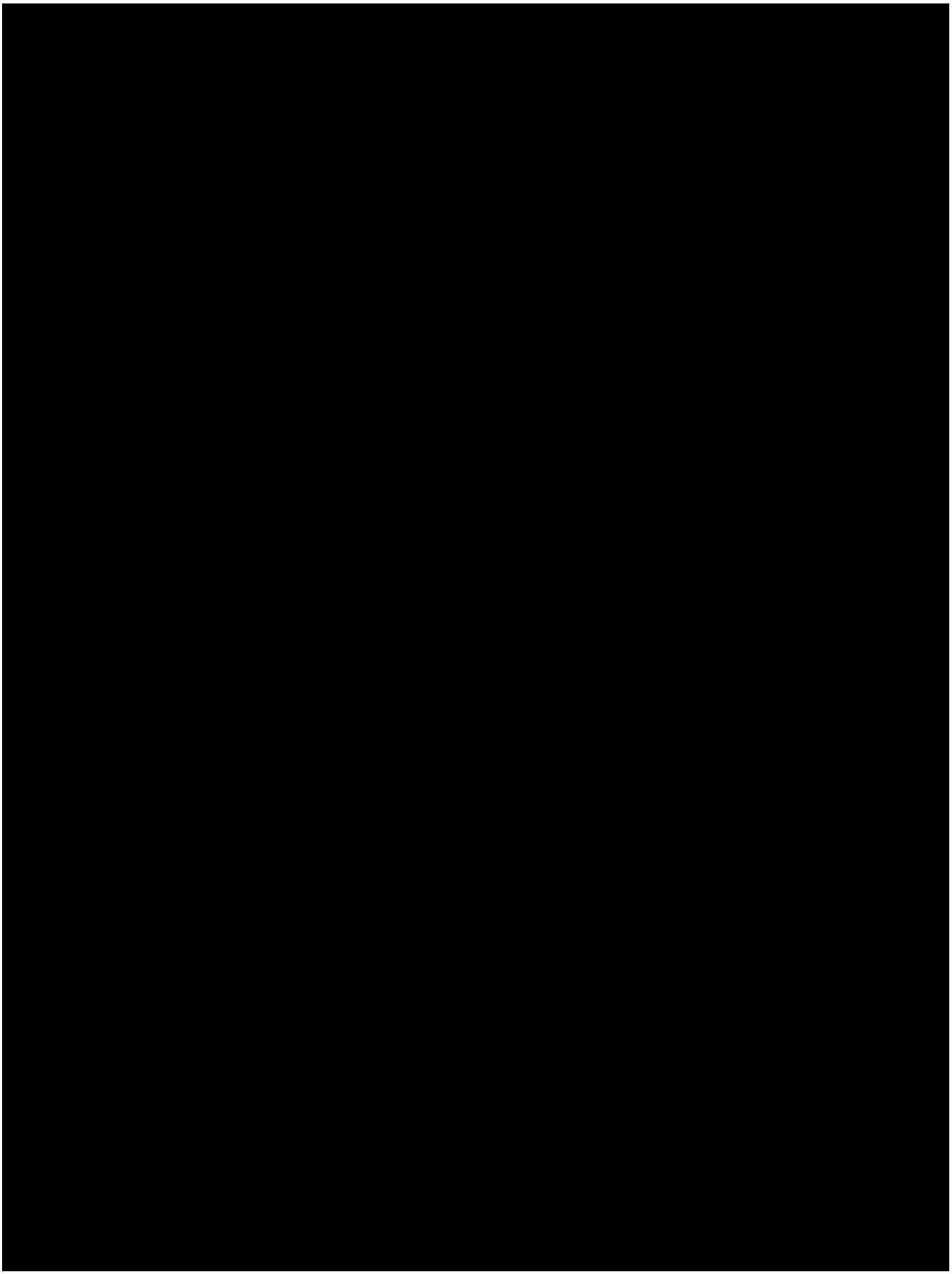
NLC have been informed of Tamboran B2's intention to submit a new AAPA authority certificate to cover the proposed works proposed for Subject Land 1.

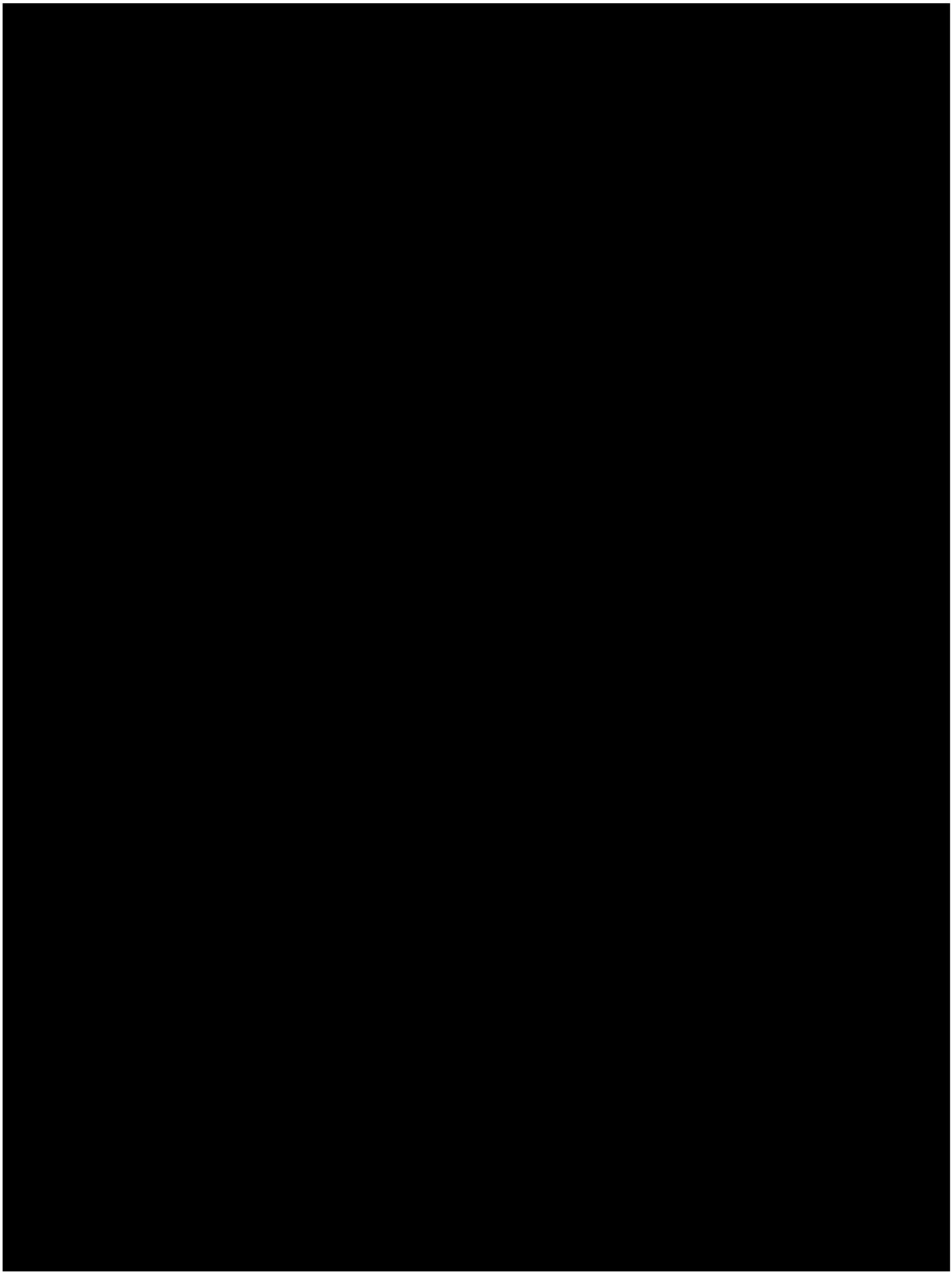
Appendix A- 2021 Sacred Sites Avoidance Survey- Conditions of Work Report

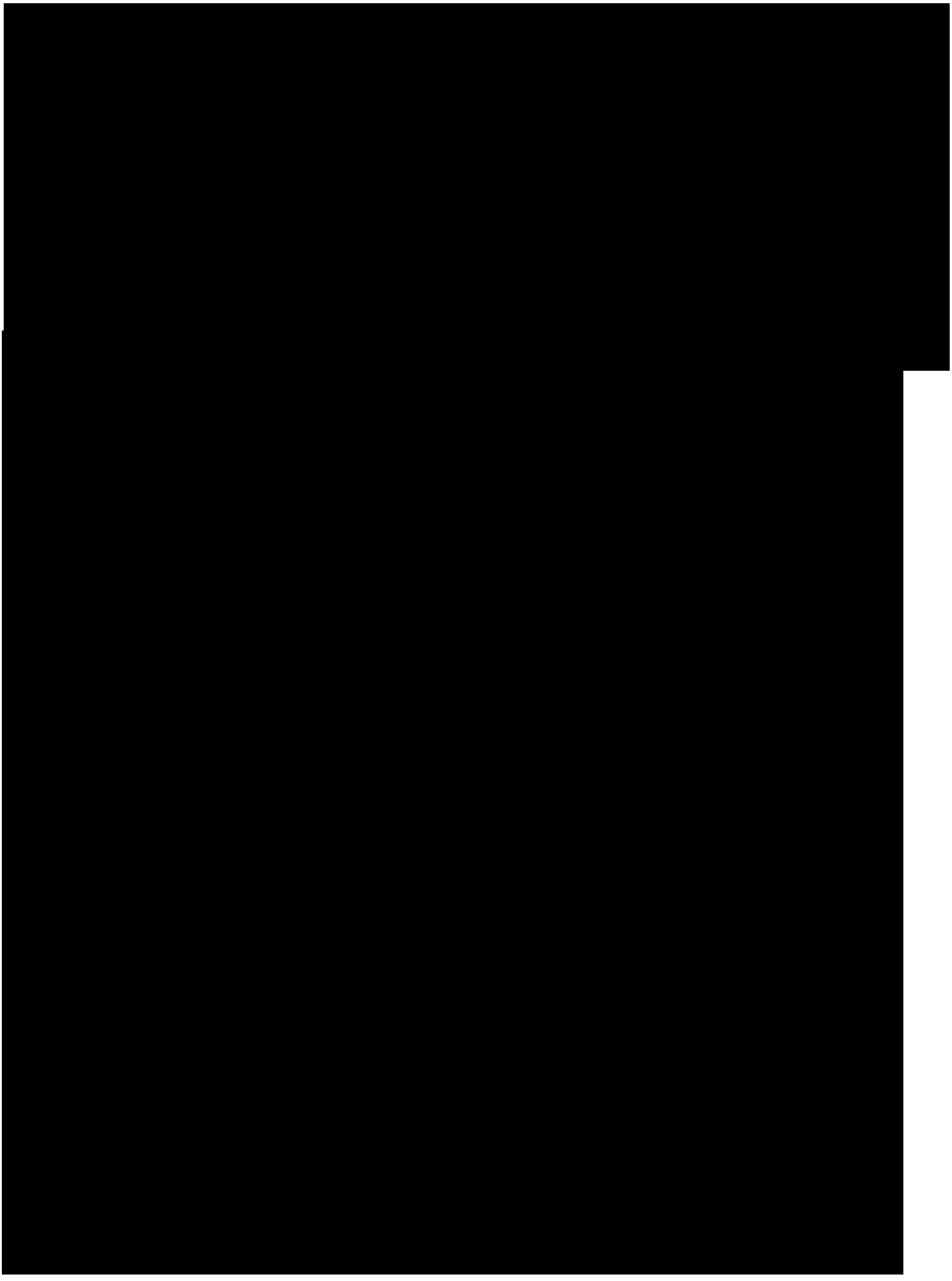




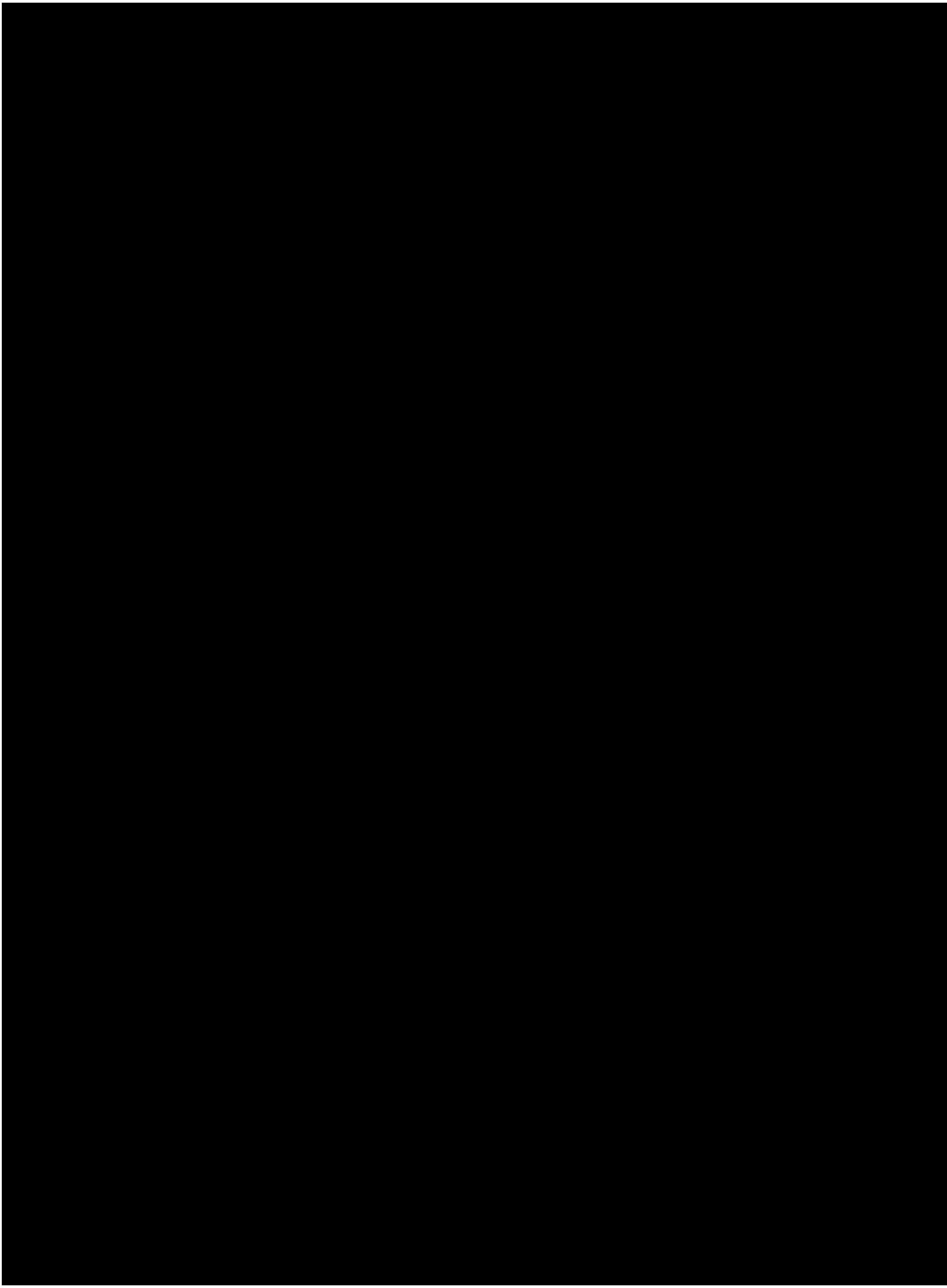


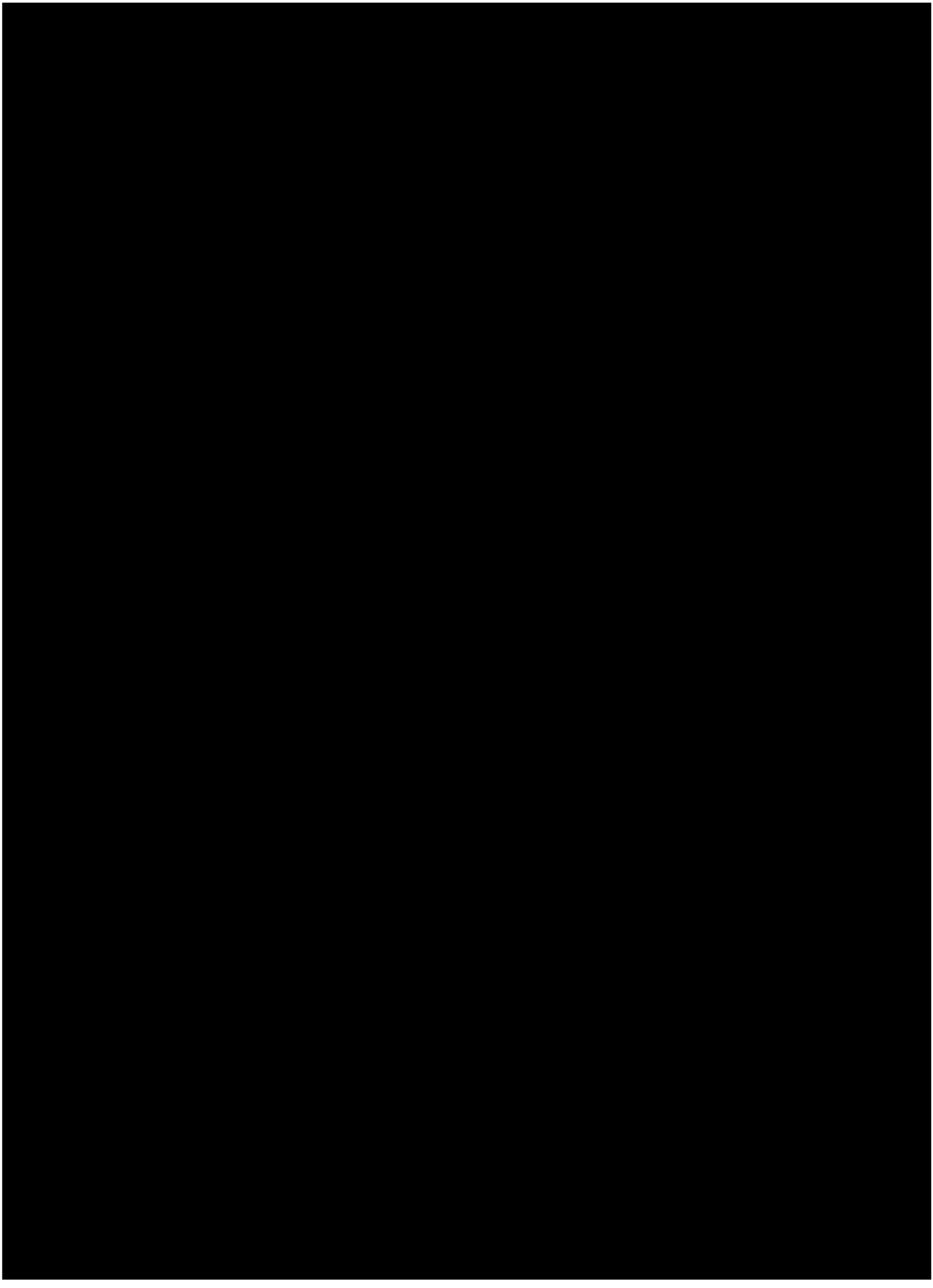






[redacted]





Annexure A:

2019 Work Program Document provided to the NLC (28 September 2020)

2019 Work Program Clearance Request

(For Potential Exploration Works from 2020)

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

Version:	**1.0**
Submitted:	
Presented by:	Origin Energy
Review Date:	November 2019

CONTENTS

EP98, 117, 76 – Beetaloo Joint Venture (Origin / Falcon) 1

CONTENTS 2

1 OVERVIEW 3

2 PROPOSED WORK PROGRAM 3

2.1 Activities 4

2.2 Areas 4

2.3 Request 5

2.4 Figures 5

2.5 Tables 5

2.6 Appendices 5

2.7 Attachments 5

3 APPENDICES 10

1 OVERVIEW

- 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). The Amungee NW 1H well was hydraulically fracture stimulated (HFS) in 2016 (prior to the introduction of a moratorium in September 2016) as part of an exploration work program to assess the potential of hydrocarbons in the Beetaloo (Figure 1).

- In 2018 the moratorium was lifted and in 2019, post the implementation of the NT Inquiry *Exploration Recommendations*, Origin resumed exploration activity in Exploration Permit 117 (EP117) drilling a vertical exploration well, and a horizonal appraisal well targeting the Kyalla formation. HFS is scheduled to be undertaken at Kyalla 117 N2 1H beginning in Q4 2020.

- The approved budget to execute two (2) exploration wells in 2019 was approximately $120 million.

- The full time period for drilling and stimulation is approximately:
  - Drilling: Two (1-4) km deep and two (2-3) km long: Twelve (12) weeks
  - Stimulation (of well with above specifications): Three (3) weeks
  - Production testing: Three (3) months (up to 12 months)
  - Maintenance and monitoring: Ongoing

- Origin's *Northern Territory Government permit commitments* across Exploration Permit 98 (EP), Exploration Permit 76 (EP76) and EP117 (the Permits) require Origin to complete a further four (4) additional exploration wells to be drilled and stimulated.

- Origin's exploration program is designed to identify areas of perspectivity for a potential, future hydrocarbon development.

- Origin respectfully requests the Northern Land Council's assistance to facilitate a *Sacred Site Clearance Survey* of eight (8) potential future exploration locations and access routes (where necessary across the Permits) 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 (Figure 2).

2 PROPOSED WORK PROGRAM

- Origin is proposing to drill, HFS and production test four (4) horizontal wells across the Permits over 2019-2022. It is possible that vertical wells will be drilled prior to proposed horizontal wells (that is, a proposed horizontal well would be drilled from a vertical well as occurred for the Amungee NW 1H well).

- Origin may seek approvals to drill, HFS and production test from two (2) to four (4) additional horizontal wells (and associated vertical wells if required).

- Civil works activities to support the exploration program may be undertaken throughout 2020 (note this is likely to include the construction of roads to enable site access along with supporting activities such as accessing aggregate from identified gravel pits, water through registered water bores and the installation of additional water monitoring bores as per the requirements of the NT Inquiry).

- Civil works and associated activities are likely to be undertaken on sites where NLC Clearance and AAPA certification is held to facilitate exploration activity beyond 2020.

- 3D or 2D seismic activity

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 Activities

The following activities would be required to complete work across the sites included in this request:

Activities, in approximate order of operation, include:

1. Scouting, surveying, and small-scale surface and shallow subsurface sampling of soils to support geotechnical studies and environmental evaluation.

2. Civil engineering activity to repair, improve and/or construct access tracks and/or unsealed roads and well pads (e.g. grading, excavation, fencing); note this activity may require borrow pits along access routes and close to well pads.

3. Drilling/installation of water bores as required.

4. Exploration drilling (vertical and horizontal wells).

5. HFS (horizontal wells and associated vertical wells if required) (including HFS monitoring equipment).

6. Production testing.

7. Follow-up testing, monitoring and work-over activity (as required).

8. 2D or 3D seismic data collection activity

8. Activities associated to the plugging, abandonment and/or remediation of wells after proper testing and monitoring has been conducted (as required).

9. Any other auxiliary works/activities required under good oilfield and/or environmental practice and accepted project commitments to support foregoing activities.

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 and digital GIS files detail the location of eight (8) potential sites, and associated access routes requested for Sacred Site Clearance surveying.

    - Sites - the initial clearance request is for an extended polygon providing a radius area area around the proposed location.

- Access Routes - the initial clearance request is for a 100 m buffer zone either side of the access tracks; however, Origin will support a wider clearance area as needed by the NLC and cultural monitors and/or Traditional Owners.

• 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 current NLC cleared locations
Figure 3 Summary map of additional proposed locations, clearance areas and associated access routes requested for Sacred Site Clearance survey

2.5 Tables

Table 1 Propose site locations for Sacred Site Clearance survey.

2.6 Appendices

Appendix 1 Indicative Activity Descriptions
Appendix 2 Minimising Environmental Impact

2.7 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

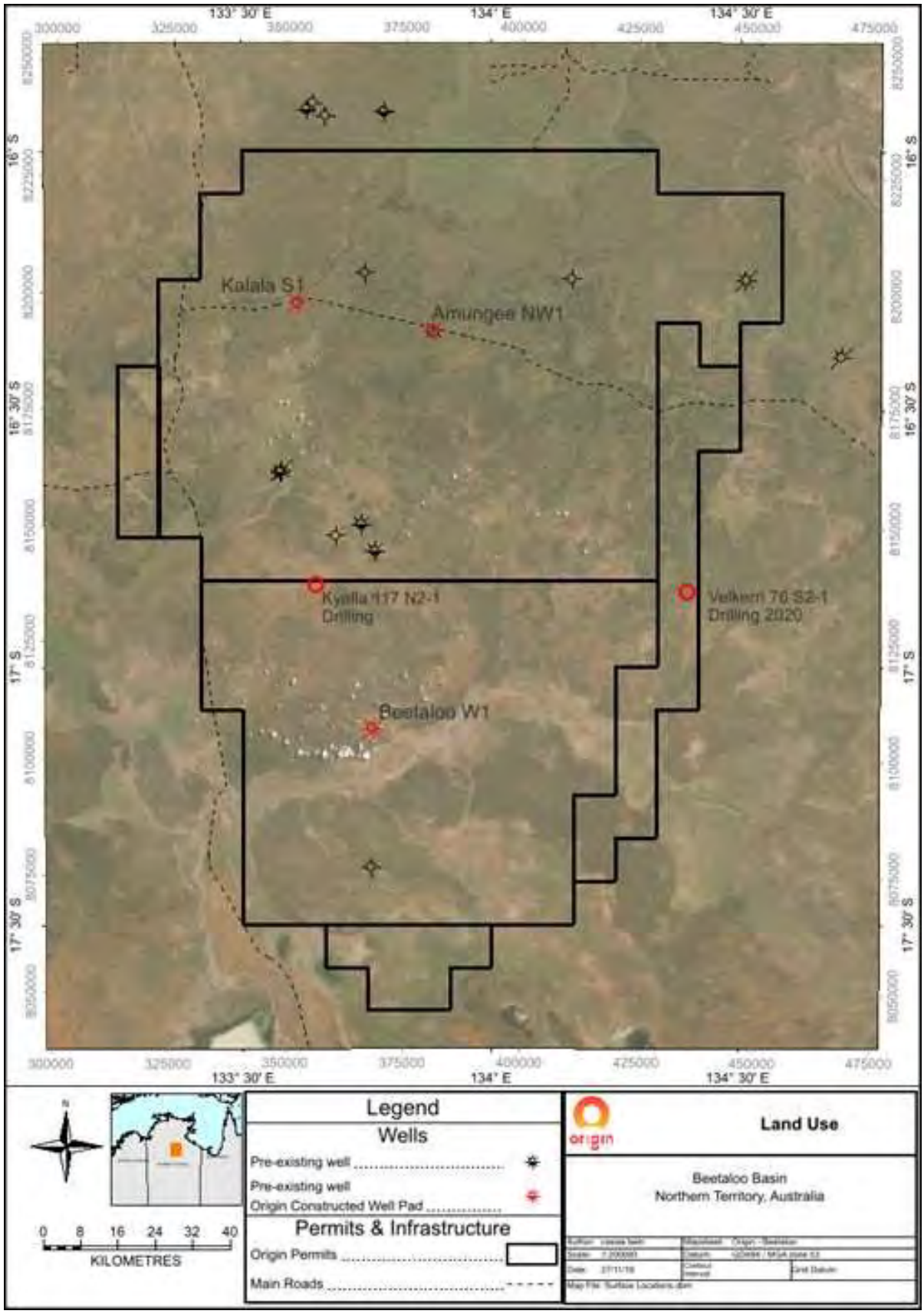
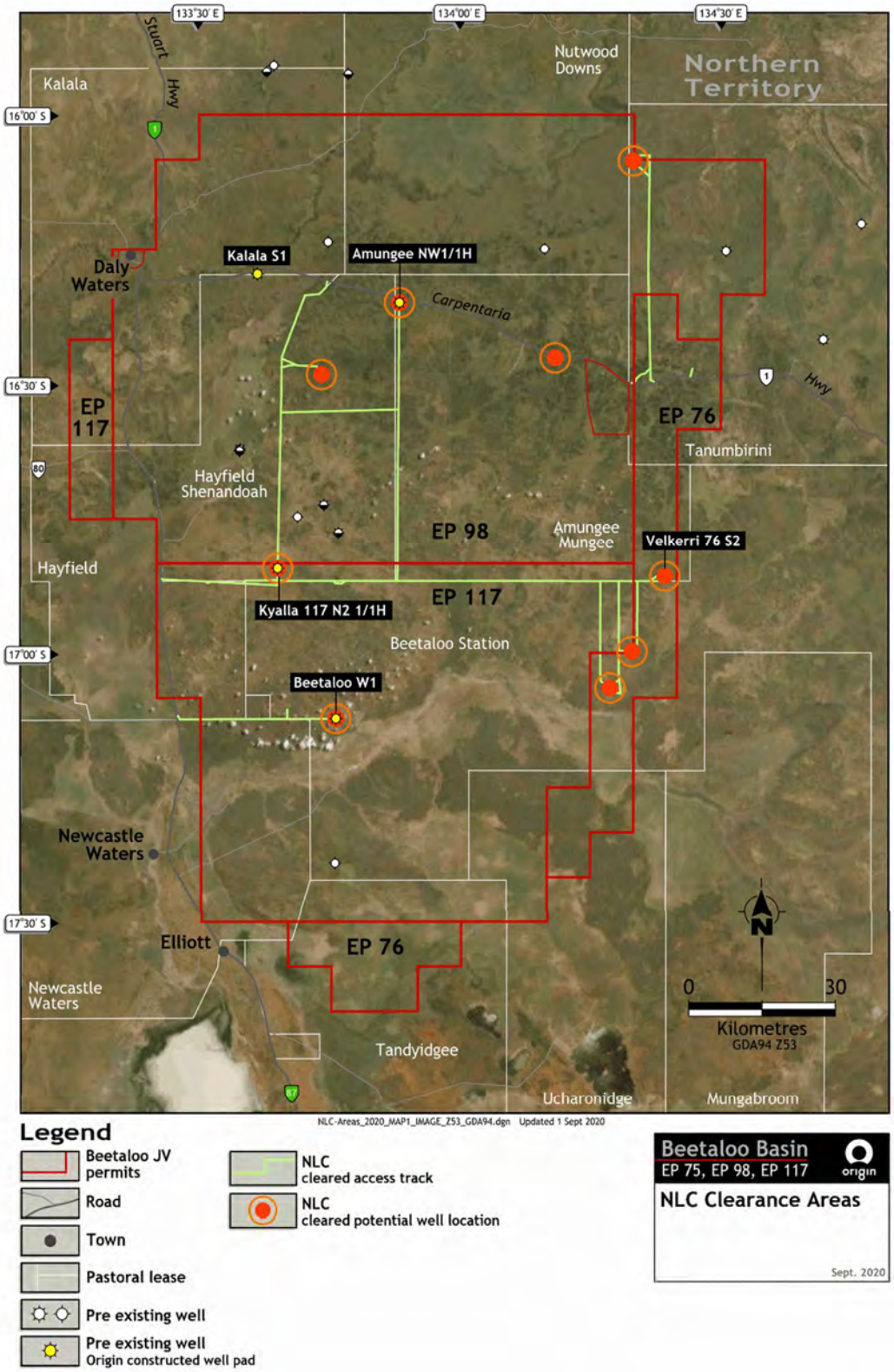

133° 30' E
134° E
134° 30' E
300000
325000
350000
375000
400000
425000
450000
475000
8250000
8225000
8200000
8175000
8150000
8125000
8100000
8075000
8050000
16° S
16° 30' S
17° S
17° 30' S
Kalala S1
Amungee NW1
Kyalla 117 N2-1
Drilling
Velkern 76 S2-1
Drilling 2020
Beetaloo W1
N
0 8 16 24 32 40
KILOMETRES
Legend
Wells
Pre-existing well
Pre-existing well
Origin Constructed Well Pad
Permits & Infrastructure
Origin Permits
Main Roads
origin
Land Use
Beetaloo Basin
Northern Territory, Australia

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



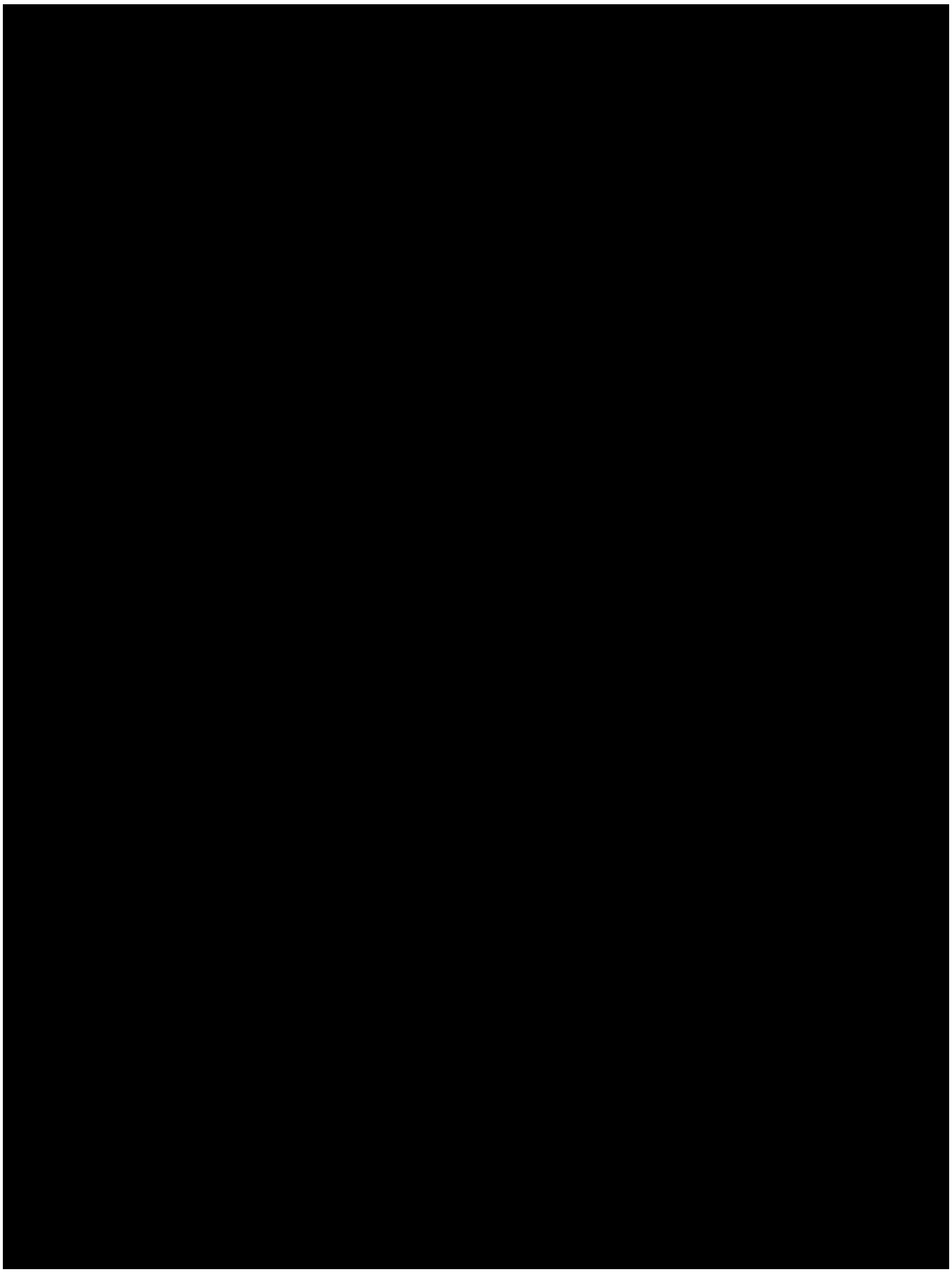


Table 1 - Proposed site locations proximity for sacred site clearance surveys

3 APPENDICES

3.1 Appendix 1

The following information and table details the typical activities associated with drilling and hydraulic fracture stimulation operations of vertical and/or horizontal exploration well as proposed in the Beetaloo. These descriptions are indicative and general in nature, minor departures from such descriptions are likely to occur and we propose that such departures are covered by the content of this application.

The first step in the exploration well process includes the construction of access roads and where necessary, land clearance to allow access to the potential well-site location. The drilling lease pad itself (ie. the area of land that would be occupied by the drilling rig and support equipment) would consist of approximately one (1) hectare of cleared and site engineered compacted earth. This area would host the drilling rig and all associated equipment as well as a mud sump (i.e. a pit where used drilling fluids would be stored while the operation is in process) and a flare pit (i.e. a pit that can be used to burn any gas or oil encountered while drilling in a safe manner, although it is unlikely to be used). The rig camp would be located within the vicinity of the drilling rig on a cleared area of approximately 100 m x 100 m. A rig camp for this type of exploration activity typically accommodate approximately 50 to 100 people.

All of the above areas would be connected to existing roads with unsealed tracks built specifically for the activity, approximately 6m wide tracks in an 18m wide corridor.

Once the surface infrastructure is in place, a drilling rig and camp would be brought in to undertake the drilling activity. A drilling rig package consists of the main rig package as well as supporting vehicles and pieces of equipment. Origin's host Traditional Owners have visited these types of facilities both at the Beetaloo well pad as well as the Amungee well pad. Generally, some, or all, of 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.
- 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.
- A work/welding shop.
- Portable onsite offices.
- Third party equipment such as cementing trucks and wireline evaluation units would also be required on site intermittently as per operational requirements.

Trucks delivering equipment and consumables (e.g. 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, 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 regional aquifer (depth varies regionally). 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 would then be set and cemented at this depth.

The drilling rig would then be set up to drill through the aquifers and the Antrim Plateau Volcanics (assuming they are present). At this point a further string of 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 may 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.

A KCl/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 potassium 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)). A synthetic based fluid system consists of a non-aqueous fluid base.

The final hole section (referred to as the “production hole section”) covers the hydrocarbon reservoir section(s) and it is drilled to the well total depth (TD). TD is likely to range between 1000-4000 m below the ground surface, with the potential for a lateral section to be drilled horizontally for 1000-3000 m within a target reservoir,depending on the stratigraphic depth and thickness of the zone of interest at a particular location. 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.

In horizontal wells, 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.

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 be hydraulically fracture stimulated (HFS), a separate set of specialised equipment, trailers or skid mounted equipment is mobilised to the well location. This equipment mainly consists of high volume/high pressure pumps, mixing equipment, water storage tanks (enclosed and open), and

control and monitoring equipment. This equipment was inspected by host NLC representatives and host Traditional Owners prior to the HFS activities at the Amungee NW 1H well. HFS involves the injection of large quantities of water and sand plus a small percentage of chemicals at high pressure down and across horizontally drilled wellbores. The pressurised mixture causes the rock (i.e. shale) to crack. The small cracks or fractures created are held open by the sand/proppant allowing hydrocarbons to flow from the shale to the wellbore and up the well. The fractures created are separated from surface aquifers by impermeable rock. Other formations (including surface aquifers) are also isolated behind several layers of steel casing and cement preventing contamination.

After the completion of HFS operations, a production test is typically carried out for a period required to assess the potential of the well and acquire important reservoir and hydrocarbon data (Origin proposes to test wells for a minimum of three (3) months, and may seek to extend this for the final wells in the 2021 and 2022 work program to up to 12 months).

Once all drilling, wireline and testing operations are completed a decision is made to either safely suspend the well (e.g. for further testing 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 maintaining and conditioning the surface well pad, as well as site rehabilitation after well decommissioning and ongoing monitoring.

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.

The drilling rig and all associated temporary equipment would be then removed from the site. If the well has been plugged and decommissioned, all disturbed areas (e.g. lease pad, pits, camp area) would be rehabilitated and re-vegetated. 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.

Table A - Summary of Exploration activities.

Activity	Description	Equipment	Duration
Water Bore / Civil Works	Installation of a water bore and water tanks, levelled areas for rig and camp, pits for fluid storage and roads for access.	Earth moving equipment and water bore drilling unit.	Approximately 1-2 months and potentially completed some months prior to drilling activity.
Exploration Drilling	Drilling with air/water to install progressively smaller cemented casing strings to ultimately reach the target rock formations and well TD	A drilling rig package (described above) as well as associated heavy and light vehicles.	Approximately 30-90 days (highly variable, especially in exploration phase and will depend on whether a horizontal section is required).

Evaluation	Running wireline tools to tests various properties of the reservoir rocks once they have been drilled into.	As well as the drilling package, there would be a wireline logging truck and a variety of industry standard tools.	Approximately 2-3 days, depending on success of testing.
DFIT	The DFIT involves injecting small volumes of water at low rates to create small fractures in the rock and then allow the pressure to fall naturally.	Specialised truck, trailer or skid mounted equipment mainly consisting of high volume/high pressure pumps and control, and monitoring equipment.	Approximately 2-3 days.
HFS	Hydraulic Fracture Stimulation involves the injection of large quantities of water and sand plus a small percentage of chemicals at high pressure down and across horizontal drilled wellbores causing the shale to crack. The cracks or fractures created are held open by the sand/proppant allowing gas from the shale to flow into and up the well.	Specialised truck, trailer or skid mounted equipment mainly consisting of high volume/high pressure pumps, mixing equipment, water storage tanks and control and monitoring equipment.	Approximately 10-30 days depending on the number of stages to be fracture stimulated.
Completions Activity	Equipment installation inside the wellbore, typically steel tubing to assist the well's ability to lift fluids/gas up the wellbore to surface.	A completions rig package and wireline units when required	Approximately 2-5 days
Production Test	Measuring the productivity of the wellbore after it has been HFS. Flow rates (gas/fluids), pressures, solids, and gas/fluid analysis are typically assessed.	Well test package, typically consisting of a 3 phase test separator, choke manifolds, flowback tanks, flare stacks and emergency shutdown valves. Wells that require artificial lift to initiate flow may also have a coiled tubing unit on location to conduct a Nitrogen (N_2) lift.	Approximately 1-12 months.

Plug and Decommissioning (activity delayed if well is suspended)	Setting and testing cement plugs to ensure permeable zones have been isolated from each other to prevent cross flow and/or flow communication to surface.	A drilling rig package.	Approximately 2 days.
Site Rehabilitation (after Plug and Decommissioning)	Earth works rehabilitation to original condition. Re-vegetation as required. Note that any water bore and some road access are likely to remain.	Earth moving equipment.	Approximately 1 week (TBA) and then sufficient time to re-establish vegetation. May be completed several months post drilling activity.
2D or 3D seismic	Collection of seismic data by placing seismic nodes on the ground surface and then creating pulse energy into the subsurface which reflects off changes in rock layers 'hardness' and are detected by the nodes when the reach surface again. This allows an 'image' of the subsurface to be collected which allows predictions on what rocks occur underneath the exploration area	Vibroseis trucks, Seismic nodes and associated cables	2 - 12 weeks

3.2 Appendix 2

Included in submissions are comprehensive environmental management plans (EMP) detailing processes and procedures that will be followed during implementation and execution of all aspects of exploration activity. These plans are also assessed and reviewed as part of the ATD process to ensure field activities are carried out in a way that meets all applicable environmental legislation and regulation. An EMP and associated documentation, assessed as part of the ATD approval, may include:

- Management of Sacred Site / Cultural Heritage, heritage, bushfire, weed control and management, erosion and sediment control, protection of Surface water and groundwater water, dust, traffic, biodiversity, and waste) - these plans will cover both the general exploration activity plus specific environmental requirements for each well site and its associated activities
- Oil Spill Contingency Plan (OSCP)
- Emergency Response Plan (ERP)
- Water Management Plans for regular testing of local water bores before, during, and after the project
- Chemicals disclosure – a list all chemicals to be used during the project
- Environment Rehabilitation Security Bond - submission of security bond calculation that covers all the rehabilitation management areas and evidence of final payment
- Archaeological, Sacred Site and Heritage clearance
- Pastoralist's consent

Copies of all documentation including all Environmental plans and documentation provided to Northern Territory regulatory agencies will also be provided to the NLC. All activities carried out by Origin as operator are also governed by stringent internal environmental policies and directives which are referenced when preparing environmental plans and undertaking work programs.

If hydraulic fracture stimulation is to be undertaken, the following additional environmental controls are also applied:

- Further validation of cement placement and its integrity
- Further pressure testing
- Continuation of baseline water monitoring and testing
- Submission of fracture modelling (maximum propagation height), confirming safe separation between any natural aquifers and the fracture zone
- Submission of all MSDS for public disclosure on the department's website
- BTEX (Benzene, Toluene, Ethyl-benzene, Xylene) products will not be accepted nor utilised as they are prohibited for use in the Northern Territory.

Origin has in place an HSE Policy that states:

At Origin, we value the wellbeing of our employees, contractors, customers, the communities in which we operate and the environment. We are committed to responsible management practices that minimise any adverse health, safety or environmental impacts, and enhance benefits associated with our activities, products or services.

We have in place a Health, Safety and Environment management system for our activities that drives continual improvement. The HSE Management System outlines accountabilities to implement this Policy and requires that we:

- Identify hazards and reduce risks so far as is reasonably practicable where there is potential to cause injury or illness to people, or to adversely impact the environment or the community
- Provide safe work places and systems of work, empower employees and contractors to address unsafe or hazardous situations and carry out their work in a manner that does not present a risk to themselves, others or the environment
- Support the recovery and rehabilitation of employees in the event of work related injury or illness
- Set objectives and targets which promote the efficient use of energy and resources, the minimisation of wastes and emissions and the prevention of pollution
- Comply with relevant HSE legal requirements and other commitments
- Require Contractors to manage HSE using standards and practices that accord with this Policy
- Regularly review and report HSE performance.

In implementing this Policy, we will engage with our employees, contractors, suppliers, business partners, customers and Government and communicate expectations to all persons working with or on behalf of Origin.

Origin field activities are also covered by a series of Environmental Directives which include the following:

- The Air Emissions directive outlines Origin's requirement for identification and management of emissions with potential to affect air quality and/or regulatory compliance.
- The Biodiversity Management directive describes requirements for identification and assessment of impacts on terrestrial and aquatic flora, fauna and ecosystems; controls for managing biodiversity-related risks; and methods for enhancing biodiversity values.
- The Cultural Heritage directive covers identification and assessment of cultural heritage values and sites, compliance with legal obligations and voluntary commitments, development of plans, and effective stakeholder engagement.
- The Environmental Noise directive describes requirements for identifying, assessing, monitoring and minimising noise emitted during normal operations as well as during construction, commissioning and decommissioning activities.
- The Greenhouse Gas and Energy Efficiency directive sets out requirements for managing greenhouse gas (GHG) emissions and energy efficiency, including identification and monitoring of energy consumption, energy production and GHG emissions.

- The Land Management directive describes requirements for identifying and assessing impacts to land, and implementing controls to manage erosion, visual amenity, contaminated sites, site closure and rehabilitation.

- The Materials and Waste directive outlines requirements for identifying, assessing and managing impacts associated with use of materials, and storage, handling, treatment and disposal of wastes.

- The Water Management directive outlines requirements for managing water extraction and consumption, water quality and controlling wastewater treatment and discharges.

Proposed Water, Gravel or other Resource Use

It is proposed that water bores to provide water for civil construction, well drilling and completion operations are to be installed adjacent to the well site pad and along access tracks within the clearance area of the well sites and access tracks. The bores will be constructed to the minimum construction requirements of the NT Government.

Gravel from existing gravel pits and new borrow pits may be required for access road sheeting and well site pad sheeting. Any new borrow pits would be located within the clearance area along the access tracks or lease pads.

Annexure B:
2021 Work program Document provided to the NLC (24 September 2021)

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

CONTENTS

EP98, 117, 76 – Beetaloo Joint Venture (Origin / Falcon) 1

CONTENTS 2

1 OVERVIEW 3

2 PROPOSED WORK PROGRAM 3

2.1 Detailed Activity List 3

2.2 Areas 4

2.3 Request 5

2.4 Figures 5

2.5 Appendices 5

2.6 Attachments 5

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

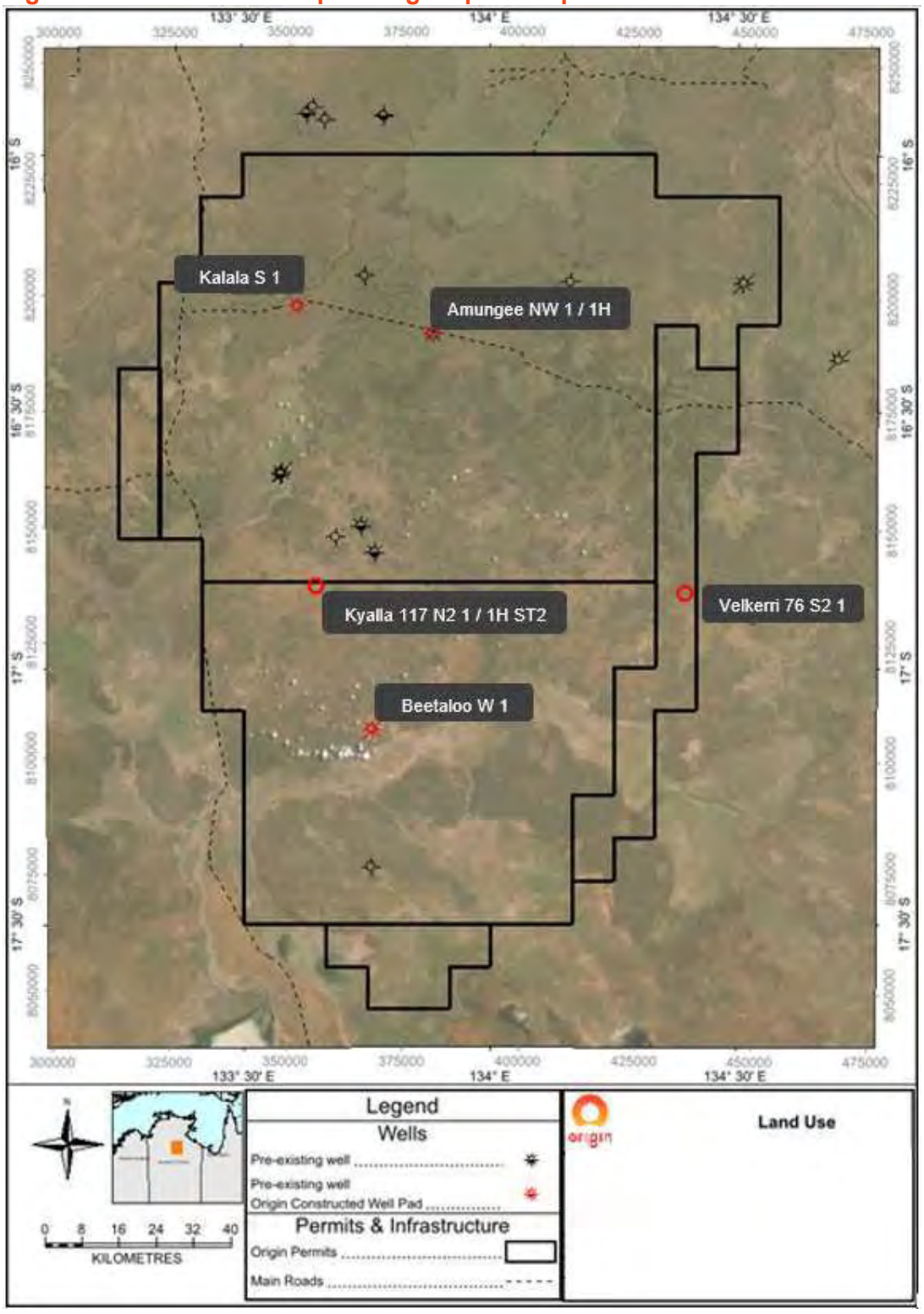
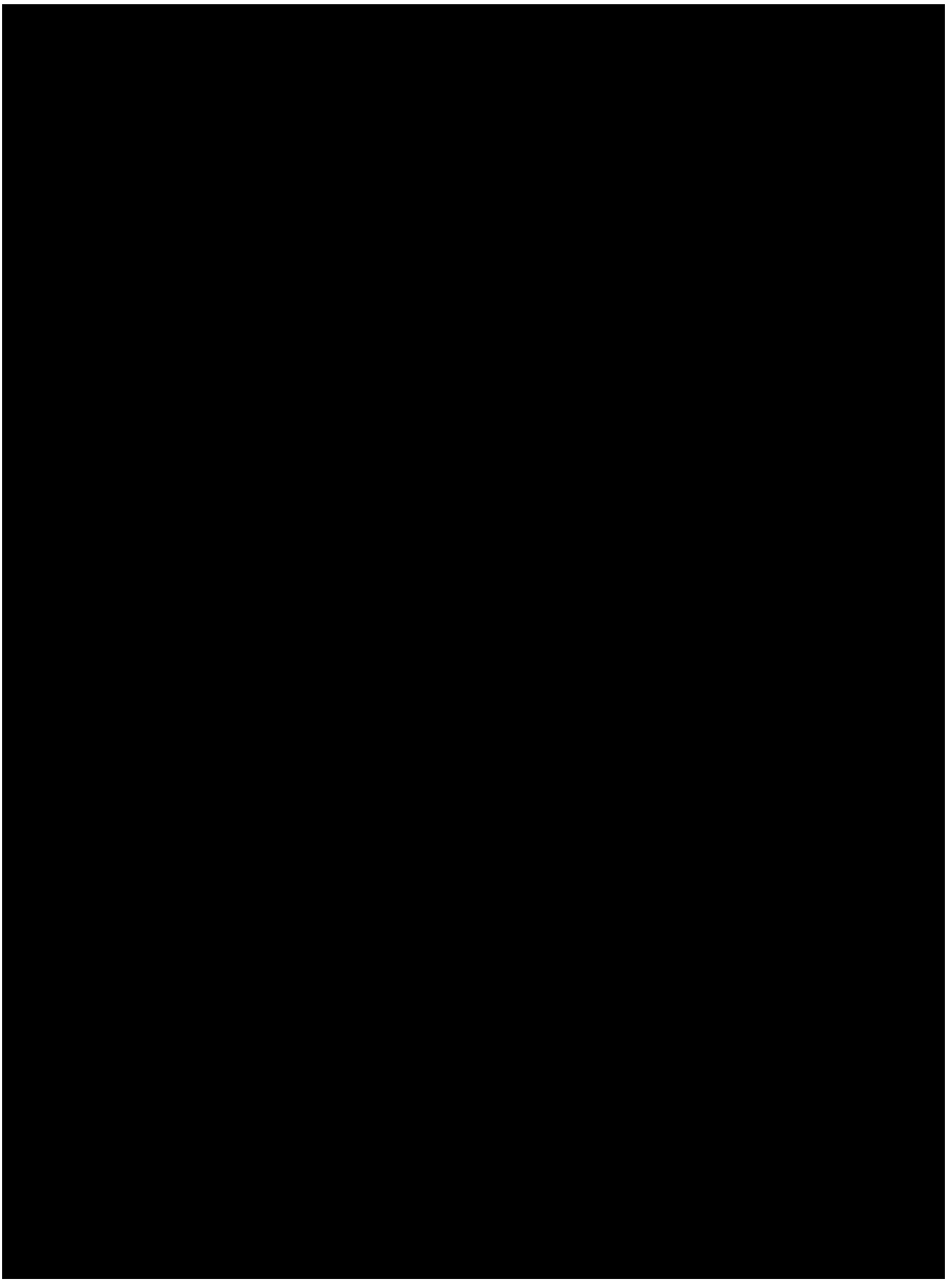


Figure 1 - Overview of Origins Beetaloo Basin Exploration permits and existing wells drilled to date

[redacted]



3 APPENDICES

3.1 Appendix 1

The following information and table details of the proposed exploration activties proposed **w** **ithin 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.

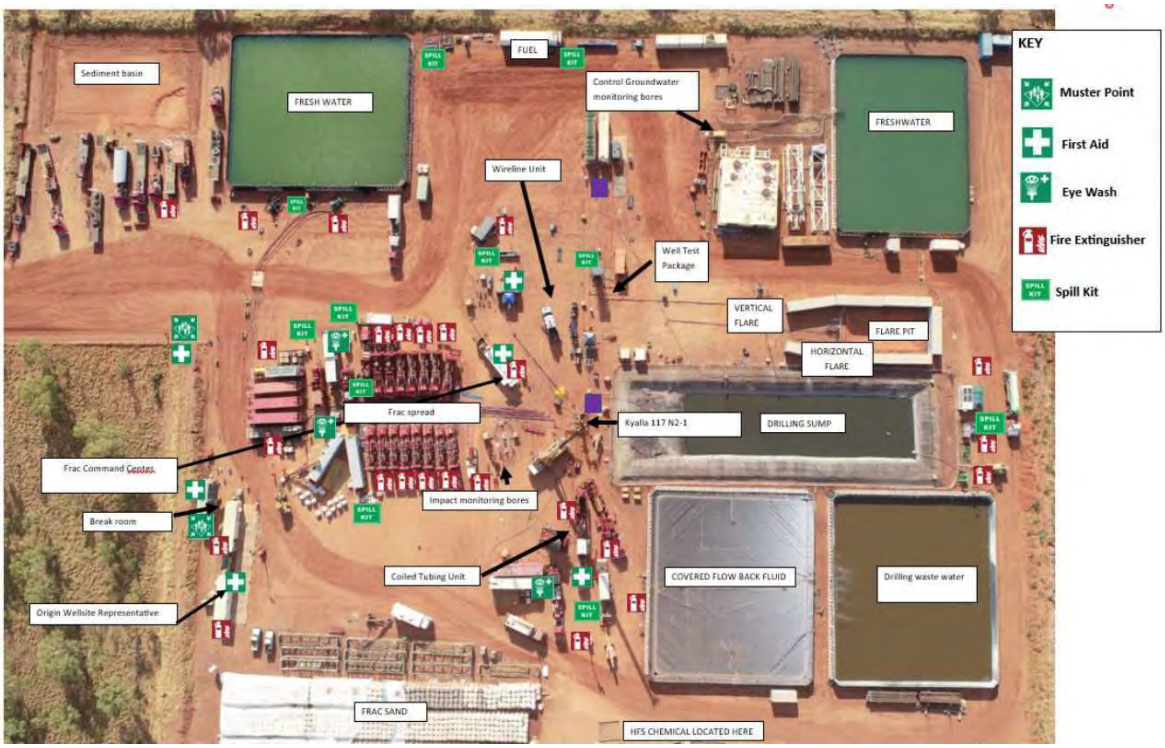


Figure 11 Typical Hydraulic fracture stimulation spread at the Kyalla 117 N2 site.

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 thelife 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 smallearthen 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 abandonmen t 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, produced water, or hydrocarbons (liquid	• 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 being added to separate aquifer units.

			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 WEL).	• 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
				• .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 environmentally acceptable.	• 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 code of Practice.

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			• 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	• 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 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	• 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 –	○ 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.