



Environment Management Plan

NT-2050-15-MP-031

BEETALOO BASIN VELKERRI 76 S2 CIVIL CONSTRUCTION Environment Management Plan

EP76

Review record

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1 Executive Summary

The Beetaloo Basin Velkerri 76 S2 Civil Construction Environmental Management Plan (EMP) forms the basis of Origin Energy's (Origin's) application to the Northern Territory (NT) Department of Environment and Natural Resources (DENR) for the construction of civil related infrastructure to support the drilling, hydraulic fracture stimulation (HFS) and well testing of a future exploration well.

This EMP has been prepared with reference to the *NT Petroleum (Environment) Regulations 2016*, Code of Practice for Petroleum Activities in the Northern Territory (Code of Practice) and the Exploration Agreements between Origin, Native Title holders and the Northern Land Council (NLC). All activities proposed under this EMP will comply with the Code of Practice, native Title exploration Agreements and all applicable legislation.

The overall objective of the EMP is to ensure that the activities the subject of this EMP are carried out in a manner by which the environmental impacts and environmental risks will be reduced to a level that is as low as reasonably practicable and acceptable. It is noted that this EMP does not seek approval for future exploration activities or potential HFS activities. Approval to commence drilling, stimulating and testing an exploration well will be covered in a separate EMP submission prior to conducting such activities.

This EMP covers a series of low impact civil construction activities required to enable Origin's 2019/20 exploration program. The civil construction program will involve the installation of a camp pad, lease pad, helipad, stockpile storage area and wet weather laydown yard.

The activities pertaining to this EMP will occur within the approved subject land area which has been approved by the custodians and the NLC and covered by AAPA Certificate C2019/039. The total area of disturbance is estimated to be 7.4 ha and the activities include:

- Establishment of a 4.5 hectare (ha) exploration lease pad, 1 hectare wet weather storage laydown yard, a 1.2 ha camp pad, 0.5 ha helipad and a 0.2 ha soil stockpile area;
- Construction of a drilling sump, cellar and sediment basin on the cleared lease pad;
- Extraction of gravel from the existing gravel pits to provide material for improving stability and integrity of the access tracks and lease pad; and
- Installation of fencing, gates and grids.

For the preparation of this EMP, a Land Condition Assessment was completed in August 2018 to review the physical, natural and cultural heritage environment of the proposed exploration activities.

The proposed location of civil construction activities is within *Corymbia* low woodland with a tussock grass understorey. The proposed site has high native grass cover and includes numerous species suitable for granivorous birds (seed eaters). Dense leaf litter and numerous logs provide suitable refuge and foraging sites for fauna such as reptiles. This vegetation type is widespread in the tropical savannas of the Northern Territory and may provide habitat for some threatened species such as the Crested Shrike-tit (*Falcunculus frontatus whitei*) (DoTEE, 2014, Ward, 2008). As the level of clearing for the proposed activity is small, no significant impacts on protected flora and fauna are predicted.

There was no evidence of weeds observed during the survey. This suggests the primary controls for this program will therefore be focused on preventing the introduction of weeds and managing weeds promoted through site disturbance.

The archaeology assessment did not identify culturally sensitive landforms or artefacts within the proposed disturbance area. In addition, a sacred site clearance survey coordinated and carried out by the Northern Land Council (NLC) in August and September 2018, was led by their anthropologist and included site visits and consultations with the Native Title holders / custodian. The Sacred Site Avoidance Survey Report / Anthropological Report has been provided to the Aboriginal Areas Protection Authority and informed the issuing of AAPA Certificate C2019/039.

The environmental, heritage and social risks associated with the civil construction activities have been assessed utilising the Origin risk assessment framework. The detailed risk assessment presents the range of potentially impact-causing activities, corresponding mitigation measures and residual risk ratings based on their assessed worst-case consequence and likelihood of occurrence.



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Key environmental impacts and risks identified for the program include;

- Impacts on flora, fauna and habitat from clearing native vegetation;
- Impacts on pastoral land and habitat from bushfire and introduction of weeds; and
- Impacts on land and surface water from erosion from civil construction activities.

It was considered that with the appropriate controls implemented to mitigate the impacts, there were no residual risks above a rating of Medium, with 43 out of the 52 risks identified as being considered Low. The Medium risks identified were consistent with standard civil construction activities completed across the NT, being the potential for the spread of weeds, erosion and sediment control and the ignition of bushfires from the proposed activities. The assessment demonstrates the risks associated with the activities covered under the EMP can be reduced to as low as reasonably practicable (ALARP) and acceptable.

At completion of activities, and once a determination has been made in relation to decommissioning, a site-specific rehabilitation plan will be developed for each site. Where the site is not able to be handed over to the pastoralist for beneficial use, the site will be rehabilitated back to a safe, stable landform consistent with surrounding land use.

Due to the limited nature of the future exploration activities, community engagement for the 2019/20 exploration installation project has focused on the host Traditional Owners via the Northern Land Council (NLC) and host pastoralists directly affected by the proposed activity. Detailed community and stakeholder engagement is ongoing and covers Origin's activities on a broader level. Further information on stakeholder engagement is provided in Section 5.

2 Introduction

2.1 Purpose

Origin is required to provide a site-based Environmental Management Plan (EMP) for the Velkerri 76 S2 civil works program to the Department of Environment and Natural Resources (DENR) in accordance with the *Petroleum Act 1984* as well as the *NT Petroleum (Environment) Regulations 2016*. The civils program is an enabling activity required to drill, stimulate and test an exploration well on the Velkerri 76 S2 well lease pad.

This EMP has been prepared with reference to the *NT Petroleum (Environment) Regulations 2016*, NT Petroleum Codes of Practice and the Exploration Agreement(s) between Origin, Native Title Holders and the Northern Land Council (NLC). All activities proposed under this EMP will comply with the Code of Practice, native Title exploration Agreements and all applicable legislation.

The overall objective of the EMP is to ensure that the activities are carried out in a manner by which the environmental impacts and environmental risks will be reduced to a level that is as low as reasonably practicable (ALARP) and acceptable

More specifically, this EMP aims to:

- Address regulatory requirements
- Provide site-specific impact management strategies to assist Origin to maintain a positive position in the local community throughout its program
- Align with the principles of Ecological Sustainable Development (ESD) through the adoption of responsible development practices that are designed to maximise social benefit, whilst minimising the level of impact on the surrounding ecosystems
- Provide a description of site-specific aspects of the existing environment (physical, biological, social and cultural)
- Provide site-specific plans for review, monitoring and rehabilitation
- Be a practical and usable document, with environmental management principles that are easily implemented and effective

The 'site' is defined as all the work areas including the exploration well lease pad, camp pad, gravel pits, helicopter pad, laydown yards and access tracks within the cleared subject land area. NOTE: Origin reference Velkerri 76 S2, is referred to by NLC and AAPA as CA10.

2.2 Background

Origin holds three petroleum exploration permits in the Barkly region under the Beetaloo Joint Venture with Falcon Oil and Gas. These permits (EP76, EP98 and EP117) cover 18,512 square kilometres (km²) of largely pastoral leases on the Sturt Plain and Barkly Tableland within the Northern Territory (Figure 1). These permits were originally granted by the NT Minister for Mines and Energy under the *Petroleum Act 1984*. Velkerri 76 S2 is situated within the eastern EP76 permit area which covers 1,391 km² of pastoral lease.

Since becoming Operator of the exploration permits in 2014, Origin has drilled three vertical wells (Kalala S-1, Amungee NW-1, Beetaloo W-1) and one horizontal well (Amungee NW-1H). A successful hydraulic fracture stimulation and production test was undertaken on the Amungee NW-1H well in 2016, highlighting the potential of the Beetaloo Basin as a future unconventional shale development. Upon completion of the 2016 work program, Kalala S-1 and Beetaloo W-1 were suspended and a pressure monitoring commenced at Amungee NW-1H.

Future exploration activity was ceased in September 2016 when the Northern Territory Government announced a moratorium on hydraulic fracture stimulation of unconventional reservoirs pending the outcome of an independent inquiry.

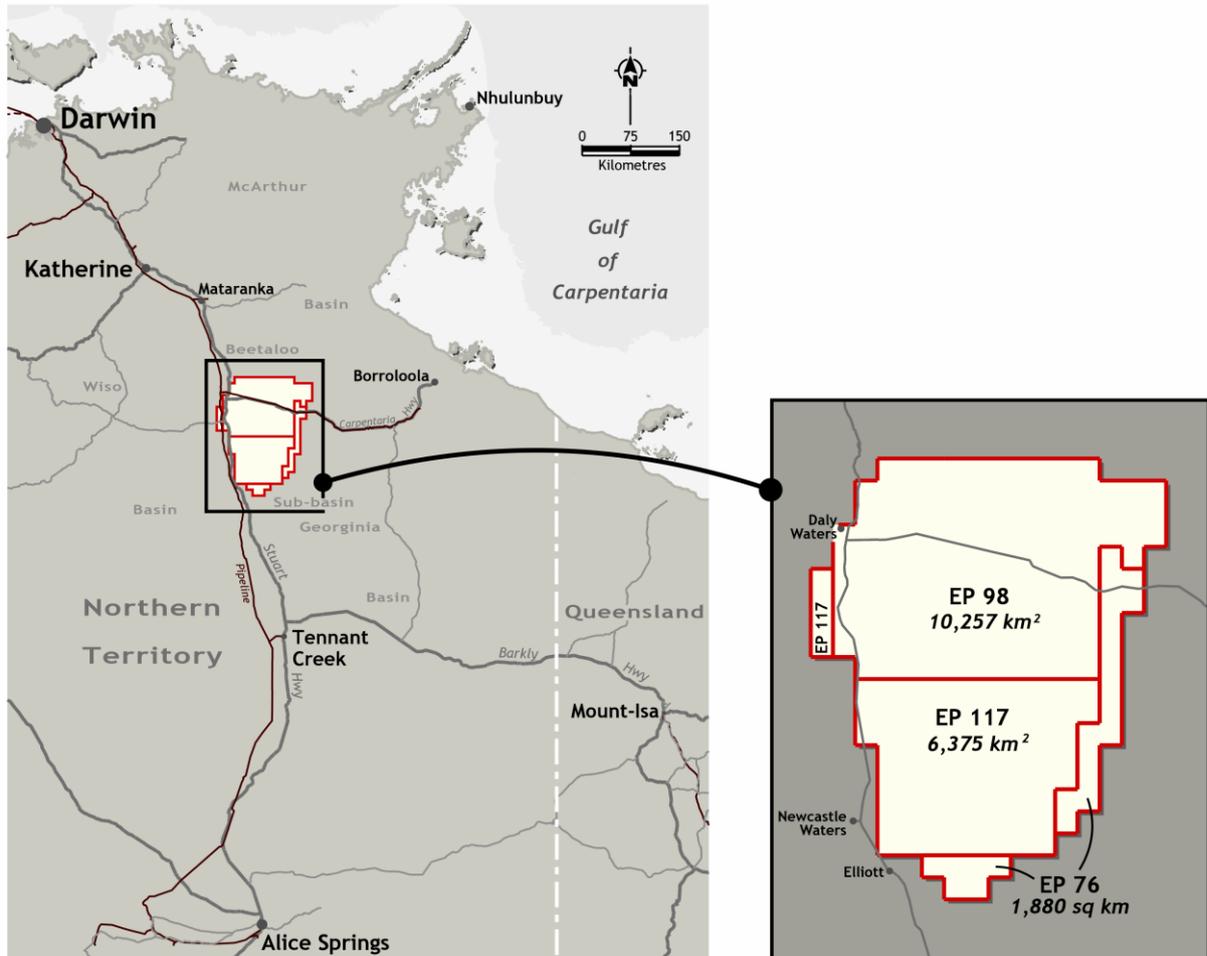
The Inquiry handed down its Final Report to the Northern Territory Government on Tuesday 27 March 2018. The Inquiry concluded that the risks associated with unconventional onshore shale gas extraction in the NT could be appropriately managed provided all the recommendations were adopted and implemented. The NTG subsequently accepted all 135 recommendations and announced the lifting of the moratorium on 17 April 2018. Of the 135 recommendations, 35 were required to be implemented prior to the commencement of exploration, with the remaining recommendations required to be implemented prior to the commencement of production.

This EMP forms the basis of Origin's application to the DENR for the Velkerri 76 S2 civils construction program. This civils EMP is required to enable the drilling, stimulation and well testing of the Velkerri 76 S2-1 petroleum

exploration wells within Origin's exploration permits. The plan provides an overview of how Origin proposes to manage the environmental risk associated with its activities, including how it will address its regulatory obligations and relevant Inquiry recommendations that have underpinned the Code of Practice for Petroleum Activities in the NT, which is currently in draft form (referred to herein as the NT Petroleum CoP).

It should be noted that this EMP does not cover the drilling, stimulation and well testing of an exploration well.

Figure 1 Location of Origin Permit Area



2.3 Project Description

Origin is proposing to construct civil infrastructure within the Velkerri 76 S2 location required for the drilling, stimulation and testing of an exploration well within the Exploration Permit 76. The data collected from the proposed Velkerri 76 S2 exploration well will be utilised to determine the technical and commercial viability of the Kyalla shale resource within Origin's exploration tenure.

The boundary of this EMP is restricted to the civil construction activities required to undertake future proposed drilling, stimulation and well testing activities of the Velkerri 76 S2 exploration well. The boundary of the civil construction program defined as the area which may be affected by exploration activities. This includes:

- Construction of an exploration well lease pad (4.5 ha) and wet weather laydown yard (1 ha)
- Construction of a temporary camp lease pad (1.2 ha)
- Construction of a helipad (0.5 ha);
- Stockpile area (0.2 ha); and
- Extraction of gravel from existing approved gravel pits and associated access tracks approved under NT-2050-15-MP-017

The proposed locations of the infrastructure is within the NLC and AAPA cleared subject land area and is provided in Table 1, Figure 2, Figure 3 and Figure 4. It is noted that the nominated areas for infrastructure may be changed slightly to minimise environmental and heritage impacts (e.g. significant tree or habitat avoidance, or any chance-finds with archaeological artefacts). Such modification will be made within the existing surveyed areas.

Table 1 Proposed infrastructure location and new disturbance area

Exploration Permit	Infrastructure Name	Station	Zone*	Approx Easting	Approx Northing	Disturbance Area (ha)
EP76	Velkerri 76 S2 well pad and wet weather laydown	Amungee Mungee	53	435557	8137497	5.5
EP76	Camp lease pad	Amungee Mungee	53	435882	8136267	1.2
EP76	Stockpile laydown	Amungee Mungee	53	435632	8136163	0.2
E76	Helipad	Amungee Mungee	53	435632	8136246	0.5
Total New Disturbance Area (Ha)						7.4

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

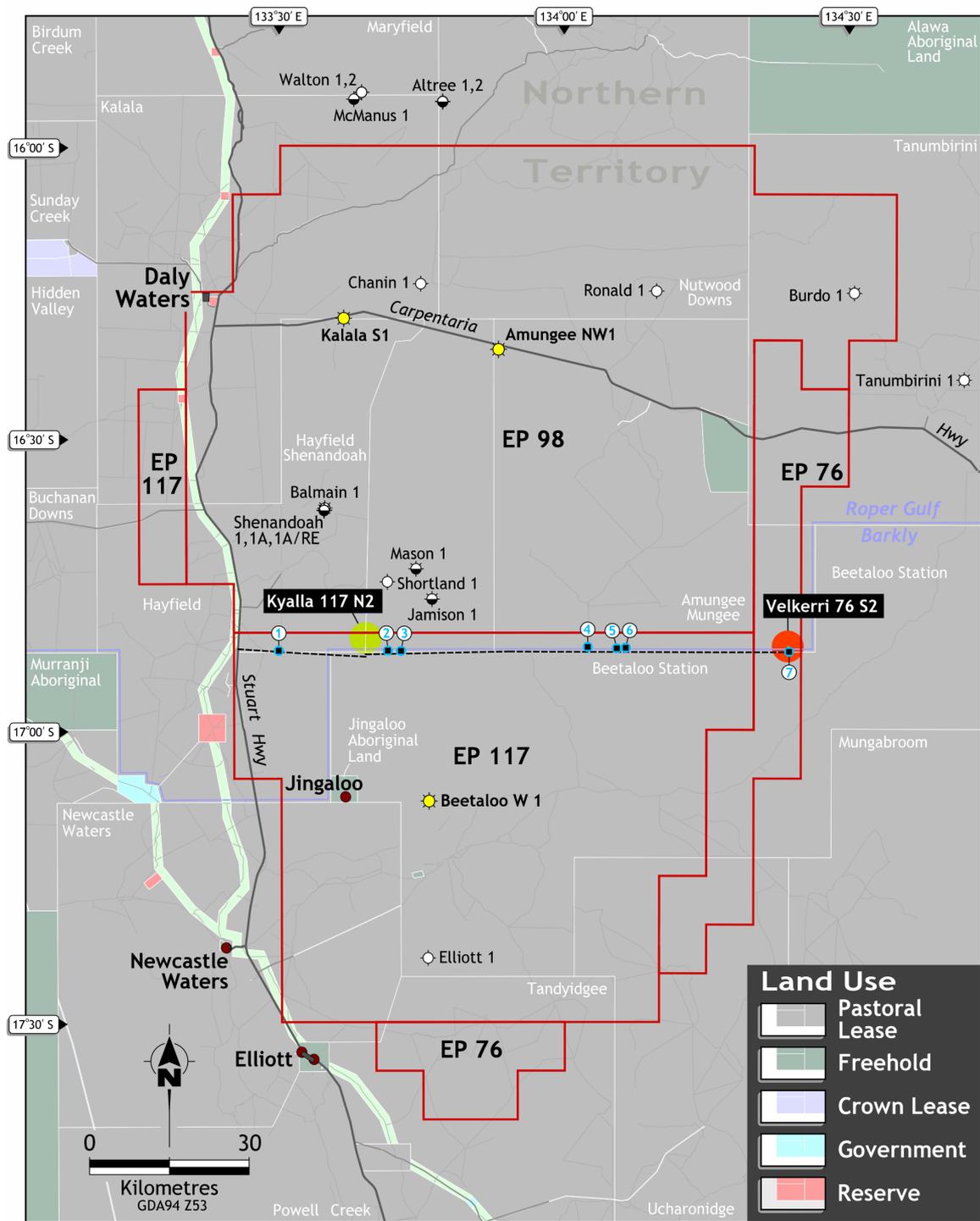
Table 2 Existing Gravel pit locations approved under NT-2050-15-MP-017

Exploration Permit	Infrastructure Name	Station	Zone*	Approx Easting	Approx Northing	Disturbance Area (ha)
EP117	Gravel pit 4	Amungee Mungee	53	397906	8136039	1.0
EP117	Gravel pit 5	Amungee Mungee	53	403386	8135809	1.0
EP117	Gravel pit 6	Amungee Mungee	53	406249	8135276	1.0
EP 76	Gravel pit 7	Amungee Mungee	53	435749	8135306	1.0
Total Existing Disturbance Area (Ha)						4

2.4 Project Proponent

The proponent for the project is Origin Energy B2 Pty Ltd (ABN 42 10 525) as the Operator. The key Operator contacts for this plan are provided below. Origin representatives can be contacted on 1800 526 369, Origin_NT_beetaloo@originenergy.com.au or Community.feedback@originenergy.com.au.

Name	Title
Tracey Boyes	General Manager- Beetaloo and Growth Assets
Matthew Hanson	Project and Operations Manager
Stephanie Stonier	Corporate Affairs Manager
Matt Kernke	Environment Specialist



Velkerri76-S2_Access_Z53_GDA94 Updated 17 May 2019

Legend

- | | | | |
|---|----------------------|----------------------------------|--------------------------------------|
| Beetaloo permits | Town | Historic petroleum well | Proposed drilling & stimulation site |
| Road | Aboriginal community | Existing Origin Exploration Well | Existing access route |
| Unsealed track | Local Govt. area | Gravel borrow pit | Proposed access route (New Section) |
| Additional proposed drilling and stimulation site, not covered under this EMP | | | |

Figure 2 Location of proposed activities within Origin's Exploration tenure

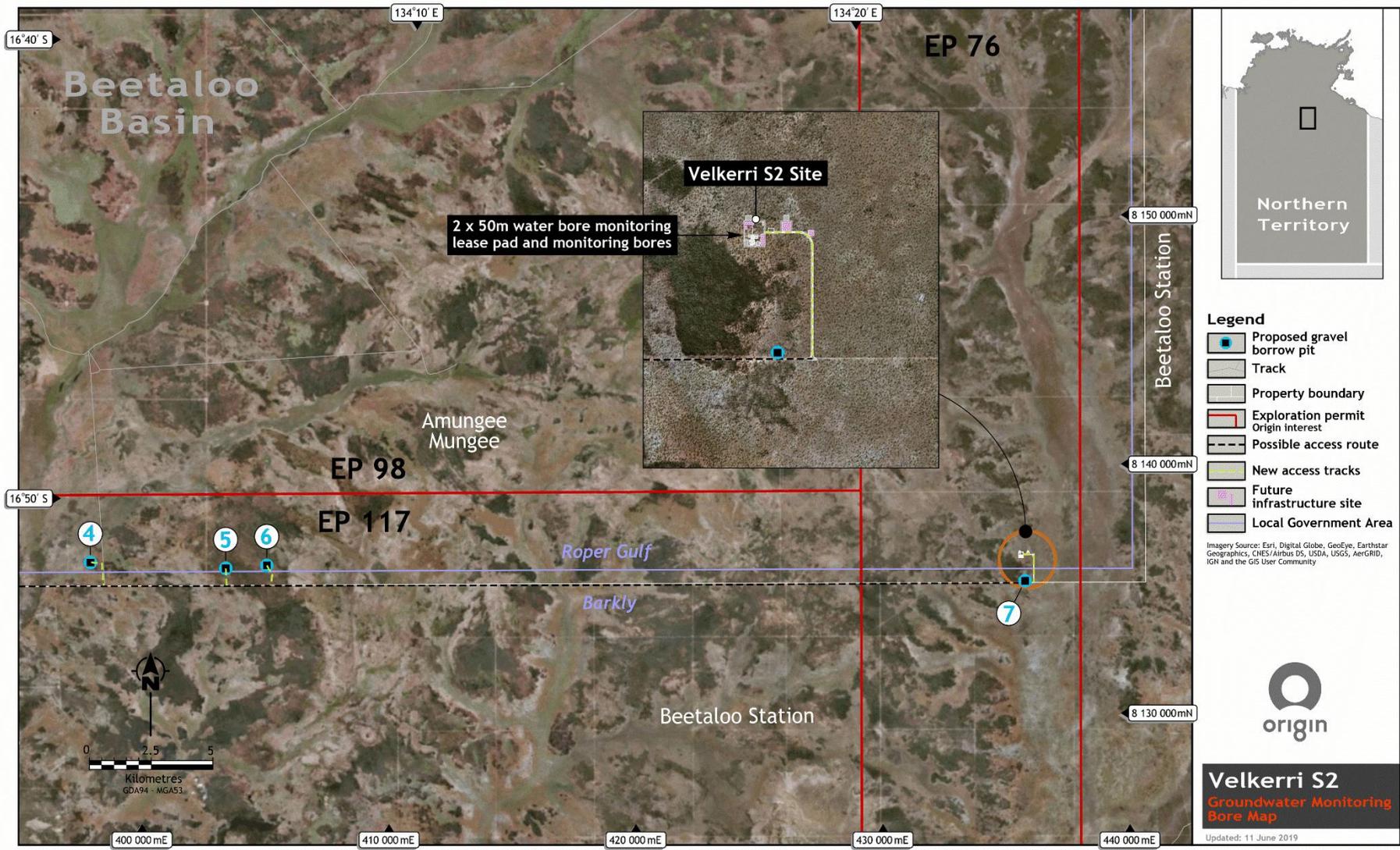
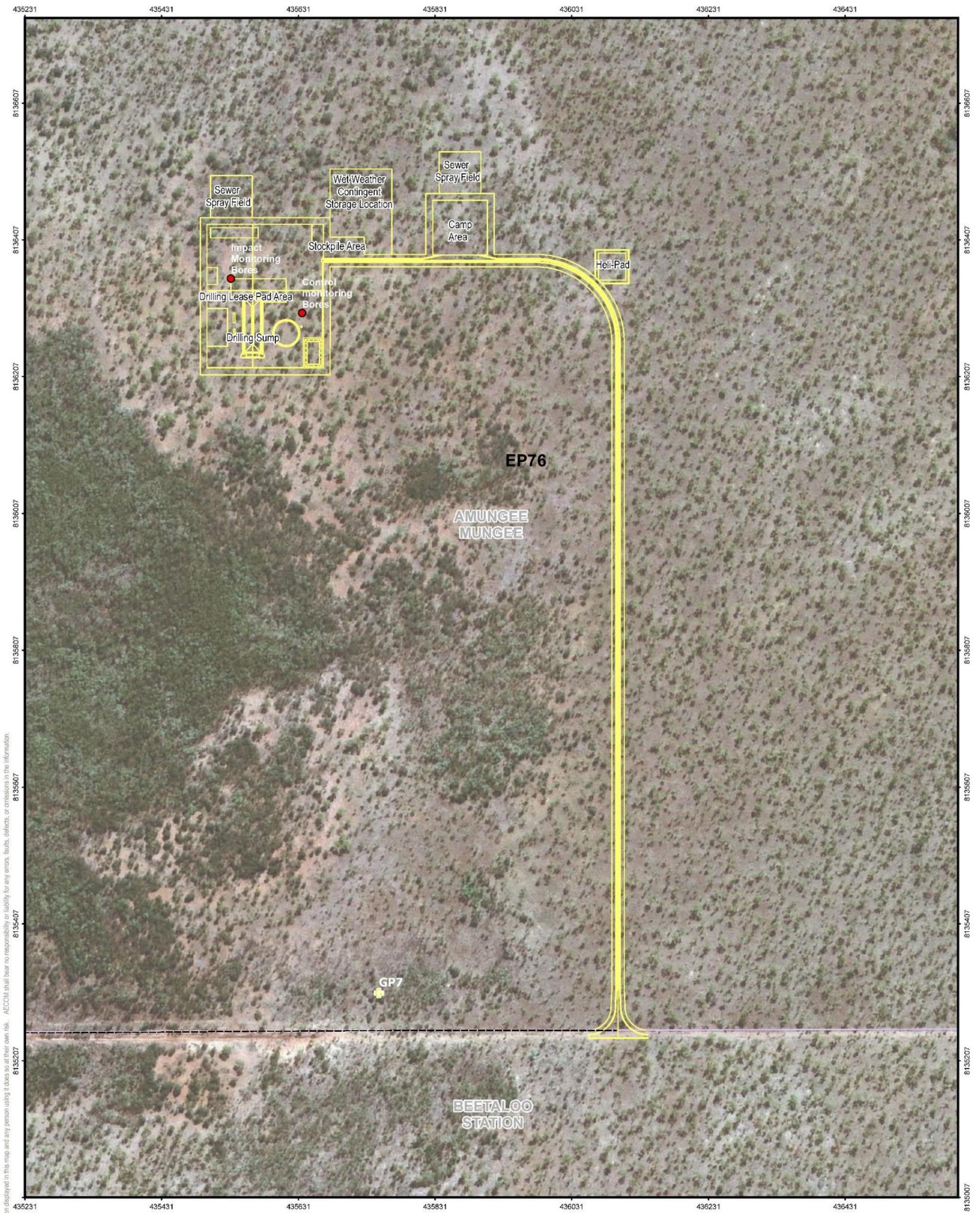


Figure 3 Site location map



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 <p>www.aecom.com</p> <p>Projection: GDA94 MGA Zone 53</p> <p>0 25 50 100 150 200 Meters</p> <p>1:5,000 (when printed at A3)</p>	<p>Legend</p> <ul style="list-style-type: none"> Permit Areas Cadastre ● Bore_Sites G Gravel Pits Access_Tracks Velkerri76_S2_Layout 	<p>LOCATION</p>  <p><small>Data sources: Co-ordinate system: GDA 1984 MGA Zone 53 Permit Area, Cadastre - NI Gov 2016, Places, Vegetation - Aust Gov 2019</small></p>	<p>ORIGIN ENERGY RESOURCES LIMITED 2019 Environmental Management Plan</p> <p style="text-align: center;">Velkerri 76 S2</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 2px;">PROJECT ID</td> <td style="padding: 2px;">60480548</td> </tr> <tr> <td style="padding: 2px;">CREATED BY</td> <td style="padding: 2px;">jace.emberg</td> </tr> <tr> <td style="padding: 2px;">LAST MODIFIED</td> <td style="padding: 2px;">08-Aug-2019</td> </tr> <tr> <td style="padding: 2px;">VERSION</td> <td style="padding: 2px;">1</td> </tr> </table>	PROJECT ID	60480548	CREATED BY	jace.emberg	LAST MODIFIED	08-Aug-2019	VERSION	1
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Figure 4 Schematic of Velkerri 76 S2 lease pad and associated infrastructure

2.5 Broader Exploration Project

Origin's Beetaloo Basin tenure is in the early stages of exploration and appraisal. Future activities are focused on proving the technical and commercial viability of the resource through the strategic placement of wells within the most prospective areas and / or formations.

As illustrated in Figure 5, Origin is in the early stages of its nine-well exploration program which is intended to better understand the potential of the resource including the technical and commercial viability of the underlying source rocks.

The Velkerri 76 S2 lease pad and associated infrastructure will be constructed to enable the drilling, stimulation and well testing of an exploration well. This exploration well is referred to as Velkerri 76 S2 -1 and will be approved under a separate EMP.

The Velkerri 76 S2 exploration well is proposed to be drilled in 2019/ 2020 upon the completion of the Kyalla 117 N2-1 well (covered under a separate approval). Exploration activities in 2020 and beyond will be informed by the well results of the 2019 campaign with an anticipated 2-4 additional wells drilled across Origin's permit per year for the foreseeable future.

In addition to the potential environmental risks associated with the civils components, broader considerations of the cumulative impacts associated with future drilling and stimulation activities have been included in this assessment.

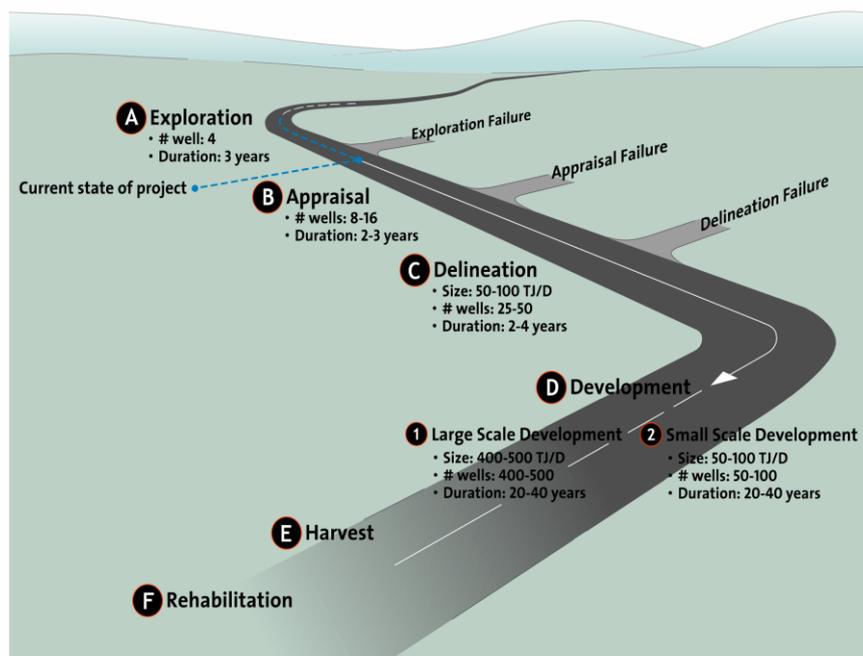


Figure 5 Conceptual Beetaloo Basin project pathway from exploration to development

3 Environmental Legislation and other Requirements

The following section provides an overview of the relevant regulatory requirements, codes of practice and agreements that apply to the activities covered under this EMP. This is the first step in defining the context of the project and provides an overview of the minimum standards and governance framework for any Petroleum related controlled activity.

3.1 Regulatory Framework

In the NT, the granting and administration of exploration permits and associated petroleum activities rests with the Minister for Primary Industry and Resources under the Petroleum Act 1984. In order to commence an activity or a stage of an activity which is carried out, or proposed to be carried out, in connection with a technical work program for a petroleum interest and that has, or will have, an environmental impact or environmental risk (a **regulated**

activity) an Environment Management Plan (**EMP**) must be approved by the Minister for Environment and Natural Resources in accordance with the *Petroleum (Environment) Regulations 2016*.

Alongside the EMP assessment and approval process under the *Petroleum (Environment) Regulations 2016*, the Northern Territory Environment Protection Authority (NT EPA) administers the *Environmental Assessment Act 1982*; which allows for proposals to be assessed as to whether they have the potential to have a significant effect on the environment and if so, whether assessment by way of public environment report or environmental impact statement is required.

A range of Territory and Commonwealth legislation, agreements, operating consents, guidelines and codes of practice are relevant to the activities described in this EMP. These are summarised in Table 3, Table 4 and Table 5.

Table 3 Key Legislation

NT Legislation	Administered By:
<p><i>Petroleum Act 1984, Petroleum (Environment) Regulations 2016</i></p> <ul style="list-style-type: none"> - Provides a framework for petroleum exploration and development to occur within the Territory. - Requires that petroleum activities are carried out in an ecologically sustainable manner and the environmental impacts and environmental risks of the activities are identified and reduced to an acceptable level. - Sets out the requirements for environmental management plans, which includes the Code of Practice for Petroleum Activities in the Northern Territory. Considered when developing this EMP. 	<p>Department of Primary Industry and Resources (Petroleum Act) and Department of Environment and Natural Resources Petroleum (Environment) Regulations</p>
<p><i>Aboriginal Land Act 1978</i></p> <ul style="list-style-type: none"> - Provides for access to Aboriginal land, certain roads bordered by Aboriginal land and the seas adjacent to Aboriginal land. - Provides that a person shall not enter onto or remain on Aboriginal land or use a road unless he has been issued with a permit to do so in accordance with <i>Part II Entry onto Aboriginal land</i> of the Act. - The Land Council for the area in which Aboriginal land or a road is situated may issue a permit to a person to enter onto and remain on that Aboriginal land or use that road subject to such conditions as the Land Council thinks fit. 	<p>Land Council established by or under the Aboriginal Land Rights (Northern Territory) Act 1976 of the Commonwealth</p>
<p><i>Bushfires Management Act 2016 and associated Regulations</i></p> <ul style="list-style-type: none"> - Provides for the protection of life, property and the environment through the mitigation, management and suppression of bushfires, and for related purposes. - Considered when preparing bushfire management plans. 	<p>Bushfires NT, Department of Environment and Natural Resources</p>
<p><i>Control of Roads Act 1953</i></p> <ul style="list-style-type: none"> - Provides for the administration and control of roads, including the maintenance of roads, construction and opening and closing of roads. - The use of any Road Bores will require a permit to work within a road reserve from the Department of Transport. 	<p>Department of Infrastructure, Planning and Logistics</p>
<p><i>Environmental Assessment Act 1982 and associated Regulations</i></p> <ul style="list-style-type: none"> - Provides for the assessment of the environmental effects of development proposals and the environment. - Ensures to the greatest extent practicable that each matter which could reasonably have a significant effect on the environment is fully examined and considered. - Defines environment as being “all aspects of the surroundings of man including the physical, biological, economic, cultural and social aspects”. 	<p>Northern Territory Environment Protection Authority, Department of Environment and Natural Resources</p>
<p><i>Heritage Act 2011 and associated Regulations</i></p> <p>Legislation requiring Origin to assess and mitigate the potential impacts on cultural heritage within the NT including:</p> <ul style="list-style-type: none"> - Sets the process by which places become heritage places. - Allows for interim protection of places. - Sets out the process for getting permission to do work to heritage places. - Declares classes of places and objects of heritage significance to be protected. 	<p>Heritage Branch, Department of Tourism, Sport and Culture</p>

NT Legislation	Administered By:
<ul style="list-style-type: none"> - Provides for heritage agreements to encourage the conservation, use and management of heritage places and objects. - Regulates work on heritage places and objects. - Establishes enforcement and offence provisions. 	
<p>Northern Territory Aboriginal Sacred Sites Act 1989 and associated Regulations</p> <p>Origin is required to obtain AAPA certificates for all exploration activities. The Legislation establishes a procedure for the protection and registration of sacred sites, through:</p> <ul style="list-style-type: none"> • providing entry onto sacred sites and the conditions to which such entry is subject • procedures for avoidance of sacred sites when developing and using land • establishing an Authority for the purposes of the Act • procedures for the review of decisions of the Authority by the Minister, and for related purposes. 	<p>Aboriginal Areas Protection Authority (AAPA); Minister for Environment and Natural Resources</p>
<p>Public and Environmental Health Act 2011 and associated Regulations</p> <ul style="list-style-type: none"> - Outlines requirements for camps, specifically waste and wastewater (sewage and greywater) management. - Provides conditions preventing pollution of watercourses and water supplies in the Northern Territory. Wastewater treatment systems may be subject to requirements under the Public Health Act and regulations.. 	<p>Department of Health</p>
<p>Territory Parks and Wildlife Conservation Act 1976 (TPWC Act) and associated Regulations</p> <ul style="list-style-type: none"> - Provides for the protection, conservation and sustainable utilisation of wildlife. - Provides protection of listed threatened species for which Origin must consider whether its activities have the potential to impact directly or indirectly on a listed threatened species or place covered under this Act. 	<p>Flora and Fauna Division of the Department of Environment and Natural Resources</p>
<p>Waste Management and Pollution Control Act 1998 and associated Regulations</p> <ul style="list-style-type: none"> - Provides for the protection of the environment through encouragement of effective waste management and pollution prevention and control practices and for related purposes. - Outlines the requirements for “listed wastes” which require specific licences for the transportation and disposal of certain prescribed wastes, including tracking and reporting requirements. - To facilitate the implementation of National Environment Protection Measures established by the National Environment Protection Council (Northern Territory) Act. - Section 12 of the Act places obligation on a person to ensure they take all practicable measures to prevent or minimise pollution when undertaking an activity that could cause pollution and environmental harm. - Waste produced within Origin’s exploration activities will need to be managed in accordance with this Act. This includes using licenced waste transportation companies, tracking listed wastes and disposing of wastes at licenced facilities. 	<p>Northern Territory Environment Protection Authority, Department of Environment and Natural Resources</p>
<p>Water Act 1992</p> <ul style="list-style-type: none"> - Provides for the investigation, allocation, use, control, protection, management and administration of water resources, including extraction of groundwater, waste water management and water pollution. - Provides for water allocation plans, beneficial uses within Water Control Districts, drilling licences, bore construction permits, water extraction licences, waste discharge licences, fees and charges, and penalties for offences against the Act. - The use of groundwater for stimulation activities (including supporting works) within the Beetaloo Basin is required to comply with the Water Act. - Act prohibits wastewater reinjection and surface water extraction for stimulation activities. 	<p>Water Resources Division, Department of Environment and Natural Resources</p>

NT Legislation	Administered By:
<p>Weeds Management Act 2001</p> <ul style="list-style-type: none"> - Protects the Territory's economy, community, industry and environment from the adverse impact of weeds. - Identifies declared weeds (those which must be controlled) and provides a framework for weed management which forms the basis of Origin's Weed Management Plans. 	Weed Management Branch, Department of Environment and Natural Resources
<p>Work Health and Safety (National Uniform Legislation) Act 2011</p> <ul style="list-style-type: none"> - Provides for a balanced and nationally consistent framework to secure the health and safety of workers and workplaces. - Provide a mandated level of protection to workers from exposures associated with chemical handling and storage. 	NT WorkSafe, Department of the Attorney-General and Justice
Commonwealth Legislation	Administered By:
<p>Aboriginal and Torres Strait Islander Heritage Protection Act 1984</p> <ul style="list-style-type: none"> - Provides for the preservation and protection of places, areas and objects from injury or desecration of particular significance to Aboriginal people in accordance with Aboriginal tradition. 	Department of the Environment and Energy
<p>Aboriginal Land Rights (Northern Territory) Act 1976</p> <ul style="list-style-type: none"> - Provides for the granting of Traditional Aboriginal Land in the Northern Territory for the benefit of Aboriginal people, and for other purposes. 	Department of Prime Minister and Cabinet
<p>Australian Heritage Council Act 2003</p> <ul style="list-style-type: none"> - Establishes the Australian Heritage Council which is the principal adviser to the Australian Government on heritage matters. - The Council's major role is to assess the heritage values of places nominated for the National Heritage List and the Commonwealth Heritage List, and to advise the Minister on promotion, research, education, policies, grants, conservation and other matters. - The Council also makes assessments under the <i>EPBC Act</i>, and performs any other functions conferred on the Council by the <i>EPBC Act</i>. 	Department of the Environment and Energy
<p>Environment Protection and Biodiversity Conservation Act 1999</p> <ul style="list-style-type: none"> - Provides for the protection of the environment and conservation of biodiversity, particularly species and places of national significance. - Invoked only if a development is likely to have environmental impacts of national significance. 	Department of the Environment and Energy
<p>National Environment Protection Council Act 1994</p> <ul style="list-style-type: none"> - The object of this Act is to ensure that, by means of the establishment and operation of the National Environment Protection Council: <ul style="list-style-type: none"> a) people enjoy the benefit of equivalent protection from air, water or soil pollution and from noise, wherever they live in Australia; and b) decisions of the business community are not distorted, and markets are not fragmented, by variations between participating jurisdictions in relation to the adoption or implementation of major environment protection measures. - Provides national standards for ambient air quality, movement of controlled wastes, and contaminated sites. - The Commonwealth, the States, the Australian Capital Territory, the Northern Territory and the Australian Local Government Association have entered into an Agreement known as the Intergovernmental Agreement on the Environment setting out certain responsibilities of each party in relation to the environment. 	Department of the Environment and Energy
<p>National Greenhouse and Energy Reporting Act 2007</p> <ul style="list-style-type: none"> - An Act to provide for the reporting and dissemination of information related to greenhouse gas emissions, greenhouse gas projects, energy consumption and energy productions of corporations. - All direct and indirect emissions from Origin's activities are required to be reported to NGERS annually. 	Department of the Environment and Energy
<p>Native Title Act 1993</p> <ul style="list-style-type: none"> - Provides for the recognition and protection of native title for Indigenous peoples. - Establishes ways in which future dealings affecting native title may proceed and to set standards for those dealings. 	Prime Minister and Cabinet

NT Legislation	Administered By:
<ul style="list-style-type: none"> - Establishes a mechanism for determining claims to native title. - Provides for the validation of past acts, and intermediate period acts, that have been invalidated because of the existence of native title. 	

Table 4 Codes of Practice and Relevant Guidelines

Codes of Practice
<p>Code of Practice for Small On-site Sewage and Sullage Treatment Systems and the Disposal or Reuse of Sewage Effluent (NT Department of Health, 2014)</p> <ul style="list-style-type: none"> - Provides guidance for the management of effluent. - It is noted that Territory Health Services will issue any amendments to the above Code on an annual basis.
<p>Code of Practice for Petroleum Well Operations in the Northern Territory</p> <ul style="list-style-type: none"> - Mandatory Code of Practice for the Petroleum industry to ensure that petroleum activities in the Northern Territory are managed according to minimum acceptable standards to ensure that risks to the environment can be managed to a level that is as low as reasonably practical (ALARP) and acceptable.
Guidelines
<p>API Guidance Document –HF3, Practices for Mitigating Surface Impacts Associated with Hydraulic Fracturing</p> <ul style="list-style-type: none"> - Describes a series of practices currently used in the oil and natural gas industry to minimise surface environmental impacts—potential impacts on surface water, soils, wildfire, other surface ecosystems and nearby communities—associated with hydraulic fracturing operations.
<p>AS 1940: The storage and handling of flammable and combustible liquids, 2004 Provides guidance for the operation and handling of flammable and combustible liquids.</p>
<p>Best Practice Erosion and Sediment Control (International Erosion Control Association, 2008)</p> <ul style="list-style-type: none"> - Facilitates the identification of those issues that should be considered when formulating and evaluating strategies for best practice erosion and sediment control. - Facilitates best practice stormwater management. - Facilitates active avoidance or minimisation of soil erosion resulting from construction activities. - Facilitate best practice soil and sediment control management on sites.
<p>Bores, drilling and dams</p> <ul style="list-style-type: none"> - Provides information on water drilling licences, bore construction permits, licensed drillers and other information regarding drilling water bores in the NT. - https://nt.gov.au/environment/waterhttps://nt.gov.au/environment/water/bores-drilling-and-dams/about-water-drilling-licences
<p>ISO 31000 Risk management- Principles and guidelines</p> <ul style="list-style-type: none"> - This international standard provides a standardised to identify, assess and manage risk. - Assessment of risk in EMP’s shall be undertaken in alignment with this guideline
<p>Guideline for the Preparation of an Environmental Management Plan (DENR, 2018)</p> <ul style="list-style-type: none"> - Details the environmental protection measures to be included in Environmental Management Plans. - Includes changes emanating from the recommendations of the NT Hydraulic Fracturing inquiry.
<p>Guideline for Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo sub-basin (DENR 2018)</p> <ul style="list-style-type: none"> - Technical guidance for the onshore gas industry establishing the minimum expectations in relation to groundwater monitoring requirements. - Requires the establishment of control and impact monitoring bores prior to undertaking stimulation activities.
<p>Northern Territory Natural Resource Management Plan 2016-2020 (Territory Natural Resource Management, 2016)</p> <ul style="list-style-type: none"> - Describes the management direction for the NT’s natural resources for the five-year period and beyond. - Four regional plans provide an overview of the current land condition, use and threats, key areas to monitor and improve approaches, and the level of coordination that occurs across key organisations responsible for implementing actions.
<p>ISO 19011: Guidelines for auditing management systems, 2018</p> <ul style="list-style-type: none"> - Provides guidance on environmental auditing to a certifiable standard.

<p>Minimum Construction Requirements for Water Bores in Australia (National Water Commission, 2012)</p> <ul style="list-style-type: none"> - Developed by the National Uniform Drillers Licensing Committee, this document outlines the minimum requirements for constructing, maintaining, rehabilitating, and decommissioning water bores in Australia.
<p>Northern Territory Land Clearing Guidelines (DENR, 2019)</p> <ul style="list-style-type: none"> - Clearing and land disturbance must be carried out in accordance with Land Clearing Guidelines. - These guidelines are specifically referenced in the Petroleum Code of Practice
<p>Northern Territory Noise Management Framework Guideline (NT EPA, 2018)</p> <ul style="list-style-type: none"> - Provides guidance to the community and industry about the noise regulatory framework as it applies in the NT.
<p>Weed Management Planning Guide - Onshore Shale Gas Development Projects (DENR, 2018)</p> <ul style="list-style-type: none"> - Provides guidance to the industry about the weed management planning required to undertake Onshore Shale Gas Developments in the NT.

Table 5 Relevant agreements and operating consents

Agreements	Administered By:
<p>Native Title Petroleum Exploration Agreement (between the Host Traditional Owners and Origin Energy [Falcon Oil and Gas])</p> <ul style="list-style-type: none"> - Includes clauses for the protection of sacred sites, objects and sensitive areas related to Aboriginal activities in the area, including cultural, hunting and foraging activities. Site clearance will occur prior to any on ground activities. The Native Title Agreement also includes clauses for the protection of the environment and rehabilitation. 	Northern Land Council
<p>AAPA Certificates</p> <ul style="list-style-type: none"> - The most current clearance certificates issued for the Origin exploration program as referenced within this EMP. 	Aboriginal Areas Protection Authority
<p>Access agreement</p> <ul style="list-style-type: none"> - A negotiated access agreement formed between a resource company and a private pastoralist relating to the rights over 'access land'. 	DPIR
<p>Apply for permit to work within a road reserve</p> <ul style="list-style-type: none"> - Road bores are usually used for road construction and maintenance work, however application to access water in the bores can be made to the Department of Transport for approval. - Approval to access the bore will be dependent on the bore having sufficient capacity to meet future needs for road construction and maintenance. 	Department of Infrastructure, Planning and Logistics (DIPL)

3.2 Referral Assessment

Approval for the proposed action has considered the need for referral under the NT Environmental Assessment Act and the Commonwealth Environment Protection and Biodiversity Conservation Act. Impacts associated with the proposed activity will be largely centred on vegetation clearing, bushfires, introduction of weeds and erosion and sediment control.

3.2.1 NT Environmental Assessment Act

In the NT, proposed actions that have the potential to have a significant effect on the environment require Environmental Impact Assessment (EIA) under the Environmental Assessment Act. In such cases, a Notice of Intent (NOI) is required to be submitted to the NT Environment Protection Agency outlining the relevant information to allow a decision on whether the proposed action requires a Public Environmental Report (PER) or an Environmental Impact Statement (EIS). Where the environmental impacts of the proposed activity are not significant, a PER or EIS will not be required.

An assessment of whether the proposed activity requires a NOI was undertaken in accordance with the NT *Referring a Proposal to the NT EPA* guideline. A summary of the relevant environmental factors is included in Table 6.

No significant impacts on any of the NT environmental factors and objectives are anticipated. Origin does not believe the activity is required to be assessed under the Environmental Assessment Act.

3.2.2 Commonwealth Environment Protection and Biodiversity Conservation Act

Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1997* (EPBC) an action that has, will have or is likely to have a significant impact on Matters of National Environmental Significance (MNES) must be referred to the Australian Government Minister for the Environment (the Minister) for assessment. A self-assessment in accordance with the EPBC Act was undertaken under this EMP. The environment and heritage assessment confirmed that no significant impacts to EPBC listed threatened species, threatened ecological communities or migratory species were likely. The proposed program will not require referral under the EPBC Act.

Table 6 Assessment against environmental factors and objectives

Environmental Factors	Project Specific Environmental Factors	Environmental Objectives at Risk	Receiving Environment	Impact Description	Mitigation Measures	Potential significant effect on an environmental factor?	Assumptions
Land	Terrestrial Flora and Fauna	Protect NT's flora and fauna so that biological diversity and ecological integrity are maintained.	Corymbia spp open woodland with mixed Terminalia spp. shrubland over low tussock grassland (Triodia bitextura)	7.4 Hectares of clearing of a non-threatened or endangered vegetation communities primarily consisting of: Corymbia spp open woodland with mixed Terminalia spp. shrubland over low tussock grassland (Triodia bitextura). The lease pad and access tracks have been positioned to avoid clearing of the adjacent patches of Lancewood and Bullwaddy. Activity not expected to impact on threatened/endangered flora and fauna.	<ul style="list-style-type: none"> •Field ecological survey •Avoidance of high value vegetation communities. •Land clearing as per NT Land Clearing Guidelines. •Weed Management Plan. 	No - Activity unlikely to result in significant impacts on high valued vegetation communities or threatened flora and fauna or areas essential habitat.	Assessment based upon field surveys. Threatened fauna may be present in the area which were not identified during the surveys.
	Terrestrial Environmental Quality	Maintain the quality of land and soils so the environmental values are protected.	Corymbia spp open woodland with mixed Terminalia spp. shrubland over low tussock grassland (Triodia bitextura)	No significant erosion impacts or risks are anticipated.	<ul style="list-style-type: none"> •Land clearing as per NT Land Clearing guidelines. •Construction to commence in dry season. •All disturbed areas to be rehabilitated. 	No - Assessment indicates activity unlikely to result in significant impacts from increased erosion and sediment releases.	Assumes internationally accepted erosion and sediment controls are sufficient to manage risk of erosion within the NT.
	Landforms	Conserve the variety and integrity of distinctive physical landforms so that environmental values are protected.	Low relief area, <1% slope on tertiary lateritic red sands	•Clearing and levelling (minor) of a 7.4 hectare area to accommodate a lease pad, camp pad, gravel pits and access tracks.	<ul style="list-style-type: none"> •Infrastructure located on flat ground. •Minimal cutting and filling required. •Pad and road design consistent with surrounding landform. 	No - No major modification to the surrounding landform is predicted.	Assessment is based upon field ecology scouting.

Environmental Factors	Project Specific Environmental Factors	Environmental Objectives at Risk	Receiving Environment	Impact Description	Mitigation Measures	Potential significant effect on an environmental factor?	Assumptions
Water	Aquatic Ecosystems	Protect aquatic ecosystems to maintain the biological diversity of flora and fauna and the ecological functions they perform.	<ul style="list-style-type: none"> • Located ~200km from any Groundwater Dependent Ecosystems. • Activity not located within close proximity to any major flow paths, wetlands or permanent watercourses. 	No significant impacts or risks anticipated.	<ul style="list-style-type: none"> • Groundwater extraction modelled within sustainable yields. • No surface water extraction. • Location of lease pad away from GDE's, wetlands, permanent streams or major watercourses and flow paths. • Erosion and sediment control plan to be implemented. 	No - Activities are not anticipated to impact on the environmental factor.	<ul style="list-style-type: none"> • Modelling based on known and assumed properties of aquifer. • Assumes internationally accepted erosion and sediment controls are sufficient to manage risk of erosion within the NT.
	Inland Water Environmental Quality	Maintain the quality of groundwater and surface water so that environment values including ecological health, land uses, and the welfare and amenity of people area protected.	Cambrian Limestone Aquifer- Gum Ridge Formation	No significant impacts or risks on pastoralist bores from groundwater extraction anticipated. Water Extraction Licence (WEL) statement of reasons confirms no long-term drawdown above 1m. (Appendix C)	<ul style="list-style-type: none"> • All groundwater take to be licenced with yield within sustainable recharge levels. 	No - Assessment indicates activity unlikely to result in significant impacts to groundwater.	Assessment based on hydrological information collected during drilling and assumed transmissivity and storage values.
	Hydrological processes	Maintain the hydrologic regimes of groundwater and surface water so that environmental values are protected.	<ul style="list-style-type: none"> • Cambrian Limestone Aquifer- Gum Ridge Formation • Activity not located within close proximity to any major flow paths, wetlands or watercourse. 	No significant impacts or risks anticipated. WEL statement of reasons confirms no impacts to Groundwater Dependent Ecosystems or springs. (Appendix C)	<ul style="list-style-type: none"> • Groundwater extraction modelled within sustainable yields. • No surface water extraction. • Location of lease pad away from GDE's, wetlands, permanent streams or major watercourses and flow paths. • Design of lease pads to avoid impacts to overland flow. • Any soft points wash out areas will be managed with gravel as per the EMP. 	No - Assessment indicates activity unlikely to result in significant impacts to groundwater or surface water.	<ul style="list-style-type: none"> • Modelling based on known and assumed properties of aquifer.

Environmental Factors	Project Specific Environmental Factors	Environmental Objectives at Risk	Receiving Environment	Impact Description	Mitigation Measures	Potential significant effect on an environmental factor?	Assumptions
Air	Air Quality and Greenhouse Gases	Maintain air quality and minimise emissions and their impact so that environmental values are protected.	Rural environment with minimal industrial or urban inputs.	No significant impacts or risks anticipated.	<ul style="list-style-type: none"> • Activity intensity low, with no local sensitive receptors. •Dust suppression to be utilised to minimise dust generation. •Equipment to be compliant with relevant pollution control device requirements and maintained to minimise emissions. 	No - Assessment indicates activity unlikely to result in significant impacts to air quality of greenhouse gas generation.	Estimates of greenhouse gas generation using estimates from Transport Authorities Greenhouse Group.
People and communities	Social, economic and cultural surroundings	Protect the social, economic, cultural and heritage values of the Northern Territory.	Rural communities, pastoralists and Traditional Owners.	Traffic increases associated with civil activities are small and not ongoing. Impacts from increased traffic will not materially impact on pastoralists, tourism or the broader community. Lease pad located approximately 100km from Stuart highway with no visual impacts. Civil construction activities will be undertaken by a Darwin based and Tennant Creek based company with strong indigenous employment levels. Workers will be housed in temporary fly camps located along the access track. Activity has considered pastoralist infrastructure and activities. The activity is located along the property boundary and away from pastoralist access points, cattle yards and water supply network	<ul style="list-style-type: none"> •All civil activities undertaken by NT businesses. •Activity located away from pastoralist access routes, cattle yards, homesteads and water supply network. •Works completed in accordance with Code of Practice: Onshore Petroleum Activities in the Northern Territory (and any land access agreement negotiated between Origin and a landholder at a later date •NLC clearances and AAPA certificates for all activities. •Remote site located away from major infrastructure, homesteads, roads or communities •All contractors and Origin employees are required to have code of conduct training to ensure appropriate behaviour in the community. Fly camps will be used to minimise impacts on 	No - Low intensity activity not anticipated to negatively impact on factor.	All relevant Traditional Owners are engaged by NLC.

Environmental Factors	Project Specific Environmental Factors	Environmental Objectives at Risk	Receiving Environment	Impact Description	Mitigation Measures	Potential significant effect on an environmental factor?	Assumptions
					accommodation. Camps will be dry, with no alcohol permitted.		
	Human health	Ensure the risks to human health are identified, understood and adequately avoided and /or mitigated.	Remote rural environment.	No impact to human health anticipated from civil construction activities.	<ul style="list-style-type: none"> •Low intensity activity with nuisance (dust) likely to be the main issue associated with civil construction activities. •Limited exposure sources and receptors. 	No - Low intensity activity with limited sources and receptors.	None.

3.3 The Independent Scientific Inquiry into Hydraulic Fracture Stimulation in the Northern Territory

On 17 April 2018, the NT Government announced the lifting of the moratorium on hydraulic fracturing of onshore unconventional gas reservoirs within the NT. The lifting of the moratorium was made with the endorsement of the 135 recommendations handed down by the Inquiry. Of these recommendations, 35 were required to be implemented before the commencement of further exploration activities. The remainder are required to be implemented prior to production approvals being granted.

One of the key recommendations of the Inquiry was the development of a series of codes of practice that prescribe minimum requirements for undertaking onshore unconventional gas activities.

All relevant recommendations and associated Code of Practice requirements have been considered in the development of this EMP.

3.4 Alignment with the Principles of Ecologically Sustainable Development (ESD)

This EMP is consistent with the principles of ESD through the adoption of responsible practices that are designed to maximise social benefit, whilst minimising the level of impact on the surrounding ecosystems. The ESD principles as defined in the Petroleum (Environment) Regulations are as follows:

- Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations;
- If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;
- The principle of inter-generational equity – that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;
- The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making; and
- Improved valuation, pricing and incentive mechanisms should be promoted.

Origin's exploration activities align with the principles of ESD through the following:

- The exploration activities are an essential step in defining a potential future commercial resource which can generate sustainable, long-term benefits to the local community, to the Barkly region generally and more broadly into the rest of the NT.
- Complying with NT Codes of Practice and industry best practice to reduce any risk to the environment and communities to an acceptable level. Noting the Inquiry Panel's Final Report Statement that "provided that all of the recommendations made in this Report are adopted and implemented in their entirety, not only should the risks associated with an onshore shale gas industry be minimised to an acceptable level, in some instances, they can be avoided altogether" (Scientific Inquiry into hydraulic fracturing in the Northern Territory 2018);
- The activities that are subject of the EMP do not constitute threats of serious or irreversible environmental damage and there is no impact on the conservation of biological diversity and ecological integrity;
- Beyond royalty payments to the NT Government (as owner of the natural resource), and payments to Native Title Holders (as per Exploration Agreements) and host pastoralists (as per Access and Compensation Agreements), Origin seeks to maximise broad-based local participation in education, training, employment and enterprise opportunities engendered by its presence;
- Prioritising the use of local employment to deliver exploration activities;
- Obtaining sacred site clearances from host Traditional Owners through open engagement custodians and the Statutory Representative body - the Northern Land Council (NLC); and
- *Complying with the Code of Practice: Onshore Petroleum Activities in the Northern Territory (and any land access agreement negotiated between Origin and a landholder at later date*

4 Description of the regulated activity

The following section provides a description of the activities that are covered under this EMP. The proposed civils construction activities are an enabler for additional exploration activities (drilling, stimulation and well testing) which will be addressed in a separate EMP submission.

The activities subject to this EMP are:

- Construction of a (5.5 ha) lease pad, including a 1 hectare wet weather storage area;
- Construction of a drilling sump, cellar and sediment retention basin within the constructed lease pad;
- Construction of a camp pad (1.2 ha);
- Construction of a stockpile area (0.2 ha);
- Construction of a helipad (0.5 ha);
- Installation of fencing, gates and grids on the Velkerri 76 site; and
- Use of existing approved 4 gravel pits

A description of each of the proposed activities is provided in the following section, along with the core management strategies for certain environmental aspects. A schematic of the proposed activity is provided in Figure 4.

4.1 Civil construction program

4.1.1 Exploration well lease and camp pads

An exploration well lease pad and camp pad will be constructed to support the exploration activities. The exploration well lease pad will be 5.5 ha in size and include provision for up to 20 m firebreaks to reduce the potential risk to infrastructure. The lease pads will be engineered to allow heavy vehicles, the drilling rig and associated equipment to manoeuvre and operate safely. Of the 5.5 ha area, 1 ha of this space is allocated to wet weather preparation, allowing material and equipment to be stored prior to and over the wet season. The additional 1 ha area will only be cleared if required. The schematic of the anticipated well lease pad design is provided in Appendix B. Please note, the final design of the internal lease layout may change depending on operational requirements.

The camp pad will be approximately 1.2 ha in size and includes an irrigation area to irrigate effluent from temporary camps used during the drilling, stimulation and well testing. The irrigation area will not be used during civil construction activities.

An additional 0.2 ha stockpile laydown yard will be constructed to store excess topsoil and vegetation from the lease pad if required. This stockpiled topsoil will remain on-site until rehabilitation for up to five years.

The location of lease and camp pads have been chosen to minimise any risk associated with the future drilling, stimulation and well testing activities. The proposed infrastructure location has been modified from the initial design, to avoid impacts to adjacent Bullwaddy and Lancewood communities. Field ecological and cultural heritage clearances have been obtained for the proposed sites. There are no areas of high conservation or habitat value or areas of cultural significance in the vicinity of the proposed project area. Approximate separation distances to the nearest environmental and community receptors from the proposed lease pad are:

- 100 km from the Stuart Highway
- 40 km from Carpentaria Highway
- 50 km from the nearest homestead
- 100 km from the nearest community (Jingaloo)
- 30 km from the closest conservation area (Bullwaddy Conservation area)
- 13 km from the closest major watercourse (Newcastle Creek)
- 11.4 km from the closest pastoralist bore
- 105 km from Frew Ponds Historical Reserve
- 7km from the closest restricted work areas

Each pad will be cleared of vegetation and stripped of up to 150mm of topsoil, with the topsoil stockpiled around the edge of the lease or on the designated stockpile area. Stockpile stripping is undertaken to reduce the physical damage to soil structure (from compaction and equipment movement) and will be used as a growth medium to support vegetation reinstatement. The topsoil stockpiles surrounding the lease pad will be allowed to

germinate with the native species from the area, maintaining the soil condition and seed bank. This will continue to provide a seed bank for the duration they are stockpiled (refer to Figure 6) which shows the topsoil stockpiled at Origin's Amungee NW1H lease pad as an example).

The anticipated stockpile depth is likely to be less than 1.5m to maximise the viability of the topsoil for future rehabilitation.

The topsoil will also be used to create a bund to prevent wastewater from leaving the site in the event of a tank failure and prevent overland flow entering the site in the event of a significant regional flood. The bund will be of an appropriate height to contain the volume of the largest wastewater storage tank on site. Additional topsoil will be stored on the stockpiled area.

The proposed timeframe for the topsoil to be stockpiled around the lease could be up to 5 years, depending on whether the infrastructure will be required to support future exploration activities. Seed bank viability in the lower half of the stockpile may become compromised, however the upper levels are likely to continue to provide a valid seed bank. Furthermore, the vegetation community in the area are adapted to soils lacking in nutrients, low to no rainfall for over 8 months of the year and occur in free draining soils. The vegetation community is adapted to the harsh conditions that occur in a semi-arid area and likely to recover quickly post rehabilitation.



Figure 6 Amungee NW-1 topsoil stockpile with native grass species

The lease pads will be levelled and compacted, with gravel added to the lease pads to aid forming the working surface. The compacted surface will also minimise the infiltration of any spills and allow for material recovery.

The pads will be constructed with an approximate 0.2 degree fall terminating at a purpose-built stormwater retention basin to manage rainfall that falls on the lease. The retention basin will only be in operation during stimulation and well testing activities, with the basin being removed at other times. Any stormwater collected will be beneficially used on-site (for dust suppression within the activity area) or tested prior to release outside of the approved activity area (i.e. surrounding area).

An 8m³ cellar will be constructed on the proposed lease to accommodate the wellhead equipment and Blow-Out Preventer (BOP). The cellar will have a conductor casing installed with an auger and will be lined with cement. The cellar itself will be fenced with cattle panels and rigid plastic screening material at all times to exclude fauna ingress.

The site will be fenced with a stock-proof fence to prevent livestock access.

Controls:

- Infrastructure will be located and constructed in accordance with the Petroleum CoP
- Infrastructure located to avoid:
 - areas of high conservation or habitat value, along with areas of cultural significance.
 - interfering with surface water flow pathways, drainage lines and watercourses
 - impacts to visual amenity and nuisance (light, dust and noise)
 - impacts on sensitive receptors such as pastoral leaseholders and the community.
- Land Condition Assessment completed to identify and avoid constraints, including field ecology and cultural heritage surveys.
- Weed surveys completed.
- Weed Management Plan (NT-2050-15-MP-0016) implemented with all equipment washdown and certified prior to mobilisation. Weed management plan provided in Appendix D.
- Weed officer has been nominated.
- The erosion and sediment control plan (NT-2050-15-MP-019) will be implemented (Appendix E).
- Clearing predicted to occur during periods of low erosion risk.
- Clearing activities to align with the NT Land Clearing Guidelines.
- Topsoil to be stripped up to 150 mm to preserve soil structure.
- Clearing area restricted to the minimum required for the activity.
- Construction on sloped areas avoided.
- Cellar to be fenced to prevent fauna ingress.
- Spotterr utilised for clearing of high-density vegetation.
- The lease pad, sumps and drilling cellar will be fenced to prevent stock and fauna access

4.1.2 Drilling sump

A drilling sump will be constructed on the cleared lease pad to support future drilling operations. Drilling sumps are engineered to store drilling fluids, muds and drill cuttings.

An overview of the anticipated sump design is provided in Appendix B. The sump surface will be rolled and compacted, with a Coletanche liner installed. Coletanche is a composite liner consisting of five (5) different layers composing of:

- A highly resistant anti-root film able to withstand puncturing by vegetation or rough substrates
- Glass fleece which ensures dimensional stability
- A non-woven geotextile reinforced structure which is highly resistant to tearing, and puncturing
- An elastomeric bitumen binder ensures that the geotextile is waterproof and resistant to ageing
- A coating of sand ensures that workers can move on the surface in all weather conditions in order to carry out maintenance work. It also provides a rough surface which allows coverage of the membrane by soil
- The Coletanche liner product data sheet is provided in Appendix B. Coletanche was selected based upon the following:
 - Easily installed and shaped to fit sump geometry
 - High resistance to tearing/puncturing and to hydrostatic pressures
 - Low water permeability, with a 6.10^{-14} m/s permeability
 - Can withstand high temperature fluctuations

The entire lease pad will be fenced with barb wire stock proof fencing. Fencing around the sump (when storing fluid and muds) will consist of cattle panels with rigid mesh placed over to prevent access to drilling sump. When the drilling sump is not storing material or fluids, the Coletanche liner has sufficient grip to allow fauna to escape. The fencing will then be restricted to cattle panels to restrict stock access. A

Controls:

- The drilling sump will be lined with an impermeable liner (Coletanche).
- The sump will be fenced during the storage of muds and fluid to prevent fauna
- QA/QC procedure for coletanche installation to be implemented as a part of construction.

4.1.3 Gravel Pits

Gravel will be sourced from the four existing 1 ha borrow pits as outlined in Figure 3 and Table 2. Approximately 10,000m³ of gravel in total will be required to surface the lease, camp pads and access tracks. This may be extracted from one pit, or from multiple pits (Gravel pits 4 – 7) depending on the volume and quality of the gravel encountered at each proposed gravel pit location (Figure 3).

Gravel pits will be cleared, with topsoil and subsoil stripped, segregated and stockpiled onsite for future revegetation. Gravel pit rehabilitation will commence within 12 months once there is no viable gravel left. However, if viable gravel remains gravel pits will remain open for up to five years as these gravels may be utilised for future exploration activities. This will reduce the ultimate disturbance footprint as new clearing for future activities won't be required.

Gravel pits are anticipated to be up to 3m in depth, with the final depth dependent on the level of gravel present at the site. Fencing will be used around gravel pits where the pit batters represent a potential fall hazard to livestock and fauna.

Upon cessation of activities, the gravel pits will be recontoured back to a stable, safe and non-polluting form. Subsoils and topsoil will be reinstated across the gravel pit and natural revegetation used as the primary vegetation reinstatement measure.

Controls:

- Topsoil and subsoil will be segregated and stockpiled onsite for future rehabilitation
- Gravel pits will be designed to minimise the risk to fauna and livestock. Fencing will be used where the pit batters represent a fall hazard.
- Erosion and sediment controls will be implemented in alignment with the erosion and sediment control plan NT-2050-15-MP-019 (Appendix E)
- Gravel pits will be backfilled and re-contoured to minimise water retention.
- Gravel Pits will have topsoil reinstated to allow for natural revegetation.
- Gravel pits will be left stable and safe for wildlife and the community.

4.1.4 Access tracks

The access tracks used to access the site have been previously approved under the Velkerri 76 S2 Groundwater Monitoring Bore EMP (NT-2050-15-MP-017). No additional clearing is proposed under this EMP.

It should be noted that large sections of the Velkerri 76 S2 access tracks are likely to become impassable during the wet season. To avoid constructing all weather roads, helicopters may be used to transport workers and materials in and out of sites when access tracks become impassable.

Controls:

- Erosion and sediment controls will be implemented in alignment with the erosion and sediment control plan NT-2050-15-MP-019 (Appendix E)
- A road corridor permit has been obtained from DPIL to manage all works within the Stuart Highway corridor; including the potential impacts on traffic.

4.1.5 Helipad

A 50x50m helipad will be constructed adjacent to the Velkerri 76 S2 lease site to accommodate potential helicopter movements associated with future drilling, stimulation and well testing activities. This pad will be cleared, grubbed and levelled to accommodate approximately 6 helicopter movements per week. Helicopters will not be used for civil construction activities.

Helicopters during the drilling, stimulation and well testing program will only be used to transport people and supplies when the access track to the Velkerri 76 S2 site becomes impossible. The use of helicopters will reduce the need to construct all-weather roads, which will significantly reduce the footprint and disturbance of the project.

4.1.6 Fly Camps

Due to the remote location of the activity, temporary portable fly camps will be used to support the activity. The fly camps will consist of a series of caravans (or similar) with sewage and rubbish being removed from site for off-site disposal in accordance with the NT WMPCA.

Greywater will be disposed of onsite in accordance with the NT Wastewater management guidelines.

All fly camps will be located in existing disturbed areas and will not require additional clearing.

Controls:

Fly camps will be:

- temporary, self-contained with all solid wastes and sewage removed from site routinely.
- be located in existing disturbed areas.

4.2 GHG Emissions

Total greenhouse gas (GHG) emissions generated during civil activities are anticipated to be approximately 626 tCO₂^e (tonnes of Carbon Dioxide equivalent) for the duration of the activity. This is small in comparison to the total Greenhouse Gas emissions for the NT of 16,500,000 tonnes (Department of Environment and Energy 2018). As outlined in Table 7, the majority of emissions are associated with land clearing.

Origin's anticipated cumulative GHG emissions are summarised in Table 8. These estimates predict a total project emissions of 156,118 tCO₂^e; which is predominantly associated with well testing. It should be noted that these estimates are extremely conservative and assume each well is successful and tested for the full 12 months.

Table 7 Civil Activity Greenhouse Gas emissions estimation

Activity	Approximate volume	Approximate tCO ₂ ^e [^]	Estimate methodology and assumptions
Land Clearing	7.2 Ha	577.9	Transport Authorities Greenhouse Group Greenhouse Gas workbook for Road Projects: Appendix E Vegetation Emission Methodology
Diesel combustion-during civil activities	30 KL of diesel	48.6	Diesel estimated using historic civil and water bore drilling multiplied by NGERs emission factor.
Total		626	

[^] Based on Global Warming Potential (GWP) of 25tCO₂^e/tCH₄ (Clean Energy Regulator 2016)

Table 8 Cumulative GHG emissions from all of Origin's 2019/20 activities

Activity	Approximate tCO ₂ ^e [^]
Emissions from drilling, stimulation and well testing of Velkerri 76 S2 production well	77,473
Emissions from drilling, stimulation and well testing of Kyalla 117 N2 production well	77,471
Emissions from civil construction program and vegetation clearing for Kyalla 117 N2	548
Emissions from civil construction program and vegetation clearing for Velkerri 76 S2	626

Activity	Approximate tCO ₂ ^{eA}
2019/2020 Activity Total GHG	156,118

4.3 Water Supply and Use

The extraction of water for all activities associated with petroleum exploration (including civil construction) activities is approved under the Water Extraction Licence (WEL) number GRF10285. This approval allows for an extraction of up to 175ML/year from the Gum Ridge formation to cover all of its proposed exploration for the next 3 years.

It is estimated that up to 20ML of water will be extracted from the Gum Ridge Formation to support the Velkerri 76 Civil construction activities. This water will be used for the construction of the lease pads, helipad and camp pads (18 ML) and for dust suppressions (~2 ML). Approximately 0.1 ML of drinking water will be sourced and trucked into site from Darwin.

All groundwater will be sourced from the Gum Ridge formation.

Water sourced for the civils operation will be extracted from the proposed Velkerri 76 S2 control groundwater monitoring bore (that will be installed under the Velkerri 76 2 Groundwater Monitoring Bore EMP) or the Kyalla 117 N2 control groundwater monitoring bore. These bores will be added to WEL GRF 10285 and are located within the proposed Velkerri 76 S2 lease pad and Kyalla 117 N2 lease pad respectively.

Four pastoralist extraction bores are located within 15 km of the proposed Velkerri 76 S2 well site with the closest being (RN36658) 11.4 km to the southeast (refer Figure 13). All bores were constructed across the CLA with reported yields of 2.0 L/sec from RN0388152 and 8 L/sec for RN036658. To assess the potential impact on groundwater levels at the nearest groundwater bores caused by groundwater extraction from the CLA at Velkerri 76 S2 for drilling and hydraulic stimulation, a simple analytical model was generated using the Theis (1935) analytical solution. The model was generated using the following inputs;

- 11.4 km to the nearest groundwater bore
- Continuous discharge (Q) of 25 L/sec (2.16 ML/d) for 30 days
- Transmissivity (T) value of 851 m²/day (RN27941 70 km east of Velkerri 76 S2)
- Storativity (S) of 0.00056 (reported for CLA in Fulton & Knapton (2015))

The modelling predicts 0.08 m of drawdown at the nearest bores after 30 days of continuous pumping, therefore indicating there would be no significant impact on the nearest groundwater users due to extraction from the CLA at Velkerri 76 S2 for exploration activities. The modelling predicts no drawdown at the nearest bores after 30 days of continuous pumping with a 0.1m drawdown radius extending to 10 km from Velkerri 76 S2. This finding is supported by the modelling completed by DENR summarised within the WEL Statement of Reason (Appendix C).

The cumulative impact associated with Origins current and future groundwater take were addressed in the water Extraction Licence GRF 10285 statement of reason provided in Appendix C. This includes water used for the civil construction, drilling, stimulation and well testing of 2 exploration wells (the Velkerri 76 S2 and potential Kyalla 117 N2 well). The following information confirms that the future use of groundwater is within the predicted sustainable yield of the Gum Ridge aquifer and is unlikely to impact on current and future users within the area:

- The sustainable yield of the Gum Ridge Formation is between 1,412,800,000 and 2,2825,600,000ML/year
- The total groundwater take for Origin's 2019/20 program (all activities associated with the proposed 2 exploration wells) is anticipated to be 132ML; well below the total annual licenced value of 175ML.
- The predicted 3-year water use for Origin's exploration use is conservatively assumed to be consistent with the total WEL level of 525ML.
- One other extraction licence from the Gum Ridge Formation exists, which authorises a total maximum extraction of 967.5ML over the May 2019 to December 2023 period.
- 300ML of groundwater per year is estimated for domestic use.
- Total extraction from the licenced and domestic extraction is 1,792.5ML; well below the lowest sustainable yield value of 1,412,800,000ML.
- DENR modelling of the Impacts to the Bitter and Rainbow Springs conclude that then proposed extraction would have no change to the reliability of the spring flows.
- DENR modelling of Roper River at Elsey National Park and red rock indicated there would be no change in reliability of surface water flows as a result of the activity.
- A maximum reduction in groundwater level of 0.12m after 58 years of continuous extraction was estimated at the closest registered bore from the nominated extraction point.

- Due to the remote location of and pastoral land use, in the area future domestic demand is unlikely to change significantly

Controls:

- ✓ Adherence to the Water Resource “*Preliminary Guideline: Groundwater Monitoring Bore for Exploration Petroleum Wells in the Beetaloo Sub-basin*” will be followed
- ✓ Water use will be minimised to only cover what is needed to perform the activity.
- ✓ Surface water will not be used during exploration activities.
- ✓ All water takes for petroleum activities will be licenced in accordance with the NT Water Act provisions.
- ✓ Water will not be extracted within 1km of an existing pastoralist bore.
- ✓ Groundwater modelling completed by Origin and DENR as a part of Water extraction Licence.
- ✓ Impacts on pastoralist bores are not anticipated.

4.4 Chemicals

Fuels and chemicals are anticipated to be utilised during the civils work program. The majority of chemicals and fuels are associated with diesel and minor volumes of oils, coolants and degreasers used to undertake routine field servicing. The estimated fuel and chemicals to be used are:

- Diesel (field storage up to 5000 L at a time).
- Hydraulic oil, coolant and engine oils (minor field storage volumes up to 250 L each).
- Degreasers and domestic cleaning chemicals (<50 L of each).

Controls:

- ✓ Any refuelling or field servicing not to be within 100m of a watercourse.
- ✓ All wastes oils, coolant, chemicals and contaminated material to be removed from site and disposed of at an approved facility by a licenced waste contractor in accordance with the NT Waste Management and Pollution Control Act.
- ✓ Double-lined diesel storage tanks to be used.
- ✓ All chemical field storages to comply with Australian Standards (such as As 1940)
- ✓ Chemical storage areas to be inspected routinely, with uncontaminated stormwater removed from bunds. Any contaminated water to be disposed of at a licenced facility.

4.5 Waste Management

Waste management methods for the proposed exploration program are summarised in Table 9. Wastes are managed in accordance with the internationally accepted guide for prioritising waste management practices with the objective of achieving optimal environmental outcomes. Waste will be managed in accordance with the following hierarchy principals:

1. **Avoid:** eliminate the generation of wastes through design modification.
2. **Reduce:** reduce unnecessary resource use or substitute a less resource intensive product or service.
3. **Re-use:** reuse a waste without further processing.
4. **Recycle:** recover resources from a waste.
5. **Treatment:** treat the waste to reduce the hazard of the waste prior to disposal.
6. **Disposal:** disposal of waste if there is no viable alternative.

The volume of civils-related waste is likely to be small, in the order of less than a 5000 kg in total. All wastes, specifically listed wastes (as described in Schedule 2 of the Waste Management and Pollution Control (Administration) Regulations (1998)) generated as part of the regulated activity will be removed from the proposed activity area, for disposal or recycling at a licensed facility authorised to receive those wastes (as summarised in the NT Listed Waste Company Summary spreadsheet). Waste transfer certificates will be retained and provided to DENR upon completion of the project.

It is anticipated that all civil-generated waste requiring disposal will be small, requiring between 1 to 5 tonnes of material to be disposed of/recycled at the Katherine landfill. Where the Katherine landfill cannot recycle or dispose of a waste, alternative disposal facilities within the Northern Territory or interstate will be utilised.

Controls:

- ✓ Origin will follow the waste management hierarchy to prioritise the prevention of creating wastes.
- ✓ Waste will be managed in accordance with the NT Waste Management and Pollution Control Act.
- ✓ Listed wastes will be tracked and disposed of at a licenced facility by approved transporters.

Table 9 Waste and disposal methods

Activity	Indicative volumes	Disposal Method
Sewage, grey and storm water	2000 L per day of grey and sewerage wastewater	All Sewage to be collected and transported off-site at a licenced disposal facility. Grey water disposed of on-site in accordance with Department of Health requirements. All stormwater will be released to grade in compliance with the following: <ul style="list-style-type: none"> • Is uncontaminated with hydrocarbons or other chemicals. • Is not released to watercourses or waterways. • The release will not cause environmental harm (soil erosion or vegetation damage). • All contaminated stormwater will be captured and disposed of off-site at a licenced facility.
Food waste, paper and plastic	10 kg/day	Disposal: Collected in dedicated waste bins for transport to an approved landfill.
Glass and cans	1 kg/day	Recycled: Collected in separate waste bins for recycling at an off-site facility.
Chemical bags and cardboard packaging materials	<100 kg in total	Recycled: Compacted and collected at rig site for transport to a licenced recycling centre.
Scrap metals	<1 tonne total	Recycled: Collected in designated skip for recycling at an approved location.
Used chemical and fuel drums	<0.5 tonnes total	Recycled: Collected in designated skip for recycling at an approved location.
Chemical wastes	<100 kg total	Re-use/disposal Collected in approved containers for disposal at approved landfill or returned to supplier or recycled.
Timber pallets	<1 tonne total	Recycled: Recycled at an approved facility.
Vehicle tyres	<1 tonne total	Disposal: Disposed of at an approved landfill.
Oily rags, oil contaminated material, filters and other hydrocarbon material	<100 kg total	Recycled/ Disposal: Oil from machinery will be collected in suitable containers for disposal at approved landfill or recycled at an approved recycling facility.

4.6 Weed Management

Exploration activities are undertaken in accordance with Origin's Beetaloo Weed Management Plan (WMP) NT-2050-15-MP-016 (Appendix D). This plan has been developed in accordance with the Weed Management Planning Guide: Onshore Shale Gas Developments Project. Weed surveys have confirmed the proposed area of

activity has an extremely low presence of weeds. Efforts will therefore focus on both eliminating the potential introduction weeds into the region and preventing the spread of existing weeds.

Routine weed inspections will be undertaken of disturbed areas. Where a weed outbreak is identified, management measures will be implemented in consultation with DENR as per the WMP.

Controls:

Weed control strategies will include:

- ✓ A Weed Management Plan (WMP) has been implemented (Appendix D).
- ✓ A dedicated Weed Officer responsible for overseeing weed management activities.
- ✓ Selection of civil construction equipment from local suppliers, with equipment sourced from Queensland the least preferred option.
- ✓ All equipment brought onto the exploration permit shall be washed-down and certified clean prior to entry.
- ✓ Equipment will be inspected and certified where movements are proposed to clean areas.
- ✓ Monitoring and maintenance activities will be undertaken pre-and post-wet season to identify and treat weed infestations.

4.7 Traffic

The potential traffic related impacts associated with broader project, including civils activities, is not considered to be significant. Traffic associated with exploration activities is generally small and of short duration.

The access to Velkerri 76 S2 site is via the Stuart Highway, approximately 23 km south of the town of Dunmarra as illustrated Figure 2. The Highway has a 130km/h posted speed limit in the vicinity of the project and is generally a two-lane, two-way road with a sealed width of 7-metres and unsealed or grassed shoulders varying between 2.5 and 5-metres in width. The access track intersection with the Stuart Highway has a valid 2-year permit and includes a traffic management plan to ensure the risk to other road users is minimised.

The peak maximum anticipated traffic flow increase associated with Origin 2019/20 activities (including drilling, completions and civils) will be approximately 44 vehicles per day. The duration of the activity will extend over a 12-month period, with the peak movements restricted to a week period during the initial rig mobilisation and final rig demobilisation. Movements of civil related infrastructure are anticipated to be minor, with a peak of 12 vehicle movements for several days during equipment mobilisation and demobilisation. Average daily traffic additions during the remainder of the project period are likely to be 10-15 movements per day for the first three-months, reducing down to three-four movements for the remainder of the period.

The dominant traffic flow for the civils program will be from the Katherine area, as all earth moving equipment will be sourced from the Katherine/ Darwin region.

Existing traffic levels, road capacity and level of service

Existing traffic figures were obtained from the DIPL Annual Traffic Report 2017 showing Average Annual Daily Traffic (AADT) figures for the Stuart Highway roughly 30km south of the proposed access location. This station is approximately 65 km north of the access point to the Velkerri 76 S2 access track and it can be assumed that the traffic figures at the site will be similar.

The total daily traffic flows from the 2017 annual survey data are in the order of 551 vehicles; effectively split evenly between north and south-bound (refer Figure 7). Traffic rates during the dry season are likely to be substantially higher than the average figures, with peak dry season traffic observed to be up to 50% higher than the average volumes (GHD 2013). A revised figure of 827 vehicles/day is considered a representative worst-case traffic volume.

AUSTROADS guidelines (Austroads 2017) were used to determine the typical capacity that would be expected by traffic on the Stuart Highway to maintain a free-flow level of service (LOS). The Stuart Highway in the project location is a two-lane, two-way road. The capacity of roads is based on the maximum rate at which persons or vehicles can reasonably be expected to traverse a point or uniform section of lane or roadway during a given time period. To maintain a Category A (free flowing) LOS for the Stuart Highway, a conservative 700 – 1000 vehicle/hr/lane figure was used to determine the vehicle movement capacity.

In an urban situation it can be assumed that the peak hour volumes will be about 10% of the daily traffic volumes. However, the remoteness of this site means that a peak hour is not realistic and has not been considered. Due to the low anticipated volumes that are likely to be spread over the duration of the day, this is considered appropriate.

Rural Coverage Count Stations				Year: 2017									
Table: 4.1 AADT For Coverage Stations - 10 Year Period				Region: Tennant Creek									
Road Name / Location	ADT Station	Direction	Units	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Carpentaria Highway 5km East of Tablelands Highway	RTVDC033	Inbound	Veh	30		37		55		51		42	
		Outbound	Veh	33		44		42		46		42	
		Both	Veh	63		81		97		97		84	
Nathan River Road 2km North of Ryans Bend Road	RTVDC034	Inbound	Veh	5		5		7		9		4	
		Outbound	Veh	6		7		4		7		5	
		Both	Veh	11		12		11		16		9	
Newcastle Waters Road 2km West of Stuart Highway	RTVDC037	Inbound	Veh		34	39	34		41		40		39
		Outbound	Veh		45	38	38		50		50		51
		Both	Veh		79	67	72		91		90		90
Old Bing Bong Road 5km North of Borroloola	RTVDC035	Inbound	Veh	76		42		60		73		59	
		Outbound	Veh	83		51		46		75		49	
		Both	Veh	159		93		106		148		108	
Ranken Road 5km East of Brunette Downs	RTVDC028	Inbound	Veh		1		3		1		1		2
		Outbound	Veh		1		4		2		2		3
		Both	Veh		2		7		3		3		5
Stuart Highway 20km North of Elliott SITE NOT SURVEYED IN 2008 and 2009	RTVDC020	Inbound	Veh			225	211	210	225	222	229	223	280
		Outbound	Veh			221	195	197	205	213	213	222	271
		Both	Veh			446	406	407	430	435	442	445	551

Figure 7: Traffic flows on the Stuart Highway approx. 30km south of the proposed site access point (DPIL 2017).

Assessment of total traffic levels and reduction to road capacity and level of service

The total anticipated peak traffic volume for the Stuart Highway has been determined at 871 vehicles per day. This consists of an additional peak project vehicle movement level of 44 vehicles/day in addition to the existing peak dry season traffic volumes of 827 vehicles/day.

The 2018e total volume of traffic is considerably lower than the capacity of the Stuart Highway, with any reduction in LOS from the volume of project traffic considered extremely unlikely.

Traffic LOS may also be impacted through changes in traffic compositions, with the volume of trucks affecting the road capacity greater than light vehicles. To assess the changes in traffic composition, vehicle category data obtained from the DIPL Annual Traffic Report 2017 were assessed against expected total project traffic figures. These figures were increased by 50% to represent peak dry season traffic volumes. The assessment is provided below.

1.	Short (light vehicles)	603 vpd (72.9%)
2.	Medium (heavy vehicles or short towing)	76 vpd (9.2%)
3.	Long (heavy vehicles)	53 vpd (6.4%)
4.	Medium combination (heavy vehicles)	27 vpd (3.3%)
5.	Large combination (heavy vehicles)	68 vpd (8.2%)

Allocating the projected 44 additional trips to the measured daily flows we get:

1.	Short - 12 additional vehicles	615 (70.6%)
2.	Medium - 0 additional vehicles	76 (8.7%)
3.	Long - 5 additional vehicles	58 (6.7%)
4.	Medium combination - 0 additional vehicles	27 (3.1%)
5.	Large combination - 27 additional vehicles	95 (10.9%)

The results demonstrate that there are minimal changes in traffic composition associated with the project, with an additional 1.2% of large combination vehicles when compared to the total volume composition. This percentage is unlikely to significantly impact upon the road's capacity and LOS.

Other potential risks and controls associated with traffic are discussed further in section 7.5.11.

4.8 Rehabilitation

Once a determination has been made to decommission an asset, a site-specific rehabilitation plan will be developed for each disturbed area. Transfer of ownership of an asset to a pastoralist for beneficial use will be the priority rehabilitation strategy. This will primarily be for water extraction bores, viable gravel pits, access tracks

and lease pads which may represent a potential asset to the pastoralist. Before considering a transfer of ownership, the following will be considered:

- Undertake an assessment of the current status of the asset and whether it can be beneficially used by the local pastoralist. Where a beneficial use is anticipated, identify works required to be undertaken to ready the asset for transfer (i.e. any repairs, site remediation, equipment removal etc.).
- Obtain written consent from the pastoralist agreeing to take the ownership of asset and document any stipulated liabilities.
- Where an asset cannot be beneficially utilised, the site shall be rehabilitated using assisted natural regeneration back to a safe, stable, non-polluting landform consistent with surrounding land use. This may include:
 - Removal of all weeds and contaminated materials/wastes.
 - Re-spreading of stockpiled topsoil.
 - Removal of surface gravel and return to gravel pits
 - Reshaping the site to as close to natural form as possible.
 - Ripping or scarifying any compacted surface.
 - Spreading seed of suitable local native species determined through analogue sites representative of surrounding vegetation communities.
 - Liaise with the DENR to confirm the rehabilitation strategy.
- Any seed supply and rehabilitation services will be sourced using Indigenous suppliers as a priority.
- Where rehabilitation is required, rehabilitation success criteria shall be developed and submitted to DENR as a part of the final rehabilitation plan. Rehabilitation site success is identified in comparison to analogue sites with the same pre-disturbed vegetation and soil units.
- Success criteria for areas requiring rehabilitation shall be included in the rehabilitation plan submitted to DENR. It is anticipated that the success criteria shall be measured with regards to the following measurement criteria (as agreed with DENR in the final rehabilitation plan):
 - Landholder and DENR agree in writing that the land supports the pre-disturbance land use.
 - Soil suitability and stability is equivalent to the surrounding soil unit.
 - No subsidence, erosion or weeds evident for at least five years.
 - A minimum of 80 % foliage cover and diversity of analogue sites is maintained in the rehabilitated sites for at least three years.
 - Maintain a density of habitat structures (litter cover, fallen woody material and hollow logs etc.) similar to analogue sites.
 - Maintenance is no greater than that required for the land prior to its disturbance.

Where a site is rehabilitated, monitoring will be undertaken annually to assess the rehabilitation success and determine where additional remedial works are required.

4.9 Monitoring program

The monitoring programs to be implemented as a part of the Velkerri 76 S2 civil program are summarised in Table 10. The data collected during these programs is designed to validate the measurement criteria outlined in Section 7.5.

Table 10 Velkerri 76 S2 Monitoring Program Summary

Program	Monitoring locations	Parameter	Frequency	Method	Monitoring criteria
Groundwater Monitoring Program	Velkerri 76 S2 Control monitoring bores (Figure 10)	Water Level	Continuous	Level logger	Section 7.5.3
Erosion and sediment control	All areas that have been disturbed/ utilised by Origin activities as per ESCP Plan (and Figure 2)	Location, GPS, erosion and sediment control present and functioning correctly (yes/no), erosion present (yes/no), extent (m ²), description (type, rill, sheet, gully).	Pre and post wet season	Visual inspections with data entered into an online inspection sheet called Arc Collector	Section 7.5.1
Weeds	All areas that have been disturbed/ utilised by Origin activities (Figure 2)	Weed species identification, Location, GPS coordinates	Pre and post wet season.	Visual inspections with all weed inspection areas and infestations photographed and GPS coordinate taken	Section 7.5.5
Rehabilitation	All rehabilitated areas	Location, GPS coordinates, vegetation cover %, species composition, presence of weed species, subsidence, erosion and sedimentation, photographs	Annually	Visual inspections with photographic evidence of rehabilitated and control sites taken.	Section 7.5.4

^ the closest landholder bore is >16km from the extraction bore located on the Velkerri 76 S2 lease pad. Monitoring will therefore be restricted to these bores.

4.10 Proposed contractors and equipment list

The civil construction program will occur seven days a week from the hours of 6am to 6pm. The contractors and list of equipment is provided in Table 11.

Table 11 Contractor equipment list

Task	Contractor	Crew List	Equipment and Machinery
Civil Activities			
Civil Construction	Out tender	2 x Origin Supervisors (HSE + Construction) 1 x Project Manager/Project Engineer (Contractor)	Excavator x 2 Dozer x 2 Grader x 2 Roller x 2 Water Cart x 2

Task	Contractor	Crew List	Equipment and Machinery
		1 x Site superintendent (Contractor) 6 x Plant operators 2 x Truck drivers 2 x Fencing contractors 1 x Surveyor	Haulage trucks (Water and/or gravel) Bob cat (Fencing contractor) Light 4WD vehicles x 3

4.11 Timeframes

The civil construction activities are likely to commence in August 2019. Following the completion of the civils program, the drilling, stimulation and well testing of Velkerri 76 S2 -1 will likely commence activities from October 2019 onwards. The drilling, stimulation and well testing program is outside of the scope of this EMP.

An overview of the time frames for the activities is provided in Table 12. A detailed breakdown of the civil construction component of the activity is provided in Figure 8.

Table 12 Anticipated exploration program activity dates

Activity	Estimate Start Date
Civil Construction Works (This EMP)	August 2019
Drilling of Velkerri 76 S2- 1 exploration well (not covered under this EMP)	October 2019
Stimulation of the Velkerri 76 S2- 1 exploration well (not covered under this EMP)	February/March 2020
Well Testing of the Velkerri 76 S2- 1 exploration well (not covered under this EMP)	March 2020 to November 2020
Rehabilitation of Gravel pits	November 2020
6 monthly site inspection for erosion and weed surveys	November 2020- November 2029
Rehabilitation of the of Velkerri 76 S2- 1 exploration well	November 2024
Ongoing 6 monthly rehabilitation monitoring and maintenance	June 2025- June 2030

Beetaloo: Velkerri 76 Civil Construction Activity Schedule

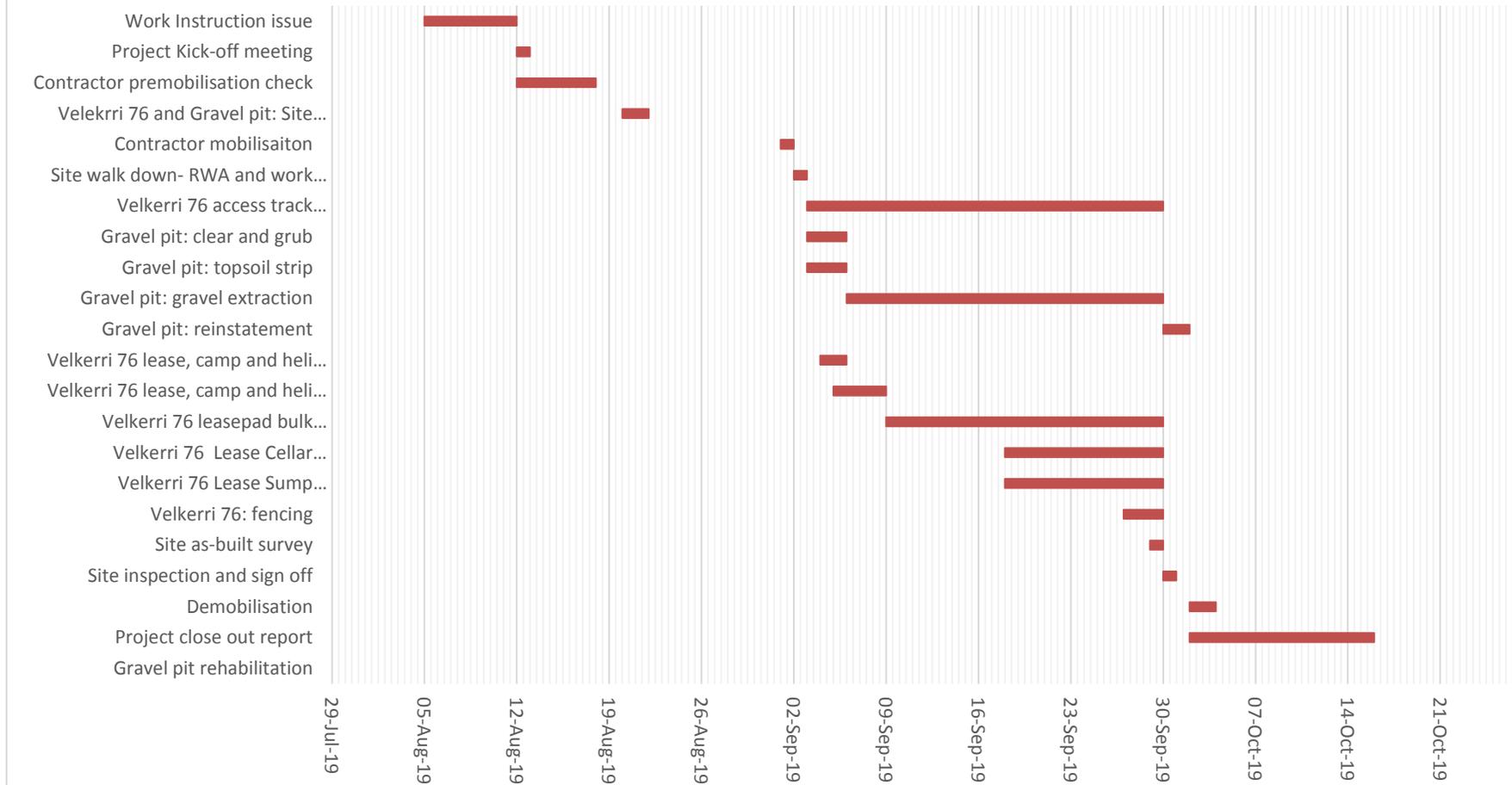


Figure 8 Gantt chart of project activities

5 Description of the existing environment

A Land Condition Assessment (LCA) was completed in August 2018 to gather baseline information on the current ecological environment within the proposed lease areas and associated access tracks.

A summary of the LCA is provided as follows, with the full LCA included in Appendix F

5.1 Physical Environment

5.1.1 Climate

The climate of the permit areas is arid to semi-arid, with rainfall decreasing in frequency and quantity from north to south. The climate is monsoon influenced, with a distinctive wet and dry season experienced through the year.

Rainfall in the north of the permit area is recorded at 681 mm at Daly Waters. The southern portion of the permit area records an average annual rainfall of 536 mm at Newcastle Waters and 602 mm listed at Elliott. Approximately 90% of the rainfall occurs during the Wet Season between the months of December to March.

The area is characterised by a net precipitation deficit of between -1800 to -2150 mm per year.

5.1.2 Geology

The Beetaloo Basin comprises a thick sequence of flat-lying mudstone and sandstone formations (Roper Group) that were deposited between 1,500 and 1,430 million years ago (Ma). The Roper Group is estimated to reach 5,000 m in thickness in the centre of the basin and with the exception of the north and eastern margins occurs at an average depth of about 500 m. The Roper Group is overlain by the Georgina Basin (630 – 497 Ma), which includes widespread basalts and a thick limestone sequence that forms the Cambrian Limestone Aquifer (CLA), a significant water supply aquifer. The Georgina Basin is capped by Cretaceous mudstone and sandstone (145 – 66 Ma) and recent alluvial and laterite deposits.

The Kyalla Formation, dominated by grey and black siltstone and shale, is separated from the Velkerri Formation by the Moroak Sandstone. The Kyalla and Velkerri formations share some similar characteristics, although the Kyalla Formation is neither as thick or as enriched in organic carbon. Organic richness within the Kyalla Formation is generally confined to the lower member; the target of the 2019 Velkerri 76 S2 -1 exploration well. The middle and upper Kyalla members provide an effective geological barrier to any HFS in the organic rich lower Kyalla. The effectiveness of geological barriers to fracture height growth can be assessed with geomechanical data from core analysis, wireline log data and modelling.

5.1.3 Soils

The Sturt Plateau bioregion covers an area of 103,857 km and comprises undulating plains on sandstones, with mostly neutral sandy red and yellow earth soils (ANRA, 2008).

The soil types located within the plateau range from the very strongly leached lateritic soils of the Tertiary land surface to the calcareous desert soils and desert loams in the southern drier areas.

The lateritic plains, located within EP98 and the northern part of EP117, are classed as very strongly leached soils of the Tertiary land surface. The three main soil types located within the permit area include:

Tertiary Lateritic Red Earths, which occur on the gently undulating topography. The soil profile can be described as:

- **A-Horizon** Grey-brown sandy loam
- **B-Horizon** Reddish brown sandy clay loam
- **C-Horizon** Red-brown to red light clay, overlying heavy ferruginous gravel and massive laterite

Tertiary Lateritic Red Sands, which occur on gently undulating to undulating topography of the Tertiary Lateritic Plain, formed from sandstones and complex parent materials of the deep sandy soils. The soil profile can be described as:

- **A-Horizon** Grey-brown to brown sand
- **B-Horizon** Brown sand
- **C-Horizon** Red-brown to yellow-brown sand overlying pisolitic ferruginous gravel and massive laterite. Altered colouring of highly siliceous parent sandstone is only evident in the mottled and pallid zones.

Tertiary Lateritic Podzolic Soils, formed on the gently undulating topography over a variety of rocks. These soils are located in the northern section of the Barkly Basin. The soil profile can be described as:

- **A-Horizon** Grey sand
- **B-Horizon** Yellowish-grey sand
- **C-Horizon** Yellow-grey sandy loam with ferruginous gravel overlying massive laterite, mottled and pallid zones.

Other areas of Black Soil Plains are located within the Barkly Tablelands, including EP76, the southern part of EP117 and a small section of EP98.

Geotechnical investigations have confirmed the proposed lease sites consist of red silty sand with some gravel pieces. The surface soils collected during the field survey indicated the soils were slightly acidic (ph range of 5.0 to 6.2) across the permit area. A dispersion test was also undertaken on the samples which indicated that the soils were non-dispersive and maintained their shape when submerged in water.

Table 13 presents the erosion risk rating based on average monthly rainfall using the rating system provided in the IECA (2008) Table 4.4.2 for Daly Waters. The construction activities are anticipated to commence following the wet season from April 2019 onwards. The overall risk of erosion is considered very low.

Table 13 Erosion Risk Rating based on average monthly rainfall at Daly Waters

-Item	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	165.4	165.4	120.1	23.6	5.0	5.6	1.5	1.7	4.9	22.5	59.4	110
Erosion Risk*	H	H	H	VL	VL	VL	VL	VL	VL	VL	M	H

* **E** = Extreme (>225 mm); **H** = High (100+ to 225 mm); **M** = Moderate (45+ to 100 mm); **L** = Low (30+ to 45 mm); **VL** = Very Low (0 to 30 mm)

5.1.4 Topography, Surface water and Drainage

The proposed Velkerri 76 S2 lease sites all fall within the Wiso River Basin. The topography of the two sites have low relief and surface water flow ultimately drains in a south and south-westerly direction. The Wiso River Basin covers the southern half of EP98 (south of the Carpentaria Highway) and the majority of EP76 and EP117 and is internally drained by Newcastle Creek and a number of small ephemeral creeks. Newcastle Creek is approximately 13km to the south of the lease pad and ultimately flows into Lake Woods, which is located south of Newcastle Waters Station. Lake Woods covers an area of inundation of approximately 50,000 ha in normal rainfall years, extending to 80,000 ha in exceptionally wet years, after which it can retain water for several years (HLA, 2005). Lake Woods is described as a major quasi-permanent surface water body in the region, although some semi-permanent and many ephemeral waterholes are located across the permit area (HLA, 2006b).

There are no major creeks in the proposed area that are likely to be potentially impacted by the proposed activities. A number (four) of small ephemeral streams (Stream Order 1 and 2) are located along the existing access tracks. The streams are overland flow paths that only flow for a short period during the wet season. During heavy wet seasons, large areas of the internal drainage systems are flooded to a depth of 30 cm, which has previously been identified by debris being collected on fence lines (HLA, 2005). The proposed area will remain dry under normal seasons, with flood modelling indicating the proposed site may be inundated by 700mm during a Q100 flooding event. The bunding around the lease pad will be designed to prevent water ingress into the lease pad during such a flood event.

5.1.5 Hydrogeology

Within the project boundary, groundwater use is primarily from the Cambrian Limestone Aquifer (CLA) with minor, localised use from other formations where shallower groundwater is intersected or where the CLA is not saturated. This includes;

- Overlying Cretaceous sediments where it is saturated in the central-south of the Beetaloo Basin;
- The Antrim Plateau Volcanics in the north-west, and;
- The Bukalara Sandstone in the north-east (absent in the vicinity).

Table 14 summarises the hydrostratigraphy of the Beetaloo Sub-basin. A schematic of the proposed future exploration well in the context of the underlying geology of Velkerri 76 S2 site is provided in Figure 9.

Across parts of the Beetaloo Basin (technically referred to as the Beetaloo Sub-basin), undifferentiated Cretaceous deposits form the uppermost aquifer are targeted for stock use. Notably, a basal sandstone unit immediately overlying the CLA produces yields of up to 5 L/s. Shallow, perched groundwater has also been recorded in the laterised zone within the permit area with groundwater levels recorded between 1 and 6 mbgl. These systems are dynamic with periodic saturation resulting from recharge during the wet season with no

documented groundwater use. The CLA, comprising the Gum Ridge Formation and the Anthony Lagoon Beds, is an extensive regional aquifer system that forms the principal water resource in the Beetaloo Sub-basin. Limestone in the CLA is commonly fractured and cavernous; regionally bore yields of up to 100 L/s have been recorded from this aquifer. Approximately 80% of groundwater bores drilled in the basin screen the CLA and the aquifer supplies water for the pastoral industry and local communities including Elliot, Daly Waters, Larrimah and Newcastle Waters. The CLA contains a significant but largely undeveloped groundwater resource with the sustainable yield from the Georgina Basin estimated to be in the order of 100,000 ML/year (NALWTF, 2009). Existing groundwater use in the Beetaloo Basin is estimated at 6,000 ML/year.

The Antrim Plateau Volcanics underlies the CLA in the north and central part of the Beetaloo sub-basin. Across much of the Basin it consists of sequences of massive basalt flows with negligible primary porosity. In the north-west of the Basin, where the formation is shallow and fractured, it forms a marginal aquifer, however reported use is primarily from a sandstone sequence at the contact with the Gum Ridge Formation. There is no reported use within the three petroleum exploration permits held by Origin.

The Bukalara Sandstone forms a localised, fractured and weathered aquifer where it outcrops beyond the north-east margin of the Beetaloo Sub-basin. The formation consists of quartz sandstone with shale interbeds and probable enhanced permeability in these areas due to jointing within the sandstone. No use is reported from the formation away from the northeast margin of the Beetaloo Basin where it is discontinuous and at considerable depth.

The regional groundwater flow direction in the CLA is north-west toward Mataranka, where the aquifer discharges into the Roper River and supports significant groundwater dependent ecosystems including the Roper River at Elsey National Park and Red Lily/57 Mile Waterhole. These discharge features occur around 100 km north-west of the Beetaloo Sub-basin. Dry season flow in the Roper River has been gauged at 95,000 – 126,000 ML/yr and provides an estimate of the magnitude groundwater discharge from the CLA. Large decadal changes in the discharge to the Roper River suggest that most recharge input occurs close to the discharge zone (i.e. beyond the Beetaloo Sub-basin region). Groundwater recharge mechanisms to the CLA are poorly characterised but are likely to be dominated by infiltration through sinkholes and preferential recharge through soil cavities.

Limited information exists on the hydrogeological characteristics of the Roper Group sequence as it occurs at depth within the Beetaloo Sub-basin. Sandstone dominated formations may behave as aquifers, however, drilling results suggest these formations have limited potential as groundwater resources due to their depth, low permeability and high salinity. Groundwater in the Roper Group is highly saline and contrasts with the shallower, utilised aquifers in which groundwater is generally of drinking water quality.

Using the available information from groundwater bore records and previous exploration drilling activities, a prognosis of stratigraphic depths has been compiled for the location (Table 14). Four groundwater bores are located within 15km of the proposed Velkerri 76 S2 well site with the closest being (RN36658) 11.4km to the southeast. All bores were constructed across the CLA with reported yields of 2.0 L/sec from RN0388152 and 8L/sec for RN036658. Refer Figure 10 for the location of the existing landholder extraction bores.

To assess the potential impact on groundwater levels at the nearest groundwater bores caused by groundwater extraction from the CLA at Velkerri 76 S2 for drilling and hydraulic stimulation, a simple analytical model was generated using the Theis (1935) analytical solution. The model was generated using the following inputs;

- 11.4km to the nearest groundwater bore
- Continuous discharge (Q) of 25 L/sec (2.16 ML/d) for 30 days
- Transmissivity (T) value of 851 m²/day (RN27941 70 km east of Velkerri 76 S2)
- Storativity (S) of 0.00056 (reported for CLA in Fulton & Knapton (2015))

The modelling predicts 0.08 metres of drawdown at the nearest bores after 30 days of continuous pumping, therefore indicating there would be no impact on the nearest groundwater users due to extraction from the CLA at Velkerri 76 S2 for exploration activities.

Table 14 Geological prognosis of Velkerri 76 S2-1

Formation	Depth (m)		Depth Uncertainty (+/- mTVD)	Expected Pore Saturation	Ave. Permeability Flag <0.001 / >0.001 mD	Primary Lithology	Fm. Pressure Gradient (psi/ft) Ref. MSL			Frac. Pressure Gradient (psi/ft)	Temp (°C) (Expected Geotherm Gradient 40.5 °C/km)
	TVDSS	TVDGL					Min	Exp	Max		
Undifferentiated Cretaceous	255	0	0	Potable Water	Green	Lateritic Claystone	-	0.43	-	-	26
Anthony Lagoon Formation	105	50	20	Potable Water	Green	Siltstones / Dolomite / Limestones	-	0.43	-	-	28
Gum Ridge Formation	165	90	50	Potable Water	Green	Limestone	-	0.43	-	-	30
Antrim Plateau Volcanics	-33	288	50	Potable Water	Red	Tholeiitic Basalt	-	0.43	-	-	38
Bukalara Sandstone	NOT EXPECTED	-	-	Potable Water	Green	Sandstone	-	0.43	-	-	-

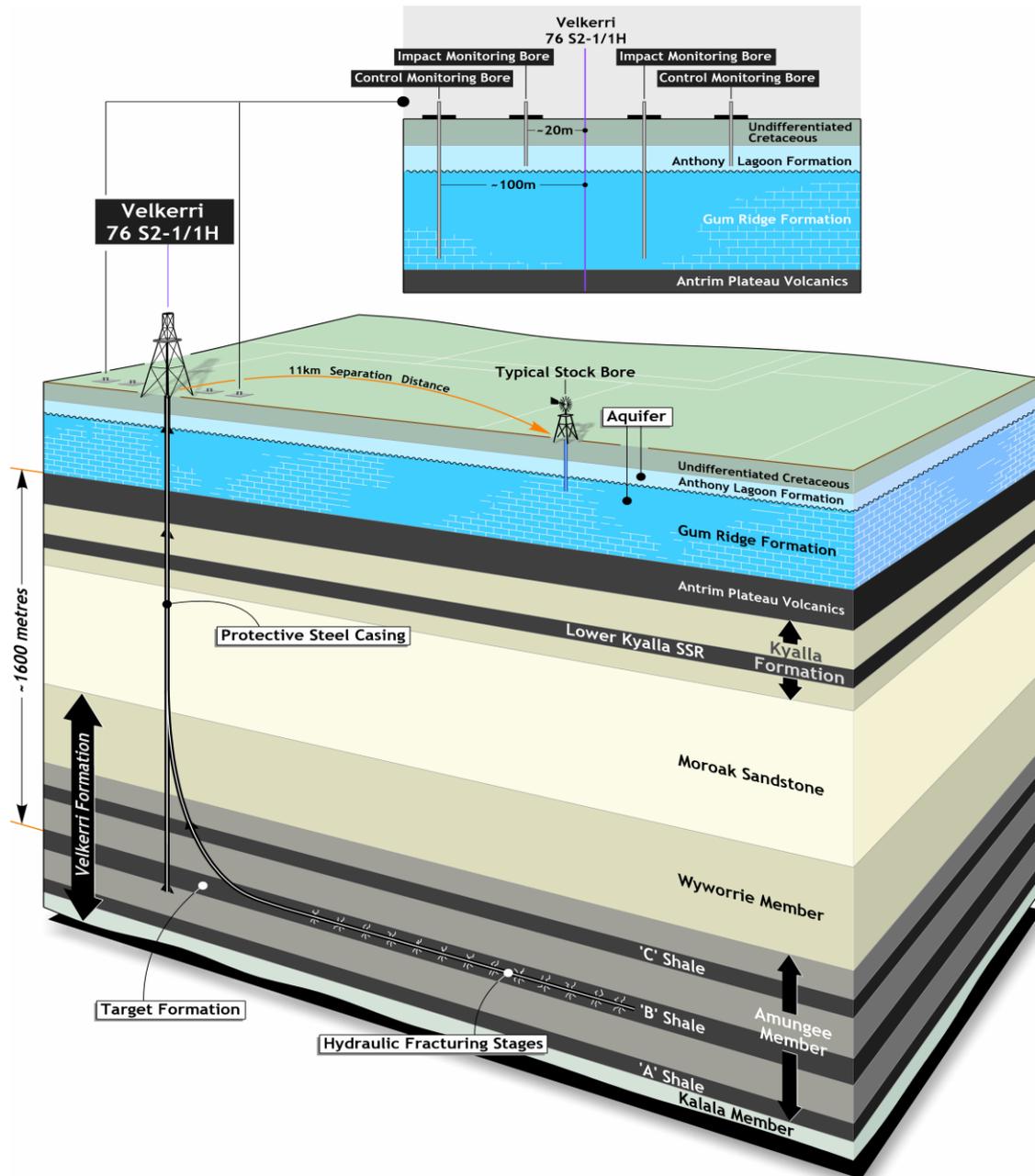


Figure 9 Anticipated hydrogeological sequences at the Velkerri 76 S2 site

Table 15 Summary of Beetaloo Sub-basin Hydrostratigraphy

Province	Period/Age	Formation		Aquifer Status	Thickness (m)	Yield (L/s)	Ave EC (µs/cm)
CARPENTARIA BASIN	CRETACEOUS 145 – 66 Ma						
GEORGINA BASIN	CAMBRIAN 497-630 Ma	Cambrian Limestone Aquifer (CLA)	Anthony Lagoon Beds	REGIONAL AQUIFER	0 – 200	1 - 10	1,600
			Gum Ridge Formation	REGIONAL AQUIFER	0 – 300	0.3 - >20	1,400
		Antrim Plateau Volcanics		REGIONAL AQUITARD	0 – 440	0.3 - 5	900
		Bukalara Sandstone		<i>Regional Aquifer</i>	0 – 75	0.3 - 5	1,000
BEETALOO BASIN (ROPER GROUP)	NOT KNOWN	Hayfield Mudstone		REGIONAL AQUITARD	0 – 450	-	32,000
		Jamison Sandstone		<i>Local Aquifer (not regionally connected)</i>	0 – 150	-	138,000
	MESO-PROTEROZOIC 1,430-1,500 Ma	Kyalla Formation		REGIONAL AQUITARD	0 – 800	-	-
		Moroak Sandstone		<i>Local Aquifer (not regionally connected)</i>	0 – 500	0.5 - 5	131,000
		Velkerri Formation		REGIONAL AQUITARD	700 – 900	-	-
		Bessie Ck Sandstone		<i>Local Aquifer (not regionally connected)</i>	450	0.5 - 5	-

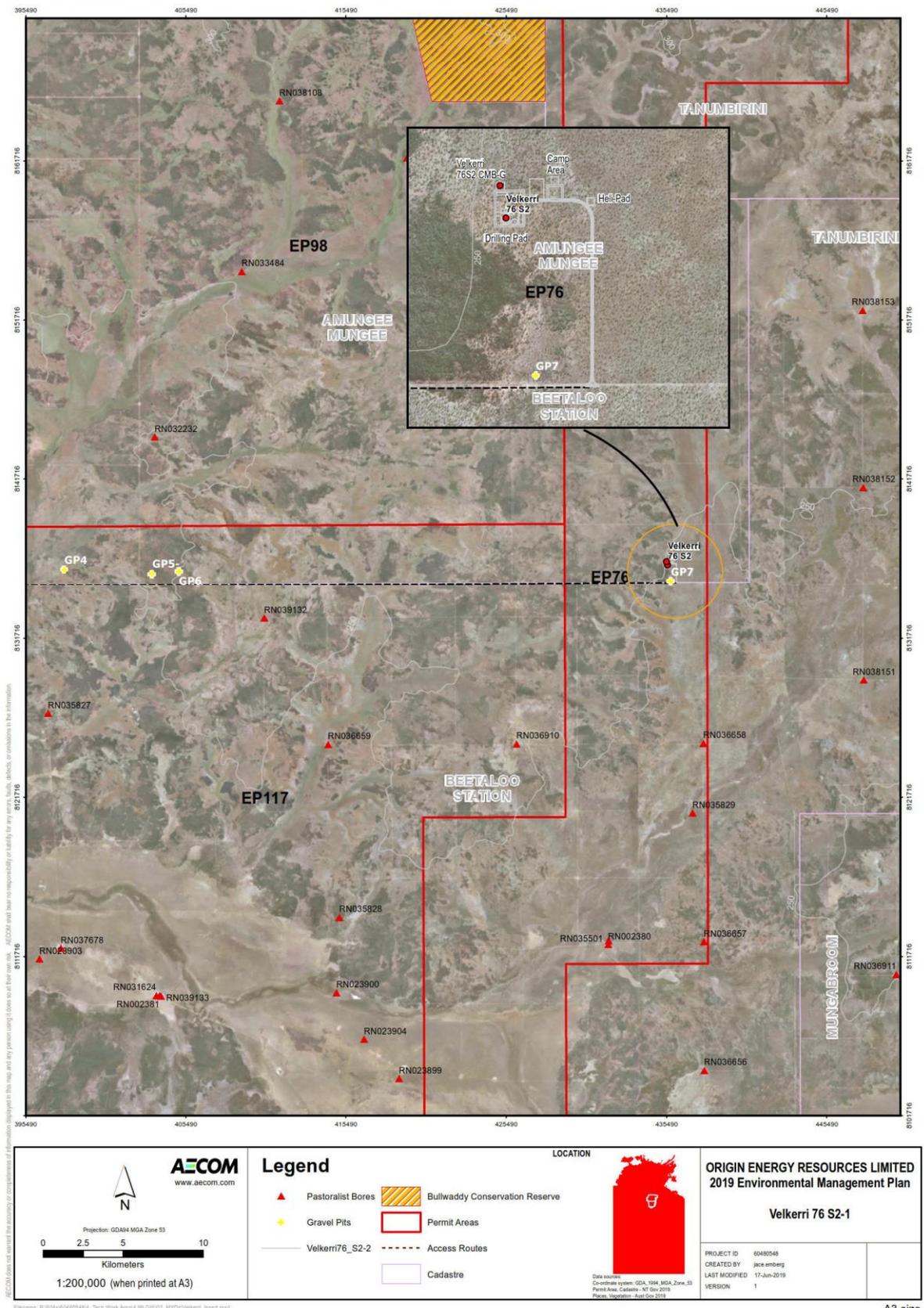


Figure 10 Existing landholder and groundwater monitoring bores

5.2 Biological Environment

5.2.1 Bioregions

Two bioregions occur within the Origin permit areas:

- The Sturt Plateau bioregion; and
- The Mitchell Grass Downs bioregion.

The 2019 proposed lease sites all fall within the Sturt Plateau Bioregion which comprises undulating plains on sandstone, with predominantly neutral sandy red and yellow earth soils. Dominant vegetation associations included extensive areas of Lancewood (*Acacia shirleyi*) - Bullwaddy (*Macropteranthes kekwickii*) vegetation and associated fauna, including the Spectacled Hare-Wallaby (*Lagorchestes conspicillatus*). Land condition in the bioregion is moderate to good but is threatened by impacts from weeds, feral animals, pastoralism and changed fire regimes.

5.2.2 Vegetation Communities

Vegetation communities within the permit areas have been ground-truthed during baseline assessments in 2004, 2006 (HLA, 2006; 2006c), 2010, 2014, 2016 (AECOM, 2011; 2014; 2016) and more recently in August 2018. The August 2018 survey focused on the full extent of areas to be impacted by Origin's proposed exploration activities.

The proposed infrastructure location has been evaluated through detailed habitat assessments which included identification of vegetation community, dominant flora species at each strata, habitat condition, disturbance factors (fire, weeds, erosion, feral fauna species), and fauna attributes (e.g. tree hollows, logs, grass cover, mistletoe abundance). The area of the proposed activity (specifically the Velkerri 76 S2 site) is characterised as *Corymbia* low woodland/*Terminalia* (mixed) sparse shrubland/*Chrysopogon* (mixed) low tussock grassland. This vegetation community is considered regionally extensive and not subjected to extensive clearing. A summary of the survey of the proposed Velkerri 76 S2 site has been summarised in Table 17.

The approximate 30 km of existing access track to be used during the program is predominantly surrounded by the same vegetation unit as Velkerri 76 S2, with patches of Bullwaddy and Lancewood and very minor stands of Melaleuca low open wood and mixed acacia woodlands.

The vegetation types described for the identified gravel pit locations are described in Table 16. The pits are located in a mixture of vegetation communities, including *Corymbia* low woodland, *Acacia* open forest and *Macropteranthes* (mixed) low woodland).

Table 16 Gravel Pit Vegetation Description

Gravel Pit Name	Vegetation Description
Gravel Pit 4	Macropteranthes (mixed) low woodland/Chrysopogon (mixed) open tussock grassland
Gravel Pit 5	Corymbia low woodland/Terminalia (mixed) sparse shrubland/Chrysopogon (mixed) low tussock grassland
Gravel Pit 6	Corymbia low woodland/Terminalia (mixed) sparse shrubland/Chrysopogon (mixed) low tussock grassland
Gravel Pit 7	Acacia low woodland/Eragrostis (mixed) low open tussock grassland

5.2.3 Flora

A total of 805 plant species have been recorded within the wider region, and during the August 2018 survey, 28 dominant flora species were identified. As the survey was conducted during the late dry season, grasses and other annual species were difficult or impossible to identify due to the lack of inflorescence or because they had already died-back.

No Commonwealth or NT threatened plant species were identified as occurring by the Protected Matters Searches or NRMap search. One species, the prostrate, herbaceous vine *Ipomoea argillicola*, is listed as Near Threatened under Section 29 of the *Territory Parks and Wildlife Conservation Act 2000* (TPWC Act) and could potentially occur in the project sites, although has not been reported in previous and current surveys. The NT flora database shows that this species has been recorded from the Bullwaddy Conservation Reserve and at locations surrounding the area in previous searches (AECOM, 2015).

The region supports fragmented stands of Bullwaddy, which is listed under the TPWC Act as 'Least Concern', which refers to species that are either widespread or common and cannot be categorised as Critically Endangered, Endangered, Vulnerable, Near Threatened or Data Deficient. However, Bullwaddy is significant in

terms of the habitat it provides for a range of native species. The extent of Bullwaddy in the permit area is far more extensive than that indicated by the NT Herbarium records.

5.2.4 Weeds

Regional Weed Management Plans (RWMP) have been developed for areas of the NT, with the Barkly and the Katherine RWMP overlapping Origin's Beetaloo exploration tenure.

The weeds species of high risk of introduction or spread through Origin's activities are listed in Table 18. These high-risk weeds have been determined through consideration of the following criteria:

- Weed species that has been confirmed in the area within the relevant RWMP or through field surveys.
- Weed species listed in a RWMP that is in close proximity to Origin tenure.
- Weed species is at risk of introduction through the use of machinery sourced from other regions in the NT or from other states.

Weed baseline surveys were completed by AECOM in August 2018 covering all proposed access tracks and lease pad areas. These surveys were completed with the DENR Weed Officer.

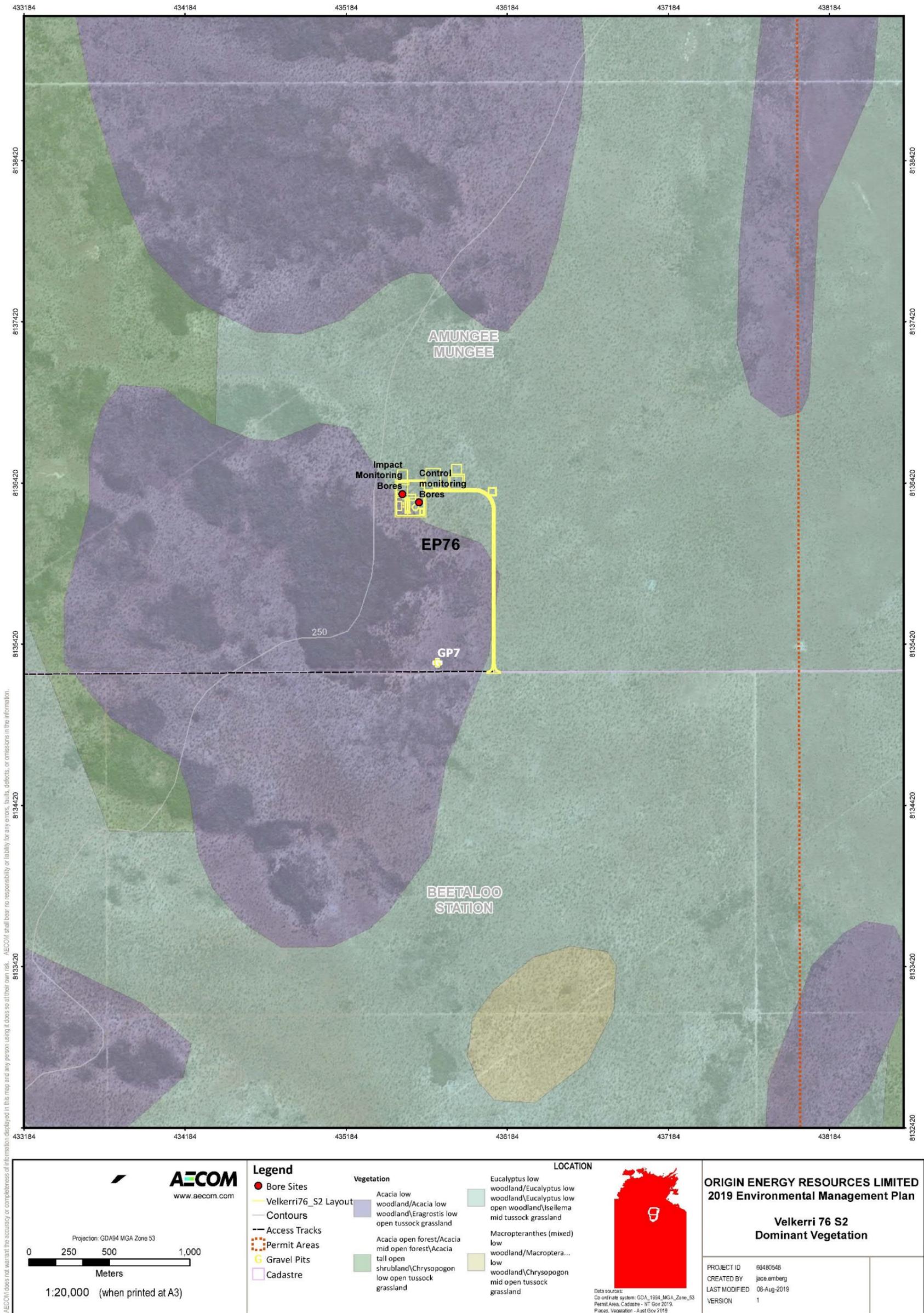
No weeds were identified along the existing access track or proposed infrastructure areas. *Parkinsonia aculeata* (Parkinsonia) and *Calotropis procera* (Rubber Bush) has been previously identified along/in close proximity to the Beetaloo W1 exploration well access track; which is approximately 30km south of the proposed areas. Parkinsonia is considered a Weed of National Significance (WoNS), which are weed species that are the focus of national management programs for the purpose of restricting their spread and/or eradicating them from parts of Australia.

The absence of weeds suggests good habitat condition in the areas of the proposed activity. Primary controls for this program will therefore be focused on preventing the introduction of weeds and managing any weeds promoted through site disturbance.

Additional information on the full list of weeds and control measures for the development are provided in the Beetaloo Weed Management Plan.

Table 17 Velkerri 76 S2 Condition Description

Site ID	Velkerri 76 S2	Habitat photos at central point of survey site (August 2018)	
Location	-16°50' 29.01, 133°39' 0.16		
Landform and soil	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils.		
Habitat type	<i>Corymbia</i> low woodland.		
Vegetation Community	<i>Corymbia</i> low woodland/ <i>Terminalia</i> (mixed) sparse shrubland/ <i>Chrysopogon</i> (mixed) low tussock grassland. This vegetation community is considered regionally extensive and not subjected to extensive clearing.		
Dominant flora species	Canopy dominated by <i>Corymbia dichromophloia</i> , <i>Eucalyptus setosa</i> . Shrub layer including <i>Acacia ancistrocarpa</i> , <i>Alphitonia pomaderroides</i> , <i>Brachychiton paradoxus</i> . Ground layer species include <i>Triodia bitextura</i> .		
Habitat condition	Good condition with evidence of recent grazing. Vegetation appeared to have been heavily burnt in recent years. No evidence of hollow bearing trees and logs. The habitat contained moderate to high refuge opportunities in the form of dense leaf litter, tussock grass cover, and woody debris. Good continuous cover adjoining adjacent woodland habitat and regionally extensive. No evidence of weeds or feral animals.		
Potential Listed Threatened Species	Grey Falcon, Northern Shrike-tit, Plains Death Adder, Gouldian Finch.		
Weeds	No <i>Weeds of National Significance</i> present.		



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A3 size

Figure 11 Vegetation communities surrounding the proposed Velkerri 76 S2 Lease pad

Table 18 High priority weeds to be managed or prevented within the permit area

Scientific Name	Common Name	Status	Priority reason
<i>Acacia nilotica</i>	Prickly Acacia	Class A, WoNS	Mapped in the exploration lease within the Katherine RWMP.
<i>Andropogon gayanus</i>	Gamba Grass	Class A WoNS	Mapped in the exploration lease within the Katherine RWMP.
<i>Calotropis procera</i>	Rubber Bush	Class B and C	Mapped in the exploration lease within the Barkly RWMP.
<i>Hyptis suaveolens</i>	Hyptis	Class B and C	Confirmed within exploration lease during previous Origin weed surveys.
<i>Jatropha gossypifolia</i>	Bellyache Bush	Class A, WoNS	Mapped in the exploration lease within the Katherine RWMP.
<i>Parkinsonia aculeata</i>	Parkinsonia	Class B and C, WONS	Confirmed within exploration lease during previous Origin weed surveys and mapped in the exploration lease within the Katherine RWMP.
<i>Prosopis pallida</i>	Mesquite	Class A and C, WONS	Mapped in the area surrounding exploration lease within the Katherine and Barkly RWMP.
<i>Themeda quadrivalvis</i>	Grader Grass	Class B and C, WoNs	Mapped in the area surrounding exploration lease within the Katherine RWMP. High potential introduction through sourcing of equipment from Katherine area.
<i>Xanthium occidentale</i>	Noogoora Burr	Class B and C	Weed Management Branch – Mapping data. DLRM databases (DLRM <i>et al</i> 2018).
<i>Parthenium hysterophorus</i>	Parthenium	Class A and Class C, WoNS	Potential introduction through equipment sourced from QLD.

5.2.5 Fauna

Previous surveys and database searches indicate that the exploration area is an important area for a diverse array of fauna. The NT Fauna database provides records for the following fauna species (excluding migratory birds): 32 species of mammal, 198 species of birds, 96 species of reptiles and 19 species of frogs. Surveys undertaken elsewhere within the region have recorded:

- 78 bird, 33 reptile, 11 mammal and six frog species in the Bullwaddy Conservation Reserve (PWCNT, 2005)
- 148 bird, 47 reptile, 21 mammal and six frog species in the Junction Stock Reserve and nearby Newcastle Waters (Fleming et al., 1983)
- 157 bird species within the project area as determined by a search of the Birds Australia bird atlas database (Birds Australia, 2010).

The Eucalypt/Corymbia woodland at the proposed locations provides habitat for a range of species. The areas have high native grass cover and included numerous species suitable for granivorous birds (seed eaters). Dense leaf litter and numerous logs provide suitable refuge and foraging sites for fauna such as reptiles. Many of the sites have a high density of hollow-bearing trees that provide important habitat for many fauna species. Although most of the species found in this vegetation type are widespread in the tropical savannas of the Northern Territory, some such as the threatened Crested Shrike-tit (*Falcunculus frontatus whitei*) are rare and known to utilise this habitat (DoTEE, 2014, Ward, 2008).

In the broader area, Savanna grasslands and open woodland provide suitable habitat for species such as Emu (*Dromaius novaehollandiae*) and Australian Bush Turkey (*Ardeotis australis*). Drainage lines and seasonally inundated grasslands may also provide habitat for migratory species during the wet season and are breeding areas for frogs. The proposed activity will have limited the disturbances in these areas.

The location of the infrastructure has been placed to minimise the clearing on areas of high value habitat (such as large hollow-bearing trees) to reduce any impact to native wildlife within the permit area. Due to the regional extensiveness of the vegetation communities and limited scale of disturbance, impacts to fauna have been assessed as unlikely.

5.2.6 Significant Fauna

A search of the DotEE Protected Matters database of nationally significant fauna (PMST), the NT Government fauna database (NRMaps), and records from the Atlas of Living Australia (ALA) was undertaken for the proposed lease areas and access tracks. The search results indicate the potential presence of 20 fauna species listed as threatened under the EPBC Act and/or the TPWC Act. These included ten birds, eight mammals and two reptiles.

The likelihood assessment of species occurrence is based on the availability of suitable habitat within the permit area, records in the vicinity and distributional data. Therefore, many of the threatened and migratory fauna species indicated in databases as 'occurring' or 'likely to occur' have been assessed as 'unlikely to occur' within the proposed lease areas. As some areas in the proposed lease area have not been subject to intensive survey and some species are very cryptic, a conservative approach has been taken to assess species presence. A full description of each species, their distribution and habitat associations are outlined in the AECOM Land Condition Report (Appendix F)

No core habitat for threatened fauna was identified at the sites. However, some species may possibly occur and are known to occur in the wider landscape. Threatened species that may possibly occur include:

- Gouldian Finch *Erythrura gouldiae* (E-EPBC Act, VU-TPWC Act)
- Crested Shrike-tit (northern) *Falcunculus frontatus whitei* (VU-EPBC Act, NT-TPWC Act)

Research has shown that critical components of suitable habitat for the Gouldian Finch include suitable nesting trees during the breeding season (particularly *E. tintinnans*, *E. brevifolia* or *E. leucophloia*), a water source and a diverse range of favoured annual and perennial grasses (DoE, 2015). No nesting habitat was recorded during the surveys and it is unlikely this species breeds in close vicinity of the sites. During the wet season, Gouldian Finches move from breeding habitat on hillsides with suitable trees down to lower lying areas where they forage on perennial grasses such as *Triodia* sp., *Alloterospis semialata*, and *Chrysopogon fallax* (Palmer *et al.* 2012). Some of the perennial grasses were recorded during recent surveys so potential foraging habitat is present, however, there are limited records in the vicinity of the sites suggesting it is not an important area for this species.

The Crested Shrike-tit lives in dry Eucalypt forests and woodland where it feeds on insects from the canopy and also under bark (Ward, 2008). It has been recorded in wet Melaleuca open woodlands, woodlands dominated by Nutwood (*Terminalia arostrata*), Bloodwoods with flaky bark and ironwood (DoE, 2014, Ward, 2008). In the NT, nesting has been recorded from September through to January and nests are built in terminal branches at the top of trees (Ward *et al.*, 2009). The stronghold of this species is north of this location and only one old record exists near Borroloola. Although it is possible this species may be present in the area, it is unlikely to represent an important area for this species and the impact of the proposed activities, given their size, would be small.

The Grey Falcon (*Falco hypoleucus*) is a widespread species listed as Vulnerable in the NT that is considered possibly to be present in the study area. The Painted Honeyeater (*Grantiella picta*) has been known to occur in the study area, however, given it does not breed in the NT it would only be present intermittently for foraging. Based on the field assessment there was no breeding habitat recorded and depending on grass seed and water availability, it is unlikely the study area comprises core habitat for this species.

5.2.7 Feral and Pest Animals

Feral animals known to occur within the region include:

- Pig (*Sus scrofa*)
- Wild Dog (*Canis lupus familiaris*)
- Feral Cat (*Felis catus*)
- Cane Toad (*Bufo marinus*)
- Horse (*Equus caballus*)
- Donkey (*Equus asinus*)

- Water Buffalo (*Bubalus bubalis*)
- Camel (*Camelus dromedarius*)
- Black Rat (*Rattus rattus*)

During the August 2018 survey, evidence of cattle grazing in present or 1-2 years previously was recorded and in previous surveys of the permit area, cat tracks were observed as the only non-native species recorded, but based on records many species, especially Dogs/Dingo, Pigs and Cane Toads, will be present in permit area. The disturbance from cattle within the proposed sites were considered to have resulted in less than 5% damage or no damage at all.

5.3 Fire Regime

Fire is a natural occurrence in most Australian ecosystems and plays an important role in their ecology. Fire is generally excluded from Mitchell grasslands by pastoral management in order to maintain forage throughout the dry season (HLA, 2005) whereas fire is more frequent in the Sturt Plateau.

Fire disturbance was evident at Velkerri 76 S2 during the ecological surveys, with evidence of an intensity 4 (some trees and shrubs killed) and Height 1-4 m fire present 1-2 years previously. It was noted that the site showed evidence of fire disturbance and were showing signs of regrowth and recovery.

5.4 Environmental and Cultural Sensitivities

5.4.1 Native Title

Two Native Title claims have been determined as non-exclusive and one Indigenous Land Use Agreement (ILUA) are current over the permit areas (see Table 19).

Table 19 Native Title and IULA Agreements Current for the Permit Areas

Type	Infrastructure	Name	Summary
Native Title	Access Track	NTD21/2010 Shenandoah Pastoral Lease	Native Title exists in parts of the determination area and is held by the Kinbininggu and Bamarrnganja groups
Native title	Velkerri 76 S2-1	NTD17/2010 Amungee Mungee Pastoral Lease	Native title exists in parts of the determination area and is held by The Karranjini group; the Bamarrnganja group
Indigenous Land Use Agreement	All Sites	D12004/014 Jingaloo CLA ILUA	Registered for Community Living Area and Tenure resolution

The Native Title Petroleum Exploration Agreement between Origin and the NLC includes clauses for the protection of sacred sites, objects and sensitive areas related to Aboriginal activities in the area, including cultural, hunting and foraging activities. Site clearance will occur prior to any on-ground activities. The Native Title Agreement also includes clauses for the protection of the environment and site rehabilitation.

5.4.2 Archaeology Assessment

An archaeological assessment, involving searches of the NT Heritage Register and Australia Heritage Database and a field survey, have been carried out by AECOM archaeologist, Luke Kirkwood, for the exploration sites and associated tracks. It should be noted that this survey covers additional sites that are not in the scope of this EMP.

A search of the NT Heritage Register identified 41 Aboriginal archaeological sites within a 125 km by 125 km area that encompasses the full proposal area. No archaeological sites are recorded within 15 km of the proposed 2019 lease areas.

A search of the Australia Heritage Database identified that no statutory listed heritage places within the proposed impact areas.

The field survey involved a combination of both pedestrian and helicopter survey of the proposed disturbance areas. During the inspections, notes were taken on landform, ground surface visibility and areas of exposure. The aim of the field survey was to identify any surface expressions of Aboriginal archaeological and cultural heritage values within the exploration area. Photographic records were taken at each proposed location.

No culturally sensitive landforms or artefacts were identified during field survey of the lease sites covered under this EMP.

The archaeological assessment is provided in Appendix G.

5.4.3 Areas of Cultural Significance

Sacred sites in the study area are primarily associated with drainage lines; natural landform features and stock routes, but there are also concentrations of sites nearby to old homesteads. The distribution of these sites may reflect historical patterns of Indigenous movements along drainage lines and subsequent development of stock routes on old Indigenous walking trails, or they may merely be indicative of the site clearance work undertaken along roads and tracks in the area. It is suspected that there will be a range of other sites also within the area, either not yet recorded, or known but not reported for cultural reasons.

AAPA clearance certificate C2019/039 has been obtained for the proposed Velkerri 76 S2 site and associated activities. The Velkerri 76 S2 site is referred to as CA10 within the AAPA certificate. Clearance certificates will be provided to DENR/DPPIR as a part of the submission.

There is a segment of the existing access track which intersects restricted work area (RWA) 4 on the way to the Velkerri 76 S2 lease pad. The middle point of this segment of track is 12 metres (either side) from the restricted work areas (RWA).

No RWA's exist within the immediate vicinity of the Velkerri 76 S2 lease pad, with a complex of water holes located 7km south of the proposed lease pad. Origin has committed to comply with conditions as prescribed by AAPA for the duration of the program.

5.4.4 Natural Resources

In addition, previous cultural heritage surveys of the permit areas were undertaken with representatives of the Traditional Owners who identified a number of natural resources of importance to Aboriginal people of the area (Table 20).

Table 20 Natural Resources of Importance in the Permit Areas

Scientific Name	Common Name	Usage
<i>Grewia retusifolia</i>	Emu-berry/Dog's Balls, Turkey Bush and Diddle Diddle	Fruit eaten. Leaves can be boiled, and body bathed in the liquid for treatment of a number of ailments.
<i>Marsdenia australis</i>	Bush Banana/Gillibi	Bush 'fruit' eaten when young, as it matures 'fruit' seeds becomes feathery for dispersal in the wind and are not eaten.
<i>Pterocaulon</i> sp.		Used for treating flu.
<i>Acacia</i> sp.	Acacia	Leaves boiled and used to treat the flu.
<i>Acacia holosericea</i>	Soapbush Wattle or strap wattle	Leaves used for washing.
	Termite (unknown species)	Mounds pulverised and mixed with water, used to treat diarrhoea.

5.4.5 Non-Indigenous Heritage

In 1860, explorer John McDougall Stuart was the first European to penetrate the area now known as 'The Centre'. The first written descriptions of the area come from Stuart during his second attempt to cross the continent from south to north (HLA, 2005).

Development in the area began as pastoral lands with an increased interest in land settlement following the completion of the Overland Telegraph Line in 1873. Most attempts were unsuccessful with the Lancewood-Bullwaddy vegetation found to be impenetrable and the lack of surface water making the land unsuitable for cattle. Daly Waters was thus recognised as one of the last watering stops on the Murrarji Stock Route.

It wasn't until the 1930s to 1950s, that the area saw regional economic growth with Daly Waters becoming a significant hub of air and mail services into the Territory. The wartime years saw this role increase with Daly Waters again playing a major role in cross-country transport and communication. This role continued until the early 1970s when the airport was closed to commercial traffic. The town and surrounding areas subsequently reverted to a primarily agriculture-based existence following the decline of air travel, but in recent times has seen commercial interest from the exploration for gas in the Beetaloo Sub-basin and the growth of the 'grey nomad' tourism market.

5.4.6 Historic Heritage Assessment

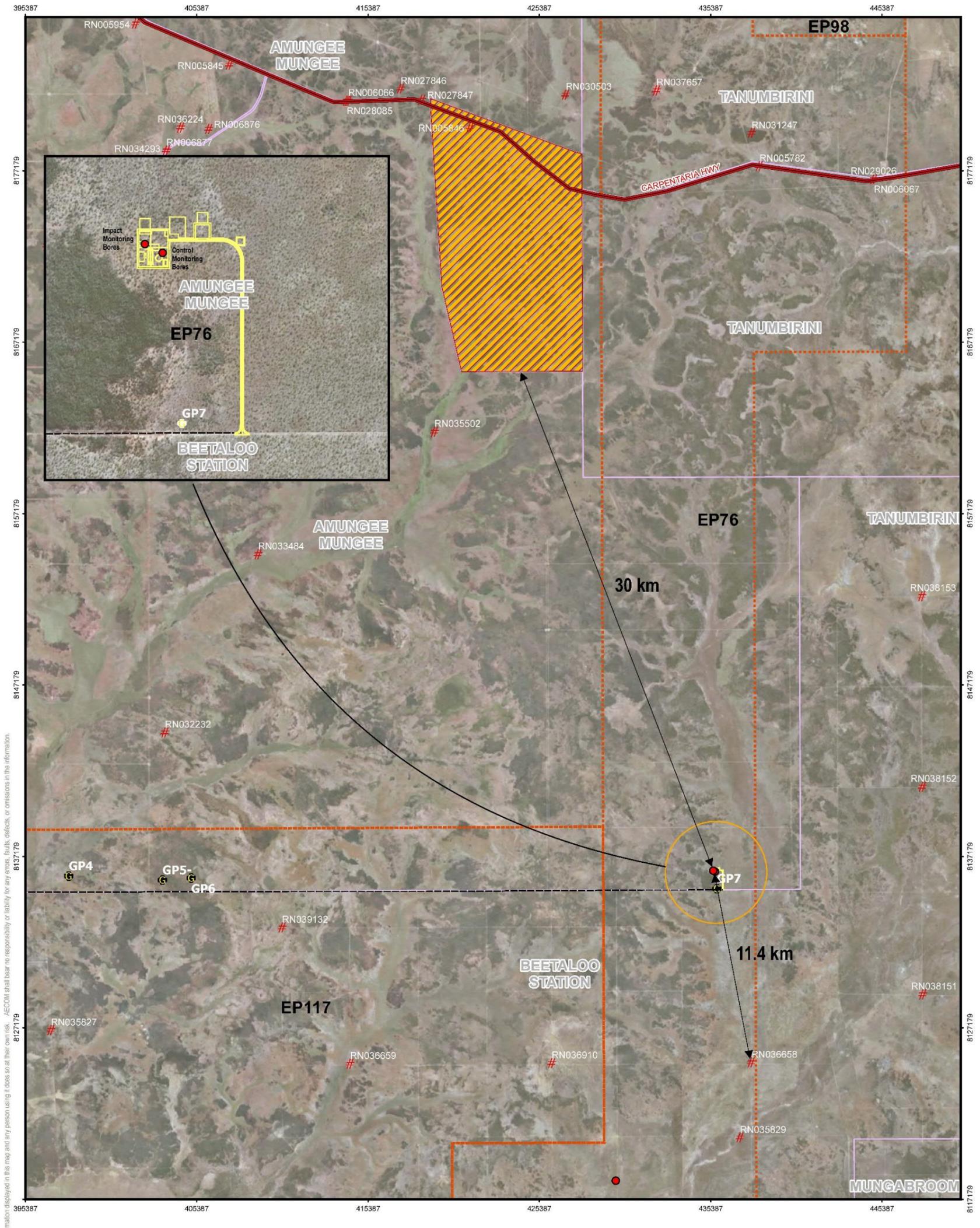
A search of relevant historic heritage registers identified a number of historic heritage sites within a 125 km by 125 km area that encompasses the full proposal area. No previously identified sites are located within 20 km of the proposed lease area, with Frew Ponds located approximately 7km south of the Stuart Highway access point. No new sites of historic heritage were identified during the August 2018 survey.

5.4.7 Protected and Conservation Areas

There are no conservation reserves, national parks, world heritage places, Commonwealth land, heritage places or critical habitat areas listed under the EPBC Act located within or immediately adjacent to the proposed exploration area.

The closest area is the Bullwaddy conservation area, which is located 30km to from the proposed activity area (Figure 13). The risks to this and other receptors through aquifer contamination, spills, sediment release, habitat destruction have been addressed in the risk assessment presented in Appendix K and include:

- As the proposed site is 30km away from the Bullwaddy conservation area contamination is not likely to reach the area at any undiluted impactable state.
- Surface water flow is to the south east direction away from the Bullwaddy conservation area with any streams between the proposed site and the Bullwaddy conservation area draining away from the Bullwaddy conservation area.
- Groundwater depth throughout the Bullwaddy conservation area and the proposed conservation area is generally 70m of depth with vegetation not being able to access groundwater at this depth.
- All access tracks are to the south of the Bullwaddy conservation area with vehicles and workers not interacting with flora and fauna from the site.



<p>www.aecom.com</p> <p>Projection: GDA94 MGA Zone 53</p> <p>0 2.5 5 10</p> <p>Kilometers</p> <p>1:200,000 (when printed at A3)</p>	<p>Legend</p> <ul style="list-style-type: none"> ● Bore Sites # Pastoralist Bores Velkerri76_S2 Layout Access Tracks Gravel Pits Permit Areas Bullwaddy Conservation Reserve Cadastre 	<p>LOCATION</p> <p>Data sources: Co-ordinate system: GDA_1994_MGA_Zone_53 Permit Area, Cadastre - NT Gov 2019 Places, Vegetation - Aus: Gov 2019</p>	<p>ORIGIN ENERGY RESOURCES LIMITED 2019 Environmental Management Plan</p> <p style="text-align: center;">Velkerri 76 S2</p>
			<p>PROJECT ID: 60480548</p> <p>CREATED BY: jace.ernberg</p> <p>LAST MODIFIED: 08-Aug-2019</p> <p>VERSION: 1</p>

Filename: P:\604\60480548\4. Tech Work Area\A.99 GIS\02_MXD\Velkerri76_S2_Insert.mxd

A3 size

Figure 13 Velkerri 76 S2 lease pad in proximity to water bores and conservation areas

5.5 Social Environment

5.5.1 Social Context

The proposed 2019 work programme will occur within the Barkly Regional Council area, which covers 323,514 km². The approximate population is estimated for the Barkly Region of 8,137 people (Barkly Regional Council, 2018).

The potential social and economic effects within the region where exploration activity for 2019 is planned is considered to be negligible.

The closest neighbouring regional towns and communities identified as being within proximity to Origin's activities include:

- Dunmarra (~100 km)
- Tennant Creek (~340 km)
- Elliott (~120 km)
- Daly Waters (~120 km)
- Newcastle Waters (~120 km); and
- Neighbouring pastoral leases of Hayfield Shenandoah and Beetaloo.

In 2014, the Tennant Creek Regional Economic Development Committee (REDC) released the *Tennant Creek and Barkly Region Strategic Action Plan (2014-2016)* identified social and economic development within the region, including oil and gas development. Origin has met with the REDC annually with its most recently project update meeting taking place in Tennant Creek on 27 September 2018.

5.5.2 Pastoral Activity

The current land use in the project area is pastoral with varying stocking rates and varying management practices. Within the permit area there are nine pastoral properties as shown in Table 21. All of the land within the permit area is Leasehold Land. There is one small area of Aboriginal Freehold land known as Jingaloo on EP117.

Table 21 Pastoral properties in the Permit Area

Pastoral Property	Permit Areas			Contact Details
	EP76	EP98	EP117	
Amungee Mungee	✓	✓	✓	
Kalala		✓	✓	
Tanumbirini	✓	✓		
Beetaloo	✓		✓	
Hayfield/Shenandoah		✓	✓	
Ucharonidge	✓		✓	
Tandyidgee	✓	✓		
Nutwood Downs		✓		
Newcastle Waters			✓	

The project area has been subject to pastoral activities for over 150 years (AECOM, 20). The average size of a Station in the Barkly Region is 8,186 km² (Bubb, 2004), which is large by global standards.

The proposed Velkerri 76 S2 exploration site is located on the Amungee Mungee Station. Access to the site is via the Hayfield Shenandoah Pastoral property.

The impact on pastoralist activities is not considered to be significant, based on the following:

- Lease pad is accessed by neighbouring property, with activity located away from main property access points, cattle yards, water bores, water supply infrastructure or pastoralist infrastructure.
- All lease areas to be fenced to prevent livestock access
- No surface water take permitted
- Environmental controls outlined in the Codes of Practice for Onshore Petroleum Activities in the northern territory to be implemented to minimise risk of fire, spills, weeds, erosion and groundwater contamination to as low as reasonably practicable (ALARP)
- Upgraded access tracks to comply with the NT Land Clearing Guidelines and relevant NT road construction standards to prevent watercourse interference, pooling or creation of erosion.
- Gates to be installed or upgraded where required, in consultation with pastoralist
- Access tracks and water bores likely to be transferred to the landholder at the end of the program.
- All sites to be rehabilitated at the end of the project life.

5.5.3 Other Land Uses in the Area

A range of other land-uses exist in the permit area or in the larger region, including a range of public utilities and facilities. These include the following:

- Tourism – Tourism is an important regional industry with the Stuart Highway being a major thoroughfare for tourists travelling in the area during the dry season. The local townships of Daily Waters, Dunmarra and Elliot provide consumables (food, fuel etc.) and accommodation. A number of heritage areas of importance to regional tourism are located in the broader region, including Elliott, Newcastle Waters and other heritage listed homesteads.
- Road networks – The Stuart Highway and Carpentaria Highway will be used to access the sites. In addition, there are numerous gravel roads connecting properties, and internal property tracks. All properties also have firebreaks on their boundaries and internally.
- Gas pipeline – A gas pipeline runs to the west of the Stuart Highway, along the eastern boundary of EP117 and crosses the boundary of one part of EP98. It also runs parallel with the Carpentaria Highway to the Gulf of Carpentaria, through EP98 and EP76.
- Alice Springs to Darwin Railway – The railway line runs to the west of the gas pipeline and Stuart Highway, and does not cross into any of the permit areas.
- Townships – The townships of Daly Waters and Dunmarra neighbour EP98 to West.
- Conservation areas – Including the Bullwaddy Conservation Reserve, which lies within EP98 and Lake Woods and the Junction Stock Reserve just outside the permit area.
- Heritage – There are seven heritage sites within the exploration permit area and a number of heritage areas of importance to regional tourism located in the broader region, including Elliott, Newcastle Waters, heritage listed homesteads as well as Frew Ponds Historical Reserve which lies just outside permit area 117.
- Archaeological sites – The permit areas have a long history of Aboriginal association and 41 archaeological sites have previously been recorded within the permit areas, as well as registered sacred sites and areas of significance which are shown in the AAPA certificate.

The proposed activities covered under this plan have been specifically designed to avoid impacts to these receptors.

6 Stakeholder Engagement

The NT *Petroleum (Environment) Regulations 2016* defines *stakeholder* as meaning:

- (a) a person or body whose rights or activities may be directly affected by the environmental impacts or environmental risks of the regulated activity proposed to be carried out; or
- (b) an agent or representative of a person or body mentioned in paragraph (a).

Origin's local and directly impacted / affected stakeholders have, and continue to be, consulted in a respectful, open and consistent manner. This has been the case since 2014, when Origin has assumed operatorship of EP98, EP117 and EP76.

Origin's consistent approach to stakeholder engagement has been to ensure that those persons and / or groups most directly impacted / affected and / or influenced by permit commitments have received Origin's full attention. Origin views the social acceptance and informed consent of these primary stakeholders of critical important and relevance during this stage of low impact and small-scale exploration activities.

For the purpose of this EMP, Origin identifies its stakeholders, in compliance with the NT *Petroleum (Environment) Regulations 2016* as:

- **host Traditional Owners** recognised as the Native Title holders and / or claimants and their representative, the Northern Land Council, as described in Exploration Agreements between the parties for EP98, EP117 and EP76; and
- **host pastoralists** recognised as the landholders of the nine Pastoral Lease Stations in Table 20, with particular engagement with the landholder of Amungee Mungee as the stakeholder most impacted by Origin's relevant permit commitments the subject of this EMP.

Origin also recognises and engages, where appropriate and acceptable, with the following list of stakeholders:

- Northern Territory community and residents;
- Federal Government, including Departments, Members of Parliament and Opposition Spokespersons;
- Local Government Agencies, including:
 - Katherine Town Council;
 - Barkly Regional Council;
 - Roper Gulf Regional Council; and
 - Regional Economic Development Committees;
- Northern and Central Land Councils;
- Environmental Protection Authority;
- Aboriginal Areas Protection Authority (AAPA);
- National, State and Local Media (Print, TV and Radio);
- Australian Petroleum, Production and Exploration Association (APPEA);
- Northern Australia Development Office (NADO);
- Northern Territory Cattlemen's Association (NTCA);
- Industry Capability Network (ICN);
- Chamber of Commerce NT;
- Business Council of Australia;
- Minerals Council of Australia;
- CSIRO / GISERA;
- NGOs;
- Darwin Major Business Group (DMBG);
- Energy Club Northern Territory (ECNT);
- Indigenous Business Network NT (NTIBN);
- Katherine Mining Services Association (KMSA).

Stakeholder and community engagement for the 2019 work programme has been held with host pastoralists and Traditional Owners directly affected by the proposed activities. Origin's proposed exploration program has been

clearly communicated to interested parties, with several written submissions and video presentations prepared by Origin for 'The Scientific Inquiry into Hydraulic Fracturing in the Northern Territory'. Information included in Origin's submission to the Inquiry is publicly available at <https://frackinginquiry.nt.gov.au/submission-library>.

Activities performed under EP98, EP117 and EP76 will be conducted in a manner consistent with the 'Code of Practice: Onshore Petroleum Activities in the Northern Territory', which Origin considers an appropriate reference for ensuring Origin's activities are in line with community expectations.

6.1 Pastoralist Stakeholder Engagement

Origin has engaged with the pastoralist stakeholders identified in Table 20 above on an ongoing basis, including engagement with the landholder of Amungee Mungee Station regarding the low impact and small-scale exploration activities. Key engagement efforts Origin has undertaken with the landholder of Amungee Mungee Station include:

- engaging in consultation for and agreeing on early works access to Amungee Mungee Station in preparation of low impact and small-scale exploration activities;
- providing the landholder with draft copies of this EMP and the EMP for civil construction works for the Velkerri 76 S2 well and providing opportunity for the landholder to comment;
- providing the landholder with copies of Beetaloo Basin Exploration Project – Weed Management Plan (Appendix D) and Trafficwerx NT Traffic Management Plan (Appendix H) for works Origin proposes to undertake as part of the broader Beetaloo Basin Exploration Project, which outline Origin's environmental risk management and outcome achievement policies; and
- ongoing engagement and consultation meetings regarding Origin's proposed exploration activities, including demonstration of the scope and activities part of Origin's Beetaloo Basin project (Appendix J).

Appendix J summarises Origin's compliance with Origin's obligation to engage with the landholder of Amungee Mungee Station as a relevant stakeholder and provide information in accordance with section 7(2)(a) of the *Petroleum (Environment) Regulations 2016*.

Appendix K provides the correspondence between Origin and the landholder and representatives of Amungee Mungee Station in fulfilment of the stakeholder engagement obligations under the *Petroleum (Environment) Regulations 2016*.

6.2 Traditional Owner Engagement

Origin has undertaken detailed engagement with the relevant Traditional Owners through the Northern Land Council to facilitate an ongoing relationship between Origin and the Traditional Owners. Engagement efforts undertaken by Origin include:

- ongoing consultation regarding Origin work programs and proposed exploration activities, including the locations of all areas of disturbance across the area of EP98, EP117 and EP76.
- in person consultation between Origin and the Northern Land Council regarding Origin's proposed exploration activities on 3 September 2018;
- ongoing communication between Origin and the Northern Land Council; and
- performance of a Sacred Site clearance survey on land with the relevant Traditional Owners between 10 September and 19 September 2018. A formal Northern Land Council Sacred Site Avoidance and Anthropological Report was provided to AAPA to assist with the certification process for Origin's exploration areas and associated infrastructure.
- Six on-country meetings with the Native Title holder family groups in Elliott. Coordinated by the NLC to comply with consultation requirements and commitments of the Exploration Agreements for EP117, EP98 and EP 76

The Northern Land Council has provided Origin with Traditional Owner consent for the activities and AAPA provided Origin certification C2019/039 on 30 November 2018.

A summary of traditional owner engagement is provided in Table 22.

6.3 Northern Territory Community Engagement

Broader engagement has occurred with local and regional business within the local communities of Daly Waters, Elliot, Katherine and the broader Northern Territory region.

Northern Territory businesses have been engaged on the scope of Origin's activities through information sessions and tender opportunities covering a range of material supply and support services, such as:

- people transport and logistics;
- accommodation and food;
- provision of temporary camps and camp services;
- civil construction work;
- freight and transport;
- water bore drilling;
- water carting and waste management;
- site maintenance and inspections;
- weed management and control;
- equipment and materials storage;
- oil country tubular goods;
- environmental and civil consulting;
- surveying and geotechnical assessments; and
- general provisions of goods and services (such as personal protective equipment and hire cars).

6.4 Ongoing Stakeholder and Community Engagement

Origin is committed to continuing to engage with stakeholders regarding the exploration activities under EP98, EP117 and EP76 and any associated environmental outcomes prior to, during and after performance of the low impact and small-scale exploration activities. For example, Origin made an express offer for further and ongoing consultation with the landholder of Amungee Mungee Station by letter on 5 June 2019 (Appendix J).

Origin recognises the growing community interest in ensuring onshore natural gas development takes place in a safe and environmentally sound way and are committed to delivering operational excellence (which encapsulates our health, safety and environmental performance standards).

Origin has further committed to ongoing engagement with the relevant Traditional Owners, including annual work plan meetings and provision of draft work programmes for future years of activity.

Detailed community and stakeholder engagement is underway covering future exploration activities which are beyond the scope of this EMP.

A number of Origin Beetaloo Basin Project series sheets have been created to provide information on Origin's activities and broader shale exploration (Appendix I).

Table 22 Traditional owner engagement information

Stakeholder	Method of communication	Date of Correspondence	Summary of information provided	Summary of response	Origin's response	Details of changes made to work program
NLC / Native Title holders (host Traditional Owners)	- Work Program Submission - Face to Face Meeting - Email Correspondence - Sacred Site Clearance Survey (In Field) -on Country meeting	- 10 Jul 2018 - 3 Sep 2018 - 3, 4 and 9 Sep 2018 - 10 to 19 Sep 2018 - 08-12/04/2019	- Locations of all potential areas of disturbance across the permits - All potential area of disturbance across the permits - Information story boards on: - Water protection -Well integrity -Hydraulic fracturing -Drilling - Environmental Controls -Traditional Owner participation - Geological information Information on Origin's Beetaloo project as provided in Appendix I	- The NLC coordinated the Sacred Site Clearance Surveys with Traditional Owners of the respective area(s) - The NLC completed their report and provided the report to AAPA on Friday 2 November -Six on-country meetings with the Native Title holder family groups in Elliott. Coordinated by the NLC to comply with consultation requirements and commitments of the Exploration Agreements for EP117, EP98 and EP 76	Process of engagement has been followed as per the exploration agreements	Origin received instructions from NLC and AAPA to ensure the disturbance areas do not interfere with cultural heritage
Aboriginal Area Protection Authority (AAPA)	Email correspondence Face to face Face to face	09/01/2019 31/01/2019 14/02/2019	Application summarising Origin's 2019 work program and AAPA certificate requirements Presentation summarising Origins proposed workplan in detail. Discussions regarding scope of submission and additional information/ clarifications	AAPA requested additional information and clarification on the scope of the proposed activities	Origin has provided this additional information and clarified work program items	AAPA Certificates issued - namely (C2018/103 and Variation to C2018/103 resulting in Certificate C2019/039)

7 Environmental Risk Assessment

7.1 Origin's Risk Management Approach

Origin utilises a robust risk management process for all its activities to achieve the following key outcomes:

- Risks are understood, eliminated or reduced and controlled to an acceptable level,
- Controls are owned, assured and continuously reviewed for effectiveness,
- All activities are compliant with regulatory standards and are guided by best practice,
- Origin and its stakeholders are confident in the way activities are conducted to manage risks, and
- The approach aligns with the findings of the NT Inquiry final report and associated recommendations (as implemented via the various Codes of Practice or legislation).

Risk management processes are mandated through the Origin Risk Management Policy and Directive, which includes a risk rating toolkit that is utilised from the Board through to frontline activity owners (Figure 14). The toolkit considers the requirements of ISO 31000 and addresses risk identification, assessment and management.

Assessment of risk is completed using Origin's Risk Matrix (Figure 15) to assess and rate risks by assessing the combination of frequency of occurrence and the severity of the outcome of a potential event, including a worst case scenario event. This allows quantification of a risk and determination can then be made about whether the risk can be accepted, or whether further mitigation is required.

Origin risk management processes require regular assessment of underlying (unmitigated) risk from an activity, the residual risk once controls are applied, the effectiveness of controls (provided in Table 23) and the likelihood and consequence of a risk event. A risk is either accepted in accordance with strict delegations of authority or the activity does not proceed.

In addition, the risks associated with unconventional gas developments activities have been thoroughly investigated and reported by the NT Inquiry. A series of risks and recommended mitigation measures were outlined to reduce the likelihood of any impacts to an acceptable level. These recommendations have been incorporated into various Codes of Practice and changes in legislation to ensure a high level of environmental protection across the industry. This ensures risks are assessed and mitigated in a consistent manner, to provide greater certainty to the community that the risks associated with exploration activities are being reduced to an acceptable level.

Inherent, or unmitigated risks have been provided in the assessment. Unmitigated risk is the risk from the activity without industry controls and is not reflective of the actual risk posed by the activity. The provision of unmitigated risk is a useful measure to identify areas where key controls are required to lower the risk down to an acceptable level, to allow for targeted risk control assurance activities.

Table 23 Risk control effectiveness definition

Rating	Explanation
Effective	<ul style="list-style-type: none"> • Controls are well designed and address the root cause/s of the risk • Controls are recognised industry best practice • All controls operate at the required level • All controls are within the power of Origin, with few external factors beyond control • Ongoing monitoring required
Can Be Improved	<ul style="list-style-type: none"> • Majority of controls are well designed and address the root cause/s of the risk • Majority of controls operate at the required level • Some controls are outside the power of Origin, with multiple external factors beyond control • Ongoing monitoring required • Certain controls can be improved or have elements below industry best practice
Must Be Improved	<ul style="list-style-type: none"> • Most controls are not well designed and do not address the root cause/s of the risk. • Most controls are not operating to the required level • A large number of controls are outside the power of Origin, with multiple external factors

- The majority of controls require improvement and are well below industry best practice

7.2 Risk Acceptance Threshold and ALARP

A risk can be considered to have been reduced to 'as low as reasonably practicable' (ALARP) when all reasonably practicable control measures (both preventative and mitigative) have been identified and implemented to reduce the risk of identified events. A key element of demonstrating ALARP is that good practice is followed, where good practice is defined as the recognised risk management practices and measures that are used by competent organisations to manage well understood hazards arising from their activities. This definition incorporates good practice as defined in codes and standards, and a consensus of good practice within the industry. ALARP is not a final position over the life of an asset or project.

The practicability and the reasonability of control measures can change over time due to changes in technology (that can make measures more readily available), industry standards (that can commoditise once-cutting-edge technology) and the socio-technical landscape (that can modify societal expectations).

In the NT context, ALARP and the definition of acceptable risk levels was a key feature of the NT Inquiry Final Report. For each aspect, acceptability criteria were defined, with recommendations outlined to reduce the potential risk to below the acceptable level. With the adoption of all recommendations by the NTG, the new Codes of Practice and associated regulatory changes provides a high level of inherent protection to ensure activities are undertaken in a safe and consistent manner.

Through adoption of the recommendations of the NT Inquiry (along with other risk management and legislative requirements), Origin can demonstrate all environmental impacts and environmental risks associated with its activities will be reduced to a level that is as low as reasonably practicable (ALARP) and acceptable.

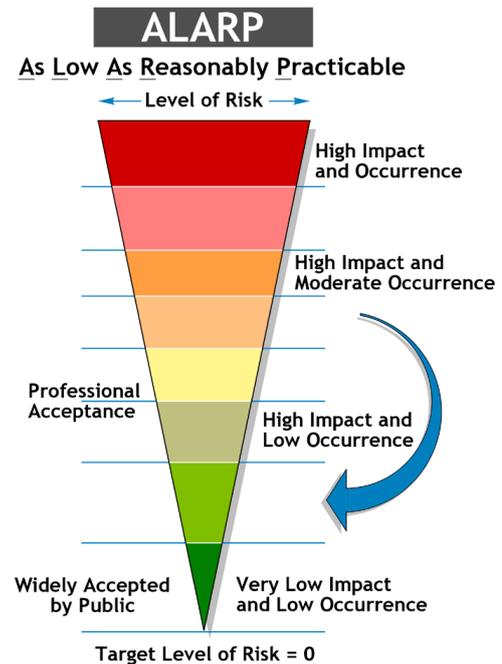
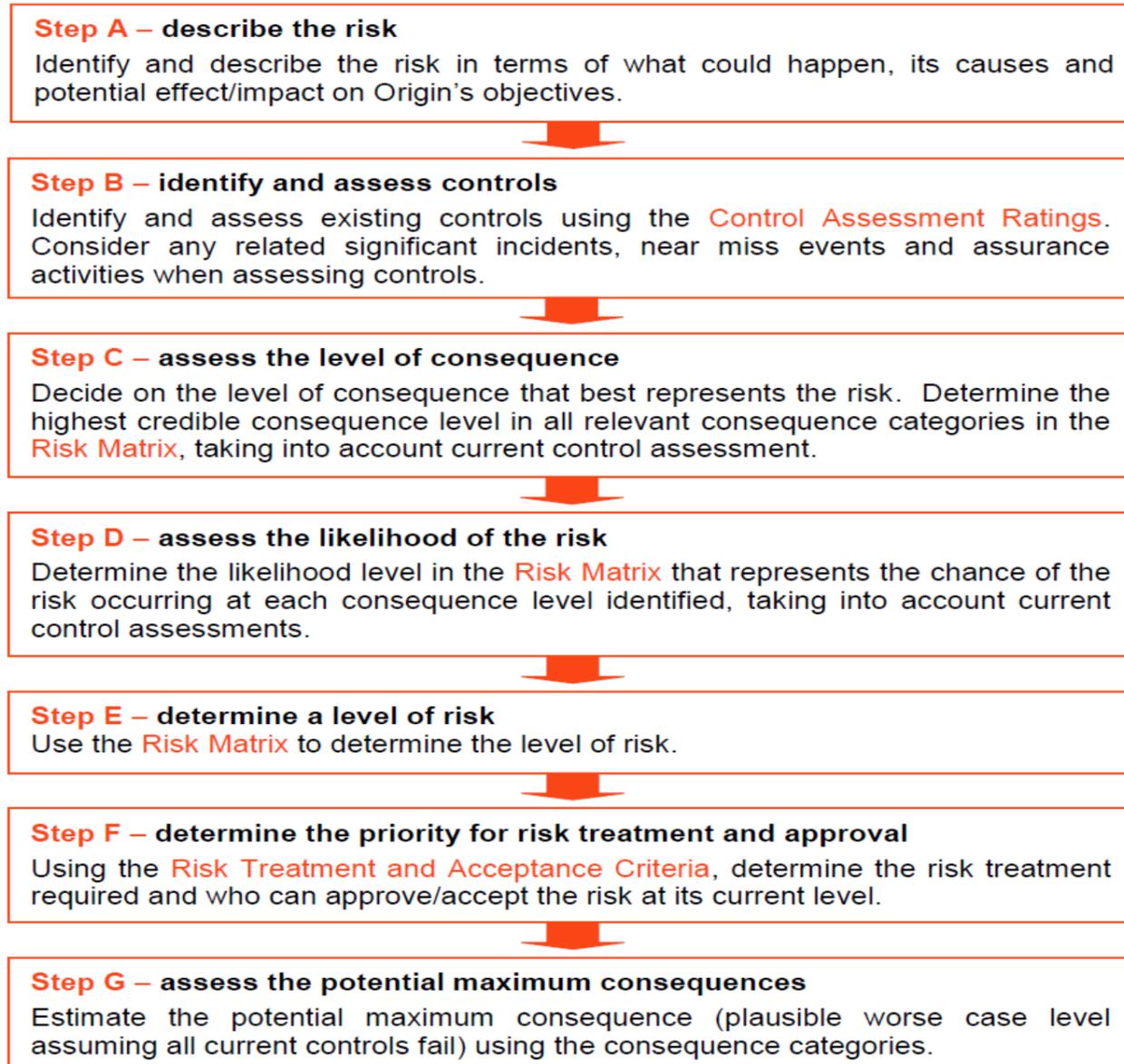


Figure 14 Origin's risk tool kit which describes the approach to identify, assess, control, treat and accept risks

Origin Risk Rating Toolkit

How to use this toolkit



Control Assessment Ratings

Rating	Explanation
Effective	<ul style="list-style-type: none"> All controls are well designed and address the root cause/s of the risk. All controls operate to the required level. Ongoing monitoring required.
Can be improved	<ul style="list-style-type: none"> Majority of controls are well designed and address the root cause/s of the risk. Majority of controls operate to the required level. Certain controls can be improved. Ongoing monitoring required.
Needs to be improved	<ul style="list-style-type: none"> Majority of controls are not well designed and do not address root cause/s of the risk. Majority of controls do not operate to the required level. Majority of controls require improvement.

Risk Treatment and Acceptance Criteria

Level of risk	Action required	Acceptance authority
VERY HIGH	<ul style="list-style-type: none"> Risk treatment must be in place immediately Review risk quarterly at a minimum 	EMT member*
HIGH	<ul style="list-style-type: none"> Risk treatment must be considered (having regard to current business priorities) Review risk annually at a minimum 	General Manager
MEDIUM	<ul style="list-style-type: none"> Risk treatment may be considered Review risk two yearly at a minimum 	Group/Asset/ Project Manager
LOW	<ul style="list-style-type: none"> No risk treatment required No ongoing review required unless determined by the relevant Group Manager 	Site/Activity Manager

* Managing Director acceptance required for risks with a Catastrophic consequence and Likely or above Likelihood

Figure 15 Origin's Risk Matrix

Risk Matrix

		IMPACT ON ORIGIN OPERATIONS					EXTERNAL RESPONSE		LIKELIHOOD					
		Conduct Business with Due Care		Create Value			Decisions are Subject to Scrutiny		1 REMOTE	2 HIGHLY UNLIKELY	3 UNLIKELY	4 POSSIBLE	5 LIKELY	6 HIGHLY LIKELY
		People	Environment and Community	EBIT	Cash flow	NPV	Stakeholder Perceptions	Laws, regulation and civil actions	<1% chance of occurring within the next year. Only occurs as a '100 year event' or less frequent.	<10% chance of occurring within the next year. Could occur within decades.	<30% chance of occurring within the next year. Could occur within the next few years.	<60% chance of occurring within the next year. Could occur within months to years.	<90% chance of occurring within the next year. Could occur within weeks to months.	Likely to happen multiple times a year
CONSEQUENCE	6 CATASTROPHIC	Multiple fatalities >4 or life threatening illness or total permanent disability to a large exposed group (10 or more people)	Extensive permanent damage to endangered species, habitats, ecosystems or area/s of cultural significance Extensive irreversible loss of community livelihood. Long-term social unrest and outrage	>\$200m	>\$1b	>\$1.5b	Multiple stakeholder groups confirming coordinated action, as reflected in media channels with significant reach and influence (eg. scheduled blockade or boycott covered in media for more than 1 week).	Criminal charges against any director or senior executive involving jail or loss of right to manage the company. Public inquiry – requiring considerable resources and Executive Management time. Loss of licence to operate an asset	HIGH	HIGH	VERY HIGH	VERY HIGH	VERY HIGH	VERY HIGH
	5 CRITICAL	1 – 3 fatalities or life threatening illness or total permanent disability to a small exposed group (<10 people)	Extensive long term partially reversible damage to vulnerable species, unique habitats, ecosystems or area/s of cultural significance Extensive reversible loss of community livelihood. Prolonged community outrage.	>\$50m - \$200m	>\$250m - \$1b	>\$375m - \$1.5b	Multiple stakeholder groups mobilising and encouraging others to take action, as reflected in media channels with significant reach and influence (eg. social media campaign calling for protest, escalating over several days).	Criminal charges against any director, senior executive or senior manager not involving jail or loss of right to manage the company. Prolonged major litigation – exposure to significant damages / fines / costs. Suspension / restriction to operate an asset.	MEDIUM	MEDIUM	HIGH	VERY HIGH	VERY HIGH	VERY HIGH
	4 MAJOR	Injury or illness to one or more persons, resulting in permanent partial disability	Long term reversible impacts to listed species, habitats, ecosystems or area of cultural significance Significant impacts to community cost of living, business viability or social wellbeing. High levels of community tension.	>\$20m - \$50m	>\$100m - \$250m	>\$150m - \$375m	More than one stakeholder group's opinion or view influencing other stakeholders, reported through media channels with some reach and influence (eg. government comments in national media or in Parliament).	Criminal charges against any employee (not described above) Major litigation – exposure to damages / fines / costs.	MEDIUM	MEDIUM	MEDIUM	HIGH	VERY HIGH	VERY HIGH
	3 SERIOUS	Injury or illness to one or more persons resulting in hospitalisation, 5 or more days lost time or alternative / restricted duties for 1 month or more	Serious medium term reversible impacts to low risk species, habitats, ecosystems or area/s of cultural significance Moderate impacts to community cost of living, business viability or social wellbeing. Moderate levels of community tension.	>\$5m - \$20m	>\$25m - \$100m	>\$37.5m - \$150m	More than one stakeholder group offering an opinion or view, reported through media channels with some reach and influence (eg. state based commentary lasting one 24 hour media cycle across internet, print, television, radio).	Non-compliance with conditions of licence to operate an asset or to conduct an activity. Litigation – exposure to damages / fines / costs.	LOW	MEDIUM	MEDIUM	MEDIUM	HIGH	HIGH
	2 MODERATE	Injury or illness to 1 or more persons resulting in medical treatment, up to 5 days lost time or alternative / restricted duties for up to 1 month	Moderate short term impacts to common regional species, habitats, ecosystems or area of cultural significance Small scale impacts to cost of living, business viability or social wellbeing. Isolated examples of community tension.	>\$1m - \$5m	>\$500k - \$25m	>\$750k - \$37.5m	A single stakeholder group drawing attention to an incident, issue or approach, conveyed through media channels with potential reach and influence (eg. some social media complaints or local media reports).	Moderate non-compliance with external mandatory obligations or breach of contractual or other legal obligations (not described above). Litigation possible.	LOW	LOW	MEDIUM	MEDIUM	MEDIUM	MEDIUM
	1 MINOR	Injury or illness requiring first aid to 1 or more persons, or no treatment (record only)	Minor environmental or community impact - readily dealt with	>\$100k - \$1m	<\$500k	<\$750k	A person or organisation within stakeholder group signaling an interest in an incident, event or approach, using channels with limited reach or influence (eg. letter of complaint/commendation).	Minor non-compliance with external mandatory obligations or breach of contractual or other legal obligations.	LOW	LOW	LOW	MEDIUM	MEDIUM	MEDIUM

* Cash Flow - change from expectation over the life of the exposure. EBIT change from expectation over 12 – 18 month period.

7.3 Assessment of scientific uncertainty

The draft NT Petroleum Environmental Management Plan Guidelines (EMP Guidelines) requires an assessment of uncertainty as a part of the risk assessment process. The assessment of potential impacts and effectiveness of controls must demonstrate that the activities are carried out in a manner consistent with the Principles of Ecologically Sustainable Development (ESD) and the Precautionary Principle.

Impact and risk identification must include consideration of uncertainty regarding impacts and risks for the activity where a precautionary approach is appropriate. Uncertainty is high where confidence in the available information is low in identifying risk or the effectiveness of a management control. Additional baseline studies or other safeguards may be required to increase the accuracy of an assessment to determine the acceptability of a risk.

As per the Draft EMP Guidelines, scientific certainty is qualitatively assessed using a generic means of ranking the data available in accordance with Table 24 below. Considerations of uncertainty have been included in the risk assessment discussed in 7.4.

Table 24 Scoring system for Scientific Uncertainty (DEFRA, 2013).

Ranking Scientific Uncertainty	
Score	Description
Low (1)	<ul style="list-style-type: none"> • Comprehensive data with strong evidence in multiple peer reviewed data • Little disagreement between authors or experts • Considerable and consistent on-ground experience and/or monitoring
Medium (2)	<ul style="list-style-type: none"> • Some or incomplete data available • Evidence provided based on a small number of references • Authors or experts conclusions vary • Limited on-ground experience and/or monitoring
High (3)	<ul style="list-style-type: none"> • Scarce or no data available; evidence provided in unpublished reports • Few on-ground observations • Authors and experts conclusions vary considerably

7.4 Risk Assessment Outcomes

The environmental, heritage and social risks associated with the civil activities have been assessed utilising the Origin risk assessment framework described in Section 7.1. The detailed risk assessment presents the range of potential impact-causing activities, corresponding mitigation measures and residual risk ratings based on their assessed worst-case consequence and likelihood of occurrence. The assessment also cross-referenced the various risk assessment outcomes in the NT Inquiry Final Report, to ensure consistency. Site specific conditions and cumulative impacts have also been considered during the assessment.

There were no residual risks above a Medium risk ranking, with 43 out of the 52 risks identified as being considered Low. The remaining Medium risks identified were consistent with standard civil construction activities completed across the NT, being the potential spread of weeds, erosion and sediment control and ignition of bushfires from the proposed activities.

The level of uncertainty for each risk was also assessed. There was no uncertainty level above Low, which is consistent with the knowledge of impacts associated with construction activities.

Table 25 provides a count of the post-treatment environmental risks associated with the civil construction program. A copy of the risk assessment is provided in Appendix L.

Table 25 Count of Post-Treatment Environmental Risks for the Civil Construction Program

	Residual Environmental Risk Level			
	Low	Medium	High	Very High
Count	43	9	0	0

7.5 Environmental Impacts and Environmental Risk Management Summary

The following section provides a summary of how any environmental impacts risks will be managed. The management summary tables include an overview of the environmental values, outcomes and potential impacts, along with the performance standards, measurement criteria and records for each environmental aspect. For aspects with multiple individual risks, these are summarised in the relevant aspect table with the highest residual risk being used.

Each table includes a statement of the residual risk, scientific uncertainty and ALARP. This is designed to provide certainty that the risks are being reduced to as low as reasonably practicable.

The risk assessment provided in Appendix L should be consulted where an overview of each individual risk is required.

7.5.1 Soils

Table 26 Environmental Values and Outcomes – Soils

Environmental Values	<ul style="list-style-type: none"> Suitability and stability of land for existing uses (Erosion and Sediment Controls implemented). Stability of land to preserve existing water quality, landscapes and ecosystems. 	
Environmental Outcomes:	<ul style="list-style-type: none"> 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. Minimise the creation of dust. 	
Activity	Environmental impacts and environmental risks	Primary risk management controls
Civil construction activities	<ul style="list-style-type: none"> Localised soil contamination Soil erosion and sedimentation 	<ul style="list-style-type: none"> Land condition assessment completed to identify and avoid sensitive soil unit. Erosion control measure to be implemented and maintained as per erosion and sediment control plan NT-2050-15-MP-01 (Appendix E). Engineering controls such as bunding, liners and secondary containment to be implemented. These are not generally controls for civil activities they are utilised within stimulation activity but are implemented here Fuel, lubricants and chemicals will be stored with appropriate secondary containment and transported, handled and used in accordance with the relevant MSDS, Work Health and Safety Act and Australian Standards Spill kits will be in place and clean-up equipment will be on-site and available in relevant areas. All solid and regulated waste to be removed from the site and disposed of as per the NT WMPCA. Following completion of the activity, disturbed areas to be restored and/or rehabilitated. Disturbed areas to be will be monitored for weed infestation, and progress towards specified rehabilitation goals.

Environmental performance standards	<ul style="list-style-type: none"> • Code of Practice for Petroleum Activities in the Northern Territory Part A- Surface Activities. • NT Land Clearing Guidelines. • International Erosion Control Association Best Practice Erosion and Sediment Control (BPESC) standard. • Dangerous goods will be stored, handled, separated and signed as required by the NT Dangerous goods Act and Flammable and Combustible Liquids Regulations and AS1940. 			
Measurement criteria:	<ul style="list-style-type: none"> • Land disturbance is equal to or less than 7.4ha. • No incidences of contamination and erosion and sedimentation that result in material environmental harm. 			
Records	<ul style="list-style-type: none"> • The extent of disturbances will be recorded within a Geographic Information System. • Monitoring for soil erosion pre and post wet seasons to ensure any defect is identified and rectified. • Rehabilitation monitoring undertaken annually until final rehabilitation success criteria has been achieved. 			
Residual Risk	<table border="1" style="width: 100%; text-align: center;"> <tr> <td style="width: 33%;">Moderate</td> <td style="width: 33%;">Scientific Uncertainty</td> <td style="width: 33%;">Low</td> </tr> </table>	Moderate	Scientific Uncertainty	Low
Moderate	Scientific Uncertainty	Low		
ALARP Statement	<p>The risk to soils is predominantly from soil erosion during construction. This is ranked as a “minor” consequence, “possible” likelihood event. The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the NT Petroleum Codes of Practice, NT Land Clearing Guidelines and International Erosion Control Association Best Practice Erosion and Sediment Control (BPESC) standard. Controls above best practice are unlikely to reduce the risk associated with erosion and sediment control further. Based upon the risk being ranked as a ‘moderate’ and consistent with standard civil activities (regardless of industry), the risk is determined to be ALARP and acceptable in accordance with the rationale within section 7.2.</p>			

7.5.2 Surface Water

Table 27 Environmental Values and Outcomes – Surface Water

Environmental Values	<ul style="list-style-type: none"> • Divert clean stormwater away from disturbed areas. • Minimise the release of sediment outside of the approved activity area. 	
Environmental Outcomes	<ul style="list-style-type: none"> • Avoid and or minimise and control any potential contamination caused by the discharge of sediment to waterways or established drainage systems. • Contain all potential contaminants for treatment or disposal. • Minimise the impacts on surface water drainage by preserving drainage system integrity and water quality. • Maintain the natural flow regime of the area to avoid pooling or diversion of water away from wetlands. 	
Activity	Environmental impacts and environmental risks	Primary risk management controls
<ul style="list-style-type: none"> • Access track, camp and drill pad construction • Civil construction and operations – refuelling and equipment maintenance 	<ul style="list-style-type: none"> • Earthmoving equipment altering natural drainage lines or sinks • Access tracks and site pads altering natural surface water flow, creating ponding and or erosion • Contamination or pollution of surface waters through hydrocarbon or chemical spill or leak 	<ul style="list-style-type: none"> • Erosion and sediment controls implemented as per the erosion and sediment control plan (NT-2050-15-MP-019) implemented to reduce offsite release of sediment. • Spill kits provided where hazardous materials and fuels are used • Spill response measures shall be implemented for spills or leaks. • Dangerous goods will be stored, handled, separated and signed as required by the Dangerous goods Act and Australian Standards1940. • Refuelling of equipment will not occur within 100m of a water course. • Waste which cannot be recycled will be transported to a designated, approved disposal site in accordance with WPMCA. • No earthworks disturbance to drainage lines proposed.

	<ul style="list-style-type: none"> Impacts associated with soil erosion such as increased water turbidity 	<ul style="list-style-type: none"> A buffer of 2 km will be maintained between operations and stock water bores. Surface water will not be used for activities. No discharges to watercourses. Treated sewerage waste will be removed from site and disposed of as per WMPCA.
Environmental Performance standards	<ul style="list-style-type: none"> Code of Practice for Petroleum Activities in the Northern Territory Part A- Surface Activities. NT Land Clearing Guidelines. International Erosion Control Association Best Practice Erosion and Sediment Control (BPESC) standard. NT Dangerous Goods Act and Flammable and Combustible Liquids Regulations and AS1940. 	
Measurement Criteria	<ul style="list-style-type: none"> No use of surface water. No release of fuel, oils or sediment into watercourses. No spills causing material harm. 	
Records	<ul style="list-style-type: none"> Records of releases, leaks and associated clean ups are to be managed using Origins Incident Management System (OCIS). Rectification work requirements and actions will be recorded in OCIS. Monitoring for soil erosion and related issues to be undertaken pre and post wet season. 	
Residual Risk	Low	Scientific Uncertainty
ALARP Statement	<p>The risk to surface water is predominantly from soil erosion during construction. This is ranked as a “minor” consequence, “highly unlikely” likelihood event. The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the NT Petroleum Codes of Practice, NT Land Clearing Guidelines and International Erosion Control Association Best Practice Erosion and Sediment Control (BPESC) standard. Controls above best practice are unlikely to reduce the risk associated with erosion and sediment control further. Based upon the risk being ranked as a low, the risk is determined to be ALARP and acceptable in accordance with the rationale within section 7.2.</p>	

7.5.3 Groundwater

Table 28 Environmental Values and Outcomes – Groundwater

Environmental Values	<ul style="list-style-type: none"> Sustainable use of groundwater. 	
Environmental Outcomes	<ul style="list-style-type: none"> To manage exploration activities to prevent over-extraction of groundwater. Preserve groundwater quantity for potable and stock supplies. 	
Activity	Environmental impacts and environmental risks	Primary risk management controls
<ul style="list-style-type: none"> Civil access track, lease pad and camp pad construction 	<ul style="list-style-type: none"> Over-extraction of groundwater impacts on pastoral leaseholders 	<ul style="list-style-type: none"> Water extraction licence obtained. Water use restricted to minimum required to complete civil construction activities. All water take as per licence conditions.
Environmental performance standards	<ul style="list-style-type: none"> Water extraction Licence GRF10285 	
Measurement Criteria	<ul style="list-style-type: none"> No drawdown >1m standing water level decline due to Origin’s activities. Monitoring completed as per Section 4.9. Groundwater take less than 20 ML. 	
Records	<ul style="list-style-type: none"> Maintain groundwater monitoring records. 	

	<ul style="list-style-type: none"> Groundwater extraction volumes will be recorded and submitted to the Water Resources division: water.regulation@nt.gov.au and in accordance with the requirements of the relevant groundwater extraction licence. 		
Residual Risk	Low	Risk control effectiveness	Low
	<p>The risk to groundwater water is predominantly from unsustainable extraction levels. This is ranked as a “minor” consequence, “highly unlikely” likelihood event. The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the NT Petroleum Codes of Practice and Water Act. Controls above best practice are unlikely to reduce the risk groundwater extraction. Based upon the risk being ranked as a low, the risk is determined to be ALARP and acceptable in accordance with the rationale within section 7.2, with no further risk reduction warranted.</p>		

7.5.4 Vegetation, Flora, Fauna and Habitat

Table 29 Environmental Values and Outcomes – Vegetation, Flora, Fauna and Habitat

Environmental Values	<ul style="list-style-type: none"> Maintain the integrity of significant ecosystems and agriculture productivity. Maintain habitat elements for native flora and fauna, including species protected by EPBC Act and TPWC Act. Avoid clearing of high value habitat. 		
Environmental Outcomes	<ul style="list-style-type: none"> Minimise disturbance to flora and fauna. Minimise disturbance to sensitive areas. 		
Activity	Environmental impacts and environmental risks	Primary risk management controls	
<ul style="list-style-type: none"> Vehicle movements Clearing of vegetation Rehabilitation 	<ul style="list-style-type: none"> Disturbance to environmentally sensitive areas and/or flora and fauna species Loss or endangerment of Threatened species Loss of habitat Vehicle collisions with fauna – fauna mortality Dust settling on vegetation inhibiting growth 	<ul style="list-style-type: none"> Ecological assessment undertaken to avoid placing infrastructure in environmentally sensitive areas (flora and fauna habitat). Clearing to avoid large habitat trees. Spotters to be present when clearing high density vegetation. No off-lease driving. Sumps leases will be fenced. Personnel will be prohibited from interfering with wildlife. Adequate fire breaks shall be maintained around infrastructure. Appropriate fuel and chemical handling and storage measures will be implemented. Fire extinguishers and firefighting equipment will be provided at each site and for vehicles. Bushfire management plan implemented. Driving at dawn and dusk to be avoided. Rehabilitate back to sites natural state once activities are completed (if required). Use of dust suppression to minimise impacts to adjacent vegetation. 	
Environmental performance standards	<ul style="list-style-type: none"> Code of Practice for Petroleum Activities in the Northern Territory Part A- Surface Activities. NT Land Clearing Guidelines. 		
Measurement criteria	<ul style="list-style-type: none"> Clearing less than or equal to 7.4 hectares. No native fauna impacts (injury or fatality) reported in OCIS during civil and drilling and stimulation related activities. 		
Records	<ul style="list-style-type: none"> Records of disturbance will be maintained within Origin’s GIS. Records of inspections will be maintained. All incidents will be reported in Origin’s OCIS and corrective action initiated. 		
Residual Risk	Low	Scientific Uncertainty	Low

ALARP Statement	The risk to vegetation, flora and fauna is predominantly from land clearing activities. This is ranked as a “moderate” consequence, “Highly Unlikely” likelihood event. The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the NT Petroleum Codes of Practice and NT Land Clearing Guidelines. Controls above best practice are unlikely to further reduce the risk to flora, fauna and habitat. Based upon the risk being ranked as a low, the risk is determined to be ALARP and acceptable in accordance with the rationale within section 7.2, with no further risk reduction warranted.
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7.5.5 Weeds

Table 30 Environmental Values and Objectives – Weeds (Biosecurity)

Environmental Values	<ul style="list-style-type: none"> Maintain the integrity of significant ecosystems and agricultural productivity. 	
Environmental Outcomes	<ul style="list-style-type: none"> Avoid the introduction of weeds. Avoid the spread of existing weeds. 	
Activity	Environmental impacts and environmental risks	Primary risk management controls
<ul style="list-style-type: none"> Vehicle and equipment movement Civil construction activities 	<ul style="list-style-type: none"> Introduction or spread of weeds 	<ul style="list-style-type: none"> Weed desktop and field-based surveys undertaken to identify existing weed areas. Weed management plan (NT-2050-15-MP-016 controls implemented, to mitigate, detect and respond to weed infestations Dedicated weeds officer nominated. All equipment will have certified equipment wash-down completed prior to entry to the field. New activities will be planned to address prevention of weed or non-indigenous plant spread. Machinery to be preferentially sourced locally, with machinery sourced from surrounding areas or Queensland being the 2nd and 3rd preferred option respectively. Pre and post wet (May/ November inspections and periodic audits will be conducted to identify and report weed outbreaks. Weeds will be actively controlled. Major equipment moves will be planned from weed-free areas to infested areas and not the other way around. Staff members to be appropriately trained. Ensuring all material imported to or between sites is free of weeds.
Environmental performance standards	<ul style="list-style-type: none"> Code of Practice for Petroleum Activities in the Northern Territory Part A- Surface Activities. NT Land Clearing Guidelines. Weed Management Planning Guide: Onshore Shale Gas Development Projects. 	
Measurement criteria	<ul style="list-style-type: none"> No introduction or spread of declared weeds resulting from Origin’s activities. Six-monthly weed inspections completed. 	
Records	<ul style="list-style-type: none"> Records of weed distribution will be maintained within Origin’s GIS and if required provided to the Weeds Officer at DENR. Records of weed inspections will be maintained. All weed outbreak incidents will be reported in Origin’s OCIS and corrective action initiated. It is noted that under Section 9 of the Weeds Management Act that: 	

	<i>'The owner and occupier of land must... within 14 days after becoming aware of a declared weed that has not previously been, or known to have been, present on the land, notify and officer of the presence of the declared weed'.</i>		
Residual Risk	Medium	Scientific Uncertainty	Low
ALARP Statement	The risk of weed introduction and spread of weeds is ranked as a “moderate consequence, “possible” likelihood event. The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the NT Petroleum Codes of Practice and NT Land Clearing Guidelines. Controls above best practice are unlikely to further reduce the risk of introduction or spread of weeds. Based upon the risk being ranked as a moderate and consistent with standard civil activities (regardless of industry), the risk is determined to be ALARP and acceptable in accordance with the rationale within Section 7.2, with no further risk reduction warranted.		

7.5.6 Waste Management

Table 31 Environmental Values and Objectives – Waste

Environmental Values	<ul style="list-style-type: none"> Maintain the integrity of ecosystems and agricultural productivity. Minimise the amount of waste generated on-site. 		
Environmental Outcomes	<ul style="list-style-type: none"> Minimise impacts on soil, surface water, groundwater, sensitive habitat and air quality. Minimise creation of food sources or habitat for pest species. Minimise waste generation through reduce, reuse, recycle programs. 		
Activity	Environmental impacts and environmental risks	Primary risk management controls	
<ul style="list-style-type: none"> Civil construction works- Lease pad, access tracks and camp pads 	<ul style="list-style-type: none"> Contaminated land Encouragement of pest species to waste sites 	<ul style="list-style-type: none"> Designated waste storage and handling area to be provided on-site. Removal and disposal of hazardous wastes to be in accordance with the WMPCA. Ensure the availability of spill clean-up equipment for operations. All sewage from min-camps to be collected and transported off-site. Domestic refuse to be disposed of in accordance with NT WMPCA. No incineration of wastes on site. Identify and remediate the affected area where applicable in accordance with the National Environmental Protection Measure (NEPM) requirements. Waste to be removed off-site to an appropriate disposal at licensed landfill facility. Waste Contractors used must have appropriate waste transportation licences 	
Environmental performance standards	<ul style="list-style-type: none"> Code of Practice for Petroleum Activities in the Northern Territory Part A- Surface Activities. NT Waste Management and Pollution Control Act. 		
Measurement criteria	<ul style="list-style-type: none"> Waste registers maintained for the duration of the project. Waste transport certificates available for all wastes generated. 		
Records	<ul style="list-style-type: none"> Waste disposal records to be maintained and kept for audit purposes and provided to DPIR/DENR. 		
Residual Risk	Low	Scientific Uncertainty	Low
ALARP Statement	The risk from waste is ranked as a “minor consequence, “unlikely” likelihood event. The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the NT Petroleum Codes of Practice and NT Land Clearing Guidelines. Controls above best practice are unlikely to further reduce the risk associated with waste management. Based upon the risk being ranked as a low, the		

	risk is determined to be ALARP and acceptable in accordance with the rationale within Section 7.2, with no further risk reduction warranted.
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7.5.7 Air Quality – Dust and Emissions

Table 32 Environmental Values and Objectives – Air Quality (Dust and Emissions)

Environmental Values	<ul style="list-style-type: none"> Rural air environment with qualities conducive to suitability for the life, health and wellbeing of humans. 		
Environmental Outcome	<ul style="list-style-type: none"> Minimise environmental nuisance at sensitive receptors. Minimise greenhouse gas emissions. 		
Activity	Environmental impacts and environmental risks	Primary risk management controls	
<ul style="list-style-type: none"> Civil construction works- access tracks, lease pads and camp pads 	<ul style="list-style-type: none"> Dust emissions Release of atmospheric contaminants from exhausts 	<ul style="list-style-type: none"> Reducing the speed of vehicles on dirt tracks to 60km/hr. Monitor road conditions to ensure deterioration with possible increase in dust creation, does not occur and undertake road rehabilitation as required. Watering of roads when appropriate and agreed with landholders. All equipment and machinery to be in good working order to minimise vehicle exhaust emissions. 	
Environmental performance standards	<ul style="list-style-type: none"> Code of Practice for Petroleum Activities in the Northern Territory Part A- Surface Activities. NT Land Clearing Guidelines. 		
Measurement criteria	<ul style="list-style-type: none"> No valid complaints received for dust/air quality nuisance. All complaints responded to and closed out. 		
Records	<ul style="list-style-type: none"> All complaints and subsequent actions are to be recorded in Origin’s OCIS incident management system. 		
Residual Risk	Low	Scientific Uncertainty	Low
ALARP Statement	<p>The risk from dust and fuel combustion on air quality is ranked as a “minor consequence, “unlikely” likelihood event. The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the NT Petroleum Codes of Practice; with site selection being the primary control. Controls above best practice are unlikely to further reduce the risk to air quality. Based upon the risk being ranked as a low, the risk is determined to be ALARP and acceptable in accordance with the rationale within Section 7.2, with no further risk reduction warranted.</p>		

7.5.8 Lighting, noise, vibration and visual amenity

Table 33 Environmental Values and Objectives – Lighting, noise, vibration and visual amenity

Environmental Values	<ul style="list-style-type: none"> A rural acoustic, lighting, vibration and visual amenity environment conducive to the wellbeing of the community, including its social and economic amenity, and an individual, including the opportunity to have sleep, relaxation and conversation without unreasonable interference from civil works and water bore drilling operations.
Environmental Outcomes	<ul style="list-style-type: none"> Manage activities in accordance with occupational health and safety guidelines for noise, vibration and light exposure. Minimise nuisance noise and vibration impacts on surrounding communities or exploration workers. Minimise disruption to fauna and stock.

Activity	Environmental impacts and environmental risks	Primary risk management controls		
<ul style="list-style-type: none"> Civil construction activities- Access tracks, lease pads and camp pads 	<ul style="list-style-type: none"> Nuisance noise impacts on surrounding communities or exploration workers through use of mechanical equipment Disrupting or altering fauna feeding, breeding or other activities through noise, vibration and lighting from use of mechanical equipment Interference with pastoral activities if noise, vibration and lighting effects behaviour of stock. 	<ul style="list-style-type: none"> Lease sites selected to minimise noise and visual amenity impacts on sensitive receptors/ local community during civils and future exploration activities. 6am to 6pm work, with no night time activities. Complaints shall be recorded in OCIS, investigated and responded to appropriately. 		
Environmental performance standards	<ul style="list-style-type: none"> Code of Practice for Petroleum Activities in the Northern Territory Part A- Surface Activities. NT Land Clearing Guidelines. 			
Measurement Criteria	<ul style="list-style-type: none"> No valid nuisance-related complaints received from local communities/pastoralists. All complaints responded to and, where appropriate, corrective action taken. 			
Records	<ul style="list-style-type: none"> All complaints and subsequent actions are to be recorded in OCIS. 			
Residual risk	Low	Scientific Uncertainty	Effective	
ALARP Statement	<p>The risk of the activity on local amenity is ranked as a “minor consequence, “unlikely” likelihood event. The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the NT Petroleum Codes of Practice; with the location of the activity being the primary control. Controls above best practice are unlikely to further reduce the risk to aesthetics Based upon the risk being ranked as a low, the risk is determined to be ALARP and acceptable in accordance with the rationale within Section 7.2, with no further risk reduction warranted.</p>			

7.5.9 Bushfires

Table 34 Environmental Values and Objectives – Bushfire

Environmental Values	<ul style="list-style-type: none"> Maintain a natural fire regime of the region. Protection of public, private infrastructure and equipment. 		
Environmental Outcomes	<ul style="list-style-type: none"> Minimise the risk of causing bushfires from Origin’s activities. Minimise impacts on environmental habitat and fauna, soil erosion, impacts on stakeholders, impacts on culturally significant sites, public infrastructure and community lands. Ensure proper health and safety plan for activities. Prevent accidental fire risk and ensure safe storage of chemicals to prevent fire damage. 		
Activity	Environmental impacts and environmental risks	Primary risk management controls	
<ul style="list-style-type: none"> Civil construction works- access tracks, lease pads and camp pads 	<ul style="list-style-type: none"> Vegetation degradation. Loss of fauna and habitat. 	<ul style="list-style-type: none"> Fire extinguishers to be fitted to all vehicles. Fire response equipment to be available. 	

	<ul style="list-style-type: none"> Increased erosion and impacts upon soil and surface water as a result of vegetation loss Damage to or loss of public infrastructure, private infrastructure and equipment or community lands Damage to or loss of culturally significant sites. Loss of life. 	<ul style="list-style-type: none"> Controls (such as smoking bans, firebreaks etc.) within bushfire management plan (NT- 20150 15-MP-033) implemented (Appendix M). Emergency Response Plan (NT-2050-15-MP-024) implemented to deal with fire (Appendix N). Access tracks and roads will serve as firebreaks to limit the spread of fire. Firebreaks to be constructed around all infrastructure.
Environmental performance standards	<ul style="list-style-type: none"> Code of Practice for Petroleum Activities in the Northern Territory Part A- Surface Activities. NT Land Clearing Guidelines. NT Bushfire Management Act. 	
Measurement criteria	<ul style="list-style-type: none"> No uncontrolled fires occurring as a result of civil works. 	
Records	<ul style="list-style-type: none"> All incidents of fire to be recorded in OCIS. 	
Residual Risk	Medium	Scientific Uncertainty
	<p>The risk of weed introduction and spread of weeds is ranked as a “moderate consequence, “possible” likelihood event. The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the NT Petroleum Codes of Practice and NT Land Clearing Guidelines. Controls above best practice are unlikely to further reduce the risk of introduction or spread of weeds. Based upon the risk being ranked as a moderate and consistent with standard civil activities (regardless of industry), the risk is determined to be ALARP and acceptable in accordance with the rationale within Section 7.2, with no further risk reduction warranted.</p>	

7.5.10 Cultural Heritage and Sacred Sites

Table 35 Environmental Values and Objectives – Cultural Heritage and Sacred Sites

Environmental Values	<ul style="list-style-type: none"> Maintain both Indigenous and non-Indigenous cultural heritage values of the region. 	
Environmental Outcomes	<ul style="list-style-type: none"> Avoid disturbance or damage to Aboriginal cultural heritage artefacts or sacred sites. Minimise impacts and disruption to activities of Indigenous stakeholders in culturally significant areas. Ensure adequate background information and training is provided to employees and contractors working in culturally significant areas. Ensure that the health and safety of employees, contractors and the community is not compromised through management of cultural and environmental awareness. 	
Activity	Environmental impacts and environmental risks	Primary risk management controls
<ul style="list-style-type: none"> Civil construction works- access track, lease pad and camp pads 	<ul style="list-style-type: none"> Damage to or loss of Indigenous and non-Indigenous cultural heritage artefacts or sacred sites. Disruption of activities of 	<ul style="list-style-type: none"> Cultural Heritage Clearance (and identification of sites of Aboriginal significance in conjunction with NLC and AAPA) have been completed. Heritage surveys completed. Activities will be conducted in accordance with the NLC Agreement and AAPA certificates. There are no restricted work areas in the vicinity of the proposed activity.

	Indigenous and non-Indigenous stakeholders.	<ul style="list-style-type: none"> An unexpected heritage finds stop procedure will be implemented (Appendix O). Site inductions and icebreakers are to ensure that all personnel are aware of the Code of Conduct prepared for social interactions with the community.
Environmental performance standards	<ul style="list-style-type: none"> AAPA Certificates. NT Bushfire Management Act. 	
Measurement criteria	<ul style="list-style-type: none"> No unauthorised activities within or access to a Restricted Work Area. 	
Records	<ul style="list-style-type: none"> A register should be kept of all occurrences of archaeological sites identified during the Project for provision to the NLC, the AAPA and Heritage Branch within DLPE. Ensure that site personnel and contractors report all new discoveries of archaeological or cultural artefacts. All work must cease and protection measures implemented until the area can be assessed. 	
Residual Risk	Low	Scientific Uncertainty Effective
ALARP Statement	The risk to community from the activity is ranked as a “low” consequence, “remote” likelihood event. The risk mitigation measures outlined in the EMP meet the Native Title Act and Sacred Sites Act requirements. Due to the limited nature of the activity and approvals granted (NLC Clearances and AAPA), additional controls are not required. Based upon the risk being ranked as a low, the risk is determined to be ALARP and acceptable in accordance with the rationale within Section 7.2, with no further risk reduction warranted.	

7.5.11 Community

Table 36 Environmental Values and Objectives – Community

Environmental Values	<ul style="list-style-type: none"> Maintain and enhance the livelihood and well-being of local communities and towns. Maintain the level of amenity and experience for tourists and local community members 	
Environmental Outcomes	<ul style="list-style-type: none"> Minimise impacts on the local community and services. Minimise safety risks to the public and other third-parties. Maintain and enhance partnerships with the local community, including using local contractors and maximising opportunities for local employment and training. Minimise reduction in the capacity of road infrastructure Minimise safety risks to the tourists and other road users Maintain the level of surface for the Stuart Highway in the vicinity of activities 	
Activity	Environmental impacts and environmental risks	Primary risk mitigation Controls
<ul style="list-style-type: none"> Civil construction works- access tracks, lease pad and camp pads 	<ul style="list-style-type: none"> Damage to third party infrastructure Loss of visual amenity- pastoralists and tourists Increased traffic within the region impacts pastoralists and tourists 	<ul style="list-style-type: none"> Local (NT) employees to be utilised as a priority, with NT based contractors utilised. Vehicle traffic impacts are small and are unlikely to be significant Traffic management plan and permit for Stuart Highway intersection works and use approved by DPIL. The intersection will be kept free of dirt and dust material, with traffic management utilised during cleaning activities Ongoing stakeholder engagement targeting directly affected parties. Equipment movements to consider time of day to reduce impacts on traffic

		<ul style="list-style-type: none"> The transportation of equipment, material, wastes etc. will comply with the applicable legislation regulating heavy vehicle driver requirements such as the Work Safe Act, Dangerous Goods by Road and Rail (National uniform Legislation), Waste Management and Pollution Control Act and NT Heavy vehicle driver handbook). This will include the use of appropriate load constraints, reduced speed limits, signage and other hazard controls during heavy vehicle movements. Access track turn-in design has been undertaken with consultation and approval from DIPL; the design has incorporated the appropriate safe sight distance and signage Site selected to avoid impacts to pastoralist activities Fly camps used to reduce impacts to tourism accommodation Code of conduct inductions to ensure appropriate behaviours when working within the community All camps a dry, with routine alcohol and drug testing.
Environmental performance standards	<ul style="list-style-type: none"> Code of Practice for Petroleum Activities in the Northern Territory Part A- Surface Activities. NT Land Clearing Guidelines. DIPL Road Corridor Permit and associated Traffic Management Plan 	
Measurement criteria	<ul style="list-style-type: none"> Local (NT) employment used for >90% for the civil campaign. All complaints are responded to and closed out. Zero traffic incidents associated with project traffic 	
Records	<ul style="list-style-type: none"> Register should be kept of all incidences relating to access issues, unauthorised access and requirements of pastoralists, recognising that these requirements may change seasonally. OCIS complaint register. Land Access Agreements closed out at completion. 	
Residual Risk	Low	Scientific Uncertainty
ALARP Statement	<p>The risk to community from the activity is ranked as a “low” consequence, “remote” likelihood event. The risk mitigation measures outlined in the EMP meet the Petroleum (Environment) Regulations stakeholder engagement requirements. Due to the limited nature of the activity, additional controls further reduce the risk to community. Based upon the risk being ranked as a low and are consistent with standard small-scale project activities (regardless of industry), the risk is determined to be ALARP and acceptable in accordance with the rationale within Section 7.2, with no further risk reduction warranted.</p>	

8 Implementation Strategy

8.1 Corporate Environmental Policy

Origin’s activities are governed by the Origin Health, Safety and Environment Management System (HSEMS). This system is underpinned by Origin’s Health, Safety and Environment (HSE) Policy (Figure 16) which is designed to:

“Conduct our business in a way that causes no harm to the health and safety of people and has no unforeseen impacts to the environment”.

8.2 Environment, Health, and Safety Management Systems

Origin has a mature HSEMS which contains the policies and procedures that Origin has in place to manage and minimise the impact from its activities. In addition to meeting legal requirements, Origin’s activities are also

governed by several additional internal directives and risk control directives designed to ensure best practice in environmental risk management.

An overview of the Origin HSEMS and the associated directives is provided in Figure 17.

OUR HEALTH, SAFETY AND ENVIRONMENT POLICY



OUR PRINCIPLE OF DUE CARE

We care about the wellbeing of our people and our impact on the environment.

OUR HSE ASPIRATION

To conduct our business in a way that causes no harm to the health and safety of people and has no unforeseen impacts to the environment.

OUR HSE ACTIONS

We all believe that our HSE aspiration is achievable and we embrace our responsibility for supporting it by:

Always mindful of risk

Recognising that risk is present in every task we do and taking the time to identify and understand these risks and manage them safely and responsibly.

Enabled and accountable

Taking ownership and using our authority, resources, systems and competencies to manage the risks associated with our work. We stop work when confronted by an unknown hazard and proceed only when satisfied we can continue safely and responsibly.

Continuously learning

Being open and transparent about how well we are doing and relentless in learning from our experience to manage our risks. We work together effectively, welcome any feedback and recognise that we can always do better.

Our Compass and HSE Management System set out how we will implement this policy.



Frank Calabria
CEO
Origin Energy

ORG-HSE-POL-001 November 2015

Figure 16 Origin’s Health, Safety and Environment (HSE) Policy

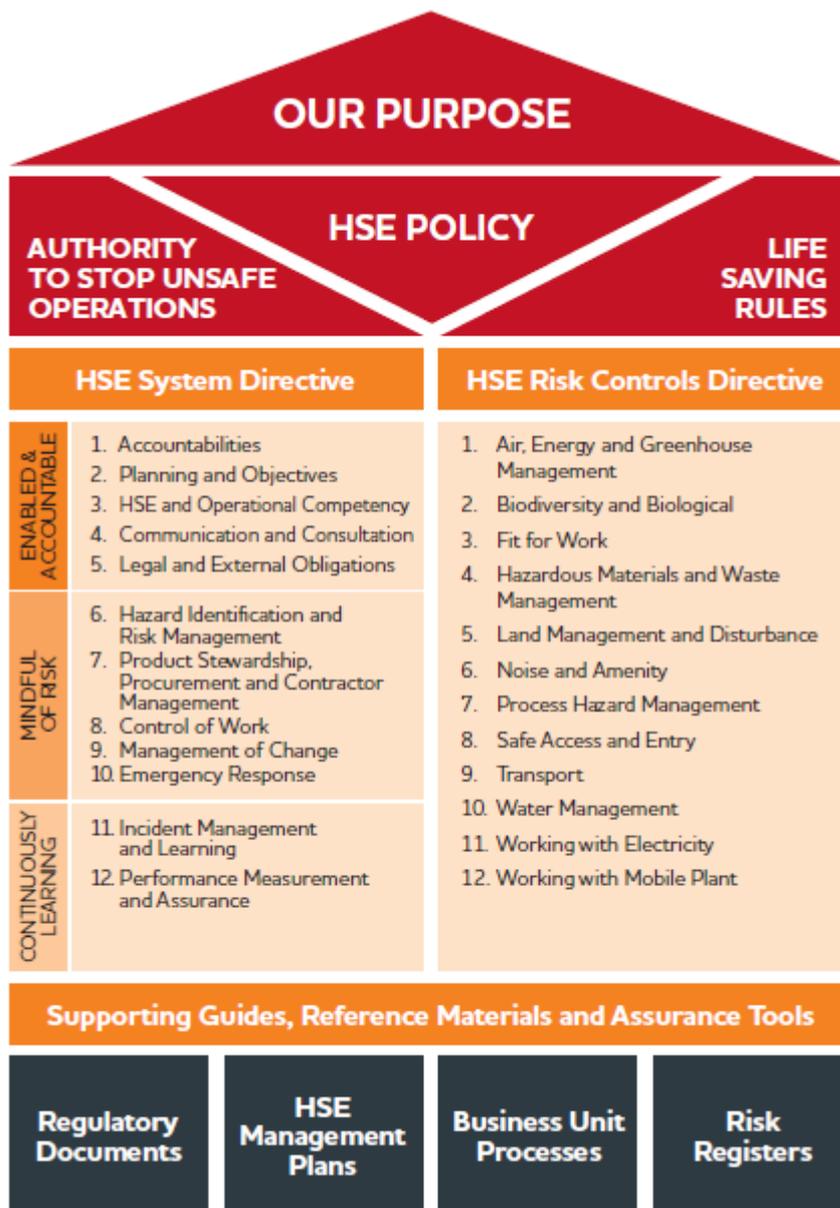


Figure 17 Origin's HSEMS Structure

8.3 Roles and Responsibility

The following sections describe in detail the management strategies for specific components of the landscape, such as soil, groundwater and vegetation, and the cultural and social environment, in relation to the different impact-causing activities that may occur.

Each management area has been assigned to specific positions within the Exploration team, as follows:

- **Asset Manager** – responsible for the overall operations in the Origin's activities in the exploration permit area.
- **Project Manager** – oversees the whole planning and execution of the exploration program and is the person ultimately responsible making all other parties aware of obligations under the HSE guidelines. The Project Manager's role is predominantly office-based. The Project Manager will be responsible for notifying the Minister, the occupier of the land on which the activity is to be carried out and the owner of the land on which the activity is to be carried out (unless the owner is also the occupier).

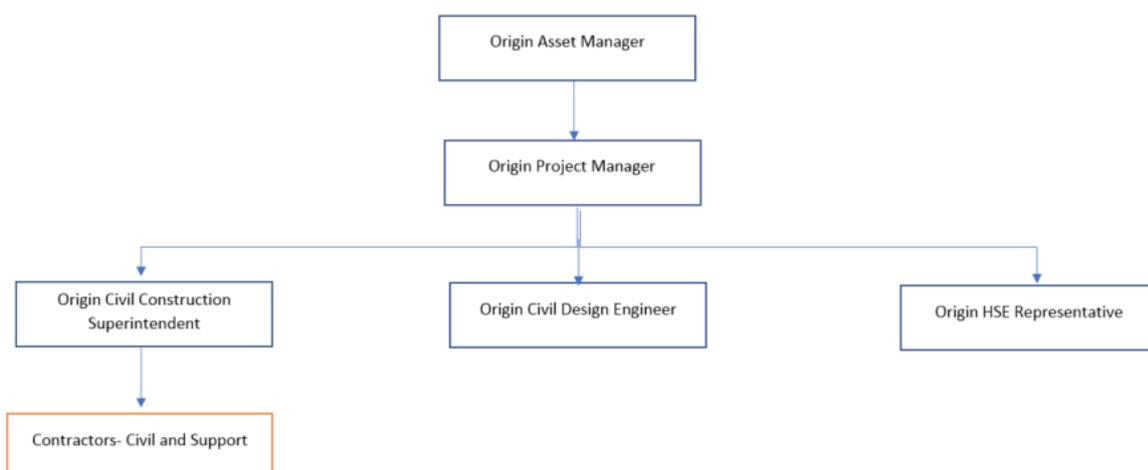
- **Civil Construction Superintendent** – person based in the field focussed on the undertaking of operations and construction in accordance with the EMP and Origin’s HSE Policy. All contractors report to this position, who is responsible to the Project Manager.

This role will also cover the role of the Weeds Officer, who will be responsible for:

- Planning and execution of weed monitoring requirements, including baseline weed assessments and ongoing monitoring both during periods of gas related activities as well as during the target identification period of February to May.
 - Facilitate training of all workers (including contractors) in weed management requirements, with support from the Northern Territory Government Regional Weed Officer - Onshore Shale Gas Development.
 - Oversight of implementation of weed control mechanisms including but not limited to wash-downs and proactive weed control programs.
 - Ensuring all reporting requirements are met.
 - Act as the designated point of contact for and rapidly responding to any civil related complaints and incidents in accordance with the pre-determined strategies in this EMP or relevant ERP.
 - Review and update of WMP’s to remain effective in communication with relevant pastoralists and Regional Weed Officer - Onshore Shale Gas Development in consideration of monitoring results and emerging weed issues for both gas and pastoral operations.
- **Civil Design Engineer** – An individual or organisation that provides professional or expert advice in the field of civil engineering and design. They determine the best locations, design, materials and construction techniques for undertaking a project to ensure it meets the needs of the end user.
 - **Health Safety and Environment Representative (HSE Representative)** – Origin representative providing guidance and advice to site personnel on the day-to-day management of the environment. This role will also support the nominated Weeds Officer, specifically in the planning and reporting phases.
 - **Field Personnel** – All staff including Origin and contractors that are working in the Exploration Permit areas. Each person is responsible for day to day management and reporting of environmental aspects under this EMP.

The organisation chain of responsibility of the activity is provided in Figure 18.

Figure 18 Origin organisational chain of responsibility



8.4 Training and Awareness

Origin’s HSEMS outlines the policies and procedures governing the training and competency of all personnel (staff and contractors) to ensure they can fulfil their obligations under this EMP and the broader Origin HSEMS.

The majority of work undertaken under this will be via contractors under supervision of Origin staff. Assuring the level of training and competency of the selected contractors and supervisors is therefore a major focus of the HSE EMS implementation strategy.

These systems include:

- General Origin HSE induction
- Contractor HSE prequalification process
- Contractor management system
- Site specific inductions
- Task specific training, procedures and competency requirements

Contractors will be required to demonstrate they have appropriate systems, procedures and training to manage specific risks covered under this EMP prior to award. The following aspects will be considered during tender award:

- Maturity of HSE systems and process.
- Previous HSE performance
- Existing procedures and training:
 - Weed identification and management
 - Refuelling procedures
 - Procedures for avoidance of potential fauna habitat and any identified heritage sites
 - Hazardous material and waste management procedures
 - Incident notification and management processes
- Internal training programs
- Internal auditing processes.

All staff and contractors entering the site will be required to attend a site-specific induction. The induction covers the following aspects:

- Regulatory requirements, for the area, including specific conditions on the Exploration Permits, agreements with the NLC and AAPA Authority certificates.
- Environmental considerations and special procedures to be used for environment protection, as well as, protection of archaeological and cultural sites within the permit areas.
- Safety procedures covering the safe use of vehicles, equipment and explosives first aid and HSE in remote area operations.
- Emergency response training.
- Landowner sensitivities, including Aboriginal communities and their specific cultural requirements.
- Procedures for handling any culturally or archaeologically sensitive materials that may be discovered.
- Provide training in safe storage and handling of flammable and combustible liquids.

Additional awareness information on environmental and cultural heritage components will be provided at all contractor icebreakers and pre-activity start up meetings. Information will be cascaded via the work instruction including exclusion zones and work restrictions. All restricted work areas provided by native title holder custodians and included in AAPA certificates are confirmed with each work party.

8.5 Work instructions

The majority of the work covered under this EMP will be executed by external contractors with Origin oversight. Efforts are therefore focused on effective contractor management, to ensure third-parties are compliant with the relevant EMP commitment and contractual requirements; including the requirements of AAPA Authority Certificates. An overview of Origin's EMP implementation strategy is provided in Figure 19.

An instrument referred to as a “work instruction” is the main mechanism that Origin cascades the relevant environmental commitments to each contractor. The work instructions are designed to be a contractual document that outline the minimum compliance requirements for a specific activity. The work instructions contain:

- Key compliance and system documents;
- A list of compliance commitments and responsible person for a specific activity;
- A list of inspections, procedures and other tools required to implement the content of the EMP;
- Monitoring and reporting requirements;
- “Hold Points” which require a deliverable to be completed prior to entry into a new activity phase (i.e. prior to mobilisation, operation and demobilisation); and
- Maps illustrating the approved disturbance areas and any restricted work areas.

The work instruction forms a critical implementation and assurance tool in that an Origin representative must sign-off the “Hold Points” to ensure the various commitments have been achieved. This provides a clear, documented approach to demonstrate compliance.

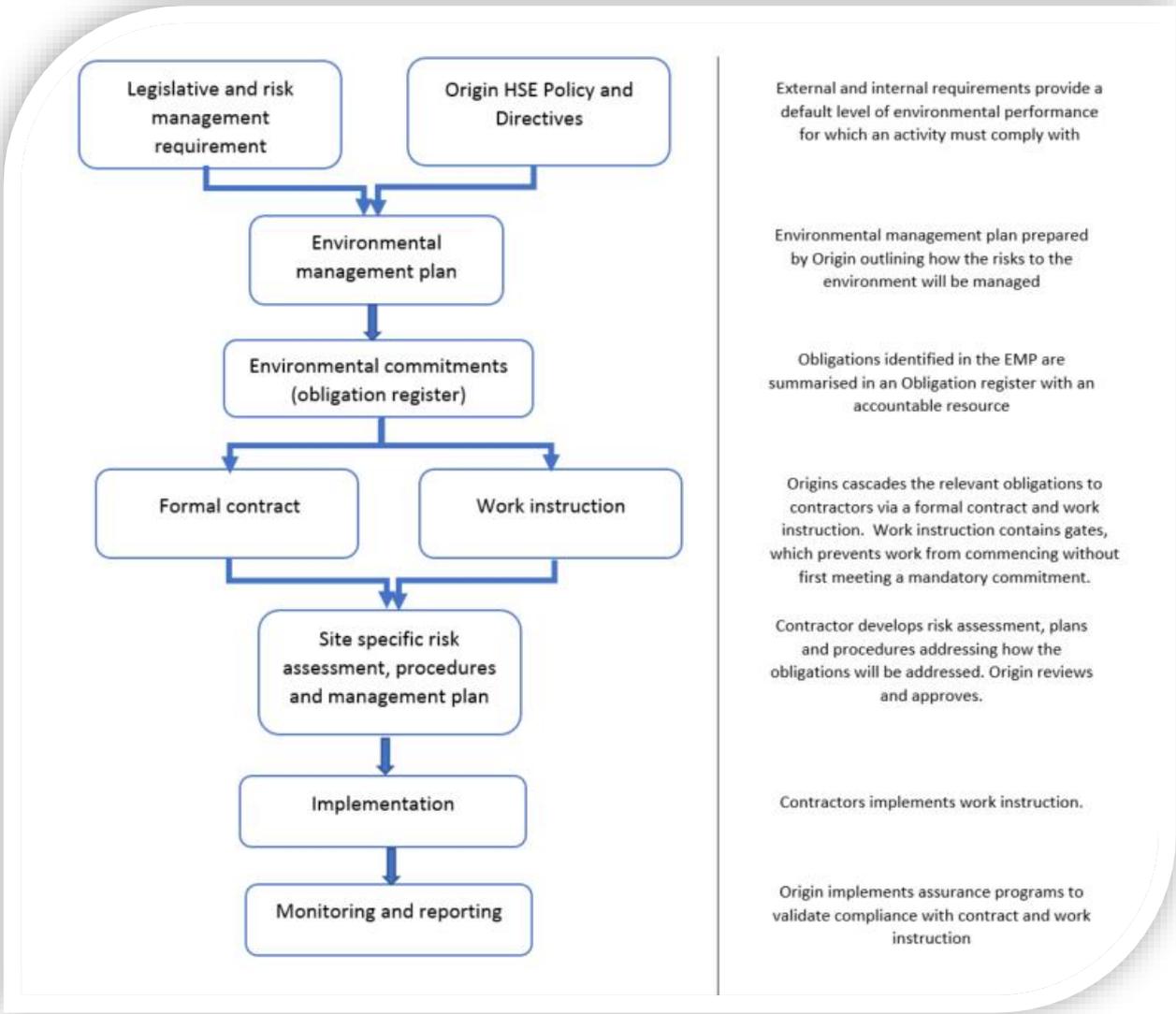


Figure 19 EMP implementation overview flowchart

8.6 Environmental Commitment (Obligations) Register

The responsibility for general environmental monitoring rests with all personnel engaged on the project. More specifically, the Origin Project Manager is responsible for monitoring procedures for the civils work program and ensuring it's designed so that appropriate environmental protection/procedures are in place.

The program environmental commitments outlined in Appendix L are sourced from the Risk Assessment (Appendix P). The implementation and compliance against these risk controls will be assessed as part of the annual environmental report (refer Section 8.10).

Specific commitments will be to:

- record information to track performance, including non-conformances and corrective actions.
- inspect and monitor of operational controls on-site via regular environmental monitoring.
- assess the level of conformance with objectives and targets detailed in this EMP.

The Operating Company Representative shall undertake random site inspections and direct such action as may be considered necessary to protect, minimise or rectify any environmental concerns.

8.7 Incident Reporting

Incident reporting and investigation provides the mechanism to prevent a recurrence. All personnel are required to proactively report all incidents, near-misses and identification of potential hazards.

Origin utilises an online incident management and reporting system. Any environmental incident, near miss or observation is reported through the online incident reporting system. All personnel are encouraged to report minor events to act as an alert to environmental risks and to maintain a program of continual improvement.

For incidents relating to the transportation of wastes outside of Petroleum tenure, the incident reporting requirements pursuant to Section 14 of Waste Management and Pollution Control Act (WMPC Act) applies.

8.7.1 Petroleum (Environment) Regulations- Reportable Environmental Incident Reporting

The NT *Petroleum (Environment) Regulations* 2016 define a reportable incident as an incident arising from a regulated activity that has caused, or has the potential to cause, material environmental harm or serious environmental harm as defined under the NT *Petroleum Act* 1984. This also includes any potential or actual damage to a sacred site.

Material environmental harm' is defined in section 117AAB (1) of the *Petroleum Act 1984* to mean environmental harm that:

- (a) is not trivial or negligible in nature;
- (b) consists of an environmental nuisance of a high impact or on a wide scale;
- (c) results, or is likely to result, in not more than \$50 000 or the prescribed amount (whichever is greater) being spent in taking appropriate action to prevent or minimise the environmental harm or rehabilitate the environment; or
- (d) results in actual or potential loss or damage to the value of not more than \$50 000 or the prescribed amount (whichever is greater).

An interest holder must notify (this may be oral or in writing) DPIR and DENR of a reportable incident as soon as practicable but no later than two hours after the first occurrence of the incident or after the time the interest holder becomes aware of the incident.

DPIR can be notified through the DPIR Operations Team Emergency number 1300 935 250.

Any verbal report to DPIR must be followed up by a written report from the Project Manager within 24 hours after giving verbal notice in accordance with the Petroleum (Environment) Regulations to both DPIR and DENR. An initial report about a reportable incident must be given as soon as practicable, but not later than three days after the incident occurs, and must include comprehensive details about the following:

- I. the results of any assessment or investigation of the conditions or circumstances that caused or contributed to the incident;
- II. the nature and extent of the material environmental harm or serious environmental harm that the incident caused or had the potential to cause;
- III. any actions taken, or proposed to be taken, to clean up or rehabilitate an area affected by the incident;
- IV. any actions taken, or proposed to be taken, to prevent a recurrence of a similar incident.

A final report must be given as soon as practicable but no later than 30 days after the clean up or rehabilitation is complete. This must include a root cause analysis.

8.7.2 Petroleum (Environment) Regulations- Recordable incidents

The Petroleum (Environment) Regulations define a recordable incident as an incident arising from a regulated activity that:

- I. Has resulted in an environmental impact or environmental risk not specified in the current plan for the activity; or
- II. Has resulted in a contravention of an environmental performance standard specified in the current plan for the activity; or
- III. Is inconsistent with an environmental outcome specified in the current plan for the activity; and
- IV. Is not a reportable incident.

An interest holder must notify (this may be oral or in writing) DPIR of a recordable incident as soon as practicable but no later than 15 days after the reporting period (agreed period or each 90-day period after the day on which the EMP is approved).

8.7.3 Waste Management and Pollution Control Act incident reporting

Where an incident occurs while carrying out an activity (such as a spill of chemical or wastewater) has caused, or threatened to cause, pollution, the incident reporting requirements of the NT *Waste Management and Pollution Control Act 1998 (WMPC Act)* apply.

In accordance with the WMPC Act, the operator has a duty to notify of incidents causing or threatening to cause pollutions as soon as practicable, but no less than 24 hours after becoming aware of the incident.

A notifiable incident is defined as an incident that causes, or is threatening or may threaten to cause, pollution resulting in material environmental harm or serious environmental harm.

A notification must include:

- (a) the incident causing or threatening to cause pollution;
- (b) the place where the incident occurred;
- (c) the date and time of the incident;
- (d) how the pollution has occurred, is occurring or may occur;
- (e) the attempts made to prevent, reduce, control, rectify or clean up the pollution or resultant environmental harm caused or threatening to be caused by the incident; and
- (f) the identity of the person notifying

The notification shall be made to the NT EPA Pollution Hotline 1800 064 567.

8.8 Monitoring, assurance and non-conformance management

In addition to regular monitoring as set out in this document, audits assessing compliance with this EMP and associated work instructions will be undertaken by Origin during the conduct of the activity. System deficiencies, adverse or potentially adverse environmental conditions arising from site activities may be subject to the issue of environmental non-conformances or corrective action requests. These non-conformances or corrective actions shall be logged, and remedial actions identified and implemented. The status of corrective actions will be tracked and reported annually in the annual environmental report.

Audits of implementation of the EMP commitments will be completed for each activity or at least annually. The results will be included in the annual environmental report.

Table 37 EMP Audit Schedule

Audit Type	Scope of Audit	Frequency	Responsibility
Annual Assurance	Compliance against EMP commitments and risk management controls	At least once during the execution of the program	OE HSE Representative

8.9 Emergency Response Plan

An Emergency Response Plan has been developed covering the proposed activities within the EMP. The ERP provides a broad framework for managing potential emergency incidents to minimise the potential risk to human safety and the environment.

The ERP covers the following aspects pertinent to the drilling and stimulation activities and associated infrastructure:

- Spills and loss of containment
- Bushfires
- Medical emergencies
- Emergency incident reporting

The ERP will be reviewed annually to ensure the content is continually kept up to date.

8.10 Reporting

Internal and government reporting on performance standards will be carried out by the Origin authorised representative, and distributed to Origin management and the DENR, in accordance with Section 35 of the *Petroleum (Environment) Regulations 2016*. Quarterly and annual reports shall be completed to summarise the compliance with this EMP, whether the environmental outcomes and performance standards in the plan were met and summarise the details of any recordable and reportable incidents.

Table 38 EMP Reporting Schedule

Frequency	Report detail	Recipient
Commencement of construction	A commencement of construction or drilling activity notification	a) the Minister for Primary Industry and Resources b) the Minister for Environment and Natural Resources c) the occupier of the land in which the activity is carried out d) the owner for the land for which the activity is to be carried out.
Only if required	Incident report summarising reportable incidents	DENR and DPIR
Quarterly	Quarterly incident report summarising recordable incidents during activities undertaken under this plan	DENR and DPIR
Annual activity report	An annual environmental report will be prepared and submitted to the Minister March each year covering the following: <ul style="list-style-type: none"> - Summary of the works completed under all EMP's (including this EMP) during the reporting period. - Compliance against environmental outcomes and environmental performance stands in the plan. - A summary of environmental incidents that occurred during the reporting period (i.e. reportable and recordable incidents that occurred). - Any environmental studies or research associated with the activity. - Technical improvements. - Consultation undertaken. - Results of related research or of an ongoing monitoring program, etc. 	Origin management DENR

8.11 Record Keeping

The following records shall be retained within Origin's Document Management system for a period of 15 years:

- records linked to measurement criteria, commitments and statutory reporting requirements;
- induction records;
- waste records;
- hazardous goods manifests;
- fuel usage;
- weed inspections;
- non-compliances and corrective action records;
- internal audits and inspection records; and
- management of change records.

8.12 EMP Review

Implementation of this EMP will be continually monitored and revised as required based on monitoring and audit results, complaints, employee and stakeholder feedback, change to the proposed work program or a material increase in risk level.

A formal review, update and resubmission of this EMP will be undertaken every five years.

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10 Acronyms & Abbreviations

Acronym	Meaning
°C	Degrees Celsius
%	Percentage
AAPA	Aboriginal Areas Protection Authority
ALA	Atlas of Living Australia
ALARP	As Low As Reasonably Practical
ANZECC	Australian and New Zealand Environment Conservation Council
APPEA	Australian Petroleum, Production and Exploration Association
AS	Australian Standard
BPESC	Best Practice Erosion and Sediment Control
CAS number	Chemical Abstracts Services number
CDEP	Community Development Employment Program
CEEVNT	Critically Endangered, Endangered, Vulnerable and Near Threatened
CLA	Cambrian Limestone Aquifer
CoP	NT Codes of Practice for Petroleum Activities in the Northern Territory
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Cth	Commonwealth
DENR	Department of Environment and Natural Resources
DIPL	Department of Infrastructure, Planning and Logistics (NT)
DoH	Department of Health (NT)
DPIR	Department of Primary Industries and Resource (NT)
DLPE	Department of Lands, Planning and the Environment (NT)
DMBG	Darwin Major Business Group
ECNT	Energy Club Northern Territory
EPA	Environment Protection Authority (NT)
EP	Exploration Permit (e.g. EP76, EP98 and EP117)
EMP	Environmental Management Plan
EPBC	Environment Protection and Biodiversity Conservation
ERP	Emergency Response Plan
ESCP	Erosion and Sediment Control Plan
ESD	Ecologically Sustainable Development
EXP	expected
FM	formation
GHG	Total Greenhouse Gas Emissions
GPS	Global Positioning Device
Ha	Hectare
HSE	Health, Safety and Environment

Acronym	Meaning
HSEMS	Health, Safety and Environment Management System
IBA	Important Bird Area
NTIBN	Indigenous Business Network Northern Territory
ICN	Industry Capability Network
ILUA	Indigenous Land Use Agreement
ISO	International Organisation for Standardisation
JV	Joint Venture
KL	Kilolitre
km	Kilometre
km ²	Square Kilometres
km/hr	Kilometres per hour
KMSA	Katherine Mining Services Association
LAG	Local Aboriginal Group
LCA	Land Condition Assessment
m	Metre
Ma	Million years ago
mbgl	Metres below ground level
MD	Measured Depth
MNES	Matters of National Environmental Significance
MSDS	Material Safety Data Sheet
mTVD	Metre below True Vertical Depth
NADO	Northern Australian Development Office
NLC	Northern Land Council
NGOs	Non-Governmental Organisations
NT	Northern Territory
NTCA	Northern Territory Cattlemen's Association
OCIS	Origins Incident Management System
PMST	Protected Matters Database of Nationally Significant Fauna
psi	Pounds per square inch
QA/QC	Quality Assurance, Quality Control
RWA	Restricted Work Area
SIA	Social Impact Assessment
SMS	Safety Management System
SWL	Standing Water Level
tCO ₂ e	Tonnes of Carbon Dioxide equivalent
TMP	Traffic Management Plan
TO	Traditional Owner
TPWC Act	Territory Parks and Wildlife Conservation Act

Acronym	Meaning
TVDgl	True Vertical Depth below ground level
TVDSS	Total Vertical Depth Sub Surface
UCS	Unconfined Compressive Strength
μ	Micro
vpd	Vehicles per day
WEL	Water Extraction License
WPMC	NT Waste Management Pollution Control Act
WoNS	Weed of National Significance