APPENDIX F Spill Management Plan

BEETALOO EXPLORATION PROJECT
SPILL MANAGEMENT PLAN

Review record

Rev	Date	Reason for issue	Consolidator	Approver
2.2	21/09/2023	Edits to Appendix A and DEPWS contacts	LP	MK
2.3	25/03/2024	Addresses regulation 10 and regulation 11 feedback from DEPWS, 29-Feb-2024	LP	MK

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1. Purpose

This Spill Management Plan (SMP) has been prepared to support Tamboran's Beetaloo exploration program. The SMP is a mandatory requirement prepared in accordance with the *Code of Practice for Petroleum Activities in the Northern Territory* (the Code). This SMP is designed to provide the strategy for the management of spills across Tamboran's Beetaloo exploration activities.

The SMP covers all regulated activities described in the Environment Management Plans (EMPs), currently in force under the Petroleum (Environment) Regulations 2016 (the Regulations). EMPs that are currently in force under the Regulations are available at: https://depws.nt.gov.au/onshore-gas/environment-management-plan/approved-emps.

Activities include civil, drilling, stimulating, rehabilitation and routine maintenance/monitoring activities undertaken by Tamboran and its subsidiaries within its exploration permit (EP) areas: EP 76, EP 98, EP 117, EP 136, EP 143, EP 161 and EP(A) 197 (Figure 1).

The SMP will reference the relevant sections within each EMP to avoid duplication. The SMP should be read in conjunction with the chemical risk assessment and operation risk assessment appended to each EMP, in accordance with section 3.4 of the Code.

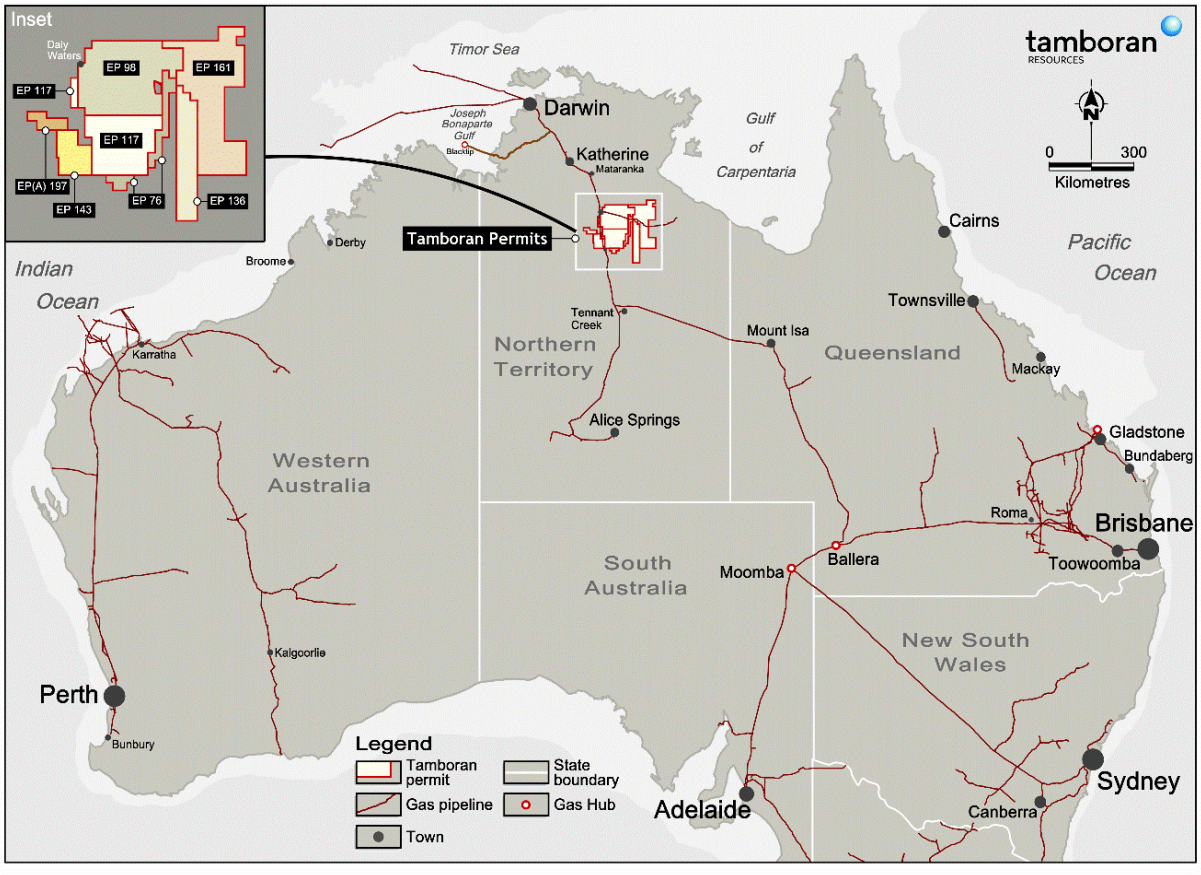

Figure 1: Location of Tamboran exploration permit areas (EPs)

2. Key legislation

Key legislation and documents consulted in the development of this plan are provided below (a full list of applicable legislation is provided in the corresponding management plans):

- **Code of Practice: Onshore Petroleum Activities in the Northern Territory (NT):** Mandatory code of practice legislating the management of chemicals and wastewater onsite, including the use of secondary containment, lined tanks and spill management plan.
- ***Transport of Dangerous Goods by Road and Rail (National Uniform Legislation) Act 2010:*** Covers the transportation of goods by road in the NT. This also covers licences for vehicles and drivers carrying dangerous goods.
- Workplace Health and Safety (National Uniform Legislation) Act 2011: Covers the storage and handling of chemicals on site.
- ***Waste Management and Pollution Control Act 1998:*** Covers the requirements for the transportation and disposal of waste within the NT. This includes the requirements for contractors, vehicles and facilities managing listed wastes to be licenced.

3. Chemicals and wastewater description

The chemicals and wastewater typically stored onsite includes:

- Chemicals used for drilling
- Waste drilling fluids, cuttings and muds
- Chemicals used for stimulation
- Flowback wastewater
- Completions and well suspension fluids
- General use chemicals such as incidental condensate and oil, diesel and fuels, general equipment maintenance chemicals (hydraulic oils, degreasers etc.)

The full list of chemicals and wastewater stored onsite, including their volume, location and hazardous status is provided in Appendix A for current EMPs. The types of chemicals used under drilling and hydraulic fracture stimulation EMPs covered by this SMP is provided in Table 1, which also identifies the relevant sections and appendices per EMP. A copy of these EMPs and appendices can be found on the Department of Environment, Parks and Water Security (DEPWS) website at: https://depws.nt.gov.au/onshore-gas/environment-management-plan/approved-emps.

The assessment of chemicals, including evaluation of the environmental hazard of the chemical additives in the hydraulic fracturing fluid systems, based on their environmental persistence, bioaccumulation and aquatic toxicity properties; evaluation of human health effects; and exposure assessment can be reviewed by accessing in the relevant hydraulic fracturing chemical risk assessment appended to each approved EMP.

All chemicals and wastewater stored on site will be in accordance with cl A.8.3 of the Code.

Table 1: Types of chemicals and wastewater relevant to each drilling and hydraulic fracture stimulation EMP

EMP	Drilling chemicals and waste fluids	Stimulation chemicals	Flowback wastewater	Completion and well suspension fluids	General use
NT-2050-15-MP-032 Velkerri 76 S2 EMP: • Chemical RA Appendix C • Risk assessment Appendix N	x	x	x	x	x
CDN/ID NT-2050-35-PH-0018 Amungee NW-1H (ORI7): • Section 2.1.1, Table 2, Table 3	N/A	N/A	x	x	x
NT-2050-15-MP-039 Beetaloo W-1 EMP (ORI8): • Section 3.9, Table 8	N/A	N/A	N/A	Incidental volumes may be generated	x
NT-2050-MP-040 Kalala S1 EMP (ORI9): • Section 3.8, Table 8	N/A	N/A	N/A	Incidental volumes may be generated	x
NT-2050-15-MP-041 Beetaloo Sub-basin Multi-well EMP (ORI10): • Chemical RA Appendix E • Risk assessment Appendix M	x	x	x	x	x
NT-2050-15-MP-0088 Amungee NW Delineation Program EMP (ORI11): • Section 4.13 and Section 3.15 • Chemical RA Appendix D • Risk assessment Appendix L	x	x	x	x	x
TB2-HSE-MP-08 Shenandoah South E&A Program EMP (TAM1) • Section 3.10 and Section 3.12 • Chemical RA Appendix E and Appendix E.1 • Risk assessment Appendix M	x	x	x	x	x

4. Spill failure scenarios

Potential spill scenarios associated with exploration activities are summarised in Table 2. These scenarios include:

- Spills from chemical, waste and wastewater handling and storage activities onsite
- Spills from chemical, waste and wastewater during transportation- trucking and gathering
- Tank, drilling sump and containment vessel overflows and structural failures

The loss of containment due to the failure of well barriers is covered under the Well Operations Management Plan (WOMP).

Table 2: Spill scenario summary table

Spill scenario	Activity duration	Mechanisms	Location	Quality[1]	Quantity	Key management controls	Monitoring	Receptors	Effectiveness of controls
Spills from chemical and waste/ wastewater handling and storage activities onsite	• Drilling–45 days • Stimulation–15-30 days • Well testing 30– 180 days	• Container rupture • Spill during chemical storage, handling and mixing • Contaminants in water and soil pass through the food chain and bioaccumulate • Runoff from drilling waste management and composting.	• Chemical storage area • Drilling rig • Stimulation spread • Drilling sumps • Flowback storage tanks • Well testing equipment	Potentially hazardous fluids such as: • Saline and drilling fluids • Saline flowback • Chemicals listed in EMP **NB:** All added chemicals have been assessed and verified to not be toxic and persistent and bio-accumulative (see EMP chemical risk assessment).	<1,000L	• Designated storage areas with appropriate segregation of incompatible chemicals • Secondary containment to be deployed under high-risk spill/leak storage and handling areas • Spill kits available • Routine inspection of chemical stores • Sites are manned during operations, with continuous leak detection and level monitoring at all other times • Wastewater management plan	• Routine inspection of chemical stores, sumps and tanks during operations • Tank leak detection	Retained on-site	High – use of secondary containment reduces the probability of a spill. High – controls managing the storage of chemicals and wastes are mature with secondary containment measures limiting potential receptor impacts. The scientific certainty around the effectiveness of secondary containment in preventing groundwater contamination is high and mature.
Loss of containment during transfer onsite (leakage from gathering lines, pipes, hoses, fittings etc)	• Drilling–45 days • Stimulation– 15-30 days • Well testing 30– 180 days • Duration of wastewater transfer – 30 – 45 days	• Coupling, valve, hosing and equipment failure • Failure of buried / aboveground gathering lines • Contaminants in water and soil pass through the food chain and bioaccumulate	• Chemical mixing and transfer areas on the drill rig, mixing hoppers and wastewater storages • Gathering lines between well pads	Potentially hazardous fluids such as: • Saline and drilling fluids and wastewater. • Chemicals listed in EMP chemical risk assessment. **NB:** All added chemicals have been assessed and verified to not be toxic and persistent and bio-accumulative (see EMP chemical risk assessment).	<1,000L	• Secondary containment to be deployed under high-risk spill/leak storage and handling areas • Spill kits available • Routine inspection of chemical stores • Sites are manned during operations, with continuous leak detection and level monitoring at all other times • Wastewater management plan • Hydrostatic testing of gathering lines prior to operation • In/out volume discrepancy and pressure monitoring during transfer operations • Valve pits installed at approximately 1 km intervals so if a leak is detected, flow can be shut off and the line repaired • Gathering lines will be purged of wastewater and	• Routine inspection of all chemical handling areas, including wastewater transfer points and chemical mixing areas • Weekly inspection of surface gathering lines when in operation. • 6 monthly Inspection during operation of buried gathering lines	Retained on-site	High – use of secondary containment reduces the probability of a spill High – use and continuous monitoring of flow and pressure meters during operations reduces the probability of a spill High – controls managing the storage of various fluids are in accordance with the requirements of the Code, which limit potential receptor impacts. The scientific certainty around the effectiveness of secondary containment and transfer in preventing groundwater contamination is high and mature.

Spill scenario	Activity duration	Mechanisms	Location	Quality[1]	Quantity	Key management controls	Monitoring	Receptors	Effectiveness of controls
						valves will be shut-in when not in operation			
Spills from chemical and wastewater during transportation (off-site-including transport on unsealed roads during the wet season)	• Drilling chemical transfer—1–5 days of bulk chemical transfer generally pre-drilling • Stimulation chemical transfer 2–3 truckloads of chemicals per week for approximately 6 weeks • Wastewater disposal over 3 weeks—up to approximately 22 truck movements total over the duration	• Transport spill due to road condition, flooding or other event • Traffic accident (total or partial release) • Contaminants in water and soil pass through the food chain and bioaccumulate	Off-site along highway or access tracks	Potentially hazardous fluids such as: • Combustible fluids (e.g. diesel) • Various chemicals as listed in EMP chemical risk assessment. • Saline wastewater **NB:** All added chemicals have been assessed and verified to not be toxic and persistent and bio-accumulative (see EMP chemical risk assessment).	<1,000 L for transport spill <50,000 L for total loss of B- triple carrying flowback	• All transport companies to be appropriately licenced to transport chemicals and waste (Dangerous goods and Waste Management and Pollution Control Act) including the requirement to detect and respond to spills • No chemical or wastewater transportation during wet season, unless a risk assessment determined the activity is safe and low risk • Transportation will not occur on tracks where the surface is not safe to allow transportation • Wastewater and chemical transportation will not be undertaken through flooded waterways • Driving on unsealed roads and access tracks will be avoided 24 hours following a >20 mm rainfall event • Area is remote with major urban centres to be avoided. • Wastewater management plan	Performance of contractors to be monitored as a part of transportation contractors	• Chemical transport between Darwin/South Australia and Queensland/ and Daly Waters • Wastewater transportation between Daly Waters and Queensland via Tennant Creek	High – The transportation of wastes and chemicals is a tightly controlled industry with mature practices designed to prevent, detect and respond to transportation spills. Transport will only be undertaken in the wet season as per the specified controls to ensure the risks are ALARP. High – Any accident is likely to be restricted to road corridors and result in "serious", short term (days-weeks) reversible impacts. The scientific certainty around the transportation of chemicals and wastes is high and mature, and well understood across Australia, limiting exposure to personnel, the public and surrounding receptors.
Tank, drilling sump and containment vessel overflows and structural failures	• Duration of all activities plus ongoing wastewater storage which may be extended beyond 12-months to allow for ongoing evaporation of fluids	• Overfilling of a sump and flowback tank • Structural failure of embankment or tank wall • Contaminants in water and soil pass through the food chain and bioaccumulate	• Sumps and tanks on lease	Potentially hazardous fluids such as: • Saline wastewater with total dissolved solids >50,000 mg/L **NB:** All added chemicals have been assessed and verified to not be toxic and	1L to >10,000 L	• Lease pads bunded during the storage of flowback • Enclosed tanks used during wet seasons operations • Open tanks with 1:1000 ARI freeboard • Tanks constructed to Australian Standards Routine tank and sump inspections • Drilling sump to be designed and operated to handle the drilling of multiple wells	Routine tank and sump level and structural integrity (visual) inspections	Retained on lease pad within bund	High – controls managing the storage of various fluids are in accordance with the requirements of the Code, which limit potential receptor impacts. The scientific certainty around the effectiveness of conservative freeboard as a mitigation is high and mature.

Spill scenario	Activity duration	Mechanisms	Location	Quality[1]	Quantity	Key management controls	Monitoring	Receptors	Effectiveness of controls
				persistent and bio-accumulative (see EMP chemical risk assessment).		• Sump solid levels to be periodically removed from the sump between wells to maintain sump capacity • Any removed drilling muds and cuttings from the sump will be stored on an impermeable liner with a permeability of less than 6 x10^{-14} m/s- and fluid captured in the sump directed to the wastewater tank			

[1] Refer Table 1 for a summary of the types of chemicals used under drilling and hydraulic fracture stimulation EMPs covered by this SMP.

5. Potential receptors

The location of Tamboran's Beetaloo exploration activities is remote. A description of the environment, including environmental and cultural sensitivities, with the potential to be impacted by a spill is provided in each of the EMPs. Figure 2 illustrates the separation distance from sensitive receptors such as:

- Watercourses and drainage features/ depressions
- Communities
- Homesteads
- Heritage places
- Vegetation communities
- Protected areas
- Water bores

Maps regarding sacred sites and restricted work areas are also applicable and will be provided to work crews to ensure awareness of these features.

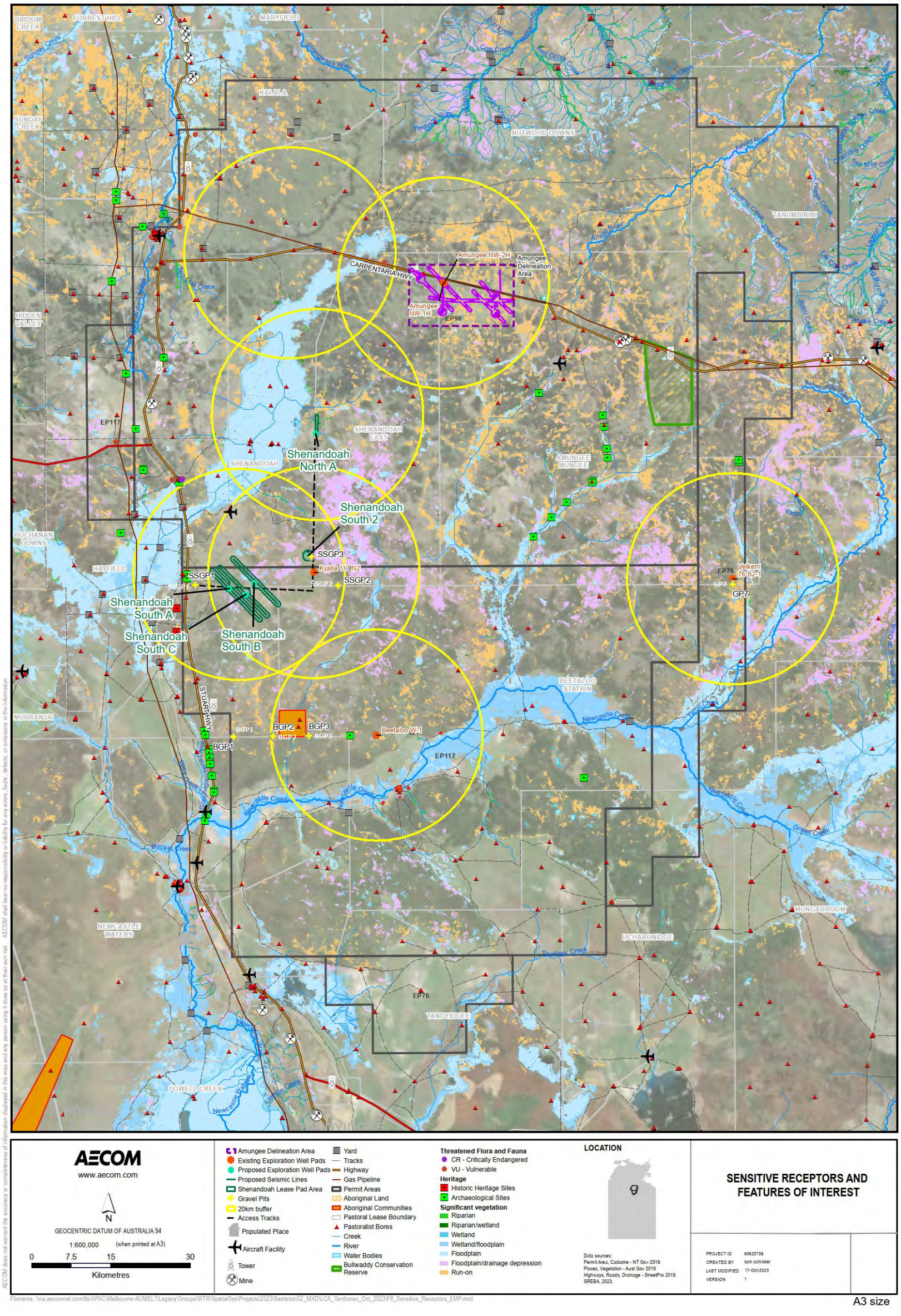

Figure 2: Location of activities and potential receptors and features of interest[1]

[1] Strategic Regional Environmental and Baseline Assessment (SREBA) 2022 mapping data has been used to draft this figure: Department of Environment, Parks and Water Security 2022. *Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin*. SREBA Data Catalogue, viewed May 2023.

6. Risk assessment

The risk of spills associated with all drilling, stimulation and well testing activities is covered under the EMPs.

7. Control measures

Controls measures to manage spills associated with exploration activities are provided in the EMPs and summarised in Table 2. The key management controls include:

- Contractors are required to develop spill management procedures to comply with the requirements of this SMP.
- All flowback, completion fluids, chemicals, oil and fuel storage will be equipped with secondary containment (or dual liners), as per the Code.
- Drilling will be lined, with enough freeboard to manage a 1:1000 Average Recurrence Interval (ARI) wet season (~1300 mm).
- Flare pits will be designed to manage a 1:1000 ARI 24-hour storm event (377 mm).
- Tanks will be designed, installed and operated as per the manufacturer's specifications and Code
- Where flowback is being stored on a lease pad, the wastewater tanks shall be earthen bunded to prevent release to surrounding areas in the case of a catastrophic failure.
- The earthen bund shall be designed to hold 110% of the volume of the largest wastewater tank onsite.
- The earthen bund shall be constructed to withstand a failure event, with the bund appropriately compacted and stabilised.
- Well sites are designed and constructed to prevent spills of hazardous chemicals; this includes:
  - compacting the lease pad surface to 100 kPa prevent infiltration.
  - provision of bunded (lined) chemical segregation areas.
- Monitoring to detect spills will be undertaken in accordance with Section 9.
- Procedures will be developed by contractors designed to detect, remediate and report any spills. This includes:
  - Chemical handling procedures
  - Chemical storage and handling inspection procedures
  - Spill prevention, detection and response procedures
- The transport of hydraulic fracturing chemicals and wastewater during the wet season (October to April inclusive) will be avoided. Any necessary transportation will be undertaken in accordance with the following:
  - Transportation will not occur on track where the surface is not safe to allow transportation vehicles to drive upon.
  - Wastewater and chemical transportation will not be undertaken through flooded

waterways.

- The transportation of wastewater/ chemicals during rainfall events will be avoided.
- Driving on unsealed roads and access tracks will be avoided 24 hours following a >20 mm rainfall event.
- After a rainfall event >20 mm, or when the integrity of any unsealed road may be compromised due to prolonged rainfall, each unsealed access track proposed to be used for wastewater/ chemical transportation will be inspected to ensure the integrity of the road is sufficient to allow safe passage of the proposed transport vehicle.
- Chemicals will not be unloaded during rainfall events.

- Effective spill clean-up material readily available at each work site and on all mobile service trucks or vehicles, where hydrocarbons and chemicals are stored and/or used.
- Inspection reports and maintenance records of secondary containment shall be kept and available for review upon request.
- Spill response mock-up drills to be completed as a part of routine emergency response.

8. Spill response and management

The following section provides an overview of the response to spills during drilling, stimulation and well testing activities. Where the spill is the result of an emergency situation that is still active, the Beetaloo Exploration Emergency Response Plan (TBN-HSE-MP-05) will take precedence over this plan.

8.1 Rapid spill assessment

When a spill occurs, the on-site Supervisor will carry out a rapid assessment to determine the potential hazards and the type and location of emergency assistance required. This assessment shall include the following:

- Determine the physical (volume and state) and location of the spill
- Determine the appropriate spill category and type of response as per section 12.1.
- Assess the hazard of the material spilled, including any potential hazards associated with chemical mixing (such as oxidising and reducing agents)
- Determine the safety hazard to immediate response personnel and whether additional resources (such as emergency services or specialised equipment or advice) are required to manage the spill safely
- Determine spill movement, factors affecting the movement (i.e. impending weather, topography, drainage lines, seasonality etc) and spill response priorities, as per Table 3.

Table 3: Spill response priorities

Spill priority	Response considerations
People and communities	• Evacuate and muster (if deemed necessary) • Account for all people and determine missing persons • Stop unauthorised access • Provide a technical resource to the Emergency Services (if required) • Protect community (including indigenous community members) and pastoralists
Environment and sacred sites	• For emergencies that are safe to manage, onsite personnel will respond with available resources to limit the extent of the impact to the environment or a protected site • For larger incidents, or where it is unsafe for onsite personnel to respond, trained people will be mobilised to control and contain the emergency to minimise the impact to the environment or protected site
Regulators	• Notify Regulators as per incident reporting requirements
Assets	• Monitor automatic shutdown of the equipment or part thereof, or initiate manual shutdowns where it is safe to do so • Mobilise emergency services to intervene
Landholders/ leaseholders/ Native Title holders	• Notify neighbours • Notify NLC

8.2 Spill containment and clean up procedures

Generic spill containment clean-up procedures must be developed and implemented by each drilling, stimulation and well testing contractor aligning with the requirements of this plan. These procedures shall be adapted (where appropriate) to consider the site and chemical specific hazards associated with each spill event.

The procedures shall consider the following generic spill containment and response procedure:

- Move all people out of harm's way.
- Alert others nearby.
- Assess the situation—determine what substances are involved, the volumes, the potential receptors (people and the environment) and if additional support is required. The substance must be known prior to taking any action (refer to the safety data sheet).
- If applicable; remove any possible risk escalating factors (e.g. ignition hazards in case of flammable/combustible spills); approach from up-wind to reduce fume risks, isolate the spill source (close containment valve, similar). Ensure appropriate controls requirements are met, e.g. personal protection equipment, first aid support, etc., prior to conducting spill clean-up.
- If it is safe to do so; stop the source of the leak (if possible) and contain the spill using onsite equipment to:
    - Prevent from leaving site or entering a waterway or sensitive feature (including flood water).
    - Recover free liquid and contaminated material as soon as possible to mitigate infiltration. Material recovery should consider the benefit of recovery versus the additional impact that recovery of all contaminated material could cause as per the National Environment Protection (Assessment of Site Contamination) Measure.
- Prevent people, livestock and wildlife access to hazardous material through fencing or other barriers.
- Store contaminated material in a manner to minimise the risk of additional contamination
- Collect and retain information on the volume of extent of the spill, including photographs.
- For Level 2 spills and higher, the Project Manager shall be notified as soon as it is safe to do so, but within 2-hours.
- Project Manager to ensure appropriate external incident reporting requirements are actioned in accordance with the impact of the spill.
- For Level 2 spills and higher, Tamboran Project Manager to seek expertise as to whether additional testing and remediation is required upon completion of the initial containment and clean up. This consideration will be undertaken in in accordance with the National Environment Protection (Assessment of Site Contamination) Measure.
- Upon rectification of a reportable spill, an incident investigation shall be completed as per the Regulations. This shall include the root cause of the incident, actions taken to mitigate the impact and ongoing monitoring and maintenance required to ensure the site is stable and non-polluting.

- Where spills have occurred in proximity to a surface water feature (such as a water course or drainage depression) ongoing monitoring of that feature may be required if impacts are reasonably expected. This includes leaks from gathering lines and transport accident. .This shall be considered on a case by case basis and included in the incident response to DEPWS.

8.3 Contaminated material disposal

Contaminated material disposal will be undertaken in consideration of the following:

- Depending on the nature of the spill (i.e. size, duration and chemical involved), contaminated material may be identified visibly during clean up (i.e. identify the extent of the wetting front) or may require in situ analysis (such as soil EC/pH testing). Where it is difficult to ascertain whether all contaminated material has been removed, additional lab analysis verification may be required (i.e. for extensive spills typically a category 3 and beyond).
- During a spill clean-up, the storage of contaminated material must be undertaken in a manner that minimises additional contamination
- Offsite disposal must be undertaken in accordance with the *Waste Management and Pollution Control Act 1998*
- All listed waste transportation shall be undertaken by licenced contractors, be tracked and disposed of at licenced waste management facilities.

9. Monitoring and inspections

The monitoring and inspection programs to identify spills is summarised in Table 4.

Table 4: Spill monitoring and inspections

Monitoring program	Frequency	Methodology	Purpose	Minimum volume of leak
Tank and sump level monitoring (when wastewater is stored on-site)	During operations: • Daily • All other times: • Weekly during the dry season (May to September) • Daily during the wet season (October to April)	• Instrument or • Level dip/ visual assessment	Prevent the overtopping of tanks	<10 L
Tank leak detection (when wastewater is stored on-site)	Continuous	Instrument	Detect the migration of fluid through primary containment into the interstitial space	<50 L
Chemical storage areas (when	During operations: Daily All other times: Weekly	Visual (a camera may be used where	Detection of leaks	<5 L

Monitoring program	Frequency	Methodology	Purpose	Minimum volume of leak
chemical stored on-site)		sites are unmanned)		
Tank structural integrity (when wastewater is stored onsite)	Weekly	Visual inspection	Detect potential structural weakness	N/A
Gathering lines	Continuous flow and pressure monitoring during wastewater transfers of gathering lines	Instrument and visual inspection	Detection of leaks	<1000 L gathering line
	Surface pipework and infrastructure: weekly during operations			<10 L surface pipework
	Buried pipework: monthly during operations			<50 L for a buried pipeline

10. Roles and responsibilities

The critical roles and responsibilities set out in Table 5 are for the main members of the spill response group. This team represents the core group of resources that will lead a spill response with the support of the broader Tamboran team.

Table 5: Roles and responsibilities

Position	Role and responsibility
Project Manager/ Drilling and completions VP	Ultimately accountable for the implementation of the spill management plan (SMP). Role, or delegate, will liaise with Tamboran environment specialists to determine remediation requirements and external reporting obligations.
On-site Supervisor/ Onsite Company representative	Responsible for the initial response to a spill. This role will be delegated to the well site representative or nominated contractor in charge of a work program. Role will undertake the initial spill assessment, engage emergency services (if required) and co-ordinate immediate spill clean-up operations associations to minimise the potential impacts to people, places and the environment.
VP Environmental and Approvals	Report spill to regulatory authorities. Provide expertise on clean up requirements and ongoing monitoring and management requirements. Interface with government and regulatory bodies for communication and consents.
HSE Manager	Provide specialist technical advice (emergency response) to support spill management activities.

11. Waste transportation and disposal

All contractors engaged to perform drilling, stimulation and well testing will be required to comply with this plan. A bridging SPMP will be developed by each contractor summarising the activities to be undertaken to comply with this plan and the Code.

12. Spill reporting

12.1 Spill rating

All spills shall be reported, with volumes of spilled material/ substances recorded.

Table 6 provides a summary of the spill classification based upon the volume and location of spill. The hazards of the potential spill to people and the environment should be assessed independently, to ensure incident specific hazards are considered in the spill response. This table provides guidance as to the likely spill scenarios that may trigger the different incident reporting requirements.

When classifying spills and determining the reporting requirements, Ministerial conditions and environmental performance objectives and criteria should also be considered when determining the whether the event is a recordable or reportable event.

The spill tiers include:

- **Not Reportable-** minor routine spills readily dealt with during normal operations (i.e. minor diesel spills during refuelling, hydraulic oil hose leaks etc.) and involve low hazard material (such as sediment, small diesel spills, low toxicity salts, grey water, drilling fluid/muds). Spill size typically below spills <200 L restricted to the lease pad or within existing bunding. Clean up time is generally hours, with no residual contamination.
- **Level 1:** Spills that can be contained within the well site and can be cleaned up without

involvement of external organisations. Most Tier 1 spills are likely to be less than 2,500 L and would include larger diesel spills during fuel transfer, oil spillage during routine maintenance or small wastewater spills during well testing. Clean up time is generally less than 1-day. These spills are not trivial or considered routine and will most likely be classified as recordable incidents as per Section 12.

- **Level 2:** Spills that have not been completely contained within the site boundary and/or may require additional resources to clean up. Clean up time is generally less than a week. Level 2 spills are typically reportable incidents as defined in section 12 and may also require notification under the *Waste Management and Pollution Control Act 1998.*
- **Level 3:** Severe spills that cannot be contained by the operator and requires substantial additional resources to manage the spill. Clean up time is generally greater than a week. Level 3 spills are reportable incidents.

Table 6: Spill tier levels

		Spill (L)		
		20-200 L	200-2,500 L	>2,500 L
Receiving environment	Bund or contained impervious area	**Not reportable***	**Level 1**	**Level 1**
	Onsite *(lease pad, camp pad, hardstand, road or work area)* compacted or sealed surface**	**Not reportable***	**Level 1**	**Level 2**
	Offsite permeable surfaces- areas adjacent to lease pads, camp pads, roads where spills have moved beyond the approved activity area. **	**Level 1**	**Level 2**	**Level 3**
	Sensitive environmental or cultural feature (such as a waterway, drainage lines, wetland, high valued habitat and sacred site) or where the spill has, or has the potential to, cause material or serious environmental harm **	**Level 2**	**Level 2**	**Level 3**

Notes: * Non-reportable spills must be recorded in Tamboran's management systems (and made available for review by contractor), with monthly reviews. For certain substances, such as flowback, there may be site specific requirements outlined in the EMP approval notice. The approvals notice should be reviewed. ** spills of Dangerous goods or wastes offsite may need to be reported under NT Dangerous Goods Act or *Waste Management and Pollution control Act 1998.*

12.2 Incident reporting

Incidents may require reporting under the Petroleum (Environment) Regulations and Waste Management Pollution Control Act.

12.2.1 Petroleum (Environment) Regulations incident reporting

12.2.1.1 Reportable environmental incident reporting

The Regulations 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 Petroleum Act.

An interest holder must notify DEPWS 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. The preferred method of notifying DEPWS is email: [2]

1. Email: Onshoregas.depws@nt.gov.au
2. Phone: 1800 064 567 NT Environment Protection Authority (NT EPA) Pollution Hotline (caller to state it is a petroleum matter)

Any verbal report to DEPWS must be followed up by a written report from the Project Manager within three days in accordance with the Regulations.

12.2.1.2 Recordable incidents

The 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.

These types of spills are typically a Level 1 type spill as defined in Table 6.

An interest holder must notify DEPWS 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). The preferred method of notifying DEPWS is email: Onshoregas.depws@nt.gov.au.

12.2.2 Waste Management and Pollution Control Act incident reporting

In accordance with the Waste Management and Pollution Control Act, where contaminants or waste is not confined within the land on which the petroleum activities are undertaken (i.e. the approved disturbance areas where the petroleum activity is occurring), Tamboran will notify the NT EPA of any incident causing or threatening to cause pollution 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;

[2] Effective 20 September 2023, the preferred method of DEPWS notification is email. However for reportable incident notifications the mobile number for the Director Petroleum Operations is also provided, if required.

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 (caller to state it is a petroleum matter) and the DEPWS email: Onshoregas.depws@nt.gov.au.

13. Acronyms and Abbreviations

Acronym / abbreviation	Meaning
km	Kilometre
kPa	kilopascal
mm	Millimetre
m/s	Metres per second
L	Litre
ARI	Average Recurrence Interval
DEPWS	Department of Environment, Parks and Water Security
EMP(s)	Environment management plan(s)
EP	Exploration Permit
NT	Northern Territory
NT EPA	Northern Territory Environment Protection Authority
SMP	Spill Management Plan
SREBA	Strategic Regional Environmental and Baseline Assessment
WOMP	Well Operations Management Plan

Appendix A Chemical volumes per well and storage areas (based on maximum 3 wells per pad)

NOTE: In accordance with the Code, a chemical risk assessment has been completed on all listed chemicals, which have been verified to not be toxic and persistent and bioaccumulative.

Material name	Typical volume	Maximum volume	Unit	Storage area	Hazardous (Y/N)
Acetic acid – 60%	3,000	9,000	L	Stimulation chemical storage area	No
BE-9 Biocide	17,000	51,000	L	Stimulation chemical storage area	Yes
Caustic Soda Liquid	15,000	45,000	L	Stimulation chemical storage area	No
DCA-11001 Breaker activator	5,000	15,000	L	Stimulation chemical storage area	Yes
DCA-13002 Breaker	300	900	kg	Stimulation chemical storage area	Yes
DCA-13003 Breaker	10,000	30,000	L	Stimulation chemical storage area	Yes
DCA-16001 Clay Stabiliser	42,000	126,000	L	Stimulation chemical storage area	No
DCA-17001 Corrosion inhibiter	1,000	3,000	L	Stimulation chemical storage area	Yes
DCA-19001 Crosslinker	600	1,800	kg	Stimulation chemical storage area	Yes
DCA-19002 Crosslinker	10,000	30,000	L	Stimulation chemical storage area	Yes
DCA-23001 Friction reducer	5,000	15,000	kg	Stimulation chemical storage area	No
DCA-23003 Friction reducer	18,000	54,000	L	Stimulation chemical storage area	No
DCA-25005 Gelling agent	35,000	105,000	kg	Stimulation chemical storage area	No
DCA-30001 Scale inhibitor	15,000	45,000	L	Stimulation chemical storage area	No
DCA-32002 Surfactant	15,000	45,000	L	Stimulation chemical storage area	Yes
DCA-32014 Surfactant	200	600	L	Stimulation chemical storage area	Yes
FE-2 Buffer	200	600	kg	Stimulation chemical storage area	No
Hydrochloric acid – 32%	50,000	150,000	L	Stimulation chemical storage area	Yes
Alcohols, C11-14-iso-, C13-rich,ethoxylated- Surfactant	5,285	15,855	L	Stimulation chemical storage area	Yes
Sodium (C14-16) olefin sulfonate - Surfactant	4,658	13,974	L	Stimulation chemical storage area	Yes
Diisobutyl glutarate - plasticiser	627	1,881	L	Stimulation chemical storage area	No
Diisobutyl succinate - plasticiser	209	627	L	Stimulation chemical storage area	No
Diisobutyl adipate- plasticiser	179	537	L	Stimulation chemical storage area	No
Sodium thiosulphate- stabilising agent	4,763	14,289	L	Stimulation chemical storage area	No
Sodium sulphate stabilising agent	913	2,739	L	Stimulation chemical storage area	No
Sodium sulphite stabilising agent	794	2,382	L	Stimulation chemical storage area	No
Ethylene glycol- crosslinker	5,112	15,336	L	Stimulation chemical storage area	Yes

Material name	Typical volume	Maximum volume	Unit	Storage area	Hazardous (Y/N)
Choline Chloride- Clay stabiliser	10,301	30,903	L	Stimulation chemical storage area	No
Glutaraldehyde- biocide	14,930	44,790	L	Stimulation chemical storage area	Yes
Ammonium sulphate- breaker	4,479	13,491	L	Stimulation chemical storage area	Yes
Polyacrylamide- friction reducer	4,479	13,491	L	Stimulation chemical storage area	No
Sodium polyacrylate- gelling agent	746	2,238	L	Stimulation chemical storage area	No
Sodium bisulfite- stabiliser	149	447	L	Stimulation chemical storage area	No
Alkyl alcohol- surfactant	149	447	L	Stimulation chemical storage area	Yes
2-Propenoic acid, homopolymer, ammonium salt- biocide	149	447	L	Stimulation chemical storage area	Yes
Potassium persulfate- breaker	149	447	L	Stimulation chemical storage area	Yes
2-Ethoxy-naphthalene- surfactant	149	447	L	Stimulation chemical storage area	Yes
Sodium gluconate- stabiliser	8,576	25,728	L	Stimulation chemical storage area	No
Boric -crosslinker	4,288	12,864	L	Stimulation chemical storage area	Yes
Potassium hydroxide- pH control	10,745	32,235	L	Stimulation chemical storage area	Yes
Mannanase- crosslinker	2	6	L	Stimulation chemical storage area	Yes
Ammonium persulphate- breaker	7,451	22,353	L	Stimulation chemical storage area	Yes
Talc- buffer	384	1,152	L	Stimulation chemical storage area	No
Sodium bromate- breaker	50,441	151,323	L	Stimulation chemical storage area	Yes
Hepta sodium phosphonate- emulsifier	3,176	9,528	L	Stimulation chemical storage area	No
Distillates, hydrotreated light- friction reducer	54,231	162,693	L	Stimulation chemical storage area	No
Guar gum- viscosity regulator	15,141	45,423	L	Stimulation chemical storage area	No
Poly-oxyethylene nonylphenol ether- surfactant	4,466	13,398	L	Stimulation chemical storage area	Yes
Quaternary ammonium compounds, bis(hydrogenated tallow alkyl)dimethyl, salts with bentonite- biocide	4,466	13,398	L	Stimulation chemical storage area	Yes
1,6-Hexanediol- cross linker	447	1,341	L	Stimulation chemical storage area	Yes
Hydrochloric acid- pH control	44,715	134,145	L	Stimulation chemical storage area	Yes

Material name	Typical volume	Maximum volume	Unit	Storage area	Hazardous (Y/N)
N-benzyl-alkyl pyridinium chloride- pH control	28	84	L	Stimulation chemical storage area	Yes
Formic acid- corrosion inhibitor	38	114	L	Stimulation chemical storage area	Yes
Sodium erythorbate- scaler prohibitor	334	1,002	L	Stimulation chemical storage area	No
Citric acid- pH control	15,878	47,634	L	Stimulation chemical storage area	No
Acetic acid- pH control	15,878	47,634	L	Stimulation chemical storage area	No
Isopropanol- clay management	83	249	L	Stimulation chemical storage area	Yes
Ethoxylated C12-C16 alcohol - surfactant	57	171	L	Stimulation chemical storage area	Yes
Ethoxylated decanol - surfactant	19	57	L	Stimulation chemical storage area	Yes
Cinnamaldehyde- biocide	57	171	L	Stimulation chemical storage area	Yes
Ethoxylated tallow alkyl amine - surfactant	9	27	L	Stimulation chemical storage area	Yes
Methanol- corrosion inhibitor	2	6	L	Stimulation chemical storage area	Yes
Polyacrylamide - friction reducer	49,093	147,279	L	Stimulation chemical storage area	No
Polyethylene glycol trimethylnonyl ether - clay manager	87	261	L	Stimulation chemical storage area	Yes
Water in additive- stabiliser	66,804	200,412	L	Stimulation chemical storage area	No
Potassium sorbate food grade- corrosion inhibitor	14	42	L	Stimulation chemical storage area	No
Mannanase (Mannan endo-1,4-beta-mannosidase)- cross linker	2	6	L	Stimulation chemical storage area	Yes
Nonoxynol-9- surfactant	9	27	L	Stimulation chemical storage area	Yes
2-Ethylhexanol PO/EO polymer- stabiliser	9	27	L	Stimulation chemical storage area	No
Corn oil- friction reducer	662	1,986	L	Stimulation chemical storage area	No
Sodium chloride	15,000	45,000	kg	Completion chemical storage area	No
ALDACIDE G	500	1,500	L	Completion chemical storage area	Yes
OXYGON	100	300	kg	Completion chemical storage area	No
BARACOR 100	2,000	6,000	L	Completion chemical storage area	Yes
Sodium Hypochlorite 10–30%	10,000	30,000	L	Completion chemical storage area	Yes
CON-DET	50	150	kg	Drilling chemical storage area	No
SAPP	50	150	kg	Drilling chemical storage area	No
Bentonite	3,000	9,000	kg	Drilling chemical storage area	No
Caustic soda	1,400	4,200	kg	Drilling chemical storage area	No

Material name	Typical volume	Maximum volume	Unit	Storage area	Hazardous (Y/N)
EZ MUD DP or EZ MUD Liquid	2,000	6,000	kg	Drilling chemical storage area	No
ALDACIDE G	336	1008	kg	Drilling chemical storage area	Yes
STOPPIT	1,000	3,000	kg	Drilling chemical storage area	No
Soda ash	350	1050	kg	Drilling chemical storage area	Yes
BARACOR 100	250	750	kg	Drilling chemical storage area	Yes
Sodium chloride (flossy salt)	96,000	288,000	kg	Drilling chemical storage area	No
Barite	500	1,500	kg	Drilling chemical storage area	No
BARACARB	500	1,500	kg	Drilling chemical storage area	Yes
Citric acid	500	1,500	kg	Drilling chemical storage area	Yes
BARADEFOAM HP	500	1,500	kg	Drilling chemical storage area	No
Sodium Bicarbonate	500	1,500	kg	Drilling chemical storage area	No
PERFORMATROL	500	1,500	kg	Drilling chemical storage area	Yes
SOURSCAV	500	1,500	kg	Drilling chemical storage area	No
DRIL-N-SLIDE	500	1,500	kg	Drilling chemical storage area	No
STEELSEAL	500	1,500	kg	Drilling chemical storage area	Yes
BARAZAN D or BARAZAN D Plus	4,150	12,450	kg	Drilling chemical storage area	No
PAC L	2,300	6,900	kg	Drilling chemical storage area	Yes
Potassium chloride	22,500	67,500	kg	Drilling chemical storage area	No
QUIK-FREE	500	1,500	kg	Drilling chemical storage area	No
BAROFIBRE, BAROFIBRE Superfine and BAROFIBRE COARSE	500	1,500	kg	Drilling chemical storage area	No
BaraBlend-657	500	1,500	kg	Drilling chemical storage area	Yes
N-DRIL HT Plus	500	1,500	kg	Drilling chemical storage area	Yes
DEXTRID LTE	4,600	13,800	kg	Drilling chemical storage area	No
BARABUF	500	1,500	kg	Drilling chemical storage area	No
BDF 933 or BaraLube W-933	864	2,592	kg	Drilling chemical storage area	Yes
BAROLIFT	500	1,500	kg	Drilling chemical storage area	No
OXYGON	500	1,500	kg	Drilling chemical storage area	No
ENVIRO-THIN	500	1,500	kg	Drilling chemical storage area	No
Lime	500	1,500	kg	Drilling chemical storage area	Yes
Calcium chloride	37,000	111,000	kg	Drilling chemical storage area	Yes
Sodium bromide	8,610	24,480	kg	Drilling chemical storage area	Yes
Evolube TR	14,500	43,500	L	Drilling chemical storage area	Yes
Radiagreen EME	4,800	14,400	L	Drilling chemical storage area	Yes
Radiagreen EBL	4,800	14,400	L	Drilling chemical storage area	Yes
Polydrill	7,500	22,500	kg	Drilling chemical storage area	Yes

Material name	Typical volume	Maximum volume	Unit	Storage area	Hazardous (Y/N)
Alpine spotting beads	1,000	3,000	kg	Drilling chemical storage area	Yes
Diesel	250	750	KL	Diesel storage tanks	Yes
Hydraulic oil	1,000	3,000	L	Workshop	Yes
Engine oil	1,000	3,000	L	Workshop	Yes
Degreasers	100	300	L	Workshop	Yes
Waste drilling fluids	2,500	7,500	m^3	Drilling mud sump	Yes
Completion fluids	1.4	4.2	ML	Drilling mud sump	No
Condensate	10	10	KL	Drilling chemical storage area	Yes
Flowback	~10.8 ML per well		ML	Flowback tanks	Yes
Proppants*					
100 mesh sand	91,000	273,000	kg	Stimulation chemical storage area	No
Quartz or organophilic phyllosilicate- proppant	1,084	3,252	L	Stimulation chemical storage area	No
40/70 sand	1,650,000	4,950,000	kg	Stimulation chemical storage area	No
30/50 sand	610,000	1,830,000	kg	Stimulation chemical storage area	No
* Proppants are sand which is inert. They do not require special chemical bunding but are co-located in the stimulation chemical storage area, within the well pad bund. Residual proppant from a stimulation campaign is often used to assist with chemical spills on the well pad, where contaminated spill material is removed.					

APPENDIX G Wastewater Management Plan

THE BEETALOO EXPLORATION PROJECT WASTEWATER MANAGEMENT PLAN

Review record

Rev	Date	Reason for issue	Author	Reviewer	Approver
2.0	27/10/2023	2023 works update	LP	MK	MK
2.1	15/03/2024	Addresses regulation 10 and regulation 11 feedback from DEPWS, 29-Feb-2024	LP	MK	MK
2.2	26/04/2024	Addresses regulation 10 and regulation 11 feedback from DEPWS, 19-Apr-2024	LP	MK	MK

Review due: 18/05/2024
Once printed, this is an uncontrolled document unless issued and stamped Controlled Copy or issued under a transmittal.

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1. Introduction

This Wastewater Management Plan (WWMP) has been prepared to support Tamboran's Beetaloo exploration program. The WWMP is a mandatory requirement prepared in accordance with the *Code of Practice for Petroleum Activities in the Northern Territory* (the Code).

The WWMP covers all regulated activities described in the Environment Management Plans (EMPs) listed in Table 1 that are currently in force under the Petroleum (Environment) Regulations 2016 (the Regulations). EMPs that are currently in force under the Regulations are available at: https://depws.nt.gov.au/onshore-gas/environment-management-plan/approved-emps.

Activities include civil, drilling, stimulating, rehabilitation and routine maintenance/monitoring activities undertaken by Tamboran and its subsidiaries in the Northern Territory (NT), within its exploration permit (EP) areas: EP 76, EP 98 and EP 117 (Figure 1).

The WWMP will reference the relevant sections within each EMP to avoid duplication.

The WWMP should be read in conjunction with the Spill Management Plan and Emergency Response Plan.

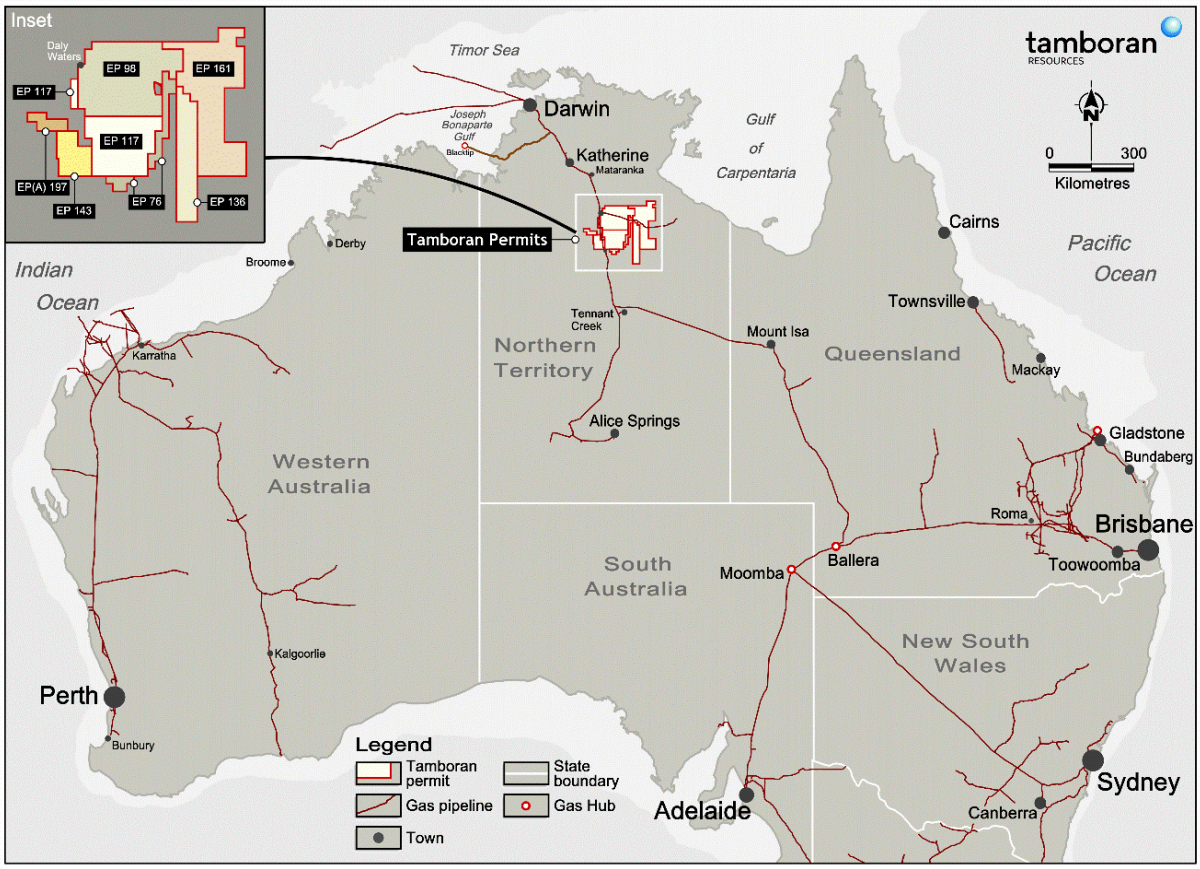

Figure 1: Location of Tamboran exploration permit areas (EPs)

2. Description of activity

Wastewater, as defined in the Code, includes the following:

- Drilling fluid, drill cuttings and cement returns
- Flowback fluid, generated during the well testing phase
- Completion fluids, kill fluids and well suspension fluids.

Wastewater is produced through the following activities:

- **Drilling**: waste drilling fluids are generated from drilling activities. The main objective of using drilling fluids is to provide primary well barrier during well construction (unless underbalance drilling is preferred drilling technique) where bottom hole hydrostatic pressure exerted by drilling fluids is used to overbalance formation pore pressure. Drilling fluids are also used to cool the bit and assist in transporting formation cuttings to surface (rock such as shale, mudstone, siltstone etc.). Excess cement when cementing a casing string and waste drill fluids and cuttings are stored in a lined mud sump, tested and either disposed of on-site or disposed of off-site at a licensed waste facility.
- **Stimulation 'flow back' water:** After the completion of hydraulic fracture stimulation, the exploration well is "flowed back" to remove all recoverable injected fluid from the formation. Flowback wastewater is stored in on-site tanks, recycled / reused, evaporated and then disposed of off-site at a licenced facility.
- **Well production test:** During production testing the well flows gas and water to the surface. The water coming to surface is defined as 'production water' and is separated from the gas stream and is stored in the on-site tanks, evaporated and then disposed of at a licenced facility. The production water is the same quality as the flow back water from stimulation.
- **Completion activities:** Completion fluids, such as kill fluids or well suspension fluids, are used to supress the formation pressure within the reservoir. The use of these fluids is a form of well control and may need to be removed from the well and disposed of where well interventions are required (i.e. the well may be suspended with fluid post drilling, with the fluid removed prior to completion and stimulation activities).

The wastewater generating activities within the scope of each drilling, hydraulic fracture stimulation and well testing EMP covered by this plan is presented in Table 1.

Table 1: Wastewater generating activities per Beetaloo drilling, hydraulic fracture stimulation and well testing EMP

EMP	Drilling	Stimulation	Well production test	Completions
NT-2050-15-MP-032 Velkerri 76 S2 Section 3.11	x	x	x	x
CDN/ID NT-2050-35-PH-0018 Amungee NW-1H (ORI7) Section 7.1	N/A	N/A	x	x
NT-2050-15-MP-039 Beetaloo W-1 EMP (ORI8) Section 7 and Section 10	N/A	N/A	N/A	Not anticipated-with incidental volumes possible

EMP	Drilling	Stimulation	Well production test	Completions
NT-2050-MP-040 Kalala S1 EMP (ORI9) Section 3.13	N/A	N/A	N/A	Not anticipated- with incidental volumes possible
NT-2050-15-MP-0088 Amungee NW Delineation Program EMP (ORI11-3) Section 3.15	x	x	x	x
TB2-HSE-MP-08 Shenandoah South E&A program EMP (TAM1) Section 3.10 and Section 3.12	x	x	x	x

3. Waste management framework

Wastewater will be managed with the objective of achieving optimal environmental outcomes and in accordance with the following hierarchy principals:

1. **Avoid:** eliminate the generation of waste through design modification.
2. **Reduce:** reduce unnecessary resource use or substitute a less resource intensive product or service.
3. **Re-use:** re-use 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.

It is recognised that the options for avoiding, reducing or re-using wastewater generated during exploration are limited. This is largely restricted to:

- Maximising the re-use and recycling of drilling fluids during operations.
- Minimising the use of suspension fluids by minimising re-entry activities (i.e. multiple entries into a well requiring fluid to be unloaded).
- Minimise the off-site transportation of flowback through maximisation of recycling / re-use, and evaporation within the designated treatment tanks.

The volume of cuttings produced during the drilling activity is dictated by the regional stratigraphy (target zone depth) and lateral length of the horizontal well, whereas the volume of the flowback is a function of stimulation design and number of stages completed during stimulation. There is however an ability to minimise the volume of waste disposed of off-site, through careful flowback recycling / re-use, A compacted hard stand area will be designated for the trial waste management and treatment.

4. Wastewater risk assessment

The risks associated with wastewater are covered in the risk assessments within each of the EMPs.

Detailed assessments of the site-specific risk associated with the disposal of drilling fluids and muds as per condition C.4.1.2 of the Code, will be undertaken upon completion of drilling activities.

Geogenic chemical composition of flowback water was sampled as a part of the Amungee NW-1H, Kyalla 117 N2-1H and Shenandoah 1 hydraulic fracture activities. These data indicate the risks associated with flowback are largely to do with salts—specifically chlorides. The presence of other compounds, such as hydrocarbons and heavy metals are also likely.

The hazards associated with flowback management have been addressed by the Code and within individual EMPs. Specific controls covered by the Code and EMPs preventing environmental harm include:

- Well operations management plan designed to ensure the risk of the well to surrounding aquifers is mitigated; including the requirement for multiple, verified well barriers containing steel and cement.
- Use of enclosed tanks.
- Freeboard requirements to accommodate a 1:1000 Average Recurrence Interval (ARI) total wet season.
- Use of double lined tanks with leak detection.
- Secondary containment requirements for all pumps and high-risk spill locations.
- Prohibition of wastewater discharges and reinjection.
- Groundwater monitoring bores.
- Spill management plan.

5. Wastewater management overview

A summary of how each wastewater stream is managed to optimise the environmental outcomes is provided in Table 2. An individual description of each wastewater stream is provided in the following section.

5.1 Drilling fluid and cuttings

Approximately 750 – 1000 m^3 of solid drilling muds and cuttings and 1 – 2 ML of drilling fluids will be generated from the drilling of each exploration well. Water-based drilling fluids and wastes are saline, polymer/bentonite-based material which are stored in lined sumps on-site. The primary contaminants associated with drilling fluids and wastes are likely to be from chlorides.

Drilling fluids and muds will be managed in accordance with the following:

- All drilling fluids, water-based drilling muds and drilling cuttings stored in engineered lined Coletanche (or similar) sumps or wastewater tanks.
- Sumps/ tanks will be designed with a 1:1000 ARI freeboard calculated in accordance with the methodology outlined in Appendix A.
- The maximum water level (1.3 m wet season and 0.3 m dry season freeboard) will be clearly marked on the side of the sump.
- Transfers of wastewater to the sump must not cause the freeboard to be exceeded. All operational inflows to cease prior to exceeding the freeboard requirements. Disposal of fluid and waste to sumps/tanks must not occur where the fluid level in the sump is above the relevant freeboard.

- Additional controls must be implemented where the sump capacity falls below the 1:1000 ARI 7-day total rainfall design criteria of 580 mm within the sump.
- All well pads will be fenced to prevent livestock and fauna ingress into open sumps.
- Muds and cuttings contained in lined sumps will be allowed to dry out, with fluid transfers to wastewater storage tanks undertaken where required to assist in dewatering.
- Drilling cuttings and muds may be removed from the sump between wells, or as required, to maintain the safe operating level of the sump. Drilling waste material will be stored in pit/sump (in compliance with the Code) with an impermeable liner, with any free water removed to the sump or wastewater tanks.
- Dry drilling muds and cuttings may be removed from a sump and blended on the well pad during the dry season in preparation for final disposal.
- Dry drilling cuttings is defined as cuttings and muds that do not have any visible free liquid that pools/ is released from the material when worked.
- Dry, blended drilling cuttings/ muds removed from the sump may only be stored temporarily onsite (well pad or laydown) without secondary containment in preparation for offsite transportation or onsite disposal. This is required as heavy equipment and trucks are likely to damage liners during material management. Storage of dry material will be undertaken in accordance with the following:
    - the storage of dry cuttings storage without secondary containment must be temporary and only for the duration required for the material to be transported offsite/ in preparation of mix bury cover (for example, some landfills may only take certain volumes over a given time)
    - Unlined storage only permissible in the dry season (May to September)
    - The material must be dry, with no free water released from the material or pooling where the material is stored
    - the location where the material is stored must be a compacted clay liner or geomembrane type liner meeting the requirements of clause B.4.16.2(h) and C.4.1.2 (b) of the Code.
    - Where rainfall is predicted within a 7 day period, the dry cuttings are to be removed from site where possible or covered with a tarp to prevent fluid access to the material
- Any leachate or water generated must be removed immediately and disposed of to the sump or wastewater tanks.
- Drilling muds and fluids may be moved between sites to manage sump volume and disposal requirements.
- Any residual liquids will be transported to a licenced interstate disposal facility (e.g. Westrex, Jackson, Queensland) with the appropriate interstate waste transport consignment authority as per the *National Environmental Protection (Movement of Controlled Waste between States and Territories) Measure 1998* (NEPM) as implemented under the NT *Waste Management and Pollution Control Act 1998* and Queensland *Environmental Protection Act 1994.*

- Leachability testing of drill cuttings and muds will be undertaken in accordance with Table 10 of the Code.
- A disposal option assessment will be completed by a suitably qualified person (as outlined in section C.4.1.2 of the Code), with on-site disposal to land only undertaken where environmental harm will not result from the disposal activities. This assessment will be submitted to the Department of Environment, Parks and Water Security (DEPWS) for approval prior to implementation.

5.1.1 Drilling waste compost/soil conditioner trial

To investigate the potential future re-use of drilling cuttings and solid waste material, a small trial to create a suitable compost/ soil conditioner for use in rehabilitation may be undertaken on a well pad. This objectives of the trial will be designed to:

- confirm whether the material can be successfully composted/ blended into a suitable compost/ soil conditioner to support future rehabilitation (such as gravel pit void backfilling).
- Develop the required procedures and know-how for future larger scale disposals
- Build capacity with local traditional owners to take over the activity in the future
- Obtain the required information to support future approvals

Material generated under this approval will be either sent to a licenced landfill or additional approvals sought for onsite disposal as per section C.4.1.2 of the Code.

The trial will involve the following steps:

- A dedicated trial area will be located on either the formed well pad/ laydown yard and will be demarcated and signed. The size of the trial area will typically be no greater than 50 m x 50 m, at either Kyalla 117 N2 or Shenandoah S2.
- The trial area will be a compacted clay liner or geomembrane type liner meeting the requirements of clause B.4.16.2(h) and C.4.1.2 (b) of the Code.
- The trial area will be bunded (using available material onsite) and graded to prevent both run-on and run-off of stormwater.
- Approximately 1 – 200 m^3 of dried drilling waste (moisture content <20%) will be transferred to the trial area and stored in stockpiles. In the unlikely event free liquids are encountered, they will be cleaned up immediately and recorded as per the spill management plan.
- Organic manure will be trucked in and stored on the trial pad in small stockpiles (~500 m^3). If manure is used, this will be sourced from local cattle stations in the region to reduce the risk of introducing weeds.
- Waste material will be blended with manure using a front end loader/tractor/bob cat onsite at several different ratios (such as 1 part waste: 1 part manure etc.).
- The material will be stockpiled in windows/ static piles to allow aerobic composting for ~60 – 90 days.
- The material will be turned/worked monthly.
- The material will be tested in accordance with the suite in Table 9 of the Code.

- A selection of material (~1 m^3) will be used in large pots/ bags to assess the re-establishment of vegetation, with a seed mix and additional nutrients (specifically nitrogen) added where required. This will be left open over the wet season, with observation taken.
- Upon completion of the trial, the material will be either a) returned to the sump b) stockpiled on a liner with a cover or c) trucked offsite to a licenced landfill.
- The trial area will have all potential contaminated material removed, with validation testing to confirming concentrations of contaminants of concern (notably EC, chlorides, barium and strontium) are consistent with background soil levels.

A simple report will be generated at the end of the trial summarising the trial results.

5.2 Produced water and flowback management

All produced water and flowback fluids will be stored in accordance with the Code.

It is anticipated that up to 12 ML of flowback may be produced from each well (subject to well test duration and recovery % observed). Flowback and production water will be highly saline, with a summary of the anticipated quality provided in Appendix B. Further details on the wastewater generated and stored on-site is found in the water balance section of each EMP.

Management controls for flowback implemented during the program include:

- Recycling of flowback in make-up fluid will be prioritised.
- No disposal of flowback wastewater to surface water or land.
- Flowback wastewater stored in above ground tanks.
- Tanks to be double lined with built in leak detection.
- All flowback wastewater to be stored in enclosed tanks unless being treated (i.e. evaporated)
- The site will have enough enclosed storage to deal with the total volume of flowback wastewater stored at any time.
- Should the freeboard of an open tank storing flowback be exceeded, wastewater transfers must commence asap to return the fluid under the freeboard requirements.
- Appropriate venting of enclosed tanks to prevent the build-up of explosive gasses.
- Tank design, construction and operation will consider environmental factors, such as wind loading, temperature bushfires and structural integrity.
- All working open evaporation tanks will have a minimum freeboard to allow for a 1 in 1000-year ARI wet or dry season (depending on which season operations are undertaken in) as calculated in Appendix A.
- Off-site flowback wastewater disposal will be minimised through the treatment of wastewater through evaporation. Evaporation tanks will be used to treat wastewater all times, except during periods of significant rainfall.
- Mechanical evaporators may be used in each tank to increase evaporation to reduce the volume of flowback. Evaporators will be positioned in a manner to ensure all drift is contained within the wastewater tank and have automated wind direction and speed cut-

offs. Any drift outside of the wastewater tank will be treated as an incident, as defined in the EMP.

- Wastewater may be transferred between approved sites to maximise the efficient use of tank capacity. Transferral may be via truck or surface/subsurface gathering lines.
- Long term (12 month +) transfers of fluid will utilise buried gathering lines.
- Where solid salt crystallising appears (through visual inspection) to occur, the fluid to be transferred to a higher puncture resistant liner, to minimise the potential for punctures from solidified materials.
- Surface gathering lines will only be utilised for temporary water transfers, with pipelines to be purged and decommissioned after use.
- The freeboard requirements will be clearly marked on each of the open tanks as the Maximum Water Level (MWL).
- During the wet season, flowback wastewater will be stored in enclosed tanks, with some additional treatment capacity available via evaporation tanks.
- During the dry season, evaporation tank capacity will be increased to facilitate flowback wastewater treatments.
- Flowback wastewater on location must be able to be transferred into enclosed tanks within 72-hours of becoming aware of a significant rainfall event (noting a minimum volume of wastewater will be required to be maintained with a tank to secure the liners). This transfer must be completed at least 8- hours prior to the predicted commencement of the significant rainfall event. The determination of a significant rainfall event is provided in section 7.1.
- Pumping infrastructure will be available to transfer flowback wastewater into enclosed storage within 24-hours (noting wastewater will be transferred 8-hours prior to the onset of the rainfall event). Sufficient pumping redundancy will be available to accommodate pump failures.
- Storage tanks that are inter-connected will be designed to prevent uncontrolled release from multiple tanks.
- Tanks are to be designed and constructed to the relevant Australian Standard (including AS1554.1 and AS3990) with a quality assurance and quality control (QA/QC) plan and installation procedures implemented by the contractor.
- Tanks will be designed to prevent the ingress of stock and fauna, with each exploration site fenced to prevent stock and public access.
- Monitoring of flowback wastewater tank levels will be undertaken daily, with management response criteria implemented to prevent tank overtopping. This includes shutting in operations where freeboard requirements cannot be met. Monitoring may be in person or via remote methods.
- Residual flowback liquids after recycling / re-use and evaporation will be evaporated and transported to a licenced interstate disposal facility (e.g. Westrex, Jackson, Queensland or alternative approved locations) with the appropriate interstate waste transport consignment authority as per the NEPM as implemented under the NT *Waste Management and Pollution Control Act 1998* and Queensland *Environmental Protection Act 1994.*

- When the wastewater tanks are decommissioned the associated residual solids, brines and liners are removed and disposed of at an appropriately licensed waste disposal facility by a licenced contractor as per NT *Waste Management and Pollution Control Act.*
- During removal of the solids within the liner, efforts will be deployed to contain any residual fluid . This includes the use of vac trucks and temporary bunding during tank deconstruction
- Tank decommissioning will not occur during the months of December to March. Tank decommissioning will not occur where there is forecasted rain.
- Daily inspections of all wastewater storages will be implemented during operations (active well testing), with continuous level logging and leak detection implemented when sites are unmanned.
- Flowback will be transferred between operating sites via a wastewater gathering network (see section 8.1 to enable wastewater storage, treatment and recycling activities).

5.3 Drilling and completion fluids (suspension and kill fluids)

Drilling and completion fluids (suspension and kill fluids) may be used to maintain bit lubrication and circulation and for well control/suppress formation pressure. Drilling and completion fluids are likely to have an elevated salinity, with calcium, sodium and potassium-based salts being the main compounds.

It is anticipated that up to 0.5–1.0 ML of drilling and completion fluids could be produced per well, with fluids stored in the drill sump or tanks (depending on whether tanks have been installed on-site at the stage). The fluids will be evaporated, and any residual transported off-site for final disposal at a licenced facility.

Table 2: Wastewater management summary and implementation plan

Wastewater	Quantity produced	Properties	Hazards	Implementation plan					Final management	Final disposal volume[1]	Alternative management options considered
				Storage	Handling	Operational controls	Routine inspections	Monitoring			
Flowback / production water	3 – 12 ML per well, depending on stimulation volume	Composition influenced by chemical composition of shale formation. Geogenic sourced contaminants include: Salinity (Typical Electrical Conductivity 50,000 µs/cm with elevated, sodium, chloride, boron, barium and hydrocarbons as per Appendix B.	High salinity wastewater representing a hazard to groundwater, surface water and soils from chloride dominated salts if released into the environment	• Stored on-site or at other approved exploration sites within the basin in double lined above ground enclosed tanks and double lined working evaporation tanks with leak detection. • All tanks have been sized with regards to the 1:1000 ARI rainfall event as per Appendix A. • Maximum water levels (MWL) to be clearly marked on each open tank.	• Transferred to storage tanks from on-site separators or directly from the well as required under B.4.13.2 (k) of the Code. • Transfer between sites via surface/ subsurface gathering lines • Secondary containment used under all pumps and connections.	• Recycling of flowback in make-up fluid • Storage volumes of ponds to be monitored daily through visual inspections or telemetry during wastewater storage. • Wastewater stored in enclosed tanks during wet season, with some evaporation tank surplus capacity. • Evaporation tank capacity increased during dry season to facilitate treatment. • Flow/pressure meters to be used to monitor flowback transfers. • Evaporators to be strategically located on or within the boundaries of the pond with drift prevention controls (automated wind direction and speed cut offs).	• Storage facilities and handling areas inspected daily during operations via electronic or manual means. • Visual inspections of tanks completed weekly. • Weekly inspection of surface gathering lines when in use.	As per section 6	Evaporated on-site using fractionating evaporators to reduce final volumes. Potentially onsite treatment using brine crystallisation to create solid salt. Then trucked off-site to a licenced waste disposal facility (where locally available or Westrex in Queensland (QLD)) in accordance with *NT Waste Management and Pollution Control Act* waste consignment authority approval.	Up to 2 ML / well	• Treatment using reverse osmosis or other mechanical filtration has been considered; salinity and scaling constraint posed by wastewater restricted the use of conventional water treatment.
Drilling muds, cuttings and fluids	750 m^3 – 1000 m^3/ well	Saline (KCl and NaCl) polymer / bentonite based drilling fluids with formation cuttings)	KCl and NaCl may represent a hazard in residual drilling muds and cuttings if not segregated prior to disposal. Formation cuttings may contain low level of hydrocarbons as per Appendix B, which are likely to be	• Stored on-site in lined drilling sumps with sufficient freeboard to accommodate a 1:1000 ARI rainfall event as per Appendix A • MWL to be clearly marked	• Transferred directly from rig via the shakers into the sump • Dry muds and cuttings may be blended onsite with clean material to aid	• Storage volumes of sumps to be monitored daily • Material to be dried out after completion of activity, with supernatant fluids evaporated in a separate tank (Code compliant storage)	• Sump level to be monitored daily during operations via electronic or manual means • Sump liner and embankments to be	As per section 6	• Supernatant fluids will be evaporated from muds prior to disposal • Residual fluids to be transported to a licenced waste disposal facility (where available locally or Westrex in QLD) in accordance with NT Waste Management and Pollution Control Act	750 m^3 – 1000 m^3/ well	Cuttings cannot be re-used- they are a waste product consisting of shales, siltstones and clays which do not have any additional usage Drill muds are continuously recycled during the drilling process as much as possible. Out of specification muds a to

[1] Note these values are indicative and the final values are outlined in the respective EMP.

Wastewater	Quantity produced	Properties	Hazards	Implementation plan					Final management	Final disposal volume[1]	Alternative management options considered
				Storage	Handling	Operational controls	Routine inspections	Monitoring			
			degraded quickly in the open sump.	on each tank and sump • Muds and cuttings allowed to dry out • Dry, blended drilling muds and cuttings may be stored onsite in a manner that prevents leaching.	recycling/ disposal.	• Dry material may be periodically removed from sump and blended to achieve stability and reduce leachability potential making tit suitable for re-use/ lower hazard disposal. • Material to be tested prior to determining final disposal requirements	inspected weekly during operations		and related interstate waste consignment authority approval • Final disposal solution of muds and cuttings to be determine through on-site characterisation and risk assessment by third party • For on-site disposal, muds and cuttings to be either mixed, buried and covered on-site or blended with material to allow for material recycling • For off-site disposal, material will be transported to a licenced waste disposal facility (where available locally or Westrex in QLD) in accordance with NT Waste Management and Pollution Control Act and related interstate waste consignment authority approval		being discharged to the sump when the fluids are no longer in specification. Out of specification drilling muds cannot be re-used as they can (and do) create well integrity issues. Drilling wastes could theoretically be composted with organic material in the future. Tamboran is looking into this as a future opportunity; however a significant amount of R&D and
Drilling, completion, suspension and kill fluids	0.5–1.0 ML / well (or incidental volumes during maintenance)	KCl or NaCl based fluids with a TDS >33,500 mg/L	High salinity wastewater representing a hazard to groundwater, surface water and soils from chloride dominated salts if released into the environment.	• Stored on-site in the sump and transferred (as required) to the double lined above ground enclosed tanks and evaporation tanks with leak detection. • All tanks have been sized with regards to the 1:1000 ARI rainfall event as per Appendix A.	• Transferred to flowback storage facilities directly from well. • Secondary containment used under all pumps and connections.	• Storage volumes of ponds to be monitored daily during operations. • Evaporators to be strategically located on or within the boundaries of the pond with drift prevention controls (automated wind direction and speed cut offs). • All wastewater to be transferred into enclosed storage when a significant rainfall event is	• Storage facilities and handling areas inspected daily during operations. • Visual inspections of tanks completed weekly.	As per section 6.	Stored in flowback tanks. Evaporated on-site using fractionating evaporators to reduce final volumes. Potentially for recycling within stimulation. Residual fluids to be trucked off-site (if required) to a licenced waste disposal facility (Westrex in QLD) in accordance with *NT Waste Management and Pollution Control Act* waste consignment authority approval. Currently, it is assumed all drilling wastewater will be evaporated with limited water removed from site.	0–0.5 ML	• Due to the saline nature of the material, recycling during exploration may be possible and will be prioritised. • Treatment using reverse osmosis or other mechanical filtration has been considered; salinity and scaling constrain the use of conventional water treatment. • Request for proposal (RFP) has been released to

Wastewater	Quantity produced	Properties	Hazards	Implementation plan					Final management	Final disposal volume[1]	Alternative management options considered
				Storage	Handling	Operational controls	Routine inspections	Monitoring			
				• Maximum water levels (MWL) to be clearly marked on each tank and sump.		predicted as per section 7.1.					identify additional technologies for a potential future trial.

6. Wastewater monitoring program

A wastewater sampling program will be implemented to characterise the quality of the wastewater during flowback activities. The monitoring program is summarised in Table 3 below.

Table 3: Minimum monitoring requirements

Monitoring Program	Location	Monitoring Requirements	Frequency
Significant rainfall event detection	Each site	Daily review of 8-day total rain forecast as per section 7.1.	Daily during wastewater storage.
Flowback characterisation	Post separator — prior to entering storage tanks	Electrical conductivity, pH, temperature and volume of flowback.	Continuous (at least one sample every 24 hours).
		Testing samples of flowback for analytes listed in Appendix C.	Weekly until the EC level stabilises (<10% change over 2 weeks) and then monthly until practical completion of flowback activities.
Stimulation fluid —pre-injection	Post blender — prior to injection	Testing sample of stimulation fluid for analytes listed in Appendix C.	1 sample pre-injection for each stimulation fluid used.
Stimulation source water characterisation	Source water used for stimulation	Testing for analytes listed in Appendix C.	Prior to stimulation
Stimulation volume	Each well stage	Total volume of stimulation fluid pumped	Each hydraulic fracture stage.
Flowback storage tanks	Each storage tank	Testing samples of flowback for analytes listed in Appendix C.	6-monthly.
	Each storage tank	Level — estimated evaporation rates.	Daily - through either visual inspections or telemetered meter.
Wastewater gathering system	Each operational gathering line (surface/ subsurface	Hydrostatic testing.	Prior to operation.
		Flow meters checked.	Continuous. During operation.
		Monthly right of way inspections for buried pipelines and weekly for surface pipelines when in use.	Monthly for buried services Weekly for surface transfers.
Drilling material	Determined by suitably qualified person	Testing samples of drilling cuttings for analytes listed in Table 10 of the Code, Naturally Occurring Radiation Material (NORMs) and volume.	Prior to disposal.
Fauna interactions	Wastewater tanks and surrounding lease area	• Ad hoc bird and fauna observations and photos to be taken around wastewater tanks. • Wastewater tank inspection for bird carcasses.	Continuous- all records of fauna interactions will be continuously logged as they occur.

Monitoring Program	Location	Monitoring Requirements	Frequency
		• Carcasses present during tank emptying.	

6.1 Sampling methodology

- Water samples will be collected in accordance with the methodology outlined in Table 4.
- All samples will be collected by appropriately qualified personnel, with all meters calibrated in accordance with the manufacturer's instructions .A suitably qualified person is defined as:
    - A person who has at least 2 years' experience relevant to the collection of samples and can conduct tasks in accordance with the relevant sampling procedural requirements.
- Samples will be collected in laboratory supplied sampling containers and placed in chilled eskies and transported under chain of custody (COC) procedures.
- Analysis will be performed by laboratories with National Association of Testing Authorities (NATA) accredited analysis methodology.
- Each sample will have a unique identifier that would be cross referenced to the monitoring location and time of sampling. Due to the remote location, samples will be couriered to the laboratory to minimise sample holding time violations.
- In accordance with of C.5.1 (d) in the Code, where there are no NATA accredited laboratories for a specific analyte or substance, then duplicate samples must be sent to at least two separate laboratories for independent testing or evaluation.

Table 4: Monitoring program methodologies

Program	Sampling methodology
Drilling sump characterisation	National Environment Protection (Assessment of Site Contamination) Measure AS4482.1-2005 guide to the investigation and sampling of sites with potentially contaminated soil
Flowback and drilling fluid monitoring	Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (ANZECC Guidelines) AS/NZ5667.1: 1998. Water Quality Sampling Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples

7. Wastewater storage management response criteria

To minimise the risk of overtopping a tank or sump, the criteria outlined in Table 5 will be implemented when hydraulic fracturing and drilling wastewater is stored on-site.

Table 5: Wastewater storage management response criteria

Monitoring program	Criteria description	Criteria	Criteria response
Significant rainfall event	Significant rainfall event predicted	The predicted 4-day total rainfall exceeds 300mm within the 8-day forecast	All flowback fluid must be transferred to enclosed storage at least 8-hours prior to the predicted commencement of the significant rainfall event. A minimum volume of flowback may be left in an open tank to maintain liner integrity.
Flowback wastewater tank level monitoring	Enclosed flowback storage level exceedance	The total volume of hydraulic fracturing wastewater stored on-site exceeds the available enclosed tank storage capacity	• Flowback activities to cease • Tamboran to provide written notification to DEPWS within 48-hours of exceedance, along with the proposed plan to return to compliance. • Actions agreed to with DEPWS are to be implemented.
	Open flowback storage tank level exceedance	The volume of flowback stored in an open tank exceeds the required tank freeboard level.	• Flowback transfer into the enclosed tank must be undertaken soon as possible to return the tank under the freeboard level. • The tank must not have any additional wastewater added until it returns back to compliance. • Tamboran to provide written notification to DEPWS within 48-hours of exceedance and corrective actions to ensure the breach of freeboard does not re-occur.
Drilling sump level monitoring	Drilling sump freeboard level exceedance	The total volume of drilling wastewater exceeds the freeboard	• Drilling wastewater disposal into the sump/tank to cease

Monitoring program	Criteria description	Criteria	Criteria response
		capacity of the drilling sump	until fluid levels return to below freeboard • Tamboran to provide written notification to DEPWS within 48hours along with a proposed monitoring, reporting and action plan to prevent the sump from overflowing (which will be case specific)Actions must be implemented where the sump freeboard is insufficient to manage a 1:1000 ARI 7 day total rainfall event of 580mm to prevent an overtopping event • Actions are to be agreed to with DEPWS and are to be implemented.
Gathering line pressure and flow monitoring	Gathering line leak detection	The gathering line pressure drops unexpectedly indicating a potential leak Flow meter reconciliation between supply and receiving meter indicates potential leak	• Wastewater transfers to stop immediately • Pipeline to be inspected for potential leaks • Meters to be inspected if suspected error • Physical reconciliation completed where no leak completed. • Transfer only to recommence once confirmation that leak has not occurred.

7.1 Significant rainfall events

The 8-day Bureau of Meteorology 4-day total rain forecast[2] shall be reviewed daily to identify periods of significant rainfall. Significant rainfall is defined in this WWMP as an event where greater than 326mm of total rainfall is predicted over a 4-day period (correlating to a 1:50 ARI 96 hours rainfall

[2] Refer http://www.bom.gov.au/jsp/watl/rainfall/pme.jsp

event). This is a type of rainfall level is consistent with that from a significant rainfall event, such as a monsoonal trough, tropical low or cyclone.

Commencement time to transfer the flowback fluid will be selected to ensure that it is completed at least 8-hours prior to the predicted commencement of the significant rainfall event.

8. Waste transportation and disposal

All wastewater transport providers will be licenced under the NT *Waste Management and Pollution Control Act 1998.*

All wastewater will be transported interstate to a licenced waste storage and treatment facility. Westrex, at Jackson, Queensland is the current default option for wastewater disposal, with other interstate disposal locations available. The transportation of wastewater between states/territories, will require an Interstate waste transport consignment authority as per the NEPM as implemented under the NT *Waste Management and Pollution Control Act 1998* and relevant accepting state/territory (such as the Queensland *Environmental Protection Act 1994*).

All wastewater storage and treatment facilities will be licenced as per the relevant accepting state/territory (such as the Queensland *Environmental Protection Act 1994*).

8.1 Wastewater gathering network

Tamboran may install a gathering network to help transfer water between locations. It is proposed that a using low-pressure (less than 1,500 kPag) polyethylene pipeline will be located between sites, either on the surface or buried. If gathering lines are used, these will be constructed as required to provide the safe and efficient transfer of high volumes of fluids between well pads and other facilities as described in the relevant EMP.

Waste fluids transferred in the gathering network may include:

- Groundwater
- Drilling fluids
- Flowback fluids
- Wastewater

The gathering lines will be constructed, operated, maintained and abandoned in accordance with the "Code of Practice for Upstream Polyethylene Gathering Networks – CSG Industry, Version 5", August 2019 (APGA 2019).[3]

Details of the construction and operation of the wastewater gathering system can is described in the individual EMP.

[3] Australian Pipelines and Gas Association Ltd (APGA), 2019. *Code of Practice for Upstream Polyethylene Gathering Networks – CSG Industry, Version 5*, August 2019. https://39713956.fs1.hubspotusercontent-na1.net/hubfs/39713956/CoP%20for%20Upstream%20PE%20Gathering%20Lines%20in%20the%20CSG%20Industry%20050919.pdf.

9. Wastewater tank decommissioning

Each wastewater tank will be decommissioned when no longer required to support current or future wastewater storage requirements. Decommissioning typically takes approximately 4 – 6 days and involves a 6 tonne telehandler, spreader bar , vac tank, prime mover and multiple 30 m skips. The process for decommissioning can be typically summarised as:

1. Tanks will be decommissioned when there is low forecasted chance of rainfall during the duration of the decommissioning activity.
2. The tank is first drained to another wastewater tank/ truck to a level that is as low as possible
3. For enclosed tanks, the lids are rolled up and removed- these will be stored on a bund/sealed skip awaiting disposal
4. Fluid transfer equipment is utilised to remove the residual fluids with ongoing fluid removal during deconstruction
5. A temporary bund (earthen or equivalent material) is constructed within the tank to prevent fluid from entering the cleaned section. The bund is sized to allow a section of the liner to be rolled up, cut and safely handled
6. Solids are removed from the section (as much as practicable).
7. The tank liners (primary and secondary) are detached from the tank wall in a section of the tank and several panels are removed to allow equipment and people access to the liner.
8. The primary liner is removed. The secondary liner is left in situ if possible (noting it may become damaged with equipment use).
9. The folded primary liner is cut off before the internal bund and transferred via telehandler to be stored within a bund to contain any potential residual fluids
10. The next area has any residual fluid removed and a new bund is constructed within the tank in preparation for the next section of liner to be removed.
11. Steps 6-9 are repeated until all liner is removed.
12. Once the primary liner is removed, the secondary liner and underlying geofab is removed to a skips (sealed if contains wet material)
13. The tanks panels are all deconstructed and removed from site/ stockpiled for re-use
14. All waste liners are removed to a licenced wastewater facility in a sealed skip (where wet and likely to spill) by a licences waste provider
15. Tank decommissioning will typically occur during the night, with a bund in place to prevent any overflow from rainfall during the evenings
16. Any spilled material/ contamination will be cleaned up immediately, with the spill management processes outlined in the EMP. If a long term suspected leak is identified, this shall be investigated with the affected material removed, stored in a bunded area/ sealed skip and trucked offsite to a licensed waste facility.
17. Any spills/ leaks will be reported as per section 11.2.

10. Waste tracking and reporting

The movement of wastewater will be tracked onsite in accordance with the following:

i. Volumes of wastewater produced from the well into a tank (Well head flow meter)
ii. Volumes of wastewater transferred into/between each tank manually (pump records, operator logs, level sensor and data platform)

iii. Volumes of wastewater stored into each tank (Level sensors and data platform)
iv. Estimates for evaporation rates from each tank updated weekly (level sensors and data platform)
v. Volumes of wastewater reused (operator logs, level sensors and data platform)
vi. Volumes of water removed from site (whether by vehicle or pipeline). (Waste transfer certificates, level sensors and data platforms)
vii. Volumes of spilled material stored onsite and disposed of offsite (Incident logs, waste transport certificates, level sensor and data platform)

Wastewater tracking will be documented and available upon request.

Off-site wastewater tracking must be in accordance with tracking requirements of listed wastes as per the *Waste Management and Pollution Control Act*, National Environment Protection Measures (NEPM) and (where relevant) the *Radiation Protection Act.*

Wastewater tracking documentation must be reported to the Minister at least annually in the annual environment performance report for the relevant EMP.

The following measurement criteria have been developed to demonstrate the risks associated with wastewater storage are reduced as low as reasonably practicable:

- Zero wastewater tank overtopping events
- No off-site releases of wastewater
- No reportable spills of wastewater

11. Reporting

11.1 Human health risk assessment

A report regarding flowback and produced water must be given to the Minister for Environment within 6 months of the flowback commencing, in accordance with Regulation 37A and 37B of the Regulations. Reporting must include a full human health risk assessment relating to any chemical found in flowback fluid and produced water (refer Reg 37A(2A) and Regulation 37B(2A), respectively).

11.2 Incident reporting

The reporting of incidents shall comply with the Petroleum (Environment) Regulations 2016 (the Regulations) and the *Waste Management and Pollution Control Act 1998.*

11.2.1 Reportable environmental incident reporting

The Regulations 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 *Petroleum Act 1984*.

An interest holder must notify DEPWS 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. The preferred method of notifying DEPWS is email: [4]

1. Email: Onshoregas.depws@nt.gov.au
2. Phone: 2. Phone: 1800 064 567 NT Environment Protection Authority (NT EPA) Pollution Hotline (caller to state it is a petroleum matter)

Any verbal report to DEPWS must be followed up by a written report from the Project Manager within three days in accordance with the Regulations.

11.2.2 Recordable incidents

The 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 DEPWS 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). The preferred method of notifying DEPWS is email: Onshoregas.depws@nt.gov.au.

11.3 Waste Management and Pollution Control Act 1998 incident reporting

In accordance with the Waste Management Pollution Control Act, where contaminants or waste is not confined within the land on which the petroleum activities are undertaken (i.e. the approved disturbance areas where the petroleum activity is occurring), Tamboran will notify the regulator of incidents causing or threatening to cause pollution as soon as practicable, but no later 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
f) the identity of the person notifying.

[4] Effective 20 September 2023, the preferred method of DEPWS notification is email. However for reportable incident notifications the mobile number for the Director Petroleum Operations is also provided, if required.

The notification shall be made to the NT EPA Pollution Hotline 1800 064 567 (caller to state it is a petroleum matter) and the DEPWS email: Onshoregas.depws@nt.gov.au.

12. Emergency response

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

Spills must be reported to the Minister in accordance with the requirements of Spill Management Plan, and reportable and recordable incidents of the Regulations.

13. Acronyms and Abbreviations

Acronym / abbreviation	Meaning
kPag	kilopascal gauge
m	metre(s)
Mm	millimetre(s)
ML	megalitre(s)
µg	micrograms
µs/cm	micro Siemens per centimetre
pH	a measure of how acidic/basic (alkaline) water is
ANZECC	Australian and New Zealand Environment and Conservation Council
APGA	Australian Pipelines and Gas Association Ltd
ARI	Average Recurrence Interval
BTEX	benzene, toluene, ethylbenzene and xylene
COC	chain of custody
DEPWS	Department of Environment, Parks and Water Security
EMP	Environment management plan(s)
EP	Exploration Permit
KCl	potassium chloride
MWL	Maximum Water Level
NaCl	sodium chloride
NATA	National Association of Testing Authorities
NT	Northern Territory
NT EPA	Northern Territory Environment Protection Agency
NEPM	National Environment Protection Measures
NORM	Naturally Occurring Radiation Material

Acronym / abbreviation	Meaning
NT EPA	Northern Territory Environment Protection Authority
PAH	polycyclic aromatic hydrocarbons
QA/QC	Quality assurance and quality control
QLD	Queensland
SILO	Scientific Information for Land Owners
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
WWMP	Wastewater Management Plan

Appendix A 1:1000 ARI Calculation

Monthly rainfall totals were analysed from the Scientific Information for Land Owners (SILO) data for to interpolate rainfall data from 1900 to the present day. Consistent with industry accepted methodology associated with practices (such as dam risk assessments which calculate the wet season based on your geographical location) a 3-month period was determined applicable.

The highest 3-month rainfall period during the wet and dry seasons was predicted for every year from 1900 till 2018. These values were then used to fit a Log Pearson III distribution to the data to allow us to extrapolate to the 1000-year, 3-month duration wet season (Figure 1) and 3-month dry season (Figure 2). This method is consistent with the *Australian Rainfall & Runoff* methodologies. The median 1 in 1000-year 3-month wet season is 1,289 mm and 3-month dry season is 300 mm. These figure does not include any evaporation and are therefore considered extremely conservative.

Based on the assessment, a 1,300 mm wet season and 300 mm dry season freeboard will be applied to all open sumps and tanks.

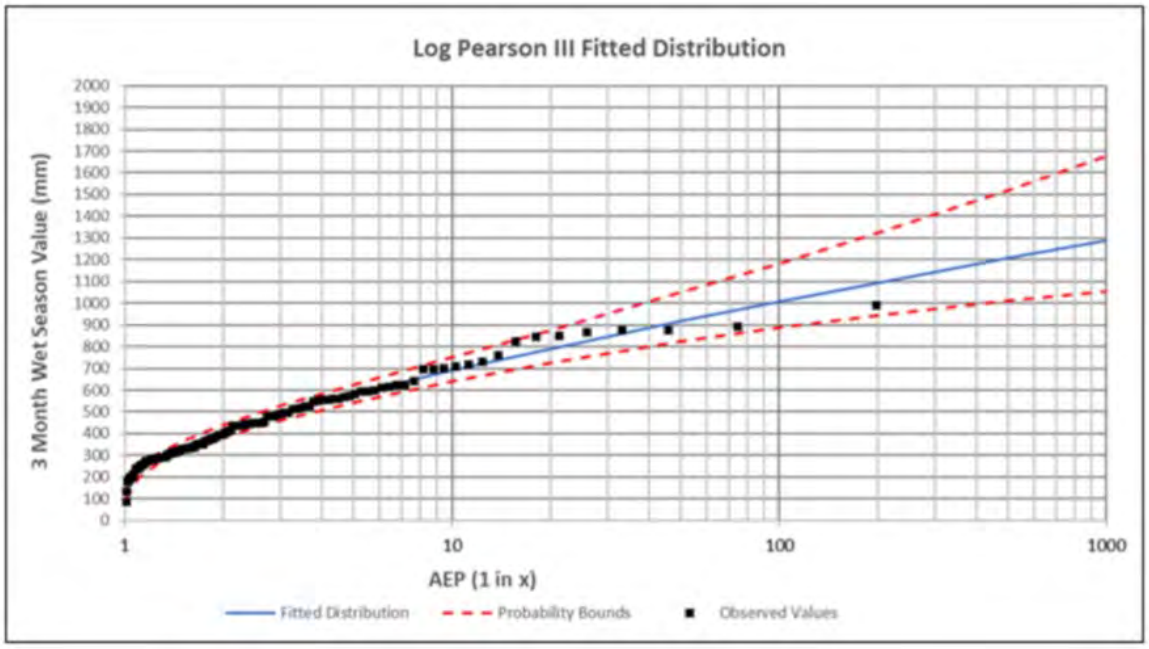

Figure 1: Log Pearson determination of 1:1000 wet season ARI

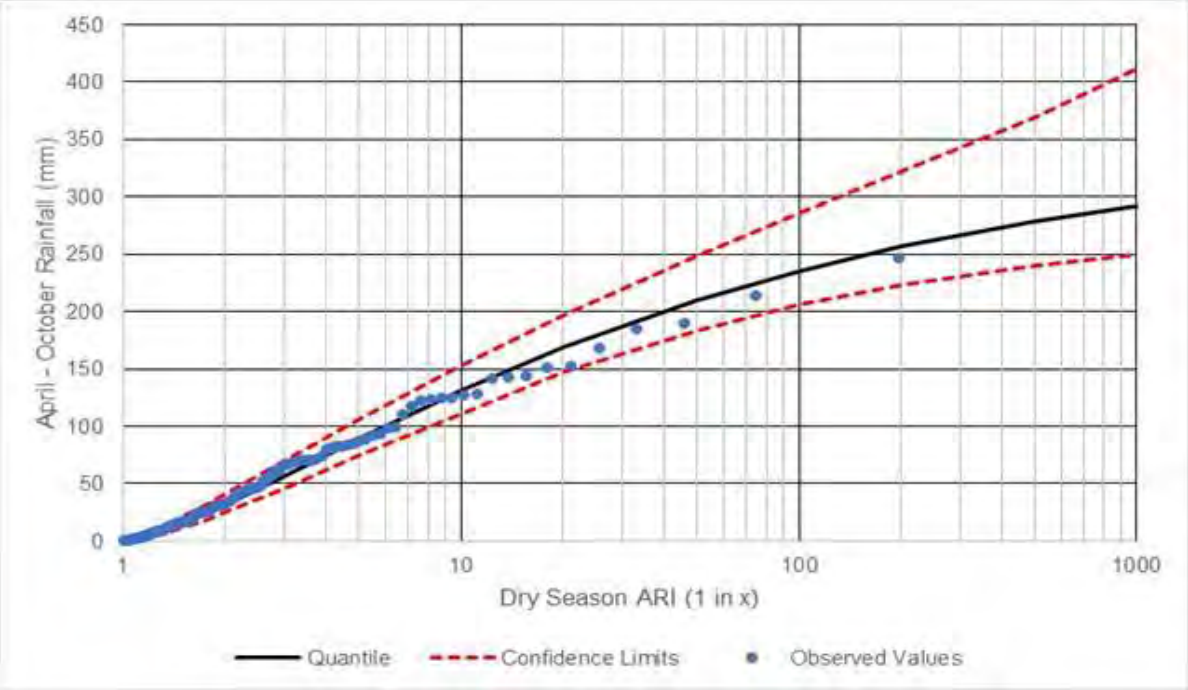

Figure 2: Log Pearson determination of 1:1000 dry season ARI

Appendix B Flowback characteristic summary

Anticipated flowback quality of the Velkerri formation based on Amungee NW-1H flowback results

Parameter	Flow back levels
BTEX compounds	BTEX levels are anticipated to be low ranging between 2 and 15 µg/L.
Total nitrogen (as N)	Maximum value of 62.1 mg/L observed within flowback.
Salinity (TDS)	Saline with total dissolved solids level exceeding 49,000 mg/L.
pH	Slightly acidic with a median value of 6.74.
Major ions	Predominantly Na and Cl dominated. Bicarbonate present at levels consistent with stimulation fluid.
Dissolved metals	Barium and boron are the main metal elements anticipated to be present at elevated levels. Maximum levels of 80.1 mg/L for barium and 54.5 mg/L for boron were recorded during the Amungee NW 1H flowback. Lower level of other metals such ash Arsenic and Manganese were observed, with maximum concentration of 0.084 mg/L and 3.09 mg/L, respectively.
Polycyclic aromatic hydrocarbons	Expected to be below detection level.
Petroleum hydrocarbons	All fractions of TPH are anticipated to be elevated.
Phenolic compounds	Low level of phenolic compounds expected, with only Phenol (max 4 µg/L) and 3-&4- methylphenol (max 11.3 µg/L).
Radionuclides	Maximum Gross Alpha Activity and Gross Beta Activity of 12.4 Bq/L and 18.3 Bq/L were recorded in the flowback of offset wells. The primary component being radium-226.

Flowback quality based on Kyalla 117 N2-1 flowback results

Parameter	Flow back levels
BTEX compounds	Total BTEX levels in the flowback ranged between 63 and 190 µg/L.
Total nitrogen (as N)	Maximum value of 180mg/L observed within flowback.
Salinity (TDS)	Saline with total dissolved solids level from 120,000–290,000 mg/L.
pH	Slightly acidic with a median value of 6.54.
Major ions	Flowback predominantly Na and Cl dominated, with elevated levels of calcium and magnesium.
Dissolved metals	All detected dissolved metal concentrations within the flowback were low, except for barium (1029 mg/L), gallium (290 mg/L) and strontium (279 mg/L).
Polycyclic aromatic hydrocarbons	All values in the flowback below laboratory Limit of Reporting (LOR).
Petroleum hydrocarbons	All fractions of TPH are anticipated to be elevated, with Total Petroleum Hydrocarbon levels likely to range from 25 mg/L–150 mg/L.

Parameter	Flow back levels
Phenolic compounds	Low levels of phenolic compounds detected in flowback with phenol and phenol compounds <3 µg/L.
Radionuclides	Maximum Gross Alpha Activity and Gross Beta Activity of 36.2 Bq/L and 97Bq/L encountered in the flowback, the anticipated source is likely to be radium-226.

Appendix C Wastewater monitoring analyte list

Parameter	Reporting units	Limit of reporting	Method
Physical Parameters			
Dissolved oxygen	mg/L	0.1	Field
Electrical Conductivity (EC)	µs/cm	1	Field
Total Dissolved Solids (TDS)	mg/L	10	APHA 2540C
Total Suspended Solids (TSS)	mg/L	5	APHA 2540C
pH	pH units	0.01	Field
Sodium Adsorption Ratio	ratio	0.01	APHA 4500 Ca, Mg, Ca, NA
Temperature	°C	0.1	Field
Nutrients			
Nitrate	mg/L	0.01	APHA VC13
Nitrite	% saturation and mg/L	0.01	APHA 4500 NO2
Total Nitrogen	mg/L	0.1	APHA 4500 NORG
Total Kjeldahl Nitrogen	mg/L	0.1	APHA NORG/TKN
Ammonia	mg/L	0.01	APHA NH4
Reactive Phosphorous	mg/L	0.01	APHA 4500P
Total Phosphorous	mg/L	0.01	APHA 4500P
Anions			
Sulfate	mg/L	1	APHA 4500-SO4-C
Chlorine/chloride	mg/L	1	APHA 4500-Cl-C
Carbonate	mg/L	1	APHA 2320 B
Bicarbonate (as $CaCO_3$ equivalent)	mg/L	1	APHA 2310 B
Bicarbonate Alkalinity (as $CaCO_3$ equivalent)	mg/L	1	APHA 2320 B
Hydroxide Alkalinity (as $CaCO_3$ equivalent)	mg/L	1	APHA 2320 B
Total Alkalinity (as $CaCO_3$ equivalent)	mg/L	1	APHA 2320 B
Nitrite (NO_2 -)	mg/L	0.01	
Nitrate (NO_3-)	mg/L	0.01	
Fluoride	mg/L	0.1	APHA 4500 F-C
Bromide	mg/L	0.01	APHA 4110B
Total Cyanide	Mg/L	0.004	AWWA/APHA Method 4500
Major Cations			
Sodium	mg/L	1	APHA 4500 Na
Magnesium	mg/L	1	APHA 4500 Mg
Potassium	mg/L	1	APHA 4500 K

Parameter	Reporting units	Limit of reporting	Method
Calcium	mg/L	1	APHA 4500 Ca
Metals and Metalloids (total and dissolved)			
Aluminium	mg/L	0.01	USEPA 6010 ICP/AES
Antimony	mg/L	0.001	USEPA 6010 ICP/AES
Arsenic	mg/L	0.001	USEPA 6010 ICP/AES
Barium	mg/L	0.001	USEPA 6010 ICP/AES
Beryllium	mg/L	0.001	USEPA 6010 ICP/AES
Boron	mg/L	0.001	USEPA 6010 ICP/AES
Bromide	mg/L	0.01	USEPA 6010 ICP/AES
Cadmium	mg/L	0.0001	USEPA 6010 ICP/AES
Chromium	mg/L	0.001	USEPA 6010 ICP/AES
Cobalt	mg/L	0.001	
Copper	mg/L	0.001	USEPA 6010 ICP/AES
Iron	mg/L	0.05	USEPA 6010 ICP/AES
Lead	mg/L	0.001	USEPA 6010 ICP/AES
Manganese	mg/L	0.001	USEPA 6010 ICP/AES
Mercury	mg/L	0.0001	USEPA 6010 ICP/AES
Molybdenum	mg/L	0.001	USEPA 6010 ICP/AES
Nickel	mg/L	0.001	USEPA 6010 ICP/AES
Selenium	mg/L	0.001	USEPA 6010 ICP/AES
Silica	mg/L	0.1	USEPA 6010 ICP/AES
Silver	mg/L	0.001	USEPA 6010 ICP/AES
Strontium	mg/L	0.001	USEPA 6010 ICP/AES
Thorium	mg/L	0.001	USEPA 6010 ICP/AES
Tin	mg/L	0.001	USEPA 6010 ICP/AES
Uranium	mg/L	0.001	USEPA 6010 ICP/AES
Vanadium	mg/L	0.05	USEPA 6010 ICP/AES
Zinc	mg/L	0.001	USEPA 6010 ICP/AES
Naturally Occurring Radioactive Material (NORM)			
alpha radiation	Bq/L	0.05 – 0.1	ASTM D7283-06
beta radiation	Bq/L	0.05 – 0.1	ASTM D7283-06
Gamma	Bq/L	0.05 – 0.1	ASTM D7283-06
BTEX			
Benzene	µg/L	1	USEPA 5030/8260 HS or P&T/GC/MS
Toluene	µg/L	2	USEPA 5030/8260 HS or P&T/GC/MS
Ethylbenzene	µg/L	2	USEPA 5030/8260 HS or P&T/GC/MS
M and P Xylene	µg/L	2	USEPA 5030/8260 HS or P&T/GC/MS
O Xylene	µg/L	2	USEPA 5030/8260 HS or P&T/GC/MS

Parameter	Reporting units	Limit of reporting	Method
Total Xylene	µg/L	2	USEPA 5030/8260 HS or P&T/GC/MS
Hydrocarbons			
TRH C6 - C10	µg/L	20	USEPA 5030/8260 HS or P&T/GC/MS
TRH C6 - C10 less BTEX	µg/L	20	USEPA 5030/8260 HS or P&T/GC/MS
TRH >C10 - C16	µg/L	100	USEPA 5030/8260 HS or P&T/GC/MS
TRH >C10 - C16 less Naphthalene	µg/L	100	USEPA 5030/8260 HS or P&T/GC/MS
TRH >C16 - C34	µg/L	100	USEPA 5030/8260 HS or P&T/GC/MS
TRH >C34 - C40	µg/L	100	USEPA 5030/8260 HS or P&T/GC/MS
Total TRH C6 - C40	µg/L	100	USEPA 5030/8260 HS or P&T/GC/MS
Polycyclic Aromatic Hydrocarbons			
3-Methylcholanthrene	µg/L	1	USEPA 3510/8270 GC/MS
7, 12- Dimethylbenz(a)anthracene	µg/L	1	USEPA 3510/8270 GC/MS
Acenaphthene	µg/L	1	USEPA 3510/8270 GC/MS
Acenaphthylene	µg/L	1	USEPA 3510/8270 GC/MS
Anthracene	µg/L	1	USEPA 3510/8270 GC/MS
Benzo (a) pyrene	µg/L	0.5	USEPA 3510/8270 GC/MS
Benzo (b) fluoranthene	µg/L	1	USEPA 3510/8270 GC/MS
Benzo (ghi) perylene	µg/L	1	USEPA 3510/8270 GC/MS
Benzo (k) fluoranthene	µg/L	1	USEPA 3510/8270 GC/MS
Benzo (a) anthracene	µg/L	1	USEPA 3510/8270 GC/MS
Chrysene	µg/L	1	USEPA 3510/8270 GC/MS
Dibenz (ah) anthracene	µg/L	1	USEPA 3510/8270 GC/MS
Fluoranthene	µg/L	1	USEPA 3510/8270 GC/MS
Fluorene	µg/L	1	USEPA 3510/8270 GC/MS
Indeno (1,2,3-cd) pyrene	µg/L	1	USEPA 3510/8270 GC/MS
Napthalene	µg/L	1	USEPA 3510/8270 GC/MS
Phenanthrene	µg/L	1	USEPA 3510/8270 GC/MS
Pyrene	µg/L	1	USEPA 3510/8270 GC/MS
Carcinogenic PAHs (benzo[a}pyrene equivalents	µg/L	0.5	USEPA 3510/8270 GC/MS
Total PAH	µg/L	0.5	USEPA 3510/8270 GC/MS
Volatile Organic Compounds			
2,3,4,6-Tetrachlorophenol	µg/L	1	USEPA 3510/8270 GC/MS
2,4,5-Trichlorophenol	µg/L	1	USEPA 3510/8270 GC/MS
2,4,6-Trichlorophenol	µg/L	1	USEPA 3510/8270 GC/MS
2,4-Dichlorophenol	µg/L	1	USEPA 3510/8270 GC/MS
2,4-Dimethylphenol	µg/L	1	USEPA 3510/8270 GC/MS
2,4-Dinitrophenol	µg/L	1	USEPA 3510/8270 GC/MS
2,6-Dichlorophenol	µg/L	1	USEPA 3510/8270 GC/MS

Parameter	Reporting units	Limit of reporting	Method
2-Chlorophenol	µg/L	1	USEPA 3510/8270 GC/MS
2-Methyl-4,6-dinitrophenol	µg/L	1	USEPA 3510/8270 GC/MS
2-Nitrophenol	µg/L	1	USEPA 3510/8270 GC/MS
4-Chloro-3-methylphenol	µg/L	1	USEPA 3510/8270 GC/MS
4-Nitrophenol	µg/L	1	USEPA 3510/8270 GC/MS
Dinoseb	µg/L	1	USEPA 3510/8270 GC/MS
Formaldehyde	mg/L	1	USEPA 3510/8270 GC/MS
Hexachlorophene	µg/L	1	USEPA 3510/8270 GC/MS
m- and p-Cresol	µg/L	1	USEPA 3510/8270 GC/MS
Pentachlorophenol	µg/L	1	USEPA 3510/8270 GC/MS
Phenol	µg/L	1	USEPA 3510/8270 GC/MS
Organic Carbon			
Dissolved Organic Carbon	mg/L	1	APHA 5310 B
Total Organic Carbon	mg/L	1	APHA 5310 B

APPENDIX H Erosion and Sediment Control Plan

BEETALOO BASIN EXPLORATION PROJECT

Erosion and Sediment Control Plan

EP 76, EP 98 and EP 117

This document outlines the basic principles for contractors to develop site specific erosion and sediment control plans for Beetaloo Basin Exploration Program.

REV	DATE	REASON FOR ISSUE	AUTHOR	APPROVER
0	29/03/2019	Issued for use	A.Court	M.Hanson
1	28/06/2019	Revised based on comments received by DEPWS	A.Court/J.Jentz	M.Hanson
2	16/07/2019	Updated Primary ESCP	A.Court/J.Jentz	M.Hanson
3	19/11/2021	Update overarching ESCP	P.Szamosi/J.Jentz	M.Kernke
4	23/02/2022	Update overarching ESCP	P.Szamosi/J.Jentz	M.Kernke
5	08/07/2022	Update for Amungee delineation area	A.Court	M.Kernke
6	13/09/2022	Update overarching ESCP	J.Jentz	L. Pugh
7	23/06/2023	Revised to include update Amungee NW3, Shenandoah North and South	A Court	L Pugh
8	20/10/2023	Revised to include updated for all sites	A Court	L Pugh
9	27/03/2024	Updated on Reg 10/11 Comments	A Court	L Pugh
10	23/04/2024	Updated on Reg 10/11 Comments	L Pugh	M Kernke

CPESC Review

Date	CPESC Name / Position	Signature
19/07/2023	Tim Anderson MAgrSc, BAgrSc (Hons), CPESC (#2723), CEnvP (#002).	

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Appendix N Other IECA standard specifications (as required)

Appendix O Table 4.4.7 IECA best practice land clearing and rehabilitation requirements

Appendix P Erosion and sediment control treatment – seismic lines

1 Introduction

This Erosion and Sediment Control Plan (ESCP) has been developed to ensure best practice erosion and sediment controls are implemented during Tamboran's[1] exploration activities within EP 76, EP 98 and EP 117, to avoid or minimise and control erosion and offsite impacts, such as sedimentation of waterways.

This ESCP has been developed to provide direction for Tamboran and contractors to implement erosion and sediment control (ESC) during construction of the well pads and associated infrastructure, worker camps and access tracks, seismic lines as well as during ongoing maintenance and monitoring once sites are established.

The design of the exploration well pads, seismic lines and access tracks will comply with Northern Territory (NT) and local government statutory laws and regulations and are to be designed to meet all relevant and applicable codes and standards. This ESCP has been developed in accordance with the following guidelines:

- Code of Practice for Petroleum Activities in the Northern Territory (DEPWS & DITT, 2019)
- Best Practice Erosion and Sediment Control (IECA, 2008)
- Land Clearing Guidelines (DEPWS, 2021)
- Erosion and Sediment Control Guidelines for Rural Development Environment Fact Sheet (DLRM, 2018).

The location of the proposed exploration activities are shown on Figure 1.

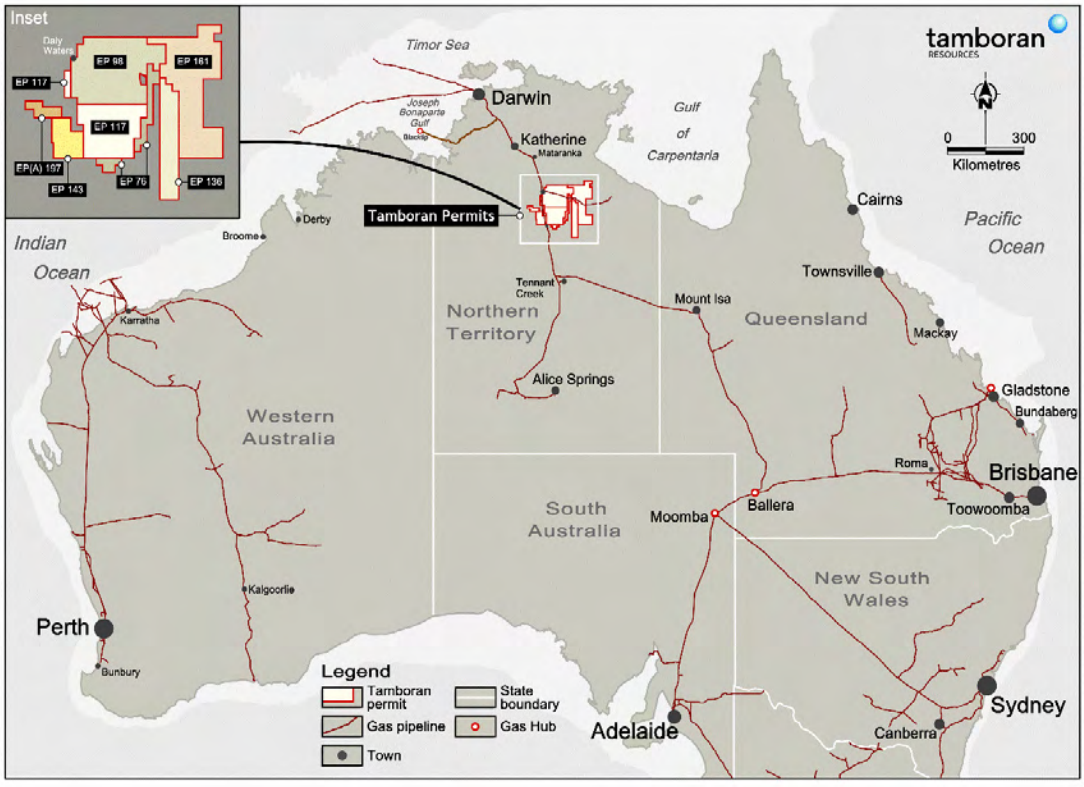


Figure 1: Location of Tamboran exploration permit areas (EPs)

[1] Including its subsidiaries.

2 Project Context

This plan covers all civil, seismic acquisition, well drilling, stimulating, rehabilitation and routine maintenance/monitoring activities undertaken by Tamboran, its subsidiaries and their contractors within permit EP76, EP98 and EP117 as detailed in Table 1 and shown in Figure 2 – Figure 4.

Table 1: Coordinates of centroid 2D seismic and exploration well sites

2D seismic line reference	Seismic line coordinates (Zone 52)			
	Start of line		End of line	
	Lat	Long	Lat	Long
Amungee delineation area seismic lines (EP 98)				
001-SR	-16.32434	133.82875	-16.39386	133.89996
002-SR	-16.32112	133.85894	-16.35325	133.89186
003-SR	-16.34104	133.87802	-16.39438	133.93218
004-SR	-16.36162	133.93763	-16.41430	133.99165
005-SR	-16.34667	133.95114	-16.39806	134.00384
006-SR	-16.37223	133.86042	-16.37795	134.00306
2D seismic line reference	**Seismic line coordinates**			
	Start of line		**End of line**	
	Lat	**Long**	**Lat**	**Long**
007-SR	-16.34267	133.88364	-16.34584	133.88032
008-SR	-16.34459	133.88562	-16.34777	133.88229
009-SR	-16.34652	133.88759	-16.34970	133.88427
010-SR	-16.34845	133.88957	-16.35163	133.88624
Shenandoah South E&A Seismic Lines (EP 117 and EP 98)				
Shenandoah South Line A	-16.83863	133.47175	-16.92103	133.55480
Shenandoah South Line B	-16.83284	133.48508	-16.91394	133.56735
Shenandoah South Line C	-16.81729	133.50872	-16.89536	133.58758
Shenandoah South E&A Gathering Lines (EP 117 and EP 98)				
Shenandoah South B to Shenandoah South C (~4.11 km)				
Start – Shenandoah South B pad	345035	8135461	-	
Intersection to existing track	345046	8134499		
Intersection to Shenandoah South C	343442	8134573		
End – Shenandoah South C pad	-		343471	8133331

Kyalla 117 N2 to Shenandoah South 2 (~4.5 km)				
Start – Kyalla 117 N2 pad	356274	8137505	-	
Intersection to existing track	356189	8137509		
Intersection to Shenandoah South 2	356205	8140071		
End – Shenandoah South 2 pad	-		355060	8141514

Well site, access track and gravel pit reference	**Well pads**		
	Zone	**Easting**	**Northing**
Velkerri 98 E1	53	415515	8180683
Amungee NW	53	415515	8180683
Amungee NW-2	53	381039	8192324
Amungee NW-3	53	375512	8195308
Amungee NW-4	53	376611	8193100
Amungee NW-5	53	390313.6	8187337
Kyalla 98 W1	53	364955	8177458
Kalala S1	53	351740	8198030
Velkerri 76 S1	53	424362	8113273
Velkerri 76 N1	53	440940	8107032
Velkerri 76 S2	53	435488	8136321
Kyalla 117 N2	53	356175	8137500
Velkerri 117 E1	53	428861	8120782
Beetaloo W (Kyalla 117 W1)	53	368312	8106695
Shenandoah S 2	53	355291	8140676
Shenandoah S B	53	345035	8135464
Shenandoah S C	53	343471	8133330
Shenandoah N A	53	356687	8163762

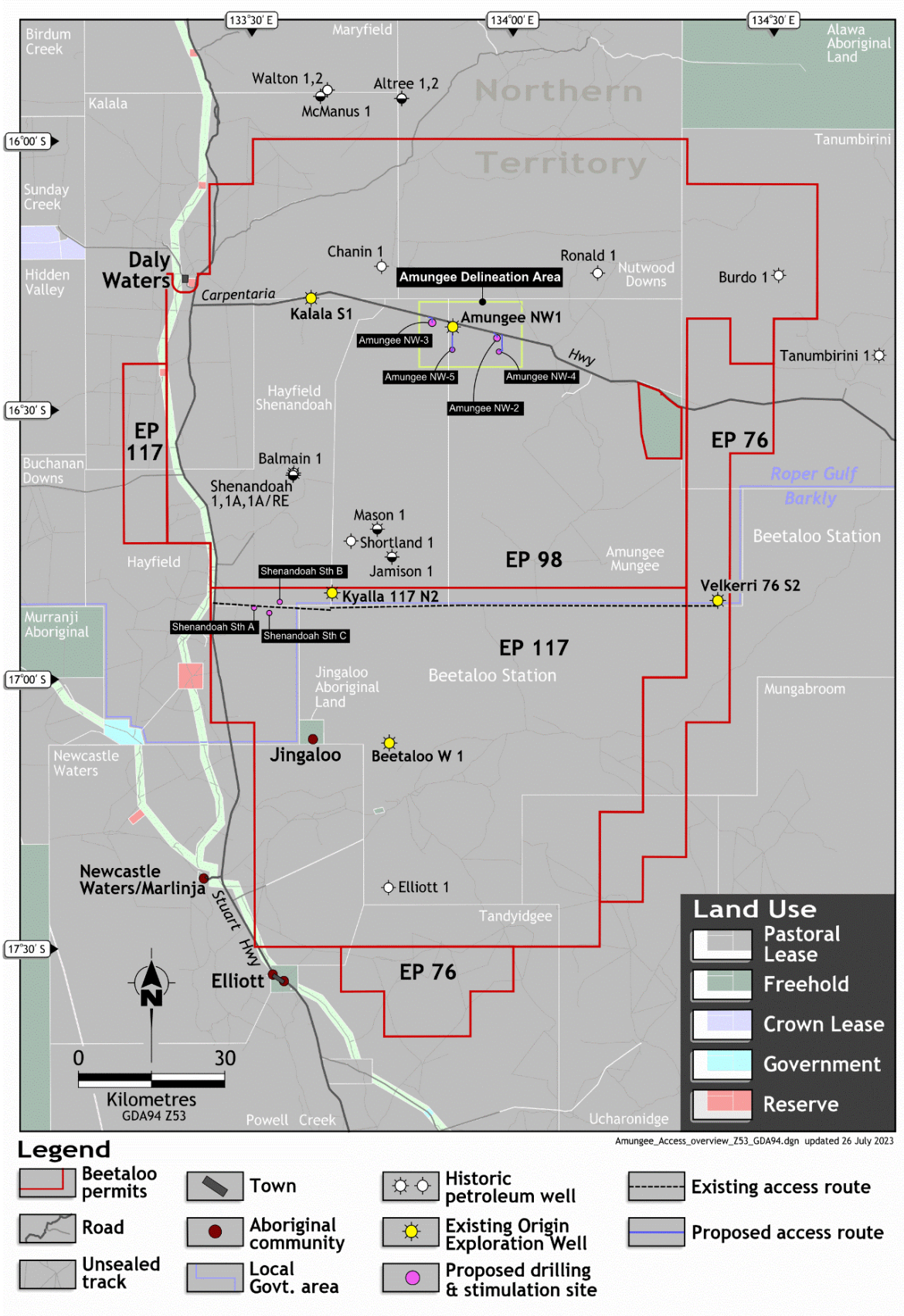


Figure 2: Location of Tamboran's exploration well sites and existing infrastructure

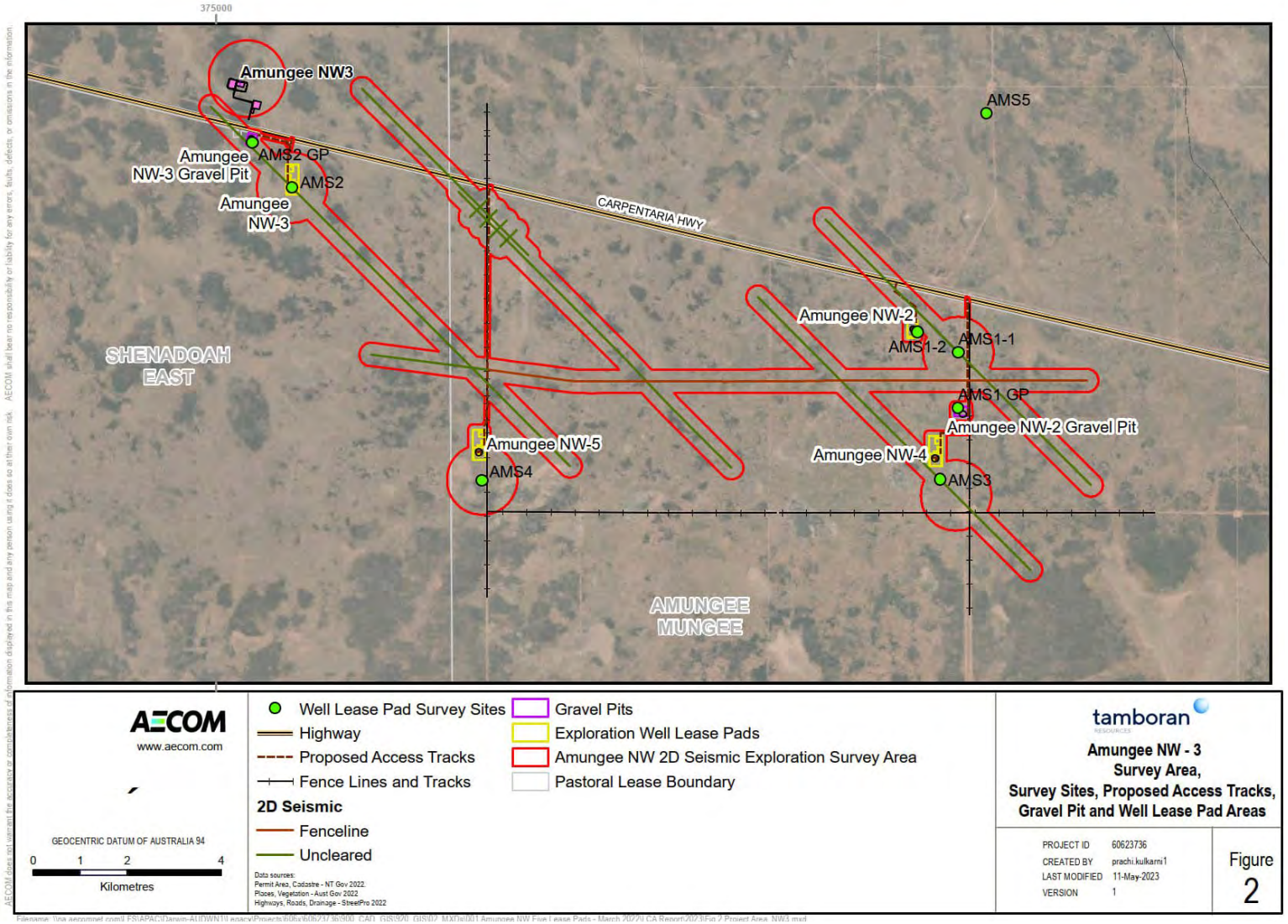


Figure 3: Location of Amungee seismic survey areas

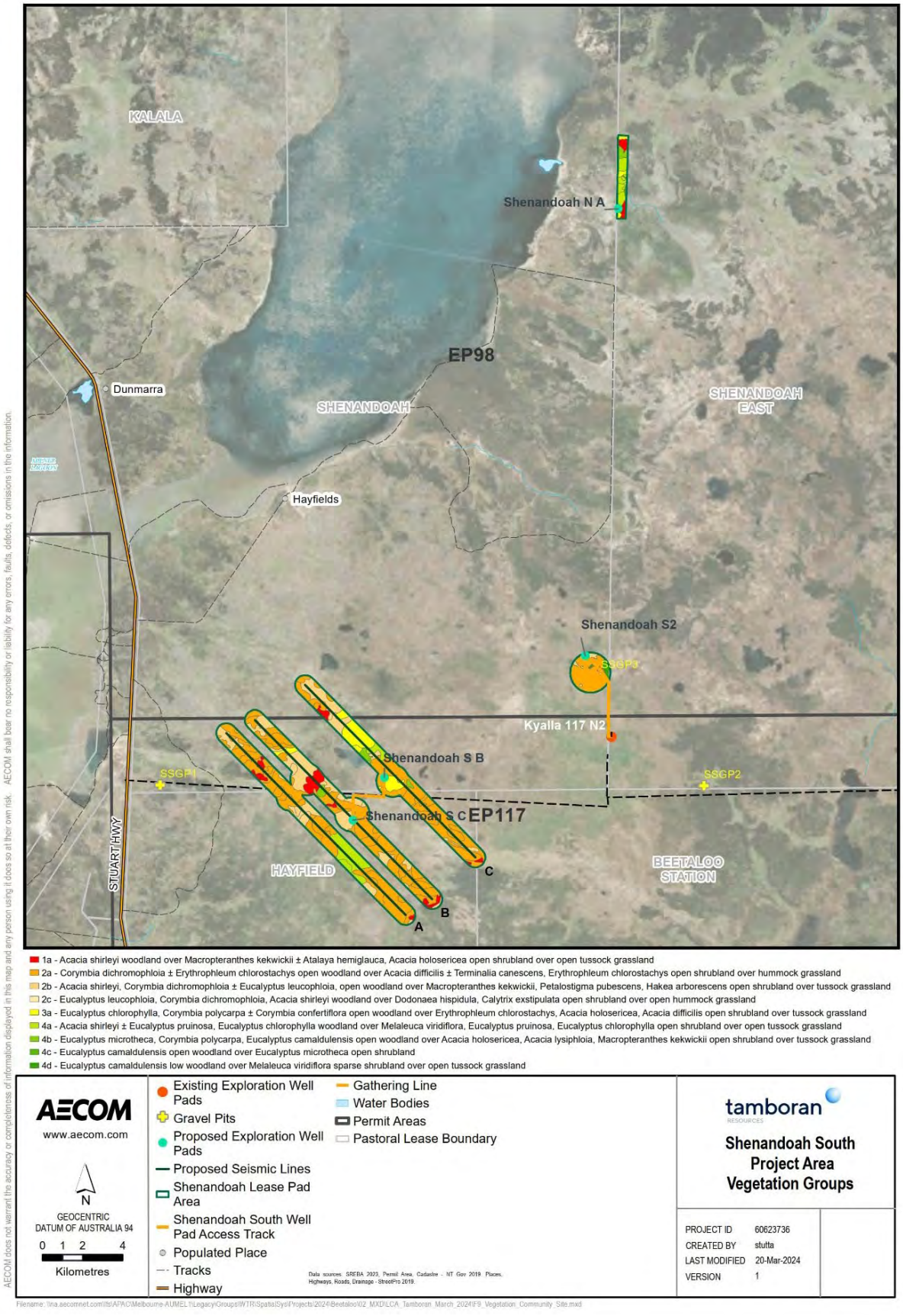


Figure 4: Location of Shenandoah South E&A (includes vegetation communities)

The primary activities subject to this ESCP are:

- Construction and or ongoing maintenance of exploration well pads, camp pads, stockpile areas, helipad and wet weather storage area.
- Minor intersection upgrade works at the intersection with the Stuart Highway and Carpentaria Highway in accordance with Road Agency approval and Permit to Work within NT Government road reserves.
- Seismic line preparation, data collection and rehabilitation.
- Installation of gathering lines between well pads
- Construction and ongoing maintenance of access tracks.
- Gravel extraction, as required, for construction and maintenance of drill pads and sections of the access tracks.
- All other activities ancillary to the seismic survey and drilling, stimulation and well testing of an exploration well.

2.1 Legislation

The activities outlined within the EMP, which this management sub-plan is a component of, aim to comply with relevant guidelines associated with exploration activities, such as International Erosion Control Association (IECA) *Best Practice for Erosion and Sediment Control* (2008), IECA *Appendix P: Land Based Pipeline Construction December 2015* (Addendum to IECA 2008), the *Australian Pipeline Industry Association Code of Environmental Practice for Onshore Pipelines 2017* and the *Code of Practice for Onshore Petroleum Activities in the Northern Territory 2019* (the Code).

2.1.1 Code of Practice for Onshore Petroleum Activities in the Northern Territory 2019

The Code is a 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.

Under these regulations, Tamboran is required to submit an EMP prior to any petroleum exploration or production activity. The EMP for a petroleum activity must include a primary ESCP outlining all activities. This should be developed by a suitably qualified person in accordance with relevant guidelines including specific environmental outcomes and environmental performance standards to be included in the implementation strategy in the EMP. The ESCP must include:

- A risk assessment in relation to the potential impact to the environment from erosion and sedimentation associated with the proposed activities. Including an assessment of site-specific conditions and the nature and timing of works with the NT Land Clearing Guidelines (DEPWS, 2021) website and any amendments.
- Where the Primary ESCP requires it, a further ESCP must be developed by a suitably qualified person in relation to the relevant matters identified in the Primary ESCP and implemented by the interest holder.
- Road and pipeline designs must:
    - minimise erosion of exposed road surfaces and drains
    - ensure that roads and pipeline surface water flow paths minimise erosion of all exposed surfaces and drains

- comply with legislative requirements.

- The requirements of the Land Clearing Guidelines as published on the DEPWS website and amended from time to time must be complied with in relation to protection of natural waterways as a result of land disturbance and ensure the following:
  - appropriate buffers are implemented around natural waterways
  - disturbance in the wet season is minimised
  - the number of crossing points is minimised
  - crossings are established as close as practicable to right angles to the waterway
  - material changes in the shape of the waterway are avoided
  - material changes in the volume, speed or direction of flow or likely flow of water in the waterway are avoided
  - alteration to the stability of the bed or banks of the waterway (including by removal of vegetation) is avoided
  - erosion risk, sedimentation and pollution of waterways is minimised through the appropriate design and implementation of best practice erosion and sediment control measures.

3 Aims and Objectives

The ESCP aims to:

- Address key soil and water management issues, including legislative and client requirements.
- Determine the "Type" of ESC to be implemented during construction, post construction and until exploration activities are completed.
- Where practical identify, eliminate and reduce hazards and associated risks inherent in specific work activities, which if untreated could lead to a diminished product or create the potential for an accident, dangerous occurrence or environmental incident.

The objective of this ESCP is to manage Tamboran's activities within the EP in a manner that minimises the impacts upon soil, vegetation and surface water which may result from soil disturbance activities including seismic line preparation, land clearing associated with well pad establishment.

This ESCP may be amended as required, in response to the monitoring and maintenance programs described herein to avoid significant and/or sustained deterioration in downstream water quality. Standard drawings are provided as a guide, with the construction supervisor and Tamboran engineers making final determination on site.

Strategies shall be developed, implemented and reviewed on a regular basis, so that risks are identified, measured and recorded throughout the course of the project.

Due to potential chance for activities to lead up to the wet season, wet weather contingencies have been identified in this plan and the overarching EMP (BOM, 2012). It is anticipated that due to the known ground conditions across the region, ground conditions following rainfall events can make access impossible. The primary mitigation will be to monitor weather forecasts daily during the program and where rainfall is likely to result in an event that has potential to limit access, the subcontractor will stabilise the current work areas and go into standby mode until such time can assess the track conditions to recommence activities.

Further strategies will be developed, implemented and reviewed on a regular basis so that risks are identified, measured and recorded throughout the course of exploration activities. Any significant changes to the ESCP will be subject to review and approval by the Department of Environment, Parks and Water Security (DEPWS) Land Management Team.

3.1 Compliance with IECA Guideline

The ESCP has been prepared by suitably qualified and experienced personnel that understand the intent and minimum standards of IECA. The team that prepared the plan consist of the following:

- Alana Court – BEnvSci, PGDipEnvMgt. Principal Environmental Scientist with over 18 years' experience and completed the IECA erosion and sediment control training (2013). Over 20 years' experience providing advice to managing environmental requirements in the Beetaloo Basin including erosion and sediment control.
- James Jentz – BEng, RPEQ, CPEng. Civil Engineer with over 30 years' experience in the design and documentation of civil engineering projects. James has signed off all civil drawings under his qualification.

4 Civil Construction Schedule

The exploration schedule for Tamboran's activities will primarily occur from May each year extending into September while rainfall risk rating is considered very low (0 to 30 mm).

Implementation of the ESCP will commence as soon as access is granted and continue throughout the exploration activities until such time that the site is stabilised.

If exploration activities continue through to the wet season, Tamboran will implement the wet weather contingency planning. Planning will occur during August – September and will be implemented between 1 October to 30 April, based on the rainfall erosion risk rating identified in Section 5.1.

Wet weather contingency planning includes the following actions:

- Tamboran to review program schedule to determine what activities will extend into the wet season.
- Undertake inspections of all assets to ensure appropriate ESC in place and are functional before 1 October each year.
- Conduct maintenance on all ESC established onsite before 1 October each year.
- Complete a stocktake on available ESC equipment on site, and where required purchase new equipment before the 1 October each year.

5 Permit Area Erosion Susceptibility

Erosion susceptibility varies throughout the Tamboran permit area, dependent upon the soil types, slope and extent of ground disturbance. Apart from the erosive impact of climatic conditions, soil erosion is influenced mainly by the inherent properties of the soils and the processes which occurred during the formation of the landscapes.

Erosion will occur in the permit area if the land is used beyond its capacity, as is seen if land is overstocked or vehicle movements not controlled, for example. The locations of the exploration well sites for Tamboran have been examined in the field to determine the risk of erosion occurring from exploration activities.

Factors considered include the following:

- Season (R Factor) – the timing of the project works will occur mostly within the dry season of the NT, which has low amounts of rainfall and is considered a low-risk factor. Risk levels of rainfall data of Daly Waters and Newcastle waters can be seen in Table 2 and Table 3 which present 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 (northern sites) and Newcastle Waters (southern sites).

Table 2: Erosion risk rating based on average monthly rainfall at Daly Waters (Bureau of Meteorology 2023)

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)

Table 3: Erosion risk rating based on average monthly rainfall at Newcastle Waters (Bureau of Meteorology 2023)

Item	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	125.5	130.9	93.7	24.6	9.3	5.3	3.4	1.0	5.4	20.9	35.7	77.3
Erosion Risk*	H	H	M	VL	VL	VL	VL	VL	VL	VL	L	M

* 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)

- Soil type (K Factor) – soils with higher clay content are prone to generation of bulldust and are easily eroded by wind and water. Gravelly soils tend to be more robust to disturbance on the scale expected for Tamboran exploration activities. The primary soil type encountered across the permit can generally be described as silty SAND, SM with some gravel. These soils are considered to have a low to medium erodibility potential when the soils are disturbed.
- Slope length – the slope of the exploration area is one of the characteristics that will help to determine the risk of erosion during rainfall events, with steeply inclined areas a higher risk than small undulations in the landform. The Tamboran exploration areas subject to this ESCP are generally flat with a slope of <1%. There are some slight undulations that occur throughout the area, generally being less than 2% gradient, however some areas are known to be greater 2%. Treatments are defined for sections less than 2% and greater than 2% in this plan. The relevant treatment will be considered on a case-by-case basis.
- Aspect – the position of the seismic lines, access tracks and pads in relation to the direction of the contour should be considered and creation of tracks and the well pads across (as opposed to parallel with) the contour should be avoided.
- Groundcover – clearing will be conducted to construct access tracks, establish gravel pits and earthworks relating to construction of the exploration well pad and associated camps, as well as line preparation for seismic exploration. The method that will be used for seismic line preparation will consist of dozer and grader, ensuring that topsoil and root stock is retained.

  The clearing method used for gravel pits and construction of well pads and camp pads will consist of a dozer to initially clear vegetation and then dozer or grader to strip topsoil, ensuring that

rootstock is retained in the stockpiled topsoil. Expected machinery includes grader, 4W loader, tip truck, water truck, water tanks, excavators and compactors.

- Drainage line crossings – potential for minor drainage lines to occur across the exploration area. Generally these can be trafficable with minimal modification of the creek bed required.

5.1 Erosion Hazard Assessment for EP 76, EP 98 and EP 117

5.1.1 Erosion Hazard Assessment for EP76, EP98 and EP117 – Well Pads, Access Tracks

An Erosion Hazard Assessment for all sites subject to this ESCP has been completed to inform the specific issues and actions that will be required for conducting activities within the permit areas. Table 4 (Amungee, Kalala, Kyalla, Velkerri and Beetaloo) and Table 5 (Shenandoah South 2, South B, South C and North A) present the results of the assessment for exploration well pads. The IECA (2008) Explanatory Notes for the assessment are presented Appendix A.

Table 4: Erosion hazard assessment for EP 76, EP 98 and EP 117 – well pads and access tracks

Condition (as described by IECA, 2008)	Points	Erosion Hazard Score					Trigger value
		Amungee Delineation Area*	Kalala S1	Kyalla 117 N2	Velkerri 76 S2	Beetaloo W	
AVERAGE SLOPE OF DISTURBANCE AREA [1]							
• not more than 3% [3% =33H:1V]	0	0	0	0	0	0	4
• more than 3% but not more than 5% [5% =20H:1V]	1	Comment - Topographical survey of well sites indicated (low relief) with a slope <3% (refer Appendix B)					
• more than 5% but not more than 10% [10% =10H:1V]	2						
• more than 10% but not • more than 15% [15%= 6.7H:1V]	4						
• more than 15%	6						
SOIL CLASSIFICATION GROUP (AS1726) [2]							
• GW, GP, GM, GC	0	2	2	2	2	2	-
• SW, SP, OL, OH	1	Comment – Geotechnical testing indicated SM - Silty sands, poorly graded sand-silt mixtures (refer Appendix C).					
• SM, SC, MH, CH	2						
• ML, CL, or if imported fill is used, or if soils are untested	3						
EMERSON (DISPERSION) CLASS NUMBER [3]							
• Class 4, 6, 7, or 8	0	4	4	4	4	4	6
• Class 5	2	Comment – Class 3 or default- Amungee Delineation Area					
• Class 3, (default value if	4						

Condition (as described by IECA, 2008)	Points	Erosion Hazard Score					Trigger value
		Amungee Delineation Area*	Kalala S1	Kyalla 117 N2	Velkerri 76 S2	Beetaloo W	
soils are untested)		Class 3 or default - soils disturbed by cut and fill operations or construction traffic are likely to discolor stormwater (i.e. cause turbid runoff). Controls to reduce turbidity are required.					
• Class 1 or 2	6						
DURATION OF SOIL DISTURBANCE [4]							
• not more than 1 month	0	2	2	2	2	2	6
• more than 1 month but not more than 4 months	2	Comment – Clearing and earthworks are expected to be between 1 and 4 months.					
• more than 4 months but not more than 6 months	4						
• more than 6 months	6						
AREA OF DISTURBANCE [5]							
• not more than 1000 m^2	0	6	6	6	6	6	6
• more than 1000 m^2 but not more than 5000 m^2	1	Comment – All exploration well sites are greater than 4 ha but less than 12 ha of disturbance.					
• more than 5000 m^2 but not more than 1 ha	2						
• more than 1 ha but not • more than 4 ha	4						
• more than 4 ha	6						
WATERWAY DISTURBANCE [6]							
• No disturbance to a watercourse, open drain or channel	0	0	0	0	0	0	2
• Involves disturbance to a constructed open drain or • channel	1	Comment – Not in close proximity to natural water courses (refer Appendix D).					
• Involves disturbance to a natural watercourse	2						
REHABILITATION METHOD [7] Percentage of area (relative to total disturbance) revegetated by seeding without light mulching (i.e. worst-case revegetation method).							
• not more than 1%	1	1	1	1	1	1	-
• more than 1% but not • more than 5%	2	Comment – topsoil replaced along batters to commence assisted natural regeneration.					
• more than 5% but not more than 10%	3						
• more than 10%	4						

Condition (as described by IECA, 2008)	Points	Erosion Hazard Score					Trigger value
		Amungee Delineation Area*	Kalala S1	Kyalla 117 N2	Velkerri 76 S2	Beetaloo W	
RECEIVING WATERS [8]							
• Saline waters only	0	2	2	2	2	2	-
• Freshwater body (e.g. creek or freshwater lake or river)	2	Comment – not located within the major flow pathway (refer to flood assessment in the Amungee Delineation Area Land Condition Assessment).					
SUBSOIL EXPOSURE [9]							
• No subsoil exposure except of service trenches	0	0	0	0	0	0	-
• Subsoils are likely to be exposed	2						
EXTERNAL CATCHMENTS [10]							
• No external catchment	0	1	1	1	1	1	-
• External catchment diverted around the soil disturbance	1	Comment – refer to civil design drawings (Appendix E to Appendix M)					
• External catchment not diverted around the soil disturbance	2						
ROAD CONSTRUCTION [11]							
• No road construction	0	2	2	2	2	2	-
• Involves road construction works	2						
pH OF SOILS TO BE REVEGETATED [12]							
• more than pH 5.5 but less than pH 8	0	0	0	0	0	0	-
• other pH values, or if soils are untested	1	Comment – Soil pH 5.5 to 8.0					
Total Score [13]		**20**	**16**	**20**	**20**	**20**	
For guidance purposes only: [13] A primary ESCP must be submitted to the local government for approval during the planning phase for any development that obtains a total point score of 17 or greater or when any trigger value is scored or exceeded							

Table 5: Erosion hazard assessment for EP 76, EP 98 and EP 117 – Shenandoah E&A Program

Condition (as described by IECA, 2008)	Points	Erosion Hazard Score					Trigger value
		Shenandoah South E&A Program					
		South B	South C	South 2	North A		
AVERAGE SLOPE OF DISTURBANCE AREA [1]							
• not more than 3% [3% =33H:1V]	0	0	0	0	0		4
• more than 3% but not more than 5% [5% =20H:1V]	1	Comment - Topographical survey of well sites indicated (low relief) with a slope <2% (refer Appendix B)					
• more than 5% but not more than 10% [10% =10H:1V]	2						
• more than 10% but not more than 15% [15%= 6.7H:1V]	4						
• more than 15%	6						
SOIL CLASSIFICATION GROUP (AS1726) [2]							
• GW, GP, GM, GC	0	2	2	2	2		-
• SW, SP, OL, OH	1	Comment – Geotechnical testing indicated SM - Silty sands, poorly graded sand-silt mixtures (refer Appendix C).					
• SM, SC, MH, CH	2						
• ML, CL, or if imported fill is used, or if soils are untested	3						
EMERSON (DISPERSION) CLASS NUMBER [3]							
• Class 4, 6, 7, or 8	0	6	6	4	6		6
• Class 5	2	Comment – Class 3 or default- Class 3 or default - soils disturbed by cut and fill operations or construction traffic are likely to discolour stormwater (i.e. cause turbid runoff). Controls to reduce turbidity are required.					
• Class 3, (default value if soils are untested)	4						
• Class 1 or 2	6						
DURATION OF SOIL DISTURBANCE [4]							
• not more than 1 month	0	2	2	2	2		6
• more than 1 month but not more than 4 months	2	Comment – Clearing and earthworks are expected to be between 1 and 4 months.					
• more than 4 months but not more than 6 months	4						
• more than 6 months	6						

Condition (as described by IECA, 2008)	Points	Erosion Hazard Score					Trigger value
		Shenandoah South E&A Program					
		South B	South C	South 2	North A		
AREA OF DISTURBANCE [5]							
• not more than 1000 m2	0	6	6	6	6		6
• more than 1000 m2 but not more than 5000 m2	1	Comment – All exploration well sites are greater than 4 ha but less than 12 ha of disturbance.					
• more than 5000 m2 but not more than 1 ha	2						
• more than 1 ha but not • more than 4 ha	4						
• more than 4 ha	6						
WATERWAY DISTURBANCE [6]							
• No disturbance to a watercourse, open drain or channel	0	0	0	0	0		2
• Involves disturbance to a constructed open drain or • channel	1	Comment – Not in close proximity to natural water courses (refer Appendix D).					
• Involves disturbance to a natural watercourse	2						
REHABILITATION METHOD [7] Percentage of area (relative to total disturbance) revegetated by seeding without light mulching (i.e. worst-case revegetation method).							
• not more than 1%	1	1	1	1	1		-
• more than 1% but not • more than 5%	2	Comment – topsoil replaced along batters to commence assisted natural regeneration.					
• more than 5% but not more than 10%	3						
• more than 10%	4						
RECEIVING WATERS [8]							
• Saline waters only	0	2	2	2	2		-
• Freshwater body (e.g. creek or freshwater lake or river)	2	Comment – not located within the major flow pathway (refer to flood assessment for each well pad)					

Condition (as described by IECA, 2008)	Points	Erosion Hazard Score					Trigger value
		Shenandoah South E&A Program					
		South B	South C	South 2	North A		
SUBSOIL EXPOSURE [9]							
• No subsoil exposure except of service trenches	0	0	0	0	0		-
• Subsoils are likely to be exposed	2						
EXTERNAL CATCHMENTS [10]							
• No external catchment	0	1	1	1	1		-
• External catchment diverted around the soil disturbance	1	Comment – refer to civil design drawings (Appendix E to Appendix M)					
• External catchment not diverted around the soil disturbance	2						
ROAD CONSTRUCTION [11]							
• No road construction	0	2	2	2	2		-
• Involves road construction works	2						
pH OF SOILS TO BE REVEGETATED [12]							
• more than pH 5.5 but less than pH 8	0	0	0	0	0		-
• other pH values, or if soils are untested	1						
Total Score [13]		**22**	**22**	**20**	**22**		
For guidance purposes only: [13] A primary ESCP must be submitted to the local government for approval during the planning phase for any development that obtains a total point score of 17 or greater or when any trigger value is scored or exceeded							

5.1.2 Erosion Hazard Assessment for Seismic Surveys

Table 6 presents the results of the assessment for the seismic programs.

Table 6: Erosion hazard assessment for EP 76, EP 98 and EP 117 –seismic survey areas

Condition (as described by IECA, 2008)	Points	Score	Trigger value
		Seismic Survey Areas	
AVERAGE SLOPE OF DISTURBANCE AREA [1]			
• not more than 3% [3% = 33H:1V]	0	1	4
• more than 3% but not more than 5% [5% = 20H:1V]	1	Comment - Topographical data of well sites indicated (low relief) with a slope <1-2%. Isolated areas increase to 3% to 5%. Value of 1 adopted as worse as scenario.	
• more than 5% but not more than 10% • [10% = 10H:1V]	2		
• more than 10% but not more than 15% [15% = 6.7H:1V]	4		
• more than 15%	6		
SOIL CLASSIFICATION GROUP (AS1726) [2]			
• GW, GP, GM, GC	0	2	-
• SW, SP, OL, OH	1	Comment – Initial soil testing during the baseline survey indicated SM - Silty sands, poorly graded sand-silt mixtures (refer EMP).	
• SM, SC, MH, CH	2		
• ML, CL, or if imported fill is used, or if soils are untested	3		
EMERSON (DISPERSION) CLASS NUMBER [3]			
• Class 4, 6, 7, or 8	0	4	6
• Class 5	2	Comment – Class 3 – Specific testing for Emerson Class not conducted. Therefore, default value used.	
• Class 3, (default value if soils are untested)	4		
• Class 1 or 2	6		
DURATION OF SOIL DISTURBANCE [4]			
• not more than 1 month	0	2	6
• more than 1 month but not more than 4 months	2	Comment – Line preparation to rehabilitation will be less than 1-month duration, however worst-case allowance used.	
• more than 4 months but not more than 6 months	4		
• more than 6 months	6		
AREA OF DISTURBANCE [5]			
• not more than 1000 m^2	0	1	6
• more than 1,000 m^2 but not more than 5,000 m^2	1	Comment – Due to the tread lightly approach of the line preparation using	

Condition (as described by IECA, 2008)	Points	Score	Trigger value
		Seismic Survey Areas	
• more than 5,000 m^2 but not more than 1 ha	2	existing tracks and minimising tree and shrub clearing and the re-instatement of topsoil and vegetation as soon as possible after acquisition, results in no more than 5,000 m^2 assessed at any one time.	
• more than 1 ha but not more than 4 ha	4		
• more than 4 ha	6		
WATERWAY DISTURBANCE [6]			
• No disturbance to a watercourse, open drain or channel	0	2	2
• Involves disturbance to a constructed open drain or channel	1	Comment – Activities require crossing of some minor drainage lines. Not considered to be major works and will be re-instated as completion of acquisition	
• Involves disturbance to a natural watercourse	2		
REHABILITATION METHOD [7] Percentage of area (relative to total disturbance) revegetated by seeding without light mulching (i.e. worst-case revegetation method).			
• not more than 1%	1	1	-
• more than 1% but not more than 5%	2	Comment – Topsoil and vegetated material to be replaced over disturbance within 2 weeks post activity for natural regeneration.	
• more than 5% but not more than 10%	3		
• more than 10%	4		
RECEIVING WATERS [8]			
• Saline waters only	0	2	-
• Freshwater body (e.g. creek or freshwater lake or river)	2	Comment – Minor drainage lines, with no flowing water at time of acquisition.	
SUBSOIL EXPOSURE [9]			
• No subsoil exposure except of service trenches	0	0	-
• Subsoils are likely to be exposed	2		
EXTERNAL CATCHMENTS [10]			
• No external catchment	0	0	-
• External catchment diverted around the soil disturbance	1	Comment – Not considered applicable based on the activities being completed are temporary seismic lines.	
• External catchment not diverted around the soil disturbance	2		
ROAD CONSTRUCTION [11]			
• No road construction	0	0	-
• Involves road construction works	2		

Condition (as described by IECA, 2008)	Points	Score	Trigger value
		Seismic Survey Areas	
		Comment – only temporary seismic lines required. No construction of new tracks is necessary. Existing pastoral tracks to be treated post activity.	
pH OF SOILS TO BE REVEGETATED [12]			
• more than pH 5.5 but less than pH 8	0	0	-
• other pH values, or if soils are untested	1	**Comment –** Majority soils recorded within Soil pH range 5.5-8 across exploration area. Some areas recorded outside range but considered minimal risk to seismic program.	
Total Score [13]		**15**	
For guidance purposes only: [13] A primary ESCP must be submitted to the local government for approval during the planning phase for any development that obtains a total point score of 17 or greater or when any trigger value is scored or exceeded.			

The erosion hazard assessment for the Tamboran permit areas, all report equal to, or just below the point score of 17. Based on the trigger value being met the ESCP is required.

5.2 Soil Loss Estimate

IECA (2008) soil loss estimation has been used to determine the type of controls the project should adopt to limit soil loss during construction when soils are exposed to rainfall. Long term average soil loss resulting from sheet and rill flow can be predicted using the Revised Universal Soil Loss Equation (RUSLE).

Soil loss calculated using RUSLE for the project area was calculated as follows:

$$A = R K LS C P$$

Where A = annual soil loss due to erosion [tonnes/hectare/year (t/ha/yr)]

R = rainfall erosivity factor based on = 6297)

K = soil erodibility factor of 0.055 for silt loam)

LS = topographic factor derived from slope length and slope gradient (0.24)

C = cover and management factor (1)

P = erosion control practice factor (1.3)

It is noted that the annual R-factor of 6297 for the Katherine region has been adopted as per comment received by DEPWS Land Management team. Since preparation of the initial ESCP, additional geotechnical information has been obtained which provides a larger sample size of the proposed permit areas.

The geotechnical sampling completed on the sites is as provided in Table 7. As such, the K-factor has been determined from Table E4 of the IECA Guidelines.

Revision of the LS-factor on more detailed design drawings shows a total slope length of approx. 200 m at a gradient of 0.00120 m/m (0.12%), indicative of the gradients across both sites. A LS factor of 0.24 was adopted, indicating a 200 m slope at 0.01 m/m (1%) for sites on the Amungee delineation, Kalala, Kyalla, Velkerri and Beetaloo. The slopes based on the contour information at hand for the Shenandoah South 2, South B, South C, North A (and option 2) are provided in Table 7.

Based on the reviewed RUSLE soil loss methodology, the Annual Soil Loss estimate using these values is 33 t/ha/yr – 204 t/ha/yr. A combination of Type 3, Type 2 and Type 1 sediment controls will be required based on the RUSLE equation.

All the proposed activities for the exploration program are planned during the dry season (May to September) when the erosion risk rating for rainfall is very low (refer to Table 2 and Table 3). Where activities occur in the wet season, Tamboran's wet weather contingency plan will be implemented (refer Table 12).

Table 7: RUSLE value and factors

Site	R	K Factor	Slope %	LS	C	P	A (t/ha/yr)
Amungee Delineation	6297	0.055	1	0.24	1	1.3	108
Kalala	6297	0.055	1	0.24	1	1.3	108
Kyalla	6297	0.055	1	0.24	1	1.3	108
Velkerri	6297	0.055	1	0.24	1	1.3	108
Beetaloo	6297	0.055	1	0.24	1	1.3	108
Shenandoah S A	6297	0.043	0.5 - 1.0	0.24	1	1.3	84
Shenandoah S B	6297	0.043	0.3 - 0.5	0.24	1	1.3	84
Shenandoah S C	6297	0.017	0.3 - 0.5	0.24	1	1.3	33
Shenandoah S2	6297	0.055	1	0.24	1	1.3	108
Shenandoah N A	6297	0.025	1.5 - 2.0	0.58	1	1.3	204
Shenandoah N A (option 2)	6297	0.025	1.5 - 2.0	0.58	1	1.3	204

5.3 Erosion Risk and Determination of ESC

Erosion risk ratings for the Project area have been determined based on the average monthly erosivity (R-factor of 6297), average monthly rainfall depth (mm) (refer Table 2 and Table 3 above) and soil loss (estimated at between 108t/ha/yr and 204t/ha/yr). As indicated in Table 8, the Project has an erosion risk rating of "very low" to "low".

Table 8: Erosion risk rating (adapted from IECA, 2008, Tables 4.4.1, 4.4.2 and 4.4.3)

Erosion Risk Rating	Average Monthly Erosivity (R-Factor)	Average Monthly Rainfall Depth (mm)	Soil Loss (t/ha/yr)
Very Low	0 to 60	0 to 30*	0 to 150
Low	60+ to 100	30+ to 45	150+ to 225
Moderate	100+ to 285	45+ to 100	225+ to 500
High	285+ to 1,500	100+ to 225	500+ to 1,500
Extreme	>1,500*	>225	>1,500

* It is noted that the monthly erosivity factor would only be triggered during rainfall events. The construction period is proposed to occur from July to October and based on assessment of the average monthly rainfall for the region (refer Table 2 and Table 3), the erosion risk rating is considered very low (0 to 30 mm during this time). It is anticipated that at completion of construction the site would be stabilised for normal operation.

Table 9 provides an indication of the "Type" of erosion and sediment controls that should be deployed during construction depending on annual soil loss. Based on the proposed construction schedule during the dry season, the project is determined to trigger the use of Type 3, Type 2and Type 1 erosion and sediment controls, based on the soil loss rate for the site in question. Refer to the results in Table 7 for the soil loss calculations and compare to Table 9, for the type of soil loss controls required.

Table 9: Sediment control standard (adapted from IECA 2008, Table 4.5.1)

Catchment Area (m^2)	Soil Loss Rate Limit (t/ha/yr)		
	Type 1	Type 2	Type 3
250	N/A	N/A	All Cases
1000	N/A	N/A	All Cases
2500	N/A	>75	75
>2500	>150	150	75

Table 10 provides a range of erosion and sediment controls that can be deployed on the project for each 'Erosion and Sediment Control Type'.

Table 10: Classifications of sediment controls

Type 1	Type 2	Type 3
Sheet flow		
Buffer zone capable of infiltrating 100% of stormwater runoff or processed water Infiltration basin or sand filter bed capable of infiltration of 100% of flow	Buffer zone capable of infiltrating 100% of stormwater runoff Compost / mulch berm	Buffer Zone capable of infiltrating 100% of stormwater runoff Filter fence Modular sediment trap Sediment fence
Concentrated flow		
Sediment basin (sized in accordance with design standard)	Sediment basin (smaller than the design standard) Filter tube dam	Coarse sediment trap Modular sediment trap U-shaped sediment trap

Type 1	Type 2	Type 3
	Rock filter dam Sediment trench Sediment weir	
Dewatering sediment control		
Type F/D Sediment Basin Stilling Pond	Filter bag or filter tube filter pond Filter tube dam Portable sediment tank Settling pond Sump pit	Compost berm Filter fence Grass filter bed Hydro cyclone Portable sediment tank Sediment fence
In-stream sediment control		
Pump sediment laden water to an off-stream type F/D sediment basin or high filtration system	Filter tube barrier Modular sediment barrier Rock filter dam Sediment weir	Modular sediment barrier Sediment filter cage

The site specific ESCP drawings are provided in Appendix E to Appendix M.

Standard drawings that may be applicable for the Project, including controls for access tracks and stream crossings are provided in Appendix N. The final design of the ESC controls will be dependent on decisions made in the field by the Supervising Engineer and site conditions. Any significant changes to those identified in this ESCP will be reported through to DEPWS Land Management Team for review and approval. Tamboran and its civil contractors will be responsible for notifying of any changes.

Standard drawings for erosion and sediment controls are available at: http://www.austieca.com.au/publications/book-6-standard-drawings.

5.3.1 Modifying the ESC Measures

It is possible that some ESC measures will require modification as the project is constructed and in response to the performance of ESC measures or changes in project circumstances. The modifications may be considered minor, moderate or significant. Moderate and minor changes will occur, and it is expected that significant modifications will be the exception. If significant erosion events occur, significant changes to the measures used will be required and should be approved by a CPESC or suitably qualified consulting engineer.

To accommodate the range of circumstances likely to occur, a change management decision matrix is presented in Table 11. Where changes are required, these will be risked assessed through a change management process and kept in a change management register.

Table 11: Change management decision matrix

Authority required	Minor	Moderate		Significant
	Maintenance of all measures	Removal or relocation of minor temporary controls	Permanent measure relocation	Permanent measure removal/revisions to ESCP
Tamboran onsite company rep	✓	×	×	×
Site supervisor	-	✓	×	×
CPESC	-	-	✓	✓
Consulting engineer	-	-	✓	✓

✓ Authorised to undertake
× Not authorised to undertake
- Denotes that authority level is not required

Examples of different types of sediment controls can be seen in Table 7. Examples of minor temporary controls would fall under Type 3 sediment controls while Type 2 and Type 1 sediment controls provide examples of permanent measures.

It is noted that minor and permanent are not indications of how long the sediment controls are in place. At completion of the activities, the disturbed areas to be restored and/or rehabilitated to pre-disturbed conditions consistent with the surrounding land use.

If ESC measures are observed to be ineffective (e.g. obvious sediment deposition has occurred, or is occurring in a waterway), the source of the sediment must be identified, and corrective ESC measures implemented.

6 Erosion and Sediment Controls

6.1 Well Exploration Areas

Based on the erosion susceptibility of the exploration area, the ESCP measures to be adopted for the exploration programs are summarised in Table 11. These ESCP measures have been considered during the design of the exploration well pads and associated infrastructures and will be implemented by the Tamboran contractors during the construction and maintenance activities.

Table 12: Measures to be implemented for erosion and sediment control – well exploration areas

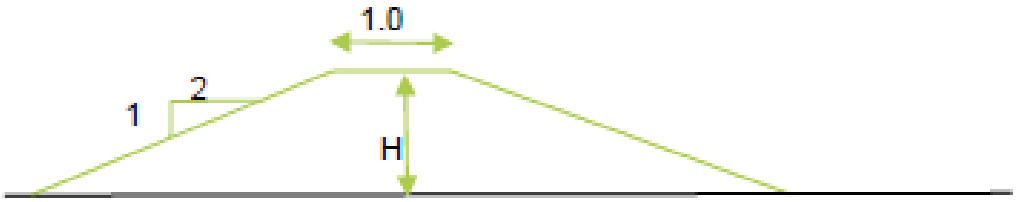
Activity	Management controls
Land clearing	• Undertake selective clearing (only clearing areas that are necessary for construction and ESC activities), using lighter machinery such as graders or smaller bulldozers, taking care not to overwork the site. Overworking the site can lead to the loss of topsoil, compaction, formation of windrows and wheel rutting. • Minimise tree clearing activities only during the dry season (May to September) to allow the ground surface to stabilise before the onset of the wet season (October to April). • Retain vegetation buffers surrounding streams and creeks, as outlined in the *NTG Land Clearing Guidelines 2021*. • Undertake clearing for each stage in small units over time, keeping the disturbed areas small and time of exposure short, in conjunction with progressive re-vegetation (assisted natural regeneration using available topsoil). • Take all reasonable and practicable measures to minimise the removal of, or disturbance to, trees, shrubs and ground covers (organic or inorganic) that are to be retained. • If bulk tree clearing is required, it must occur in a manner that minimises disturbance to existing ground cover (organic or inorganic). • Bulk tree clearing and grubbing of the site must be immediately followed by specified temporary stabilisation measures (e.g. gravel, soil berm) prior to commencement of each stage of construction works. • Land clearing should not occur unless preceded by the installation of appropriate drainage and sediment control measures. The exception would be any land clearing necessary to allow installation of these control measures. Prior to land clearing, establish tree protection zones around vegetation to be retained e.g. identify with high-visibility tape, or light fencing. • All land clearing must be in accordance with the Federal, Territory and local government vegetation clearing requirements and IECA Table 4.4.7 Best practice land clearing and rehabilitation requirements. • All reasonable and practicable steps to be taken to apply best practice Erosion control measures following earthworks and site stabilised prior to anticipated rainfall. Disturbed areas will be stabilised with a minimum 60% cover within 30 days of completion.

Activity	Management controls

Access tracks	• Where possible, use existing roads and tracks to access the well sites, and where new tracks are required, they should be located along the most direct and practicable route to the well site (noting Velkerri 76 S1 access track has been diverted around the sensitive Bullwaddy/Lancewood vegetation type).
	• Trucks entering and exiting the site will be constrained in such a manner to prevent dropping or tracking material on the Highway in accordance with the Road Agency Approval (ref 2018-0186-D2).
	• Monitor Stuart Highway during construction and operation. Where tracked material on the road pavement becomes a potential safety issue, Tamboran and its contractors will sweep and clean material off the road. If Stuart Highway turn-in results in dust, dirt creating hazard to road users, additional ESC will be considered including installation of shaker grid or rock pad.
	• Minimise track width and surface disturbance (e.g. topsoil, seed and root stock) as far as practicable to allow safe passage of required equipment.
	• Disturbed areas will be stabilised with a minimum 60% cover 30 days of completion if rainfall possible.
	• Where gravelling is warranted (Stuart Highway and Carpentaria Turn-in), the formation process can remove undesirable material and/or box the imported material where it is required. Track formation will be required for the following reasons:
	  • Drainage control, especially in areas where erosion or sediment influences are evident, any vegetation, topography, wheel rutting or
	  • compaction is likely to intercept, concentrate and channel water.
	  • Where the topography of the track location or the drainage characteristics of the soil are likely to hinder access for a protracted time period following rain (e.g. 1 to 2 weeks).
	  • Where natural side-slope poses a safety hazard to potential users of the track (e.g. contractors, landowners).
	• Place scrub and vegetation cleared from the route adjacent to the route where practical to facilitate its return to the disturbed area. Where this occurs, spread the material out rather than form windrows. Allow disturbed areas to be stabilised and natural regeneration of the native grasses to occur.
	• Construct access tracks with table drains that are free draining.
	• Avoid road crowning to allow water to naturally cross the road.
	• Form tracks to allow off-road drainage. Where track intercepts the direction of overland flow and re-directs this flow to a non-natural drainage line, install erosion control works to minimise potential erosion.
	• The design and position of erosion control measures to be determined in the field by experienced operator and site engineer, based on the site characteristics of the access track location.
	• Where construction of table drains are deemed necessary, they should have a broad flat base at least 1 m wide and should not be graded to produce a ‘V’ shape. To minimise erosion, the slope should be no greater than 0.5% on erodible soils or 1% on stable soils.

Activity	Management controls
	• Where encounter dispersive / erosive soils they should be stabilised with gypsum or other stabiliser, as determined by laboratory analysis of soils. • Where cut-out drains are required, they should be spaced based on the slope of the area i.e. 0.5% slope, allow for cut-out draining every 170-180 m or 1 % slope, allow for cut-out drainage every 120-130 m etc. (refer to NT Road Drainage Fact Sheet). It is noted that the recommended distance between turn-out drains is a guide and may not apply to all locations along the access track. • Monitor road conditions to ensure deterioration does not occur. Assist in the maintenance and repair work on roads and tracks used. • Following completion of activities and within 2 years after the surrender of a lease, the land surrounding or affected by the installation of access tracks shall be restored in accordance with the site-specific rehabilitation plan and final determination of asset (i.e. if transferring asset ownership to landholder).
Placement of gathering lines along access tracks	• Placement and installation of gathering lines in accordance with the Upstream Polyethylene Gathering Networks – CSG Industry Code of Practice (Version 5.0 August 2019) and Appendix P - Land-based pipeline construction (IECA, December 2015). • Route selection of gathering lines should consider the location of start and end points, well locations and access requirements, hydraulic requirements based on topography, existing services and infrastructure, and current and future land use. • Gathering line route to be selected such that the pipe can be installed, tested, and operated safely and practically. • Gathering line to be placed above ground within the access track corridor (but not within the trafficable area), minimising the need for additional vegetation clearing where possible. Topsoil to be removed to allow gathering line to be placed directly on the subsoil layer to minimise soil disbursement. • Extra protection of gathering line to be provided where necessary, particularly to prevent damage from conditions such as traffic and cattle movement and at stream and river crossings (where applicable). • Allow for trafficable cross banks where gathering line crosses the access tracks. No other area of the gathering line to be trafficable. • Where gathering line intersects an overland flow path, allow for sheet flow to pass to avoid concentrated flow resulting in scouring. • Install sediment controls such as fibre rolls or mulch berms along line to control velocity and capture minor sediment. • Avoid rocky areas and steep slopes and side slopes if possible. • Align gathering line straight up and down slopes. • Contents of pipes to be clearly labelled based on Table 3.3.1 Colour Specification (i.e. yellow for gas, produced formation water purple, etc.). • Fire protection measures to be employed by reducing fuel loads by up to 5 m either side of the gathering line. • Regularly inspect, monitor and maintain ESC measures.

Activity	Management controls

Pad construction / maintenance	• Pad construction to be in accordance with the typical ESCP (refer **Appendix E**). The topsoil berm dimension to be in accordance with the IECA Figure 1 Standard Drawing MB-01 presented in **Appendix N**.
	  • Use topsoil berms to divert upstream runoff from undisturbed areas ('clean' water) around and away from disturbed areas, and back to the environment.
	  • Topsoil bunds are to be formed to the profile provided in the sketch below. Bund height (H) is specified on the drawings.
	  • Where topsoil bunds are to be utilised for wastewater storage spill containment, topsoil bunds are to be formed to the profile provided in the sketch below. Bund height shall consider the well pad slope and volume of wastewater stored onsite. The typical, low point bund height is specified on the drawings, assuming a 0.2% storage area fall.
	 
	
	  • Topsoil to be compacted to 95% mmdd.
	  • Use topsoil berms to contain / manage runoff from disturbed construction areas ('dirty' water) and prevent release to environment without treatment.
	  • Treat runoff from construction areas through suitable sediment controls (e.g. sediment traps).
	  • Configure berms so that upstream runoff does not mix with construction area runoff prior to treatment of construction area runoff.
	• Where topsoil stripping is required, the stripping depth would be in accordance with Technical Instruction (NT-2050-15-TI-0001) and amelioration rates agreed with the Construction Supervisor, Tamboran engineers and by a suitably qualified ESC practitioner. It is noted that the expected nominal depth of topsoil across the well pads at locations ranges from <100 mm to 150 mm. Final strip depth will be confirmed in the field. Any changes to the adopted ESCs will be reflected in the ESCP and to satisfaction of DEPWS.
	• Stockpiled felled trees nearby for future use in rehabilitation.
	• Inspect on a regular basis in accordance with Section 5 Maintenance.
	• Damage or maintenance is undertaken by an appropriately qualified person i.e. contractor / Tamboran.
	• Following completion of activities and within 2 years after the surrender of a lease, the land surrounding or affected by the exploration wells

Activity	Management controls
	shall be restored in accordance with the site-specific rehabilitation plan and final determination of asset (i.e. if transferring asset ownership to landholder).
Stream and creek crossings	Where a crossing is required to be upgraded, a bed level crossing as detailed in **Appendix L**, will be installed in accordance with the following: • Crossings will be aligned perpendicular to the water flow. • Crossing will be constructed from clean rocks (minimal fine material) that are an equivalent or larger size than the natural bed material at the crossing. • The surface is to be left rough and not to be over compacted (e.g. track-rolled finish or rougher). • The lowest point of the bed level crossing will be installed at the level of the lowest point of the natural stream bed (preconstruction), within the footprint of the proposed crossing. • There must be a height difference of at least 100 mm up to ≤ 300 mm from the lowest point of the crossing to the edges of the low flow section of the crossing. Where scour protection is required: • Scour protection must abut the surface edge of the crossing at the same level (this is to ensure that there is no drop in elevation at the join). • If the crossing is set below bed level then the surface of the scour protection must also be below bed level. • The stream bed must abut the scour protection at the same level (this is to ensure that there is no drop in elevation at the join). • The scour protection is installed at a gradient no steeper than 1 in 20 or the natural channel gradient, whichever is steeper. • Scour protection must incorporate a low flow channel. Use clean rocks (minimal fine material), at least 100 mm diameter. • Ensure the rock armouring is not over compacted but left at the same level and uneven (track-rolled finish or rougher). • Use clean rocks (minimal fine material), at least 100 mm diameter. • The retention of vegetation buffers, as outlined in the NTG Land Clearing Guidelines 2019, as they relate to stream order has been considered for the siting of proposed access tracks and pads. • Site specific progressive ECPs should be approved by DEPWS prior to any disturbance. • Should activities pushout to the wet season, the ESCP to be reviewed and updated for wet season conditions. The revision to be reviewed and approved by DEPWS during September to allow implementation of the plan prior to the onset of the wet season. Wet season ESCP to be implemented between 1 October to 30 April.

Activity	Management controls

Soil and stockpile management	• Stockpile existing topsoil, where available, so that it can be reused on the site for ESC and future rehabilitation at completion of project.
	• Stockpiles of erodible material that has the potential to cause environmental harm if displaced, must be:
	  • Appropriately protected from wind, rain, concentrated surface flow and excessive up-slope stormwater surface flows.
	  • Located at least 2m from any hazardous area or retained vegetation.
	  • Located up-slope of an appropriate sediment control system.
	  • Provided with an appropriate protective cover (synthetic or vegetative) if the materials are likely to be stockpiled for more than 28 days.
	  • Provided with an appropriate protective cover (synthetic or vegetative) if the materials are likely to be stockpiled for more than 10 days during those months that have an erosion risk rating higher than medium.
	• A suitable flow diversion system must be established immediately up-slope of a stockpile of erodible material that has the potential to cause.
	• environmental harm if displaced, if the up-slope catchment area draining to the stockpile exceeds 1,500m^2.
	• Avoid creating windrows. Do not create windrows across creeks, use rollers when putting in tracks in preference to dozers, or walk the dozer with the blade raised off the ground.

Site management	• All disturbed areas identified as very low, low, medium or high erosion risk must be suitably stabilised prior to anticipated rainfall, from the day that soil disturbances on the area have been finalised- IECA Table 4.4.7. • Tracks to be regularly inspected for early signs of compaction, erosion and soil degradation (generation of bulldust). Ongoing maintenance and repair work should be implemented as required on tracks. • No off-lease or off-road driving. • The construction schedule must aim to minimise the duration that any and all areas of soil are exposed to the erosive effects of wind, rain and surface water flow. • Land-disturbing activities must: • allow stormwater to pass through the site in a controlled manner and at non-erosive flow velocities. • minimise soil erosion resulting from rain, water flow and/or wind. • minimise adverse effects of sediment runoff, including safety issues. • prevent, or at least minimise, environmental harm resulting from work-related soil erosion and sediment runoff. • ensure that the value and use of land/properties adjacent to the site (including access roads) are not diminished as a result of the adopted ESC measures. • Additional and/or alternative ESC measures must be implemented in the event that unacceptable off-site sedimentation is occurring as a

Activity	Management controls
	result of the work activities. • Sediment deposited off the site as a direct result of an on-site activity, must be collected and the area appropriately rehabilitated as soon as reasonable and practicable, and in a manner that gives appropriate consideration to the safety and environmental risks associated with the sediment deposition.
Drainage control	• Where reasonable and practicable, stormwater runoff entering the site, must be diverted around or through the area in a manner that minimises soil erosion and the contamination of water for all discharges. • All reasonable and practicable measures must be implemented to control flow velocities a manner that prevents soil erosion along drainage paths and at the entrance and exit of all drains and drainage pipes during storms up to the relevant design storm discharge.

Erosion control	• If synthetic reinforced erosion control mats or blankets are required, they must not be placed in, or adjacent to, riparian zones and watercourses if such materials are likely to cause environmental harm to wildlife or wildlife habitats.
	• A minimum 60% ground cover must be achieved on all non-completed earthworks exposed to accelerated soil erosion. If further construction activities or soil disturbances are likely to be suspended for more than 30 days during months when the expected rainfall erosivity is less than 60;
	  • minimum 70% cover within 30 days if between 60 and 100;
	  • minimum 70% cover within 20 days if between 100 and 285;
	  • minimum 80% cover within 10 days if between 285 and 1,500; and
	  • minimum 95% cover within 5 days if greater than 1,500.

Sediment control	• Optimum benefit must be made of every opportunity to trap sediment within the work site, and as close as practicable to its source. • Sediment pond to be installed and operated to both collect and retain sediment (refer to Drawing NT-2050-15-MP-0021 and NT-2050-15-MP-022 in Appendix E). Design details of the sediment pond is provided in NT-2050-20-DD-0030. • All reasonable and practicable measures must be taken to prevent, or at least minimise, the release of sediment from the site (section 7.5). • Sediment control devices must be de-silted and made fully operational as soon as reasonable and practicable after a sediment-producing event if the device's sediment retention capacity falls below 75% of its design retention capacity. • Materials removed from sediment control devices must be disposed of in a manner that does not cause ongoing soil erosion or environmental harm.
Wet weather contingency	• 7-day forecast from the Bureau of Meteorology (BOM) to be monitored and the civil and water bore construction activities planned around the forecasts. • Where forecasts indicate rainfall is likely to result in an event that has potential to limit access to the work area, the civil and water bore

Activity	Management controls
	contractor will stabilise the current work areas and go into standby mode until such time they can assess the track condition after an event to recommence activities. • Emergency response – a post-rainfall/flood damage reconnaissance and assessment will be undertaken as soon as the area becomes accessible. Any damage observed would be repaired as soon as practicable after the event and ensure the controls and measures are in place prior to the next rainfall event.
Site rehabilitation	• Following completion of works, disturbed areas are to be restored and/or rehabilitated. • Gravel pits to have topsoil returned and re-profiled. • All compacted areas will be ripped and scarified to promote regeneration of vegetation; this may require assistance through spread of native seed stock. • All disturbed areas will be allowed to naturally regenerate or be revegetated on completion of use. • Compacted areas will be contour ripped to 0.5m depth where practicable. • At completion of activities, establish vegetation similar to adjacent vegetation, unless agreement with landowner for alternative use. • Remove and appropriately dispose of all synthetic erosion and sediment control materials. • All disturbed areas identified as very low, low, medium or high erosion risk must be suitably stabilised prior to anticipated rainfall, from the day that soil disturbances on the area have been finalised- IECA Table 4.4.7. • Stabilise disturbed areas quickly to reduce the potential for erosion. Methods of stabilisation will be site specific and based, in part, on laboratory analysis of soils for erosive and dispersive characteristics. • Previously removed vegetation and topsoil will be uniformly re-spread over disturbed area to assist with rehabilitation process through agencies of increased infiltration and return of seed-bearing topsoil. If required, additional native seed mix from the area could be respread to speed up rehabilitation process. • Windrows of debris that cannot be removed should be aligned down the contour or in a manner appropriate to avoid channeling and concentrating runoff. All other windrows are to be removed as soon as practicable. • The type of ground cover applied to completed earthworks is compatible with the anticipated long-term land use, environmental risk, and site rehabilitation measures.

6.2 2D Seismic Activities

Based on the erosion susceptibility of the exploration areas, the ESCP measures to be adopted for the 2D seismic exploration programs are summarised in Table 12 below. These ESCP measures have been considered during the design of the seismic program and will be implemented by the Tamboran contractors during the construction and maintenance activities.

Table 13: Measures to be implemented for erosion and sediment control – seismic survey areas

Activity	Management controls
Vegetation clearing	• Undertake selective clearing (only clearing areas that are necessary for surveying lines), using lighter machinery such as graders or smaller bulldozers, taking care not to overwork tracks. Overworking the site can lead to the loss of topsoil, compaction, formation of windrows and wheel rutting. Refer to the first dot point in the seismic line preparation and access track and camp establishment/maintenance section below. • Ground surface to be stabilised before the onset of the wet season (November to March). • Undertake clearing for each stage in small units over time, keeping the disturbed areas small and exposure time short, in conjunction with progressive re- vegetation (assisted natural regeneration using available topsoil and removed vegetation). • Take all reasonable and practicable measures to minimise the removal of, or disturbance to, trees, shrubs and ground covers (organic or inorganic) that are to be retained. • All vegetation clearing must be in accordance with the Federal, Territory and local government vegetation clearing requirements and IECA Table 4.4.7 Best practice land clearing and rehabilitation requirements detailed Appendix O. • Best practice erosion control measures will be implemented in accordance with the ESCP following earthworks and site stabilised prior to anticipated rainfall. • Disturbed areas will be stabilised in accordance with the Rehabilitation Management Plan, as per Section 7.4.

<table>
<tr><th>Activity</th><th>Management controls</th></tr>
<tr><td>Creek and Drainage Line Crossings</td><td>Minimise disturbance in the riparian buffers in accordance with the stream order of the encountered drainage line in accordance with the buffers provided below:
<table>
<tr><th>Riparian class</th><th>Stream order</th><th>Minimum buffer width (m)</th><th>Measured from</th></tr>
<tr><td>Drainage depression</td><td>Not applicable</td><td>25</td><td>The outer edge of the drainage depression, which is the extent of the associated poorly drained soils and associated vegetation.</td></tr>
<tr><td>Intermittent streams</td><td>First</td><td>25</td><td>The outer edge of the riparian vegetation or levee (whichever is greater).
If braided channels are present, the edge of the outer most stream channel</td></tr>
<tr><td>Intermittent streams</td><td>Second</td><td>50</td><td>As above</td></tr>
<tr><td>Creeks</td><td>Third and fourth</td><td>100</td><td>As above</td></tr>
<tr><td>Rivers</td><td>Fifth and higher</td><td>250</td><td>As above</td></tr>
</table>

No additional material will be used for the seismic acquisition to cross over the creek crossing. Existing crossings will not be altered.
The activities shall be completed in a manner that does not cause a:

material change to the shape of a waterway,
material change to the volume, speed or direction of flow or likely flow of water in or into a waterway, or
alteration to the stability of the bed or banks of a waterway, including by removal of vegetation.

Ongoing monitoring of creek and drainage crossing condition prior to, during and at completion of rehabilitation.
Reinstate the original topography of the creek or drainage bed following seismic acquisition.
</td></tr>
<tr><td>Seismic line preparation</td><td>
The method for line preparation described in the EMP is to use existing pastoral station tracks wherever practicable, or minimise the complete removal of the vegetation, with vehicles to traverse over or around the vegetation instead, leaving as much intact as possible. Assessment of the survey area indicates that in the order of 80 to 90% of the undisturbed areas will be traversed as a blade up exercise.
Minimising vegetation and soil disturbance is the default position for the seismic program. Wherever possible vegetation and soil shall not
</td></tr>
</table>

Activity	Management controls
	be disturbed when establishing survey lines (i.e. blade up). If disturbance is required, establishment of survey lines which will form a runoff channel is to be avoided. • Seismic vehicles that enter and exit the site will be constrained in such a manner to prevent dropping or tracking material on the Highway in accordance with the Road Agency Approval. • Place scrub and vegetation cleared from the route adjacent to the route where practical to facilitate its return to the disturbed area. Where this occurs, spread the material out rather than form windrows. Allow disturbed areas to be stabilised and natural regeneration of the native grasses to occur.

Site management	• All plant and equipment brought to site is to be certified a "free" of weeds, soil pathogens and pests.
	• All disturbed areas identified as very low, low, medium or high erosion risk must be suitably stabilised prior to anticipated rainfall, from the day that soil disturbances on the area have been finalised - IECA Table 4.4.7 in Appendix O.
	• Land-disturbing activities must:
	  • Allow stormwater to pass through the site in a controlled manner and at non-erosive flow velocities. Where this cannot be achieved, reference should be made to installing controls as detailed in the following section.
	  • Minimise soil erosion resulting from rain, water flow and/or wind.
	  • Minimise adverse effects of sediment runoff, including safety issues.
	  • Prevent, or at least minimise, environmental harm resulting from work-related soil erosion and sediment runoff.
	  • Ensure that the value and use of land/properties adjacent to the site (including access roads) are not diminished as a result of the adopted ESC measures.
	• Additional and/or alternative ESC measures must be implemented in the event that unacceptable off-site sedimentation is occurring as a result of the work activities.
	• Sediment deposited off the site as a direct result of an on-site activity, must be collected and the area appropriately rehabilitated as soon as reasonable and practicable, and in a manner that considers the safety and environmental risks associated with the sediment deposition.

Wet weather contingency	• Wet season contingency planning to be conducted where activities extend into the wet season. • 7-day forecast from the Bureau of Meteorology (BOM) to be monitored and the seismic exploration activities planned around the forecasts. • Where forecasts indicate rainfall is likely to result in an event that has potential to limit access to the work area, the seismic contractor will stabilise the current work areas and go into standby mode until such time they can assess the track condition after an event to recommence activities. • Emergency response - a post-rainfall/flood damage reconnaissance and assessment will be undertaken as soon as area becomes accessible.

Activity	Management controls
	• Any damage observed would be repaired as soon as practicable after the event.
Site rehabilitation	• Within 2 weeks of the activities being completed, disturbed areas are to be restored and/or rehabilitated. Reference should be made to Tamboran's Rehabilitation Management Plans. • All compacted areas will be ripped and scarified to promote regeneration of vegetation. • All disturbed areas will be allowed to naturally regenerate or be revegetated on completion of use. • At completion of activities, establish vegetation to the standard of that registered in the pre-assessment, or better. • All disturbed areas identified as very low, low, medium or high erosion risk must be suitably stabilised prior to anticipated rainfall, from the day that soil disturbances on the area have been finalized as per the requirements of IECA Table 4.4.7 (Appendix O). • Stabilise disturbed areas quickly to reduce the potential for erosion. • Previously removed vegetation and topsoil will be uniformly re-spread over disturbed area to assist with rehabilitation process through agencies of increased infiltration and return of seed-bearing topsoil. If required, additional native seed mix from the area could be respread to speed up rehabilitation process. This will be confirmed during rehabilitation monitoring activities. • This will be confirmed during rehabilitation monitoring activities. • Windrows to be removed as soon as practicable. • The type of ground cover applied to completed earthworks is compatible with the anticipated long-term land use, environmental risk, and site rehabilitation measures. • At completion, the disturbed areas are to be restored and/or rehabilitated to original pre-disturbed condition consistent with surrounding land use. • Remove and appropriately dispose of all synthetic erosion and sediment control materials.

6.3 ESC Treatment Options for Specific Situations

Appendix N to Appendix P contain typical erosion and sediment control measures that are to be applied throughout the project when required. Treatments are identified for specific situations and should be applied appropriately. Five different seismic line treatments are identified below.

- Blade up areas where only wheel tracks will develop – no treatments required.
- Surface bladed by grader to smooth out ground surface to allow vehicle movements. No tree removal. Topsoil will be bladed off by grader and windrowed for later respreading at completion of data recording, to preserve the soil structure. Whoa boys or roll over banks to be provided as per details in Appendix P.
    - At the conclusion of activities, or as part of progressive rehabilitation, or the anticipated onset of a significant rainfall event which will require the site to be abandoned, topsoil would be respread and ripped into the soil surface.
    - Works on grade (>2%)– Surface bladed by grader to smooth out ground surface to allow vehicle movements. No tree removal. Topsoil will be bladed off by grader and windrowed for later respreading at completion of data recording, to preserve the soil structure. Whoa boys or roll over banks to be provided as per details in Appendix P.
    - At the conclusion of activities, or as part of progressive rehabilitation, or the anticipated onset of a significant rainfall event which will require the site to be abandoned, topsoil would be respread and ripped into the soil surface.
- Wooded communities e.g. Lancewood/Bullwaddy – For most of the program wherever practical, activities should be planned to avoid impacts to Lancewood and Bullwaddy vegetation communities. Where this is not possible, the vegetation community would require measures as follows:
    - A survey line of 5 m maximum should be cleared by the dozer removing the trees. Felled trees should be pushed to the side to enable vehicle access through the site.
    - Following clearing the topsoil bladed off by grader and windrowed for later respreading with the vegetated material at completion of data recording.
    - The line preparation will require blading to a sufficient depth, no greater than 150 mm, to enable the safe access of the vehicles. The purpose of the blading is to reduce the risk of tyre puncture from the Lancewood which is known to snap off at ground level leaving a spike protruding.
    - Whoa boys or roll over banks to be provided as per detail in Appendix P.
    - At the conclusion of activities, or as part of progressive rehabilitation, or the anticipated onset of a significant rainfall event which will require the site to be abandoned, topsoil would be respread at a thickness of 150 mm and ripped into the soil surface.
    - Felled vegetation will be evenly spread over the top soiled area to provide additional protection against erosion.

- Seasonally inundated areas - Similar to the wooded communities described above, high clay content soils (vertosols) are also found in seasonally inundated areas and in the southern survey area. Unlike the wooded areas these clays continue at depth, making the scraping back of topsoil less effective in keeping bulldust down and preserving soil structure. The recommendation in these locations is that line preparation would consist primarily of the vehicles traversing directly of the annual grasses, flattening or slashing for data acquisition i.e. blade up.

7 Monitoring

7.1 Construction

Monitoring for soil erosion and related issues is best undertaken at critical stages, such as:

- At the time of the baseline land condition assessment.
- During siting of access tracks and exploration areas, this is when there is the greatest opportunity to avoid erosion problems.
- After completion of a specific phase of activity, all disturbed areas will be monitored before and after the wet season.
- When accessing the site after the wet season, all disturbed areas should be inspected for signs of erosion. If significant impacts are identified remediation works may need to be conducted prior to continued vehicular access.
- In the unlikely event that water is required to be released from the sediment pond, the stored water will be visually assessed (no sheen, or turbidity) and physical parameters (pH, EC) taken to ensure release water will not impact on any downgradient sensitive receiving environments (refer Section 7.3). It is noted that well sites do not have any sensitive receiving water bodies located in proximity to the sites.

When accessing the site after the wet season, all disturbed areas should be inspected for signs of erosion. If significant impacts are identified remediation works may need to be conducted.

7.2 Operations

Visual inspections will be undertaken throughout the seismic survey activities to assess the impact risk level of the regulated activities being undertaken and the likelihood of accelerated erosion occurring. A review of mitigation measures that are implemented throughout the project phase will be conducted regularly to assess the efficacy and that the standard is maintained.

All other areas to be inspected before and after the wet season to identify the occurrence of erosion and sedimentation. Where erosion is observed, maintenance activities shall be undertaken. Ongoing monitoring and maintenance shall occur throughout the life of the infrastructure until the land is handed back.

7.3 ESC Trigger Action Response Plan

The following Trigger Action Response Plan (TARP) is to be implemented during construction:

- Monitoring requirements:
  - 7-day forecast from Bureau of Meteorology (BOM) to be monitored and construction and ground disturbance activities to planned around the forecast.
  - Daily visual inspection of access track, lease pads and campsite conditions for duration of civil construction activities.

- Routine visual inspections of the creek and drainage line access track crossings and the wastewater containment system at the camp weekly or following a rainfall event (i.e. greater than 20 mm in 24 hours).
- Review ESC across the site and where required implement maintenance prior to 1 October each year.

- Action:
  - On establishment of each exploration well pad, undertake jar testing work to determine anticipated settling rate of sediments on site. This will inform flocculent dosing requirements as required.
  - Where monitoring has indicated weather condition have impacted the integrity of the erosion and sediment controls, operators must adopt one of the treatment plans from section 6.0 to mitigate the impacts of rainfall and ensure that the ESC devices are reinstated as soon as physically practicable after the event.
  - Inspection of all ESC devices across the worksite and physical water quality testing (physical parameters only) at the well pad sediment basin should be conducted prior to discharge of water offsite. Water quality discharge indicators include:
    - No visible oil, grease or other hydrocarbons
    - pH: Between 6.0 – 8.0
    - EC: 1300 µS/cm.

  The adopted discharge criteria are based on ANZECC 2000 Table 3.3.4 and Table 3.3.5 default trigger values for pH and conductivity (EC, salinity) indicative of slightly disturbed ecosystems in tropical Australia, as well as consideration of the distance and type of nearby sensitive surface water receptors as ephemeral drainage lines and creeks.

- **Response:**
  - Post-rainfall/flood damage reconnaissance and assessment to be undertaken as soon as the area becomes accessible. Any damage observed would be repaired as soon as practicable after the event and ensure the controls and measures are in place prior to the next rainfall event.
  - If water quality conditions meet discharge indicators, beneficial reuse of water may be considered for construction activities.
  - External NATA accredited laboratory testing of soil/sediment or surface water would only be required for the following triggers:
    - Work area has a known existing contaminating event in the preceding 3 months that could influence stormwater discharge quality (refer to Tamboran's Spill Management Plan appended to the EMP).
    - The visual inspection and physical water quality testing indicated potential contamination.
    - Where there is a sensitive receiving water body within 200 m of the discharge point.

7.4 Rehabilitation

7.4.1 Well Sites including, Access Tracks, Gathering Lines, Gravel Pits and Camps

Where rehabilitation of a site is required, rehabilitation monitoring will be undertaken annually to assess the rehabilitation success and determine whether additional remedial works are required. Success criteria are defined in the relevant EMP and include:

- Safe for humans and wildlife
- Non-polluting
- Stable, with appropriate vegetation cover
- Land condition suitable for existing pastoral land use.

7.4.2 Seismic Line Acquisition

Rehabilitation will be undertaken along all newly cleared survey lines concurrently with the completion of the survey process. Reference should be made to the relevant Rehabilitation Management Plan prepared in support of each EMP. Rehabilitation of all areas must be undertaken in accordance with the methodologies described in the Rehabilitation Management Plan and treatments in Appendix P of this document.

Rehabilitation monitoring will be undertaken before and after the initial wet season and then annually for 5 years to assess the rehabilitation success and determine whether additional remedial works are required. Success criteria are defined in the relevant EMP and include:

- safe for humans and wildlife
- non-polluting
- stable, with appropriate vegetation cover
- waterways are not materially changed.
- land condition suitable for existing pastoral land use.

7.5 Incident Reporting

The constructor must follow incident reporting requirements covered in the Tamboran incident management directive.

Sediment release and turbidity increase incidents can require some assessment to determine if they are reportable, as controls are only designed to cope with certain rain events (refer to IECA, 2008).

The constructor must:

- Report sediment release and turbidity increase incidents.
- Include justification in each case of why the incident is, or is not, reportable to the regulator based on:
    - The state of the controls prior to the rainfall
    - The design standard applied (IECA, 2008)
    - The actual rainfall received, based on the nearest data source available
    - Whether the design storm event was exceeded or not; and
    - Whether environmental harm was caused or not.

7.6 Records

Records shall be retained demonstrating areas have been inspected. Photographic records will be maintained over the duration of the activities for documenting soil disturbance.

All environmentally relevant incidents are to be recorded in a field log that must remain accessible to all relevant regulatory authorities.

Minimum records to be retained for each site include:

Location of disturbance	Area of disturbance	Date	Close out

7.7 ESCP Revisions

Where major changes are required to the proposed controls in the ESCP through Tamboran's change management processes, DEPWS would be advised and a revised ESCP provided. Should any civils be required during the wet season, the wet weather contingency plan outlined in Table 13 will be implement.

7.8 Maintenance

All temporary erosion and sediment control measures, including drainage control measures, must be fully operational and maintained in proper working order at all times during the project.

When undertaking construction work, erosion and sediment control measures must be inspected:

- at least daily (when work is occurring on-site during the wet season)
- within 24 hours of expected rainfall
- within 18 hours of a rainfall event of sufficient intensity and duration to cause runoff on-site or greater than 20 mm in 24 hours.

Once operational, inspections of the site will continue daily while onsite, and before and after the wet season. Where erosion is observed, maintenance activities shall be undertaken.

Sediment removed from sediment traps and places of sediment deposition must be disposed of in a lawful manner that does not cause ongoing soil erosion or environmental harm.

Prior to the completion of activities on the ground, the construction areas will be stabilised to the satisfaction of the construction supervisor.

8 References

APGA. 2019. *Upstream Polyethylene Gathering Networks – CSG Industry Code of Practice* (Version 5.0 August 2019). Australian Pipelines and Gas Association, QLD.

Catchment and Creeks Pty Ltd. 2012. *Erosion & Sediment Control – A Field Guide for Construction Site Managers V5*. Catchment and Creeks. Brisbane. QLD.

Department of Agriculture, Fisheries and Forestry. 2013. *Code for Self-Assessable Development Minor Waterway Barrier Works Part 4: Bed Level Crossings Code Number WWBW01 April 2013*. State of Queensland, Qld.

Department of Environment, Parks and Water Security (DEPWS) 2021. *Land Clearing Guidelines*. Northern Territory Government.

IECA. 2008. *Best Practice Erosion and Sediment Control – for building and construction sites*. Picton, NSW: International Erosion Control Association (Australasia).

IECA & Australian Pipelines and Gas Association Ltd (APGA). 2015. *Appendix P: Land-Based Pipeline Construction* (addendum to IECA 2008). Picton, NSW: International Erosion Control Association (Australasia).

Scientific Inquiry into Hydraulic Fracturing in the Northern Territory. 2018. *Scientific Inquiry into Hydraulic Fracturing in the Northern Territory – Final Report*.

APPENDIX A Erosion hazard assessment explanatory notes

reference: IECA, 2008, *Best Practice Erosion and Sediment Control Hazard Assessment Form)*

Requirements: Specific issues or actions required by the proponent.

Warnings: Issues that should be considered by the proponent.

Comments: General information relating to the topic.

[1] **REQUIREMENTS:**

For sites with an average slope of proposed land disturbance greater than 10%, a preliminary ESCP must be submitted to the regulatory authority for approval during planning negotiations.

Proponents must demonstrate that adequate erosion and sediment control measures can be implemented on-site to effectively protect downstream environmental values.

If site or financial constraints suggest that it is not reasonable or practicable for the prescribed water quality objectives to be achieved for the proposal, then the proponent must demonstrate that alternative designs or construction techniques (e.g. pole homes, suspended slab) cannot reasonably be implemented on the site.

WARNINGS:

Steep sites usually require more stringent drainage and erosion controls than flatter grade sites.

COMMENTS:

The steeper the land, the greater the need for adequate drainage controls to prevent soil and mulch from being washed from the site.

[2] **REQUIREMENTS:**

If the actual soil K-factor is known from soil testing, then the Score shall be determined from Table 1.

If a preliminary ESCP is required during planning negotiations, then it must be demonstrated that adequate space is available for the construction and operation of any major sediment traps, including the provision for any sediment basins and their associated embankments and spillways. It must also be demonstrated that all reasonable and practicable measures can be taken to divert the maximum quantity of sediment-laden runoff (up to the specified design storm) to these sediment traps throughout the construction phase and until the contributing catchment is adequately stabilised against erosion.

WARNINGS: -

The higher the point score, the greater the need to protect the soil from raindrop impact and thus the greater the need for effective erosion control measures. A point score of 2 or greater will require a greater emphasis to be placed on revegetation techniques that do not expose the soil to direct rainfall contact during vegetation establishment, e.g. turfing and *Hydro mulching*.

COMMENTS:

Table 2 provides an *indication* of soil conditions likely to be associated with a particular Soil group based on a statistical analysis of soil testing across NSW. This table provides only an initial estimate of the likely soil conditions.

The left-hand-side of the table provides an indication of the type of sediment basin that will be required (Type C, F or D). The right-hand-side of the table provides an indication of the likely erodibility of the soil based on the Revised Universal Soil Loss Equation (RUSLE) K-factor.

Table 3 provides some general comments on the erosion potential of the various soil groups.

Table 1 – Score if soil K-factor is known

	RUSLE soil erodibility K-factor			
	K < 0.02	0.02<K<0.04	0.04<K<0.06	K > 0.06
Score	0	1	2	3

Table 2 – Statistical analysis of NSW soil data [1]

Unified Soil Class System	Likely sediment basin classification (%)			Probable soil erodibility K-factor (%) [2]			
	Dry	Wet		Low	Moderate	High	Very High
	Type C	Type F	Type D	K < 0.02	0.02<K<0.04	0.04<K<0.06	K > 0.06
GM	30	58	12	12	51	26	12
GC	42	33	25	13	71	17	0
SW	40	48	12	49	39	12	0
SP	53	32	15	76	18	5	1
SM	21	67	12	26	48	25	1
SC	26	50	24	16	64	18	2
ML	5	63	32	4	35	45	16
CL	9	51	39	12	56	19	13
OL	2	80	18	34	61	5	1
MH	12	41	48	15	19	41	25
CH	5	44	51	39	43	11	7

Notes: [1] Analysis of soil data presented in Landcom (2004).
[2] Soil erodibility based on Revised Universal Soil Loss Equation (RUSLE) K-factor.

Unified Soil Classification System (USCS)

GW Well graded gravels, gravel-sand mixtures, little or no fines
GP Poorly graded gravels, gravel-sand mixture, little or no fines
GM Silty gravels, poorly graded gravel-sand-silt mixtures
GC Clayey gravels, poorly graded gravel-sand-clay mixtures SW Well graded sands, gravelly sands, little or no fines
SP Poorly graded sands, gravelly sands, little or no fines
SM Silty sands, poorly graded sand-silt mixtures
SC Clayey sands, poorly graded sand-clay mixtures
ML Inorganic silts & very fine sands, rock flour, silty or clayey fine sands with slight plasticity
CL Inorganic clays, low–medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
OL Organic silts and organic silt-clays of low plasticity
MH Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
CH Inorganic clays of high plasticity, fat clays
OH Organic clays of medium to high plasticity

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Table 3 – Typical properties of various soil groups [1]

Soil Groups	Typical properties [2]
GW, GP	Low erodibility potential.
GM, GC	Low to medium erodibility potential. May create turbid runoff if disturbed as a result of the release of silt and clay particles.
SW, SP	Low to medium erodibility potential.
SM, SC	Medium erodibility potential. May create turbid runoff if disturbed as a result of the release of silt and clay particles.
MH, CH	Highly variable (low to high) erodibility potential. Will generally create turbid runoff if disturbed.
ML, CL	High erodibility potential. Tendency to be dispersive. May create some turbidity in runoff if disturbed.

Note: [1] After Soil Services & NSW DLWC (1998).
[2] Any soil can represent a high erosion risk if the binding clays or silts are unstable.

Table 4 provides **general** guidelines on the suitability of various soil groups to various engineering applications.

Table 4 – Engineering suitability based on Unified Soil Classification [1]

Unified Soil Class	USC Group	Embankments		Fill	Slope stability	Untreated roads
		Water retaining	Non- water retaining			
Well graded gravels	GW	Unsuitable	Excellent	Excellent	Excellent	Average
Poorly graded gravel	GP	Unsuitable	Average	Excellent	Average	Unsuitable
Silty gravels	GM	Unsuitable	Average	Good	Average	Average
Clayey gravels	GC	Suitable	Average	Good	Average	Excellent
Well graded sands	SW	Unsuitable	Excellent	Excellent	Excellent	Average
Poorly graded sands	SP	Unsuitable	Average	Good	Average	Unsuitable
Silty sands	SM	Suitable [2]	Average	Average	Average	Poor
Clayey sands	SC	Suitable	Average	Average	Average	Good
Inorganic silts	ML	Unsuitable	Poor	Average	Poor	Unsuitable
Inorganic clays	CL	Suitable [2]	Good	Average	Good	Poor
Organic silts	OL	Unsuitable	Unsuitable	Poor	Unsuitable	Unsuitable
Inorganic silts	MH	Unsuitable	Poor	Poor	Poor	Unsuitable
Inorganic clays	CH	Suitable [2]	Average	Unsuitable	Average	Unsuitable
Organic clays	OH	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable
Highly organic soils	Pt	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable

Unified Soil Class	USC Group	Embankments		Fill	Slope stability	Untreated roads
		Water retaining	Non- water retaining			
Notes: [1] Modified from Hazelton & Murphy (1992) [2] Suitable only after modifications to soil such as compaction and/or erosion protection						

[3] If the soils have not been tested for Emerson Class, then adopt a score of 4.

REQUIREMENTS:

Works proposed on sites containing Emerson Class 1 or 2 soils have a very high pollution potential and must submit a conceptual ESCP to the regulatory authority for review and/or approval (as required by the authority) during planning negotiations.

WARNINGS:

Class 3 and 5 soils disturbed by cut and fill operations or construction traffic are highly likely to discolour stormwater (i.e. cause turbid runoff). Chemical stabilisation will likely be required if these soils are placed immediately adjacent to a retaining wall. Any disturbed Class 1, 2, 3 and 5 soils that are to be revegetated must be covered with a non-dispersive topsoil as soon as possible (unless otherwise agreed by the regulatory authority).

Class 1 and 2 soils are highly likely to discolour (pollute) stormwater if exposed to rainfall or flowing water. Treatment of these soils with gypsum (or other suitable substance) will most likely be required. These soils should not be placed directly behind a retaining wall unless it has been adequately treated (stabilised) or covered with a non-dispersible soil.

[4] The duration of disturbance refers to the total duration of soil exposure to rainfall up until a time when there is at least 70% coverage of all areas of soil.

REQUIREMENTS:

All land developments with an expected soil disturbance period greater than 6 months must submit a conceptual ESCP to the regulatory authority for review and/or approval (as required by the authority) during planning negotiations.

COMMENTS:

Construction periods greater than 3 months will generally experience at least some significant storm events, independent of the time of year that the construction (soil disturbance) occurs.

[5] **REQUIREMENTS:**

Development proposals with an expected soil disturbance in excess of 1ha must submit a conceptual ESCP to the regulatory authority for review and/or approval (as required by the regulatory authority) during planning negotiations.

The area of disturbance refers to the total area of soil exposed to rainfall or dust-producing winds either as a result of:

(a) the removal of ground cover vegetation, mulch or sealed surfaces;
(b) past land management practices;
(c) natural conditions.

WARNINGS:

A *Sediment Basin* will usually be required if the disturbed area exceeds 0.25ha (2500m^2) within any sub-catchment (i.e. land flowing to one outlet point).

COMMENTS:

For soil disturbances greater than 0.25ha, the revegetation phase should be staged to minimise the duration for which soils are exposed to wind, rain and concentrated runoff.

[6] **REQUIREMENTS:**

All developments that involve earthworks or construction within a natural watercourse (whether that

watercourse is in a natural or modified condition) must submit a conceptual ESCP to the regulatory authority for review and/or approval (as required by the regulatory authority) during planning negotiations.

Permits and/or licences may be required from the State Government, including possible submission of the ESCP to the relevant Government department.

[7] **REQUIREMENTS:**

No areas of soil disturbance shall be left exposed to rainfall or dust-producing winds at the end of a development without an adequate degree of protection and/or an appropriate action plan for the establishment of at least 70% cover.

COMMENTS:

Grass seeding without the application of a light mulch cover is considered the least favourable revegetation technique. A light mulch cover is required to protect the soil from raindrop impact, excessive temperature fluctuations, and the loss of essential soil moisture.

[8] **COMMENTS:**

All receiving waters can be adversely affected by unnatural quantities of sediment-laden runoff. Freshwater ecosystems are generally more susceptible to ecological harm resulting from the inflow of fine or dispersible clays than saline water bodies. The further inland a land disturbance is, the greater the potential for the released sediment to cause environmental harm as this sediment travels towards the coast.

For the purpose of this clause it is assumed that all sediment-laden runoff will eventually flow into saline waters. Thus, sediment-laden discharges that flow first into freshwater are likely to adversely affect both fresh and saline water bodies and are therefore considered potentially more damaging to the environment.

This clause does **not** imply that sediment-laden runoff will not cause harm to saline waters.

[9] **COMMENTS:**

This clause refers to subsoils exposed during the construction phase either as a result of past land practices or proposed construction activities. The exposure of subsoils resulting from the excavation of minor service trenches should not be considered.

[10] **WARNINGS:**

The greater the extent of external catchment, the greater the need to divert up-slope stormwater runoff around any soil disturbance.

COMMENTS:

The ability to separate “clean” (i.e. external catchment) stormwater runoff from “dirty” site runoff can have a significant effect on the size, efficiency and cost of the temporary drainage, erosion, and sediment control measures.

[11] **REQUIREMENTS:**

Permission must be obtained from the owner of a road reserve before placing any erosion and sediment control measures within the road reserve.

WARNINGS:

Few sediment control techniques work efficiently when placed on a road and/or around roadside stormwater inlets. Great care must be taken if sediment control measures are located on a public roadway, specifically:

- safety issues relating to road users;
- the risk of causing flooding on the road or within private property.

The construction of roads (whether temporary or permanent) will usually modify the flow path of stormwater runoff. This can affect how “dirty” site runoff is directed to the sediment control measures.

COMMENTS:

“On-road” sediment control devices are at best viewed as secondary or supplementary sediment control measures. Only in special cases and/or on very small projects (e.g. kerb and channel replacement) might these controls be considered as the “primary” sediment control measure.

[12] **WARNINGS:**

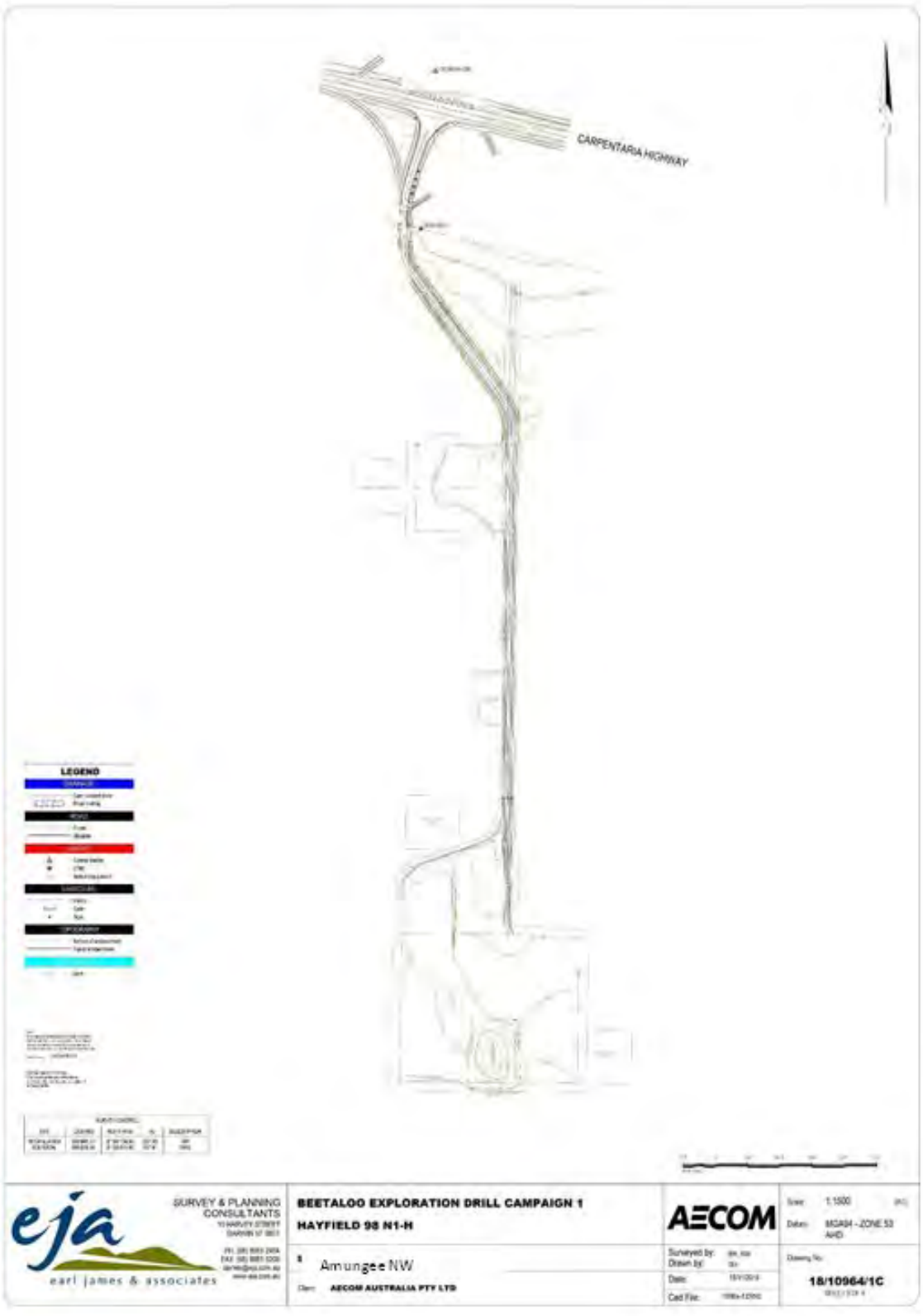
Soils with a pH less than 5.5 or greater than 8 will usually require treatment in order to achieve satisfactory revegetation. Soils with a pH of less than 5 (whether naturally acidic or in acid sulfate soil areas) may also

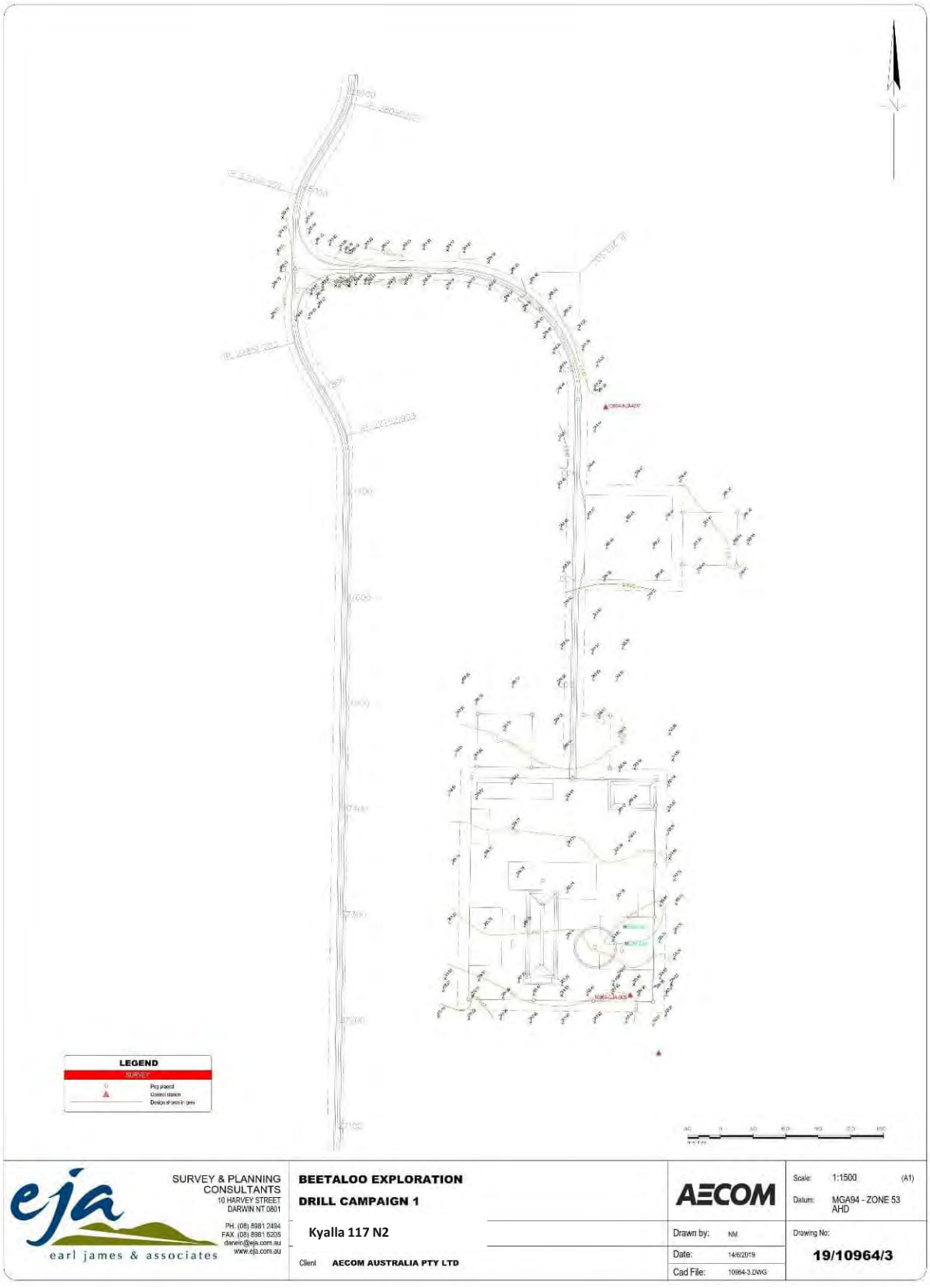
limit the choice of chemical flocculants (e.g. Alum) for use in the flocculation of *Sediment Basins*.

[13] **REQUIREMENTS:**

A preliminary ESCP must be submitted to the local government for approval during the planning phase for any development that obtains a total point score of 17 or greater or when any trigger value is scored or exceeded.

APPENDIX B Well pad and highway topographical survey

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SURVEY
SURVEY & PLANNING CONSULTANTS
10 HARVEY STREET
DARWIN NT 0801
PH. (08) 8981 2484
FAX. (08) 8981 5205
darwin@eja.com.au
www.eja.com.au
earl james & associates
BEETALOO EXPLORATION
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AECOM
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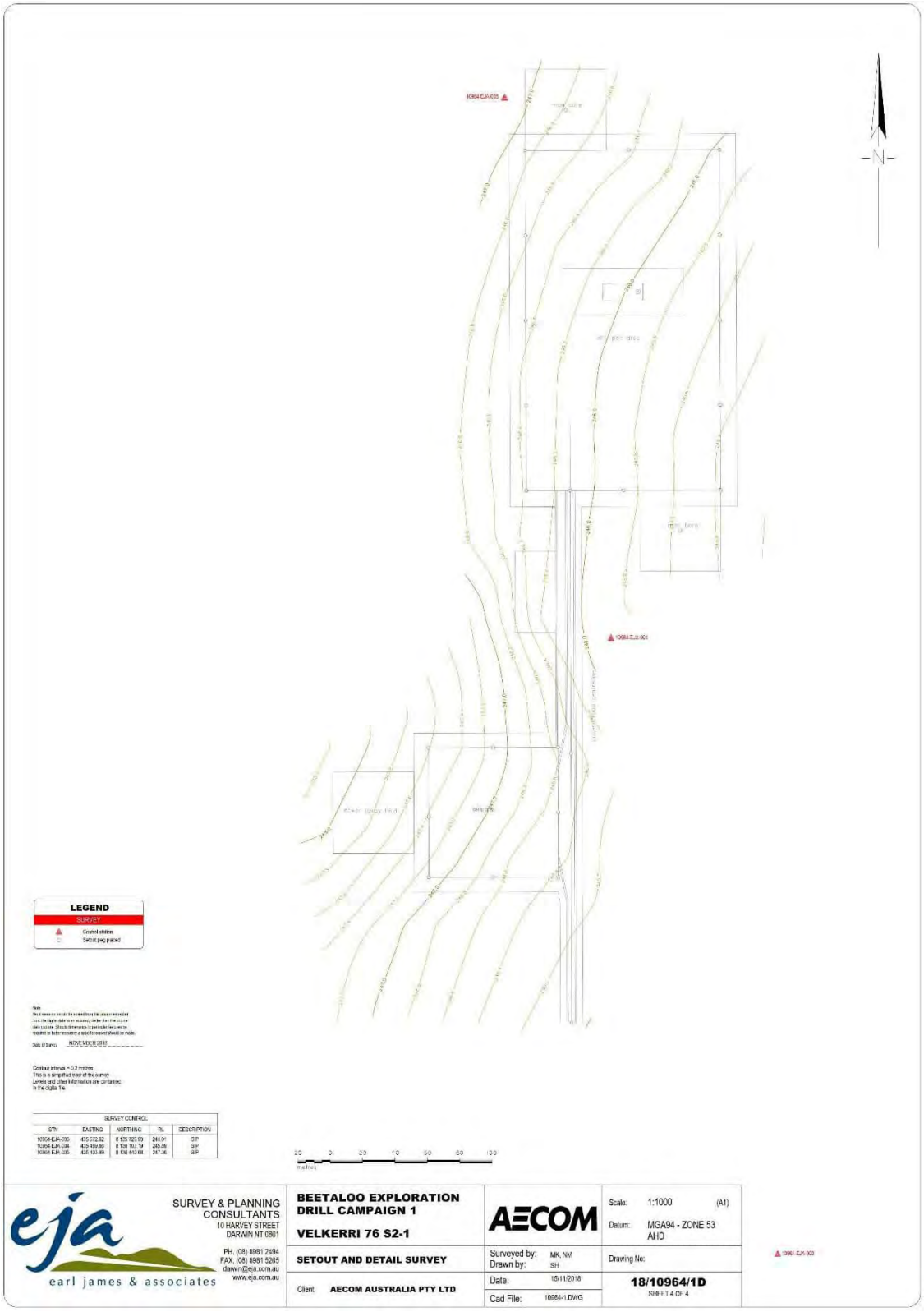
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Contour interval = 0.2 metres
This is a simplified map of the survey.
Levels and other information are contained in the digital file.
20 0 20 40 60 80 100
metres
N
SURVEY & PLANNING CONSULTANTS
10 HARVEY STREET
DARWIN NT 0801
PH. (08) 8981 2494
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darwin@eja.com.au
www.eja.com.au
earl james & associates
BEETALOO EXPLORATION DRILL CAMPAIGN 1
VELKERRI 76 S2-1
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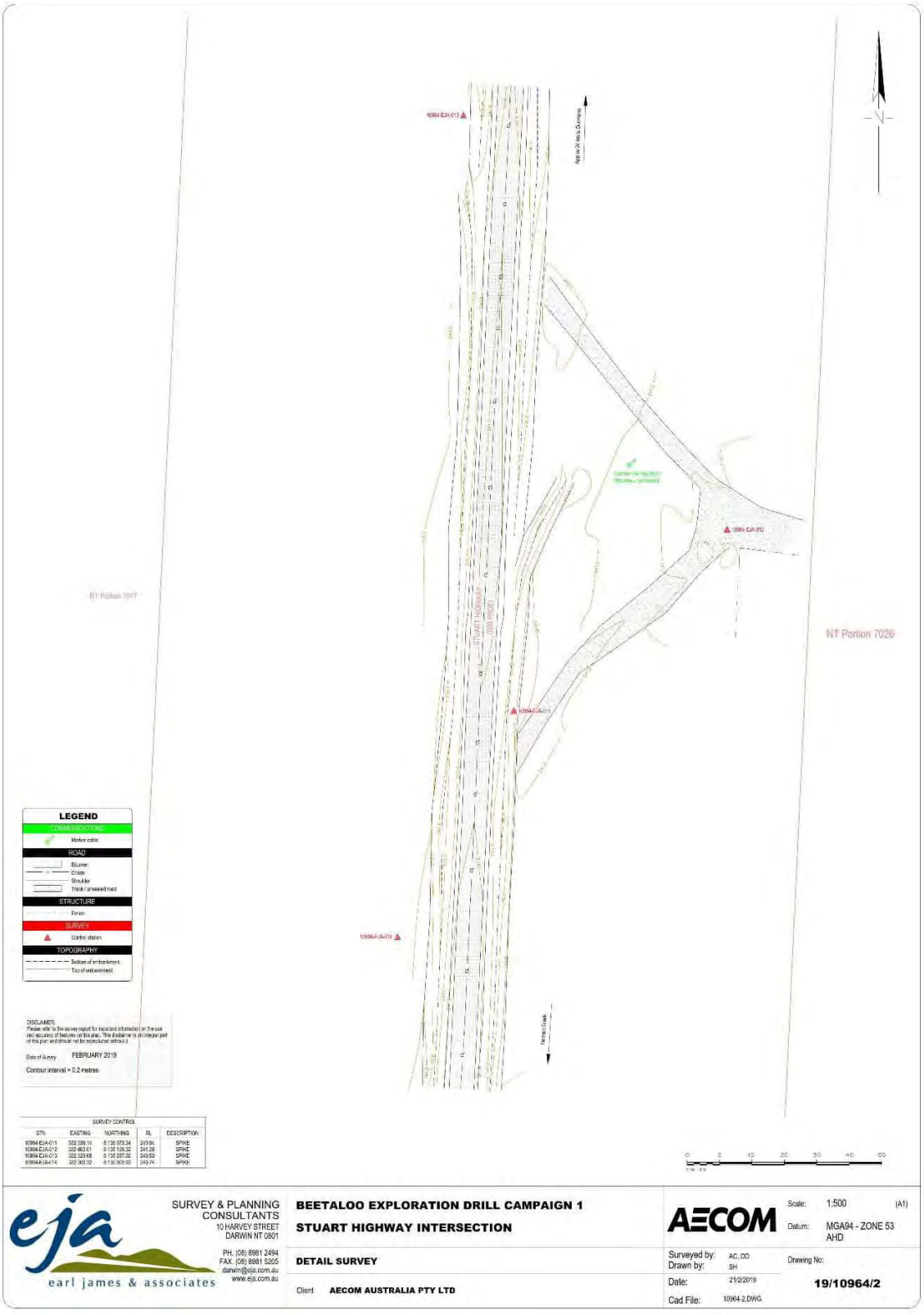
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STRUCTURE
SURVEY
TOPOGRAPHY
NT Portion 7026
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DISCLAIMER
Date of survey FEBRUARY 2019
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BEETALOO EXPLORATION DRILL CAMPAIGN 1
STUART HIGHWAY INTERSECTION
DETAIL SURVEY
Client AECOM AUSTRALIA PTY LTD
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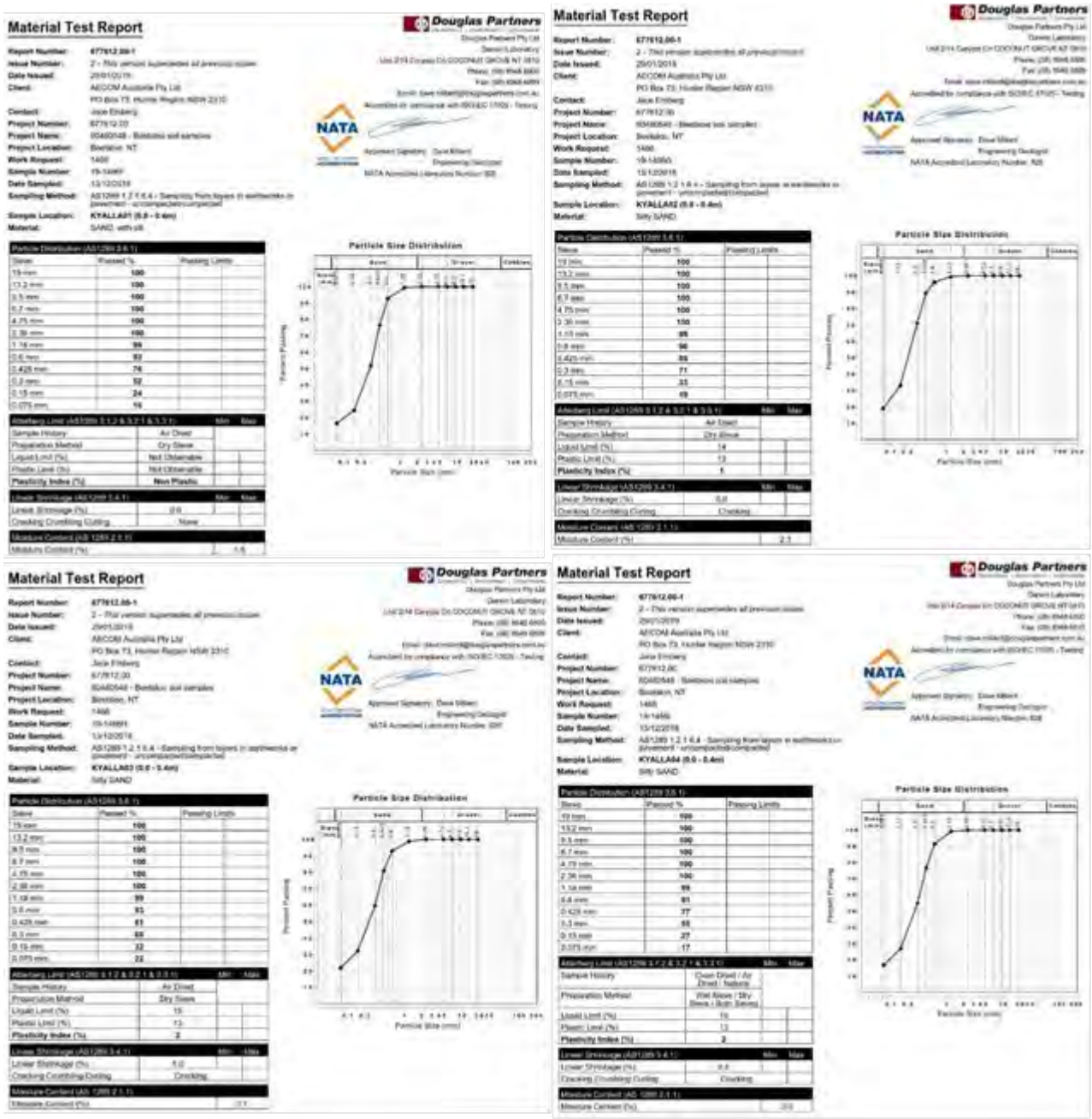
APPENDIX C Geotechnical laboratory results



Material Test Report

Douglas Partners

Particle Size Distribution

Material Test Report

Douglas Partners

Particle Size Distribution

Material Test Report

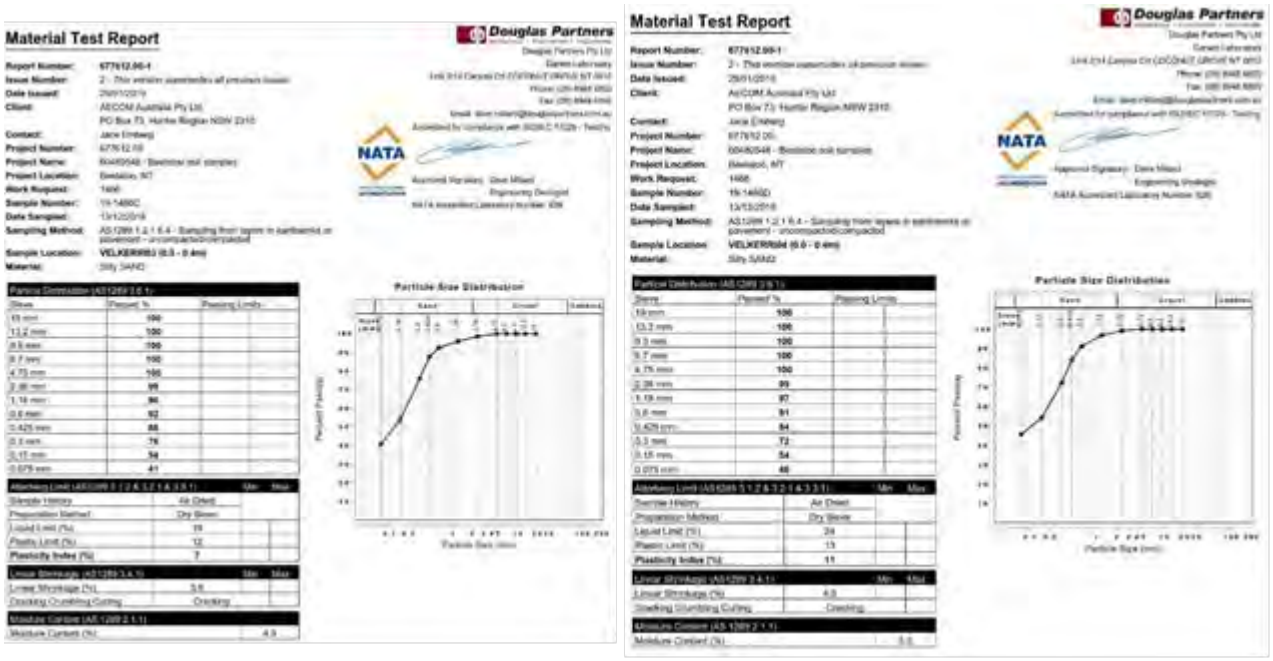
Douglas Partners

Particle Size Distribution

Material Test Report

Douglas Partners

Particle Size Distribution



Material Test Report

Douglas Partners

NATA

Particle Size Distribution

Material Test Report

Douglas Partners

NATA

Particle Size Distribution

Material Test Report

Report Number: 220270.00-2
Issue Number: 1
Date Issued: 21/04/2023
Client: AECOM Australia Pty Ltd
PO Box 3175, Darwin NT 0801
Contact: William Iddell
Project Number: 220270.00
Project Name: Material Testing
Project Location: Beetaloo basin, Beetaloo N.t
Work Request: 4919
Sample Number: DW 4919G
Date Sampled: 02/04/2023
Dates Tested: 13/04/2023 - 20/04/2023
Sampling Method: Sampled by Client
The results apply to the sample as received
Sample Location: **Shenandoah NA (Option 2)**
Material: Sandy Clay

Particle Size Distribution (AS1289 3.6.1)

Sieve	Passed %	Passing Limits
9.7 mm	100	
4.75 mm	100	
2.36 mm	99	
1.18 mm	96	
0.6 mm	93	
0.425 mm	89	
0.3 mm	77	
0.15 mm	54	
0.075 mm	46	

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1) Min Max

Sample History	Air Dried
Preparation Method	Wet Sieve
Liquid Limit (%)	25
Plastic Limit (%)	12
Plasticity Index (%)	**13**

Linear Shrinkage (AS1289 3.4.1) Min Max

Moisture Condition Determined By	AS 1289.3.1.2
Linear Shrinkage (%)	**6.5**
Cracking Crumbling Curling	Cracking

Emerson Class Number of a Soil (AS 1289 3.8.1) Min Max

Emerson Class	**6**
Soil Description	Natural Soil
Nature of Water	Distilled Water
Temperature of Water (°C)	25.5

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Douglas Partners Pty Ltd
Darwin Laboratory
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Phone: (08) 8948 6800
Email: Sunil.Sukhdeo@douglaspartners.com.au

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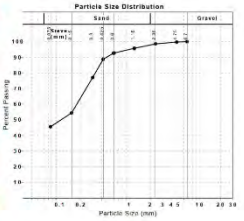
Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Sunil Sukhdeo
Laboratory Manager
Laboratory Accreditation Number: 828

Particle Size Distribution



Material Test Report

Report Number: 220270.00-2
Issue Number: 1
Date Issued: 21/04/2023
Client: AECOM Australia Pty Ltd
PO Box 3175, Darwin NT 0801
Contact: William Iddell
Project Number: 220270.00
Project Name: Material Testing
Project Location: Beetaloo basin, Beetaloo N.t
Work Request: 4919
Sample Number: DW 4919F
Date Sampled: 02/04/2023
Dates Tested: 13/04/2023 - 20/04/2023
Sampling Method: Sampled by Client
The results apply to the sample as received
Sample Location: **Amungee NW3**
Material: Clayey Gravelly Sand

Particle Size Distribution (AS1289 3.6.1)

Sieve	Passed %	Passing Limits
26.5 mm	100	
19 mm	99	
13.2 mm	98	
9.5 mm	97	
6.7 mm	94	
4.75 mm	91	
2.36 mm	65	
1.18 mm	45	
0.6 mm	40	
0.425 mm	39	
0.3 mm	37	
0.15 mm	28	
0.075 mm	20	

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1) Min Max

Sample History	Air Dried
Preparation Method	Wet Sieve
Liquid Limit (%)	18
Plastic Limit (%)	10
Plasticity Index (%)	**8**

Linear Shrinkage (AS1289 3.4.1) Min Max

Moisture Condition Determined By	AS 1289.3.1.2
Linear Shrinkage (%)	**4.5**
Cracking Crumbling Curling	Cracking

Emerson Class Number of a Soil (AS 1289 3.8.1) Min Max

Emerson Class	**3**
Soil Description	Natural Soil
Nature of Water	Distilled Water
Temperature of Water (°C)	25.5

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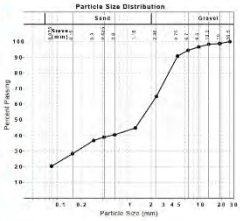
Approved Signatory: Sunil Sukhdeo
Laboratory Manager
Laboratory Accreditation Number: 828

Particle Size Distribution



Material Test Report

Report Number: 220270.00-2
Issue Number: 1
Date Issued: 21/04/2023
Client: AECOM Australia Pty Ltd
PO Box 3175, Darwin NT 0801
Contact: William Iddell
Project Number: 220270.00
Project Name: Material Testing
Project Location: Beetaloo basin, Beetaloo N.t
Work Request: 4919
Sample Number: DW 4919E
Date Sampled: 01/04/2023
Dates Tested: 13/04/2023 - 19/04/2023
Sampling Method: Sampled by Client
The results apply to the sample as received
Sample Location: **Shenandoah NA (Option 1)**
Material: Clayey Sand

Particle Size Distribution (AS1289 3.6.1)

Sieve	Passed %	Passing Limits
19 mm	100	
13.2 mm	100	
9.5 mm	100	
6.7 mm	99	
4.75 mm	98	
2.36 mm	95	
1.18 mm	91	
0.6 mm	90	
0.425 mm	87	
0.3 mm	78	
0.15 mm	54	
0.075 mm	46	

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1) Min Max

Sample History	Air Dried
Preparation Method	Wet Sieve
Liquid Limit (%)	19
Plastic Limit (%)	11
Plasticity Index (%)	**8**

Linear Shrinkage (AS1289 3.4.1) Min Max

Moisture Condition Determined By	AS 1289.3.1.2
Linear Shrinkage (%)	**4.0**
Cracking Crumbling Curling	None

Emerson Class Number of a Soil (AS 1289 3.8.1) Min Max

Emerson Class	**3**
Soil Description	Natural Soil
Nature of Water	Distilled Water
Temperature of Water (°C)	25.5

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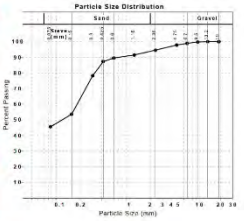
Approved Signatory: Sunil Sukhdeo
Laboratory Manager
Laboratory Accreditation Number: 828

Particle Size Distribution



Material Test Report

Report Number: 220270.00-2
Issue Number: 1
Date Issued: 21/04/2023
Client: AECOM Australia Pty Ltd
PO Box 3175, Darwin NT 0801
Contact: William Iddell
Project Number: 220270.00
Project Name: Material Testing
Project Location: Beetaloo basin, Beetaloo N.t
Work Request: 4919
Sample Number: DW 4919D
Date Sampled: 01/04/2023
Dates Tested: 13/04/2023 - 19/04/2023
Sampling Method: Sampled by Client
The results apply to the sample as received
Sample Location: **Shenandoah SB**
Material: Silty Sand

Particle Size Distribution (AS1289 3.6.1)

Sieve	Passed %	Passing Limits
9.7 mm	100	
4.75 mm	100	
2.36 mm	100	
1.18 mm	99	
0.6 mm	95	
0.425 mm	86	
0.3 mm	62	
0.15 mm	34	
0.075 mm	27	

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1) Min Max

Sample History	Air Dried
Preparation Method	Wet Sieve
Liquid Limit (%)	14
Plastic Limit (%)	10
Plasticity Index (%)	**4**

Linear Shrinkage (AS1289 3.4.1) Min Max

Moisture Condition Determined By	AS 1289.3.1.2
Linear Shrinkage (%)	**2.0**
Cracking Crumbling Curling	None

Emerson Class Number of a Soil (AS 1289 3.8.1) Min Max

Emerson Class	**3**
Soil Description	Natural Soil
Nature of Water	Distilled Water
Temperature of Water (°C)	25.5

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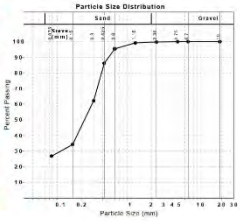
Laboratory Manager
Laboratory Accreditation Number: 828

Particle Size Distribution



Material Test Report

Report Number: 220270.00-2
Issue Number: 1
Date Issued: 21/04/2023
Client: AECOM Australia Pty Ltd
PO Box 3175, Darwin NT 0801
Contact: William Iddell
Project Number: 220270.00
Project Name: Material Testing
Project Location: Beetaloo basin, Beetaloo N1
Work Request: 4919
Sample Number: DW 4919C
Date Sampled: 31/03/2023
Dates Tested: 13/04/2023 - 19/04/2023
Sampling Method: Sampled by Client
The results apply to the sample as received
Sample Location: Shenandoah SC
Material: Sandy Clay With Gravel

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Laboratory Manager
Laboratory Accreditation Number: 828

Particle Size Distribution (AS1289 3.6.1)

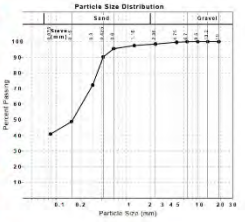
Sieve	Passed %	Passing Limits
19 mm	100	
13.2 mm	100	
9.5 mm	100	
6.7 mm	100	
4.75 mm	100	
2.36 mm	98	
1.18 mm	98	
0.6 mm	95	
0.425 mm	90	
0.3 mm	72	
0.15 mm	49	
0.075 mm	41	

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)	Min	Max
Sample History	Air Dried	
Preparation Method	Wet Sieve	
Liquid Limit (%)	22	
Plastic Limit (%)	12	
Plasticity Index (%)	**10**	

Linear Shrinkage (AS1289 3.4.1)	Min	Max
Moisture Condition Determined By	AS 1289.3.1.2	
Linear Shrinkage (%)	5.0	
Cracking Crumbling Curling	Cracking	

Emerson Class Number of a Soil (AS 1289 3.8.1)	Min	Max
Emerson Class	3	
Soil Description	Natural Soil	
Nature of Water	Distilled water	
Temperature of Water (°C)	25.5	

Particle Size Distribution



Material Test Report

Report Number: 220270.00-2
Issue Number: 1
Date Issued: 21/04/2023
Client: AECOM Australia Pty Ltd
PO Box 3175, Darwin NT 0801
Contact: William Iddell
Project Number: 220270.00
Project Name: Material Testing
Project Location: Beetaloo basin, Beetaloo N1
Work Request: 4919
Sample Number: DW 4919S
Date Sampled: 03/04/2023
Dates Tested: 13/04/2023 - 19/04/2023
Sampling Method: Sampled by Client
The results apply to the sample as received
Sample Location: Amungee NW4
Material: Silty Sand with Gravel

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Approved Signatory: Sunil Sukhdeo
Laboratory Manager
Laboratory Accreditation Number: 828

Particle Size Distribution (AS1289 3.6.1)

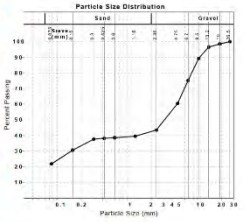
Sieve	Passed %	Passing Limits
26.5 mm	100	
19 mm	99	
13.2 mm	97	
9.5 mm	89	
6.7 mm	75	
4.75 mm	60	
2.36 mm	43	
1.18 mm	40	
0.6 mm	39	
0.425 mm	38	
0.3 mm	38	
0.15 mm	31	
0.075 mm	22	

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)	Min	Max
Sample History	Air Dried	
Preparation Method	Wet Sieve	
Liquid Limit (%)	16	
Plastic Limit (%)	12	
Plasticity Index (%)	**4**	

Linear Shrinkage (AS1289 3.4.1)	Min	Max
Moisture Condition Determined By	AS 1289.3.1.2	
Linear Shrinkage (%)	1.0	
Cracking Crumbling Curling	Cracking	

Emerson Class Number of a Soil (AS 1289 3.8.1)	Min	Max
Emerson Class	5	
Soil Description	Natural Soil	
Nature of Water	Distilled water	
Temperature of Water (°C)	25.5	

Particle Size Distribution



Material Test Report

Report Number: 220270.00-2
Issue Number: 1
Date Issued: 21/04/2023
Client: AECOM Australia Pty Ltd
PO Box 3175, Darwin NT 0801
Contact: William Iddell
Project Number: 220270.00
Project Name: Material Testing
Project Location: Beetaloo basin, Beetaloo N1
Work Request: 4919
Sample Number: DW 4919A
Date Sampled: 31/03/2023
Dates Tested: 13/04/2023 - 19/04/2023
Sampling Method: Sampled by Client
The results apply to the sample as received
Sample Location: Shenandoah SA
Material: Silty Sand with Gravel

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Email: Sunil.Sukhdeo@douglaspartners.com.au

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Approved Signatory: Sunil Sukhdeo
Laboratory Manager
Laboratory Accreditation Number: 828

Particle Size Distribution (AS1289 3.6.1)

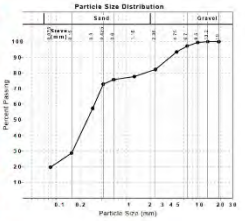
Sieve	Passed %	Passing Limits
19 mm	100	
13.2 mm	100	
9.5 mm	99	
6.7 mm	97	
4.75 mm	93	
2.36 mm	82	
1.18 mm	78	
0.6 mm	76	
0.425 mm	73	
0.3 mm	67	
0.15 mm	29	
0.075 mm	20	

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)	Min	Max
Sample History	Air Dried	
Preparation Method	Wet Sieve	
Liquid Limit (%)	13	
Plastic Limit (%)	11	
Plasticity Index (%)	**2**	

Linear Shrinkage (AS1289 3.4.1)	Min	Max
Moisture Condition Determined By	AS 1289.3.1.2	
Linear Shrinkage (%)	5.0	
Cracking Crumbling Curling	Cracking	

Emerson Class Number of a Soil (AS 1289 3.8.1)	Min	Max
Emerson Class	3	
Soil Description	Natural Soil	
Nature of Water	Distilled Water	
Temperature of Water (°C)	25.5	

Particle Size Distribution



Material Test Report

Report Number: 220270.00-2
Issue Number: 1
Date Issued: 21/04/2023
Client: AECOM Australia Pty Ltd
PO Box 3175, Darwin NT 0801
Contact: William Iddell
Project Number: 220270.00
Project Name: Material Testing
Project Location: Beetaloo basin, Beetaloo N1
Work Request: 4919
Sample Number: DW 4919H
Date Sampled: 03/04/2023
Dates Tested: 13/04/2023 - 20/04/2023
Sampling Method: Sampled by Client
The results apply to the sample as received
Sample Location: Shenandoah NB
Material: Silty Sandy Gravel

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Darwin Laboratory
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Email: Sunil.Sukhdeo@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Sunil Sukhdeo
Laboratory Manager
Laboratory Accreditation Number: 828

Particle Size Distribution (AS1289 3.6.1)

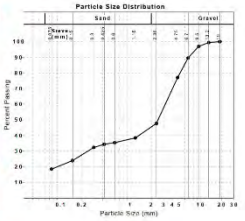
Sieve	Passed %	Passing Limits
19 mm	100	
13.2 mm	99	
9.5 mm	97	
6.7 mm	90	
4.75 mm	77	
2.36 mm	48	
1.18 mm	38	
0.6 mm	35	
0.425 mm	34	
0.3 mm	32	
0.15 mm	24	
0.075 mm	18	

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)	Min	Max
Sample History	Air Dried	
Preparation Method	Wet Sieve	
Liquid Limit (%)	15	
Plastic Limit (%)	11	
Plasticity Index (%)	**4**	

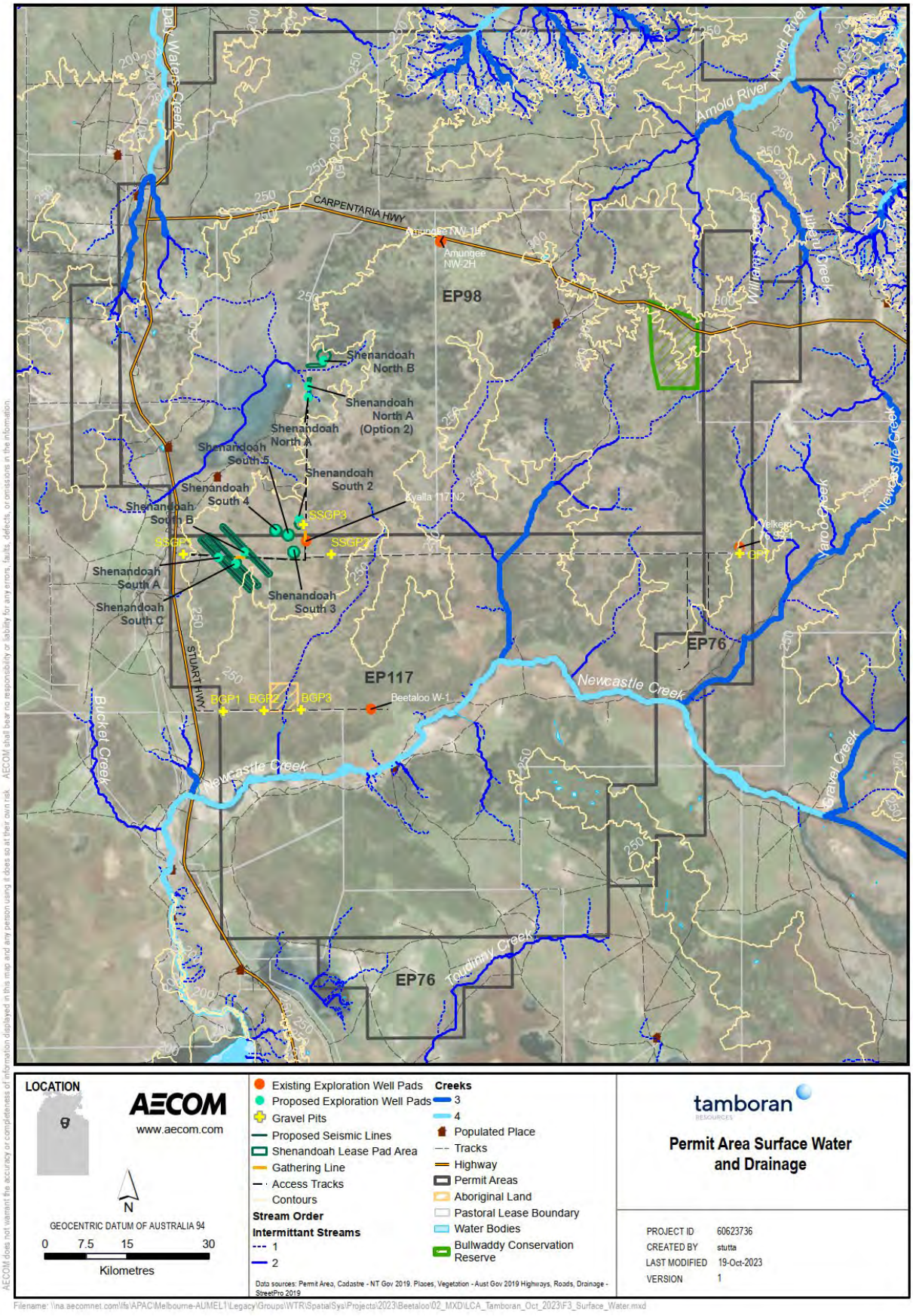
Linear Shrinkage (AS1289 3.4.1)	Min	Max
Moisture Condition Determined By	AS 1289.3.1.2	
Linear Shrinkage (%)	3.0	
Cracking Crumbling Curling	Cracking	

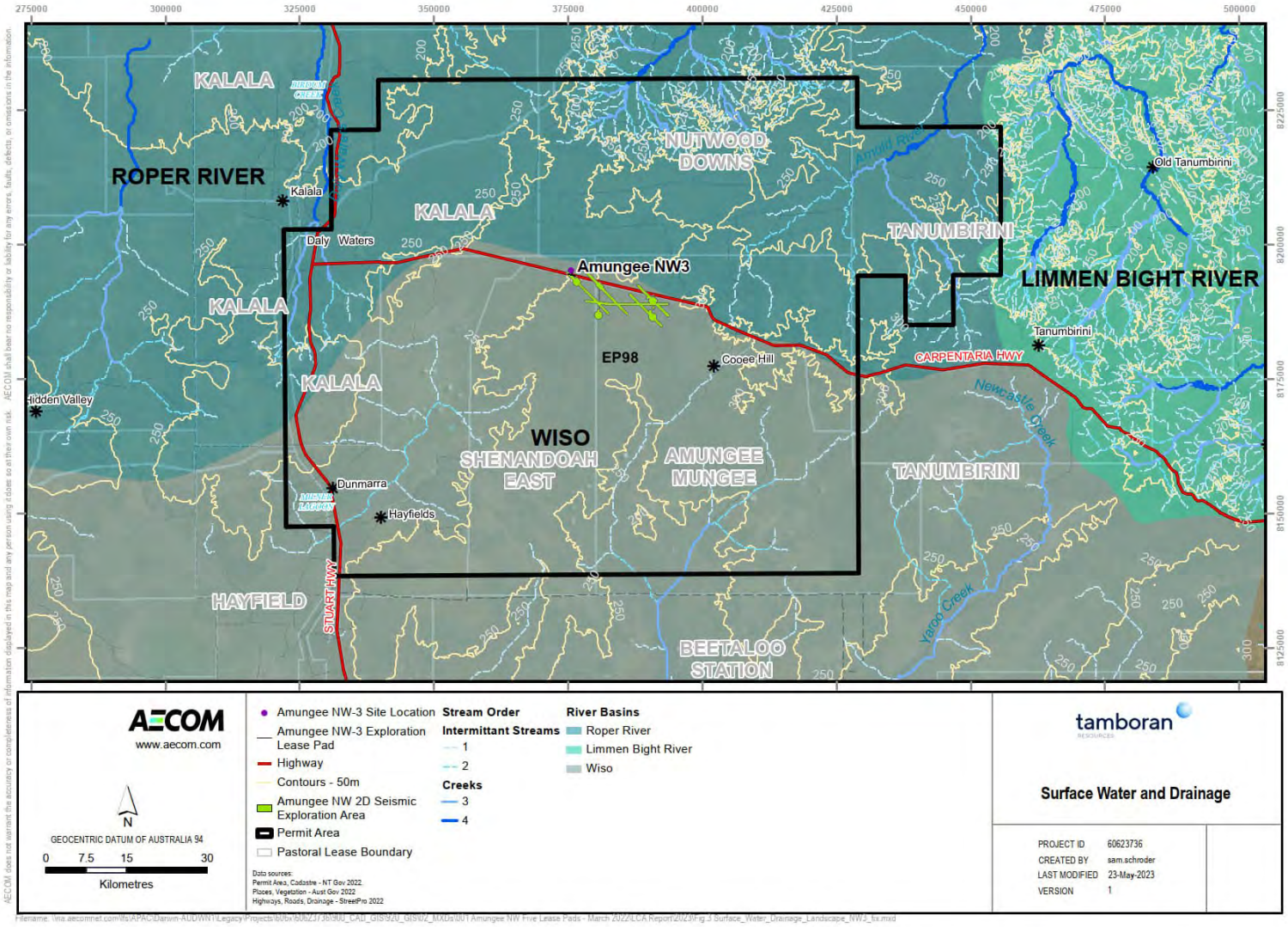
Emerson Class Number of a Soil (AS 1289 3.8.1)	Min	Max
Emerson Class	3	
Soil Description	Natural Soil	
Nature of Water	Distilled Water	
Temperature of Water (°C)	25.5	

Particle Size Distribution



APPENDIX D Permit area surface water




KALALA
ROPER RIVER
Kalala
NUTWOOD DOWNS
Old Tanumbirini
KALALA
TANUMBIRINI
Daly Waters
Amungee NW3
LIMMEN BIGHT RIVER
KALALA
Tanumbirini
EP98
Cooee Hill
CARPENTARIA HWY
KALALA
Hidden Valley
WISO
SHENANDOAH EAST
AMUNGEE MUNGEE
TANUMBIRINI
Dunmarra
Hayfields
HAYFIELD
STUART HWY
BEETALOO STATION
Yarrar Creek
AECOM
www.aecom.com
N
GEOCENTRIC DATUM OF AUSTRALIA 94
0 7.5 15 30
Kilometres
Amungee NW-3 Site Location
Amungee NW-3 Exploration Lease Pad
Highway
Contours - 50m
Amungee NW 2D Seismic Exploration Area
Permit Area
Pastoral Lease Boundary
Stream Order
Intermittant Streams
1
2
Creeks
3
4
River Basins
Roper River
Limmen Bight River
Wiso
tamboran RESOURCES
Surface Water and Drainage
PROJECT ID 60623736
CREATED BY sam.schroder
LAST MODIFIED 23-May-2023
VERSION 1

APPENDIX E Erosion and sediment control plans:

- **Amungee NW**
- **Amungee NW-2**
- **Amungee NW-3**
- **Amungee NW-4**
- **Amungee NW-5**
- **Shenandoah South A**
- **Shenandoah South B**
- **Shenandoah South C**
- **Shenandoah South 2**
- **Shenandoah North A**
- **Shenandoah North A (option 2)**

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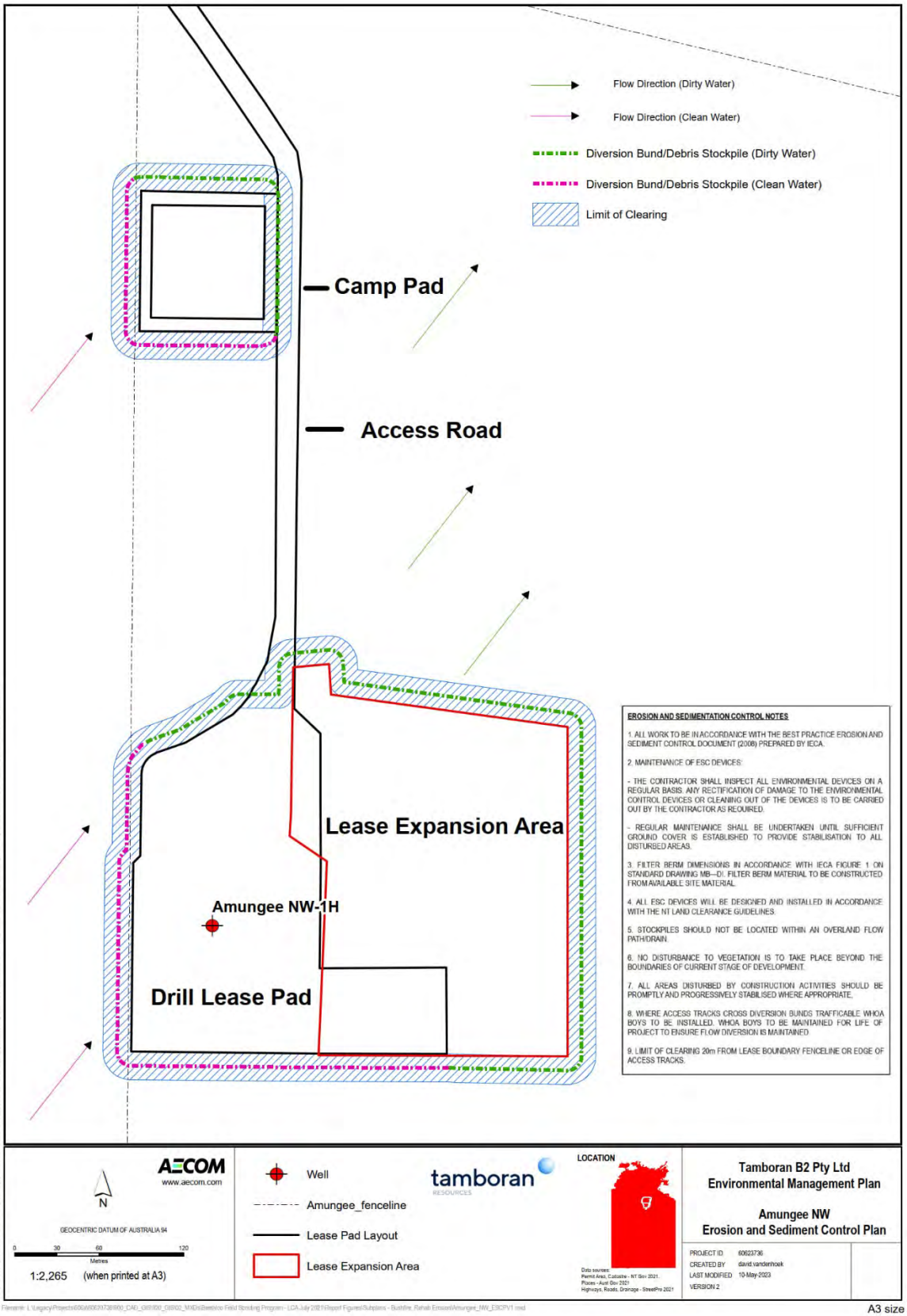
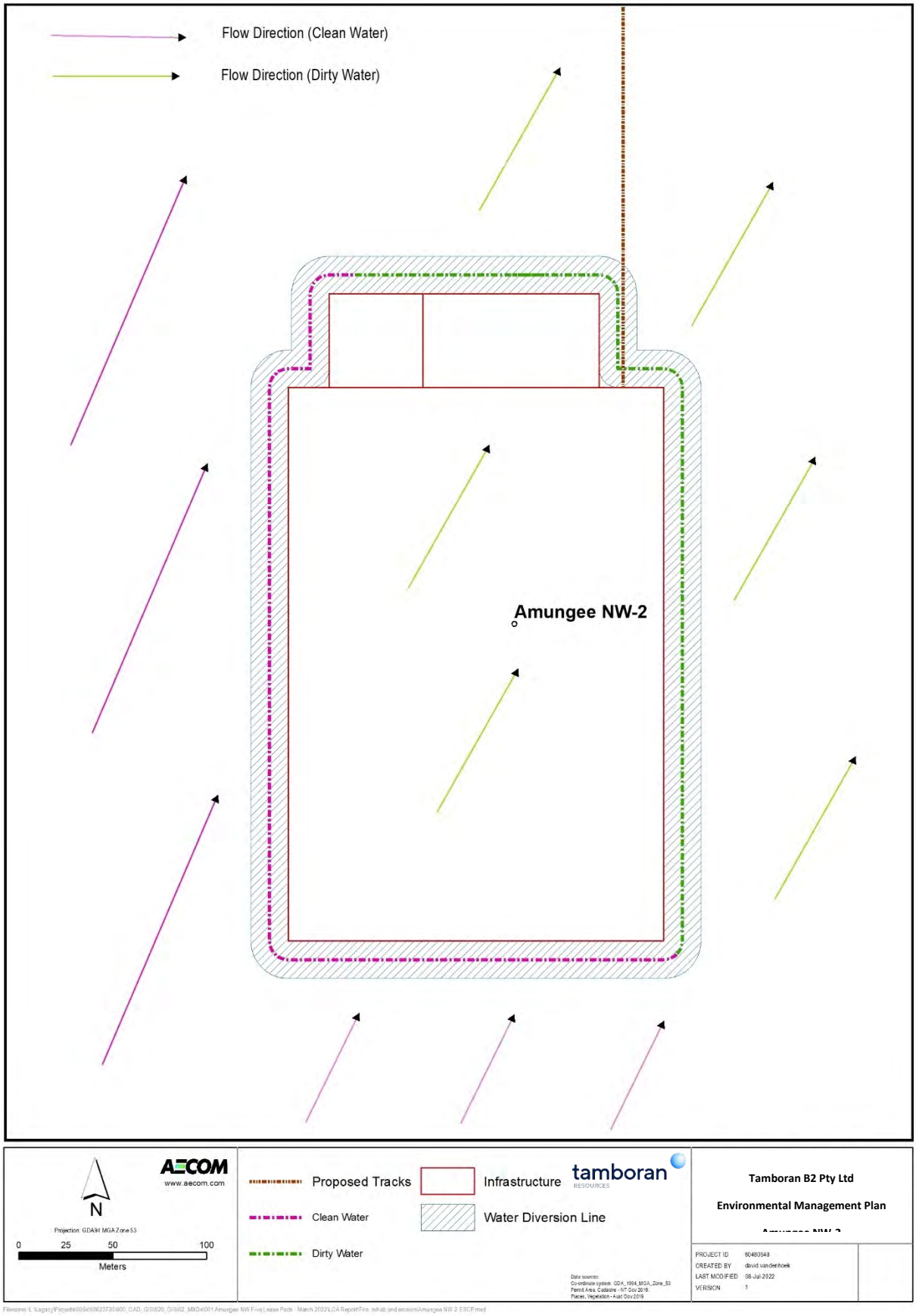
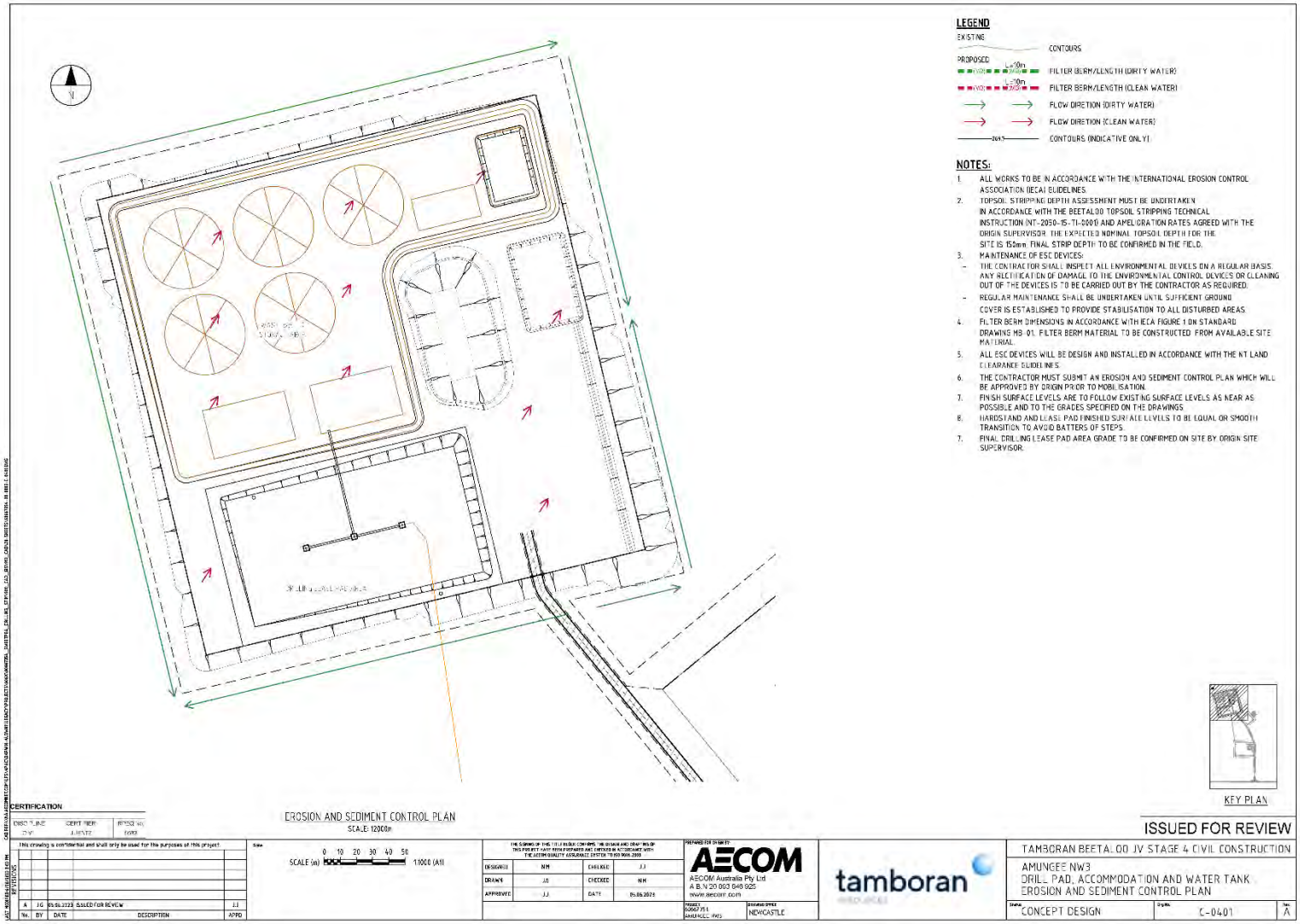

Flow Direction (Dirty Water)
Flow Direction (Clean Water)
Diversion Bund/Debris Stockpile (Dirty Water)
Diversion Bund/Debris Stockpile (Clean Water)
Limit of Clearing
Camp Pad
Access Road
Lease Expansion Area
Amungee NW-1H
Drill Lease Pad
EROSION AND SEDIMENTATION CONTROL NOTES
1. ALL WORK TO BE IN ACCORDANCE WITH THE BEST PRACTICE EROSION AND SEDIMENT CONTROL DOCUMENT (2008) PREPARED BY IECA.
2. MAINTENANCE OF ESC DEVICES:
- THE CONTRACTOR SHALL INSPECT ALL ENVIRONMENTAL DEVICES ON A REGULAR BASIS. ANY RECTIFICATION OF DAMAGE TO THE ENVIRONMENTAL CONTROL DEVICES OR CLEANING OUT OF THE DEVICES IS TO BE CARRIED OUT BY THE CONTRACTOR AS REQUIRED.
- REGULAR MAINTENANCE SHALL BE UNDERTAKEN UNTIL SUFFICIENT GROUND COVER IS ESTABLISHED TO PROVIDE STABILISATION TO ALL DISTURBED AREAS.
3. FILTER BERM DIMENSIONS IN ACCORDANCE WITH IECA FIGURE 1 ON STANDARD DRAWING MB—DI. FILTER BERM MATERIAL TO BE CONSTRUCTED FROM AVAILABLE SITE MATERIAL.
4. ALL ESC DEVICES WILL BE DESIGNED AND INSTALLED IN ACCORDANCE WITH THE NT LAND CLEARANCE GUIDELINES.
5. STOCKPILES SHOULD NOT BE LOCATED WITHIN AN OVERLAND FLOW PATH/DRAIN.
6. NO DISTURBANCE TO VEGETATION IS TO TAKE PLACE BEYOND THE BOUNDARIES OF CURRENT STAGE OF DEVELOPMENT.
7. ALL AREAS DISTURBED BY CONSTRUCTION ACTIVITIES SHOULD BE PROMPTLY AND PROGRESSIVELY STABILISED WHERE APPROPRIATE.
8. WHERE ACCESS TRACKS CROSS DIVERSION BUNDS TRAFFICABLE WHOA BOYS TO BE INSTALLED. WHOA BOYS TO BE MAINTAINED FOR LIFE OF PROJECT TO ENSURE FLOW DIVERSION IS MAINTAINED.
9. LIMIT OF CLEARING 20m FROM LEASE BOUNDARY FENCELINE OR EDGE OF ACCESS TRACKS.
AECOM
www.aecom.com
N
GEOCENTRIC DATUM OF AUSTRALIA 94
0 30 60 120
Metres
1:2,265 (when printed at A3)
Well
Amungee_fenceline
Lease Pad Layout
Lease Expansion Area
tamboran RESOURCES
LOCATION
Tamboran B2 Pty Ltd
Environmental Management Plan
Amungee NW
Erosion and Sediment Control Plan
PROJECT ID 60623736
CREATED BY david.vanderhoek
LAST MODIFIED 10-May-2023
VERSION 2

A3 size


Flow Direction (Clean Water)
Flow Direction (Dirty Water)
Amungee NW-2
N
AECOM
www.aecom.com
Projection: GDA94 MGA Zone 53
0 25 50 100
Meters
Proposed Tracks
Clean Water
Dirty Water
Infrastructure
Water Diversion Line
tamboran RESOURCES
Tamboran B2 Pty Ltd
Environmental Management Plan
PROJECT ID 60480549
CREATED BY david.vanderhoek
LAST MODIFIED 08-Jul-2022
VERSION 1



Review due: 13/09/25

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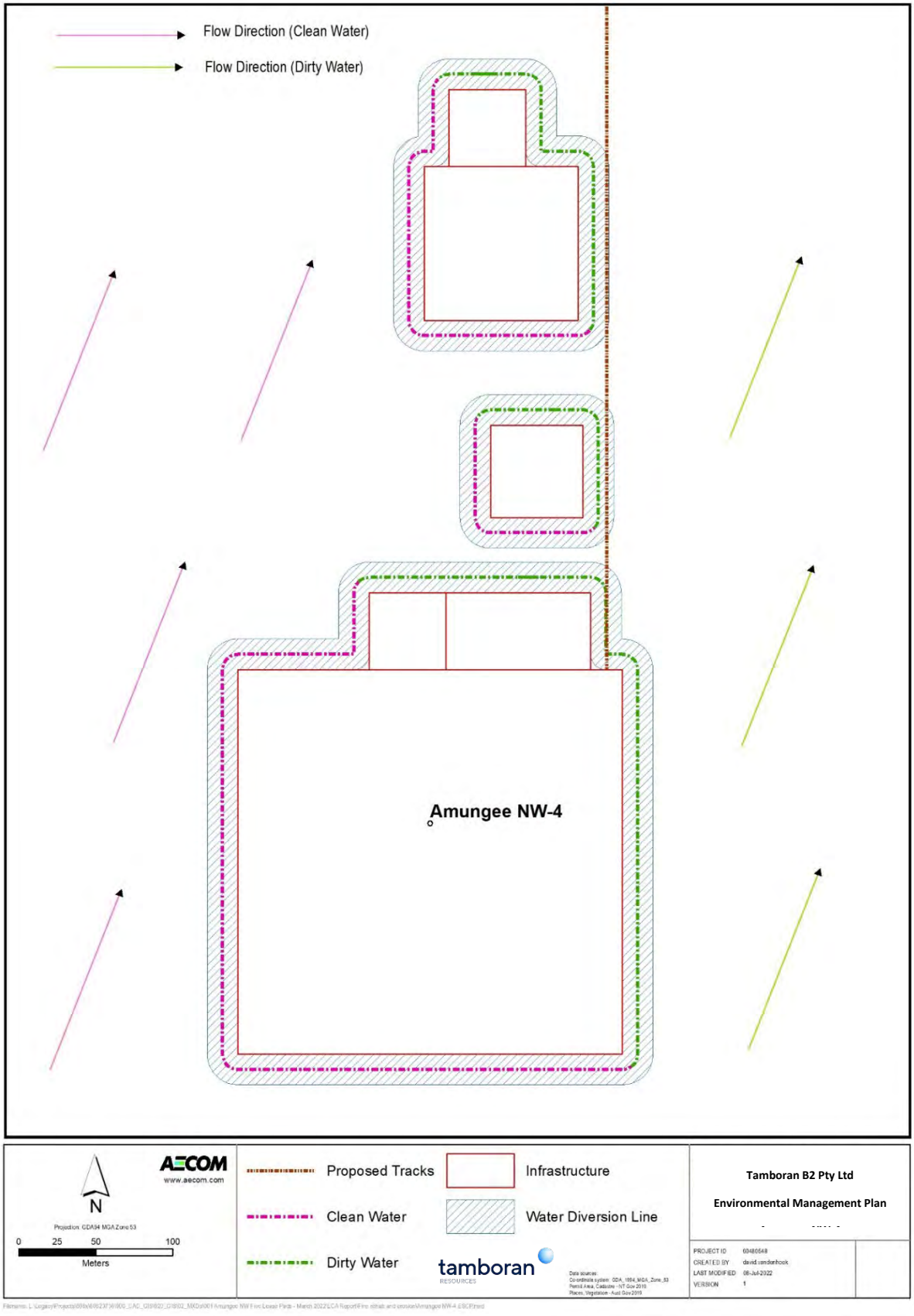
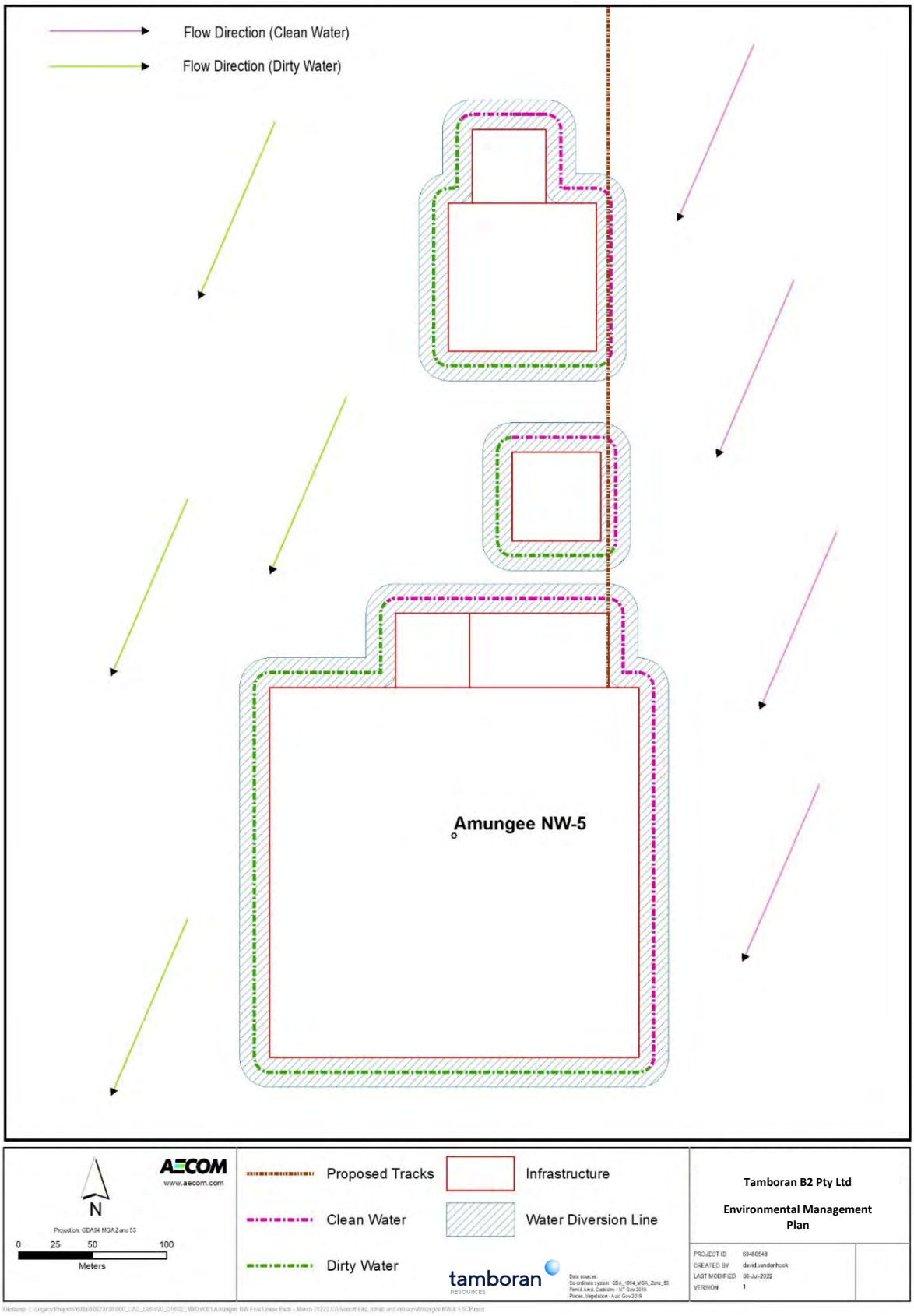
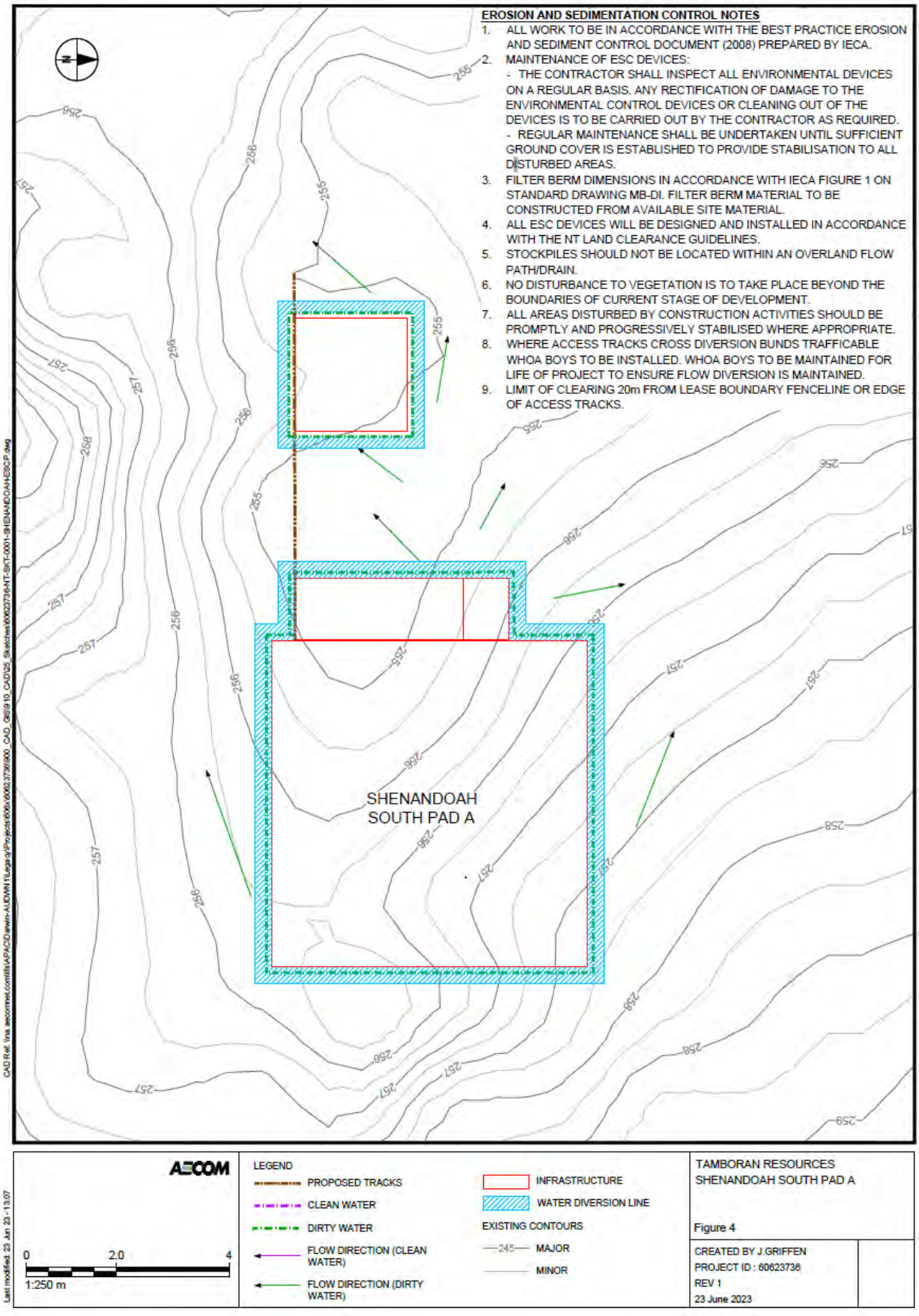
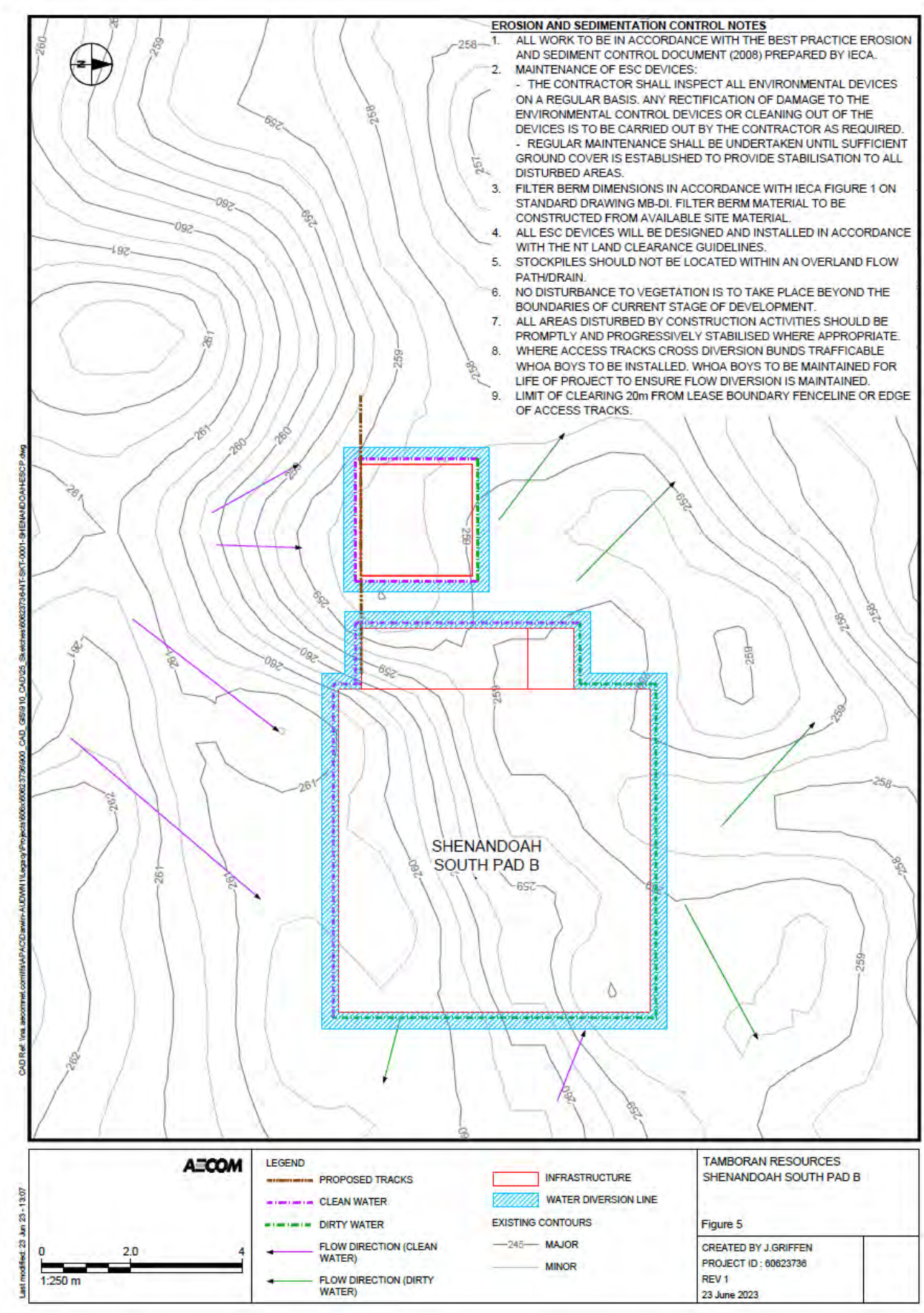

Flow Direction (Clean Water)
Flow Direction (Dirty Water)
Amungee NW-4
N
AECOM
www.aecom.com
Projection: GDA94 MGA Zone 53
0 25 50 100
Meters
Proposed Tracks
Infrastructure
Clean Water
Water Diversion Line
Dirty Water
tamboran RESOURCES
Tamboran B2 Pty Ltd
Environmental Management Plan
PROJECT ID 60480648
CREATED BY david.vandenhoek
LAST MODIFIED 08-Jul-2022
VERSION 1


Flow Direction (Clean Water)
Flow Direction (Dirty Water)
Amungee NW-5
N
AECOM
www.aecom.com
Projection: GDA94 MGA Zone 53
0 25 50 100
Meters
Proposed Tracks
Clean Water
Dirty Water
Infrastructure
Water Diversion Line
tamboran RESOURCES
Tamboran B2 Pty Ltd
Environmental Management Plan
PROJECT ID 60480548
CREATED BY david.vandonkook
LAST MODIFIED 08-Jul-2022
VERSION 1


EROSION AND SEDIMENTATION CONTROL NOTES
1. ALL WORK TO BE IN ACCORDANCE WITH THE BEST PRACTICE EROSION AND SEDIMENT CONTROL DOCUMENT (2008) PREPARED BY IECA.
2. MAINTENANCE OF ESC DEVICES:
- THE CONTRACTOR SHALL INSPECT ALL ENVIRONMENTAL DEVICES ON A REGULAR BASIS. ANY RECTIFICATION OF DAMAGE TO THE ENVIRONMENTAL CONTROL DEVICES OR CLEANING OUT OF THE DEVICES IS TO BE CARRIED OUT BY THE CONTRACTOR AS REQUIRED.
- REGULAR MAINTENANCE SHALL BE UNDERTAKEN UNTIL SUFFICIENT GROUND COVER IS ESTABLISHED TO PROVIDE STABILISATION TO ALL DISTURBED AREAS.
3. FILTER BERM DIMENSIONS IN ACCORDANCE WITH IECA FIGURE 1 ON STANDARD DRAWING MB-DI. FILTER BERM MATERIAL TO BE CONSTRUCTED FROM AVAILABLE SITE MATERIAL.
4. ALL ESC DEVICES WILL BE DESIGNED AND INSTALLED IN ACCORDANCE WITH THE NT LAND CLEARANCE GUIDELINES.
5. STOCKPILES SHOULD NOT BE LOCATED WITHIN AN OVERLAND FLOW PATH/DRAIN.
6. NO DISTURBANCE TO VEGETATION IS TO TAKE PLACE BEYOND THE BOUNDARIES OF CURRENT STAGE OF DEVELOPMENT.
7. ALL AREAS DISTURBED BY CONSTRUCTION ACTIVITIES SHOULD BE PROMPTLY AND PROGRESSIVELY STABILISED WHERE APPROPRIATE.
8. WHERE ACCESS TRACKS CROSS DIVERSION BUNDS TRAFFICABLE WHOA BOYS TO BE INSTALLED. WHOA BOYS TO BE MAINTAINED FOR LIFE OF PROJECT TO ENSURE FLOW DIVERSION IS MAINTAINED.
9. LIMIT OF CLEARING 20m FROM LEASE BOUNDARY FENCELINE OR EDGE OF ACCESS TRACKS.
SHENANDOAH SOUTH PAD A
AECOM
LEGEND
PROPOSED TRACKS
CLEAN WATER
DIRTY WATER
FLOW DIRECTION (CLEAN WATER)
FLOW DIRECTION (DIRTY WATER)
INFRASTRUCTURE
WATER DIVERSION LINE
EXISTING CONTOURS
245 MAJOR
MINOR
0 2.0 4
1:250 m
TAMBORAN RESOURCES
SHENANDOAH SOUTH PAD A
Figure 4
CREATED BY J.GRIFFEN
PROJECT ID : 60623736
REV 1
23 June 2023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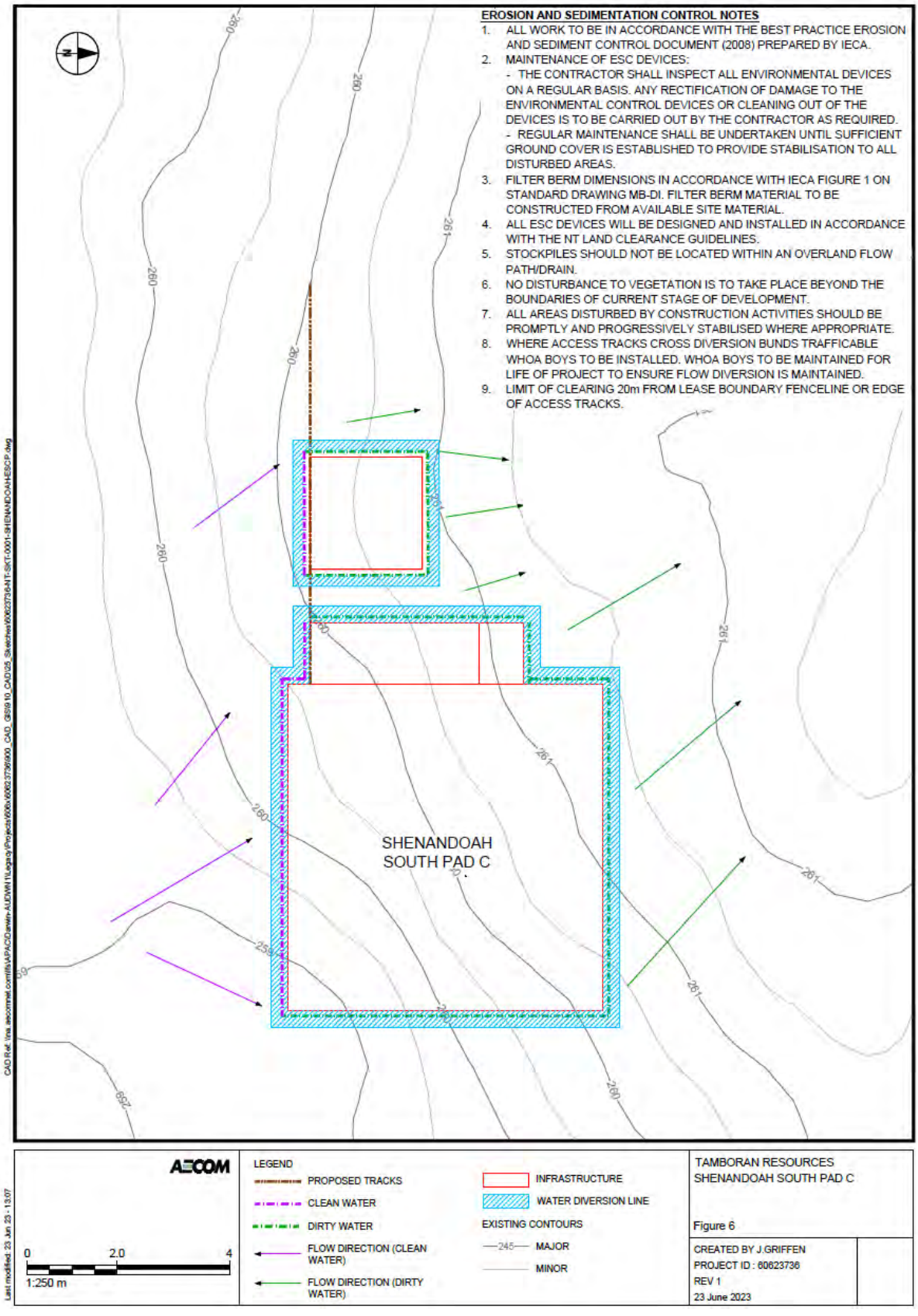
9. LIMIT OF CLEARING 20m FROM LEASE BOUNDARY FENCELINE OR EDGE OF ACCESS TRACKS.
SHENANDOAH
SOUTH PAD B
AECOM
LEGEND
PROPOSED TRACKS
CLEAN WATER
DIRTY WATER
FLOW DIRECTION (CLEAN WATER)
FLOW DIRECTION (DIRTY WATER)
INFRASTRUCTURE
WATER DIVERSION LINE
EXISTING CONTOURS
MAJOR
MINOR
0 2.0 4
1:250 m
TAMBORAN RESOURCES
SHENANDOAH SOUTH PAD B
Figure 5
CREATED BY J.GRIFFEN
PROJECT ID : 60623736
REV 1
23 June 2023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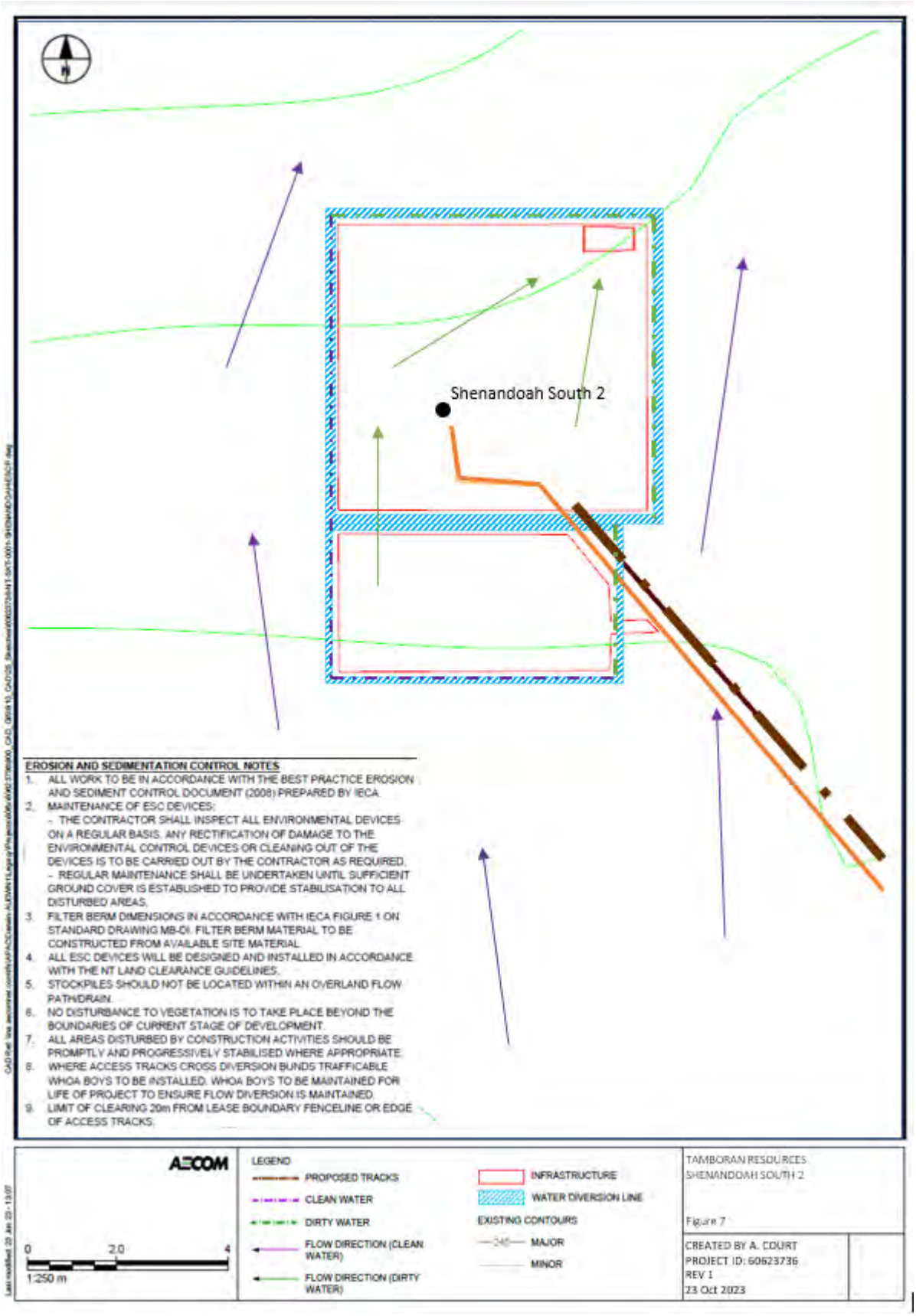
SHENANDOAH SOUTH PAD C
AECOM
LEGEND
PROPOSED TRACKS
CLEAN WATER
DIRTY WATER
FLOW DIRECTION (CLEAN WATER)
FLOW DIRECTION (DIRTY WATER)
INFRASTRUCTURE
WATER DIVERSION LINE
EXISTING CONTOURS
MAJOR
MINOR
0 2.0 4
1:250 m
TAMBORAN RESOURCES
SHENANDOAH SOUTH PAD C
Figure 6
CREATED BY J.GRIFFEN
PROJECT ID : 60623736
REV 1
23 June 2023


Shenandoah South 2
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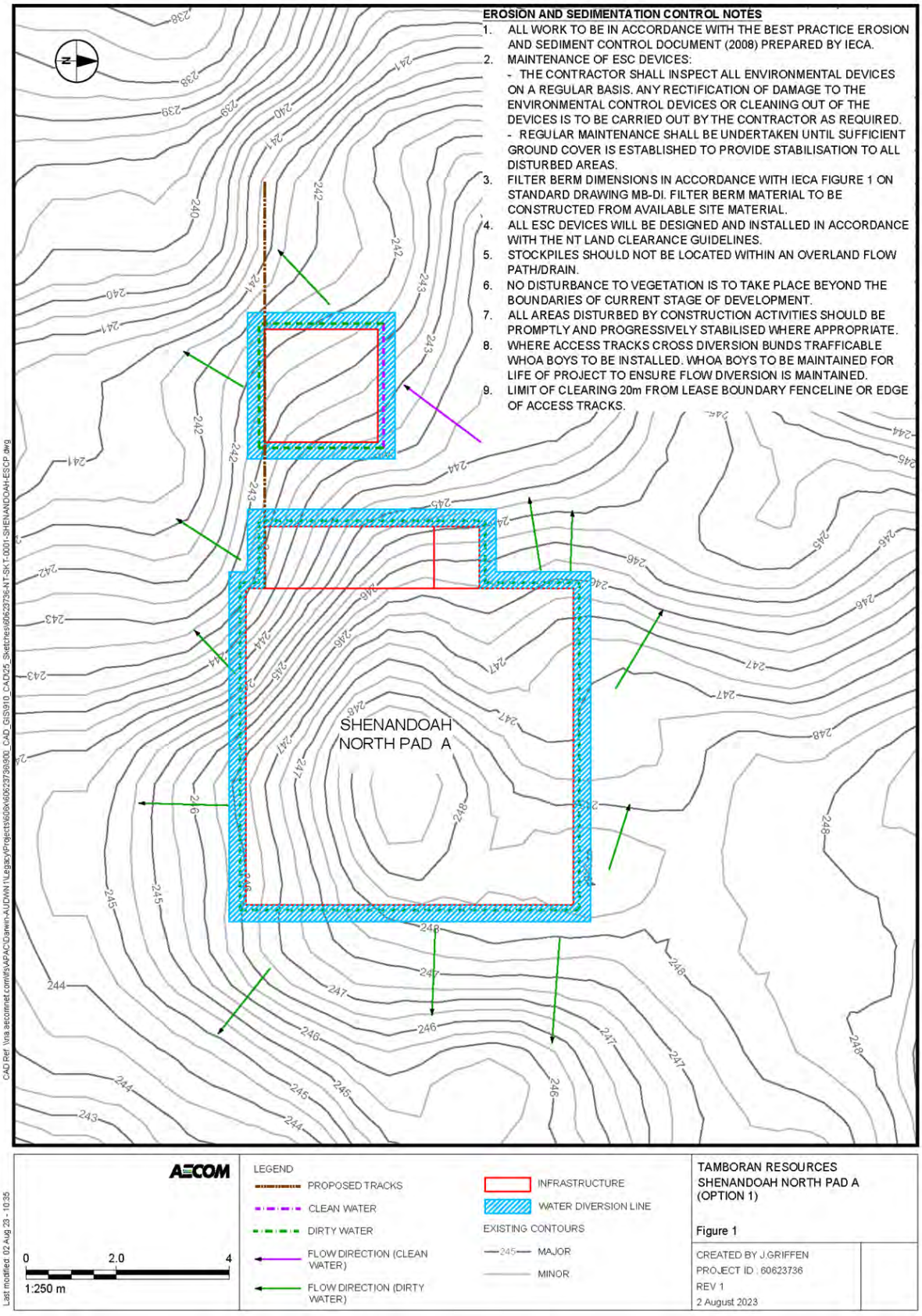
AECOM
0 2.0 4
1:250 m
LEGEND
PROPOSED TRACKS
CLEAN WATER
DIRTY WATER
FLOW DIRECTION (CLEAN WATER)
FLOW DIRECTION (DIRTY WATER)
INFRASTRUCTURE
WATER DIVERSION LINE
EXISTING CONTOURS
MAJOR
MINOR
TAMBORAN RESOURCES
SHENANDOAH SOUTH 2
Figure 7
CREATED BY A. COURT
PROJECT ID: 60623736
REV 1
23 Oct 2023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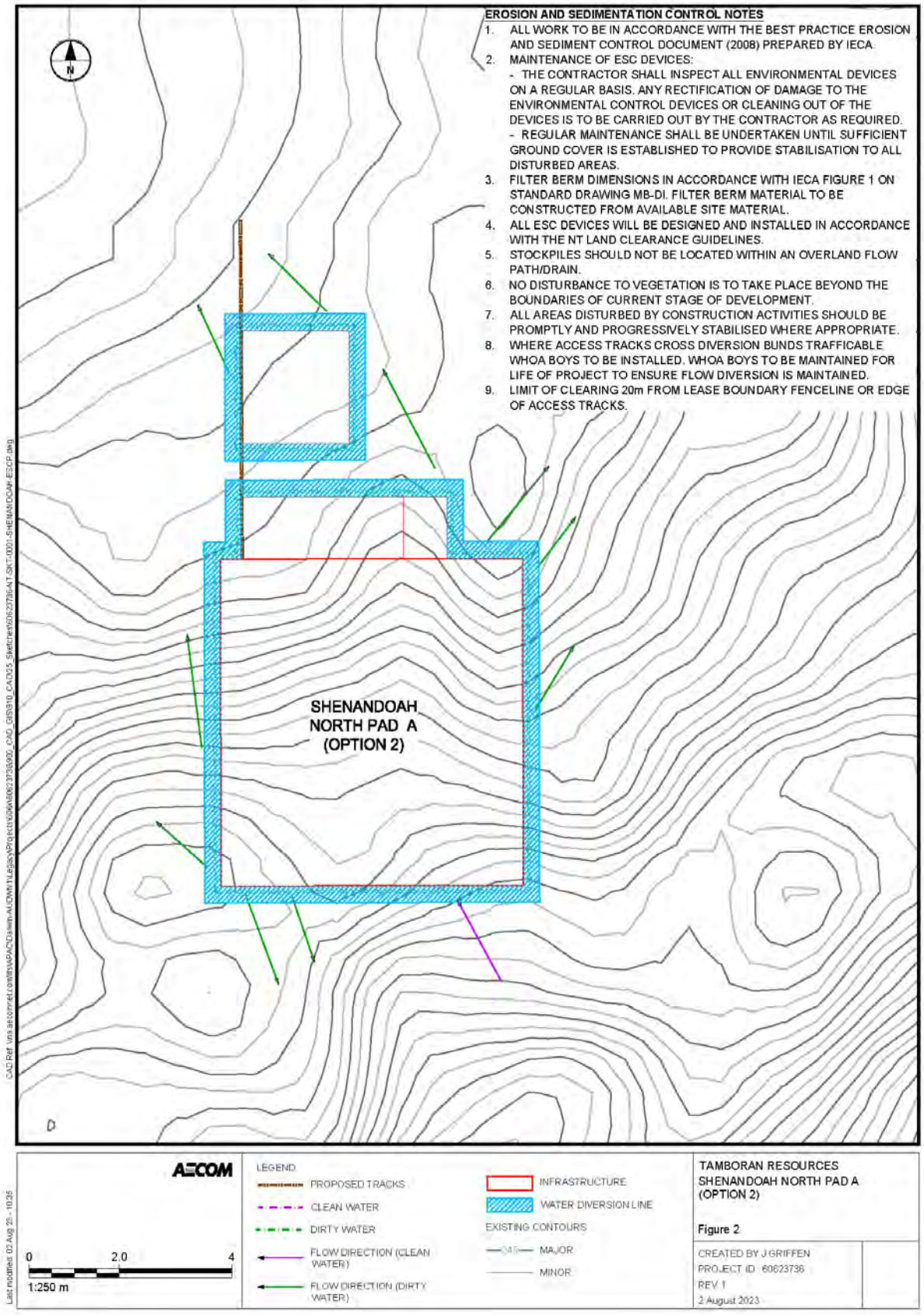
SHENANDOAH NORTH PAD A
N
AECOM
LEGEND
PROPOSED TRACKS
CLEAN WATER
DIRTY WATER
FLOW DIRECTION (CLEAN WATER)
FLOW DIRECTION (DIRTY WATER)
INFRASTRUCTURE
WATER DIVERSION LINE
EXISTING CONTOURS
245 MAJOR
MINOR
0 2.0 4
1:250 m
TAMBORAN RESOURCES
SHENANDOAH NORTH PAD A
(OPTION 1)
Figure 1
CREATED BY J.GRIFFEN
PROJECT ID : 60623736
REV 1
2 August 2023
CAD Ref: \\na.aecomnet.com\fs\APAC\Darwin-AUDWN1\Legacy\Projects\606x\60623736\300_CAD_GIS\910_CAD\25_Sketches\60623736-NT-SKT-0001-SHENANDOAH-ESCP.dwg
Last modified: 02 Aug 23 - 10:35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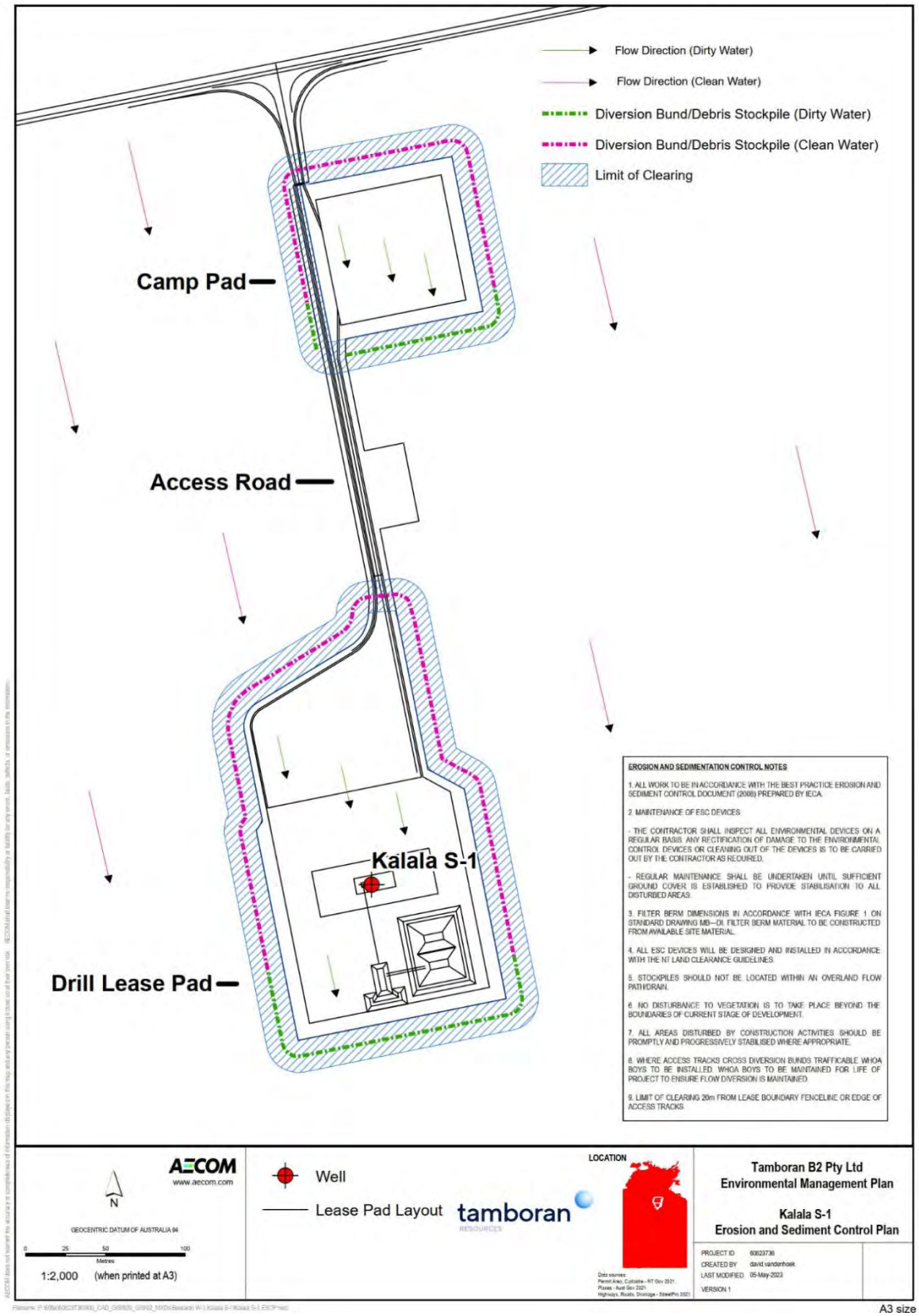
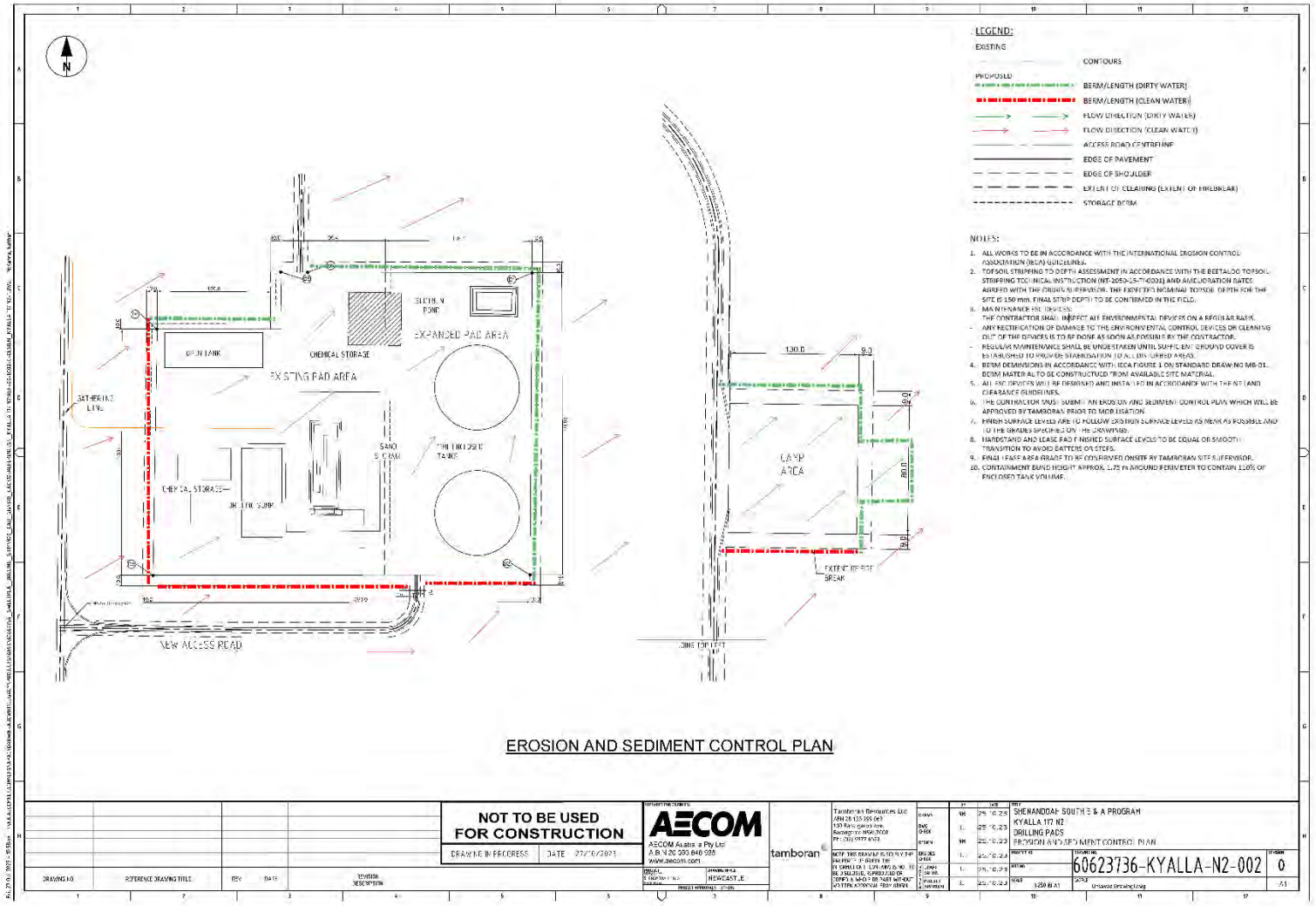
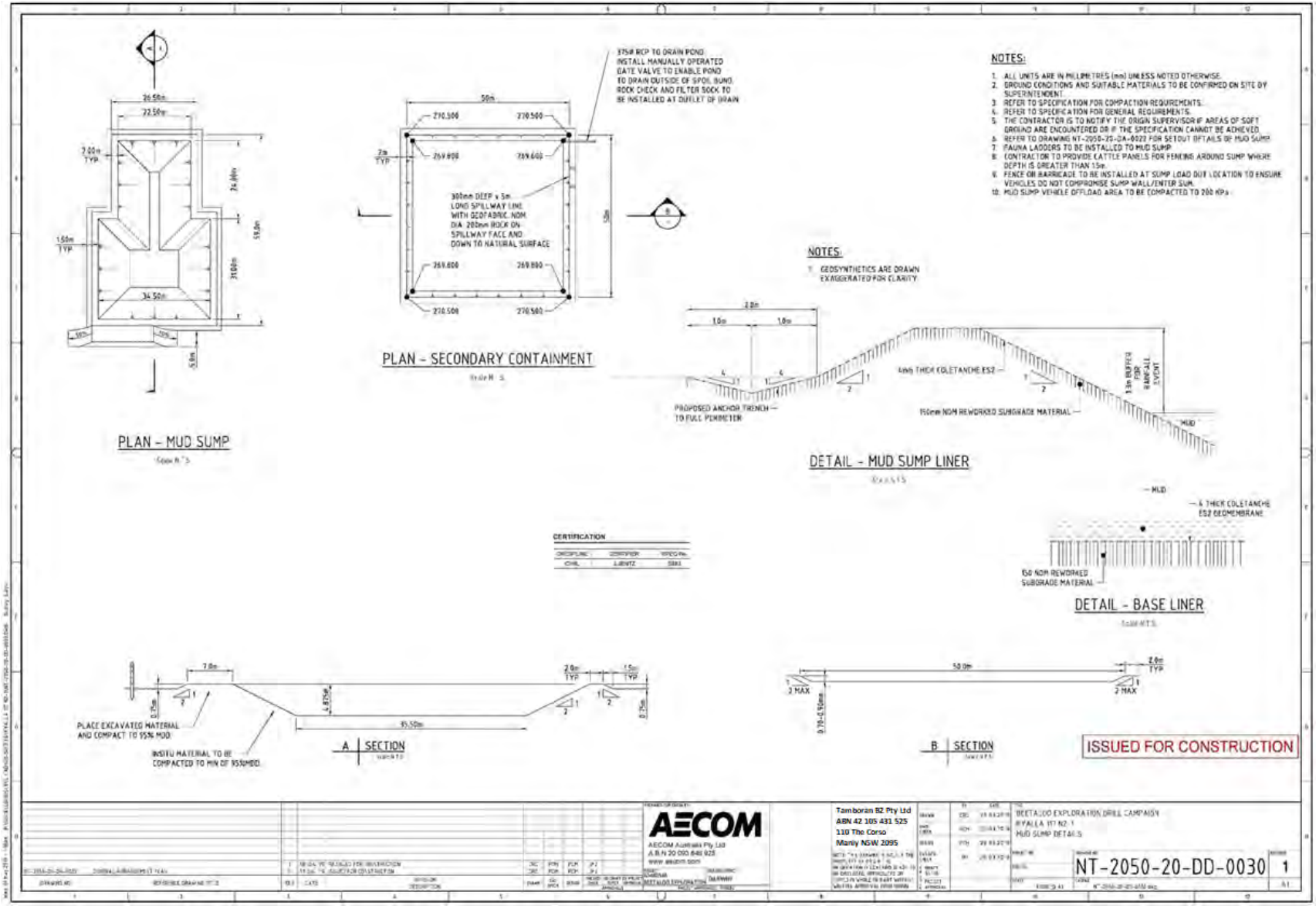
9. LIMIT OF CLEARING 20m FROM LEASE BOUNDARY FENCELINE OR EDGE OF ACCESS TRACKS.
N
SHENANDOAH NORTH PAD A (OPTION 2)
D
AECOM
LEGEND
PROPOSED TRACKS
CLEAN WATER
DIRTY WATER
FLOW DIRECTION (CLEAN WATER)
FLOW DIRECTION (DIRTY WATER)
INFRASTRUCTURE
WATER DIVERSION LINE
EXISTING CONTOURS
MAJOR
MINOR
0 2.0 4
1:250 m
TAMBORAN RESOURCES
SHENANDOAH NORTH PAD A (OPTION 2)
Figure 2
CREATED BY J GRIFFEN
PROJECT ID : 60623736
REV 1
2 August 2023

Appendix F Erosion and sediment control plan for Kalala S1

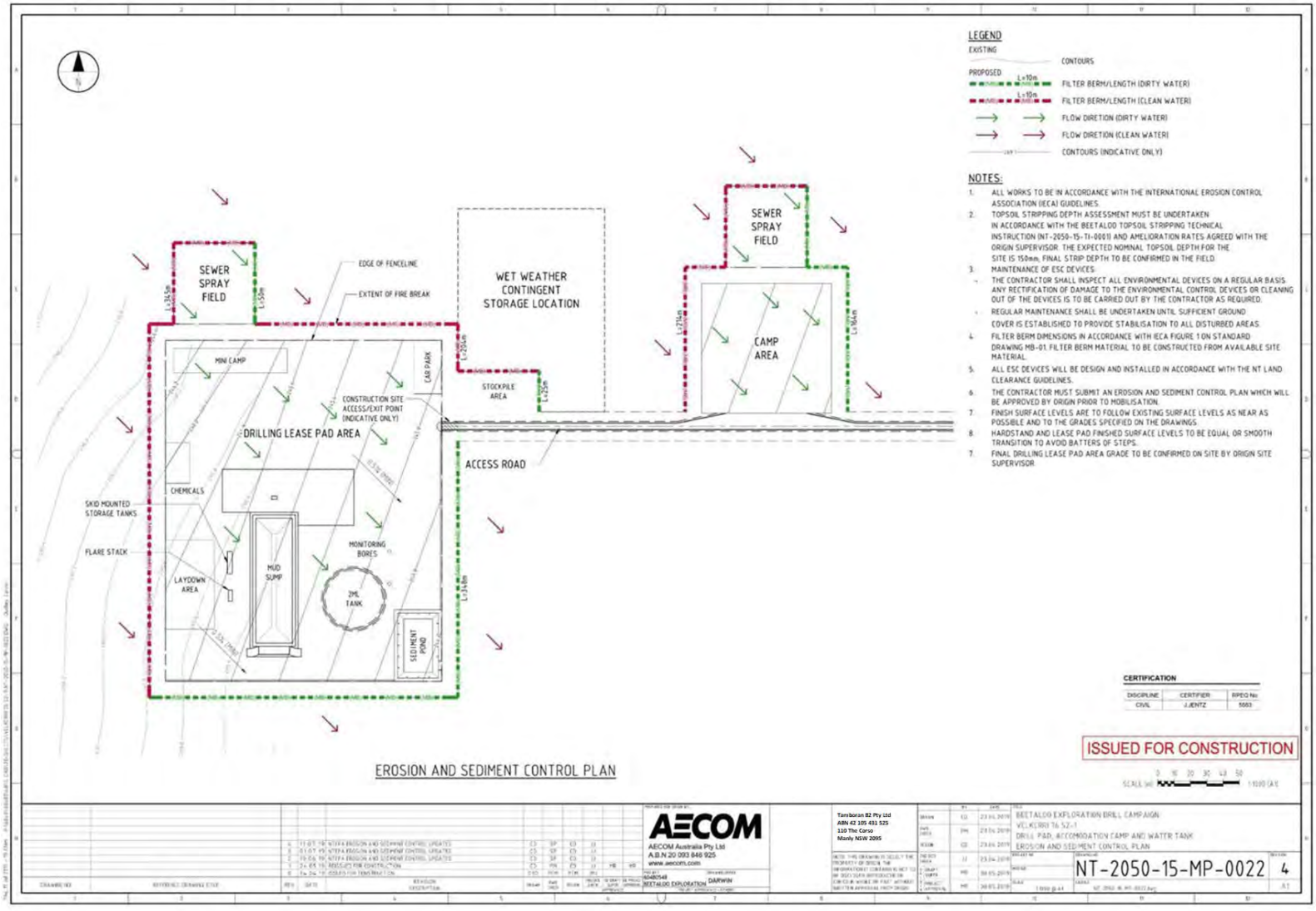


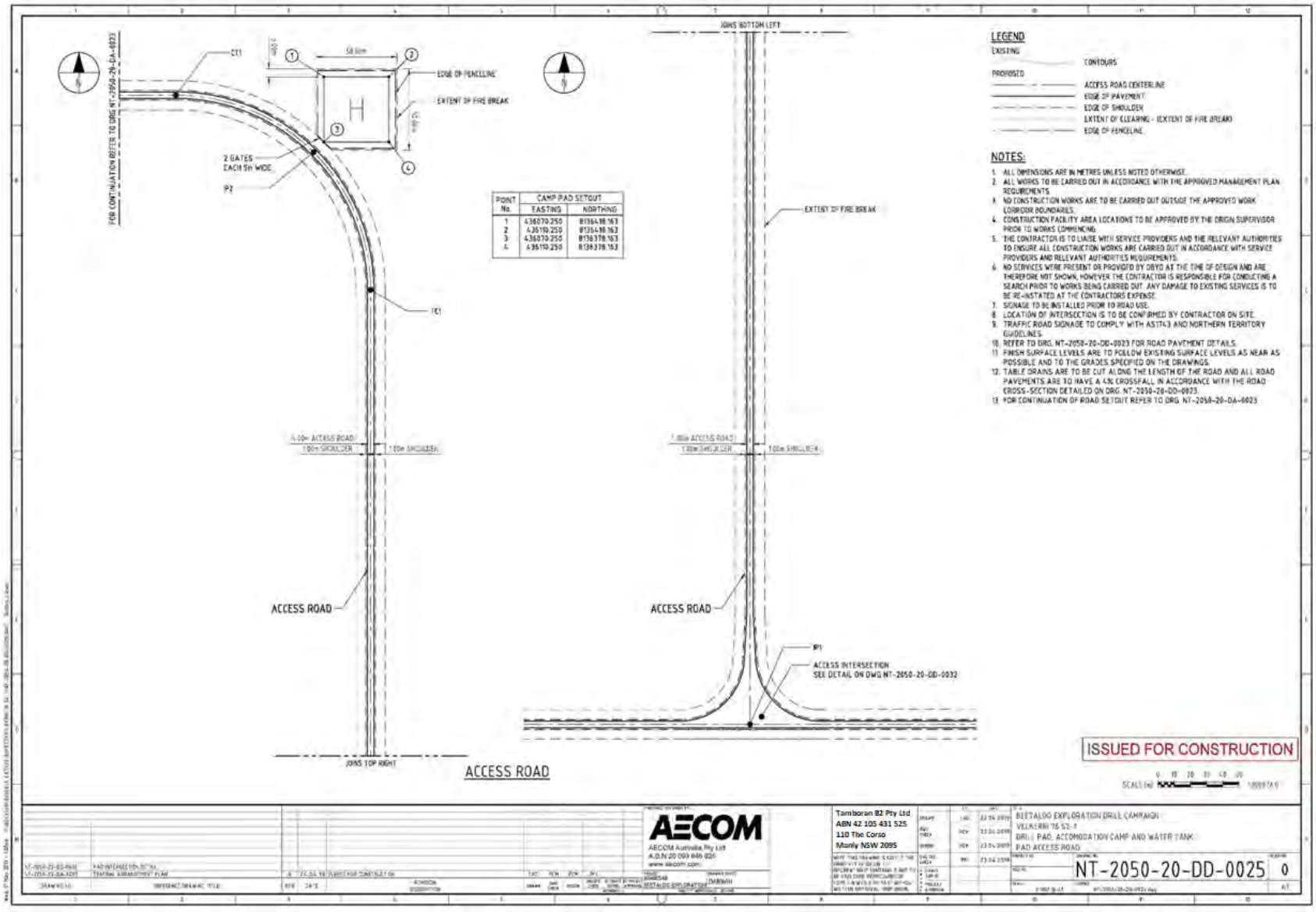
Appendix G Erosion and sediment control plan for Kyalla 117-N2

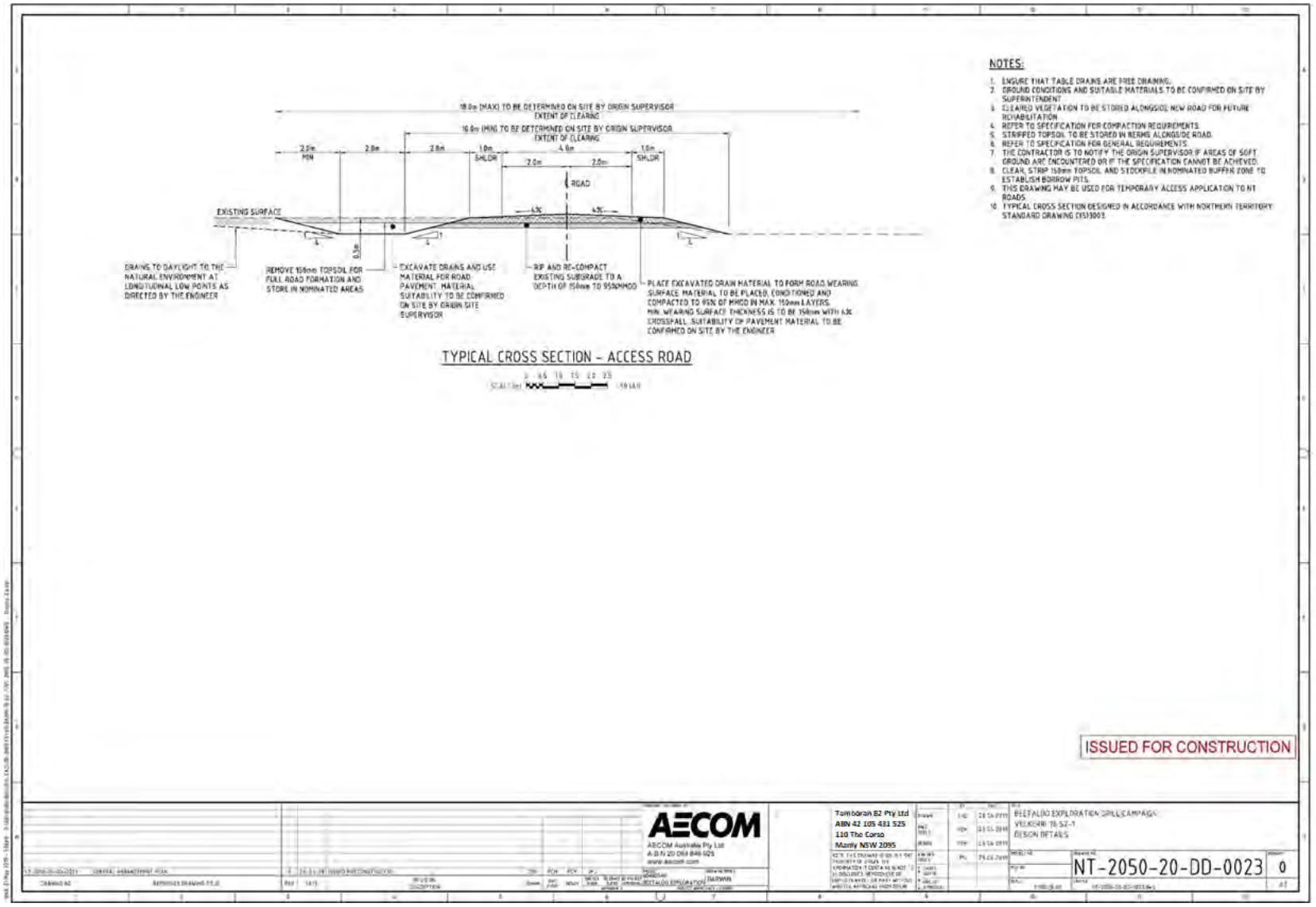


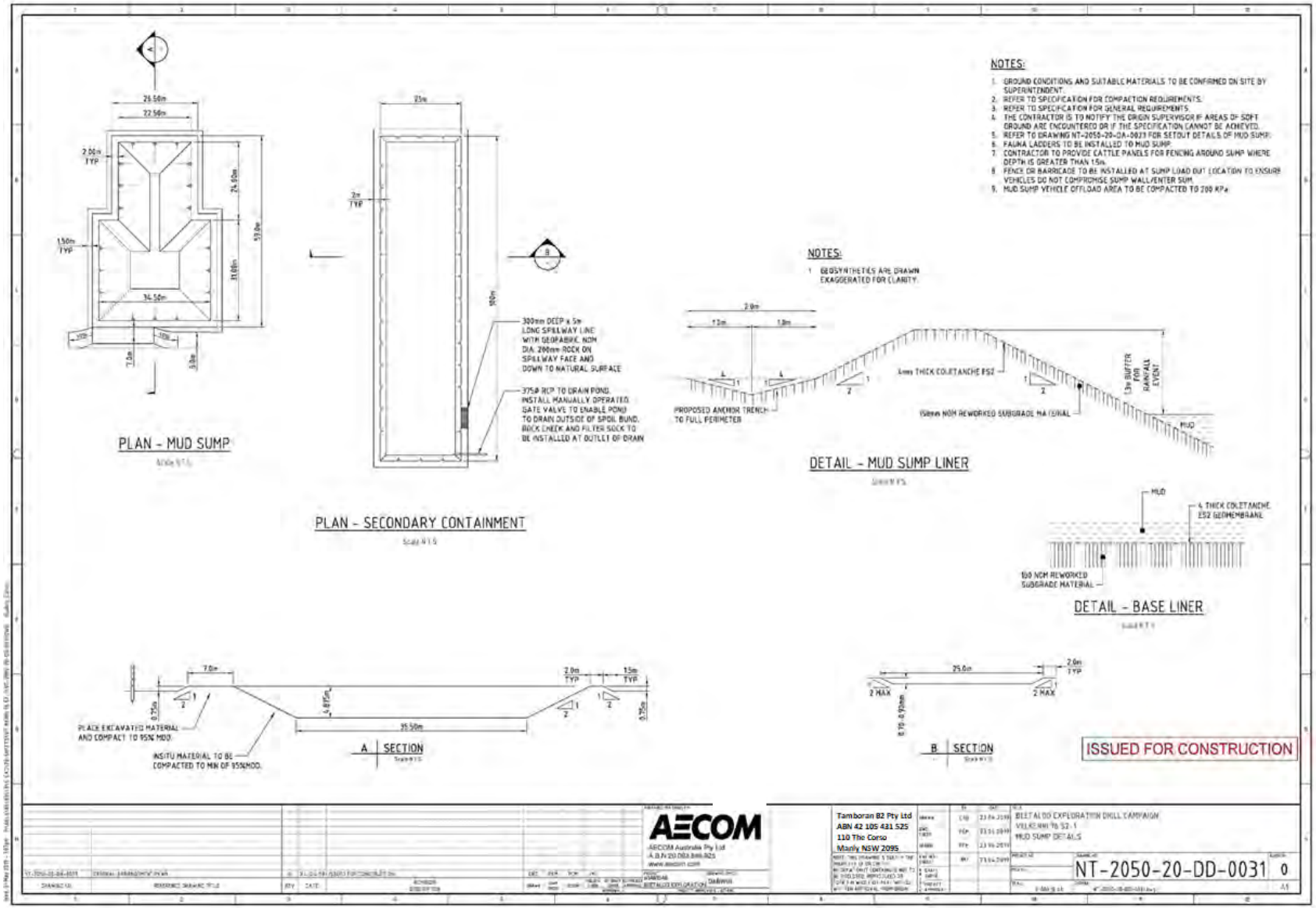

PLAN - MUD SUMP
PLAN - SECONDARY CONTAINMENT
375ø RCP TO DRAIN POND. INSTALL MANUALLY OPERATED GATE VALVE TO ENABLE POND TO DRAIN OUTSIDE OF SPOIL BUND. ROCK CHECK AND FILTER SOCK TO BE INSTALLED AT OUTLET OF DRAIN
300mm DEEP x 5m LONG SPILLWAY LINE WITH GEOFABRIC. NOM DIA 200mm ROCK ON SPILLWAY FACE AND DOWN TO NATURAL SURFACE
NOTES:
1. ALL UNITS ARE IN MILLIMETRES (mm) UNLESS NOTED OTHERWISE.
2. GROUND CONDITIONS AND SUITABLE MATERIALS TO BE CONFIRMED ON SITE BY SUPERINTENDENT.
3. REFER TO SPECIFICATION FOR COMPACTION REQUIREMENTS.
4. REFER TO SPECIFICATION FOR GENERAL REQUIREMENTS.
5. THE CONTRACTOR IS TO NOTIFY THE ORIGIN SUPERVISOR IF AREAS OF SOFT GROUND ARE ENCOUNTERED OR IF THE SPECIFICATION CANNOT BE ACHIEVED.
6. REFER TO DRAWING NT-2050-ZS-DA-0022 FOR SETOUT DETAILS OF MUD SUMP.
7. FAUNA LADDERS TO BE INSTALLED TO MUD SUMP.
8. CONTRACTOR TO PROVIDE CATTLE PANELS FOR FENCING AROUND SUMP WHERE DEPTH IS GREATER THAN 1.5m.
9. FENCE OR BARRICADE TO BE INSTALLED AT SUMP LOAD OUT LOCATION TO ENSURE VEHICLES DO NOT COMPROMISE SUMP WALL/ENTER SUM.
10. MUD SUMP VEHICLE OFFLOAD AREA TO BE COMPACTED TO 200 KPa.
NOTES:
1. GEOSYNTHETICS ARE DRAWN EXAGGERATED FOR CLARITY
PROPOSED ANCHOR TRENCH - TO FULL PERIMETER
4mm THICK COLETANCHE ES2
150mm NOM REWORKED SUBGRADE MATERIAL
MUD
DETAIL - MUD SUMP LINER
DETAIL - BASE LINER
CERTIFICATION
PLACE EXCAVATED MATERIAL AND COMPACT TO 95% MOD
INSITU MATERIAL TO BE COMPACTED TO MIN OF 95%MOD
A SECTION
B SECTION
ISSUED FOR CONSTRUCTION
AECOM
Tamboran B2 Pty Ltd
ABN 42 105 431 525
110 The Corso
Manly NSW 2095
BEETALOO EXPLORATION DRILL CAMPAIGN
MUD SUMP DETAILS
NT-2050-20-DD-0030
1

Appendix H Erosion and sediment control plan for Velkerri 76 S2

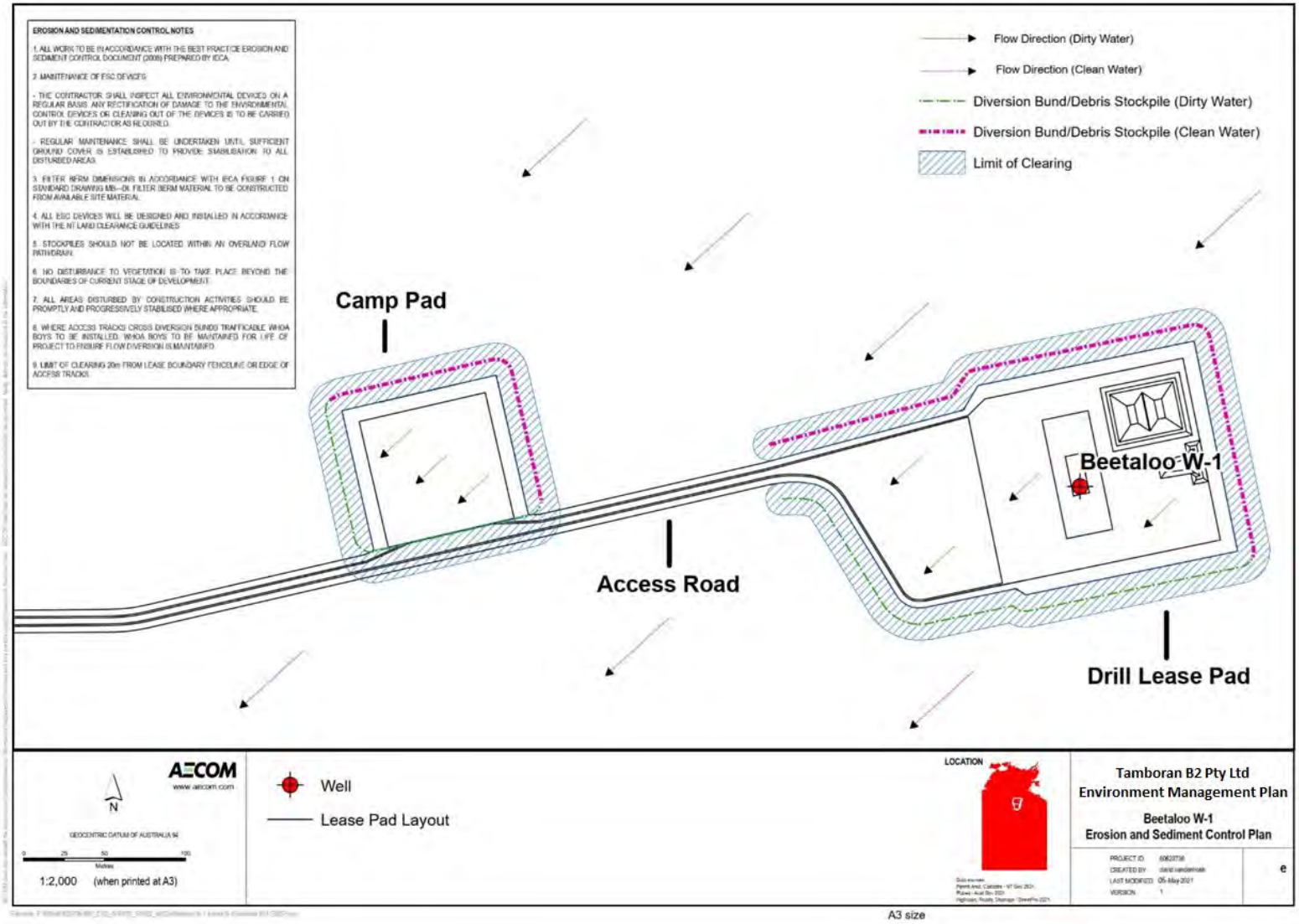



JOINS BOTTOM LEFT
FOR CONTINUATION REFER TO DRG NT-2050-20-DA-0023
CT1
EDGE OF FENCELINE
EXTENT OF FIRE BREAK
2 GATES EACH 5m WIDE
IP2
TC1
CAMP PAD SETOUT
POINT No.
EASTING
NORTHING
1 436070.250 8136498.163
2 436159.250 8136498.163
3 436070.250 8136378.163
4 436159.250 8136378.163
EXTENT OF FIRE BREAK
ACCESS ROAD
ACCESS ROAD
IP1
ACCESS INTERSECTION
SEE DETAIL ON DWG NT-2050-20-DD-0032
JOINS TOP RIGHT
ACCESS ROAD
LEGEND
EXISTING
CONTOURS
PROPOSED
ACCESS ROAD CENTERLINE
EDGE OF PAVEMENT
EDGE OF SHOULDER
EXTENT OF CLEARING - (EXTENT OF FIRE BREAK)
EDGE OF FENCELINE
NOTES:
1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ALL WORKS TO BE CARRIED OUT IN ACCORDANCE WITH THE APPROVED MANAGEMENT PLAN REQUIREMENTS.
3. NO CONSTRUCTION WORKS ARE TO BE CARRIED OUT OUTSIDE THE APPROVED WORK CORRIDOR BOUNDARIES.
4. CONSTRUCTION FACILITY AREA LOCATIONS TO BE APPROVED BY THE ORIGIN SUPERVISOR PRIOR TO WORKS COMMENCING.
5. THE CONTRACTOR IS TO LIAISE WITH SERVICE PROVIDERS AND THE RELEVANT AUTHORITIES TO ENSURE ALL CONSTRUCTION WORKS ARE CARRIED OUT IN ACCORDANCE WITH SERVICE PROVIDERS AND RELEVANT AUTHORITIES REQUIREMENTS.
6. NO SERVICES WERE PRESENT OR PROVIDED BY DBYD AT THE TIME OF DESIGN AND ARE THEREFORE NOT SHOWN, HOWEVER THE CONTRACTOR IS RESPONSIBLE FOR CONDUCTING A SEARCH PRIOR TO WORKS BEING CARRIED OUT. ANY DAMAGE TO EXISTING SERVICES IS TO BE RE-INSTATED AT THE CONTRACTORS EXPENSE.
7. SIGNAGE TO BE INSTALLED PRIOR TO ROAD USE.
8. LOCATION OF INTERSECTION IS TO BE CONFIRMED BY CONTRACTOR ON SITE.
9. TRAFFIC ROAD SIGNAGE TO COMPLY WITH AS1743 AND NORTHERN TERRITORY GUIDELINES.
10. REFER TO DRG. NT-2050-20-DD-0023 FOR ROAD PAVEMENT DETAILS.
11. FINISH SURFACE LEVELS ARE TO FOLLOW EXISTING SURFACE LEVELS AS NEAR AS POSSIBLE AND TO THE GRADES SPECIFIED ON THE DRAWINGS.
12. TABLE DRAINS ARE TO BE CUT ALONG THE LENGTH OF THE ROAD AND ALL ROAD PAVEMENTS ARE TO HAVE A 4% CROSSFALL IN ACCORDANCE WITH THE ROAD CROSS-SECTION DETAILED ON DRG. NT-2050-20-DD-0023.
13. FOR CONTINUATION OF ROAD SETOUT REFER TO DRG. NT-2050-20-DA-0023
ISSUED FOR CONSTRUCTION
AECOM
AECOM Australia Pty Ltd
A.B.N 20 093 846 925
Tamboran B2 Pty Ltd
ABN 42 105 431 525
110 The Corso
Manly NSW 2095
BEETALOO EXPLORATION DRILL CAMPAIGN
VELKERRI 7S S2-1
DRILL PAD, ACCOMODATION CAMP AND WATER TANK
PAD ACCESS ROAD
NT-2050-20-DD-0025 0


NOTES:
1. ENSURE THAT TABLE DRAINS ARE FREE DRAINING.
2. GROUND CONDITIONS AND SUITABLE MATERIALS TO BE CONFIRMED ON SITE BY SUPERINTENDENT.
3. CLEARED VEGETATION TO BE STORED ALONGSIDE NEW ROAD FOR FUTURE REHABILITATION.
4. REFER TO SPECIFICATION FOR COMPACTION REQUIREMENTS.
5. STRIPPED TOPSOIL TO BE STORED IN BERMS ALONGSIDE ROAD.
6. REFER TO SPECIFICATION FOR GENERAL REQUIREMENTS.
7. THE CONTRACTOR IS TO NOTIFY THE ORIGIN SUPERVISOR IF AREAS OF SOFT GROUND ARE ENCOUNTERED OR IF THE SPECIFICATION CANNOT BE ACHIEVED.
8. CLEAR, STRIP 150mm TOPSOIL AND STOCKPILE IN NOMINATED BUFFER ZONE TO ESTABLISH BORROW PITS.
9. THIS DRAWING MAY BE USED FOR TEMPORARY ACCESS APPLICATION TO NT ROADS.
10. TYPICAL CROSS SECTION DESIGNED IN ACCORDANCE WITH NORTHERN TERRITORY STANDARD DRAWING DS13003.
18.0m (MAX) TO BE DETERMINED ON SITE BY ORIGIN SUPERVISOR EXTENT OF CLEARING
10.0m (MIN) TO BE DETERMINED ON SITE BY ORIGIN SUPERVISOR EXTENT OF CLEARING
2.5m MIN
2.0m
2.0m
1.0m SHLDR
4.0m
2.0m
2.0m
1.0m SHLDR
ROAD
EXISTING SURFACE
4.5%
4.5%
0.15
DRAINS TO DAYLIGHT TO THE NATURAL ENVIRONMENT AT LONGITUDINAL LOW POINTS AS DIRECTED BY THE ENGINEER
REMOVE 150mm TOPSOIL FOR FULL ROAD FORMATION AND STORE IN NOMINATED AREAS
EXCAVATE DRAINS AND USE MATERIAL FOR ROAD PAVEMENT. MATERIAL SUITABILITY TO BE CONFIRMED ON SITE BY ORIGIN SITE SUPERVISOR
RIP AND RE-COMPACT EXISTING SUBGRADE TO A DEPTH OF 150mm TO 95%MMDD
PLACE EXCAVATED DRAIN MATERIAL TO FORM ROAD WEARING SURFACE MATERIAL TO BE PLACED, CONDITIONED AND COMPACTED TO 95% OF MMDD IN MAX. 150mm LAYERS. MIN. WEARING SURFACE THICKNESS IS TO BE 350mm WITH 6% CROSSFALL. SUITABILITY OF PAVEMENT MATERIAL TO BE CONFIRMED ON SITE BY THE ENGINEER
TYPICAL CROSS SECTION – ACCESS ROAD
ISSUED FOR CONSTRUCTION
AECOM
AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com
Tamboran B2 Pty Ltd
ABN 42 105 431 525
110 The Corso
Manly NSW 2095
BEETALOO EXPLORATION DRILL CAMPAIGN
VELKERRI 76 S7-1
DESIGN DETAILS
NT-2050-20-DD-0023
0
A1

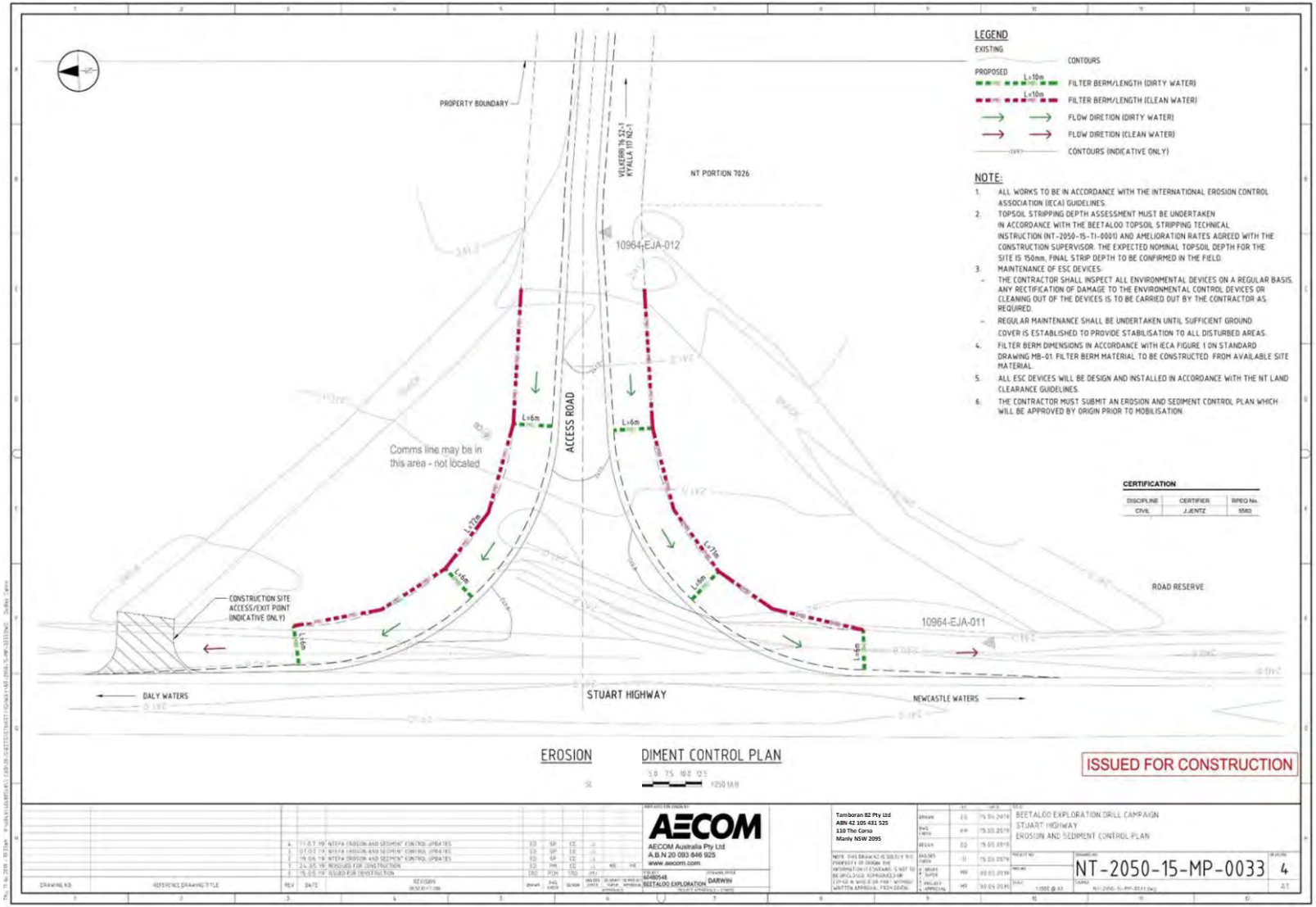

NOTES:
1. GROUND CONDITIONS AND SUITABLE MATERIALS TO BE CONFIRMED ON SITE BY SUPERINTENDENT.
2. REFER TO SPECIFICATION FOR COMPACTION REQUIREMENTS.
3. REFER TO SPECIFICATION FOR GENERAL REQUIREMENTS.
4. THE CONTRACTOR IS TO NOTIFY THE ORIGIN SUPERVISOR IF AREAS OF SOFT GROUND ARE ENCOUNTERED OR IF THE SPECIFICATION CANNOT BE ACHIEVED.
5. REFER TO DRAWING NT-2050-20-DA-0023 FOR SETOUT DETAILS OF MUD SUMP.
6. FAUNA LADDERS TO BE INSTALLED TO MUD SUMP.
7. CONTRACTOR TO PROVIDE CATTLE PANELS FOR FENCING AROUND SUMP WHERE DEPTH IS GREATER THAN 1.5m.
8. FENCE OR BARRICADE TO BE INSTALLED AT SUMP LOAD OUT LOCATION TO ENSURE VEHICLES DO NOT COMPROMISE SUMP WALL/ENTER SUM.
9. MUD SUMP VEHICLE OFFLOAD AREA TO BE COMPACTED TO 200 KPa
PLAN - MUD SUMP
300mm DEEP x 5m LONG SPILLWAY LINE WITH GEOPAVING, NOM DIA. 200mm ROCK ON SPILLWAY FACE AND DOWN TO NATURAL SURFACE
375Ø RCP TO DRAIN POND. INSTALL MANUALLY OPERATED GATE VALVE TO ENABLE POND TO DRAIN OUTSIDE OF SPOIL BUND. BACK CHECK AND FILTER SOCK TO BE INSTALLED AT OUTLET OF DRAIN
PLAN - SECONDARY CONTAINMENT
NOTES:
1 GEOSYNTHETICS ARE DRAWN EXAGGERATED FOR CLARITY.
PROPOSED ANCHOR TRENCH TO FULL PERIMETER
4mm THICK COLETANCHE PS2
1.5m BUFFER FOR 1:100 YEAR RAINFALL EVENT
150mm NOM REWORKED SUBGRADE MATERIAL
MUD
DETAIL - MUD SUMP LINER
4. THICK COLETANCHE PS2 GEOMEMBRANE
150 NOM REWORKED SUBGRADE MATERIAL
DETAIL - BASE LINER
PLACE EXCAVATED MATERIAL AND COMPACT TO 95% MDD.
INSITU MATERIAL TO BE COMPACTED TO MIN OF 95%MDD.
A SECTION
B SECTION
ISSUED FOR CONSTRUCTION
AECOM
Tamboran B2 Pty Ltd
ABN 42 105 431 525
110 The Corso
Manly NSW 2095
BEETALOO EXPLORATION DRILL CAMPAIGN
MUD SUMP DETAILS
NT-2050-20-DD-0031
0

Appendix I Erosion and sediment control plan for Beetaloo W

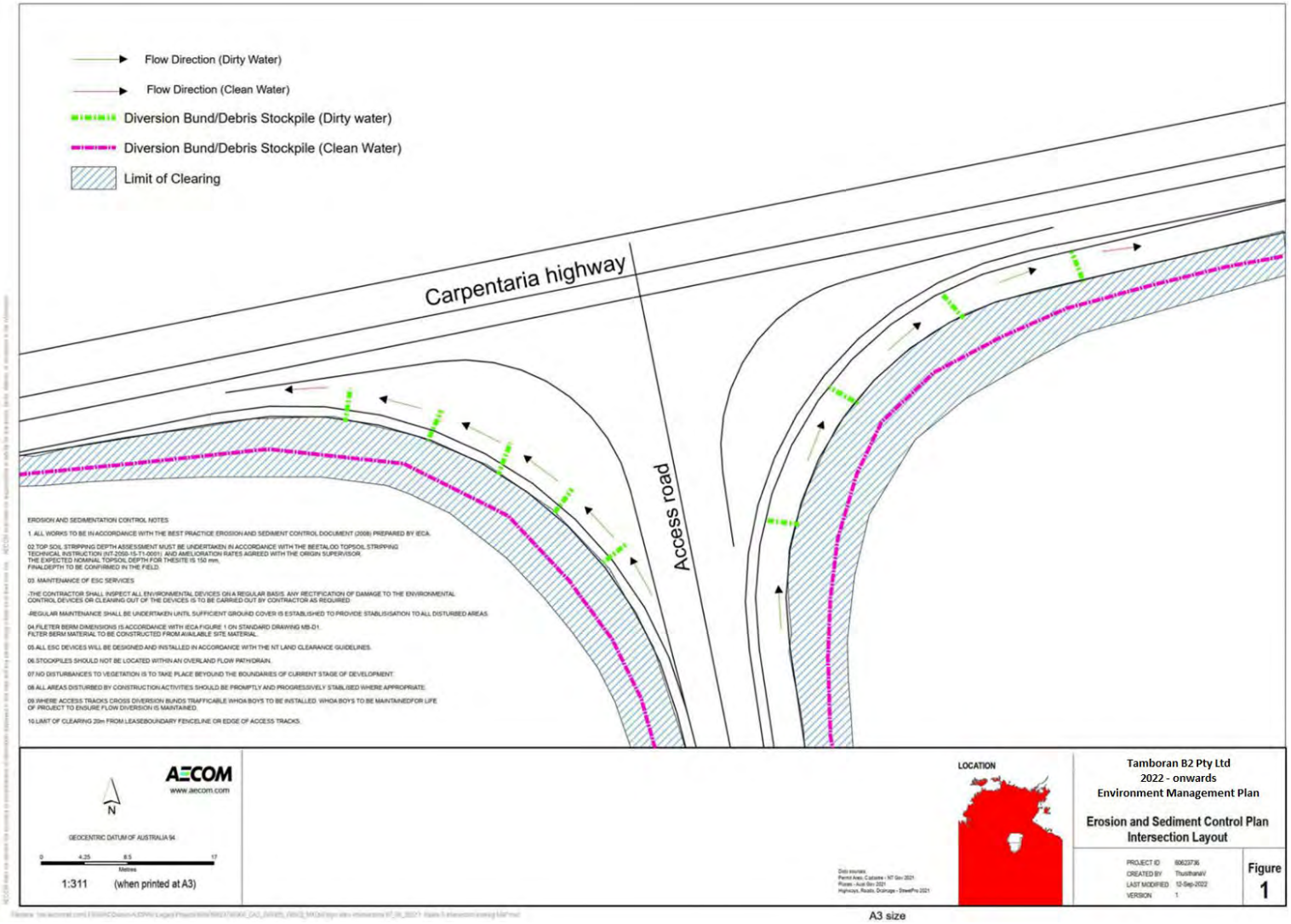


A3 size

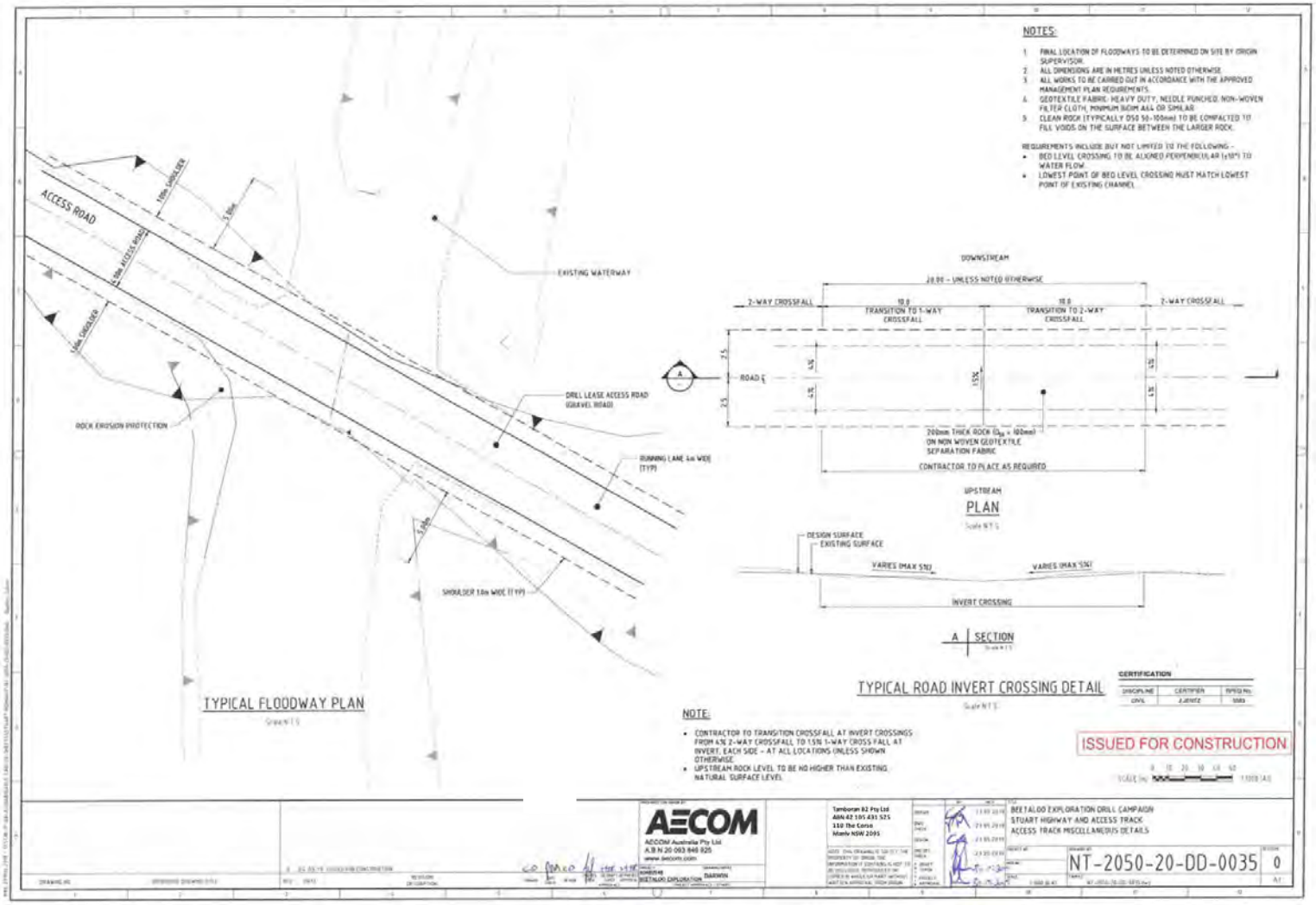
Appendix J Erosion and sediment control plan for Stuart Highway intersection



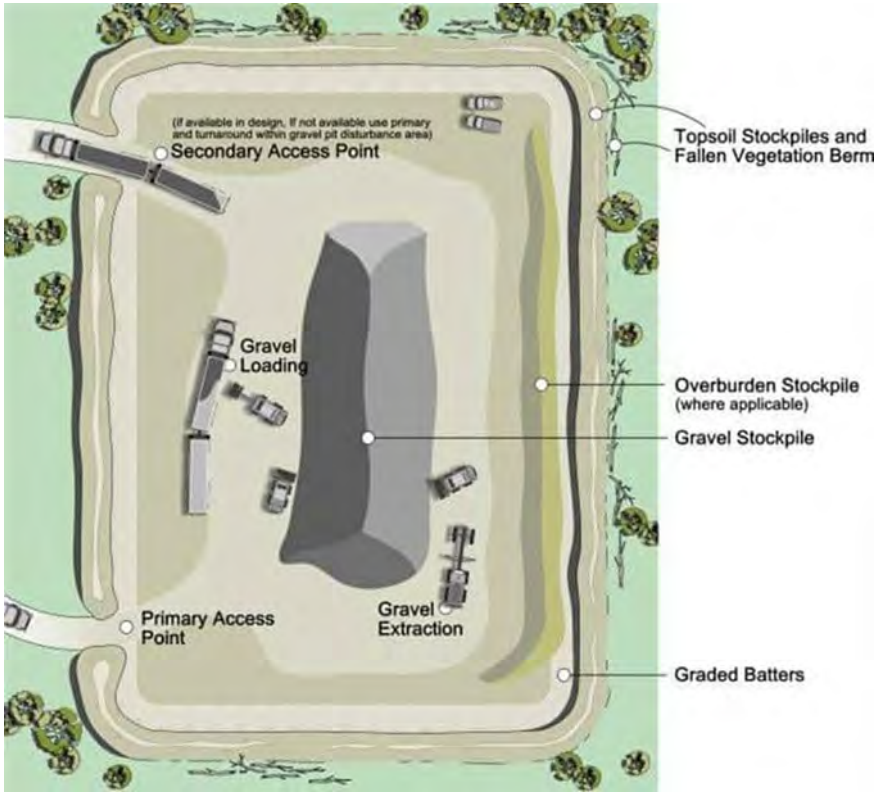
Appendix K Erosion and sediment control plan for typical Carpentaria Highway intersection

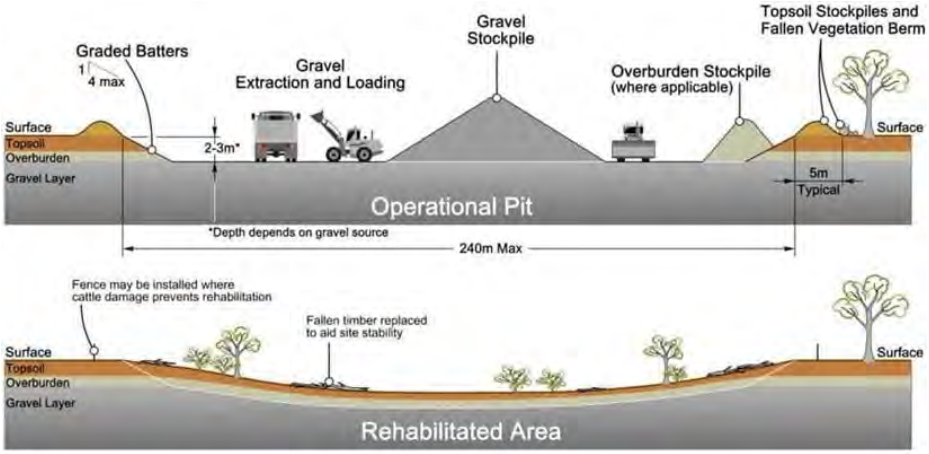


Appendix L Erosion and sediment control plan for typical road invert crossing



Appendix M Erosion and sediment control schematic for typical gravel pit





Appendix N Other IECA standard specifications (as required)

MATERIALS

(i) MULCH MUST COMPLY WITH THE REQUIREMENTS OF AS4454.

(ii) MAXIMUM SOLUBLE SALT CONCENTRATION OF 5dS/m.

(iii) MOISTURE CONTENT OF 30 TO 50% PRIOR TO APPLICATION.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION AND EXTENT. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, MATERIAL TYPE, OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. WHEN SELECTING THE LOCATION OF A MULCH FILTER BERM, TO THE MAXIMUM DEGREE PRACTICAL, ENSURE THE BERM IS LOCATED:

(i) TOTALLY WITHIN THE PROPERTY BOUNDARIES;

(ii) ALONG A LINE OF CONSTANT ELEVATION (PREFERRED, BUT NOT ALWAYS PRACTICAL);

(iii) AT LEAST 1m, IDEALLY 3m, FROM THE TOE OF A FILL EMBANKMENT;

(iv) AWAY FROM AREAS OF CONCENTRATED FLOW.

3. ENSURE THE BERM IS INSTALLED IN A MANNER THAT AVOIDS THE CONCENTRATION OF FLOW ALONG THE BERM, OR THE UNDESIRABLE DISCHARGE OF WATER AROUND THE END OF THE BERM.

4. ENSURE THE BERM HAS BEEN PLACED SUCH THAT PONDING UP-SLOPE OF THE BERM IS MAXIMISED.

5. ENSURE BOTH ENDS OF THE BERM ARE ADEQUATELY TURNED UP THE SLOPE TO PREVENT FLOW BYPASSING PRIOR TO WATER PASSING OVER THE BERM.

6. ENSURE 100% CONTACT WITH THE SOIL SURFACE.

7. WHERE SPECIFIED, TAKE APPROPRIATE STEPS TO VEGETATE THE BERM.

MAINTENANCE

1. DURING THE CONSTRUCTION PERIOD, INSPECT ALL BERMS AT LEAST WEEKLY AND AFTER ANY SIGNIFICANT RAIN. MAKE NECESSARY REPAIRS IMMEDIATELY.

2. REPAIR OR REPLACE ANY DAMAGED SECTIONS.

3. WHEN MAKING REPAIRS, ALWAYS RESTORE THE SYSTEM TO ITS ORIGINAL CONFIGURATION UNLESS AN AMENDED LAYOUT IS REQUIRED OR SPECIFIED.

4. REMOVE ACCUMULATED SEDIMENT IF THE SEDIMENT DEPOSIT EXCEEDS A DEPTH OF 100mm OR 1/3 THE HEIGHT OF THE BERM.

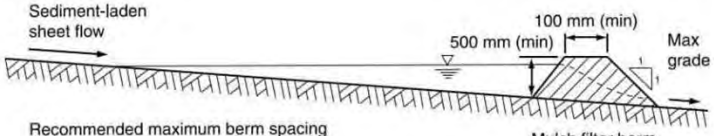
5. DISPOSE OF SEDIMENT IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

REMOVAL (IF REQUIRED)

1. WHEN DISTURBED AREAS UP-SLOPE OF THE BERM ARE SUFFICIENTLY STABILISED TO RESTRAIN EROSION, THE BERM MAYBE REMOVED.

2. REMOVE ANY COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

3. REHABILITATE/REVEGETATE THE DISTURBED GROUND AS NECESSARY TO MINIMISE THE EROSION HAZARD.



Recommended maximum berm spacing

Land slope	Max spacing
< 2%	30 m
5%	25 m
10%	15 m
20%	8 m

Figure 1 - Typical placement of mulch filter berm

Drawn:	Date:		
GMW	Apr-10	Mulch Filter Berms	MB-01

Catchments & Creeks Pty Ltd

MATERIAL

ROCK MULCH: 25–75mm DURABLE, WEATHER RESISTANT AND EVENLY GRADED WITH 50% BY WEIGHT LARGER THAN THE SPECIFIED NOMINAL ROCK SIZE (IF SPECIFIED).

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND APPLICATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF APPLICATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. SPREAD ENOUGH ROCK TO COMPLETELY COVER THE SURFACE OF THE SOIL AT THE DENSITY OR THICKNESS SPECIFIED IN THE APPROVED PLANS. IF THE APPLICATION DENSITY IS NOT SUPPLIED, THEN APPLY AT A THICKNESS OF AT LEAST 50mm OR TWICE THE NOMINAL ROCK SIZE (WHICHEVER IS GREATER).

3. IF THE EXPOSED SOILS ARE DISPERSIVE, THEN ENSURE THESE SOILS ARE COVERED WITH A LAYER OF NON-DISPERSIVE SOIL (MINIMUM 200mm) BEFORE PLACEMENT OF ROCK.

4. MAKE ALL NECESSARY ADJUSTMENTS TO ENSURE ANY SURFACE FLOW IS ALLOWED TO PASS FREELY ACROSS THE TREATED AREA FOLLOWING ITS NATURAL DRAINAGE PATH.

MAINTENANCE

1. INSPECT ALL TREATED SURFACES FORTNIGHTLY AND AFTER RUNOFF-PRODUCING RAINFALL.

2. CHECK FOR RILL EROSION, OR DISLODGMENT OF THE ROCKS.

3. REPLACE ANY DISPLACED ROCKS TO MAINTAIN THE REQUIRED COVERAGE.

4. IF WASH-OUTS OCCUR, REPAIR THE SLOPE AND REINSTALL ROCK COVER.

5. IF THE ROCK MULCHING IS NOT EFFECTIVE IN CONTAINING THE SOIL EROSION IT SHOULD BE REPLACED, OR AN ALTERNATIVE EROSION CONTROL PROCEDURE ADOPTED.

Catchments & Creeks Pty Ltd

Drawn:	Date:		
GMW	Dec-09	Rock Mulching	MR-01

PREPARATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND DIMENSIONAL DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, OR EXTENT, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. TAKE ALL NECESSARY STEPS TO ENSURE DISTURBANCE TO THE BUFFER ZONE IS MINIMISED THROUGHOUT THE TIME IT IS USED AS A SEDIMENT TRAP.

3. TO THE MAXIMUM DEGREE PRACTICABLE, ENSURE FLOW PASSING THROUGH THE BUFFER ZONE IS NOT ALLOWED TO CONCENTRATE WITHIN DRAINAGE DEPRESSIONS, SWALES, RILLS OR WHEEL TRACKS.

4. WHERE NECESSARY, INSTALL APPROPRIATE DRAINAGE CONTROLS UP-SLOPE OF THE BUFFER ZONE TO DISTRIBUTE THE INFLOW ALONG THE FULLY LENGTH OF THE BUFFER ZONE AS 'SHEET FLOW'.

5. WHERE NECESSARY, INSTALL A COARSE SEDIMENT TRAP, SUCH AS A SEDIMENT FENCE, UP-SLOPE OF THE BUFFER ZONE TO REDUCE THE QUANTITY OF SEDIMENT PASSING ONTO THE GRASS. GENERALLY THIS IS REQUIRED IF LARGE QUANTITIES OF COARSE SEDIMENT ARE EXPECTED.

6. IF REQUIRED, INSTALL A LIGHT BARRIER FENCE TO CLEARLY IDENTIFY THE BUFFER ZONE AND HELP EXCLUDE CONSTRUCTION TRAFFIC.

MAINTENANCE

1. INSPECT THE BUFFER ZONE ON A REGULAR BASIS AND AFTER RUNOFF-PRODUCING RAINFALL.

2. ENSURE THAT THERE IS NO SOIL EROSION AND THAT SEDIMENT DEPOSITION IS NOT CAUSING THE CONCENTRATION OF FLOW THROUGH THE BUFFER ZONE, OR FLOW BYPASSING.

3. IF THE BUFFER ZONE HAS BEEN DISTURBED, TAKE NECESSARY STEPS TO RE-ESTABLISH SUITABLE SHEET FLOW CONDITIONS.

4. REMOVE EXCESSIVE ACCUMULATIONS OF SEDIMENT THAT MAY CAUSE THE CONCENTRATION OF FLOW. EXCESSIVE SEDIMENT SHOULD BE REMOVED AFTER EACH RUNOFF-PRODUCING RAINFALL EVENT, OR WHERE APPROPRIATE, EVENLY RAKED INTO THE SOIL. SEDIMENT SHOULD BE REMOVED IN A MANNER THAT AVOIDS DAMAGE TO THE BUFFER ZONE OR THE CREATION OF WHEEL TRACKS DOWN THE SLOPE.

5. EXCESSIVE SEDIMENT MAY BE DEFINED AS:

(i) ANY SEDIMENT THAT COVERS A PORTION OF THE GRASSED SURFACE; OR

(ii) SEDIMENT DEPOSITION SUCH THAT THE GRASS STRAND HEIGHT ABOVE THE SEDIMENT IS LESS THAN 50mm; OR

(iii) A DEPOSITION OF SEDIMENT IN EXCESS OF 750g/m^2 (APPROXIMATELY THE EQUIVALENT OF THREE 70mm DIAMETER BALLS OF DRY SOIL).

6. THE SOURCE OF ANY EXCESSIVE SEDIMENT SHOULD BE INVESTIGATED AND CONTROLLED WHERE PRACTICAL.

7. TAKE APPROPRIATE STEPS TO MAINTAIN AT LEAST 75% GRASS COVER OVER THE BUFFER ZONE.

8. WHERE PRACTICAL, MAINTAIN ANY GROUNDCOVER VEGETATION AT A HEIGHT GREATER THAN THE EXPECTED DEPTH OF WATER FLOW AND AT LEAST 50mm.

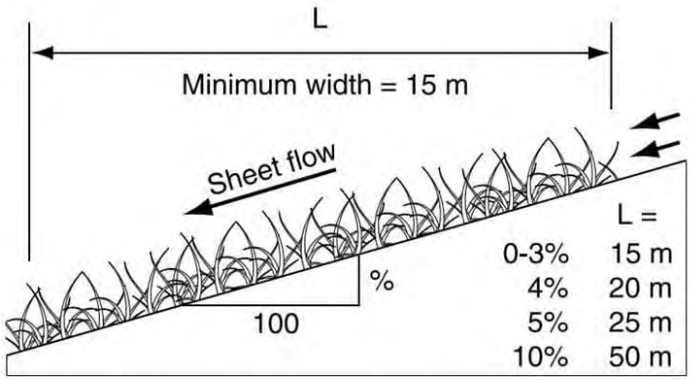
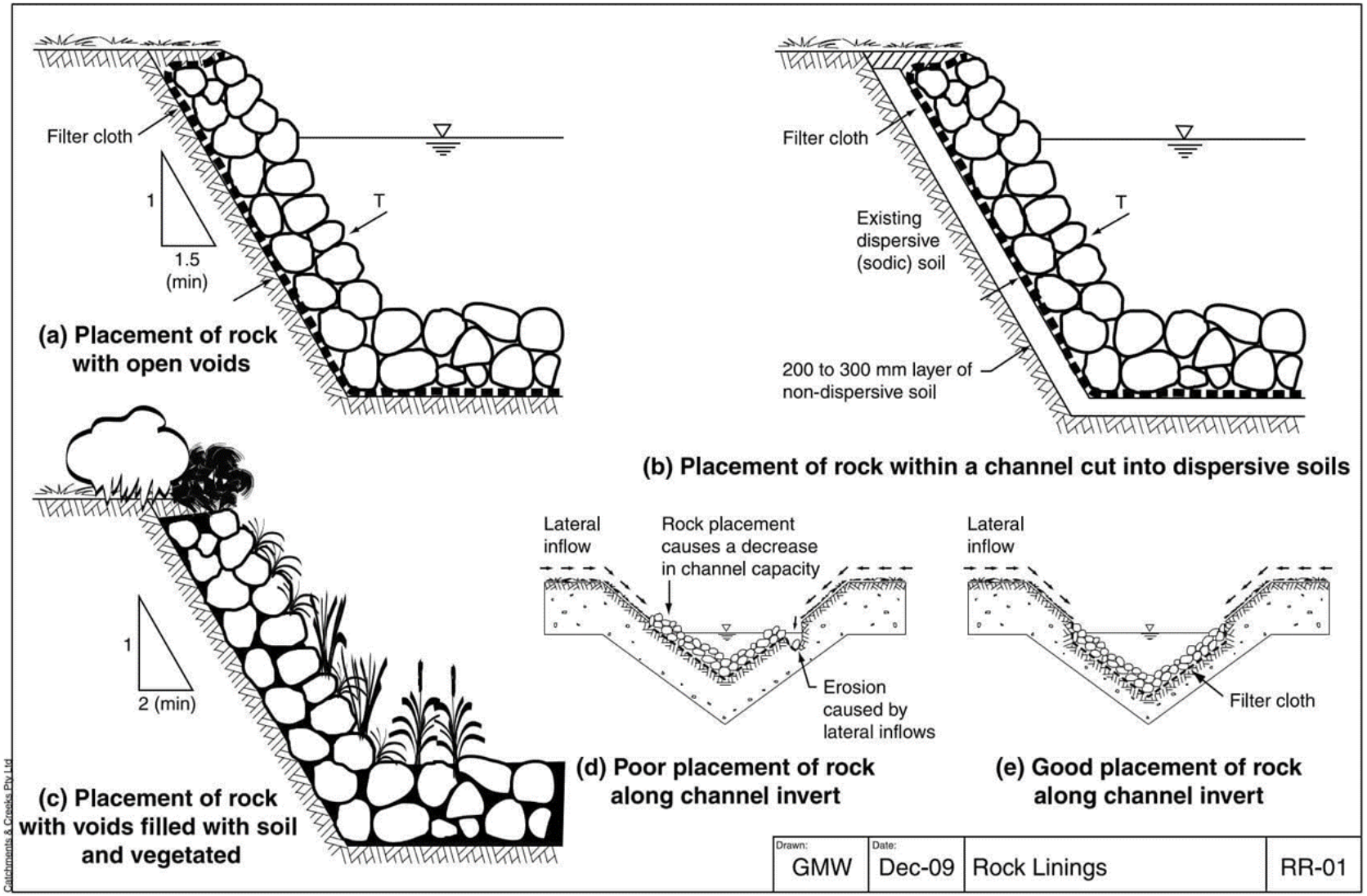


Figure 1 - Minimum dimensional requirements of a grassed buffer zone

Drawn:	Date:		
GMW	Apr-10	Buffer Zones (grassed)	BZ-01

Catchments & Creeks Pty Ltd


Filter cloth
1
1.5
(min)
T
(a) Placement of rock with open voids
Filter cloth
T
Existing dispersive (sodic) soil
200 to 300 mm layer of non-dispersive soil
(b) Placement of rock within a channel cut into dispersive soils
1
2 (min)
(c) Placement of rock with voids filled with soil and vegetated
Lateral inflow
Rock placement causes a decrease in channel capacity
Erosion caused by lateral inflows
(d) Poor placement of rock along channel invert
Lateral inflow
Filter cloth
(e) Good placement of rock along channel invert
Catchments & Creeks Pty Ltd
Drawn: GMW
Date: Dec-09
Rock Linings
RR-01

MATERIALS

ROCK: HARD, ANGULAR, DURABLE, WEATHER RESISTANT AND EVENLY GRADED WITH 50% BY WEIGHT LARGER THAN THE SPECIFIED NOMINAL ROCK SIZE AND SUFFICIENT SMALL ROCK TO FILL THE VOIDS BETWEEN THE LARGER ROCK. THE DIAMETER OF THE LARGEST ROCK SIZE SHOULD BE NO LARGER THAN 1.5 TIMES THE NOMINAL ROCK SIZE. SPECIFIC GRAVITY TO BE AT LEAST 2.5.

GEOTEXTILE FABRIC: HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH, MINIMUM BIDIM A24 OR EQUIVALENT.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT AND INSTALLATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE PROPOSED CHANNEL AREA OF TREES, STUMPS, ROOTS, LOOSE ROCK, AND OTHER OBJECTIONABLE MATERIALS.

3. EXCAVATE THE CHANNEL TO THE LINES AND GRADES AS SHOWN ON THE PLANS. OVER-CUT THE CHANNEL TO A DEPTH EQUAL TO THE SPECIFIED DEPTH OF ROCK PLACEMENT SUCH THAT THE FINISHED ROCK SURFACE WILL BE AT THE ELEVATION OF THE SURROUNDING LAND.

4. ROCK MUST BE PLACED WITHIN THE CHANNEL AS SPECIFIED WITHIN THE APPROVED PLANS, INCLUDING THE PLACEMENT OF ANY SPECIFIED FILTER LAYER.

5. IF DETAILS ARE NOT PROVIDED ON THE ROCK PLACEMENT, THEN THE PRIMARY ARMOUR ROCK MUST BE EITHER PLACED ON:

(i) A FILTER BED FORMED FROM A LAYER OF SPECIFIED SMALLER ROCK (ROCK FILTER LAYER);

(ii) AN EARTH BED LINED WITH FILTER CLOTH;

(iii) AN EARTH BED NOT LINED IN FILTER CLOTH, BUT ONLY IF ALL VOIDS BETWEEN THE ARMOUR ROCK ARE TO BE FILLED WITH SOIL AND POCKET PLANTED IMMEDIATELY AFTER PLACEMENT OF THE ROCK.

6. IF A ROCK/AGGREGATE FILTER LAYER IS SPECIFIED, THEN PLACE THE FILTER LAYER IMMEDIATELY AFTER THE FOUNDATIONS ARE PREPARED. SPREAD THE FILTER ROCK IN A UNIFORM LAYER TO THE SPECIFIED DEPTH BUT A MINIMUM OF 150mm. WHERE MORE THAN ONE LAYER OF FILTER MATERIAL HAS BEEN SPECIFIED, SPREAD EACH LAYER SUCH THAT MINIMAL MIXING OCCURS BETWEEN EACH LAYER OF ROCK.

7. IF A GEOTEXTILE (FILTER CLOTH) UNDERLAY IS SPECIFIED, PLACE THE FABRIC DIRECTLY ON THE PREPARED FOUNDATION. IF MORE THAN ONE SHEET OF FABRIC IS REQUIRED TO OVER THE AREA, OVERLAP THE EDGE OF EACH SHEET AT LEAST 300mm AND PLACE ANCHOR PINS AT MINIMUM 1m SPACING ALONG THE OVERLAP.

8. ENSURE THE GEOTEXTILE FABRIC IS PROTECTED FROM PUNCHING OR TEARING DURING INSTALLATION OF THE FABRIC AND THE ROCK. REPAIR ANY DAMAGE BY REMOVING THE ROCK AND PLACING WITH ANOTHER PIECE OF FILTER CLOTH OVER THE DAMAGED AREA OVERLAPPING THE EXISTING FABRIC A MINIMUM OF 300mm.

9. WHERE NECESSARY, A MINIMUM 100mm LAYER OF FINE GRAVEL, AGGREGATE OR SAND SHOULD BE PLACED OVER THE FABRIC TO PROTECT IT FROM DAMAGE.

10. PLACEMENT OF ROCK SHOULD FOLLOW IMMEDIATELY AFTER PLACEMENT OF THE FILTER LAYER. PLACE ROCK SO THAT IT FORMS A DENSE, WELL-GRADED MASS OF ROCK WITH A MINIMUM OF VOIDS.

11. PLACE ROCK TO ITS FULL THICKNESS IN ONE OPERATION. DO NOT PLACE ROCK BY DUMPING THROUGH CHUTES OR OTHER METHODS THAT CAUSE SEGREGATION OF ROCK SIZES.

12. THE FINISHED SURFACE SHOULD BE FREE OF POCKETS OF SMALL ROCK OR CLUSTERS OF LARGE ROCKS. HAND PLACING MAY BE NECESSARY TO ACHIEVE THE PROPER DISTRIBUTION OF ROCK SIZES TO PRODUCE A RELATIVELY SMOOTH, UNIFORM SURFACE. THE FINISHED GRADE OF THE ROCK SHOULD BLEND WITH THE SURROUNDING AREA. NO OVERFALL OR PROTRUSION OF ROCK SHOULD BE APPARENT.

13. IMMEDIATELY UPON COMPLETION OF THE CHANNEL, VEGETATE ALL DISTURBED AREAS OR OTHERWISE PROTECT THEM AGAINST SOIL EROSION.

14. WHERE SPECIFIED, FILL ALL VOIDS WITH SOIL AND VEGETATE THE ROCK SURFACE IN ACCORDANCE WITH THE APPROVED PLAN.

MAINTENANCE

1. ROCK-LINED CHANNELS SHOULD BE INSPECTED PERIODICALLY AND AFTER SIGNIFICANT STORM EVENTS. CHECK FOR SCOUR OR DISLODGED ROCK. REPAIR DAMAGED AREAS IMMEDIATELY.

2. CLOSELY INSPECT THE OUTER EDGES OF THE ROCK PROTECTION. ENSURE WATER ENTRY INTO THE CHANNEL OR CHUTE IS NOT CAUSING EROSION ALONG THE EDGE OF THE ROCK PROTECTION.

3. CAREFULLY CHECK THE STABILITY OF THE ROCK LOOKING FOR INDICATIONS OF PIPING, SCOUR HOLES, OR BANK FAILURES.

4. REPLACE ANY DISPLACED ROCK WITH ROCK OF A SIGNIFICANTLY (MINIMUM 110%) LARGER SIZE THAN THE DISPLACED ROCK.

Drawn:	Date:		
GMW	May-10	Rock Linings	RR-02

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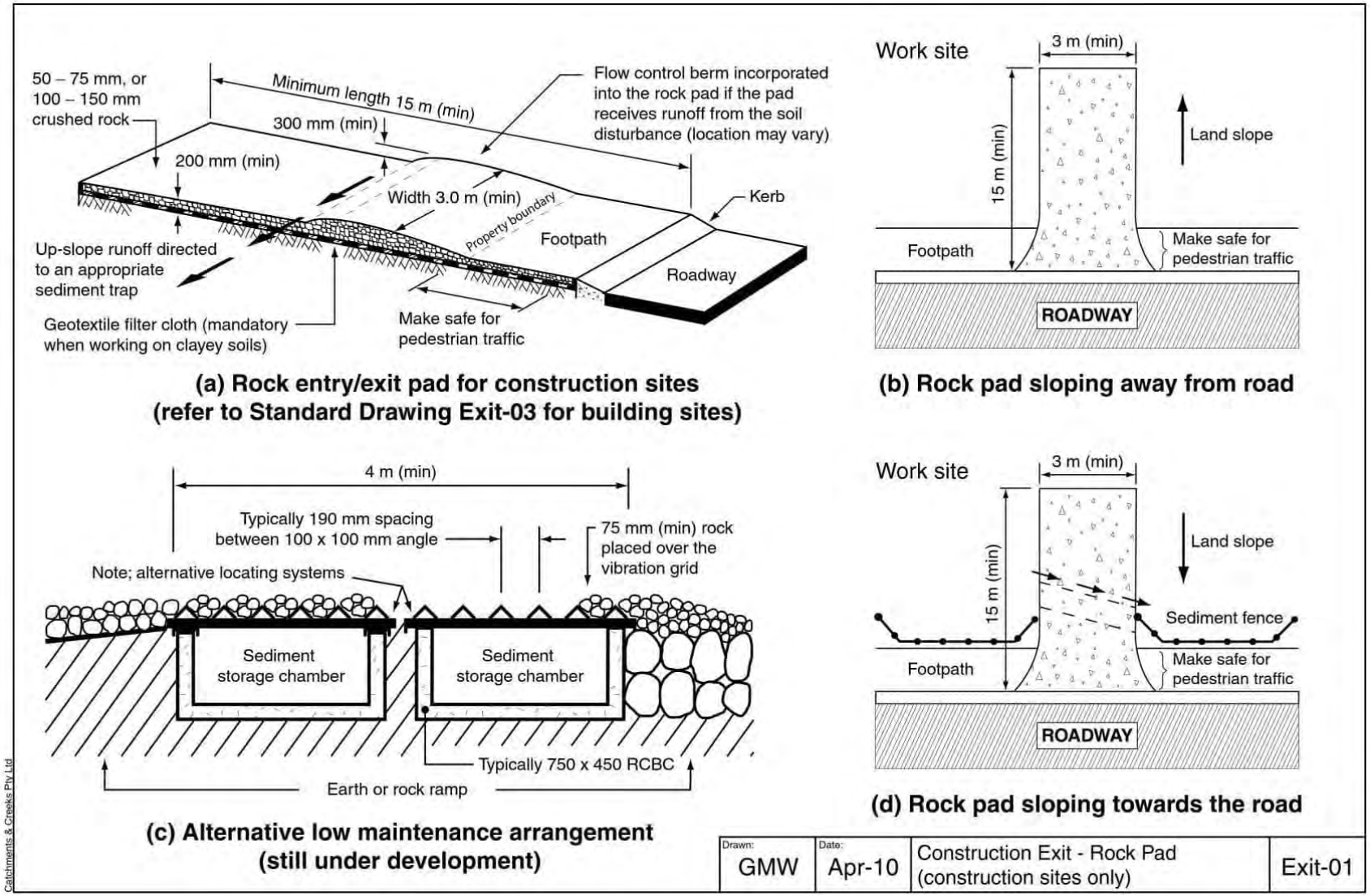
50 – 75 mm, or
100 – 150 mm
crushed rock
Minimum length 15 m (min)
300 mm (min)
200 mm (min)
Flow control berm incorporated into the rock pad if the pad receives runoff from the soil disturbance (location may vary)
Width 3.0 m (min)
Property boundary
Kerb
Footpath
Roadway
Up-slope runoff directed to an appropriate sediment trap
Geotextile filter cloth (mandatory when working on clayey soils)
Make safe for pedestrian traffic
(a) Rock entry/exit pad for construction sites
(refer to Standard Drawing Exit-03 for building sites)
Work site
3 m (min)
15 m (min)
Land slope
Footpath
Make safe for pedestrian traffic
ROADWAY
(b) Rock pad sloping away from road
4 m (min)
Typically 190 mm spacing between 100 x 100 mm angle
75 mm (min) rock placed over the vibration grid
Note; alternative locating systems
Sediment storage chamber
Sediment storage chamber
Typically 750 x 450 RCBC
Earth or rock ramp
(c) Alternative low maintenance arrangement
(still under development)
Work site
3 m (min)
15 m (min)
Land slope
Sediment fence
Footpath
Make safe for pedestrian traffic
ROADWAY
(d) Rock pad sloping towards the road
Drawn: GMW
Date: Apr-10
Construction Exit - Rock Pad (construction sites only)
Exit-01
Catchments & Creeks Pty Ltd

MATERIALS

ROCK: WELL GRADED, HARD, ANGULAR, EROSION RESISTANT ROCK, NOMINAL DIAMETER OF 50 TO 75mm (SMALL DISTURBANCES) OR 100 TO 150mm (LARGE DISTURBANCES). ALL REASONABLE MEASURES MUST BE TAKEN TO OBTAIN ROCK OF NEAR UNIFORM SIZE.

FOOTPATH STABILISING AGGREGATE: 25 TO 50mm GRAVEL OR AGGREGATE.

GEOTEXTILE FABRIC: HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH ('BIDIM' A24 OR EQUIVALENT).

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION AND DIMENSIONAL DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, DIMENSIONS, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE LOCATION OF THE ROCK PAD, REMOVING STUMPS, ROOTS AND OTHER VEGETATION TO PROVIDE A FIRM FOUNDATION SO THAT THE ROCK IS NOT PRESSED INTO SOFT GROUND. CLEAR SUFFICIENT WIDTH TO ALLOW PASSAGE OF LARGE VEHICLES, BUT CLEAR ONLY THAT NECESSARY FOR THE EXIT. DO NOT CLEAR ADJACENT AREAS UNTIL THE REQUIRED EROSION AND SEDIMENT CONTROL DEVICES ARE IN PLACE.

3. IF THE EXPOSED SOIL IS SOFT, PLASTIC OR CLAYEY, PLACE A SUB-BASE OF CRUSHED ROCK OR A LAYER OF HEAVY-DUTY FILTER CLOTH TO PROVIDE A FIRM FOUNDATION.

4. PLACE THE ROCK PAD FORMING A MINIMUM 200mm THICK LAYER OF CLEAN, OPEN-VOID ROCK.

5. IF THE ASSOCIATED CONSTRUCTION SITE IS UP-SLOPE OF THE ROCK PAD, THUS CAUSING STORMWATER RUNOFF TO FLOW TOWARDS THE ROCK PAD, THEN FORM A MINIMUM 300mm HIGH FLOW CONTROL BERM ACROSS THE ROCK PAD TO DIVERT SUCH RUNOFF TO A SUITABLE SEDIMENT TRAP.

6. THE LENGTH OF THE ROCK PAD SHOULD BE AT LEAST 15m WHERE PRACTICABLE, AND AS WIDE AS THE FULL WIDTH OF THE ENTRY OR EXIT AND AT LEAST 3m. THE ROCK PAD SHOULD COMMENCE AT THE EDGE OF THE OFF-SITE SEALED ROAD OR PAVEMENT.

7. FLARE THE END OF THE ROCK PAD WHERE IT MEETS THE PAVEMENT SO THAT THE WHEELS OF TURNING VEHICLES DO NOT TRAVEL OVER UNPROTECTED SOIL.

8. IF THE FOOTPATH IS OPEN TO PEDESTRIAN MOVEMENT, THEN COVER THE COARSE ROCK WITH FINE AGGREGATE OR GRAVEL, OR OTHERWISE TAKE WHATEVER MEASURES ARE NEEDED TO MAKE THE AREA SAFE.

MAINTENANCE

1. INSPECT ALL SITE ENTRY AND EXIT POINTS PRIOR TO FORECAST RAIN, DAILY DURING EXTENDED PERIODS OF RAINFALL, AFTER RUNOFF-PRODUCING RAINFALL, OR OTHERWISE AT FORTNIGHTLY INTERVALS.

2. IF SAND, SOIL, SEDIMENT OR MUD IS TRACKED OR WASHED ONTO THE ADJACENT SEALED ROADWAY, THEN SUCH MATERIAL MUST BE PHYSICALLY REMOVED, FIRST USING A SQUARE-EDGED SHOVEL, AND THEN A STIFF-BRISTLED BROOM, AND THEN BY A MECHANICAL VACUUM UNIT, IF AVAILABLE.

3. IF NECESSARY FOR SAFETY REASONS, THE ROADWAY SHALL ONLY BE WASHED CLEAN AFTER ALL REASONABLE EFFORTS HAVE BEEN TAKEN TO SHOVEL AND SWEEP THE MATERIAL FROM THE ROADWAY.

4. WHEN THE VOIDS BETWEEN THE ROCK BECOMES FILLED WITH MATERIAL AND THE EFFECTIVENESS OF THE ROCK PAD IS REDUCED TO A POINT WHERE SEDIMENT IS BEING TRACKED OFF THE SITE, A NEW 100mm LAYER OF ROCK MUST BE ADDED AND/OR THE ROCK PAD MUST BE EXTENDED.

5. ENSURE ANY ASSOCIATED DRAINAGE CONTROL MEASURES (e.g. FLOW CONTROL BERM) ARE MAINTAINED IN ACCORDANCE WITH THEIR DESIRED OPERATIONAL CONDITIONS.

6. DISPOSE OF SEDIMENT AND DEBRIS IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. THE ROCK PAD SHOULD BE REMOVED ONLY AFTER IT IS NO LONGER NEEDED AS A SEDIMENT TRAP.

2. REMOVE MATERIALS AND COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.
3. RE-GRADE AND STABILISE THE DISTURBED GROUND AS NECESSARY TO MINIMISE THE EROSION HAZARD.

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Drawn:	Date:		
GMW	Apr-10	Construction Exit - Rock Pad (construction sites only)	Exit-02

APPLICATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND APPLICATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF APPLICATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. FILL OR SUITABLY CONTOUR ANY EXISTING RUTTING, RILLING OR GULLIES.

3. SUITABLY DIVERT UP-SLOPE STORMWATER RUNOFF AROUND TREATED AREA AS DIRECTED WITHIN THE APPROVED PLANS, OR OTHERWISE AS DIRECTED BY THE SITE ENGINEER.

4. APPLY TREATMENT TO THE AREA TO THE DEPTH AND FREQUENCY (SPACING) SPECIFIED ON THE APPROVED PLANS, OR OTHERWISE AS DIRECTED BY THE SITE ENGINEER.

5. IMMEDIATELY SEED AND MULCH ROUGHENED AREAS TO OPTIMISE SEED GERMINATION AND GROWING CONDITIONS.

MAINTENANCE

1. DURING THE CONSTRUCTION PERIOD, INSPECT THE TREATED AREA PRIOR TO FORECAST RAINFALL, DAILY DURING EXTENDED PERIODS OF RAINFALL, AFTER SIGNIFICANT RUNOFF PRODUCING RAINFALL, OR OTHERWISE ON A WEEKLY BASIS.

2. FILL EROSION RILLS SLIGHTLY ABOVE THE ORIGINAL GRADE, OR REGRADE THE SLOPE AS DIRECTED TO REMOVE THE RILLS.

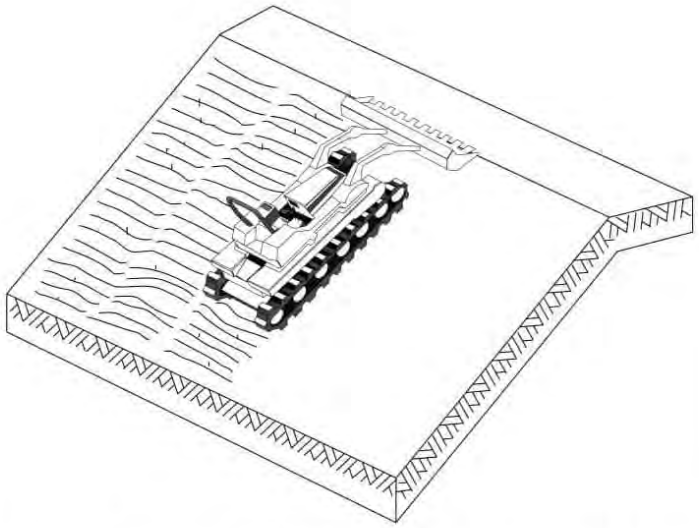

Figure 1 - Application of surface roughening on slope

Drawn:	Date:		
GMW	Dec-09	Surface Roughening	SR-01

Catchments & Creeks Pty Ltd

Appendix O Table 4.4.7 IECA best practice land clearing and rehabilitation requirements

Risk[1]	Best practice requirements
All cases	• All reasonable and practicable steps taken to apply best practice erosion control measures to completed earth works, or otherwise stabilise such works, prior to anticipated rainfall – including existing unstable, undisturbed, soil surfaces under the management or control of the building/construction works.
Very low	• Land clearing limited to 8 weeks of work if rainfall is reasonably possible. • Disturbed soil surfaces stabilised with minimum 60% cover[2] within 30 days of completion of works if rainfall is reasonably possible. • Unfinished earthworks are suitably stabilised if rainfall is reasonably possible, and disturbance is expected to be suspended for a period exceeding 30 days.
Low	• Land clearing limited to maximum 8 weeks of work. • Disturbed soil surfaces stabilised with minimum 70% cover[2] within 30 days of completion of works within any area of a work site. • Unfinished earthworks are suitably stabilised if rainfall is reasonably possible and disturbance is expected to be suspended for a period exceeding 30 days. • Appropriate protection of all planned garden beds is strongly recommended.
Moderate	• Land clearing limited to a maximum 6 weeks of work. • Disturbed soil surfaces stabilised with minimum 70% cover[2] within 20 days of completion of work within any area of a work site. • All planned garden beds protected with a minimum 75mm layer of organic *Mulching*, heavy *Erosion Control Blanket, Rock Mulching,* or the equivalent. • Staged construction and stabilisation of earth batters (steeper than 6H:1V) in maximum 3m vertical increments wherever reasonable and practicable. • The use of turf to form grassed surfaces given appropriate consideration. • Soil stockpiles and unfinished earthworks are suitably stabilised if disturbance is expected to be suspended for a period exceeding 10 days.

Risk[1]	Best practice requirements
High	• Land clearing limited to a maximum 4 weeks of work. • Disturbed soil surface stabilised with minimum 75% cover[2] within 10 days of completion of works within any area of a work site. • All planned garden beds protected with a minimum 75mm layer of organic *Mulching*, heavy *Erosion Control Blanket, Rock Mulching,* or the equivalent. • Staged construction and stabilisation of earth batters (steeper than 6H:1V) in maximum 3m vertical increments wherever reasonable and practicable. • The use of turf to form grassed surfaces given appropriate consideration. • Soil stockpiles and unfinished earthworks are suitably stabilised if disturbance is expected to be suspended for a period exceeding 10 days.
Extreme	• Land clearing limited to maximum 2 weeks of work. • Disturbed soil surfaces stabilised with minimum 80% cover[2] within 5 days of completion of works within any area of a work site. • All planned garden beds protected with a minimum 75mm layer of organic *Mulching*, heavy *Erosion Control Blanket, Rock Mulching,* or the equivalent. • Staged construction and stabilisation of earth batters (steeper than 6H:1V) in maximum 2m vertical increments wherever reasonable and practicable. • High priority given to the use of turf to form grassed surfaces. • Soil stockpiles and unfinished earthworks are suitably stabilised if disturbance is expected to be suspended for a period exceeding 5 days.

1. Erosion risk based on monthly erosivity (Table 4.4.1), average monthly rainfall depth (Table 4.4.2), or soil loss rate (Table 4.4.3) as directed by the regulatory authority.
2. Minimum cover requirements may be redirected if the natural cover of the immediate land is less than the nominated value, for example in arid and semi-arid areas or on coastal sand dunes.

Appendix P Erosion and sediment control treatment – seismic lines

Blade up erosion controls

Figure 1 shows the condition of land following blade up traverse of survey area. No treatment required.

Figure 1 Typical condition 'blade up' treatment

Surface bladed by grader (including woodland areas)

Erosion control treatments as follows:

- A diversion bank shall be installed along sections of the survey lines where material has been stripped from the surface (refer Table 12).
- The bank shall be constructed as a cut and push operation. Lines shall be ripped across the area at a grade of 0.3%. A shallow channel should be cut along this line (approximately 0.6 metres deep). Excavated material is dumped on the down slope side of the channel then compacted and smoothed out to form a bank with even batters and a level top (refer Figure 2).
- To aid trafficability, an approach and departure ramp shall be shaped during construction of the bank.
- The bank should direct runoff into undisturbed vegetation or into an existing drain (care needs to taken to ensure that erosion does not occur where the water runs down into the drain).
- Ensure the diversion bank is not eroded by traffic.
- Undertake maintenance as necessary.

Table 12: Bank spacing requirements (m)

Slope		Diversion bank spacing (m)
%	Gradient	
0.5	1:200	170-180
1	1:100	120-130
2	1:50	90-100
3	1:33	70-80
4	1:25	60-70
5	1:20	55-60
6	1:17	40-45

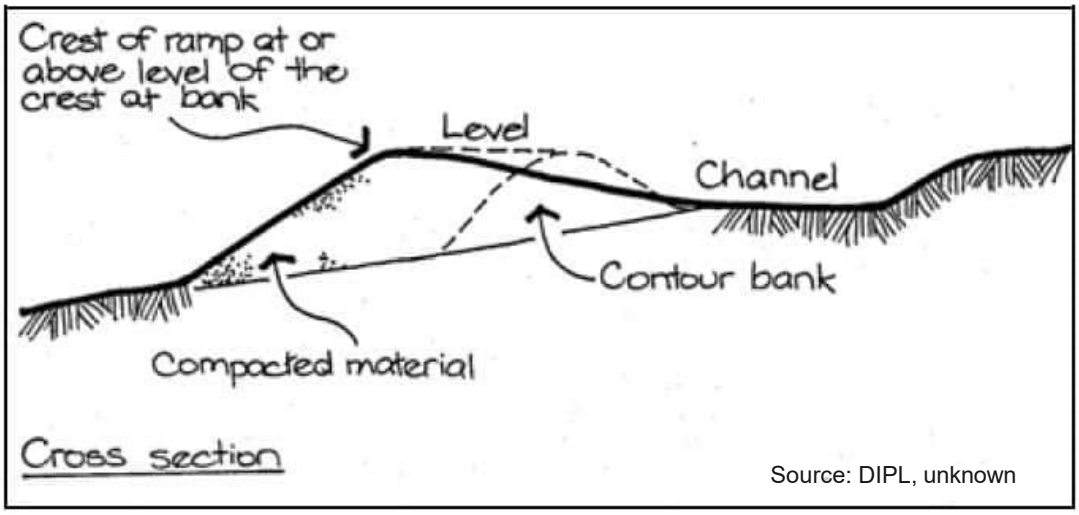

Figure 2 Whoa boys or roll over banks drawing

Woodland area erosion controls

Figure 3 shows the expected final rehabilitation treatment for woodland areas disturbed by the seismic survey activities. In the event of an expected significant rainfall event which will require the site to be abandoned, a similar treatment is to be adopted.

- Step 1. Respread windrowed topsoil of disturbed area and ripped into the soil surface.
- Step 2. Spread vegetation over top soiled area in an even layer.

Felled vegetation will be evenly spread over the top soiled area to provide additional protection against erosion.

Figure 3 Treatment for woodland areas

Typical offlet drain detail of access tracks

Figure 4 shows the typical offlet drain and table drain block detail, which consists of the following actions:

- Construct access tracks with table drains that are free draining.
- Avoid road crowning to allow water to naturally cross the road.
- Form tracks to allow off-road drainage. Where track intercepts the direction of overland flow and re-directs this flow to a non-natural drainage line, install erosion control works to minimise potential erosion.
- The design and position of erosion control measures to be determined by experienced operator and site engineer, based on the site characteristics of the access track location.
- Where construction of table drains are deemed necessary, they should have a broad flat base at least 1 m wide and should not be graded to produce a 'V' shape. To minimise erosion,
- the slope should be no greater than 0.5% on erodible soils or 1% on stable soils.
- Where encounter dispersive / erosive soils they should be stabilised with gypsum or other stabiliser, as determined by laboratory analysis of soils.
- Where cut-out drains are required, they should be spaced based on the slope of the area i.e. 0.5% slope, allow for cut-out draining every 170-180 m or 1 % slope, allow for cut-out drainage every 120-130 m etc. (refer to NT Road Drainage Fact Sheet). It is noted that the recommended distance between turn-out drains is a guide and may not apply to all locations along the access track.

- Monitor road conditions to ensure deterioration does not occur. Assist in the maintenance and repair work on roads and tracks used.

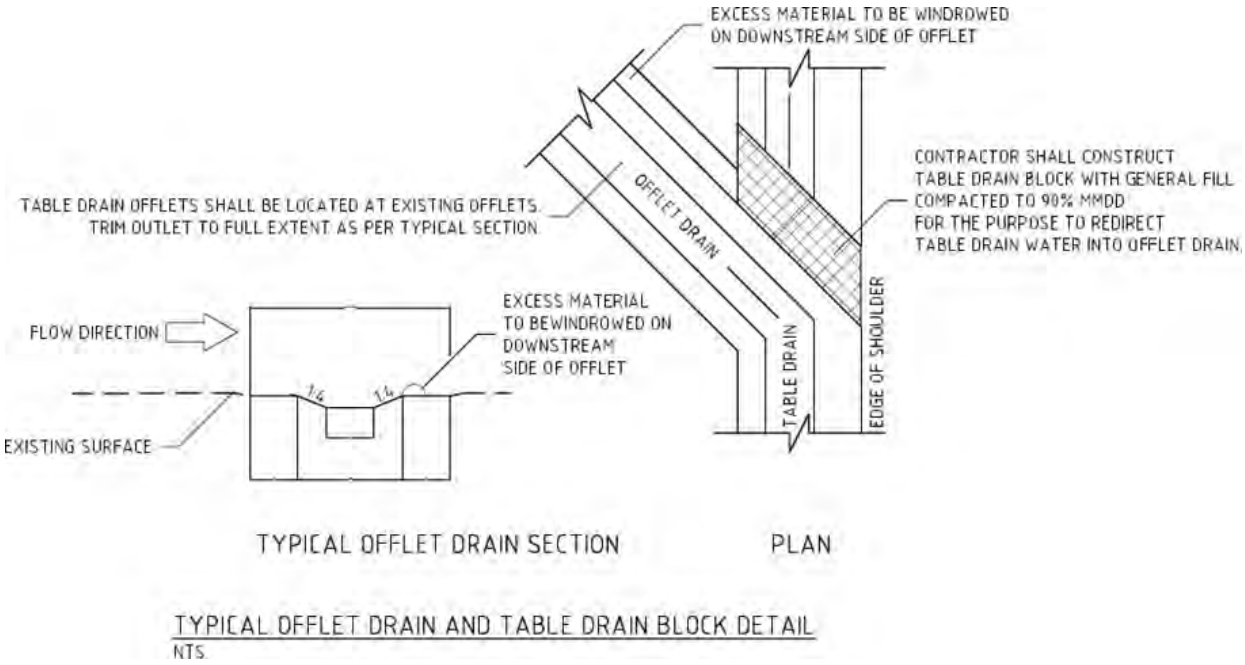

Figure 4 Typical offlet drain and table drain block diagram

APPENDIX I Methane Emissions Management Plan

tamboran
RESOURCES

MEMP

NT-2050-MP-15- 030

BEETALOO EXPLORATION PROGRAM

Methane Emission Management Plan

Review record

Rev	Date	Reason for issue	Reviewer(s)	Consolidator	Approver
0	15/04/2019	Released for use	MK	LF	MH
1	12/04/2023	Minor amendments	LP	LP	LP
2	15/03/2024	Response to regulation 10 and 11	LP	LP	MK

Review date: 18/05/2024.

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Abbreviations

Acronym	Definition
API	American Petroleum Institute
CRDS	cavity ring-down spectrometer
ISO	International Organization for Standardization
m	metres
mm	millimetres
MEMP	Methane Emissions Management Plan
N/A	not applicable
NORSOK	Standards Norway (originally “the Norwegian shelf’s competitive position”)
ppb	parts per billion
ppm	parts per million
REC	reduced emission completions
US EPA	United States Environment Protection Authority

1 Purpose

This Methane Emissions Management Plan (MEMP) is designed to outline the measures as to how the risks of methane emissions associated with Tamboran B2 Pty Ltd Beetaloo Basin exploration activities will be managed. This Plan has been developed in accordance with the *Code of Practice for Petroleum Activities in the Northern Territory* ("the Code").

2 Key Legislation

Key legislation and documents consulted in the development of this plan are provided below. A full list of applicable legislation is provided in the corresponding management plans.

- **Code of Practice for Petroleum activities in the Northern Territory:** Mandatory code of practice legislating the management of chemicals and wastewater onsite, including the use of secondary containment, lined tanks and spill management plan
- **National Greenhouse and Energy Reporting Act 2007:** Regulates the reporting of greenhouse gas emissions, energy production and energy consumption associated with company activities. Data to be supplied annually to the regulator in accordance with emission/energy use guidance manuals.

3 Activity Description

The activities undertaken as a part of this MEMP are summarised in Table 1. These activities are restricted to the drilling, stimulation, well testing and ongoing operation of exploration wells. They do not cover any production, compression or pipeline activities as these are currently not proposed.

Table 1: Activity and emission description summary

Activity	Emission description	Controls	Emission monitoring
Drilling	Methane emissions are small (<1 tonne) and restricted to outgassing of hydrocarbon within intersected shales brought to surface.	• Drilling is overbalanced, preventing gas influx into well bore. • Shale formations have negligible permeability with limited influx of gas from target formations.	• Due to low emission level, gas is qualitatively monitored in mud stream as a concentration (not flow rate). • Gas desorption data is collected from target reservoir allowing emission estimates.
Stimulation	During stimulation, the well will be overbalanced restricting the flow of hydrocarbons to surface.	• Well is kept overbalanced to prevent gas influx during and after stimulation. • Flowback kept within the formation after each stage.	N/A
Well testing	• Well is unloaded to allow hydrocarbons and fluid to flow to surface; • All fluids and hydrocarbons diverted to a separator and then a flare onsite; • Small emissions (<1	• Well heads are designed in accordance with the Code and API standards to minimise loss of methane containment. • A reduced emission completion will be utilised; where all gas is sent to a separator and then flared. Personal gas detector during all	• Personal gas detector during well testing activities. • All flared gas measured using flow meters.

Activity	Emission description	Controls	Emission monitoring
	tonne) of methane may be released prior to the onsite of flaring, as the hydrocarbon production rate may not be enough to sustain a flare initially; • Small volumes (kg/day) of methane is entrained within liquid hydrocarbons; and • flowback fluid and will be released to atmosphere.	operational visits.	
Gathering line operations	• Emissions from pipelines, high point vents and drains	• Gas pipelines are designed in accordance with Australian Standards • Pipelines are pressure tested prior to use • HPV's and LPD are constructed with gas tight fittings	• 6 monthly inspection of gathering lines and surface facilities.
Ongoing well operations/ suspension	Methane emissions restricted to unplanned leaks from well heads, including surface casing vents.	• Operation staff to carry personal calibrated gas detectors during every routine operational visit to well sites. • Routine wellhead maintenance as per the Integrity Management System. • Each well and equipment on the well pad to be inspected every 6 months for leaks using the US EPA Method 21 compliance technique.	• Personal gas detector during well testing activities. • 6 monthly leak detection.

4 Equipment Selection and Activity Design

The uncontrolled emissions of natural gas during drilling, stimulation and well testing activities represents a potential hazard to workers and the environment. All equipment will be selected to minimise the emissions during production activities.

- Exploration wells and associated surface infrastructure shall be designed to mitigate leaks in accordance with the relevant standards. These Standards include:

- ISO 16530-1-2017 Petroleum and natural gas industries- Well Integrity - Life cycle governance
- API SPEC 5CT 2016 Casing and Tubing
- API SPEC 16D 2013 Control Systems for Drilling Well Control Equipment and Control Systems for Diverter Equipment
- API RP 59 2012 Well control operations
- API SPEC 6A 2016 Wellhead and Christmas Tree equipment
- NORSOK Standard D-010, Well integrity in drilling and well operations

- Leak detection implemented consistent with Codes of Practice.
- Ongoing well maintenance as per the Well Operations Management Plan.

5 Flowback Activities

5.1 Reduced emission completion

- A reduced emission completions (REC) shall be used to minimise the amount of venting.
- A REC for the purpose of the Beetaloo exploration project is a separator equipped with a flare.
- Venting shall only be used where the capture or flaring is not possible.
- The recovery of gas and hydrocarbons for sale will be prioritised (where practicable) to minimise flaring.

6 Leak Detection Inspections

The leak inspection programs will be implemented in accordance with Table 2.

Table 2: Leak detection program

Facility/ system	Frequency	Monitoring methodology
Routine operational inspections		Calibrated personal gas detector
Well heads and above ground facility	6 monthly	US EPA Method 21
Gathering lines and low pressure pipelines	6 monthly	US EPA Method 21
Compressor stations and pneumatic devices	Quarterly	US EPA Method 21
All gas containing equipment following major maintenance	48 hours of commissioning	US EPA Method 21

7 Monitoring Methodology

Mandatory inspections will be completed on all surface infrastructure (vents, flanges, valves, connections, drains, pressure relief vents, etc.) of the exploration well in accordance with the US EPA Method 21 requirements or a vehicle mounted cavity ring-down spectrometer (CRDS).

7.1 Instrument Selection

- A Method 21 detector must be able to detect methane at the minimum detection range of 10 parts per million (ppm), with an +/- accuracy of 50 ppm.
- A vehicle mounted CRDS detectors shall have a 10 parts per billion (ppb) minimum detection accuracy

with an accuracy of +/- 10 ppb.

- The instrument shall be intrinsically safe (where used within hazardous areas) and equipped with an electrically driven pump, to ensure that a sample is provided to the detector at a constant flow rate.

7.2 Qualifications

- Inspections must be carried out by a suitably qualified person.
- A suitably qualified person is defined as a person that has been specifically trained in leak detection or has at least 3 years industry experience in conducting leak detection activities.

7.3 Calibrations

- Gas detectors must be maintained and calibrated in accordance with the manufacturers' instructions. Records of instrument calibration shall be retained.
- A two-stage calibration shall be used, with an air calibration and a 10 ppm by volume CH_4 calibration gas used.
- The instrument response time shall be less than 30 seconds.

7.4 Testing procedure

7.4.1 Method 21

Method 21 inspections are used to survey individual pieces of equipment. These types of inspections require access to the surface of the equipment and are extremely effective at pinpointing leaks. The following procedure is to be followed when conducting method 21 inspections:

1. Ensure gas detector is calibrated and functioning properly.
2. Ensure the appropriate permitting is obtained before entry into a hazardous area.
3. Place the probe inlet at the surface of the component interface where leakage could occur.
4. Move the probe along the interface periphery while observing the instrument readout. If an increased meter reading is observed, slowly sample the interface where leakage is indicated until the maximum meter reading is obtained.
5. Leave the probe inlet at this maximum reading location for approximately two times the instrument response time (i.e. at least a minute).
6. If the maximum observed meter reading is greater than 500 ppm at the surface of a piece of infrastructure, the leak is to be measured again at 150 mm immediately above (and downwind) of the leak in an open-air environment.
7. The leak shall be classified in accordance with section 7.
8. The location of the leak shall be clearly documented and photographs taken (if safe to do so).
9. Any liquid petroleum leaks should also be identified, along with estimates of leak rate and volume released.

7.4.2 Vehicle mounted CRDS

Vehicle mounted CSRDS uses highly sensitive, PPB level detectors to screen clumps of infrastructure for leaks. They are extremely effective at providing a rapid assessment and are used in combination of method 21 assessment to pinpoint leaks. The following procedure shall be followed when conducting vehicle mounted CRDS inspections:

1. The vehicle shall be driven within 20 m up and downwind of the infrastructure at a speed below 20 km/hour: it is advisable to drive around a piece of infrastructure in a circular motion to obtain up and down wind in the same pass.
2. Where a survey cannot be made within 20 m downwind of a piece of infrastructure, a method 21 inspection shall be undertaken.
3. Downwind methane concentrations shall be compared to upwind (background) concentration.
4. Where an emission is identified at 5 ppm above background, a method 21 inspection shall be undertaken.
5. Where enrichment is recorded below 5 ppm, the infrastructure has no material leaks present.

8 Leak Classification, Repair and Notification

Each leak shall be classified, repaired and reported in accordance with Table 3. It should be noted, that classification of leaks is only undertaken using a method 21 approach outlined in 7.4.1.

Table 3: Leak classification and remediation summary

Classification	Threshold	Response	Notification	Comments
Minor Leak	>500 ppm measured at the surface of the component in accordance with section 6.4.1	All minor leaks must be documented and repaired as soon as practicable, but within 30 days. Where 30 days in unachievable, the reason for the delay and target date for completion must be submitted.	All minor leaks must be documented	A minor leak is an unplanned release that does not occur during commissioning or bringing equipment back into service. These leaks should be corrected immediately as a part of commissioning
Significant Leak	>5000 ppm (or 10% of the Lower Explosive Limit) when measured at the surface of the leak source. Or A Liquid Petroleum (condensate/oil) loss of containment that exceeds 200 L. Or The leak is too large or not safe to measure. Or A leak due to an unplanned release from a gathering system -subsurface pipeline that, at ground level; gives a sustained reading greater than 500 ppm (by volume) for a 15 second duration.	1. The activities safety management plan, risk assessment and emergency response requirements must be followed. 2. Remediation work must only commence after a suitable risk assessment has been undertaken (at a level appropriate to the nature of the leak) and the relevant safety procedures are followed including the consideration of all the required Personal Protective Equipment and emergency response material. 3. If safe to do so, the leak source should be isolated and repaired immediately. The response priority must be to make the site safe above all other actions. 4. The leak shall be repaired or made safe as soon as practicable, as follows: i) the leak must be isolated, repaired if possible, contained or otherwise made safe within 72 hours. ii) Where isolation and repair are not	In the case of an emergency, DPIR must be notified within 24 hours via the emergency response hotline number 1300 935 250. Notification must include the date of identification, nature and level of the leak, infrastructure name, number and location as well as the initial actions to minimise the risk. The landowner or occupier of the property in which these leaks are occurring must be notified in the following circumstances: i) if the leak cannot be repaired immediately; and ii) if the leak is likely to affect any of the landowners or occupiers'	A significant leak is an unplanned release that does not occur during commissioning or bringing equipment back into service. These leaks should be corrected immediately as a part of commissioning.

Classification	Threshold	Response	Notification	Comments
		possible, an exclusion zone must be established around the leak and appropriate restrictions to on access to the exclusion zone imposed. iii) in the event the 72-hour deadline is unachievable, the reason for the delay and the target date for repair shall be submitted to DPIR before the deadline has passed. 5. If it is contended that the risk of immediately repairing the leak exceeds the risk posed by the leak, an extension of the 72-hour deadline may be sought provided that other measures to mitigate the risk are undertaken (e.g. ensuring an appropriate exclusion zone has been implemented). 6. For leaks identified on well equipment, higher order controls such as containment by repair must be implemented wherever possible. 7. For leaks identified on well casings or adjacent to the well casing (where a work over rig is necessary to effect repair) it must be determined whether the leak requires immediate repair, or whether the risk can be adequately managed via other control measures until a work over of the well is scheduled for normal operational reasons. The risk assessment to determine the above shall consider the location of the well, likely access to the well from landholders or the public, and	facilities or activities. A written close-out report must be submitted within 5 business days of the remediation of the leak, specifying the date of identification, nature and level of leak, location and name of the operating plant, and the rectification actions taken. If finalising the remediation is delayed more than 7 business days from the identification of the leak an update must be submitted on that day. The final close out report shall be provided when all work is completed.	

Classification	Threshold	Response	Notification	Comments
		landholder/community concerns in relation to the leak. 8. For leaks identified on gathering systems (where an excavation is necessary to effect repair) repairs must be completed as soon as reasonably practicable in consideration of the location of the site, safety to personnel and the public, potential environmental harm, likely access to the site from landholders or the general public, and landholder/community concerns in relation to the leak.		

9 Reporting

9.1 Flaring and Venting Emissions

Where natural gas is vented or flared during exploration activities, these emissions shall be measured or estimated using methods consistent with those outlined under the National Greenhouse and Energy Reporting (Measurement) Determination 2008. This includes:

1. Leaks, venting and flaring during flowback activities.
2. Equipment blowdowns, system upsets and accidental releases.

9.2 Annual reporting

An annual report will be provided to the Northern Territory Government summarising the following:

3. The records of the stages of flowback activities including:

i. the date and time of the onset of flowback;

ii. the date and time of each attempt to route flowback fluid to the separator;

iii. the date and time of each occurrence in which the operator reverted to the initial flowback stage;

iv. the date and time of well shut in or connected into adjacent gathering lines;

v. the date and time that temporary flowback equipment is disconnected; and

vi. the total duration of venting, combustion and flaring over the flowback period.

4. The results of leak detection surveys (in the annual report under the Act) outlining:

i. the extent of compliance with the leak management plan;

ii. a summary of monitoring undertaken during the period;

iii. a summary of minor and significant leaks identified during the reporting period,

iv. including the date of identification and repair for each leak and those leaks that

v. could not be repaired; and

vi. an explanation of why any component could not be repaired and what actions will be taken to either decommission the component or otherwise remedy the problem.

5. Emission estimates using NGERS methodology covering all emissions associated with the activity, including fuel combustion, wastewater emissions, venting and flaring.

APPENDIX J Water Monitoring Suites

Appendix J Water Monitoring Suites

Groundwater monitoring suite extracted from the *Code of Practice for Onshore Petroleum Activities in the Northern Territory*

Table 6: Minimum suite of analytes for groundwater monitoring.

General	LOR	Cations and Metals	LOR
pH	0.01 pH units	Calcium	1 mg/L
Electrical conductivity	1 µS/cm	Chromium	0.001 mg/L
Total Dissolved Solids	10 mg/L	Copper	0.001 mg/L
Total Suspended Solids	1 mg/L	Iron	0.05 mg/L
Alkalinity	1 mg/L	Lead	0.001 mg/L
Gross Alpha	0.05 Bq/L	Magnesium	1 mg/L
Gross Beta	0.1 Bq/L	Manganese	0.001 mg/L
Water level	±10 cm (AHD)	Mercury	0.0001 mg/L
Groundwater pressure		Potassium	1 mg/L
Anions		Silver	0.001 mg/L
Chloride	1 mg/L	Arsenic	0.001 mg/L
Fluoride	0.1 mg/L	**Barium**	0.001 mg/L
Sulfate	1 mg/L	Boron	0.05 mg/L
Nitrate	0.01 mg/L	Cadmium	0.0001 mg/L
Nitrite	0.01 mg/L	Lithium	0.001 mg/L
Petroleum		Selenium	0.01 mg/L
TRH	100 µg//L	Silica	0.1 mg/L
PAH Suite	0.5 µg//L	**Strontium**	0.001 mg/L
BTEX	1 µg/L	Sodium	1 mg/L
Diss. Methane	10 µg/L	Zinc	0.005 mg/L
Diss. Ethane	10 µg/L		
Diss. Propane	10 µg/L		

Wastewater characterisation suite as per Table C.8 of the Code

Parameter	Reporting units	Limit of reporting	Method
Physical Parameters			
Dissolved oxygen	mg/L	0.1	Field
Electrical Conductivity (EC)	µs/cm	1	Field
Total Dissolved Solids (TDS)	mg/L	10	APHA 2540C
Total Suspended Solids (TSS)	mg/L	5	APHA 2540C
pH	pH units	0.01	Field
Sodium Adsorption Ratio	ratio	0.01	APHA 4500 Ca, Mg, Ca, NA
Temperature	°C	0.1	Field
Nutrients			
Nitrate	mg/L	0.01	APHA VC13
Nitrite	% saturation and mg/L	0.01	APHA 4500 NO2
Total Nitrogen	mg/L	0.1	APHA 4500 NORG
Total Kjeldahl Nitrogen	mg/L	0.1	APHA NORG/TKN
Ammonia	mg/L	0.01	APHA NH4
Reactive Phosphorous	mg/L	0.01	APHA 4500P
Total Phosphorous	mg/L	0.01	APHA 4500P
Anions			
Sulfate	mg/L	1	APHA 4500-SO4-C
Chlorine/chloride	mg/L	1	APHA 4500-Cl-C
Carbonate	mg/L	1	APHA 2320 B
Bicarbonate (as $CaCO_3$ equivalent)	mg/L	1	APHA 2310 B
Bicarbonate Alkalinity (as $CaCO_3$ equivalent)	mg/L	1	APHA 2320 B
Hydroxide Alkalinity (as $CaCO_3$ equivalent)	mg/L	1	APHA 2320 B
Total Alkalinity (as $CaCO_3$ equivalent)	mg/L	1	APHA 2320 B
Nitrite (NO_2 -)	mg/L	0.01	
Nitrate (NO_3-)	mg/L	0.01	
Fluoride	mg/L	0.1	APHA 4500 F-C
Bromide	mg/L	0.01	APHA 4110B
Total Cyanide	Mg/L	0.004	AWWA/APHA Method 4500
Major Cations			
Sodium	mg/L	1	APHA 4500 Na
Magnesium	mg/L	1	APHA 4500 Mg
Potassium	mg/L	1	APHA 4500 K
Calcium	mg/L	1	APHA 4500 Ca
Metals and Metalloids (total and dissolved)			
Aluminium	mg/L	0.01	USEPA 6010 ICP/AES
Antimony	mg/L	0.001	USEPA 6010 ICP/AES

Parameter	Reporting units	Limit of reporting	Method
Arsenic	mg/L	0.001	USEPA 6010 ICP/AES
Barium	mg/L	0.001	USEPA 6010 ICP/AES
Beryllium	mg/L	0.001	USEPA 6010 ICP/AES
Boron	mg/L	0.001	USEPA 6010 ICP/AES
Bromide	mg/L	0.01	USEPA 6010 ICP/AES
Cadmium	mg/L	0.0001	USEPA 6010 ICP/AES
Chromium	mg/L	0.001	USEPA 6010 ICP/AES
Cobalt	mg/L	0.001	
Copper	mg/L	0.001	USEPA 6010 ICP/AES
Iron	mg/L	0.05	USEPA 6010 ICP/AES
Lead	mg/L	0.001	USEPA 6010 ICP/AES
Manganese	mg/L	0.001	USEPA 6010 ICP/AES
Mercury	mg/L	0.0001	USEPA 6010 ICP/AES
Molybdenum	mg/L	0.001	USEPA 6010 ICP/AES
Nickel	mg/L	0.001	USEPA 6010 ICP/AES
Selenium	mg/L	0.001	USEPA 6010 ICP/AES
Silica	mg/L	0.1	USEPA 6010 ICP/AES
Silver	mg/L	0.001	USEPA 6010 ICP/AES
Strontium	mg/L	0.001	USEPA 6010 ICP/AES
Thorium	mg/L	0.001	USEPA 6010 ICP/AES
Tin	mg/L	0.001	USEPA 6010 ICP/AES
Uranium	mg/L	0.001	USEPA 6010 ICP/AES
Vanadium	mg/L	0.05	USEPA 6010 ICP/AES
Zinc	mg/L	0.001	USEPA 6010 ICP/AES
Naturally Occurring Radioactive Material (NORM)			
alpha radiation	Bq/L	0.05 – 0.1	ASTM D7283-06
beta radiation	Bq/L	0.05 – 0.1	ASTM D7283-06
Gamma	Bq/L	0.05 – 0.1	ASTM D7283-06
BTEX			
Benzene	µg/L	1	USEPA 5030/8260 HS or P&T/GC/MS
Toluene	µg/L	2	USEPA 5030/8260 HS or P&T/GC/MS
Ethylbenzene	µg/L	2	USEPA 5030/8260 HS or P&T/GC/MS
M and P Xylene	µg/L	2	USEPA 5030/8260 HS or P&T/GC/MS
O Xylene	µg/L	2	USEPA 5030/8260 HS or P&T/GC/MS
Total Xylene	µg/L	2	USEPA 5030/8260 HS or P&T/GC/MS
Hydrocarbons			
TRH C6 - C10	µg/L	20	USEPA 5030/8260 HS or P&T/GC/MS
TRH C6 - C10 less BTEX	µg/L	20	USEPA 5030/8260 HS or P&T/GC/MS

Parameter	Reporting units	Limit of reporting	Method
TRH >C10 - C16	µg/L	100	USEPA 5030/8260 HS or P&T/GC/MS
TRH >C10 - C16 less Naphthalene	µg/L	100	USEPA 5030/8260 HS or P&T/GC/MS
TRH >C16 - C34	µg/L	100	USEPA 5030/8260 HS or P&T/GC/MS
TRH >C34 - C40	µg/L	100	USEPA 5030/8260 HS or P&T/GC/MS
Total TRH C6 - C40	µg/L	100	USEPA 5030/8260 HS or P&T/GC/MS
Polycyclic Aromatic Hydrocarbons			
3-Methylcholanthrene	µg/L	1	USEPA 3510/8270 GC/MS
7, 12- Dimethylbenz(a)anthracene	µg/L	1	USEPA 3510/8270 GC/MS
Acenaphthene	µg/L	1	USEPA 3510/8270 GC/MS
Acenaphthylene	µg/L	1	USEPA 3510/8270 GC/MS
Anthracene	µg/L	1	USEPA 3510/8270 GC/MS
Benzo (a) pyrene	µg/L	0.5	USEPA 3510/8270 GC/MS
Benzo (b) fluoranthene	µg/L	1	USEPA 3510/8270 GC/MS
Benzo (ghi) perylene	µg/L	1	USEPA 3510/8270 GC/MS
Benzo (k) fluoranthene	µg/L	1	USEPA 3510/8270 GC/MS
Benzo (a) anthracene	µg/L	1	USEPA 3510/8270 GC/MS
Chrysene	µg/L	1	USEPA 3510/8270 GC/MS
Dibenz (ah) anthracene	µg/L	1	USEPA 3510/8270 GC/MS
Fluoranthene	µg/L	1	USEPA 3510/8270 GC/MS
Fluorene	µg/L	1	USEPA 3510/8270 GC/MS
Indeno (1,2,3-cd) pyrene	µg/L	1	USEPA 3510/8270 GC/MS
Napthalene	µg/L	1	USEPA 3510/8270 GC/MS
Phenanthrene	µg/L	1	USEPA 3510/8270 GC/MS
Pyrene	µg/L	1	USEPA 3510/8270 GC/MS
Carcinogenic PAHs (benzo[a}pyrene equivalents	µg/L	0.5	USEPA 3510/8270 GC/MS
Total PAH	µg/L	0.5	USEPA 3510/8270 GC/MS
Volatile Organic Compounds			
2,3,4,6-Tetrachlorophenol	µg/L	1	USEPA 3510/8270 GC/MS
2,4,5-Trichlorophenol	µg/L	1	USEPA 3510/8270 GC/MS
2,4,6-Trichlorophenol	µg/L	1	USEPA 3510/8270 GC/MS
2,4-Dichlorophenol	µg/L	1	USEPA 3510/8270 GC/MS
2,4-Dimethylphenol	µg/L	1	USEPA 3510/8270 GC/MS
2,4-Dinitrophenol	µg/L	1	USEPA 3510/8270 GC/MS
2,6-Dichlorophenol	µg/L	1	USEPA 3510/8270 GC/MS
2-Chlorophenol	µg/L	1	USEPA 3510/8270 GC/MS
2-Methyl-4,6-dinitrophenol	µg/L	1	USEPA 3510/8270 GC/MS
2-Nitrophenol	µg/L	1	USEPA 3510/8270 GC/MS
4-Chloro-3-methylphenol	µg/L	1	USEPA 3510/8270 GC/MS
4-Nitrophenol	µg/L	1	USEPA 3510/8270 GC/MS
Dinoseb	µg/L	1	USEPA 3510/8270 GC/MS

Parameter	Reporting units	Limit of reporting	Method
Formaldehyde	mg/L	1	USEPA 3510/8270 GC/MS
Hexachlorophene	µg/L	1	USEPA 3510/8270 GC/MS
m- and p-Cresol	µg/L	1	USEPA 3510/8270 GC/MS
Pentachlorophenol	µg/L	1	USEPA 3510/8270 GC/MS
Phenol	µg/L	1	USEPA 3510/8270 GC/MS
Organic Carbon			
Dissolved Organic Carbon	mg/L	1	APHA 5310 B
Total Organic Carbon	mg/L	1	APHA 5310 B

APPENDIX K Land Condition Assessment

Prepared for
Tamboran B2 Pty Ltd
ABN: 42 105 431 525

Land Condition Assessment

Shenandoah South E&A Program

27-Mar-2024
Beetaloo Joint Venture Exploration Project

aecom.com

Delivering a better world

Land Condition Assessment

Shenandoah South E&A Program

Client: Tamboran B2 Pty Ltd

ABN: 42 105 431 525

Prepared by

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27-Mar-2024

Job No.: 60623736

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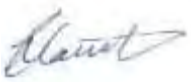
1	27-Mar-2024	LCA update based on TAM1-1 Regulation 10 and 11 Comments	Alana Court Technical Director - Environment	

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Acronym	Meaning
°C	Degrees Celsius
%	Percentage
AAPA	Aboriginal Areas Protection Authority
AS	Australian Standard
BOM	Bureau of Meteorology
CLA	Cambrian Limestone Aquifer
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DoH	Department of Health (NT)
DPIR	Department of Primary Industry and Resources (NT)
DEPWS	Department of Environment, Parks and Water Security (NT)
E&A	Exploration and Appraisal
EPA	Environment Protection Authority (NT)
EP##	Exploration Permit (e.g., EP76, EP98 and EP117)
EMP	Environmental Management Plan
EPBC	Environmental Protection and Biodiversity Conservation
ESCP	Erosion and Sediment Control Plan
GPS	Global Positioning Device
Ha	hectare
IBA	Important Bird Area
ILUA	Indigenous Land Use Agreement
km	Kilometre
km^2	Square kilometres
km/hr	Kilometre per hour
LCA	Land Condition Assessment
m	metre
MD	Measured Depth
MNES	Matters of National Environmental Significance
mm	millimetre
NLC	Northern Land Council
NT	Northern Territory
OHS	Occupational Health and Safety
RWA	Restricted Work Area
TO	Traditional Owner
TPWC Act	*Territory Parks and Wildlife Conservation Act*
WoNS	Weed of National Significance

1.0 Introduction

1.1 Purpose of this Report

AECOM Australia Pty Ltd (AECOM) completed a Land Condition Assessment (LCA) for Tamboran B2 Pty Ltd (Tamboran) associated with the proposed exploration areas located within Exploration Permit 98 (EP98) and EP117 in the Beetaloo Sub-Basin, Northern Territory (NT). The Beetaloo Joint Venture are proposing establishing exploration drill pads and associated infrastructure and seismic survey for the Shenandoah South Exploration and Appraisal (E&A) program.

The primary aim of this LCA is to identify and document site condition of the proposed Shenandoah South E&A Program areas to inform the environmental risk assessment. This LCA report summarises the result of the survey and documents baseline conditions of the areas assessed for the Shenandoah South E&A program.

The baseline field survey was completed in December 2022 and March-April 2023.

1.2 Project Boundary

The areas assessed under this LCA occur on Hayfield Perpetual Pastoral Lease (PPL) and Shenandoah PPL and are within Tamboran permits EP98 and EP117 (Figure 1). The Shenandoah South E&A area is accessed via the existing Kyalla Turn-in located off the Stuart Highway and along the existing access track prepared as part of the existing Kyalla 117 N2 exploration program.

The location of the Shenandoah South E&A area is presented in Figure 2.

1.3 Tamboran's Proposed Activities

Tamboran is planning to undertake a Shenandoah South E&A program which will require construction of a number of exploration well lease areas and their associated infrastructure, as well as a seismic program along three seismic lines (Shenandoah South Line A, B and C).

This report has been prepared for Tamboran B2 Pty Ltd (Tamboran) for the clearing and placement of infrastructure, including but not limited to lease pads, gathering lines, pipelines, access tracks, seismic lines, camp pads, helipads, laydown areas, groundwater bores, site turn-ins, firebreaks / fence lines, and associated infrastructure in accordance with the Regulation 5 of the Petroleum (Environment) Regulations 2016.

1.4 Scope of Works

This report describes the assessment methodology and outcomes of field surveys for future onshore gas exploration sites.

The scope of work for the LCA involved:

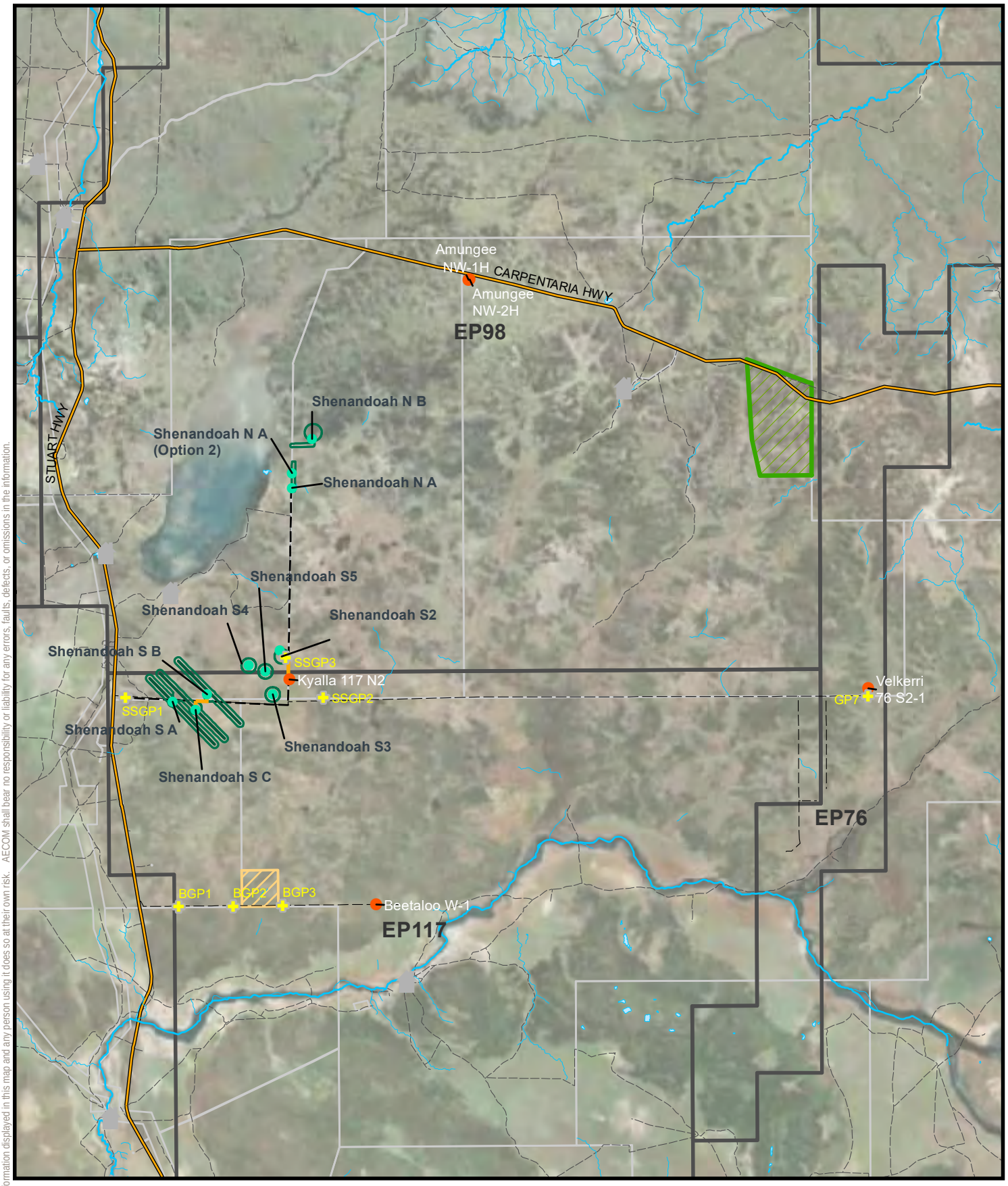
- A review of historical data and reports prepared during the previous Beetaloo onshore oil and gas exploration programs.
- A search of the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) Protected Matters database at 10 km and 50 km buffer (June 2023).
- A search of the Northern Territory (NT) Natural Resource Maps Database (flora and fauna Atlas database) (6/02/2023) and the more recently published Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin (SREBA) data set.
- Completion of a LCA field survey of the proposed exploration E&A area (March-April 2023).
- Preparation of this report.

1.5 Naming Convention

Due to changes in operational requirements, there have been changes to the naming of some of the Project Areas since the original assessments were completed. The operational names are presented below in Table 1. This document has been updated to reference the current operational names, using abbreviations where relevant.

Table 1 Project Area Naming Convention

Original Name	Operational or Abbreviated Name
Amungee NW4	Amungee NW-4
Amungee NW3	Amungee NW-3
Shenandoah North A	Shenandoah N A
Shenandoah North B	Shenandoah N B
Shenandoah South A	Shenandoah S A
Shenandoah South B	Shenandoah S B
Shenandoah South C	Shenandoah S C
Kyalla 117 N1	Kyalla 117 N1
Kyalla 117 N2-1	Kyalla 117 N2
Kyalla98 S1	Kyalla 98 S1
Kyalla98 S2	Kyalla 98 S2
Shenandoah South 1	Shenandoah S5
Shenandoah South 2	Shenandoah S2
Shenandoah South 3	Shenandoah S3
Shenandoah South 4	Shenandoah S4
Shenandoah South 5	Currently unnamed



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GEOCENTRIC DATUM OF AUSTRALIA 94

0 7.5 15 30
Kilometres

- Existing Exploration Well Pads
- Proposed Exploration Well Pads
- Gravel Pits
- Gathering Line
- Proposed Seismic Lines
- Shenandoah Lease Pad Area
- Tracks
- Highway
- Water Bodies
- Permit Areas
- Pastoral Lease Boundary
- Aboriginal Land
- Bullwaddy Conservation Reserve

LOCATION

Data sources:
Permit Area, Cadastre - NT Gov 2019.
Places, Vegetation - Aust Gov 2019
Highways, Roads, Drainage - StreetPro 2019

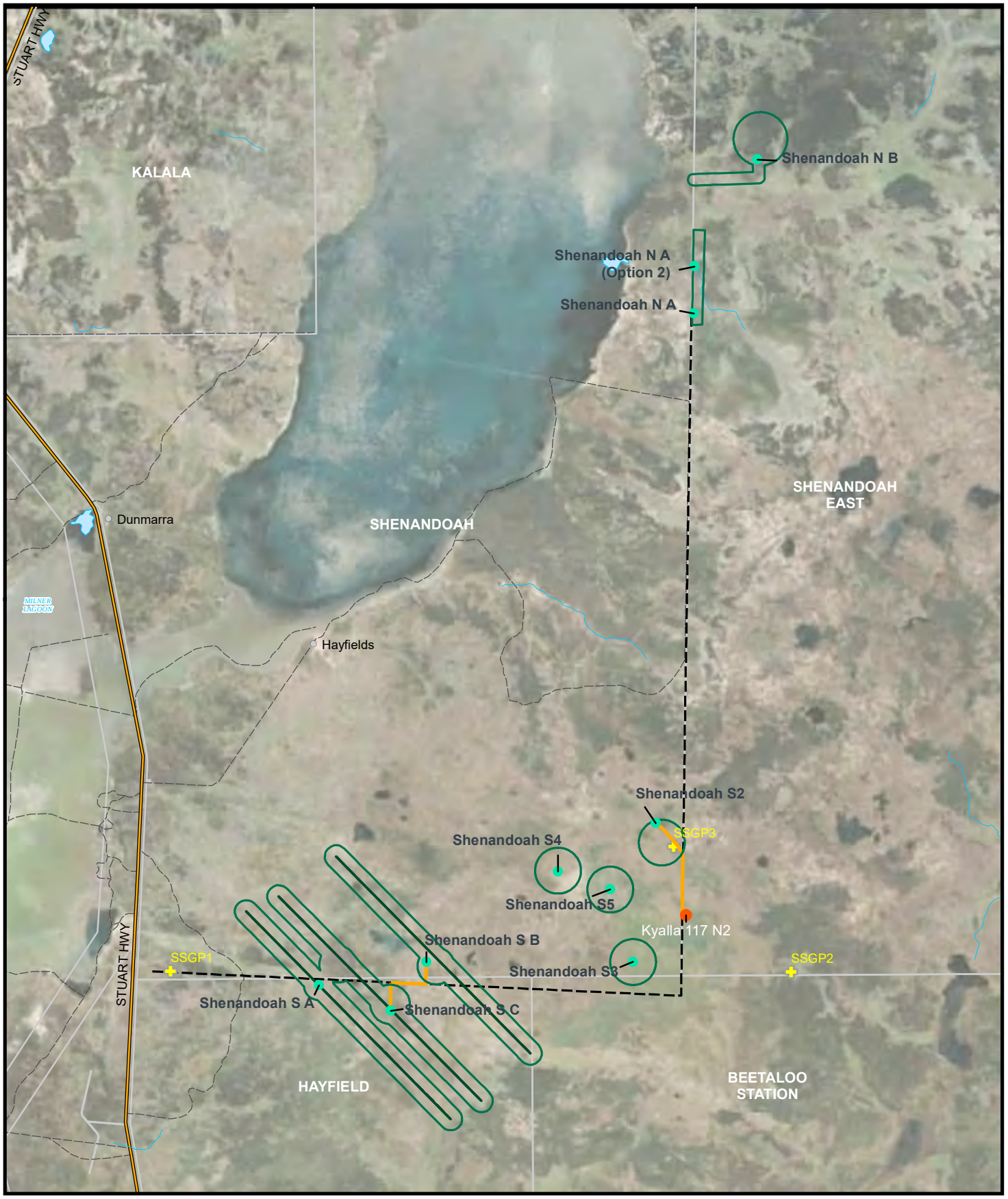
tamboran

Project Location - Land Tenure, Exploration Permits and Well Pad

PROJECT ID	60623736
CREATED BY	sam.schroder
LAST MODIFIED	19-Oct-2023
VERSION	1

Figure
1

Filename: \\na.aecomnet.com\lfs\APAC\Melbourne-AUMEL1\Legacy\Groups\WTR\SpatialSys\Projects\2023\Beetaloo\02_MXD\LCA_Tamboran_Oct_2023\F1_Location_001.mxd



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GEOCENTRIC DATUM OF AUSTRALIA 94

0 1 2 4

Kilometers

- Proposed Exploration Well Pads
- Existing Exploration Well Pads
- Gravel Pits
- Proposed Seismic Lines
- Shenandoah Lease Pad Area
- Gathering Line
- Populated Place
- Access Tracks
- Tracks
- Highway
- Water Bodies
- Pastoral Lease Boundary

LOCATION

Data sources:
Permit Area, Cadastre - NT Gov 2019.
Places, Vegetation - Aust Gov 2019
Highways, Roads, Drainage - StreetPro 2019

tamboran

Project Area
Shenandoah South E&A Program

PROJECT ID	60623736
CREATED BY	stutta
LAST MODIFIED	19-Oct-2023
VERSION	1

Figure
2

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2.0 Assessment Method

2.1 Desktop Review

Field data collected between 2005 and 2023 within the permit areas was mapped based on image interpretation, with ground-truthing of the proposed survey areas being completed during field assessments (refer Section 2.3). This information was reviewed prior to the field work to identify the following:

- Vegetation types and flora and fauna species within the region that potentially occur within the Shenandoah South E&A Program area, using previous reports and aerial / satellite imagery.
- *Environment Protection and Biodiversity Conservation Act* (EPBC Act) and *Territory Parks and Wildlife Conservation Act* (TPWC Act) listed threatened species or communities that potentially occur within the Shenandoah South E&A Program area.
- Matters of national environmental significance or other matters protected by the EPBC Act that potentially occur within the Shenandoah South E&A Program area.
- Weeds or feral animals listed under the EPBC Act or *Weeds Management Act* that potentially occur within the Shenandoah South E&A Program area.

Table 2 provides a chronological list of reports (2004 - 2023), previously compiled in relation to environmental approvals and management support for petroleum exploration activities in the Beetaloo Sub-basin, NT.

The extent of work undertaken since 2004 has enabled a good understanding of the natural environment, which has been used in assessing the land condition of the Shenandoah South E&A Program area.

Table 2 Summary of Existing Environmental Assessment and Reports for the Beetaloo Basin (2004-2023)

Date	Report
Sweetpea Petroleum	
Jul- Aug 2004	Baseline land condition assessment (LCA)
	Site database established
Jul 2005	Exploration EMP finalised and approved
November 2019 to February 2020	LCA for EP136 (Seismic and Drilling Exploration Program)
Petrohunter Australia (Partner to Sweetpea)	
Dec 2006	Baseline vegetation assessment
Apr 2007	Drill site assessments
Apr 2007	Annual report
Jun 2007	Update of the existing EMP to include the new Exploration Permit areas
Jul 2007	Drill Site maps
Jul 2007	Supplemental Environmental Management Plan, Drilling Program 2007, Beetaloo Basin, NT
Jul 2007	Soil erosion assessment
Jul 2007	Groundwater quality
July 2007	Emergency Maps
Jul 2007	Environment & Heritage Induction Materials

Date	Report
Falcon Oil and Gas	
Dec 2010	Drill site condition assessments
Jan 2011	Archaeological survey
March 2011	Site-specific drilling EMP
2011	Falcon Shenandoah 1 Stimulation and Testing Groundwater Monitoring
2011/2012	Shenandoah 1 Re-Entry Environment Plan (EP)
July 2012	EP99 Archaeological Survey, Beetaloo Basin
2013	EP99 Seismic Exploration Environmental Management Plan
Tamboran B2 Pty Ltd	
2015 and 2016	Beetaloo Basin Environmental and Heritage Assessment and preparation of Approval documentation
October 2018	LCA and Heritage Assessment of proposed lease area (Velkerri 76 S1-1, Velkerri 76 S2-1, Velkerri 117 E1-1, Velkerri 98 N1-2, Kyalla 117 N2-1 and Kyalla 117 W1-2, Kyalla 98 W1-1)
July 2019	Weed Survey of Kyalla 117 N2-1 and access tracks, including Kalala S1 and Amungee NW-1H
December 2019	LCA and Heritage Assessment of EP76, EP117 and EP98
June 2020	Beetaloo Exploration Program Annual Weed Survey Report 2020
September 2021	Land Condition Assessment and weed surveys for Velkerri 76 N1, Amungee NW and Beetaloo W
May 2022	Additional Land Condition Assessment field survey of this specific proposed exploration program
December 2022	Land Condition Assessment field survey in Tamboran B2 Pty Ltd permit area
March - April 2023	Land Condition Assessment specific to the revised Amungee NW-3, Amungee NW-4, Shenandoah South and Shenandoah North lease pad and seismic areas.

2.2 SREBA Data Set

AECOM have undertaken a review of the recently published SREBA data and reports which were prepared by the Northern Territory Government specifically for the Beetaloo Sub-basin. The aim of the SREBA is to provide the information necessary for sound decisions to be made about the development of any onshore shale gas industry in the region.

To prepare this LCA report, AECOM have utilised the outputs to supplement the data obtained in the field during the survey. The terrestrial ecosystem baseline data reviewed include:

- regional vegetation mapping
- description of regional biogeographic patterns for terrestrial biodiversity
- spatial distribution models for significant species and communities
- identification and mapping of areas of high conservation value
- evaluation of the sensitivity of significant species to development.

2.3 Field Assessment and Reporting

The aim of this LCA is to document the proposed Shenandoah South E&A Program area condition prior to activities occurring and inform Tamboran on potential constraints that will require specific environmental mitigations.

The LCA field surveys completed for the Shenandoah South E&A Program used an aerial rapid condition assessment method like previous assessments carried out by AECOM for past exploration activities. The method allows for large areas to be surveyed over a relatively short period of time using a helicopter platform to assess proposed exploration area, as well access remote locations for on-ground-truthing.

The following site characteristics were recorded as part of the LCA:

- the presence of drainage lines and the direction of surface flows
- the distance to the nearest sensitive receptors (such as significant vegetation communities or fauna habitats)
- soil characteristics and intactness
- soil suitability for wastewater disposal
- vegetation communities (based on dominant species within each canopy strata)
- fauna habitat features, such as hollows, logs, and burrows (the fauna habitat quality for each mapped vegetation community type would be assessed)
- incidental fauna sightings
- the presence or absence of Northern Shrike-tit (*Falcunculus whitei*) via call-playback surveys and active searches
- the presence or absence of Gouldian Finch (*Erythrura gouldiae*) via active searches
- the presence of weeds and/or feral animals (*i.e.* indication of scats, tracks, wallows etc.)
- general land use description.

The field locations assessed for the Shenandoah South E&A Program are presented in Table 3 and Figure 2. A total of 14 proposed lease pad areas and three seismic lines were surveyed in December 2022 and April 2023.

Table 3 Field survey assessment site names and corresponding proposed exploration area

Exploration Area	GDA94, zone 53	
	Easting	Northing
Lease Pads		
Shenandoah S A	340335	8134450
Shenandoah S B	345035	8135464
Shenandoah S C	343471	8133330
Shenandoah S2	355291	8140676
Shenandoah S3	354041	8135466
Shenandoah S4	349802	8139709
Shenandoah S5	353046	8138627
Shenandoah N A	356687	8163762
Shenandoah N A (Option 2)	356718	8165809
Shenandoah N B	359459	8170476

Exploration Area	GDA94, zone 53	
	Easting	Northing
Shenandoah South B and Shenandoah South C Gathering Lines (~3.8 km)		
Start – Shenandoah S B pad	345035	8135461
Intersection to existing track	345046	8134499
Intersection to Shenandoah S C	343442	8134573
End – Shenandoah S C pad	343471	8133331
Kyalla 117 N2 and Shenandoah South 2 Gathering Lines (~4.6 km)		
Start – Kyalla 117 N2 pad	356274	8137505
Intersection to existing track	356189	8137509
Intersection to Shenandoah S2	356205	8140071
End – Shenandoah S2 pad	355060	8141514
Shenandoah South Seismic Lines		
Shenandoah South Line A – Start (12.7 km)	337173	8137667
Shenandoah South Line A – End	346090	8128616
Shenandoah South Line B – Start (12.5 km)	338589	8138319
Shenandoah South Line B – End	347421	8129410
Shenandoah South Line C – Start (12 km)	341095	8140059
Shenandoah South Line C – End	349562	8131482

2.4 Flood Assessment

A hydraulic assessment was conducted to inform potential flooding risks and design requirements for the Shenandoah South E&A Program proposed areas. The extent of inundation within the project area depends on the severity of the wet season and can range from remaining completely dry to widespread flooding. An assessment of the flood levels was completed for the proposed lease pad locations (Figure 3).

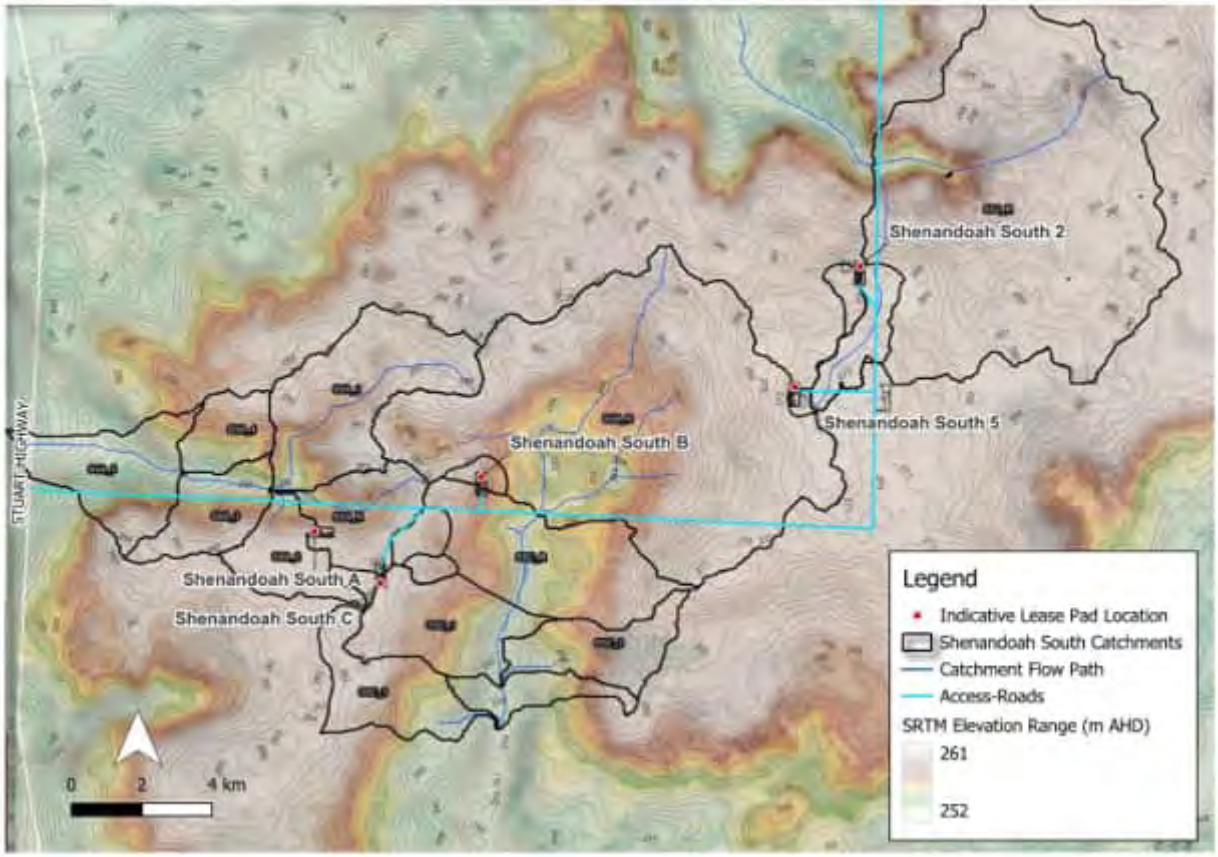


Figure 3 Catchments of Shenandoah South E&A Program Area

The Shenandoah North area catchment is shown in Figure 4.

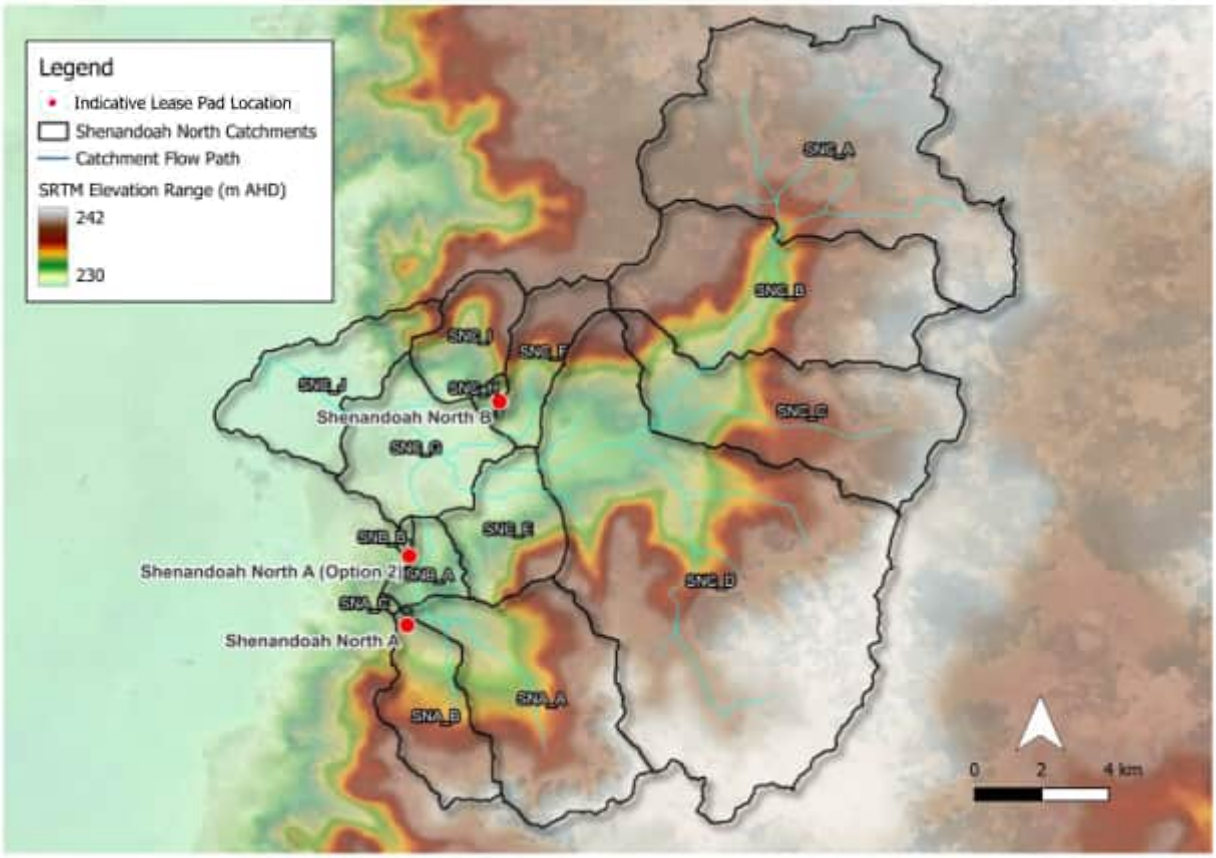


Figure 4 Catchments of the Shenandoah North Area

The methodology used for the hydraulic assessment is described in Table 4. For consistency, the same methodology previously used for Tamboran lease pads has been adopted.

Table 4 Hydraulic Assessment Methodology

Item	Description
Topographical Data	Shuttle Radar Topography Mission (SRTM) ~1s (30 m). There was no other available ground level survey and aerial Light Detection And Ranging (LiDAR) data available for the areas around the lease pads. This includes the LASer (LAS) LiDAR point cloud data of the Beetaloo Basin which also does not cover the proposed lease pad locations.
Catchment Flow Estimation	Queensland Urban Drainage Manual (QUDM) 2017 Rural rational method. The flow estimation method is consistent with the previous investigation used for Tamboran's exploration areas which is in the same catchment as the proposed lease pads (Figure 3).
Hydraulic Assessment	One-dimensional (1D) Manning's n open channel flow calculation using FlowMaster software: • Channel cross sectional information – Taken from the available STRM data • Channel slope – Estimated from the available STRM data • Manning's n roughness – Estimated for Google Earth© satellite photography.

It is noted that the vertical accuracy of SRTM data varies from 5 to 10 m and therefore the vertical accuracy of the flood levels in the investigation should be expected to have a similar order of accuracy. Further detailed surveys will be conducted of the lease pad areas to inform final placement of the lease pads within the landscape to avoid flood areas.

3.0 Physical Environment

3.1 Climate

The climate of the Shenandoah South E&A Program area can be described as arid to semi-arid, with rainfall decreasing in frequency and quantity from north to south. The climate is monsoon influenced and has a distinctive wet and dry season. The wet season occurs in summer, between October and March and is characterised by hot and wet conditions. The dry season occurs during the winter months between May and August and is characterised by mild days and cool nights. September and April are transitional months, with occasional rainfall. Approximately 90% of the rainfall occurs during the Wet Season, and annual totals show moderate variability from year to year.

There is a pronounced north-south rainfall gradient through the region, with mean annual rainfall of ~1,200 mm in the north and ~500 mm in the south (DEPWS 2022b). The maximum rainfall for the permit areas occurs in January and February, coinciding with the northern Australian annual monsoon event and average monthly rainfall is very low in the dry season (between May and October) (BOM 2023; DEPWS 2022b). Daly Waters airstrip is on a similar latitude with the northern end of the permit areas and recorded the highest average rainfall in the region at this time, with 163 mm falling in January and 183 mm in February. The May to September period is generally very dry, with average monthly rainfall ranging from 0.3 – 6.4 mm (BOM, 2023). The annual rainfall pattern within the area is highly variable. Drought conditions are known to occur in the region once every 10 years (Holt & Bertram, 1981).

Average maximum and minimum temperatures are also high in the wet season and lower in the dry season, with slightly greater extremes of temperature in the southern part of the region. At Daly Waters, annual monthly maximum temperatures range between 28.9 °C (June) and 38.2 °C (Nov), and minimums between 11.9 °C (Jul) and 24.2 °C (Dec) (DEPWS 2022b).

Land capability assessment for Shenandoah South E&A Program was completed in December 2022 at the start of the wet season and April 2023 at the end of the wet.

The average annual rainfall experienced in the region (which includes the BOM data from Daly Waters Airstrip) is shown in Table 5.

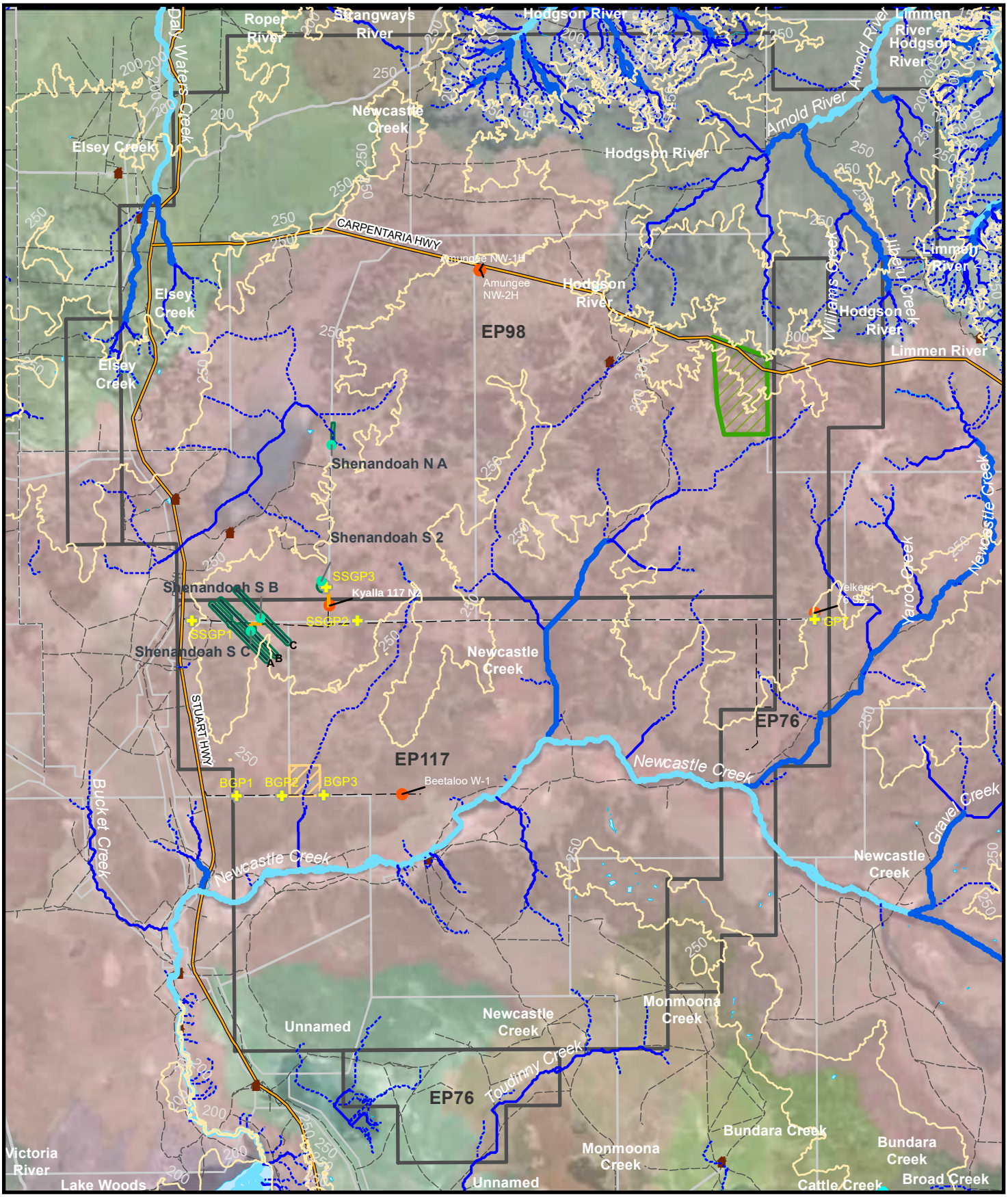
Table 5 Annual rainfall 2019 – 2022

Year	Annual rainfall (mm)	Months during which rain was recorded
2016	608	12
2017	866	7
2018	752	7
2019	277	8
2020	951	9
2021	679	7
2022	561	10

3.2 Topography, Surface Water and Drainage

The Shenandoah South E&A Program occurs within a topographic zone classified as laterite plains that predominantly slope in a south and south westerly direction (Tickell, 2003).

Shenandoah South E&A Program is situated within the Newcastle Creek Catchment as part of the Georgina Basin Water Management Area (DEPWS, 2022a) (Figure 5). The Georgina Basin Water Management Area covers approximately 120,000 km^2 southeast of the township of Daly Waters and east of the Stuart Highway (DEPWS, 2022a). The Shenandoah E&A Program area is internally drained by the ephemeral waterway of Newcastle Creek and several small ephemeral creeks and floodplains. Newcastle Creek flows into Lake Woods, which is located south of Newcastle Waters Station, around 79 to 90 km south of the Shenandoah South E&A Program.



LOCATION

AECOM

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N

GEOCENTRIC DATUM OF AUSTRALIA 94

0 7.5 15 30

Kilometres

- Existing Exploration Well Pads
- Proposed Exploration Well Pads
- Gravel Pits
- Shenandoah Lease Pad Area
- Proposed Seismic Lines
- Gathering Line
- Contours

Stream Order

Intermittant Streams

- 1
- 2

Creeks

- 3
- 4

- Populated Place
- Tracks
- Highway
- Permit Areas
- Aboriginal Land
- Pastoral Lease Boundary
- Water Bodies
- Bullwaddy Conservation Reserve

Wiso Catchments

- Elsey Creek
- Lake Woods
- Newcastle Creek
- Victoria River

Georgina Catchments

- Broad Creek
- Bundara Creek
- Cattle Creek
- Elsey Creek
- Hodgson River
- Limmen River
- Monmoona Creek
- Newcastle Creek
- Roper River
- Strangways River
- Unnamed

Data sources: Permit Area, Cadastre - NT Gov 2019. Places, Vegetation - Aust Gov 2019 Highways, Roads, Drainage - StreetPro 2019

tamboran

Permit Area Surface Water and Drainage

PROJECT ID	60623736
CREATED BY	stutta
LAST MODIFIED	20-Mar-2024
VERSION	1

Figure 5

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

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Lake Woods covers an area of inundation of approximately 200 km^2 in normal rainfall years, extending to 900 km^2 in exceptionally wet years, after which it can retain water for several years (AECOM 2015; DEPWS 2022a). 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 2006; DEPWS 2022a). Lake Woods fills during major flood events of Newcastle Creek and is listed as a wetland of national significance in the Directory of Important Wetlands in Australia (DIWA: NT013 Lake Woods) (DEPWS 2022a).

Although Lake Woods is located outside of the exploration permit area, it is fed principally by surface inflow of Newcastle Creek, originating more than 160 km north-east on Amungee Mungee Station (NTG, undated). During the period of inundation, Lake Woods supports over 100,000 waterbirds including internationally significant numbers of Plumed Whistling-Duck. Numerous bird species nest and feed in the diverse wetland habitat, and the conservation group 'Birdlife International' nominated Lake Woods as an 'Important Bird Area' (IBA). The lake also includes the largest area of lignum swamp in the Northern Territory and in tropical Australia (NRETAS 2009; DEPWS 2022a).

DEPWS studies (2022a) have identified over 7,000 records of 81 waterbird species and all large-scale waterbird breeding events and the largest congregation of waterbirds, were from Lake Woods and nearby waterholes on Newcastle Creek.

There are no creeks intersecting proposed sites within the Shenandoah South E&A Program. However, there are some occurrences of palustrine (non-riverine or non-channel systems) and floodplain systems, with shallow depressions and gullies to the north of the for Shenandoah S B well pad and a stream order 1, known as an intermittent stream, that is located over 450 m east of the Shenandoah N A well pad (Figure 5). These surface water systems will require management actions that aim to avoid activity in a waterway as to not materially change the shape of the water way, the volume, speed or direction divert local water or a cause change to the bed or bank stability. Where avoidance is not achievable Tamboran will seek a permit to Interfere with a Waterway under the NT *Water Act 1992*. (refer Section 3.3).

3.3 Flood Risk

The extent of inundation within the permit area depends on the severity of the wet season and can range from remaining completely dry to widespread flooding. As part of the preparation of the LCA, AECOM assessed the 1% Annual Exceedance Probability (AEP) flood depths and levels to determine the risk of flood inundation during the 100-year flood event from a local or regional flooding for the priority lease pad locations as presented in Table 6.

Table 6 1% AEP results for Shenandoah South E&A Program well pads

Lease Pad	SRTM Ground Elevation (m AHD)	Maximum Water Depth (m)	Flood Level at Nearest Channel (m AHD)
Shenandoah S A	260.6	-	256.7
Shenandoah S B	258.8	-	254.6
Shenandoah S C	263.4	-	262.4
Shenandoah S2	267.5	-	267.3
Shenandoah S5	272.8	-	253.4
Shenandoah N A	240.5	-	238.0

The greatest risk of flooding to the proposed exploration lease areas is from local catchment sheet-flow (rainfall immediately over the area draining to the site). The local catchment runoff from major storm events will be the considering factor for the establishment of lease pad finish levels and the lease pad designs will take this into consideration for the final placement in the landscape.

The following sections provide a summary of the hydraulic assessment outcomes for the Shenandoah South E&A Program exploration well pads.

3.3.1 Shenandoah S A well pad

Table 7 presents the hydraulic assessment outcomes for the proposed Shenandoah S A well pad area.

Table 7 Shenandoah S A well pad result summary

Item	Description
Location	Shenandoah S A (Figure 6)
1% AEP Peak Flow	Local Catchment: 109 m^3/s
Results	Local Catchment: Figure 7 (Flow east to west)
Results Summary	
Figure 7 shows that the northern extent of the well pad could be inundated in the 1% AEP from the flooding of the nearby flow path. The drill pad located further south of the nearby flow path has a lower risk of inundation in the 1% AEP than the whole site. The position of the site on the side of a hill means that drainage diversion works will be required along the southern boundary of the site. The diversion drain will prevent minor flooding of the site from sheet flow running down the hill and northwards towards the site.	

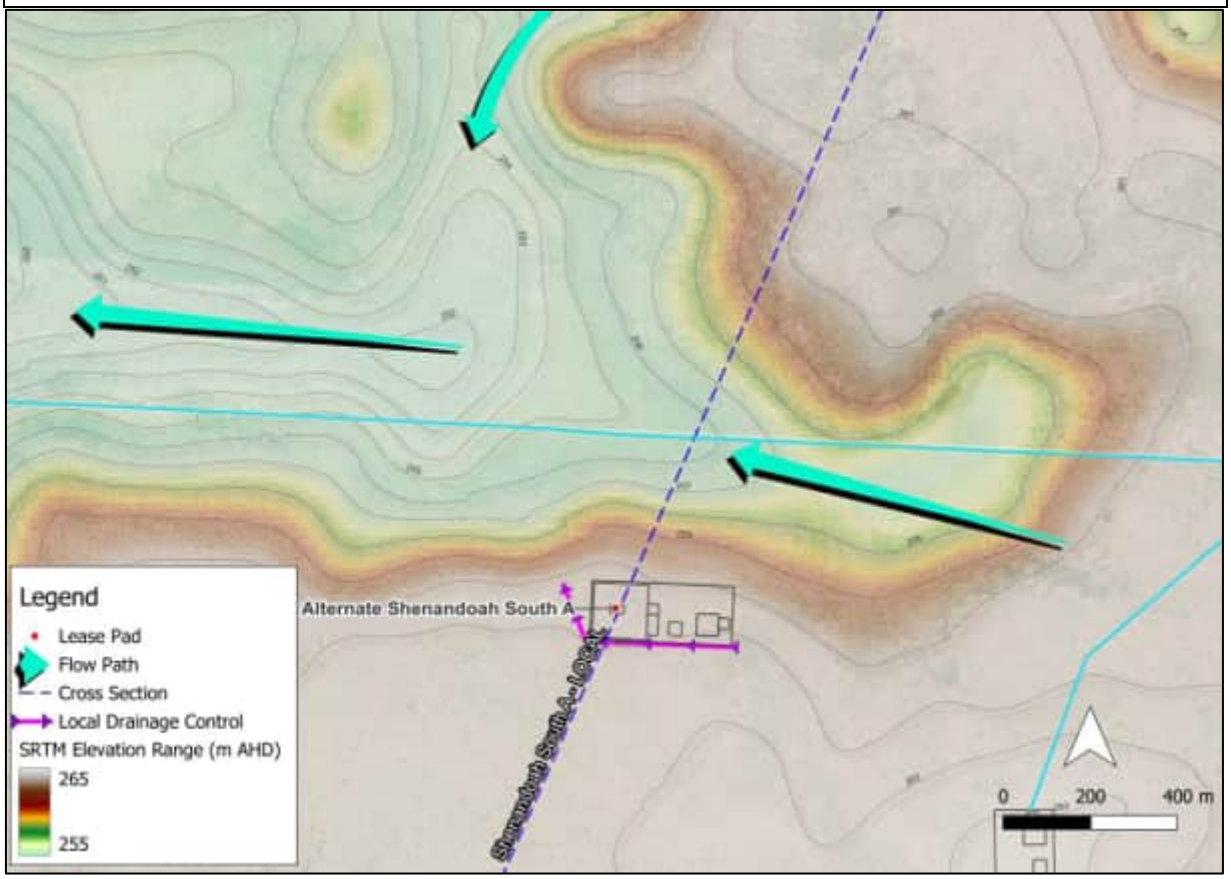


Figure 6 Locality map - Shenandoah S A

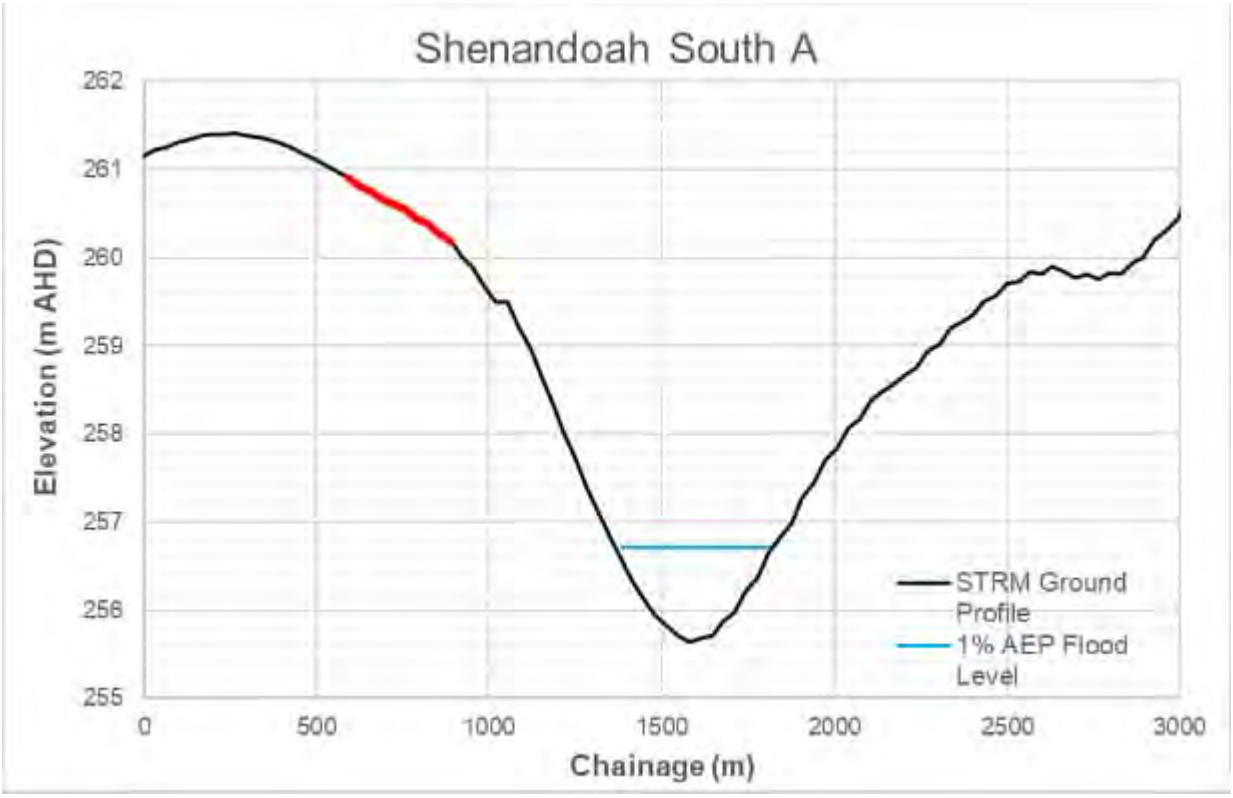


Figure 7 Shenandoah S A – cross section local

3.3.2 Shenandoah S B well pad

Table 8 presents the hydraulic assessment outcomes for the proposed Shenandoah S B well pad.

Table 8 Shenandoah S B well pad result summary

Item	Description
Location	Shenandoah S B (Figure 8)
1% AEP Peak Flow	Regional Catchment: 510 m^3/s
Results	Regional Catchment: Figure 9 (Northeast to Southwest)
Results Summary	
Figure 9 demonstrates that the risk of inundation of the well pad in the 1% AEP flood event from the regional catchment flooding is low. The low flood risk from regional flooding is associated with the position of the pad on the side of a flat hill above the nearest watercourse channel. The position of the well pad on the side of a hill means that diversion drains along the western perimeter of the site is required to direct local catchment flows around the site. The local catchment flooding is anticipated to be from low velocity sheet flows from runoff.	

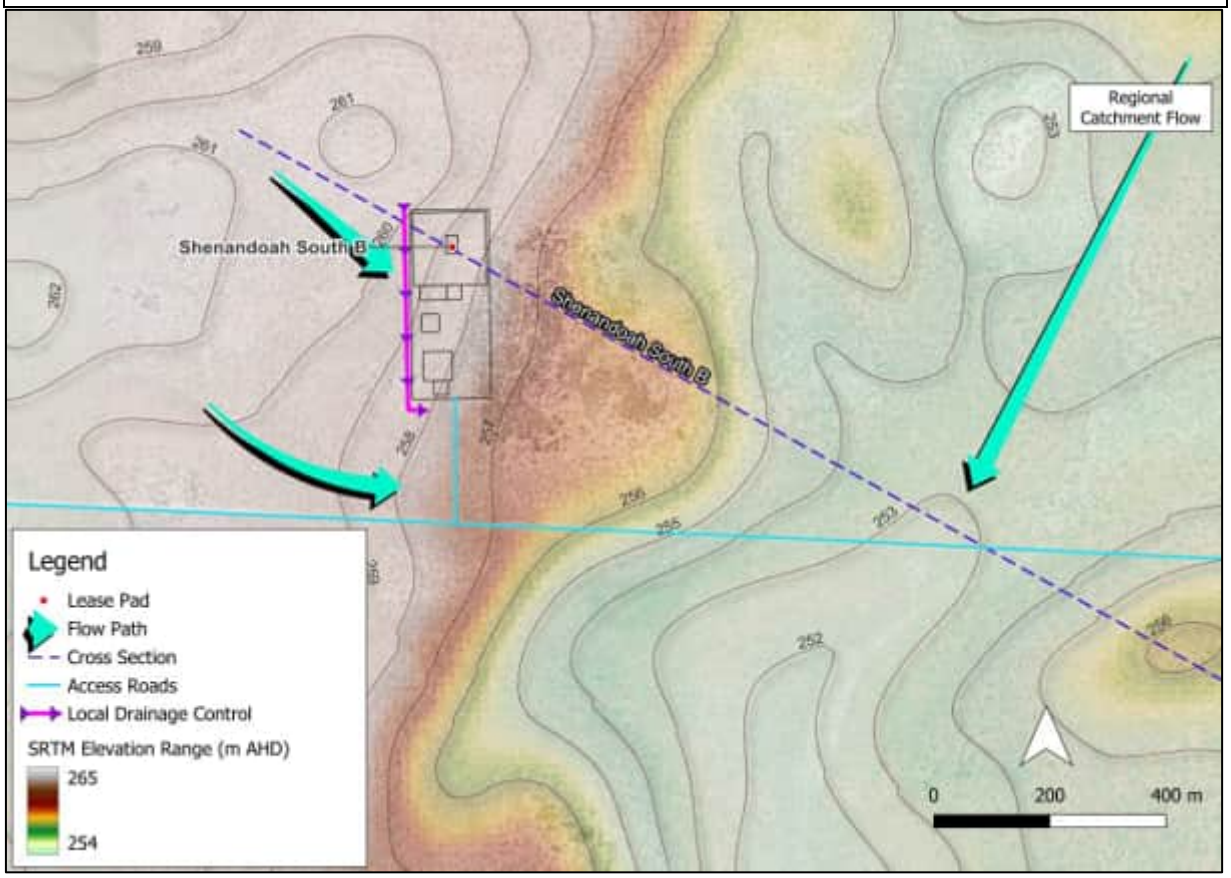


Figure 8 Locality map - Shenandoah S B

Figure 9 Shenandoah S B – cross section

3.3.3 Shenandoah S C well pad

Table 9 presents the hydraulic assessment outcomes for the proposed Shenandoah S C well pad.

Table 9 Shenandoah S C well pad result summary

Item	Description
Location	Shenandoah S C (Figure 10)
1% AEP Peak Flow	Local Catchment: 21 m^3/s Regional Catchment: 584 m^3/s
Results	Local Catchment: Figure 11 (South to North) Regional Catchment: Figure 11 (North to South)
Results Summary	
Figure 11 demonstrates that the flood risk for the well pad in the 1% AEP flood event is low. The low flood risk is associated with the position of the well pad on a high ridge where runoff flows away from the site. The position of the well pad also means that diversion drainage works around the perimeter of the well pad are not required. Figure 11 provides a potential alignment for the access track to the well pad. The alignment of the potential access road follows the ridgeline between two adjacent flow paths. This reduces the risk of flooding on the access road during a rainfall event and also reduces the need for drainage works.	

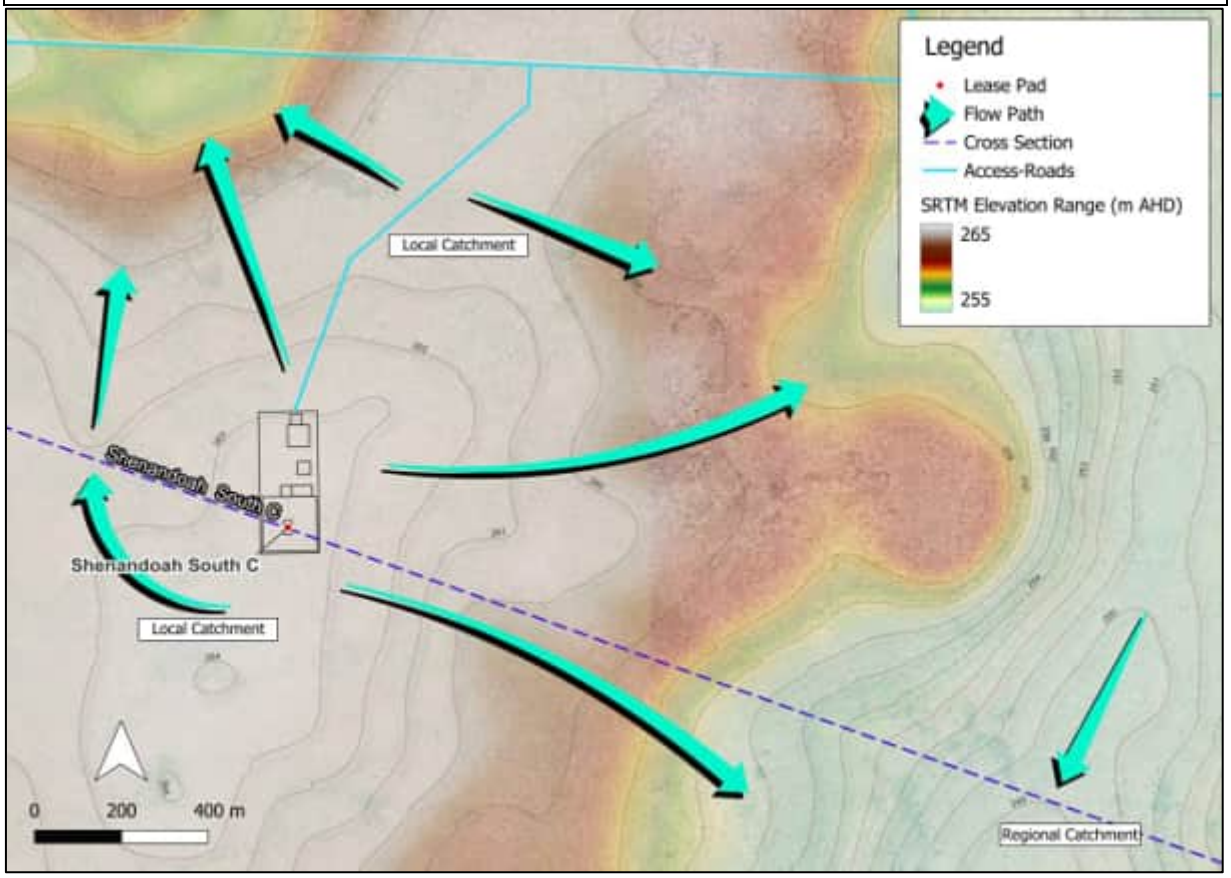


Figure 10 Locality map - Shenandoah S C

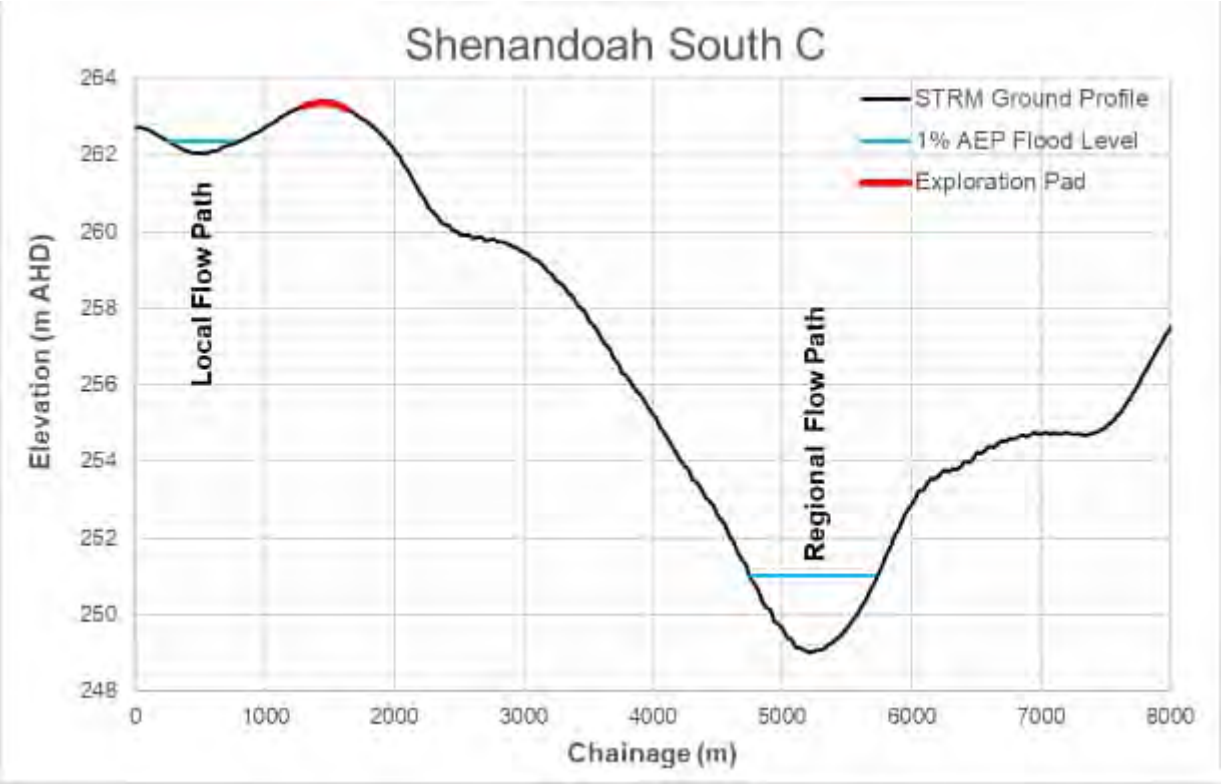


Figure 11 Shenandoah S C – cross section

3.3.4 Shenandoah S2 well pad

Table 12 provides a summary of the hydraulic assessment outcomes for the proposed Shenandoah S2 well pad.

Table 10 Shenandoah S2 well pad result summary

Item	Description
Location	Shenandoah S2 (Figure 12)
1% AEP Peak Flow	Local Catchment: 26 m^3/s Regional Catchment: 515 m^3/s
Results	Local Catchment: Figure 13 (West to East) Regional Catchment: Figure 18 (Northeast to Southwest)
Results Summary	
Figure 13 and Figure 14 show that the well pad has a low risk of inundation in the 1% AEP from both local and regional catchment flood events. This is attributed to the position of the well pad on a ridge between two local flow paths which is also well above (17.2 m) the invert of the nearest regional catchment flow path.	

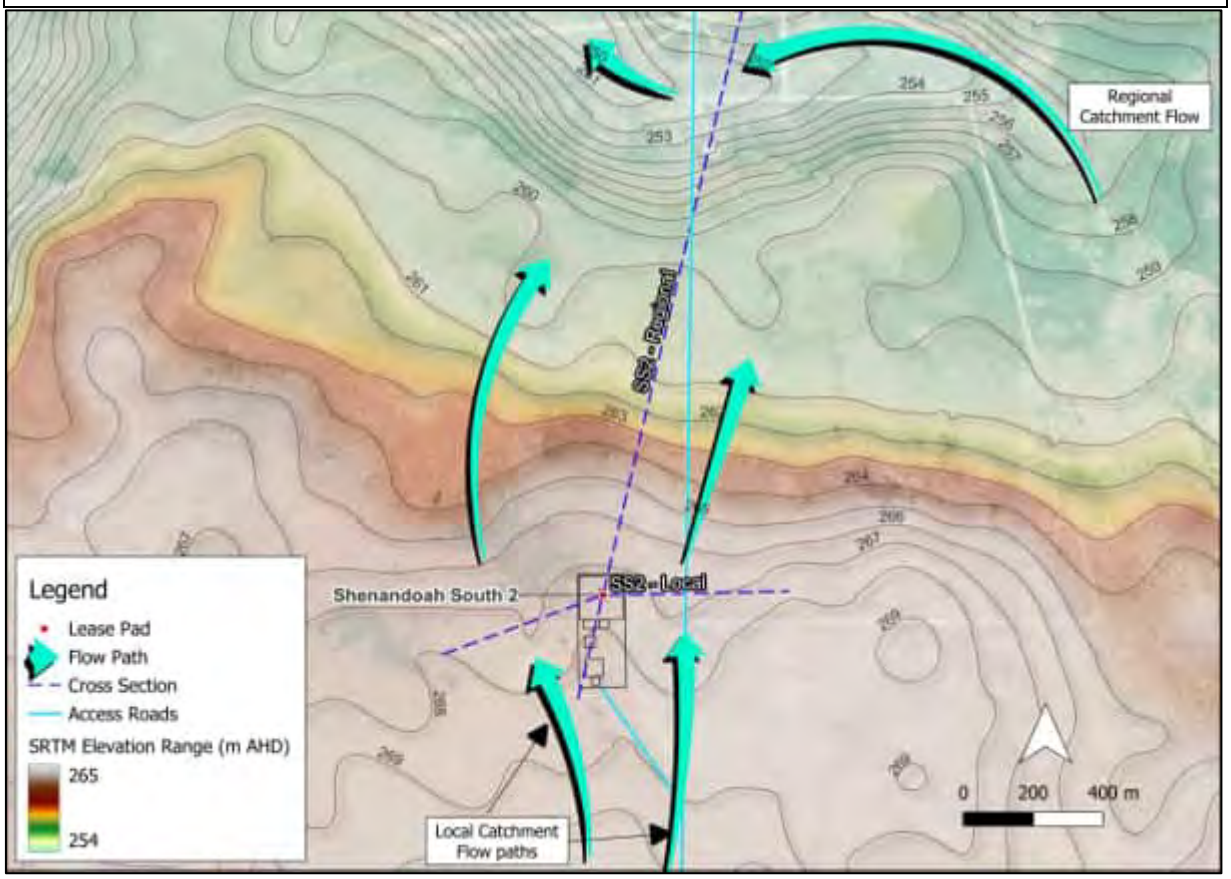


Figure 12 Locality Map - Shenandoah S2

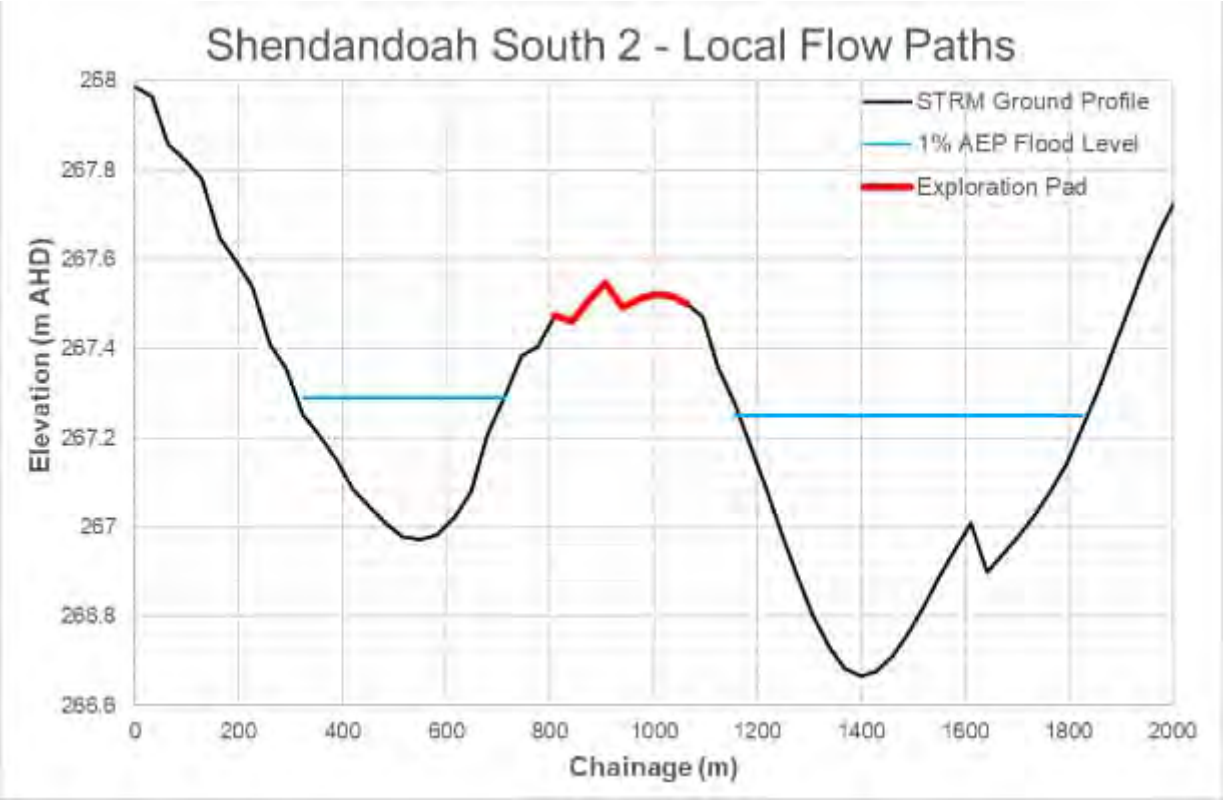


Figure 13 Shenandoah S2 – Cross Section: Local Flow Path

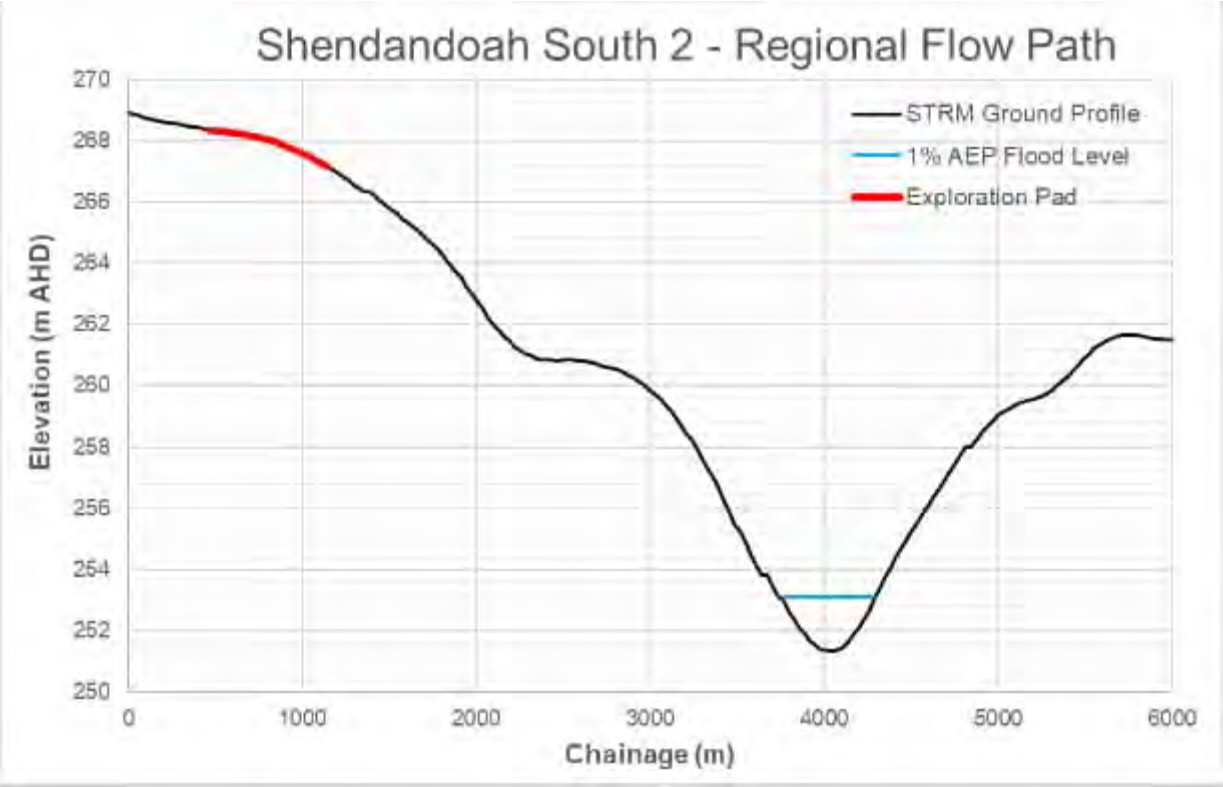


Figure 14 Shenandoah S2 – Cross Section: Regional Flow Path

3.3.5 Shenandoah S5 well pad

Table 11 provides a summary of the hydraulic assessment outcomes for the proposed Shenandoah South 5 well pad.

Table 11 Shenandoah S5 well pad results summary

Item	Description
Location	Shenandoah S5 (Figure 15)
1% AEP Peak Flow	Local Catchment: 21 m^3/s
Results	Local Catchment: Figure 16 (West to East)
Results Summary	
Figure 15 demonstrates that the well pad is located within a localised sag captured by the SRTM elevation data. However, the 1% AEP flood risk to the well pad can be considered low given the following: • The well pad area is located close to the top of the a nearby ridge. • The well pad is located above the 1% AEP flood level of 272.8 m AHD. • The catchment contributing to the well pad is small and has a flat gradient. This means that the peak flow rate from the catchment is relatively low resulting in shallow flood depths (20 mm) and velocities (0.2 m/s). A diversion drain along the eastern perimeter of the site will be provided to divert flows southwards and around the site. The elevation position of the well pad relative to the nearest watercourse in Figure 15 means that there is a low risk of inundation from a regional catchment flood event.	

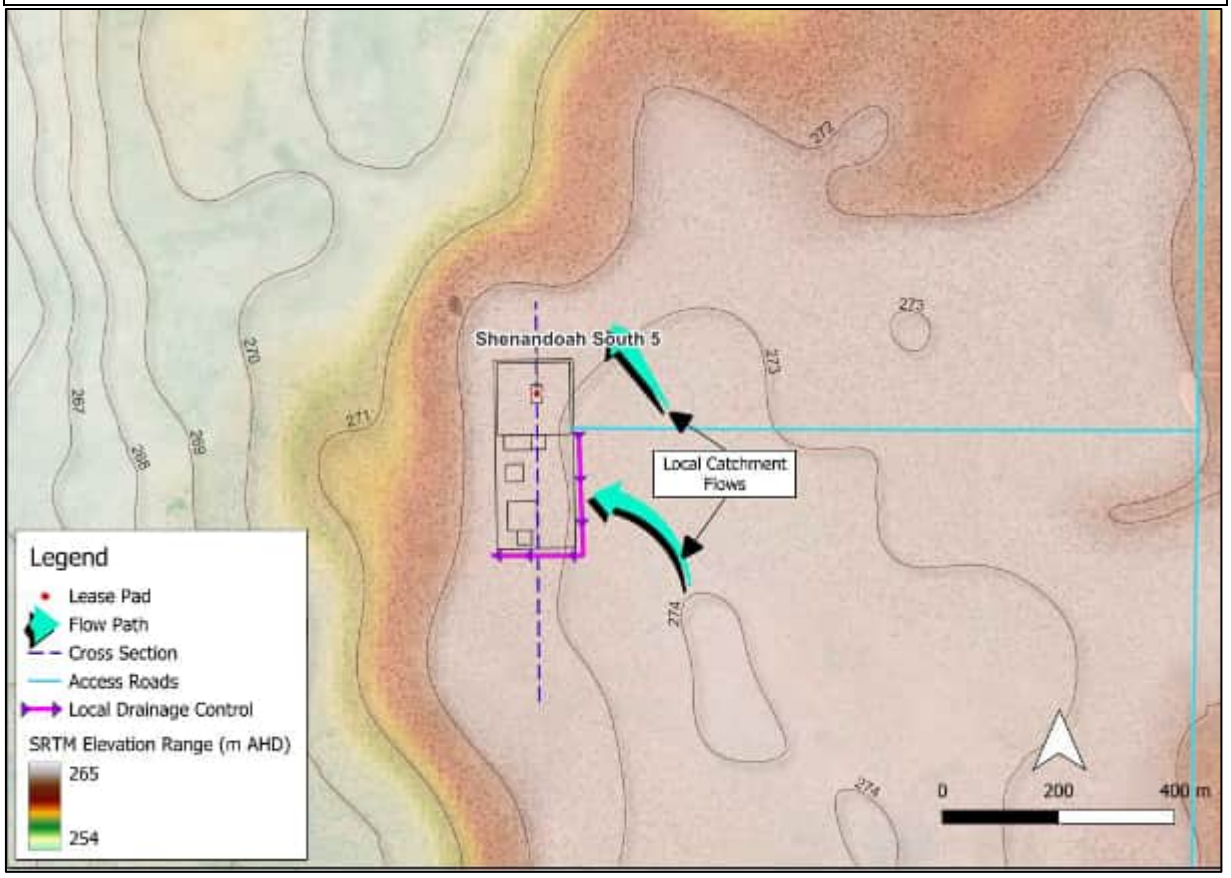


Figure 15 Locality Map - Shenandoah S5

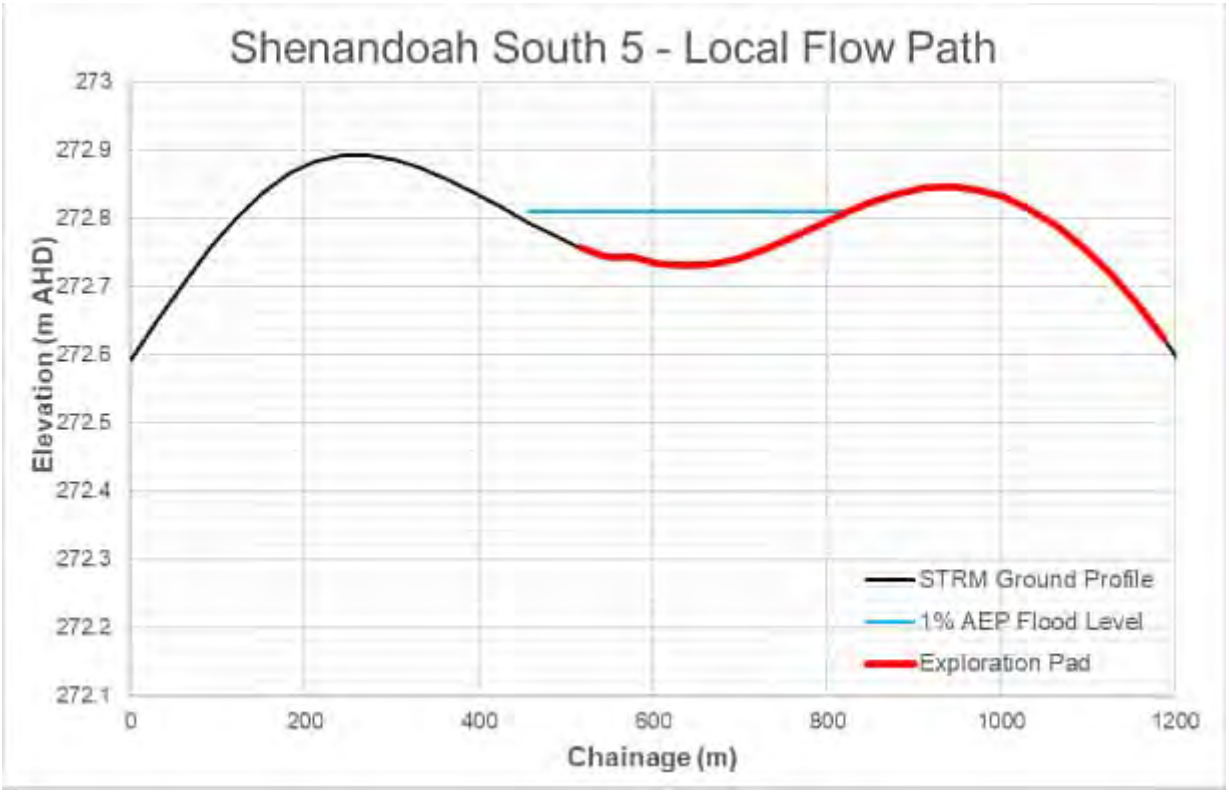


Figure 16 Shenandoah S5 – Cross Section: Local Flow Path

3.3.6 Shenandoah N A well pad

Table 12 presents the hydraulic assessment outcomes for the proposed Shenandoah N A well pad.

Table 12 Shenandoah N A well pad result summary

Item	Description
Location	Shenandoah N A (Figure 17)
1% AEP Peak Flow	Local Catchment: 14 m^3/s Regional Catchment: 653 m^3/s
Results	Regional Catchment: Figure 18 (South to North)
Results Summary	
The elevated position of the well pad relative to the nearest watercourse Figure 18 means that there is a low risk of inundation from a regional catchment flood event. However, the well pad in subject to potential inundation from local catchment runoff driven by runoff from a smaller catchment to the site. This is demonstrated by the catchment Figure 17. • To manage the inundation risk of the lease pad from local catchment flows, the following will be completed: • The lease pad level will be at least 300 mm above natural ground levels. This is a typical mitigation measure used for developments and has been adopted for other locations across the project. Erosion and Sediment Control measure will be used to manage flow around the site and capture any sediment before it enters the nearby drainage channel.	

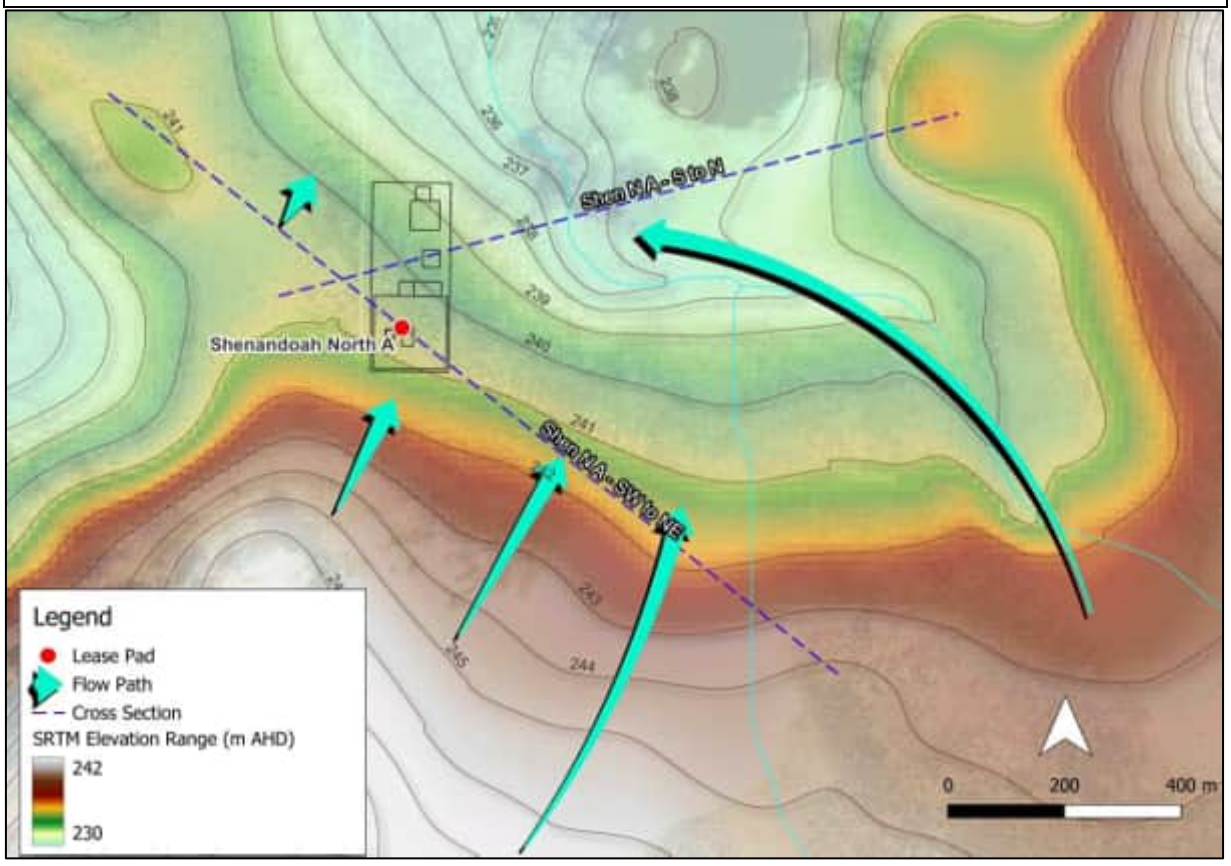


Figure 17 Locality Map - Shenandoah N A

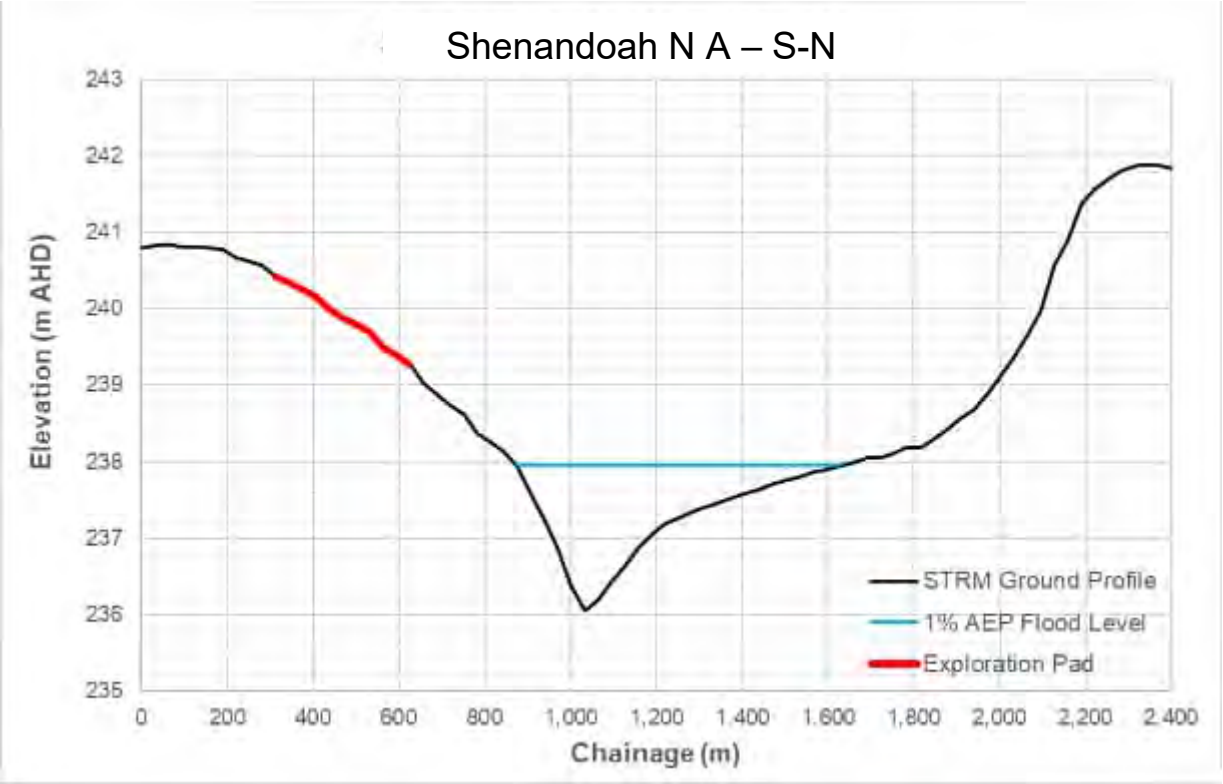


Figure 18 Shenandoah N A – Cross Section: Regional Flow Path

3.4 Hydrogeology

The Beetaloo Basin consists of a series of stacked sedimentary basins ranging in age from Mesoproterozoic to Cretaceous with a thin Cenozoic cover (DEPWS 2022c). Beetaloo Basin is characterised by lateritic plains and rises, clay plains, alluvial flood plains, sandstone plains and rises, lateritic plateau and basalt plains and rises. Shenandoah south consist of a thick sequence of sandstone formations and rises that were deposited between 1,500 and 1,430 million years ago (Ma) (Table 13). The sandstone formation is estimated to reach 5,000 m in thickness in the centre of the basin, while the northern and eastern margins have an average depth of approximately 500 m (CloudGMS, 2015).

The sandstone formations are overlain by the Georgina Basin (630 – 497 Ma), which includes widespread basalts and a thick limestone sequence that forms the Cambrian Limestone Aquifer (CLA), which is a significant water supply aquifer in the region. The Georgina Basin is capped by Cretaceous mudstone and sandstone (145 – 66 Ma) and recent alluvial and laterite deposits.

The generalised Hydrostratigraphy of the Beetaloo Basin is presented in Table 13.

Table 13 Summary of Beetaloo Basin Hydrostratigraphy (DEPWS 2022b; CloudGMS 2015)

Province	Period/Age	Formation		Aquifer Status	Thickness (m)	Yield (L/s)	Ave EC (µs/cm)
CARPENTARIA BASIN	CRETACEOUS 145 – 66 Ma	Undifferentiated		*Local Aquifer*	0 - 130	0.3 - 4	1,800
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		*Local Aquifer (not regionally connected)*	0 – 75	0.3 - 5	1,000
BEETALOO BASIN (ROPER GROUP)	NOT KNOWN	Hayfield Mudstone		REGIONAL AQUITARD	0 – 450	-	32,000
		Jamison Sandstone		*Local Aquifer (not regionally connected)*	0 – 150	-	138,000
	MESO-PROTEROZOIC 1,430-1,500 Ma	Kyalla Formation		REGIONAL AQUITARD	0 – 800	-	-
		Moroak Sandstone		*Local Aquifer (not regionally connected)*	0 – 500	0.5 - 5	131,000
		Velkerri Formation		REGIONAL AQUITARD	700 – 900	-	-
		Bessie Ck Sandstone		*Local Aquifer (not regionally connected)*	450	0.5 - 5	-

Across parts of the Beetaloo Basin, undifferentiated Cretaceous deposits form the uppermost aquifer 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 Basin. The aquifer system covers at least 200,000 km^2 that forms the principal water resource in the Beetaloo Sub-basin, (SREBA, 2022). Limestone in the CLA is commonly fractured and cavernous; regionally bore yields of up to 100 L/s have been recorded from this aquifer near Kyalla 117 N2 site which has a standing water level of 114 m below top of casing. 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. Existing groundwater use in the Beetaloo Basin is estimated at 6,000 ML/year.

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 Basin. Dry season flow in the Roper River has been gauged at 95,000 – 126,000 ML/year 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 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 deeper Roper Group and undefined Neoproterozoic group sequence is available as it occurs at depth within the Beetaloo Sub-basin. This unit lies below the Georgina Basin which contains the CLA and other important aquifers. The deeper sandstone dominated formations may behave as aquifers, however, drilling results suggest these formations have limited potential as groundwater resources due to their depth and very high salinity. Groundwater in the Roper Group and undefined Neoproterozoic group is highly saline (>100,000 mg/L chlorides) and contrasts with the shallower, utilised aquifers of the Georgina Basin sediments in which groundwater is generally of drinking water quality.

The Velkerri Formation represents the primary unconventional gas target in the Beetaloo Basin, although small hydrocarbons intersections have been encountered in other formations within the Roper Group. Vertical pressure gradients between the Roper Group and the CLA are not well characterised, however, previous exploration well formation tests indicate there is an upward pressure gradient from the Roper Group to the CLA. Over much of the basin the CLA is separated from these formations by multiple aquitards including the Antrim Plateau Volcanics and Hayfield Mudstone.

The Tamboran permit area currently falls within the Daly Roper Beetaloo Water Control District, that encompasses 175,580 km^2 and includes the Roper River and its tributaries as well as the Beetaloo Sub-basin (DENR, 2018). Legislation in Water Control Districts covers all aspects of sustainable water management, including the investigation, use, control, protection and allocation of water resources. Through the NT *Water Act*, water control districts and water allocation plans, allocation of water to various declared beneficial uses, including agriculture, aquaculture, public water supply, riparian and industry while ensuring that adequate provisions are made to maintain cultural and environmental requirements. Water control districts are geographical areas declared under the *Water Act* by the minister to allow for intensive management of water resources. Tamboran have an existing water extraction licence from DEPWS Water Resource Division in accordance with the *Water Act 1992* (Cloud GMS, 2015).

There are 12 groundwater bores located within 12 km of the Shenandoah South E&A Program. Six of the bores are associated with Tamboran activities at Kyalla 117 NE and the remaining are Stuart Highway Roadside bores or pastoral bores.

3.5 Land Systems

Land systems are defined because of their distinct differences from the surrounding areas and by the recurring pattern of geology, topography, soils and vegetation. Land system mapping for the project area is derived from *Land Systems of the Southern Part of the NT*, which is a compilation of three existing land system surveys and the Atlas of Australian Soils (scale 1:1,000,000). It covers the southern part (approximately 70%) of the Northern Territory. Published maps were made digital and edited to accommodate overlaps, gaps and mismatching boundaries. Where possible, the land system descriptions have been extrapolated into areas covered by the broader scale Atlas mapping (DLRM, 2013).

The Shenandoah South E&A Program occurs within the Beetaloo Land System, which is classified as lateritic plains and rises. This land system is characterised by plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products, sandy and earth soils.

The land system for the Shenandoah South E&A Program is summarised in Table 14 and Figure 19.

Table 14 Beetaloo land system details

Land System	Geological Zone	Class	Description
Beetaloo	Sturt Plateau	Lateritic plains and rises	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils

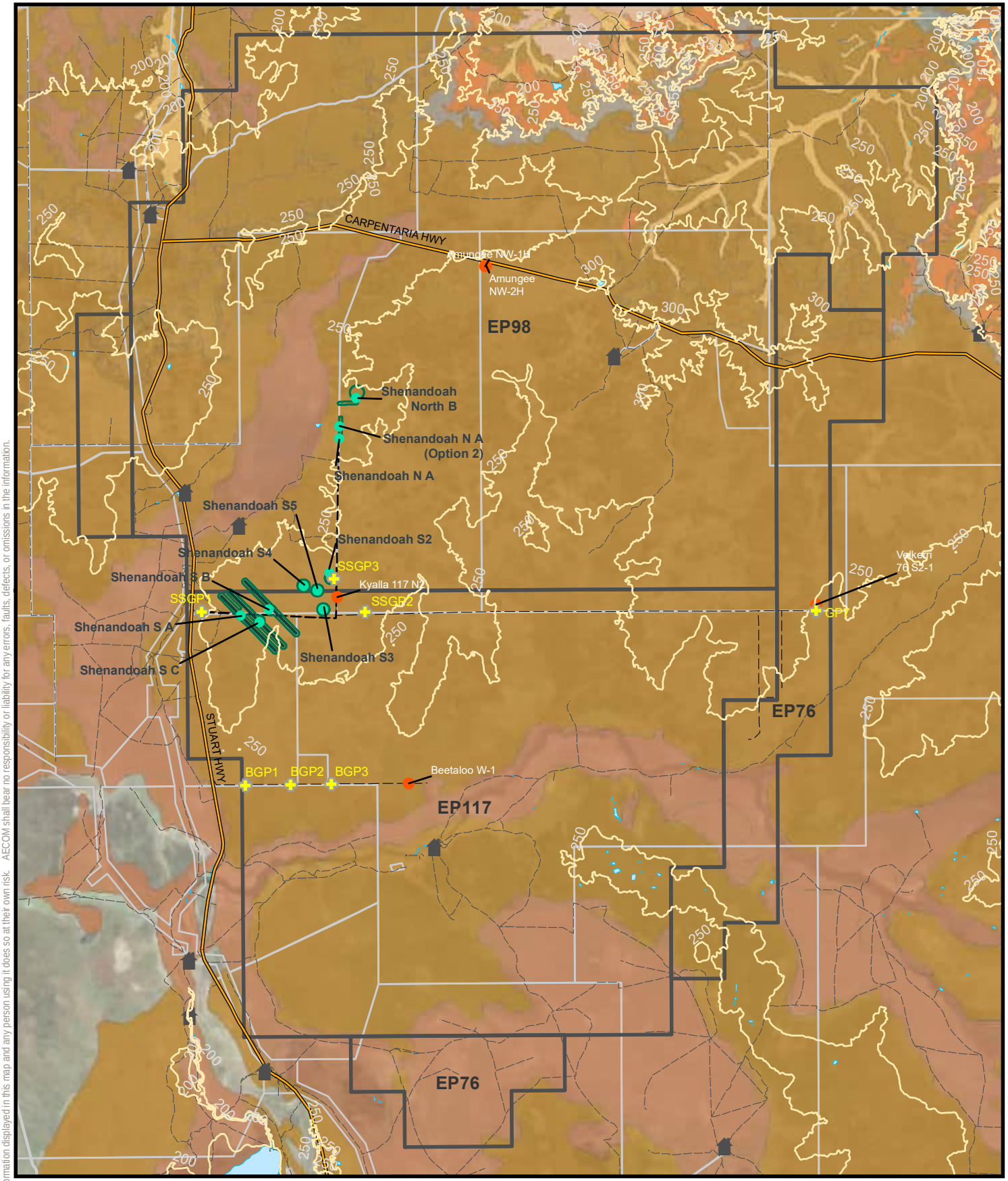
3.6 Soils

Soils within the Sturt Plateau have been derived from ancient rock formations and ancestral soils that were formed during earlier weathering cycles. The soils have been deeply weathered, leached and are relatively infertile because they have not been enriched by any recent geological events (Orr & Holmes, 1984). 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 and rises, which encompass the Shenandoah South E&A Program, are classed as very strongly leached soils of the Tertiary land surface. The primary soil type in this area are Kandosols as per the Australian Soil Classification Map (Richards *et al* 2023).

A soil assessment was completed at the Shenandoah South E&A Program. The result of the assessment is presented in Table 15. The soils within the Shenandoah South E&A Program are predominantly a reddish sandy loam or grey clay. Shenandoah S B, Shenandoah S C, Shenandoah S4, Shenandoah S5 and Shenandoah N A well pad areas all reported a higher percentage of clay then the other sites. Soils at these sites have a neutral pH then the sandy loams.

Soil material structure samples were collected during the field work. Soil lab results are provided in Appendix A.



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Kilometres

- Existing Exploration Well Pads
- Proposed Exploration Well Pads
- Gravel Pits
- Proposed Seismic Lines
- Shenandoah Lease Pad Area
- Access Tracks
- Contours
- Populated Place
- Tracks
- Highway
- Permit Areas
- Pastoral Lease Boundary
- Water Bodies

Landscape Class

- lateritic plains and rises
- clay plains
- alluvial floodplains
- sandstone plains and rises
- lateritic plateaux
- basalt plains and rises

Data sources:
Permit Area, Cadastre - NT Gov 2019.
Places, Vegetation - Aust Gov 2019
Highways, Roads, Drainage - StreetPro 2019

tamboran

Permit Area Land Systems Landscape Class

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Figure 19

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Table 15 Proposed Shenandoah South E&A exploration well pads soil summary

Horizon	Depth (m)	Texture	Colour	Coarse fragments	pH	EC (µS/cm)	Moisture	Emerson class no.	Photo
Shenandoah South A									
A	0-0.2	Sandy Loam with Gravel	7.5YR 4/3 Brown	10% coarse, 3 mm	-	-	Dry	-	
B	0.2-0.5	Sandy Loam with Gravel	7.5YR 3/4 Dark Brown	30% coarse, 3-5 mm	7.3	6	Dry	2	
C	0.5-0.75	Sandy Loam with Gravel	5YR 3/3 Dark Reddish Brown	40% coarse, 3-10 mm	7.1	7	Dry	2	
Shenandoah South B									
A	0-0.3	Clay Loam Sandy	10YR 4/1 Dark Gray	40% fines, no coarse	7.0	17	Moist	2	
B	0.2-0.5	Light Medium Clay	10YR 6/1 Gray	40% fines, no coarse	-	-	Moist	2	
C	0.5-0.75	Medium Clay	10YR 6/1 Gray	40% fines, no coarse	7.4	13	Moist	2	

Horizon	Depth (m)	Texture	Colour	Coarse fragments	pH	EC (µS/cm)	Moisture	Emerson class no.	Photo
Shenandoah South C									
A	0-0.3	Silty Clay Loam	10YR 4/1 Dark Gray	<5% coarse, 2mm	6.7	8	Dry	2	
B	0.2-0.5	Clay Loam Sandy	10YR 5/3 Brown	20% coarse, 3-7mm	7.0	10	Dry	2	
C	0.5-0.75	Clay Loam Sandy	10YR 5/2 Greyish Brown	20% coarse, 3-7mm	6.8	12	Moist	2	
Shenandoah South 2									
A	0-0.2	Loamy Sand	5YR – 3/4 Pale Brown	No Coarse Fragments	5.8	24	Dry	3	
B	0.2-0.7 Did not hit refusal, deep soil >0.7m	Sandy Loam	5YR 3/3 Dark Reddish Brown	65% fines, 20% 1-2 mm subangular ironstone, 15% 2-5 mm subangular ironstone	6.3	13	Dry	6	

Horizon	Depth (m)	Texture	Colour	Coarse fragments	pH	EC (µS/cm)	Moisture	Emerson class no.	Photo
Shenandoah South 3									
A	0 – 0.25	Loamy Sand	5YR – 3/4 Dark Reddish Brown	No Coarse Fragments	6.4	9	Dry	3	
B	0.25 – 0.60+	Sandy Loam	5YR – 4/4 Reddish Brown	No Coarse Fragments	6.3	9	Dry	6	
Shenandoah South 4									
A	0 – 0.15	Sandy Clay Loam	10YR – 4/1 Dark Grey	No Coarse Fragments	5.3	15	Dry	3	
B	0.15– 0.75+	Clay Loam Sandy	10YR 7/1 Light Grey	No Coarse Fragments	5.4	8	Slightly Moist	6	

Horizon	Depth (m)	Texture	Colour	Coarse fragments	pH	EC (µS/cm)	Moisture	Emerson class no.	Photo
Shenandoah South 5 (note field name was Shenandoah South 1)									
A	0 – 0.15	Sandy Clay Loam	10YR – 3/4 Dark Yellowish Brown	No Coarse Fragments	7.1	16	Dry	3	
B	0.15– 0.60+	Clay Loam Sandy	10YR – 6/3 Pale Brown	No Coarse Fragments	7.6	13	Dry	6	
Shenandoah North A									
A	0-0.4	Clay Loam Sandy	5YR 4/1 Dark Grey	10% coarse, 2-3mm	6.5	12	Dry	2	
B	0.4-0.6	Sandy Clay Loam	10YR 4/4 Dark Yellowish Brown	20% coarse, 2-4 mm	6.3	8	Moist	2	
C	0.6-0.8	Clay	10YR 5/1 Weak Red	-	-	-	-	-	

Horizon	Depth (m)	Texture	Colour	Coarse fragments	pH	EC (µS/cm)	Moisture	Emerson class no.	Photo
Shenandoah North A (Option 2)									
A	0-0.2	Clay Loam Sandy	7.5YR 5/1 Gray	<5% coarse, 2-3 mm	5.8	10	-	2	
B	0.2-0.5	Light Medium Clay	10YR 5/3 Brown	10% coarse, 2-3 mm	5.6	10	-	2	
C	0.5-0.8	Medium Clay	10YR 5/3 Strong Brown	-	6.2	9	Moist	2	
Shenandoah North B									
A	0-0.2	Clayey Sand	5YR 3/3 Dark Reddish Brown	50% coarse, 3-7 mm	6.2	5	-	2	
B	0.2-0.5	Silty Loam	5YR 3/4 Dark Reddish Brown	50% coarse, 3-12 mm	6.2	6	-	2	
C	0.5-0.7	Silty Loam	5YR 3/4 Reddish Brown	60% coarse 3-17 mm	6.1	6	-	2	

3.6.1 Erosion Susceptibility

Soil erosion susceptibility varies throughout the permit area, dependent upon soil types, slope and extent of ground disturbance. Apart from the erosive impact of climatic conditions, soil erosion is influenced mainly by the inherent properties of the soils and the processes which occurred during the formation of the landscapes (Aldrick & Wilson, 1990).

Erosion will occur in the permit area if the land is used beyond its capacity, as is seen if land is overstocked or vehicle movements not controlled, for example. The location of proposed well pads and seismic lines have been examined to determine the risk of erosion occurring. Factors considered include the following:

- Soil type – soils with higher clay content are prone to generation of bulldust and are easily eroded by wind and water. The surface soils at the well pad sites had low clay content in the upper 0.2m, ranging from loamy sands (5-10% clay) to sandy loams (10-20% clay). Gravelly soils tend to be more robust to disturbance on the scale expected during the lease exploration program. The well pad areas were found to have high gravel content and generally non-dispersive soils as shown below:
  - Shenandoah S A – Surface gravel 10-30%, Emerson class number 2
  - Shenandoah S B – no surface gravels, Emerson class number 2
  - Shenandoah S C – 5-10% surface gravels, Emerson class number 2
  - Shenandoah S2 – no surface gravels, Emerson class number 3
  - Shenandoah S3 – no surface gravels, Emerson class number 3
  - Shenandoah S4 – no surface gravels, Emerson class number 3
  - Shenandoah S5 – no surface gravels, Emerson class number 3
  - Shenandoah N A – 5% surface gravels, Emerson class number 2
  - Shenandoah N A (Option 2) – 5-10% surface gravels, Emerson class number 2
  - Shenandoah N B – 50% coarse surface gravels, Emerson class number 2.
- Slope – the slope of the site will determine the risk of erosion during rainfall events, with steeply inclined areas a higher risk than small undulations in the landform. All well pad areas within Shenandoah South E&A Program were considered flay with slopes of ≤1%.
- Aspect – the position of the access track and pads in relation to the direction of the contour should be considered and creation of tracks across (as opposed to parallel with) the contour should be avoided.
- Rainfall – Table 16 presents the erosion risk rating based on average monthly rainfall using the rating system provided in the IECA (2008) for Daly Waters Aerodrome (located north of the Shenandoah South E&A Program). Construction activities for exploration lease area is planned for completion prior to the wet season, to minimise the risk of erosion resulting from rainfall impacts.

Table 16 Erosion Risk Rating based on average monthly rainfall at Daly Waters Aerodrome

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	163.2	182.7	107.5	20.7	6.4	2.8	1.7	0.3	1.9	21.8	49.4	118.1
Erosion Risk	H	H	H	VL	VL	VL	VL	VL	VL	VL	M	H

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) Data sourced from Bureau of Meteorology, Climate Averages for Station 014626 Daly Waters Aerodrome recorded from 1939-2022.

Table 17 Erosion Risk Rating based on average monthly rainfall at Newcastle Waters

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	125.0	130.4	82.3	19.0	7.3	4.8	2.7	1.2	4.8	18.2	39.1	75.0
Erosion Risk	H	H	M	VL	VL	VL	VL	VL	VL	VL	L	M

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) Data sourced from Bureau of Meteorology, Climate Averages for Station 015086 Newcastle Waters recorded from 1889-2022.

3.7 Bushfire

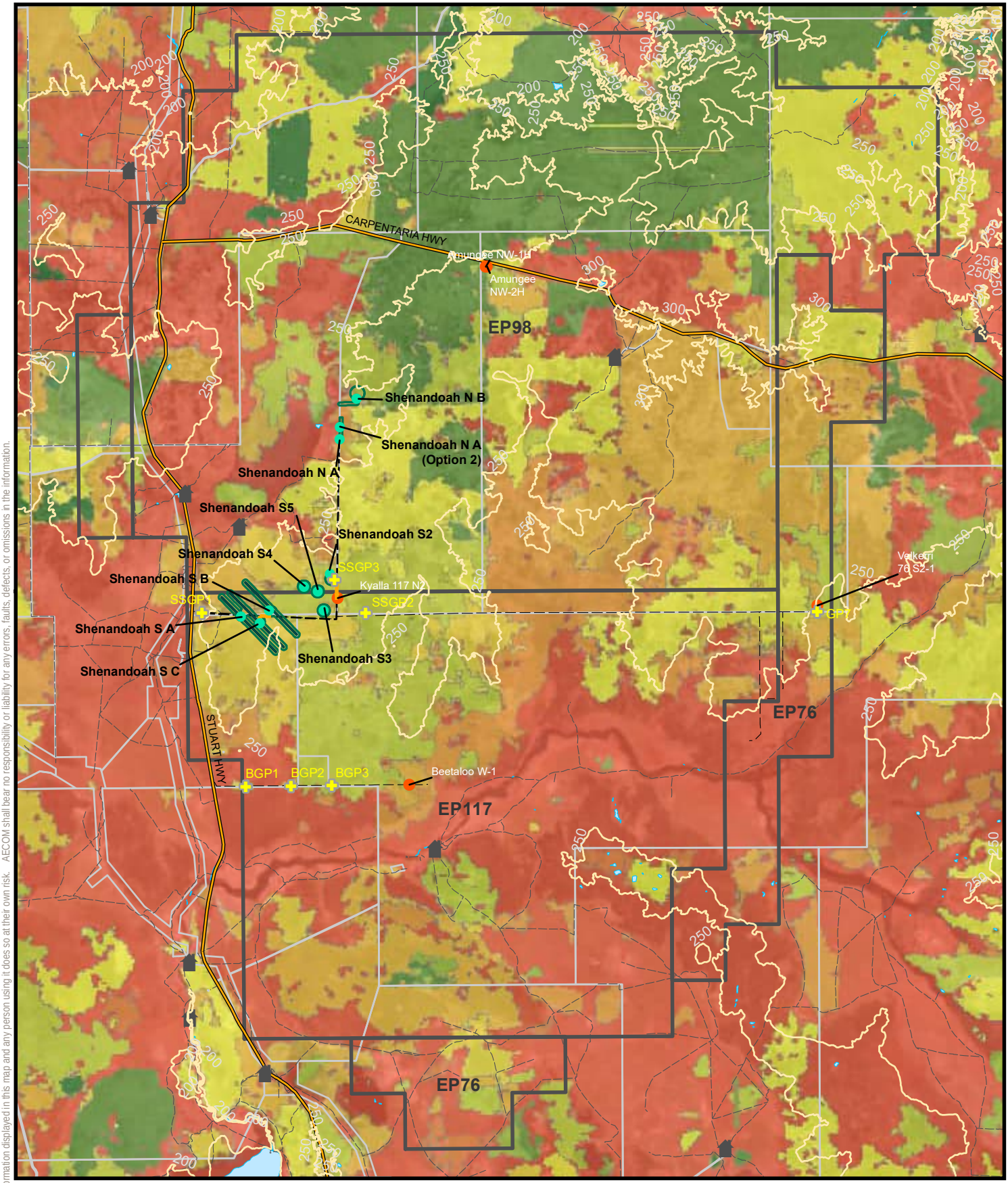
Fire is a natural occurrence in most Australian ecosystems and plays an important role in their ecology. Fire management practices by the Pastoralists, generally exclude fire from the Mitchell grasslands (dominated by *Astrebla* spp.) to maintain forage throughout the dry season (HLA, 2005). Mitchell grasslands are located west of the Shenandoah South E&A program in the floodplain area. Fires are more frequent in the Sturt Plateau in the Eucalypt/Corymbia and Acacia woodlands where Shenandoah South E&A program is located.

Historically most high intensity fires within EP98 and 117 occur during the dry season fires (June to September) (HLA, 2005). Wet season fires (October to May) have occurred within the permit area. These fires are likely to be patchy and of lower intensity, depending on the state of curing of the fuel load.

Fire sensitive Bullwaddy and Lancewood communities are located throughout the permit area. The impacts of hot fires can impact flora and fauna species and reduce habitat quality. Research suggests that hot fires may impact fauna diversity and in particular diurnal reptiles (e.g., Legge *et al*., 2008).

Land condition assessments undertaken of the Shenandoah South E&A Program indicated low intensity fire events greater than 2 years ago at Shenandoah South A and B, and moderate intensity fire greater than 2 years ago at Shenandoah South C, Shenandoah North A, Shenandoah North A (Option 2) and Shenandoah North B.

Fire data was acquired from the NAFI site and queried for the Shenandoah South E&A area. Ten-year fire data (2013 to 2022) shows a large portion of the area has not been impacted by fire for some time ranging from 4-8 years. Figure 20 shows the fire frequency within the exploration areas over the past 10 years (2011 to 2021). Fire has occurred 4 to 6 times at each area within the last 10 years.



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Kilometres

- Existing Exploration Well Pads
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- Tracks
- Highway
- Gathering Line
- Permit Areas
- Pastoral Lease Boundary
- Water Bodies

Years Burnt 2013 - 2022

1 2 3 4 5 6 7 8 9 10 11

Data sources:
Permit Area, Cadastre - NT Gov 2019.
Places, Vegetation - Aust Gov 2019
Highways, Roads, Drainage - StreetPro 2019

tamboran

Permit Area Annual Fire Frequency 10 year, 2013 - 2022

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Figure 20

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3.8 Land use and sensitve receptors

Approximate separation distances from the project area to the nearest environmental and community receptors is summarised in Table 18 for the seismic lines and Table 19 for the well pads. Sensitive receptors for the Shenandoah E&A area are illustrated in Figure 21.

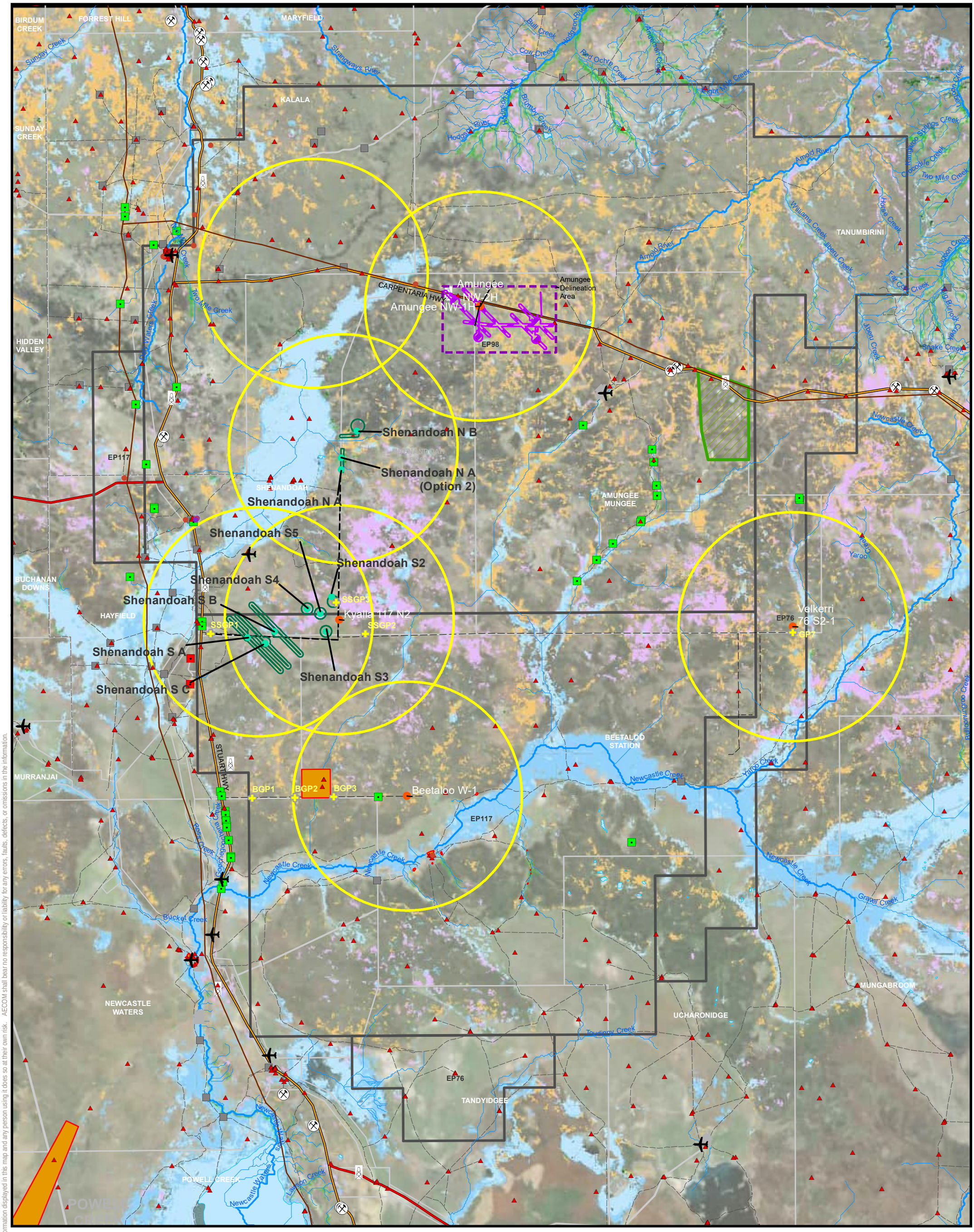
Table 18 Environmental and community Receptors – Seismic Lines

Receptor	Seismic Lines		
	Line A	Line B	Line C
Nearest pastoralist bore	11 to 34 km west	14 to 35 km west	19 to 38 km west
Nearest homestead	24 to 43 km north-west	22 to 42 km north-west	18 to 40 km north-west
Nearest community – Dunmarra	17.5 km north-west	17.7 km north-west	17.5 km north-west
Nearest Indigenous community - Jingaloo	22 km south-west	22.6 km south-west	24.2 km south-west
Stuart Highway	28 km west	31 km west	35 km west
Carpentaria Highway	63 km north	62 km north	64 km north
Bullwaddy Conservation Reserve	87 km north-east	81 km north-east	84 km north-east
Frew Ponds Reserve	16 km south-west	18 km south-west	21 km south-west
Lake Woods	92 km south	91 km south	93 km south
Nearest Mapped Watercourse downgradient (Stream Order 1)	9.6 km south-west	11 km south-west	14 km south-west
Aquatic Ecosystem (SREBA 2023) P = Palustrine system F = Floodplain system	Seismic line intersects with floodplains (Low Sensitivity) in small sections.		

Table 19 Environmental and community receptors – Well pads

Receptors	Shenandoah Well pads									
	Shenandoah S A	Shenandoah S B	Shenandoah S C	Shenandoah N A	Shenandoah N A (Option 2)	Shenandoah N B	Shenandoah S2	Shenandoah S3	Shenandoah S4	Shenandoah S5
Nearest pastoralist bore	7.9 km west	19.2 km north	9.8 km south-west	12.4 km west	12.8 km south-west	17.1 km south-west	16.3 km north-west	19.1 km north-west	13.1 km north-west	16.3 km worth-west
Nearest homestead – Hayfield Station	15 km south	15 km south	16 km south	22 km north-east	23 km north-east	28 km north-east	17 km south-east	20 km south-east	14 km south-east	17 km south-east
Nearest community – Dunmarra	22.5 km north-west	24 km north-north-west	24.4 km north-north-west	27.5 km north-west	28 km north-west	36 km north-west	27.5 km north-west	30 km north-north-west	24 km north-north-west	33 km north-north-west
Nearest Indigenous community – Jingaloo	29.6 km south	29 km south	27.8 km south	58 km south	59 km south	63 km south	35 km south	28 km south	33 km south	31 km south
Stuart Highway	8 km west	11 km west	14 km west	32 km west	32 km west	34 km west	22 km west	22 km west	17 km west	20 km west
Carpentaria Highway	63 km north	62 km north	64 km north	35 km north	33 km north	27 km north	57 km north	63 km north	58 km north	59 km north
Frew Ponds Reserve	16 km south-west	21 km south-west	18 km south-west	47 km south-west	49 km south-west	54 km south-west	32 km south-west	29 km south-west	27 km south-west	29 km south-west
Bullwaddy Conservation Reserve	87 km north-east	82 km north-east	85 km north-east	63 km north-east	63 km north-east	60 km north-east	63 km north-east	74 km north-east	63 km north-east	76 km north-east
Lake Woods	92 km south	93 km south	91 km south	122 km south	124 km south	129 km south	100 km south	94 km south	98 km south	97 km south
Nearest Mapped Watercourse downgradient (SO 1)	9 km south-west	12.5 km south-west	14 km west	0.45 km east	0.2 km east	1.7 km south	14 km south-east	21.7 km south-west	20 km south-west	22.2 km south-west

Aquatic ecosystem (SREBA 2023) P = Palustrine F = Floodplain	1 (F)	0.9 (F) 1.5 (P)	0.6 (F)	3.3 (F, P)	0.7 (F)	1 (F)	1 (F)	4.7 (F)	1 (F)	0.5 (F)



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GEOCENTRIC DATUM OF AUSTRALIA 94

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0 7.5 15 30

Kilometres

- Amungee Delineation Area
- Existing Exploration Well Pads
- Proposed Exploration Well Pads
- Proposed Seismic Lines
- Shenandoah Lease Pad Area
- 20km buffer
- Access Tracks
- Populated Place
- Aircraft Facility
- Tower
- Mine
- Yard
- Tracks
- Highway
- Gas Pipeline
- Permit Areas
- Aboriginal Land
- Aboriginal Communities
- Pastoral Lease Boundary
- Pastoralist Bores
- Creek
- River
- Water Bodies
- Bullwaddy Conservation Reserve

Threatened Flora and Fauna
- CR - Critically Endangered
- VU - Vulnerable

Heritage
- Historic Heritage Sites
- Archaeological Sites

Significant vegetation
- Riparian
- Riparian/wetland
- Wetland
- Wetland/floodplain
- Floodplain
- Floodplain/drainage depression
- Run-on

LOCATION

Data sources:
Permit Area, Cadastre - NT Gov 2019.
Places, Vegetation - Aust Gov 2019
Highways, Roads, Drainage - StreetPro 2019.
SREBA, 2023.

COMMUNITY AND ENVIRONMENT RECEPTORS AND FEATURES OF INTEREST

PROJECT ID	60623736
CREATED BY	sam.schroder
LAST MODIFIED	20-Oct-2023
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Figure 21

A3 size

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4.0 Natural Environment

4.1 Bioregions

The Interim Biogeographic Regionalisation of Australia (IBRA) classifies the Shenandoah South E&A Program as occurring within the Sturt Plateau Bioregion. The Sturt Plateau Bioregion comprises undulating plains on sandstone, with predominantly neutral sandy red and yellow earth soils. Dominant vegetation is eucalypt woodland (dominated by variable-barked bloodwood *Eucalyptus dichromophloia*) with spinifex understorey, as well as extensive areas of Lancewood (*Acacia shirleyi*) - Bullwaddy (*Macropteranthes kekwickii*) vegetation association 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 (Baker *et al*, 2005).

4.2 Vegetation Communities

The SREBA Terrestrial Ecosystems Baseline Report identified 51 vegetation communities and 21 broad vegetation groups (BVG) comprising the final vegetation classification for the study area (Young *et al*, 2022). Within the Shenandoah South E&A Program 21 broad vegetation communities are noted (refer Figure 22).

Significant vegetation communities listed by the SREBA Baseline Report were identified in the Shenandoah South E&A area. These include wetland, floodplains, drainage depressions and run-on areas. The planned well pads are shown to be outside these areas (refer Figure 23), with only minor interaction associated with the seismic lines on floodplains, drainage depressions and run-on areas.

Based on the SREBA definition of significant vegetation, it is considered that the floodplains and drainage depressions within the Shenandoah South E&A Program area are not classified as high value wetlands, however they do have some ecological values for the local flora and fauna. The floodplains, drainage depressions and run-on areas are generally not considered sensitive to impacts from adjacent land use due to the relatively large spatial extent (DEPWS 2022). Seismic exploration activities can be conducted to minimise the extent and duration of any disturbances on the significant vegetation communities. This can be achieved by minimising clearing impacts to the greatest extent practicable on the key habitat features that contribute to their importance in the region.

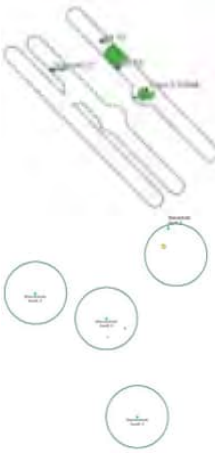
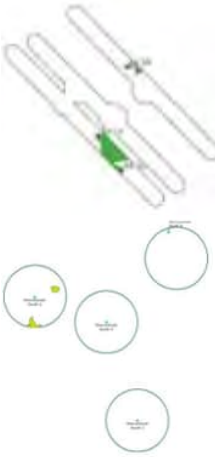
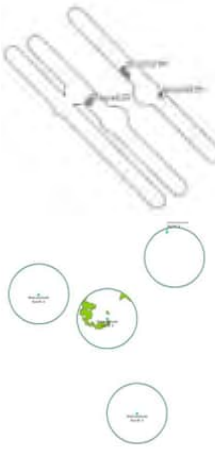
In accordance with the NT *Water Act* 1992 to interfere with a waterway, it is considered that the seismic program would either not cause a material change or alteration to the waterway or occur generally in a lower tier stream order (i.e. Stream Order 1). Permits to interfere with a waterway can be obtained through DEPWS Water Resources Branch.

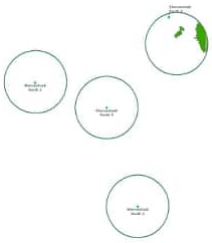
The field assessment undertaken in December 2022 and March – April 2023 confirmed that the main vegetation communities identified within the Shenandoah South E&A area consists of woodlands, typically dominated by bloodwoods (*Corymbia* spp.) and Eucalypt and patches of tall shrubland / woodland of Lancewood (*Acacia shirleyi*) and Bullwaddy (*Macropteranthes kekwickii*) with open grassland understorey (AECOM 2021 and 2022).

The survey of the Shenandoah South well pads identified seven vegetation communities from numerous vegetation assessment sites. The vegetation communities are described in Table 20.

Table 20 Vegetation community description – Shenandoah South lease areas

Vegetation Community	Description	Survey Sites	Photo Reference
1a	*Acacia shirleyi* mid high woodland over *Macropteranthes kekwickii, Terminalia volucris* ± *Acacia difficilis* mid high shrubland, over *Panicum trichoides, Panicum mindanaense, Bulbostylis barbata* mid high open tussock grassland	**No of sites:** (5) Ground 9, Ground 170, Air 44, Air 50, Air 69	**Plate 1** ***Acacia shirleyi mid high woodland***
2a	*Corymbia dichromophloia* ± *Erythrophleum chlorostachys* mid high open woodland, over *Acacia difficilis* ± *Terminalia canescens, Erythrophleum chlorostachys* mid high open shrubland, over *Triodia bitextura, Aristida hygrometrica, Chrysopogon fallax* mid high hummock grassland	**No of sites:** (46) Shen S A, Ground 8, Ground 16, Ground 17, Ground 24, Ground 40, Ground 41, Ground 43, Ground 60, Ground 61, Ground 66, Ground 68, Air 1, Air 2, Air 4, Air 5, Air 6, Air 7, Air 11, Air 12, Air 19, Air 20, Air 21, Air 22, Air 23, Air 25, Air 28, Air 34, Air 35, Air 36, Air 37, Air 38, Air 39, Air 42, Air 46, Air 47, Air 49, Air 58, Air 62, Air 63, Air 64, Air 65, Shen S 2, 3, 4, 5	**Plate 2** **Open woodland dominated by *Corymbia dichromophloia*, ± *Erythrophleum chlorostachys***
2b	*Acacia shirleyi, Corymbia dichromophloia* ± *Eucalyptus leucophloia, Corymbia polycarpa* mid high open woodland, over *Macropteranthes kekwickii, Petalostigma pubescens, Hakea arborescens* mid high open shrubland, over *Chrysopogon fallax, Mnesithea formosa, Eriachne ciliata* mid high tussock grassland	(14) Shen S C, Air 3, Air 15, Air 18, Air 26, Air 30, Air 32, Air 33, Air 45, Air 48, Air 51, Air 56, Air 67, Air 171, Shen S 4	**Plate 3** ***Acacia shirleyi mid high open woodland***

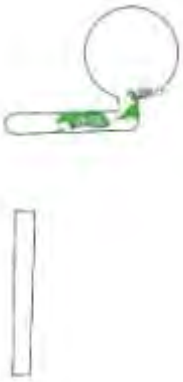
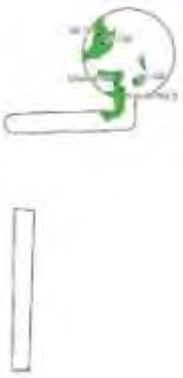
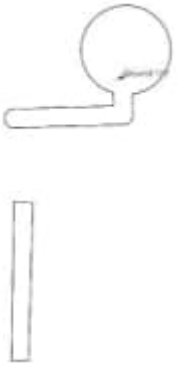
Vegetation Community	Description	Survey Sites	Photo Reference
3a 	*Corymbia polycarpa, Eucalyptus chlorophylla, Acacia shirleyi* mid high open woodland, over *Acacia difficilis, Macropteranthes kekwickii, Erythrophleum chlorostachys* mid high open shrubland, over *Aristida* sp1, *Aristida sp*3 mid high open tussock grassland	(4) Shen S B, Ground 27, Air 52, Air 53	 **Plate 4** ***Corymbia polycarpa, Eucalyptus chlorophylla, Acacia shirleyi* mid high open woodland**
4a 	*Acacia shirleyi* ± *Eucalyptus pruinosa, Eucalyptus chlorophylla* mid high woodland, over *Melaleuca viridiflora, Eucalyptus pruinosa, Eucalyptus chlorophylla* mid high open shrubland, *over Eriachne armitii, Eragrostis cumingii, Aristida contorta* mid high open tussock grassland	(3) Air 13, Air 14, Air 55	 **Plate 5** ***Acacia shirleyi mid high woodland***
4b 	*Corymbia polycarpa, Eucalyptus microtheca* low open woodland, over *Melaleuca nervosa, Hakea arborescens, Melaleuca viridiflora* mid high open shrubland, over *Aristida contorta, Waltheria indica, Eriachne armitii* mid high tussock grassland	(3) Ground 29, Ground 54, Ground 59	 **Plate 6** ***Corymbia polycarpa and Eucalyptus microtheca low open woodland***

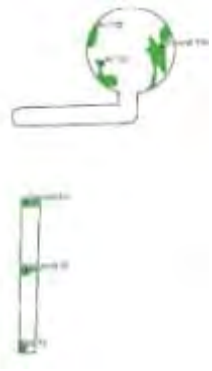
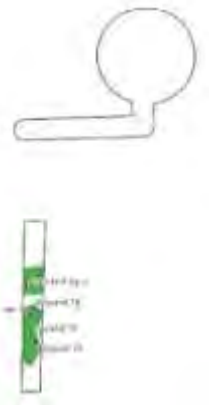
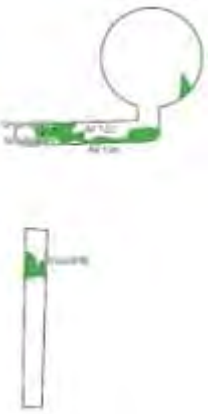
Vegetation Community	Description	Survey Sites	Photo Reference
4c	*Melaleuca viridiflora* low open woodland +/- *Acacia torulosa* over *Triodia bitextura* hummock grassland	(2) Shen S 4 and Shen S 5	**Plate 7** ***Melaleuca viridiflora low open woodland +/- Acacia torulosa***
4d 	*Eucalyptus camaldulensis* low woodland over *Melaleuca viridiflora* sparse shrubland over open tussock grassland	(1) Ground 75 (north)	**Plate 8** ***Eucalyptus camaldulensis low woodland***

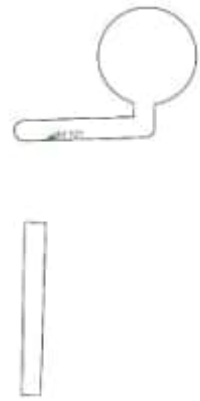
The Shenandoah North well pad areas identified nine vegetation communities across the vegetation assessment sites. The vegetation communities are described in Table 21.

Table 21 Vegetation community description – Shenandoah North lease areas

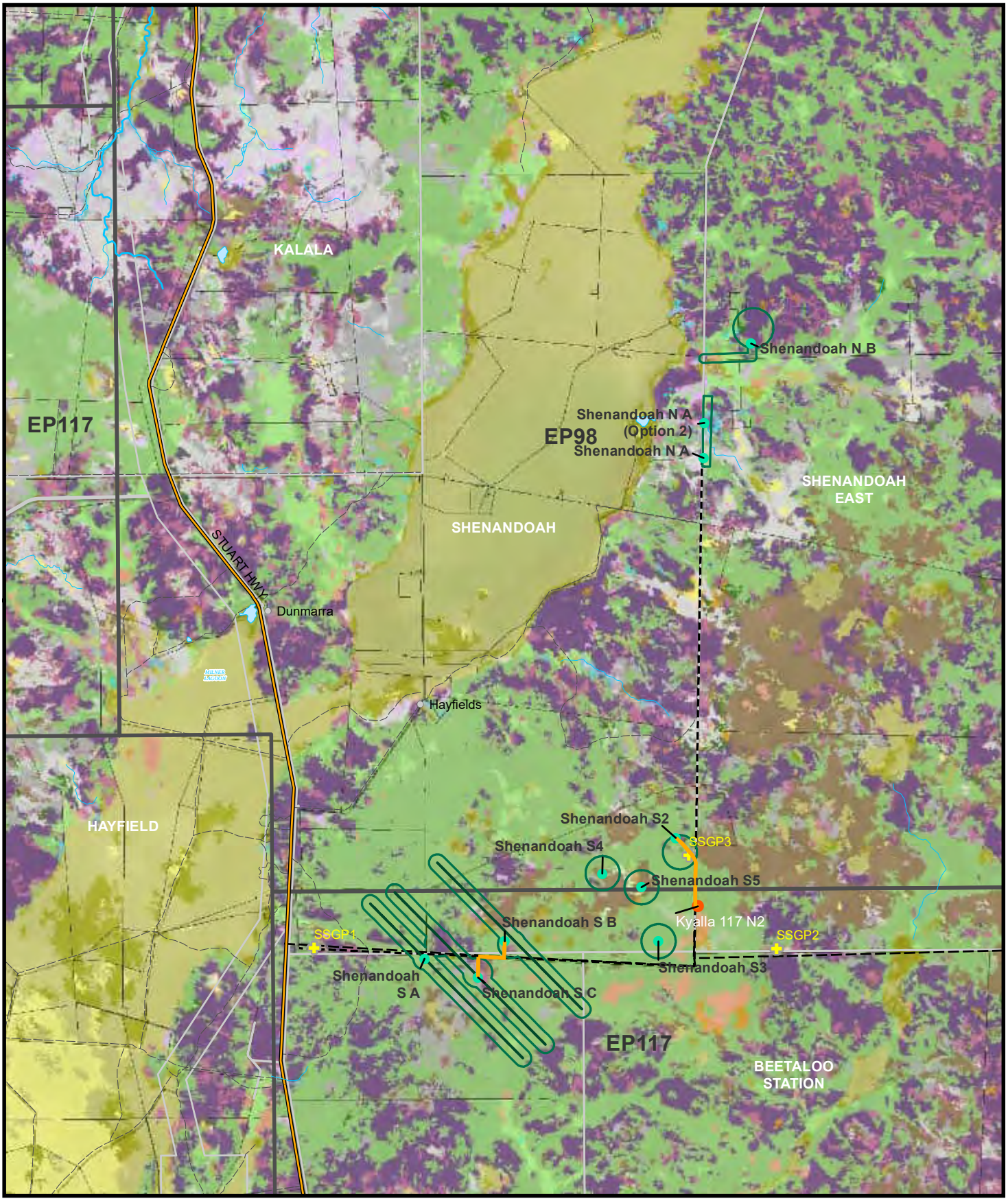
Vegetation Community	Description	Survey Sites	Photo Reference
1a	*Acacia shirleyi* mid high woodland over *Macropteranthes kekwickii* ± *Atalaya hemiglauca, Acacia holosericea* mid high open shrubland over *Fimbristylis sp*, *Brachyachne convergens*, *Aristida sp3* mid high open tussock grassland	**No of sites:** (4) Shen N A, Air 81, Air 126, Air 134	**Plate 9** ***Acacia shirleyi mid high woodland***

Vegetation Community	Description	Survey Sites	Photo Reference
2a 	*Corymbia dichromophloia* ± *Erythrophleum chlorostachys* mid high open woodland, over *Acacia difficilis* ± *Terminalia canescens, Erythrophleum chlorostachys* mid high open shrubland, over *Triodia bitextura, Aristida hygrometrica, Chrysopogon fallax* mid high hummock grassland	**No of sites:** (44) Shen S A, Ground 8, Ground 16, Ground 17, ground 24, Ground 40, Ground 41, Ground 43, Ground 60, Ground 61, Ground 66, Ground 68, Air 1, Air 2, Air 4, Air 5, Air 6, Air 7, Air 11, Air 12, Air 19, Air 20, Air 21, Air 22, Air 23, Air 25, Air 28, Air 34, Air 35, Air 36, Air 37, Air 38, Air 39, Air 42, Air 46, Air 47, Air 49, Air 58, Air 62, Air 63, Air 64, Air 65, Air 122, Air 129	 **Plate 10** **Open woodland dominated by *Corymbia dichromophloia*, ± *Erythrophleum chlorostachys***
2b 	*Acacia shirleyi, Corymbia dichromophloia* ± *Eucalyptus leucophloia,* mid high open woodland over *Macropteranthes kekwickii, Petalostigma pubescens, Hakea arborescens* mid high open shrubland over *Chrysopogon fallax, Mnesithea formosa, Eriachne ciliata* mid high tussock grassland	(19) Shen S C 5ell, Air 3, Air 15, Air 18, Air 26, Air 30, Air 32, Air 33, Air 45, Air 48, Air 51, Air 56, Air 67, Air 171, Shen N Pad B, Ground 135, Air 128, Air 130, Air 131	 **Plate 11** ***Acacia shirleyi mid high open woodland***
2c 	*Eucalyptus leucophloia, Corymbia dichromophloia, Acacia shirleyi* mid high woodland over *Dodonaea hispidula, Calytrix exstipulata* mid high open shrubland over *Triodia bitextura, Eriachne ciliata, Aristida contorta* mid high open hummock grassland	(1) Ground 127	 **Plate 12** ***Eucalyptus/Corymbia mid high open woodland***

Vegetation Community	Description	Survey Sites	Photo Reference
3a 	*Eucalyptus chlorophylla, Corymbia polycarpa* ± *Corymbia confertiflora* mid high open woodland over *Erythrophleum chlorostachys, Acacia holosericea, Acacia difficilis* mid high open shrubland over *Chrysopogon fallax, Dichanthium fecundum, Sehima nervosum* mid high tussock grassland	(6) Ground 79, Ground 82, Ground 136, Air 73, Air 133, Air 132	 **Plate 13** ***Corymbia polycarpa, Eucalyptus chlorophylla, Acacia shirleyi* mid high open woodland**
4a 	*Acacia shirleyi* ± *Eucalyptus pruinosa, Eucalyptus chlorophylla* mid high woodland over *Melaleuca viridiflora, Eucalyptus pruinosa, Eucalyptus chlorophylla* mid high open shrubland over *Eriachne armitii, Eragrostis cumingii, Aristida contorta* mid high open tussock grassland	(5) Ground 74, Ground 76, Ground 78, Shen N A Op 2, Air 77	 **Plate 14** ***Acacia shirleyi mid high woodland***
4b 	*Eucalyptus microtheca, Corymbia polycarpa, Eucalyptus camaldulensis* mid high open woodland over *Acacia holosericea, Acacia lysiphloia, Macropteranthes kekwickii* mid high open shrubland over *Eulalia aurea, Panicum mindanaense, Eragrostis cumingii* mid high tussock grassland	(5) Ground 80, Ground 118, Ground 119, Air 123, Air 124	 **Plate 15** ***Corymbia polycarpa and Eucalyptus microtheca low open woodland***

Vegetation Community	Description	Survey Sites	Photo Reference
4d	*Eucalyptus camaldulensis* low woodland over *Melaleuca viridiflora* sparse shrubland over open tussock grassland	(1) Ground 75	**Plate 16** ***Eucalyptus camaldulensis low woodland***
4e 	*Eucalyptus camaldulensis* mid high open woodland over *Eucalyptus microtheca* mid high open shrubland	(1) Air 121	**Plate 17** ***Eucalyptus camaldulensis mid-high open woodland***

Detailed vegetation community descriptions are presented in (Appendix B) and shown in Figure 24.



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Kilometres

- Proposed Exploration Well Pads
- Existing Exploration Well Pads
- Gravel Pits
- Proposed Seismic Lines
- Shenandoah Lease Pad Area
- Shenandoah South Well Pad Access Track
- Populated Place
- Access Tracks
- Tracks
- Highway
- Gathering Line
- Water Bodies
- Permit Areas
- Pastoral Lease Boundary

SREBA Broad vegetation group

- Corymbia/Eucalyptus open woodland on sandy loam
- Corymbia/Eucalyptus woodland (run-on areas and heavier soils)
- Corymbia bella woodland on alluvial plains
- Eucalyptus miniata open woodland on loamy sand
- Riparian woodland (ephemeral streams)
- Melaleuca forests (springs, river channels)
- Snappy gum low open woodland
- Lancewood forest
- Bullwaddy shrubland and woodland
- Bauhinia and Corymbia open woodland on sandy clay
- Eucalyptus chlorophylla low open woodland
- Silver box low open woodland
- Coolabah low open woodland on clay
- Coolabah, Lophostemon and Gutta Percha swamps
- Melaleuca low open woodland on floodplains and drainage depressions
- Tussock grassland
- Ephemeral wetland
- Corymbia/Eucalyptus woodland on sandstone
- Acacia shrubland and hummock grassland on sandplains
- Track
- Intensive Uses; Production from Dryland Agriculture and Plantations; Production from Irrigated Agriculture and Plantations

Data sources:
SREBA 2023, Permit Area, Cadastre - NT Gov 2019. Places, Highways, Roads, Drainage - StreetPro 2019.

tamboran

Shenandoah South Project Area Vegetation Groups

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VERSION	1

Figure
22

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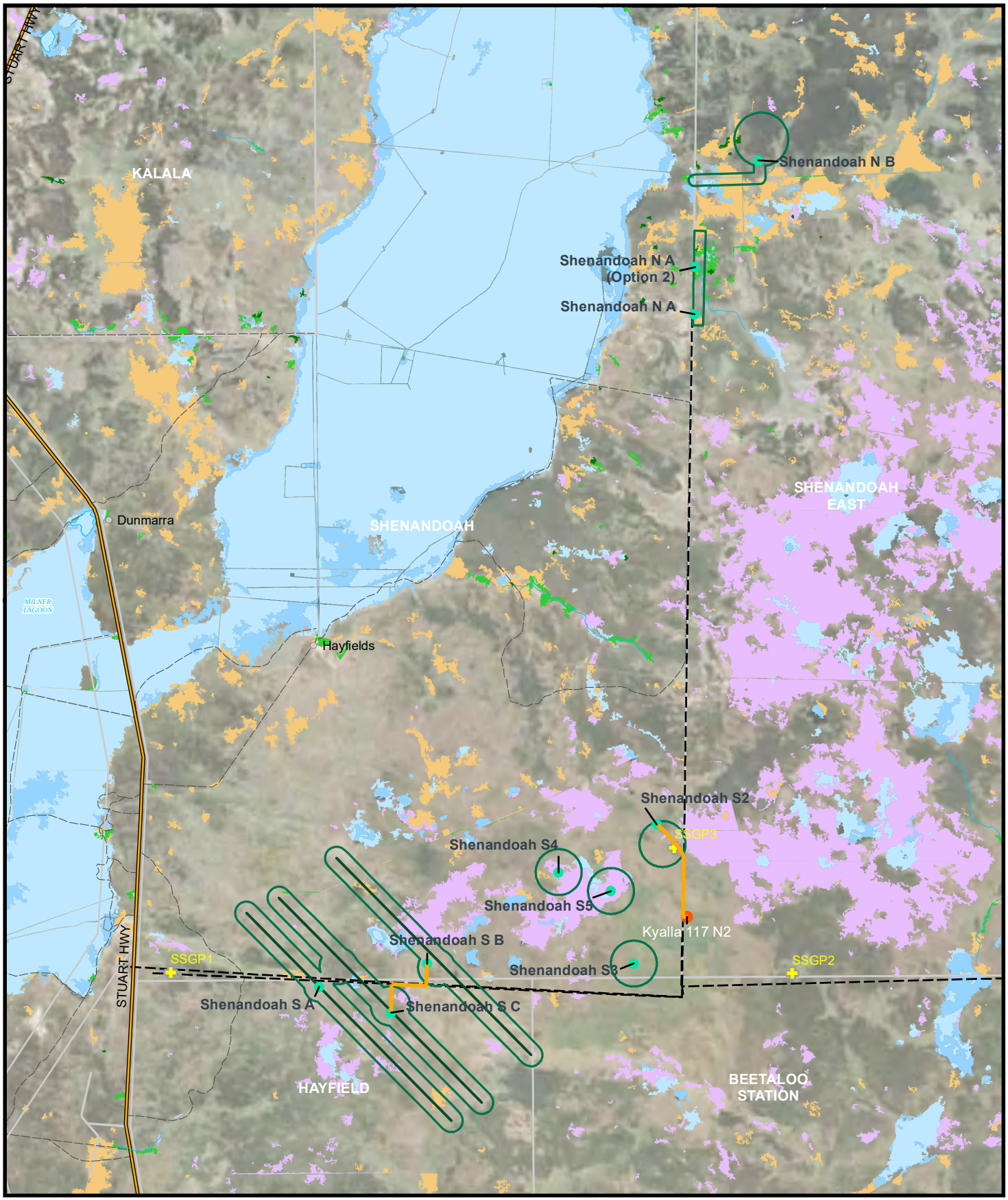

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SREBA Significant vegetation

- Riparian
- Riparian/wetland
- Wetland
- Wetland/floodplain
- Floodplain
- Floodplain/drainage depression
- Run-on

Data sources:
Permit Area, Cadastre - NT Gov 2019.
Places, Vegetation - Aust Gov 2019
Highways, Roads, Drainage - StreetPro 2019

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Significant Vegetation

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Figure 23

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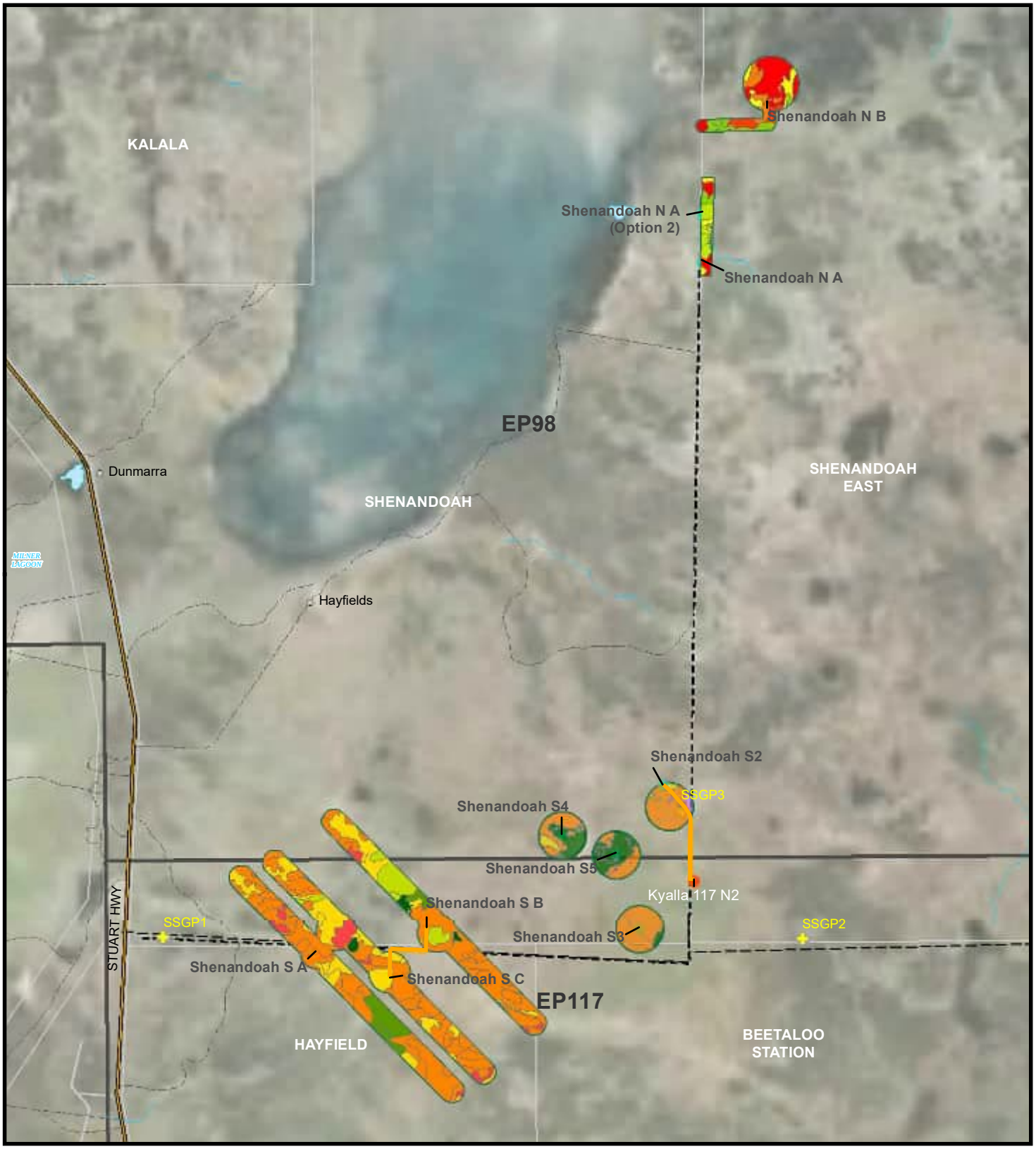

2a - Corymbia dichromophloia ± Erythrophleum chlorostachys open woodland, over Acacia difficilis ± Terminalia canescens, Erythrophleum chlorostachys open shrubland, over hummock grassland

2b - Acacia shirleyi, Corymbia dichromophloia ± Eucalyptus leucophloia, Corymbia polycarpa open woodland, over Macropteranthes kekwickii, Petalostigma pubescens, Hakea arborescens open shrubland, over tussock grassland

3a - Corymbia polycarpa, Eucalyptus chlorophylla, Acacia shirleyi open woodland, over Acacia difficilis, Macropteranthes kekwickii, Erythrophleum chlorostachys open shrubland, over open tussock grassland

4a - Acacia shirleyi ± Eucalyptus pruinosa, Eucalyptus chlorophylla woodland, over Melaleuca viridiflora, Eucalyptus pruinosa, Eucalyptus chlorophylla open shrubland, over open tussock grassland

4b - Corymbia polycarpa, Eucalyptus microtheca low open woodland, over Melaleuca nervosa, Hakea arborescens, Melaleuca viridiflora open shrubland, over tussock grassland

4c - Melaleuca viridiflora low open woodland ± Acacia torulosa over Triodia bitextura hummock grassland

4d - Eucalyptus camaldulensis low woodland over Melaleuca viridiflora sparse shrubland over open tussock grassland

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Kilometres

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Data sources: SREBA 2023, Permit Area, Cadastre - NT Gov 2019. Places, Highways, Roads, Drainage - StreetPro 2019.

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Shenandoah South Project Area Vegetation Groups

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Filename: \\na.aecomnet.com\lfs\APAC\Melbourne-AUMEL1\Legacy\Groups\WTR\SpatialSys\Projects\2023\Beetaloo\02_MXD\LCA_Tamboran_Oct_2023\F9_Vegetation_Community_Site.mxd

4.3 Flora

A search of the DCCEEW Protected Matters database of nationally significant fauna (PMST) and the NT Government flora atlas database was undertaken for the exploration area, with a 10 km buffer applied. No threatened vegetation communities are listed as likely to occur within the Shenandoah South E&A Program.

The SREBA Terrestrial Ecosystem Report (Young *et al*, 2022) indicated that the flora surveys completed over 2021-2022 contributed 15,419 new plant records within the Beetaloo sub-basin.

Field survey undertaken during April 2023 recorded 1,372 individual flora species. The survey focused on recording dominant species to describe vegetation communities rather than undertake a comprehensive floristic assessment.

4.3.1 Threatened Flora

Initial desktop analysis of flora in the region indicated that no threatened species are likely to occur in the project area. In 2022 *Carex fascicularis* (Tassel Sedge) was recorded in a seasonal wetland adjacent to the Stuart Highway, approximately 20 km south of the project area. This species listed as Vulnerable under the TPWC Act.

Carex fascicularis is an erect densely tufted perennial sedge to 1 m with trigonous culms and short rhizome. The species is common in south-eastern Australia and was previously known from a single population in the West MacDonnell Ranges. The scarcity of *Carex fascicularis* in the NT is likely due to the absence of suitable habitat, which comprises swampy areas in mesic and sub-coastal regions throughout its range (DEPWS, 2021a).

The species may occur within swamps and springs in the project area. Avoidance of these habitats will ensure the species is not impacted by the Shenandoah South E&A Program.

4.4 Weeds

Previous surveys within the Tamboran Permit Areas have recorded a low number and density of weed species, indicating that land condition is generally good. Three declared weed species, *Calotropis procera* (Rubber bush), *Parkinsonia aculeata* (Parkinsonia) and *Mesosphaerum suaveolens* (Hyptis), have been recorded during previous surveys. No weeds were detected within the Shenandoah South E&A Program during December 2022 and April 2023 (Figure 25).

Table 22 provides a list of weed species that are known to occur or likely to occur Shenandoah South E&A Program area based on a desktop review of the following sources:

- Tennant Creek Regional Weeds Strategy (DEPWS, 2021b),
- Katherine Regional Weeds Strategy (DEPWS, 2021c).
- Mapping data provided by the Weed Management Branch, DEPWS.
- Guidelines for the Management of the Weeds of Beetaloo 2018 (DLRM & CDU, 2018).
- Department of Climate Change, Energy, the Environment and Water (DCCEEW) EPBC Act Protected Matters Report database.
- Previous data collected by AECOM in the permit area.

There are four classes of weeds under the NT *Weed Management Act 2001*, which was amended in May 2022. The classes are described as:

a. it is necessary to eradicate the plant

b. it is necessary to prevent the growing and spreading of the plant

c. it is necessary to prevent the introduction of the plant into the Territory or a part of the Territory

d. it is necessary to prevent the plant being spread by the actions of persons.

Based on the available data the current status for the weeds likely to occur within the Shenandoah South E&A Program area, there is no Class D status.

Table 22 NT Listed Weeds known or likely to occur within Shenandoah South E&A Program

Scientific Name	Common Name	Status
Alternanthera pungens	Khaki Weed	Class B and C
Andropogon gayanus	Gamba Grass	Class A and C, WoNS
Azadirachta indica	Neem	Class B and C
Calotropis procera	Rubber Bush	Class B and C (south of 16°30' S latitude)
Cenchrus ciliaris	Buffel Grass	Not declared in NT
Cenchrus echinatus	Mossman River Grass	Class B and C
Datura ferox	Fierce Thornapple	Class A and C
Mesosphaerum suaveolens	Hyptis	Class B and C
Jatropha gossypiifolia	Bellyache Bush	Class B and C, WoNS
Parkinsonia aculeata	Parkinsonia	Class B and C, WoNS
Sida acuta	Spinyhead Sida	Class B and C
Sida cordifolia	Flannel Weed	Class B and C
Sida rhombifolia	Paddy's Lucerne	Class B and C
Tamarix aphylla	Athel Pine	Class B and C, WoNS
Themeda quadrivalvis	Grader Grass	Class B and C, WoNS
Tribulus terrestris	Caltrop	Class B and C
Vachellia nilotica	Prickly Acacia	Class A and C, WoNS

In addition to the species listed in Table 23, a range of grassy weeds are known to occur along road corridors throughout the region. This includes Buffel Grass which was originally introduced for livestock feed and soil stabilisation but has subsequently shown to alter fire regimes and impact biodiversity.

The *Katherine Regional Weeds Strategy 2021-2026* (DEPWS, 2021c) provides strategic approach to reduce the adverse impact of weeds in the Katherine Region. The plan includes a list of weed species that require priority management attention. The nine priority weed species are listed in Table 24. If located, the program EMP requires the Weed Management Branch to be contacted for identification and disposal.

Table 23 Priority weed species identified for the Katherine Region (DEPWS, 2021c)

Scientific Name	Common Name	Declaration
Vachellia nilotica	Prickly Acacia	Class A
Prosopis spp.	Mesquite	Class A
Parthenium hysterophorus	Parthenium	Class A, WoNS
Mimosa pigra	Mimosa	Class A
Cryptostegia grandiflora	Rubber vine	Class A, WoNS
Salvinia molesta	Salvinia	Class B
Cylindropuntia spp.	Rope cactus	Class A

Scientific Name	Common Name	Declaration
Hyparrhenia rufa	Thatch grass	Class A
Sporobolus spp.	Giant rats tail grass	Not Declared

The *Tennant Creek Regional Weeds Strategy* and *Katherine Regional Weeds Strategy* also identifies three alert weed species that potentially occur within the Tamboran permit areas (Table 25). Alert weeds have been identified as the principal threatening weeds to specific regions of the NT.

Table 24 Alert weed species in the Katherine and Tennant Creek regions (DEPWS, 2021b; DEPWS, 2021c).

Scientific name	Common name	Declaration
Themeda quadrivalvis	Grader Grass Class B	Class B
Parthenium hysterophorus	Parthenium	Class A and C, WoNS
Chromolaena odorata	Siam weed	Class C

Weed surveys undertaken during May 2022 field survey focused on the edge of tracks, disturbance areas and along the Stuart and Carpentaria Highways. The following weeds were recorded during the field survey which pose a hygiene and biosecurity risk to the exploration program:

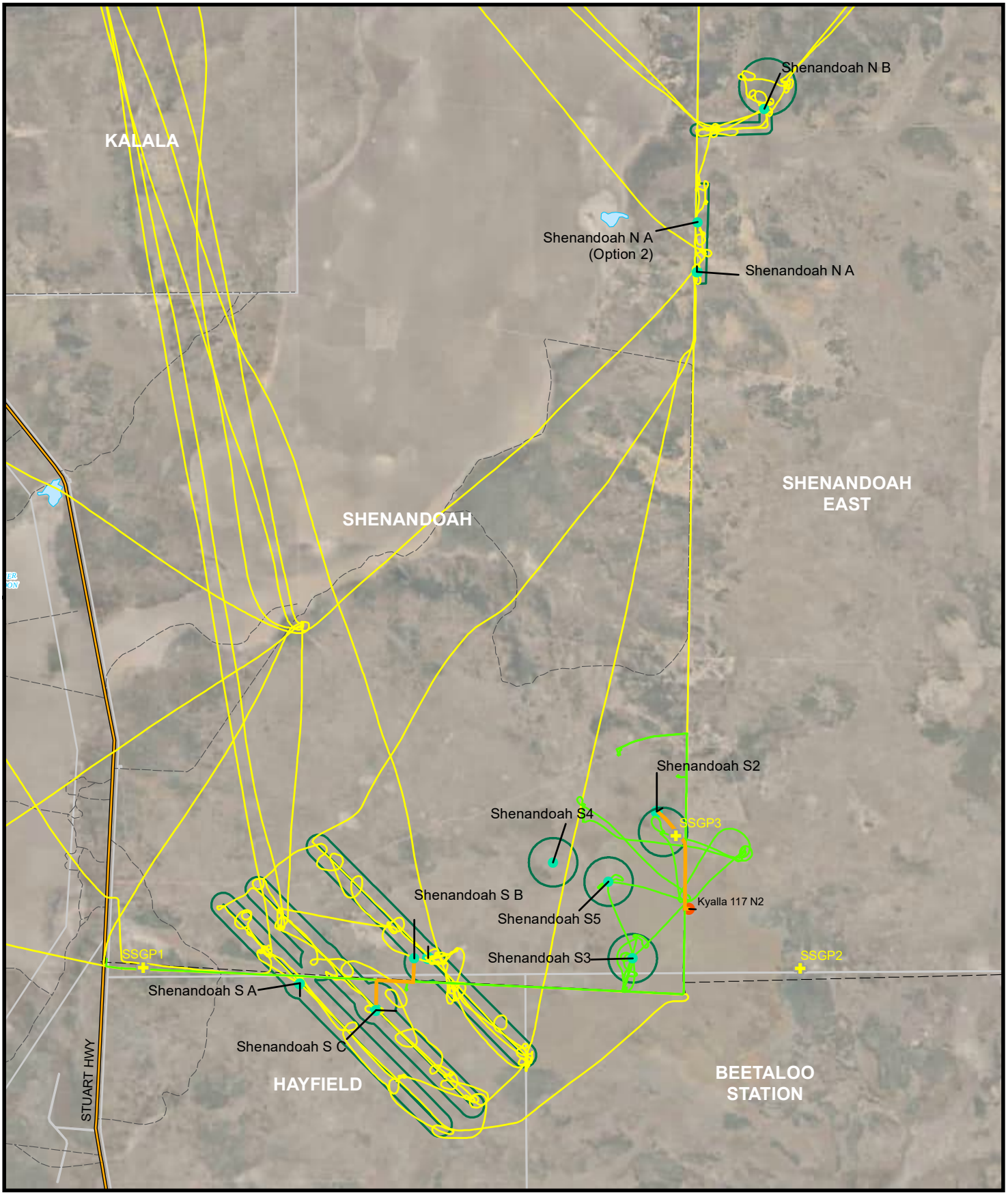
- Hyptis (*Mesosphaerum suaveolens*) – Class B
- Sida (*Sida acuta*) - Class B
- Annual Mission grass (*Cenchrus pedicellatus*) - Environmental weed of concern

The class B weed Hyptis was observed along the Carpentaria Highway and along fence line tracks. Sida was observed predominantly in areas heavily disturbed by cattle, such as where drinking troughs were located.

In the last 12 months, observations along the Stuart Highway between Katherine and Mataranka, have identified an erect woody shrub that has appeared. It is believed this species has potential to become weedy and should be treated by Tamboran as a weed to avoid spreading within the Permit area.

- Kapok bush (*Aerva javanica*) – Not declared (Plate 18).

Plate 18 Kapok bush (*Aerva javanica*) spread on a site near Katherine, NT



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Kilometres

- Gravel Pits
- Lease Pad Areas
- Proposed Exploration Well Pads
- Proposed Seismic Lines
- Shenandoah Lease Pad Area
- Tracks
- Highway
- Water Bodies
- Pastoral Lease Boundary
- March 2023 weed survey track
- December 2022 weed survey track
- Gathering Line

LOCATION

Data sources:
Permit Area, Cadastre - NT Gov 2019.
Places, Vegetation - Aust Gov 2019
Highways, Roads, Drainage - StreetPro 2019

tamboran

Weed Survey

PROJECT ID	60623736
CREATED BY	sam.schroder
LAST MODIFIED	20-Ma-2024
VERSION	1

Figure 25

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

Filename: \\na.aecomnet.com\lfs\APAC\Melbourne-AUMEL1\Legacy\Groups\WTR\SpatialSys\Projects\2023\Beetaloo\02_MXD\LCA_Tamboran_Oct_2023\F10_Weeds.mxd

4.5 Fauna and Habitat

A search of the Department of Environment, Parks and Water Security (DEPWS) Natural Resource Maps database reveals that a total of 88 fauna species have been recorded within 5 km of the Shenandoah South E&A Program comprising 76 species of bird, eight reptiles and four mammals.

The recent Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin (SREBA) surveys identified 354 vertebrate species have been recorded within the region consisting of 202 bird species, 99 reptile species and 39 mammal species and 14 amphibians (Young, 2022).

A full list of recorded species is provided – Appendix C (Flora Atlas records) and Appendix D (Fauna Atlas records).

The Shenandoah South E&A Program primarily comprises open woodland consisting of mixed Eucalyptus/Corymbia species with a mixed tussock grass understorey. Often, scattered stands of Bullwaddy/Lancewood communities occur across the proposed sites and individuals of both species are dispersed throughout. In the wider landscape, including proposed access tracks, additional vegetation types include those associated with drainage lines, grasslands/floodplains and *Acacia sp.* shrublands.

*Eucalypt*us/*Corymbia* sp. woodland provides habitat for a range of species. The proposed sites had 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. 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 Northern Shrike-tit (*Falcunculus whitei*) are rare and known to utilise this habitat (Ward, 2008). Many of the sites have a high density of hollow-bearing trees that provide important habitat for many fauna species. Avoiding clearing large hollow-bearing trees will reduce the impact to native wildlife within the permit area.

The Lancewood/Bullwaddy vegetation community provides shady habitat for fauna within a hot arid landscape, including species species as the Spectacled Hare-Wallaby (*Lagorchestes conspicillatus leichardtii*) and the Northern Nailtail Wallaby (*Onychogalea unguifera*) (PWCNT, 2005).

No fauna sightings to enable identification were recorded within the Shenandoah South E&A Program during the April 2023 field survey. Incidental fauna sightings during the December 2022 field survey identified a total of nine birds and one reptile (Plate 19). Table 26 provides summary of the incidental fauna observations.

Table 25 Incidental fauna observations

Scientific Name	Common name	Survey Site/s Identification
Birds		
Artamus personatus	Masked Woodswallow	Kyalla 117 N1
Cracticus nigrogularis	Pied Butcherbird	Kyalla 98 S1, Kyalla 98 S2, Shenandoah Pad 5, Shenandoah South 3
Dacelo leachii	Blue-winged Kookaburra	Kyalla 117 N1
Merops ornatus	Rainbow Bee-eater	Kyalla 98 S1
Oreoica gutturalis	Crested Bellbird	Kyalla 117 N1
Pachycephala rufiventris	Rufous Whistler	Kyalla 98 S1, Kyalla 98 S2, Kyalla 117 N1, Shenandoah South 2
Pardalotus striatus	Striated Pardalote	Shenandoah South 3
Pomatostomus temporalis	Grey-crowned Babbler	Kyalla 98 S1
Todiramphus sanctus	Sacred Kingfisher	Shenandoah South 3
Reptiles		
Diporiphora magna	Yellow-sided Two-lined Dragon	Kyalla 117 N1

Plate 19 ***Diporiphora magna*** **at Kyalla 117 N1**

4.5.1 Threatened Fauna

A search of the DCCEEW Protected Matters database of nationally significant fauna (PMST) and records from the NT Government Fauna Atlas database (NR Maps) was undertaken at 10 km and 50 km of the proposed Shenandoah South E&A Program. The search results indicate the potential presence of 18 fauna species listed as threatened under the EPBC Act and/or the TPWC Act at the 50 km. These included ten birds, five mammals, two reptiles and one shark.

The likelihood of occurrence assessment 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 project area. As some areas in the proposed well pad areas 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 Table 27 below.

Table 26 EPBC and TPWC Listed Threatened Species and Likelihood of Occurrence within the Tamboran Shenandoah South E&A Program

Species	Status		Distribution	Habitat	Likelihood
	EPBC	TPWC			
Birds					
Curlew Sandpiper *Calidris ferruginea*	Marine Migratory CE	VU	In the NT this species occurs around Darwin, north to Melville Island and Cobourg Peninsula, and east and south-east to Gove. It has been recorded inland from Victoria River Downs and around Alice Springs (Higgins & Davies, 1996).	Coastal habitats, inland it has been found around lakes, dams and ephemeral/permanent waterholes.	Unlikely No suitable habitat within project area
Red Goshawk *Erythrotriorchis radiatus*	EN	VU	Found across most of Northern Australia, in the NT most records are from the Top End but there are records from central Australia (Pizzey & Knight, 2012).	Red Goshawks occupy a range of habitats, often at ecotones, including coastal and sub-coastal tall open forest, tropical savannahs crossed by wooded or forested watercourses. In the NT, it inhabits tall open forest/woodland as well as tall riparian woodland (Aumann & Baker-Gabb, 1991).	Unlikely No records and no suitable breeding habitat within the project area
Gouldian Finch *Erythrura gouldiae*	EN	VU	Formerly widespread across northern Australia. In the NT they are found in the Top End south past Daly Waters (Palmer *et al*., 2012).	Gouldian Finches occupy different habitat types in the breeding and non-breeding season. Breeding habitat consists of hillsides with suitable nesting trees. Outside of the breeding season they are found in lowland drainages to feed on suitable perennial grasses (Dostine & Franklin, 2002).	Possible The closest record occurs 75 km east of the project area. Suitable foraging habitat is present
Grey Falcon *Falco hypoleucos*	VU	VU	This species has a widespread distribution and records occur throughout the NT. However, most records are from arid and semi-arid regions (Pizzey & Knight, 2012).	Grey Falcon is typically found on inland drainage systems in lightly treed lowland plains, pastoral lands, timbered watercourses and, occasionally, the driest deserts (DEPWS, 2021d).	Possible The species may forage within the project area but is unlikely to breed

Species	Status		Distribution	Habitat	Likelihood
	EPBC	TPWC			
Northern Shrike-tit *Falcunculus whitei*	VU	NT	This species has been recorded from widely scattered localities from near Timber Creek to the east Gulf Country, north to Kakadu National Park and in north-eastern Arnhem Land (DEPWS, 2021e).	Occupies wet and semi-arid melaleuca and eucalypt open woodlands. May be associated with bloodwoods with flaky bark and ironwood (Ward, 2008).	Possible No records in the vicinity of the project area. Sub-optimal habitat is present. Call-playback surveys failed to detect the species
Painted Honeyeater *Grantiella picta*	VU	VU	This species is migratory based on seasonal variation in occurrence. They breed on the inland slopes of the Great Dividing Range. After the breeding season they sometimes occur in the north-eastern NT, south of the Roper River (Garnett & Baker, 2021).	Painted Honeyeater inhabits woodlands dominated by Acacia and/or Eucalyptus species and open forests but prefers habitats with abundant mature trees that host mistletoes. The species specialises on the fruit of mistletoes although it may also forage on nectar and insects (Garnett *et al.*, 2011).	Possible No recent records occur close to the project area; however suitable habitat is present
Night Parrot *Pezoporus occidentalis*	EN	EN	Night Parrot was once widespread across arid and semi-arid regions. Recent confirmed records of the species come from widely separated locations in western Queensland and Western Australia (DEPWS, 2021f).	This species occupies spinifex grasslands in stony or sandy areas, in ephemeral herblands, samphire and chenopod shrublands on floodplains (DEPWS, 2021f).	Unlikely Suitable habitat does not occur within the project area. No recent records occur within the area
Princess Parrot, Alexandra's Parrot *Polytelis alexandrae*	VU	VU	This species irregularly occurs across the arid zone from near Oodnadatta in South Australia, west to near Coolgardie and the east Murchison River in Western Australia, and north to near the Fitzroy River in Western Australia and to Howell Ponds in the Northern Territory (Higgins 1999; Baxter & Henderson 2000)	Princess Parrot is usually recorded from shrubland in swales between sand dunes, with occupied sites typically having a variety of shrubs (including Grevillea, Hakea, Cassia and Eremophila species) among scattered emergent trees, with a ground-cover of spinifex Triodia species.	Unlikely No recent records occur close to the project area. Suitable habitat limited.

Species	Status		Distribution	Habitat	Likelihood
	EPBC	TPWC			
				The species occurs less often in woodland. The princess parrot forages on the ground and in flowering shrubs and trees (Higgins 1999; Pavey *et al*. 2014)	
Australian Painted Snipe *Rostratula australis*	EN	VU	Records of the species occur across the NT. More recent records come from McMinns Lagoon near Darwin, Yellow Waters in Kakadu, the Sturt Plateau, the Barkly and the Tanami (DEPWS, 2021g).	Australian Painted Snipe prefers a habitat of recently flooded temporary vegetated wetlands during the non-breeding period and brackish temporary freshwater wetlands with minimum vegetation during breeding periods. Birds usually forage in thick, low vegetated areas during the day (Curtis *et al*, 2012).	Unlikely Suitable habitat does not occur within the project area
Masked Owl (northern) *Tyto novaehollandiae kimberli*	VU	VU	The subspecies occurs in northern Australia, although its distribution is not well known. In the NT, occurs from Cobourg south to Katherine and the VRD and east to the McArthur River (DoE, 2014).	This species inhabits tall open eucalypt forest in the NT, especially those associated with *Eucalyptus miniata* and *E. tetrodonta (*Woinarski, 2007*)*. Also found in riparian and monsoonal forest and rainforest (DoE, 2014).	Unlikely No recent records occur close to the project area and suitable habitat is not present
Mammals					
Northern Quoll *Dasyurus hallucatus*	CE	EN	The species once occurred throughout most of Northern Australia although it is has declined across much of its range (Woinarski & Hill, 2012). In the NT it is found in the Top End as far southeast as Borroloola.	Northern Quolls do not have highly specific habitat requirements although the most suitable appear to be rocky habitats. They occur in a variety of habitats across their range, including open forest and woodland. Daytime den sites provide important shelter. Shelter sites include rocky outcrops, tree hollows, hollow logs, termite mounds, goanna burrows and human dwellings (Woinarski & Hill, 2012).	Unlikely No recent records, occur in the vicinity of the project area and habitat is sub-optimal

Species	Status		Distribution	Habitat	Likelihood
	EPBC	TPWC			
Ghost Bat *Macroderma gigas*	VU	NT	The species' range in northern Australia is from relatively arid conditions in the Pilbara region of Western Australia to humid rainforests of northern Queensland. A large colony occurs in a series of gold mine workings at Pine Creek, NT. This species has also been recorded throughout the mainland Top End north of approximately 17° latitude (DEPWS, 2021h).	The distribution of Ghost Bats is influenced by the availability of suitable caves and mines for roost sites. The species often roosts in a deep crack or cave during the day (DEPWS, 2021h).	Unlikely Suitable habitat does not occur within the project area
Greater Bilby *Macrotis lagotis*	VU	VU	This species occurs in south-western Queensland and in arid north-western Australia (Western Australia and Northern Territory). This species was previously widespread in arid and semi-arid Australia (Pavey, 2006). The most northern records are from Newcastle Waters and Wave Hill (Southgate & Paltridge, 1998).	In the NT, this species is found on sandy soils dominated by spinifex. It also occurs in hummock grassland associated with low lying drainage systems and alluvial areas (Pavey, 2006). Recent surveys in the Beetaloo region have recorded Greater Bilby in Eucalyptus and Corymbia woodlands mixed tussock and hummock grasses in sandy/loam soils (Davis *et al*., 2021).	Unlikely No recent records, occur in the vicinity of the project area and suitable habitat is not present
Bare-rumped Sheath-tailed Bat *Saccolaimus saccolaimus nudicluniatus*	VU	DD	Wide distribution from India through south-eastern Asia to the Solomon Islands, including north-eastern Queensland and the NT. Records of the species in the NT are sparsely scattered across the Top End (DEPWS, 2021i).	Previous specimens have been collected from Open *Pandanus* woodland fringing the sedgelands of the South Alligator River in Kakadu National Park, and from eucalypt woodlands and forests from coastal and adjacent inland areas (DEPWS, 2021i).	Unlikely No recent records, occur in the vicinity of the project area and habitat is not suitable

Species	Status		Distribution	Habitat	Likelihood
	EPBC	TPWC			
Common Brushtail Possum *Trichosurus vulpecula arnhemensis*	VU	NT	The Common Brushtail Possum (northern subspecies) occurs discontinuously from the Gulf of Carpentaria hinterland near Borroloola, NT westward to the Kimberley, WA (TSSC, 2020b).	The species occurs mainly in tall eucalypt open forests with large hollow-bearing trees, particularly where the understorey includes some shrubs that bear fleshy fruits (TSSC, 2020b).	Possible Recent records of the species occur at nearby Kalala Station and suitable habitat occurs within the project area
Pale Field-rat *Rattus tunneyi*	-	VU	Pale Field-rat inhabits higher rainfall areas of northern and eastern Australia, including the Top End of the NT (Menkhorst & Knight, 2011).	This species favours dense vegetation found along rivers where it occupies burrows in loose colonies (Cole & Woinarski, 2002). Pale Field-rat occurs within a variety of habitats including woodlands if a dense understorey of grasses is present (Menkhorst & Knight, 2011)	Possible One record from 1999 occurs approximately 55 km from the project area. Suitable habitat occurs within the project area
Reptiles					
Plains Death Adder *Acanthophis hawkei*	VU	VU	Fragmented populations of the plains death adder are known to occur in the Mitchell Grass Downs of western Queensland, the Barkly Tableland on the Northern Territory / Queensland border and east of Darwin in the Northern Territory.	Suitable habitat for the plains death adder consists of flat, treeless, cracking-soil riverine floodplains (Cogger, 2000).	Possible No recent record within the vicinity of the project area.
Gulf Snapping Turtle *Elseya lavarackorum*	-	EN	Gulf Snapping Turtle is restricted to rivers draining into the Gulf of Carpentaria, including the Calvert and Nicholson River systems (DEPWS, 2021j)	The species occurs in deep pools in the upper catchments of permanently flowing spring-fed river systems, particularly in areas with intact riparian vegetation (DEPWS, 2021j).	Unlikely No rivers or large permanent water bodies occur within the project area

Species	Status		Distribution	Habitat	Likelihood
	EPBC	TPWC			
Northern Blue-tongue Skink *Tiliqua scincoides intermedia*	CE	-	The northern blue-tongue skink occurs across northern Australia from Eighty Mile Beach in Western Australia (WA), across the southern Kimberley and Top End of the Northern Territory (NT), to approximately the Gregory Downs / Cloncurry area in western Queensland (DCCEEW, 2023a).	The northern blue-tongue skink occurs in a wide variety of ecosystems, including riparian forest, vine scrub, monsoon rainforest, pandanus-lined gorges, melaleuca forest, eucalypt woodland and savanna, sparse and dense shrubland, and spinifex and tussock grassland. GPS tracking has shown that northern blue-tongue skinks move widely across savanna landscapes in the wet-season, but they spend most (~ 95 %) of their time in small, fragmented patches of relatively dense vegetation that provide cool, shaded, and damp conditions (DCCEEW, 2023a).	Possible Recent records occur nearby and suitable habitat occurs within the project area.
Mertens' Water Monitor *Varanus mertensi*	EN	VU	Mertens' Water Monitor has a broad distribution that encompasses coastal and inland waters across the far north of Australia. In the NT, the species has been recorded across most of the Top End and the Gulf region (DEPWS, 2021k).	Mertens' Water Monitor is highly aquatic and rarely ventures more than 5-10 m from the edge of water. The species has been recorded in the following habitat: • Perennial and semi-permanent pools, including springs, seeps, swamps, creeks and gorges, • The margins of permanent streams, rivers and lakes, • Floodplain billabongs, lagoons, swamps and soaks, • Perennial waterholes in woodlands, • Man-made irrigation channels and the margins of dams (DCCEEW, 2023b).	Possible Sparse records at similar latitudes occur across the NT, and suitable habitat is sparsely distributed across the project area.

Species	Status		Distribution	Habitat	Likelihood
	EPBC	TPWC			
Mitchell's Water Monitor *Varanus mitchelli*	CE	VU	Mitchell's water monitor occurs across the wet-dry tropics of northern Australia from the far west Kimberley of WA across the Top End of the NT to far northwest Queensland (DCCEEW, 2023c).	Mitchell's water monitor inhabits freshwater and saline wetlands that range from seasonal gorges in upper catchments to large rivers and coastal floodplains. It is recorded from rivers, creeks, gorges, springs, lagoons, swamps, mangroves, and foreshores (DCCEEW, 2023c).	Unlikely No recent records occur at similar latitudes and the project area appears to be south of the species current distribution.
Yellow-spotted Monitor *Varanus panoptes*	-	VU	Occurs across a broad geographic range across northern Australia. In the NT most records are from the Top End but occurs as far south as Renner Springs (Ward *et al.*, 2012).	Occupies a variety of habitats including coastal beaches, floodplains, grasslands and woodlands (Ward *et al*., 2012).	Possible 2017 records occur approximately 20 km from the project area and suitable habitat is present.
Shark					
Freshwater Sawfish *Pristis pristis*	VU	VU	Freshwater Sawfish may potentially occur in all large rivers of northern Australia from the Fitzroy River, Western Australia, to the western side of Cape York Peninsula, Queensland. It is mainly confined to the main channels of large rivers (Allen 2000, pers. comm.).	This species in northern Australia appears to be confined to freshwater drainages and the upper reaches of estuaries, occasionally being found as far as 400 km from the sea (Thorburn *et al.* 2007; Whitty *et al*. 2008).	Unlikely No rivers or large permanent water bodies occur within the project area.

VU = Vulnerable, EN = Endangered, CE = Critically Endangered, NT = Near Threatened, DD = Data Deficient

No habitat that can be classified as critical to the survival of threatened fauna was identified within the Shenandoah E&A area. However, some species may occur and are known to occur in the wider landscape. Threatened species that potentially occur include:

- Gouldian Finch *Erythrura gouldiae* (Endangered EPBC Act, Vulnerable TPWC Act)
- Grey Falcon *Falco hypoleucos* (Vulnerable EPBC Act and TPWC Act)
- Northern Shrike-tit *Falcunculus whitei* (Vulnerable EPBC Act)
- Painted Honeyeater *Grantiella picta* (Vulnerable EPBC Act and TPWC Act)
- Pale Field-rat *Rattus tunneyi* (Vulnerable TPWC Act)
- Common Brushtail Possum (northern) *Trichosurus vulpecula arnhemensis* (Vulnerable EPBC Act)
- Plains Death Adder *Acanthopsis hawkei* (Vulnerable EPBC ACT and TPWC Act)
- Northern Blue-tingue Skink Tiliqua scincoides intermedia (Critically Endangered EPBC Act)
- Yellow-spotted Monitor *Varanus panoptes* (Vulnerable TPWC Act).

As records of species may be limited in remote areas the precautionary principle has been applied. There are some species that have been assessed as possibly occurring even though their primary habitat is not found within the proposed sites or access tracks. These include species that are associated with ephemeral wetlands, low lying areas that may be seasonally inundated and creeks. During the wet and early dry season these areas may sustain threated species such as wetland birds (including migratory species).

The following provides summary of each threatened species that may potentially occur within the Shenandoah South E&A Program area.

Gouldian Finch

Research has shown that critical components of suitable habitat for the Gouldian Finch include suitable nesting trees during the breeding season (particularly *Eucalyptus tintinnans*, *E. brevifolia* or *E. leucophloia*), a water source and a diverse range of favoured annual and perennial grasses (Dostine & Franklin, 2002).

No nesting habitat was recorded during the surveys, and it is unlikely this species breeds in close vicinity to the exploration lease areas within the Shenandoah South E&A Program area. 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.*, *Alloteropsis 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.

The proposed exploration lease areas, gravel pits and vegetation sites were surveyed for Gouldian Finch, congruent with the Northern Shrike-tit surveys. Call playback was not undertaken for Gouldian Finch. Primary nesting trees such as *Eucalyptus brevifolia*, *Eucalyptus leucophloia* and *Eucalyptus tintinnans* were not observed in the area. Corymbia and Eucalyptus trees that are potentially suitable for nesting and perennial grasses suitable for feeding were observed at several sites. Habitat in the Shenandoah South E&A Program area was moderately suitable for Gouldian Finch but critical habitat was absent. No Gouldian Finch were observed during the bird surveys.

The SREBA species distribution model for Gouldian Finch indicates a low probability of the species occurring throughout most of the project area, as displayed in Figure 27 (Young *et al*, 2022).

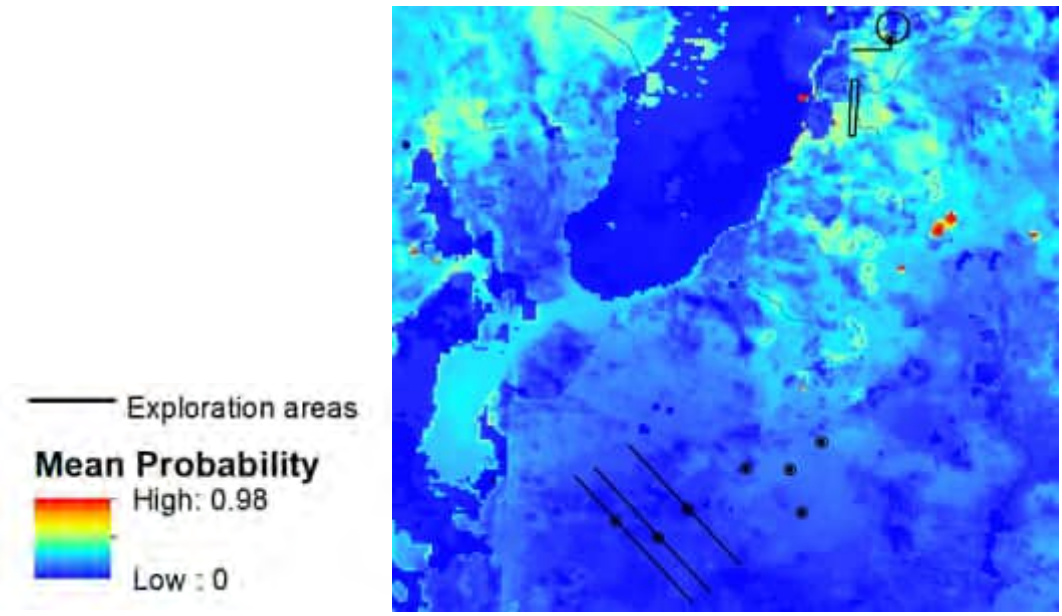

Figure 26 Mean probability of presence of Gouldian Finch within the exploration areas (Young *et al*., 2022)

Grey Falcon

The Grey Falcon (*Falco hypoleucos*) is a widespread species listed as Vulnerable in the NT and possibly occurs in the study area. The species occurs in low densities throughout arid and semi-arid areas of Australia (DEPWS, 2021d). The species is known to nest on repeater towers in the region, including one site located approximately 100 km south-west of Shenandoah South E&A Program where the species bred in 2014 (Jonny Schoenjahn, personal communication, 2022). The species is also known to nest in the tallest trees along watercourses, such as Red River Gums (*Eucalyptus camaldulensis*) (TSSC, 2020). Grey Falcon may forage within the Shenandoah South E&A Program but is unlikely to be impacted by project activities because it is unlikely suitable nesting trees would be cleared.

One repeater tower located within the lease area next to the Carpentaria Highway was surveyed for Grey Falcon. The species was not detected.

While the risks to Gouldian Finch are low, impacts can be reduced by avoiding impacts to large hollow bearing trees with a trunk diameter greater than 25 cm at 1.3 m above the ground (NT Land Clearing Guideline).

Northern Shrike-tit

The Northern Shrike-tit lives in dry Eucalypt forests and woodlands where it feeds on insects from the canopy and also under bark. It has been recorded in wet Melaleuca open woodlands and woodlands dominated by Nutwood (*Terminalia arostrata*) and Bloodwoods with flaky bark and ironwood (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 the Shenandoah E&A area, with NR Maps showing only four records south of -16.25° latitude. Targeted surveys by the NT Government in the Beetaloo Basin failed to detect the species south of -16.0° latitude despite significant survey effort (>30 call playback surveys) (Young *et al*., 2022).

Although it is possible the Northern Shrike-tit may be present in the area, it is unlikely to represent an important area for this species.

During the May 2022 and April 2023 field survey call-playback was undertaken for Northern Shrike-tit. Call-playback was undertaken for approximately 5 minutes at all of the proposed exploration lease areas. Following 5 minutes of call playback the area was surveyed for approximately 10 minutes with binoculars. The search area was within 50 m of where call playback was undertaken, covering an approximate 0.8 ha search area. No Northern Shrike-tits have been observed during these surveys.

The targeted call-playback surveys failed to detect the bird at the exploration lease area or the vegetation assessment sites.

Painted Honeyeater

The Painted Honeyeater (*Grantiella picta*) has been known to occur in the region, however, given it does not breed in the NT it would only be present intermittently for foraging. Suitable habitat for the species potentially occurs within the Shenandoah South E&A Program. The area proposed for clearance is relatively small compared to available suitable habitat within the region.

Pale Field-rat

The Pale Field-rat occurs in a wide range of habitats, including tall grasslands and woodlands (Cole & Woinarski, 2002). There are no recent records of the species within the region; however, this may reflect a lack of survey effort. Suitable habitat for the species occurs within the Shenandoah South E&A Program area. The proposed area of impact is relatively small compared to available suitable habitat within the region.

Common Brushtail Possum

Recent surveys have detected Common Brushtail Possum (*Trichosurus vulpecula arnhemensis*) on Kalala Station (NTG Flora & Fauna, personal communication, 2022). Suitable woodland habitat is contiguous through the landscape; therefore the species potentially occurs within the Shenandoah South E&A Program. Given the large amount of suitable habitat within the region comparative to the project footprint the risk to regional populations of the species is small.

Plains Death Adder

Suitable habitat for the Plains Death Adder consists of flat, treeless, cracking-soil riverine floodplains (Cogger, 2000). A population of the species occur in the Barkly Tableland from the Northern Territory to central-western Queensland. In the Beetaloo Basin Records of the species occur close to Lake Woods, Lake Sylvester and Lake Tarrabool. The species may occur within the project area, particularly following heavy wet season rainfall.

Northern Blue-tongue Skink

The Northern Blue-tongue Skink occurs in a wide variety of vegetation communities, eucalypt woodland and savanna, sparse and dense shrubland, and spinifex and tussock grassland. Areas of dense vegetation that provide cool and moist conditions within hot, dry, and flammable landscapes are critical habitat for the survival of the species, as such habitat provides the Northern Blue-tongue Skink with food, water and protection from environmental exposure and predation. Examples of such habitat includes rainforest and vine thicket, riparian forests, well-vegetated creeks and drainage lines, well-vegetated swamps and springs, and dense thickets within floodplains, grasslands, shrublands, savannas and woodlands (DCCEEW, 2023).

Several recent (2020-2022) records of the species occur within 100 km, and suitable habitat occurs within the project area. The Northern Blue-tongue Skink was recently listed as Critically Endangered under the EPBC Act in December 2023, therefore the species has not been assessed under the SREBA assessments.

Yellow-spotted Monitor

The Yellow-spotted Monitor (*Varanus panoptes*) occurs across northern Australia where it occupies a variety of habitats, including grasslands and woodlands (Ward *et al*., 2012). Most records of this species are from the Top End, though it has been recorded in the Barkly Tablelands. The species likely occurs close to wetlands and riparian habitats within the permit areas; however, such habitat won't be impacted by proposed activities.

The SREBA Terrestrial Ecosystem Report developed a species distribution for Yellow-spotted Monitor that indicated low-high probability for the species throughout the north of the project area, while the probability is low in most parts of the south of the project area, as displayed in Figure 28 (Young *et al*, 2022).

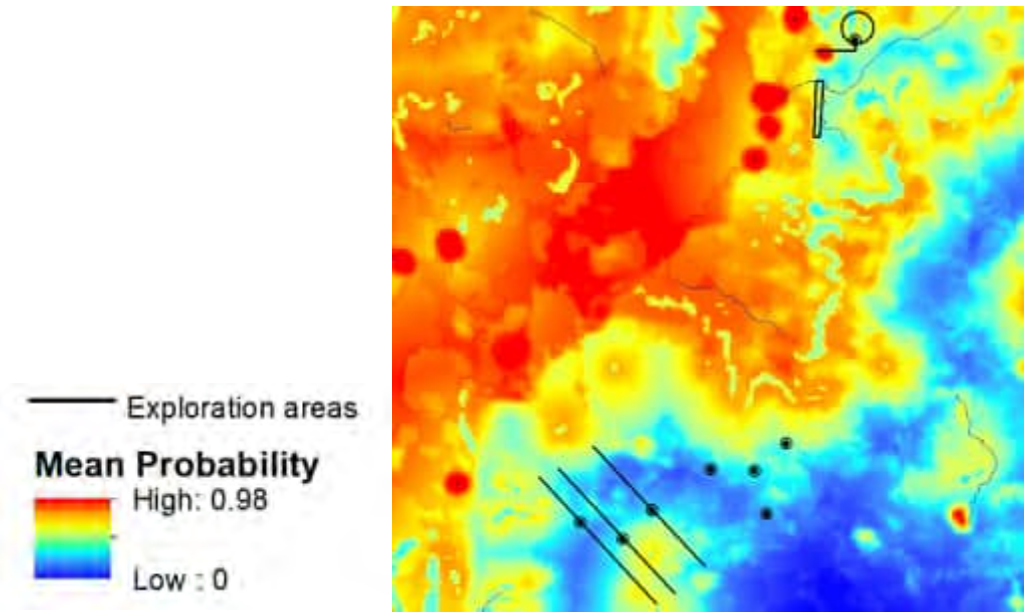

Figure 27 Mean probability of presence of Yellow-spotted Monitor within the exploration areas (Young *et al*., 2022)

4.5.2 Migratory and Marine Species

The EPBC Protected Matters database Appendix E) indicated the potential presence of 13 Migratory and 18 Marine listed species within the Shenandoah South E&A Program area (Table 28). Of these species, three are considered likely to occur, nine possibly occur and eight are unlikely to occur within the Shenandoah South E&A Program. Several migratory wetland bird would possibly occur within the area in ephemeral wetlands that would fill up following wet season rainfall. The Shenandoah South E&A Program does not contain critical habitat for any Migratory or Marine listed species.

Table 27 Migratory listed species potentially occurring within the Shenandoah South E&A Program Area

Scientific Name	Common Name	EPBC Act	Likelihood of Occurrence
Actitis hypoleucos	Common Sandpiper	Migratory, Marine	Possible
Anseranas semipalmata	Magpie Goose	Marine	Possible
Apus pacificus	Fork-tailed Swift	Migratory, Marine	Likely
Bubulcus ibis (Ardea ibis)	Cattle Egret	Marine	Likely
Calidris acuminata	Sharp-tailed Sandpiper	Migratory, Marine	Possible
Calidris ferruginea	Curlew Sandpiper	Migratory, Marine	Possible
Calidris melanotos	Pectoral Sandpiper	Migratory, Marine	Possible
Cecropis daurica	Red-rumped Swallow	Migratory, Marine	Unlikely
Charadrius veredus	Oriental Plover	Migratory, Marine	Possible
Chalcites osculans (Chrysococcyx osculans)	Black-eared Cuckoo	Marine	Possible
Cuculus optatus	Oriental Cuckoo	Migratory	Possible
Glareola maldivarum	Oriental Pratincole	Migratory, Marine	Possible
Haliaeetus leucogaster	White-bellied Sea-eagle	Marine	Unlikely
Hirundo rustica	Barn Swallow	Migratory, Marine	Unlikely
Merops ornatus	Rainbow Bee-eater	Marine	Likely
Motacilla cinerea	Grey Wagtail	Migratory, Marine	Unlikely

Scientific Name	Common Name	EPBC Act	Likelihood of Occurrence
Motacilla flava	Yellow Wagtail	Migratory, Marine	Unlikely
Pristis pristis	Freshwater Sawfish	Migratory	Unlikely
Rostratula australis (Rostratula benghalensis)	Australian Painted Snipe	Migratory, Marine	Unlikely

4.5.3 Feral 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*)
- Domestic cattle (*Bos Taurus*)

During December 2022 and April 2023 field survey evidence of current cattle grazing or grazing within the last 1 to 2 years was recorded at the majority of assessed sites.

The cane toad is known to be present in the project area and the Commonwealth DCCEEW recognises this species as a 'key threatening process' related to their impacts on biodiversity through predation, competition, land degradation and poisoning. In the NT, the cane toad has been implicated in the decline of several species including a large number of reptiles such as the Plains Death Adder (*Acanthophis hawkei*), King Brown Snake (*Pseudechis australis*) and Varanus monitors (Smith & Phillips, 2006).

Pest predators such as cats likely occur within the project area, though their abundance is difficult to assess due to their cryptic nature. Introduced predators such as cats can impact many vertebrates (Dickman, 1996 & 2009). One of the primary concerns of introduced predators are the impacts on reptiles and ground-dwelling birds. Feral cats are also believed to be one of the factors that have led to the decline of the threatened ground-dwelling Partridge Pigeon (Woinarski *et al*. 2007).

There is potential for pest species to be attracted to the Shenandoah South E&A program area due to increased site activities causing an abundance in the landscape. Pest controls to minimise potential for pest species include:

- Camp wastes to be storage to be animal proof.
- All food scraps to be removed from site and disposed of at a licenced facility.
- Food scraps to be frozen and stored within freezer during wet season.
- Water sources are reduced around camps through centralised mess halls.

4.6 Conservation Areas

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

The Bullwaddy Conservation Reserve occurs approximately 81-87 km north east of the Shenandoah South E&A Program. The Reserve was declared in 2000 and is approximately 11,500 ha in area. It represents the only declared conservation area within the Sturt Plateau region to protect the Lancewood/Bullwaddy vegetation community. Less than 3% of this vegetation community is reserved nationally (PWCNT, 2005). The most significant values of the reserve are the flora and the associated fauna for which it provides habitat. This includes the Spectacled Hare-Wallaby, the Northern Nailtail Wallaby and the Giant Frog (*Cyclorana australis*). It is also a valuable area for research on the ecology of Bullwaddy, particularly the effects of fire (PWCNT, 2005).

Lake Woods is located approximately 91-129 km south-west of the Shenandoah South E&A Program area on Newcastle Waters Station. This wetland is listed as a Site of Conservation Significance by the Department of Land Resource Management and is listed in the Directory of Important Wetlands in Australia. Although Lake Woods is located outside of the project area, it is fed principally by surface inflow of Newcastle Creek, itself originating more than 160 km north-east on Amungee Mungee Station. During the period of inundation, Lake Woods supports over 100,000 waterbirds including internationally significant numbers of Plumed Whistling-Duck (*Dendrocygna eytoni*). Numerous bird species nest and feed in the diverse wetland habitat, and the conservation group 'Birdlife International' nominated Lake Woods as an 'Important Bird Area' (IBA). The lake also includes the largest area of lignum swamp in the Northern Territory and in tropical Australia (NRETAS, 2009).

4.7 Groundwater Dependent Ecosystems

A search of the National Groundwater Dependent Ecosystems (GDE) Atlas (Bureau of Meteorology 2023) was conducted in September 2023. The dataset expresses the potential for groundwater interaction/use for river/spring/wetland ecosystems across Australia. It shows the ecosystems that rely on groundwater that has been discharged to the surface, such as baseflow or spring flow.

The Atlas identifies two aquatic GDEs within the Shenandoah South E&A program area, consisting of Newcastle Creek and Yaroo Creek. The Shenandoah South E&A program is not anticipated to impacts these GDEs.

The SREBA Beetaloo vegetation map spatial data (DEPWS, 2022) identifies three broad vegetation groups predominantly occurring within the Beetaloo Sub-basin that are classified as groundwater-dependent ecosystems:

- *Corymbia bella* woodland on alluvial plains
- *Melaleuca* forests (springs, river channels)
- Riparian woodland (ephemeral streams).

Of the three vegetation groups, Melaleuca forests associated with springs and river channels and other Riparian woodlands associated with the ephemeral streams strongly depend on ground water and are considered as riparian vegetation.

Within the Shenandoah E&A program Area, *Corymbia bella* woodland on alluvial plains and Riparian woodland (ephemeral streams) were recorded approximately 14 to 20 km west to the Shenandoah South E&A program area. No other terrestrial GDE's have been recorded within the area.

4.7.1 Stygofauna

Stygofauna comprise aquatic taxa occurring in groundwater aquifers and subterranean water bodies. Stygofauna inhabit and form a component of groundwater dependent ecosystems. Stygofauna are likely to be present in the karstic systems such as the Gum Ridge Formation aquifer where water level is less than 100 m below ground level (GISERA, 2020).

Stygofauna inhabit the interstitial spaces of the cavities of alluvial, sedimentary and karstic aquifers. The studies by GISERA identified and characterised stygofauna assemblages in the Cambrian limestone aquifer units of the Beetaloo Sub-basin. Data is available that can provide an indication of the likelihood of stygofauna presence, with the following factors determining the distribution of stygofauna:

- Formation type: Stygofauna are predominantly found in aquifers with large (mm or greater) pore spaces, which are more common for alluvial, karstic and some fractured rock aquifers.

- Depth below ground level: The abundance and diversity of stygofauna typically decreases with depth below ground, with fauna being rarely found more than 100 m below ground level.
- Proximity of exchange and recharge: Stygofauna are more abundant in areas of surface water-groundwater exchange, compared to deeper areas or those further along the groundwater flow path remote from areas of exchange or recharge (Hose *et al*., 2015).

The presence of significant assemblages of stygofauna in the Shenandoah South E&A is considered limited and impacts are unlikely. Stygofauna surveys have been undertaken in the Beetaloo Sub-basin in August and October of 2019 (Rees *et al*, 2020), and during May 2021 and October 2022 (Humphreys *et al*., 2022). These surveys involved sampling across several bores in the region, including five bores within 50 km of the Shenandoah South E&A. The results of stygofauna surveys at these bores are summarised in Table 28.

Table 28 Stygofauna survey results (Rees *et al*, 2020; Humphreys *et al*., 2022)

Bore	Distance from Shenandoah South E&A Area	Summary of results
RN041444	28 km north-west	No stygofauna detected
Hayfield Shenandoah Homestead Bore	10 km north	25 stygofauna identified by DNA: • 6 to family level • 7 to order level • 8 to class level • 4 to phylum level
Sturt Plains Homestead Bore	22 km south-west	11 stygofauna identified by DNA: • 1 to family level • 4 to order level • 5 to class level • 1 to phylum level
RN038816	17 km south-west	18 *Enchytraeidae* sp. (pot worms) detected
RN00592	Greater than 50 km north	2 stygofauna specimens detected: • *Parisia unguis* • *Bathynellaceae Bresvisomabathynella* sp. 1 stygofauna eDNA

The study found two stygofauna specimens (*Parisia unguis* and *Bathynellaceae Bresvisomabathynella* sp.) and stygofauna eDNA from the Carpentaria Highway Roadside Bore (RN00592) located over 50 km north of the Shenandoah South E&A program area, while there were no reported findings of stygofauna in the Hayfield Homestead bore and the Sturt Plains Homestead bore. However, the study did identify eDNA which may indicate stygofauna presence. The results are consistent with Hose et al (2015), which indicates stygofauna are likely to be present at lower abundance at the observed groundwater depth within the Shenandoah South sites (~106 m below ground level).

4.7.2 Aquatic Ecosystems

Mapping of aquatic ecosystems undertaken by the NT Government indicates that while the majority of the project area can be classified as terrestrial aquatic ecosystems, these are sparsely scattered throughout the Shenandoah South E&A Program area. Most of these are classified as palustrine systems and floodplain systems, which are seasonally or intermittently flooded areas that have hydric soils and contain vegetation that has adapted to the intermittent presence of water. A smaller portion of the area is classified as a lacustrine system, which are characterised by deep standing or slow-moving water, and have less than 30% of their extent covered by vegetation such as trees, shrubs or persistent emergent vegetation (DEPWS, 2022d).

The occurrences of palustrine (non-riverine or non-channel systems) and floodplain systems, with shallow depressions and gullies are to the north of the for Shenandoah S B well pad and are intersected by the seismic lines. Only one stream order 1 intermittent stream is located in close proximity (450 m east) to the Shenandoah N A and Shenandoah N A (Option 2) well pads. Erosion and sediment control for localised flow paths as detailed in Section 3.3 will minimise impacts to the ephemeral stream.

4.8 Matters of National Environmental Significance

4.8.1 Potential EPBC Act Controlling Provisions

Actions such as the proposed 2023 Tamboran exploration program may require approval by the Commonwealth Minister for the Environment, under the *EPBC Act*. Approval is only required if the action is likely to result in significant impacts on Matters of National Environmental Significance (MNES) or if the action will have or is likely to have a significant impact on the environment.

Potential triggers under the EPBC Act include a significant impact on:

- The world heritage values of a declared World Heritage Property
- The national heritage values of a listed National Heritage Place
- The ecological character of a declared Ramsar wetland
- A listed Threatened Ecological Community, or its habitat
- The members of a listed threatened species
- The members of a listed migratory species or their habitat
- A water resource, in relation to coal seam gas development and large coal mining development.

4.8.2 Matters of National Environmental Significance

An EPBC Protected Matters Search was generated on the 12 October 2023 (refer Appendix E) to identify whether MNES or other matters protected by the EPBC Act are likely to occur on or in the near vicinity of the project area. Results of the search are provided below in Table 30.

Table 29 Summary of EPBC Aspects for Shenandoah South E&A Program

Aspect	Located within the Shenandoah South E&A Program Area
Matters of National Environmental Significance	
World Heritage Properties	None
National Heritage Places	None
Wetlands of International Significance	None
Great Barrier Marine Park	None
Commonwealth Marine Area	None
Listed Threatened Ecological communities	None
Listed Threatened Species	18
Listed Migratory Species	13
Other Matters Protected by the EPBC Act	
Commonwealth Land	None
Commonwealth Heritage Places	None
Listed Marine Species	18
Whales and other Cetaceans	None

Aspect	Located within the Shenandoah South E&A Program Area
Critical Habitat	None
Commonwealth Reserves Terrestrial	None
Australian Marine Parks	None
Habitat Critical to the Survival of Marine Turtles	None
Extra Information (Information that may also be relevant to the Exploration sites)	
State and Territory Reserves	None
Regional Forest Agreement	None
Nationally Important Wetlands	None
EPBC Act Referrals	1 - Improving rabbit biocontrol: releasing another strain of RHDV, southern two thirds of Australia, Not Controlled Action - Completed
Key Ecological Features (Marine)	None
Biologically Important Areas	None
Bioregional Assessments	None
Geological and Bioregional Assessments	1 - Beetaloo GBA region

Section 4.5 provides details on threatened, migratory and marine fauna species that potentially occur within the project area. The threatened and migratory species that potentially occur within the Shenandoah South E&A Program area are unlikely to be significantly impacted by the exploration activities.

5.0 Land Condition Assessment

AECOM undertook land condition assessment of the proposed Shenandoah South E&A Program area. The aim of the assessment was to provide a baseline assessment of ecological conditions to support Tamboran's application to the NTG DEPWS to continue exploration activities. Information obtained during the LCA will assist in determining the effectiveness of site rehabilitation once exploration activities have ceased.

The vegetation communities that will be disturbed by the Shenandoah South E&A Program is summarised in Table 31. The total area of vegetation in hectares and percent for the buffered area of interest is also presented.

Table 30 % of Vegetation Community Disturbance for Seismic and Exploration Area

Vegetation Community Descriptions		Shenandoah South Lease Buffered Area (Ha)	Shenandoah North Lease Buffered Areas (Ha)	Total Vegetation Community in Shenandoah E&A Area (Ha)
Lateritic Plains and Rises with sandy loam kandosol soils				
Comm 1a	*Acacia shirleyi* woodland over *Macropteranthes kekwickii, Terminalia volucris* ± *Acacia difficilis* shrubland, over open tussock grassland	194	326	520 (8.34%)
Comm 2a	*Corymbia dichromophloia* ± *Erythrophleum chlorostachys* open woodland, over *Acacia difficilis* ± *Terminalia canescens, Erythrophleum chlorostachys* open shrubland, over hummock grassland	3,385	66	3,451 (55.43%)
Comm 2b	*Acacia shirleyi, Corymbia dichromophloia* ± *Eucalyptus leucophloia, Corymbia polycarpa* open woodland, over *Macropteranthes kekwickii, Petalostigma pubescens, Hakea arborescens* open shrubland, over tussock grassland	912	99	1,011 (16.24%)
Comm 2c	*Eucalyptus leucophloia, Corymbia dichromophloia, Acacia shirleyi* woodland over *Dodonaea hispidula, Calytrix exstipulata* open shrubland over open hummock grassland	-	2	2 (0.03%)
Comm 3a	*Corymbia polycarpa, Eucalyptus chlorophylla, Acacia shirleyi* open woodland, over *Acacia difficilis, Macropteranthes kekwickii, Erythrophleum chlorostachys* open shrubland, over open tussock grassland	258	102	360 (5.79%)
Drainage floors and relic drainages with clay and alluvial soils				
Comm 4a	*Acacia shirleyi* ± *Eucalyptus pruinosa, Eucalyptus chlorophylla* woodland, over *Melaleuca viridiflora, Eucalyptus pruinosa, Eucalyptus chlorophylla* open shrubland, over open tussock grassland	249	88	337 (5.40%)

Vegetation Community Descriptions		Shenandoah South Lease Buffered Area (Ha)	Shenandoah North Lease Buffered Areas (Ha)	Total Vegetation Community in Shenandoah E&A Area (Ha)
Comm 4b	*Corymbia polycarpa, Eucalyptus microtheca* low open woodland, over *Melaleuca nervosa, Hakea arborescens, Melaleuca viridiflora* open shrubland, over tussock grassland	89	109	198 (3.18%)
Comm 4c	*Melaleuca viridiflora low open woodland +/- Acacia torulosa over Triodia bitextura hummock grassland*	312	-	312 (5.02%)
Riparian creek lines with sandy and alluvial soils				
4d	*Eucalyptus camaldulensis* low woodland over *Melaleuca viridiflora* sparse shrubland over open tussock grassland	26	6	32 (0.52%)
Closed drainage, waterholes and swamps				
Comm 4e	*Eucalyptus camaldulensis* open woodland over *Eucalyptus microtheca* open shrubland	-	3	3 (0.05%)

During the survey the proposed exploration lease area, seismic lines and associated access tracks was assessed to be in generally moderate to good condition with no current evidence of weeds, minor erosion, and some disturbance from cattle.

EPBC and TPWC Act Listed Threatened species that have a potential to be encountered within the Shenandoah South E&A Program:

- Gouldian Finch *Erythrura gouldiae* (Endangered EPBC Act, Vulnerable TPWC Act)
- Grey Falcon *Falco hypoleucos* (Vulnerable EPBC Act and TPWC Act)
- Northern Shrike-tit) *Falcunculus whitei* (Vulnerable EPBC Act)
- Painted Honeyeater *Grantiella picta* (Vulnerable EPBC Act and TPWC Act)
- Pale Field-rat *Rattus tunneyi* (Vulnerable TPWC Act)
- Common Brushtail Possum (northern) *Trichosurus vulpecula arnhemensis* (Vulnerable EPBC Act)
- Plains Death Adder *Acanthopsis hawkei* (Vulnerable EPBC ACT and TPWC Act)
- Yellow-spotted Monitor *Varanus panoptes* (Vulnerable TPWC Act).

Due to a scarcity of records and lack of critical habitat, it is unlikely that significant populations of these species occur within the Shenandoah South E&A Program area. It is therefore unlikely threatened species will be significantly impacted from Tamboran's proposed exploration activities. No threated ecological communities are listed within the area.

Mitigation measures are presented in Tamboran's exploration program EMPs and will assist in minimising the impacts from Tamboran's activities on the natural environment and threatened species that may occur within the project area.

Detailed land condition description and photographs of the Shenandoah South E&A Program has been provided in Table 31 to Table 40.

Table 31 Shenandoah South A exploration lease area land condition description

Shenandoah South A					
Location	GDA94, Zone 53, 340335E, 8134450N	**Vegetation community**	**Comm 2a:** *Corymbia dichromophloia ± Erythrophleum chlorostachys* mid high open woodland		
Vegetation description	*Corymbia dichromophloia* mid high open woodland over *Acacia difficilis, Terminalia canescens, Grevillea parallela* mid high shrubland over *Triodia bitextura, Chrysopogon fallax, Mnesithea formosa.*				
Vegetation transect	*A. difficilis (62%), C. dichromophloia (18.8%), Terminalia canescens (15.4%), Brachychiton diversifolius (2.9%), Erythrophleum chlorostachys (1%)*				
Basal area (5 sweeps)	*C. dichromophloia 14.5, Terminalia canescens 1, Dead 1*			**Stand basal area (average)**	3.1 m²/ha
Landform	Simple slope	**Habitat**	Moderate -scattered tree hollows, fallen logs and flowering plants. Mistletoe and leaf litter absent.		
Slope	< 1%				
Site Photos					
Disturbance	Fire damage low > 2 years ago. No erosion. Minor cattle impacts.				
Termite mounds	Sparse				
Ground cover	35% Vegetation, 10% Litter, 45% Bare Soil, 10% Gravel				
Vegetation Structure	**Upper storey (6 - 12 m)**	*Corymbia dichromophloia (12%)*			
	Mid-storey (0.5 - 6 m)	*Acacia difficilis (20%), Terminalia canescens (6%), Grevillea parallela (2%)*			
	Understorey (0 - 0 5 m)	*Triodia bitextura (15%), Chrysopogon fallax (10%), Mnesithea formosa (5%)*			
Soil texture	Sandy loam in upper 0.75 m. Surface gravels present.				
Soil drainage	Well drained				
Soil colour	7.5YR 3/4. Dark brown				
Soil pH	7.3				

Table 32 Shenandoah South B exploration lease area land condition description

<table>
<tr><th colspan="6">Shenandoah South B</th></tr>
<tr><td>Location</td><td>GDA94, Zone 53, 345579E, 8135469N</td><td>Vegetation community</td><td colspan="3">Comm 3a: Corymbia polycarpa, Eucalyptus chlorophylla, Acacia shirleyi mid high open woodland</td></tr>
<tr><td>Vegetation description</td><td colspan="5">Corymbia polycarpa, Eucalyptus chlorophylla, Acacia shirleyi mid high open woodland over Acacia difficilis, Acacia gonoclada, Macropteranthes kekwickii mid high open shrubland over Aristida contorta, Aristida hygrometrica mid high open tussock grassland.</td></tr>
<tr><td>Vegetation transect</td><td colspan="5">A. shirleyi (28.4%), E. chlorophylla (23.4%), A. gonoclada (19.9%), A. difficilis (11.3%), C. polycarpa (7.8%), Terminalia canescens (3.5%), Bauhinia cunninghamii (2.1%), Macropteranthes kekwickii (2.1%), Dolichandrone heterophylla (1.4%).</td></tr>
<tr><td>Basal area (5 sweeps)</td><td colspan="3">A. shirleyi 8, E. chlorophylla 4.5, C. polycarpa 4.5, Bauhinia cunninghamii 2, Dead 1.5</td><td>Stand basal area (average)</td><td>4.1 m²/ha</td></tr>
<tr><td>Landform</td><td>Simple slope</td><td rowspan="2">Habitat</td><td colspan="3" rowspan="2">Moderate -Scattered tree hollows, fallen logs and flowering plants common. Mistletoe and leaf litter absent.</td></tr>
<tr><td>Slope</td><td>< 1%</td></tr>
<tr><td>Disturbance
Fire damage low > 2 years ago. No erosion. Minor cattle impacts.</td><td colspan="5"> </td></tr>
<tr><td>Termite mounds
Sparse</td><td colspan="5"></td></tr>
<tr><td>Ground cover
15% Vegetation, 10% Litter, 25% Bare Soil, 50% Gravel</td><td colspan="5"> </td></tr>
<tr><td rowspan="3">Vegetation Structure</td><td colspan="2">Upper storey (7 - 12 m)</td><td colspan="3">Corymbia polycarpa (6%), Eucalyptus chlorophylla (5%), Acacia shirleyi (5%)</td></tr>
<tr><td colspan="2">Mid-storey (0.5 - 7 m)</td><td colspan="3">Acacia difficilis (12%), Acacia gonoclada (8%), Macropteranthes kekwickii (5%)</td></tr>
<tr><td colspan="2">Understorey (0 - 0 5 m)</td><td colspan="3">Aristida contorta (8%), Aristida hygrometrica (7%)</td></tr>
<tr><td>Soil texture</td><td>Clay Loam Sandy in upper 0.5 m. Light Medium Clay to 0.7 m. No surface gravels.</td><td colspan="3" rowspan="4"> </td><td rowspan="4">No Gravels</td></tr>
<tr><td>Soil drainage</td><td>Well drained, potential for standing water following rainfall.</td></tr>
<tr><td>Soil colour</td><td>10YR 4/1. Dark Gray.</td></tr>
<tr><td>Soil pH</td><td>7.0</td></tr>
</table>

Table 33 Shenandoah South C exploration lease area land condition description

<table>
<tr><th colspan="6">Shenandoah South C</th></tr>
<tr><td>Location</td><td>GDA94, Zone 53, 343472E, 8133331N</td><td>Vegetation community</td><td colspan="3">Comm 2b: Acacia shirleyi, Corymbia dichromophloia ± Eucalyptus leucophloia, C. polycarpa mid high open woodland</td></tr>
<tr><td>Vegetation description</td><td colspan="5">Acacia shirleyi, Ventilago viminalis mid high open woodland over Macropteranthes kekwickii, Terminalia volucris, Eucalyptus chlorophylla mid high open shrubland over Sorghum intrans, Eulalia aurea, Chrysopogon fallax mid high tussock grassland</td></tr>
<tr><td>Vegetation transect</td><td colspan="5">A. shirleyi (24.5%), Macropteranthes kekwickii (41.2%), C. grandifolia (13.7%), Ventilago viminalis (6.9%), Calytrix exstipulata (6.9%), Terminalia volucris (5.9%), Gyrocarpus americanus (1%)</td></tr>
<tr><td>Basal area (5 sweeps)</td><td colspan="3">Macropteranthes kekwickii 6.5, A. shirleyi 3, Gyrocarpus americanus 2</td><td>Stand basal area (average)</td><td>1 m²/ha</td></tr>
<tr><td>Landform</td><td>Simple slope</td><td rowspan="2">Habitat</td><td colspan="3" rowspan="2">Moderate - Tree hollows, Mistletoe and leaf litter absent. Fallen logs and flowering plants common.</td></tr>
<tr><td>Slope</td><td>< 1%</td></tr>
<tr><td>Disturbance
Fire damage moderate > 2 years ago. No erosion. Minor cattle impacts.
Termite mounds
Sparse</td><td colspan="5"> </td></tr>
<tr><td>Ground cover
40% Vegetation, 25% Litter, 25% Bare Soil, 10% Gravel</td><td colspan="5"> </td></tr>
<tr><td rowspan="3">Vegetation Structure</td><td>Upper storey (7 - 12 m)</td><td colspan="4">Acacia shirleyi (8%), Ventilago viminalis (2%)</td></tr>
<tr><td>Mid-storey (0.5 - 7 m)</td><td colspan="4">Macropteranthes kekwickii (12%), Terminalia volucris (6%), Eucalyptus chlorophylla (2%)</td></tr>
<tr><td>Understorey (0 - 0 5 m)</td><td colspan="4">Sorghum intrans (20%), Eulalia aurea (10%), Chrysopogon fallax (10%)</td></tr>
<tr><td>Soil texture</td><td>Silty Clay Loam in upper 0.3 m. Progressing to Clay. No surface gravels.</td><td rowspan="4"> </td><td rowspan="4"> </td><td rowspan="4"> </td></tr>
<tr><td>Soil drainage</td><td>Well drained</td></tr>
<tr><td>Soil colour</td><td>5YR 3/3. Dark reddish brown</td></tr>
<tr><td>Soil pH</td><td>6.7</td></tr>
</table>

Table 34 Shenandoah North A exploration lease area land condition description

Shenandoah North A					
Location	GDA94, Zone 53, 356697E, 8163759N	**Vegetation community**	**Comm 1a:** *Acacia shirleyi mid high woodland*		
Vegetation description	*Acacia shirleyi mid high woodland over Macropteranthes kekwickii, Atalaya hemiglauca, Acacia holosericea mid high open shrubland over Fimbristylis sp., Brachyachne convergens, Aristida contorta mid high open tussock grassland.*				
Vegetation transect	*Macropteranthes kekwickii (31%), A. shirleyi (24.6%), A. holosericea (13.4%), Terminalia volucris (11.3%), E. pruinosa (5.6%), Atalaya hemiglauca (4.9%), Corymbia polycarpa (3.5%), Dolichandrone filiformis (2.1%), Gyrocarpus americanus (2.1%), Hakea arborescens (1.4%)*				
Basal area (5 sweeps)	*Macropteranthes kekwickii 7, A. shirleyi 6, Terminalia volucris 2.5, Atalaya hemiglauca 2. Ventilago viminalis 1, Dead 0.5*			**Stand basal area (average)**	3.7 m²/ha
Landform	Simple slope	**Habitat**	Moderate - tree hollows, Mistletoe and leaf litter absent, fallen logs and flowering plants common.		
Slope	< 1%				
Site Photos					
Disturbance	Fire damage moderate >2years ago. No erosion. Mod. cattle impacts				
Termite mounds	Sparse				
Ground cover	70% Vegetation, 5% Litter, 10% Bare Soil, 15% Gravel				
Vegetation Structure	**Upper storey (7 - 12 m)**	*Acacia shirleyi (8%)*			
	Mid-storey (0.5 - 7 m)	*Macropteranthes kekwickii (17%), Atalaya hemiglauca (2%), Acacia holosericea (1%)*			
	Understorey (0 - 0 5 m)	*Fimbristylis sp. (10%), Brachyachne convergens (7%), Aristida contorta (3%)*			
Soil texture	Sandy loam in upper 0.4 m. No surface gravels.				No Gravels
Soil drainage	Well drained				
Soil colour	5YR 4/1. Dark Gray				
Soil pH	6.5				

Table 35 Shenandoah North A (Option 2) exploration lease area land condition description

Shenandoah North A (Option 2)					
Location	GDA94, Zone 53, 356718E, 8165809N	**Vegetation community**	**Comm 4a:** *Acacia shirleyi* ± *Eucalyptus pruinosa*, *E. chlorophylla* mid high woodland		
Vegetation description	*Acacia shirleyi* mid high open forest over *Eucalyptus pruinosa, Corymbia grandifolia, E. chlorophylla* mid high open shrubland over *Aristida contorta, Eriachne armitii, Eragrostis cumingii* mid high open tussock grassland.				
Vegetation transect	*A. shirleyi* (79.9%), *E. chlorophylla* (9.5%), *E. pruinosa* (6.5%), *C. grandifolia* (4.1%).				
Basal area (5 sweeps)	*A. shirleyi* (42), *E. chlorophylla* (8), *Dead* (8.5)			**Stand basal area (average)**	10 m²/ha
Landform	Simple slope	**Habitat**	Moderate - scattered tree hollows, fallen logs, shallow leaf litter. Mistletoe and flowering plants absent.		
Slope	< 1%				
Disturbance					
Fire damage Mod. > 2 years ago. No erosion. Mod cattle impacts.					
Termite mounds					
Abundant					
Ground cover					
15% Vegetation, 45% Litter, 40% Bare Soil					
Vegetation Structure	**Upper storey (7 - 12 m)**	*Acacia shirleyi (60%)*			
	Mid-storey (0.5 - 7 m)	*Eucalyptus pruinosa (6%), Corymbia grandifolia (4%), E. chlorophylla (2%)*			
	Understorey (0 - 0 5 m)	*Aristida contorta (5%), Eriachne armitii (5%), Eragrostis cumingii (5%)*			
Soil texture	Clay Loam Sandy in upper 0.5 m. Light Medium Clay to 0.7 m. Very minor gravels.				
Soil drainage	Well drained, potential for standing water following rainfall.				
Soil colour	7.5YR 5/1. Gray.				
Soil pH	5.8				

Table 36 Shenandoah North B exploration lease area land condition description

<table>
<tr><th colspan="6">Shenandoah North B</th></tr>
<tr><td>Location</td><td>GDA94, Zone 53, 359454E, 8170480N</td><td>Vegetation community</td><td colspan="3">Comm 2b: Acacia shirleyi, Corymbia dichromophloia ± Eucalyptus leucophloia, mid high open woodland</td></tr>
<tr><td>Vegetation description</td><td colspan="5">Acacia shirleyi, Corymbia dichromophloia, Eucalyptus leucophloia, mid high open woodland over Calytrix exstipulata, Macropteranthes kekwickii, Hakea arborescens mid high sparse shrubland over, Chrysopogon fallax, Mnesithea formosa mid high tussock grassland.</td></tr>
<tr><td>Vegetation transect</td><td colspan="5">A. shirleyi (74.3%), E. leucophloia (15%), Macropteranthes kekwickii (5.4%), C. dichromophloia (3%), C. polycarpa (2.4%)</td></tr>
<tr><td>Basal area (5 sweeps)</td><td colspan="3">A. shirleyi (25), Macropteranthes kekwickii (14), C. dichromophloia (2), E. leucophloia (1.5), Terminalia volucris (0.5), Dead (4)</td><td>Stand basal area (average)</td><td>8.6 m²/ha</td></tr>
<tr><td>Landform</td><td>Simple slope</td><td rowspan="2">Habitat</td><td colspan="3" rowspan="2">Moderate -scattered tree hollows, fallen logs common, flowering plants abundant. Mistletoe and leaf litter absent.</td></tr>
<tr><td>Slope</td><td>< 1%</td></tr>
<tr><td>Disturbance
Fire damage moderate > 2 years ago. No erosion. Minor cattle impacts.
Termite mounds
Common</td><td colspan="5"> </td></tr>
<tr><td>Ground cover
60% Vegetation, 25% Litter, 5% Bare Soil, 10% Gravel</td><td colspan="5"> </td></tr>
<tr><td rowspan="3">Vegetation Structure</td><td>Upper storey (7 - 12 m)</td><td colspan="4">Acacia shirleyi (30%), Corymbia dichromophloia (3%), Eucalyptus leucophloia (2%)</td></tr>
<tr><td>Mid-storey (0.5 - 7 m)</td><td colspan="4">Calytrix exstipulata (4%), Macropteranthes kekwickii (2%), Hakea arborescens (1%)</td></tr>
<tr><td>Understorey (0 - 0 5 m)</td><td colspan="4">Chrysopogon fallax (50%), Mnesithea formosa (10%)</td></tr>
<tr><td>Soil texture</td><td>Clayey Sand in upper 0.3 m. To silty Clay Loam at depth. 50% Course Gravels of 3-17 mm.</td><td colspan="4" rowspan="4"> </td></tr>
<tr><td>Soil drainage</td><td>Well drained</td></tr>
<tr><td>Soil colour</td><td>5YR 3/3. Dark reddish brown</td></tr>
<tr><td>Soil pH</td><td>6.2</td></tr>
</table>

Table 37 Shenandoah South 2 exploration lease area land condition description

<table>
<tr><th colspan="6">Shenandoah South 2</th></tr>
<tr><td>Location</td><td>GDA94, Zone 53, 355291E, 8140676N</td><td>Vegetation community</td><td colspan="3">Comm 2a: Corymbia dichromophloia ± Erythrophleum chlorostachys open woodland over Acacia difficilis ± Terminalia canescens, Erythrophleum chlorostachys open shrubland over hummock grassland</td></tr>
<tr><td>Vegetation description</td><td colspan="5">Corymbia dichromophloia and Erythrophleum chlorostachys mid high open woodland, over Erythrophleum chlorostachys, Acacia difficilis and Terminalia canescens mid high open shrubland, over Triodia bitextura hummock grassland.</td></tr>
<tr><td>Basal area (5 sweeps)</td><td colspan="3">Corymbia dichromophloia (16), Erythrophleum chlorostachys (8), Corymbia ferruginea (6), Dead tree (9.5)</td><td>Stand basal area (average)</td><td>6 m²/ha</td></tr>
<tr><td>Landform</td><td>Flat</td><td rowspan="2">Habitat</td><td colspan="3" rowspan="2">Moderate - Common tree hollows and falling logs. Mistletoe and flowering plants absent. Shallow leaf litter.</td></tr>
<tr><td>Slope</td><td>0 %</td></tr>
<tr><td>Disturbance
Fire damage > 2 years ago. No erosion. Minor cattle impacts.
Termite mounds
Nil</td><td colspan="2"> </td><td colspan="3"> </td></tr>
<tr><td>Ground cover
55% vegetation, 2% leaf litter, 43% bare</td><td colspan="2"> </td><td colspan="3"> </td></tr>
<tr><td rowspan="3">Vegetation Structure</td><td colspan="2">Upper storey (8 - 15 m)</td><td colspan="3">Corymbia dichromophloia (13%), Erythrophleum chlorostachys (2%)</td></tr>
<tr><td colspan="2">Mid-storey (0.5 - 3 m)</td><td colspan="3">Erythrophleum chlorostachys (4%), Acacia difficilis (3%), Terminalia canescens (3%)</td></tr>
<tr><td colspan="2">Understorey (0 - 0 5 m)</td><td colspan="3">Triodia bitextura (55%)</td></tr>
<tr><td>Soil texture</td><td colspan="2">Clay Loam Sandy.</td><td colspan="3" rowspan="4"> </td></tr>
<tr><td>Soil drainage</td><td colspan="2">Well drained.</td></tr>
<tr><td>Soil colour</td><td colspan="2">5YR 3/4 dark reddish brown (upper) to 5YR 3/3 dark reddish brown</td></tr>
<tr><td>Soil pH</td><td colspan="2">5.8</td></tr>
</table>

Table 38 Shenandoah South 3 exploration lease area land condition description

<table>
<tr><th colspan="6">Shenandoah South 3</th></tr>
<tr><td>Location</td><td>GDA94, Zone 53, 354043E, 8135463N</td><td>Vegetation community</td><td colspan="3">Comm 2a: Corymbia dichromophloia ± Erythrophleum chlorostachys open woodland over Acacia difficilis ± Terminalia canescens, Erythrophleum chlorostachys open shrubland over hummock grassland</td></tr>
<tr><td>Vegetation description</td><td colspan="5">Corymbia dichromophloia and Erythrophleum chlorostachys mid high open woodland, over Erythrophleum chlorostachys, Acacia difficilis and Terminalia canescens mid high open shrubland, over Triodia bitextura hummock grassland.</td></tr>
<tr><td>Basal area (5 sweeps)</td><td colspan="3">Corymbia dichromophloia (3.5), Eucalyptus coolibah (3), Erythrophleum chlorostachys (0.5), Acacia tumida (0.5) Dead tree (1)</td><td>Stand basal area (average)</td><td>1.5 m²/ha</td></tr>
<tr><td>Landform</td><td>Plain</td><td rowspan="2">Habitat</td><td colspan="3" rowspan="2">Moderate - Common tree hollows and fallen logs. Scattered flowering plants, moderate litter. Mistletoe absent.</td></tr>
<tr><td>Slope</td><td>< 1%</td></tr>
<tr><td>Disturbance
Fire damage > 2 years ago. No erosion. No Cattle observable impacts.
Termite mounds
Nil</td><td colspan="2"> </td><td colspan="3"> </td></tr>
<tr><td>Ground cover
30% vegetation, 30% leaf litter, 40% bare</td><td colspan="2"> </td><td colspan="3"> </td></tr>
<tr><td rowspan="3">Vegetation Structure</td><td>Upper storey (7 - 12 m)</td><td colspan="4">Corymbia dichromophloia (15%), Eucalyptus microtheca (1%)</td></tr>
<tr><td>Mid-storey (1.5 - 5 m)</td><td colspan="4">Acacia tumida (30%), Alphitona excelsa (30%), Erythrophleum chlorostachys (5%)</td></tr>
<tr><td>Understorey (0 - 0 5 m)</td><td colspan="4">Triodia bitextura 60%</td></tr>
<tr><td>Soil texture</td><td colspan="2">Loamy Sand grading to sandy loam at 0.25 m</td><td colspan="3" rowspan="4"> </td></tr>
<tr><td>Soil drainage</td><td colspan="2">Rapidly drained</td></tr>
<tr><td>Soil colour</td><td colspan="2">5YR 3/4 dark reddish brown grading to 5YR 4/4 reddish brown</td></tr>
<tr><td>Soil pH</td><td colspan="2">6.4</td></tr>
</table>

Table 39 Shenandoah South 4 exploration lease area land condition description

<table>
<tr><th colspan="6">Shenandoah South 4</th></tr>
<tr><td>Location</td><td>GDA94, Zone 53, 352021E, 8141797N</td><td>Vegetation community</td><td colspan="3">Comm 4c: Melaleuca viridiflora low open woodland +/- Acacia torulosa over Triodia bitextura hummock grassland</td></tr>
<tr><td>Vegetation description</td><td colspan="5">Acacia tumida, Acacia torulosa and Melaleuca viridiflora open shrubland, over Triodia bitextura open hummock grassland.</td></tr>
<tr><td>Basal area (5 sweeps)</td><td colspan="2">Nil</td><td>Stand basal area (average)</td><td colspan="2">0.1 m²/ha</td></tr>
<tr><td>Landform</td><td colspan="2">Drainage floors and relic drainages with clay and alluvial soils</td><td rowspan="2">Habitat</td><td colspan="2" rowspan="2">Moderate - Moderate litter. Tree hollows, fallen logs, mistletoe and flowering plants absent.</td></tr>
<tr><td>Slope</td><td colspan="2">< 1%</td></tr>
<tr><td>Disturbance
Fire damage > 2 years ago. No erosion. Minor cattle impacts.
Termite mounds
Nil</td><td colspan="5"> </td></tr>
<tr><td>Ground cover
50% vegetation, 10% leaf litter, 40% bare</td><td colspan="5"> </td></tr>
<tr><td rowspan="3">Vegetation Structure</td><td>Upper storey (7 - 12 m)</td><td colspan="4">Nil</td></tr>
<tr><td>Mid-storey (1.5 - 5 m)</td><td colspan="4">Acacia tumida 20% and Melaleuca viridiflora 10%</td></tr>
<tr><td>Understorey (0 - 0 5 m)</td><td colspan="4">Triodia bitextura 45% and Melaleuca viridiflora 5%</td></tr>
<tr><td>Soil texture</td><td colspan="3">Sandy Clay Loam grading to Clay Loam Sandy.</td><td colspan="2" rowspan="4"> </td></tr>
<tr><td>Soil drainage</td><td colspan="3">Well drained.</td></tr>
<tr><td>Soil colour</td><td colspan="3">10YR 4/1 dark grey grading to 10YR 5/2 greyish brown</td></tr>
<tr><td>Soil pH</td><td colspan="3">5.3</td></tr>
</table>

Table 40 Shenandoah South 5 exploration lease area land condition description

<table>
<tr><th colspan="6">Shenandoah South 5</th></tr>
<tr><td>Location</td><td>GDA94, Zone 53, 353046E, 8138627N</td><td>Vegetation community</td><td colspan="3">Comm 4c: Melaleuca viridiflora low open woodland +/- Acacia torulosa over Triodia bitextura hummock grassland.</td></tr>
<tr><td>Vegetation description</td><td colspan="5">Acacia tumida, Acacia torulosa and Melaleuca viridiflora open shrubland, over Triodia bitextura open hummock grassland.</td></tr>
<tr><td>Basal area (5 sweeps)</td><td colspan="3">Nil</td><td>Stand basal area (average)</td><td>0 m²/ha</td></tr>
<tr><td>Landform</td><td colspan="2">Drainage floors and relic drainages with clay and alluvial soils</td><td>Habitat</td><td colspan="2">Moderate - Scattered fallen logs and moderate leaf litter. Tree hollows, mistletoe and flowering plants absent.</td></tr>
<tr><td>Slope</td><td colspan="2">< 1%</td><td></td><td colspan="2"></td></tr>
<tr><td>Disturbance
Fire damage > 2 years ago. No erosion. Minor cattle impacts.
Termite mounds
Nil</td><td colspan="3"> </td><td colspan="2"> </td></tr>
<tr><td>Ground cover
30% vegetation, 30% leaf litter, 40% bare</td><td colspan="3"> </td><td colspan="2"> </td></tr>
<tr><td rowspan="3">Vegetation Structure</td><td>Upper storey (7 - 12 m)</td><td colspan="4">Nil</td></tr>
<tr><td>Mid-storey (1.5 - 5 m)</td><td colspan="4">Acacia tumida 20%, Acacia torulosa 10% and Melaleuca viridiflora 10%</td></tr>
<tr><td>Understorey (0 - 0 5 m)</td><td colspan="4">Triodia bitextura 30%</td></tr>
<tr><td>Soil texture</td><td colspan="3">Sandy Clay Loam grading to Clay Loam Sandy.</td><td colspan="2" rowspan="4"> </td></tr>
<tr><td>Soil drainage</td><td colspan="3">Well drained.</td></tr>
<tr><td>Soil colour</td><td colspan="3">10YR 3/4 dark yellowish brown (upper), 10YR 6/3 Pale Brown (lower)</td></tr>
<tr><td>Soil pH</td><td colspan="3">7.1</td></tr>
</table>

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Appendix A

Soil Material Laboratory Results

Appendix A Soil Material Laboratory Results

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2245889**	Page	: 1 of 5
Client	: **AECOM AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MS ALANA COURT	Contact	: Sepan Mahamad
Address	: GPO BOX 3175 DARWIN NT, AUSTRALIA 0801	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 08 8942 6200	Telephone	: +61 2 8784 8555
Project	: 60667354	Date Samples Received	: 20-Dec-2022 08:30
Order number	: 60667354	Date Analysis Commenced	: 20-Dec-2022
C-O-C number	: ----	Issue Date	: 04-Jan-2023 15:56
Sampler	: WILLIAM RIDDELL		
Site	: ----		
Quote number	: EN/004/21		
No. of samples received	: 13		
No. of samples analysed	: 13		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Layla Hafner	Acid Sulphate Soils - Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ALS is not NATA accredited for the analysis of Exchangeable Cations on Alkaline Soils when performed under ALS Method ED006.
- EA058 Emerson: V. = Very, D. = Dark, L. = Light, VD. = Very Dark
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity (H+ + Al3+).

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Sample ID	Shen South 1, A	Shen South 1, B	Shen South 2, A	Shen South 2, B	Shen South 3, A
				Sampling date / time	15-Dec-2022 00:00	15-Dec-2022 00:00	15-Dec-2022 00:00	15-Dec-2022 00:00	14-Dec-2022 00:00
					ES2245889-001	ES2245889-002	ES2245889-003	ES2245889-004	ES2245889-005
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**7.1**	**7.6**	**5.8**	**6.3**	**6.4**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		**16**	**13**	**24**	**13**	**9**
EA058: Emerson Aggregate Test									
Color (Munsell)	----	-	-		**Dark Yellowish Brown (10YR 3/4)**	**Pale Brown (10YR 6/3)**	**Dark Reddish Brown (5YR 3/4)**	**Dark Reddish Brown (5YR 3/3)**	**Dark Reddish Brown (5YR 3/4)**
Texture	----	-	-		**Sandy Clay Loam**	**Clay Loam Sandy**	**Clay Loam Sandy**	**Clay Loam Sandy**	**Sandy Clay Loam**
Emerson Class Number	EC/TC	-	-		**3**	**6**	**3**	**6**	**3**
ED006: Exchangeable Cations on Alkaline Soils									
Exchangeable Calcium	----	0.2	meq/100g		**----**	**2.8**	**----**	**----**	**----**
Exchangeable Magnesium	----	0.2	meq/100g		**----**	**1.2**	**----**	**----**	**----**
Exchangeable Potassium	----	0.2	meq/100g		**----**	**0.5**	**----**	**----**	**----**
Exchangeable Sodium	----	0.2	meq/100g		**----**	**0.5**	**----**	**----**	**----**
Cation Exchange Capacity	----	0.2	meq/100g		**----**	**5.1**	**----**	**----**	**----**
Exchangeable Sodium Percent	----	0.2	%		**----**	**9.2**	**----**	**----**	**----**
ED007: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		**1.0**	**----**	**1.0**	**0.7**	**0.7**
Exchangeable Magnesium	----	0.1	meq/100g		**0.3**	**----**	**0.2**	**0.3**	**0.2**
Exchangeable Potassium	----	0.1	meq/100g		**0.1**	**----**	<0.1	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g		<0.1	**----**	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g		**1.4**	**----**	**1.4**	**1.1**	**1.0**
Exchangeable Sodium Percent	----	0.1	%		**1.3**	**----**	**1.8**	**2.0**	**1.4**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	Shen South 3, B	Shen Pad 4, A	Shen Pad 4, B	Shen Pad 5, A	Shen Pad 5, B
			Sampling date / time	14-Dec-2022 00:00	14-Dec-2022 00:00	14-Dec-2022 00:00	15-Dec-2022 00:00	15-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	ES2245889-006	ES2245889-007	ES2245889-008	ES2245889-009	ES2245889-010
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	6.3	5.3	5.4	5.6	5.9
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	9	15	8	9	7
EA058: Emerson Aggregate Test								
Color (Munsell)	----	-	-	Reddish Brown (5YR 4/4)	Gray (7.5YR 5/1)	Light Gray (10YR 7/1)	Gray (10YR 5/1)	Gray (10YR 6/1)
Texture	----	-	-	Sandy Clay Loam	Sandy Clay Loam	Clay Loam Sandy	Sandy Clay Loam	Sandy Clay Loam
Emerson Class Number	EC/TC	-	-	6	3	6	3	6
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	0.6	0.5	0.4	0.5	0.5
Exchangeable Magnesium	----	0.1	meq/100g	0.3	0.2	0.2	0.2	0.3
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	0.9	0.8	0.7	0.8	0.8
Exchangeable Sodium Percent	----	0.1	%	1.7	3.6	2.1	2.0	1.6

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	Kyalia 98 S2, A3	Kyalia 98 S2, B	Kyalia 117 N1, B1	----	----
			Sampling date / time	15-Dec-2022 00:00	15-Dec-2022 00:00	15-Dec-2022 00:00	----	----
Compound	CAS Number	LOR	Unit	ES2245889-011	ES2245889-012	ES2245889-013	--------	--------
				Result	Result	Result	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**7.2**	**7.0**	**7.5**	**----**	**----**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**17**	**19**	**18**	**----**	**----**
EA058: Emerson Aggregate Test								
Color (Munsell)	----	-	-	**Dark Brown (7.5YR 3/2)**	**Brown (7.5YR 4/2)**	**Brown (7.5YR 4/2)**	**----**	**----**
Texture	----	-	-	**Sandy Loam**	**Sandy Loam**	**Sandy Clay Loam**	**----**	**----**
Emerson Class Number	EC/TC	-	-	**3**	**3**	**3**	**----**	**----**
ED006: Exchangeable Cations on Alkaline Soils								
Exchangeable Calcium	----	0.2	meq/100g	**----**	**----**	**0.5**	**----**	**----**
Exchangeable Magnesium	----	0.2	meq/100g	**----**	**----**	<0.2	**----**	**----**
Exchangeable Potassium	----	0.2	meq/100g	**----**	**----**	<0.2	**----**	**----**
Exchangeable Sodium	----	0.2	meq/100g	**----**	**----**	<0.2	**----**	**----**
Cation Exchange Capacity	----	0.2	meq/100g	**----**	**----**	**0.5**	**----**	**----**
Exchangeable Sodium Percent	----	0.2	%	**----**	**----**	<0.2	**----**	**----**
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	**1.2**	**0.7**	**----**	**----**	**----**
Exchangeable Magnesium	----	0.1	meq/100g	**0.3**	**0.2**	**----**	**----**	**----**
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	**----**	**----**	**----**
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	**----**	**----**	**----**
Cation Exchange Capacity	----	0.1	meq/100g	**1.6**	**1.0**	**----**	**----**	**----**
Exchangeable Sodium Percent	----	0.1	%	**1.1**	**2.3**	**----**	**----**	**----**

Inter-Laboratory Testing

Analysis conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818 (Chemistry) 18958 (Biology).

(SOIL) EA058: Emerson Aggregate Test

CERTIFICATE OF ANALYSIS

Work Order	: **ES2311781**	Page	: 1 of 6
Client	: **AECOM AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MS ALANA COURT	Contact	: Sepan Mahamad
Address	: GPO BOX 3175 DARWIN NT, AUSTRALIA 0801	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 08 8942 6200	Telephone	: +61 2 8784 8555
Project	: 60667354	Date Samples Received	: 12-Apr-2023 08:30
Order number	: 60667354	Date Analysis Commenced	: 15-Apr-2023
C-O-C number	: ----	Issue Date	: 24-Apr-2023 15:20
Sampler	: Tiane Mcquire		
Site	: ----		
Quote number	: EN/004/21		
No. of samples received	: 20		
No. of samples analysed	: 20		

Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

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- Analytical Results

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Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Dian Dao	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW

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Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EA058 Emerson: V. = Very, D. = Dark, L. = Light, VD. = Very Dark
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity (H+ + Al3+).

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	Shen SA - B Horizon	Shen SA - C Horizon	Shenandoah SC - Horizon A	Shenandoah SC - B Horizon	Shenandoah SC - C Horizon
				Sampling date / time	31-Mar-2023 00:00	31-Mar-2023 00:00	31-Mar-2023 00:00	31-Mar-2023 00:00	31-Mar-2023 00:00
Compound	CAS Number	LOR	Unit		ES2311781-001	ES2311781-002	ES2311781-003	ES2311781-004	ES2311781-005
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		7.3	7.1	6.7	7.0	6.8
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		6	7	8	10	12
EA058: Emerson Aggregate Test									
Color (Munsell)	----	-	-		Dark Brown (7.5YR 3/4)	Dark Reddish Brown (5YR 3/3)	Dark Gray (10YR 4/1)	Brown (10YR 5/3)	Grayish Brown (10YR 5/2)
Texture	----	-	-		Sandy Loam	Sandy Loam	Silty Clay Loam	Clay Loam Sandy	Clay Loam Sandy
Emerson Class Number	EC/TC	-	-		2	2	2	2	2
ED007: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		1.8	1.5	3.6	4.4	4.8
Exchangeable Magnesium	----	0.1	meq/100g		0.4	0.5	0.7	1.1	1.6
Exchangeable Potassium	----	0.1	meq/100g		0.2	0.2	0.1	0.1	0.1
Exchangeable Sodium	----	0.1	meq/100g		<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g		2.4	2.2	4.4	5.6	6.5
Exchangeable Sodium Percent	----	0.1	%		<0.1	<0.1	<0.1	0.2	0.4

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	Shenandoah SB - Horizon A	Shenandoah SB - Horizon C	Shen NA - Option 1 - A Horiz	Shen NA - Option 1 - Horiz B	Amungee NW3 - Horiz A
			Sampling date / time	01-Apr-2023 00:00	01-Apr-2023 00:00	01-Apr-2023 00:00	01-Apr-2023 00:00	02-Apr-2023 00:00
Compound	CAS Number	LOR	Unit	ES2311781-006	ES2311781-007	ES2311781-008	ES2311781-009	ES2311781-010
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**7.0**	**7.4**	**6.5**	**6.3**	**6.5**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**17**	**13**	**12**	**8**	**8**
EA058: Emerson Aggregate Test								
Color (Munsell)	----	-	-	**Dark Gray (10YR 4/1)**	**Gray (10YR 6/1)**	**Dark Gray (5YR 4/1)**	**Dark Yellowish Brown (10YR 4/4)**	**Dark Reddish Gray (5YR 4/2)**
Texture	----	-	-	**Clay Loam Sandy**	**Light Medium Clay**	**Clay Loam Sandy**	**Sandy Clay Loam**	**Clay Loam**
Emerson Class Number	EC/TC	-	-	**2**	**2**	**2**	**2**	**2**
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	**2.2**	**3.4**	**3.4**	**3.8**	**2.3**
Exchangeable Magnesium	----	0.1	meq/100g	**0.4**	**1.2**	**1.5**	**2.3**	**0.5**
Exchangeable Potassium	----	0.1	meq/100g	**0.2**	**0.3**	**0.2**	**0.2**	**0.2**
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	**2.8**	**4.9**	**5.1**	**6.3**	**3.0**
Exchangeable Sodium Percent	----	0.1	%	<0.1	<0.1	<0.1	**0.3**	<0.1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	Amungee NW3 - Horiz C	Shenandoah NA - OP 2 - Horiz A	Shenandoah NA - Option 2 - Horiz B	Shenandoah NA - Option 2 - Horiz C	Shenandoah NB - Horiz A
			Sampling date / time	02-Apr-2023 00:00	02-Apr-2023 00:00	02-Apr-2023 00:00	02-Apr-2023 00:00	03-Apr-2023 00:00
Compound	CAS Number	LOR	Unit	ES2311781-011	ES2311781-012	ES2311781-013	ES2311781-014	ES2311781-015
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**6.9**	**5.8**	**5.6**	**6.2**	**6.2**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**14**	**10**	**10**	**9**	**5**
EA058: Emerson Aggregate Test								
Color (Munsell)	----	-	-	**Dark Reddish Brown (5YR 3/4)**	**Gray (7.5YR 5/1)**	**Brown (10YR 5/3)**	**Strong Brown (7.5YR 4/6)**	**Dark Reddish Brown (5YR 3/3)**
Texture	----	-	-	**Silty Loam**	**Clay Loam Sandy**	**Light Medium Clay**	**Medium Clay**	**Clayey Sand**
Emerson Class Number	EC/TC	-	-	**3**	**2**	**2**	**2**	**2**
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	**3.2**	**1.5**	**1.9**	**2.9**	**1.7**
Exchangeable Magnesium	----	0.1	meq/100g	**0.8**	**0.7**	**1.1**	**1.8**	**0.3**
Exchangeable Potassium	----	0.1	meq/100g	**0.2**	**0.2**	**0.1**	<0.1	**0.2**
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	**4.2**	**2.4**	**3.1**	**4.7**	**2.2**
Exchangeable Sodium Percent	----	0.1	%	<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	Shenandoah NB - Horiz B	Shenandoah NB - Horiz C	Amungee NW4 - Horizon A	Amungee NW4 - Horizon B	Amungee NW4 - Horizon C
			Sampling date / time	03-Apr-2023 00:00	03-Apr-2023 00:00	03-Apr-2023 00:00	03-Apr-2023 00:00	03-Apr-2023 00:00
Compound	CAS Number	LOR	Unit	ES2311781-016	ES2311781-017	ES2311781-018	ES2311781-019	ES2311781-020
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**6.2**	**6.1**	**6.8**	**6.9**	**6.9**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**6**	**6**	**15**	**12**	**10**
EA058: Emerson Aggregate Test								
Color (Munsell)	----	-	-	**Dark Reddish Brown (5YR 3/4)**	**Reddish Brown (2.5YR 4/4)**	**Dark Reddish Brown (5YR 3/4)**	**Dark Reddish Brown (5YR 3/4)**	**Dark Reddish Brown (5YR 3/4)**
Texture	----	-	-	**Silty Loam**	**Silty Clay Loam**	**Silty Loam**	**Silty Loam**	**Sandy Loam**
Emerson Class Number	EC/TC	-	-	**2**	**3**	**3**	**2**	**2**
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	**1.1**	**0.8**	**3.1**	**1.8**	**1.4**
Exchangeable Magnesium	----	0.1	meq/100g	**0.3**	**0.5**	**0.6**	**0.5**	**0.5**
Exchangeable Potassium	----	0.1	meq/100g	**0.2**	**0.1**	**0.2**	**0.2**	**0.2**
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	**1.6**	**1.4**	**3.9**	**2.4**	**2.2**
Exchangeable Sodium Percent	----	0.1	%	<0.1	<0.1	<0.1	<0.1	<0.1

Inter-Laboratory Testing

Analysis conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818 (Chemistry) 18958 (Biology).

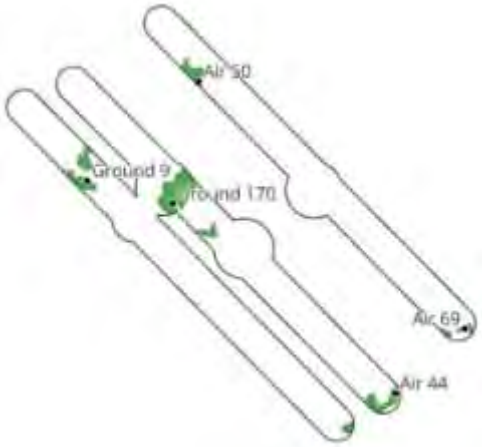
(SOIL) EA058: Emerson Aggregate Test

Appendix B

Vegetation Community Description

Appendix B Vegetation Community Description

Shenandoah South Well pad Areas

Community 1a - *Acacia shirleyi* mid high woodland over *Macropteranthes kekwickii, Terminalia volucris* ± *Acacia difficilis* mid high shrubland, over *Panicum trichoides, Panicum mindanaense, Bulbostylis barbata* mid high open tussock grassland	
Upper 1: Mid high woodland dominated by *Acacia shirleyi*	
Mid 1: Mid high shrubland dominated by *Macropteranthes kekwickii, Terminalia volucris* ± *Acacia difficilis* mid	
Ground 1: Mid high open tussock grassland dominated by *Panicum trichoides, Panicum mindanaense, Bulbostylis barbata*	
	
No. of sites: (5) Ground 9, Ground 170, Air 44, Air 50, Air 69	
Other common species	
Upper stratum (U1): -	
Mid stratum (M1): -	
Ground stratum (G1): *Bidens bipinnata, Waltheria indica, Hibiscus sturtii var. campylochlamys*	
Landform: Lateritic Plains and Rises -associated with deeply weathered profiles (laterite) including sand sheets and other depositional products, sandy and earth soils	
Soil: Brown sandy loam kandosol soils.	
Total area of the survey area: 193.73 ha (3.57%)	
Community structural summary	

Strata	Modal growth form	Mean cover %	Mean height (m)
Upper U1	Tree	39 (35 – 40)	11 (10 – 12)
Mid M1	Shrub	37.5 (35 – 40)	6
Ground G1	Tussock grass	20	0.5

Community 2a - *Corymbia dichromophloia ± Erythrophleum chlorostachys* mid high open woodland, over *Acacia difficilis ± Terminalia canescens, Erythrophleum chlorostachys* mid high open shrubland, over *Triodia bitextura, Aristida hygrometrica, Chrysopogon fallax* mid high hummock grassland

Upper 1: Mid high open woodland dominated by *Corymbia dichromophloia ± Erythrophleum chlorostachys*

Mid 1: Mid high open shrubland dominated by *Acacia difficilis ± Terminalia canescens, Erythrophleum*

Ground 1: Mid high hummock grassland dominated by *Triodia bitextura, Aristida hygrometrica, Chrysopogon fallax*

No. of sites: (46) Shen S A, Ground 8, Ground 16, Ground 17, ground 24, Ground 40, Ground 41, Ground 43, Ground 60, Ground 61, Ground 66, Ground 68, Air 1, Air 2, Air 4, Air 5, Air 6, Air 7, Air 11, Air 12, Air 19, Air 20, Air 21, Air 22, Air 23, Air 25, Air 28, Air 34, Air 35, Air 36, Air 37, Air 38, Air 39, Air 42, Air 46, Air 47, Air 49, Air 58, Air 62, Air 63, Air 64, Air 65, Shen S 2, 3, 4, 5

Other common species

Upper stratum (U1): *Acacia shirleyi, Eucalyptus chlorophylla*

Mid stratum (M1): *Grevillea parallela, Dodonaea hispidula, Ehretia saligna, Acacia drepanocarpa subsp. latifolia, Acacia thomsonii, Acacia gonoclada, Brachychiton diversifolius, Brachychiton paradoxus, Grewia savannicola, Macropteranthes kekwickii, Persoonia falcata, Petalostigma pubescens, Wrightia saligna*

Ground stratum (G1): *Aristida inaequiglumis, Setaria surgens, Corchorus sidoides, Eriachne ciliata, Mnesithea formosa*

Landform: Lateritic Plains and Rises -associated with deeply weathered profiles (laterite) including sand sheets and other depositional products, sandy and earth soils

Soil: Brown sandy loam kandosol soils.

Total area of the survey area: 3,385.2 ha (62.40%)

Community structural summary

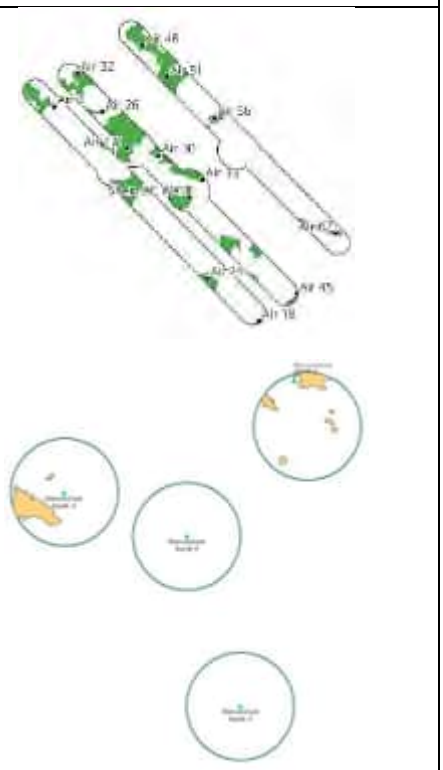
Strata	Modal growth form	Mean cover %	Mean height (m)
Upper U1	Tree	14 (8 – 16)	12.2 (12 – 14)
Mid M1	Shrub	21 (10 – 30)	6.2 (6 – 7)
Ground G1	Tussock grass	37 (15 – 70)	0.5

Community 2b - *Acacia shirleyi, Corymbia dichromophloia ± Eucalyptus leucophloia, Corymbia polycarpa* mid high open woodland, over *Macropteranthes kekwickii, Petalostigma pubescens, Hakea arborescens* mid high open shrubland, over *Chrysopogon fallax, Mnesithea formosa, Eriachne ciliata* mid high tussock grassland

Upper 1: Mid high open woodland dominated by *Acacia shirleyi, Corymbia dichromophloia ± Eucalyptus leucophloia, Corymbia polycarpa*

Mid 1: Mid high open shrubland dominated by *Macropteranthes kekwickii, Petalostigma pubescens, Hakea arborescens*

Ground 1: Mid high tussock grassland dominated by *Chrysopogon fallax, Mnesithea formosa, Eriachne ciliata*



No. of sites: (15) Shen S C Well, Air 3, Air 15, Air 18, Air 26, Air 30, Air 32, Air 33, Air 45, Air 48, Air 51, Air 56, Air 67, Air 171 (incorporated veg description from Shenandoah North), Shen S 4

Other common species

Upper stratum (U1): *Ventilago viminalis*

Mid stratum (M1): *Calytrix exstipulata, Eucalyptus chlorophylla, Terminalia volucris*

Ground stratum (G1): *Sorghum intrans, Eulalia aurea*

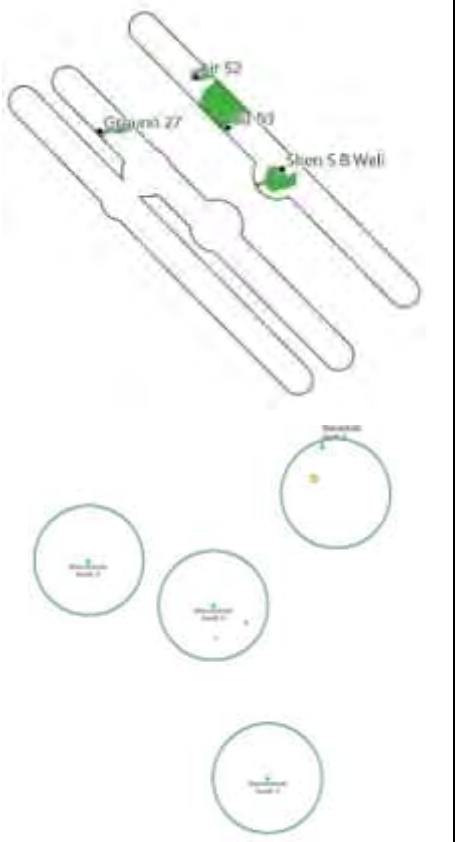
Landform: Lateritic Plains and Rises -associated with deeply weathered profiles (laterite) including sand sheets and other depositional products, sandy and earth soils

Soil: Brown sandy loam kandosol soils.

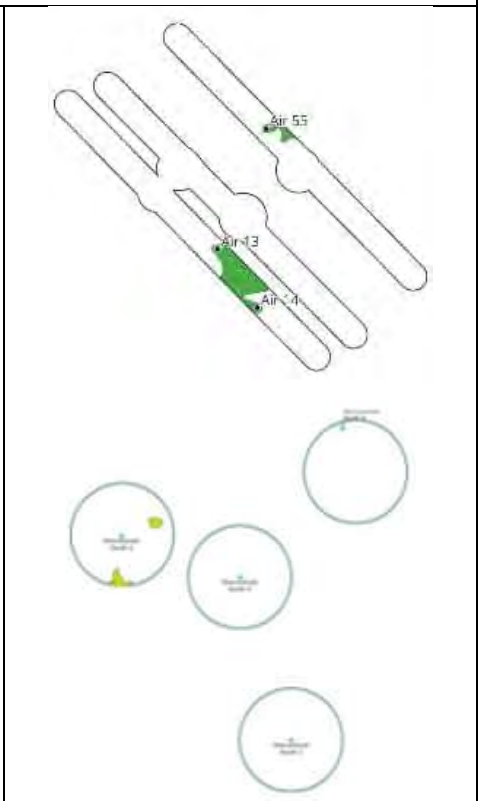
Total area of the survey area: 912.17 ha (16.81%)

Community structural summary

Strata	Modal growth form	Mean cover %	Mean height (m)
Upper U1	Tree	17 (10 – 35)	12
Mid M1	Shrub	17.8 (7 – 20)	6.3 (5 – 8)
Ground G1	Tussock grass	65 (60 – 70)	0.5

Community 3a - *Corymbia polycarpa, Eucalyptus chlorophylla, Acacia shirleyi* mid high open woodland, over *Acacia difficilis, Macropteranthes kekwickii, Erythrophleum chlorostachys* mid high open shrubland, over *Aristida sp1, Aristida sp3* mid high open tussock grassland	
Upper 1: Mid high open woodland dominated by *Corymbia polycarpa, Eucalyptus chlorophylla, Acacia shirleyi*	
Mid 1: Mid high open shrubland dominated by *Acacia difficilis, Macropteranthes kekwickii, Erythrophleum chlorostachys*	
Ground 1: Mid high open tussock grassland dominated by *Aristida hygrometrica, Aristida contorta*	
	
No. of sites: (4) Shen S B Well, Ground 27, Air 52, Air 53	
Other common species	
Upper stratum (U1): -	
Mid stratum (M1): *Atalaya hemiglauca*	
Ground stratum (G1): *Pterocaulon serrulatum, Grewia savannicola*	
Landform: Lateritic Plains and Rises -associated with deeply weathered profiles (laterite) including sand sheets and other depositional products, sandy and earth soils	
Soil: Brown sandy loam kandosol soils.	
Total area of the survey area: 258.05 ha (4.76%)	
Community structural summary	

Strata	Modal growth form	Mean cover %	Mean height (m)
Upper U1	Tree	16	12
Mid M1	Shrub	20 (15 – 25)	5
Ground G1	Tussock grass	15	0.5

Community 4a - *Acacia shirleyi ± Eucalyptus pruinosa, Eucalyptus chlorophylla* mid high woodland, over *Melaleuca viridiflora, Eucalyptus pruinosa, Eucalyptus chlorophylla* mid high open shrubland, over *Eriachne armitii, Eragrostis cumingii, Aristida contorta* mid high open tussock grassland	
Upper 1: Mid high woodland dominated by *Acacia shirleyi ± Eucalyptus pruinosa, Eucalyptus chlorophylla*	
Mid 1: Mid high open shrubland dominated by *Melaleuca viridiflora, Eucalyptus pruinosa, Eucalyptus chlorophylla*	
Ground 1: Mid high open tussock grassland dominated by *Eriachne armitii, Eragrostis cumingii, Aristida contorta*	
	
No. of sites: (3) Air 13, Air 14, Air 55 (incorporated veg description from Shenandoah North)	
Other common species	
Upper stratum (U1): -	
Mid stratum (M1): *Acacia difficilis, Carissa lanceolata, Macropteranthes kekwickii, Corymbia grandifolia*	
Ground stratum (G1): -	
Landform: Drainage floors and relic drainages associated with clay and alluvial soils	
Soil: Brown clay soils	
Total area of the survey area: 248.52 ha (4.58%)	
Community structural summary	

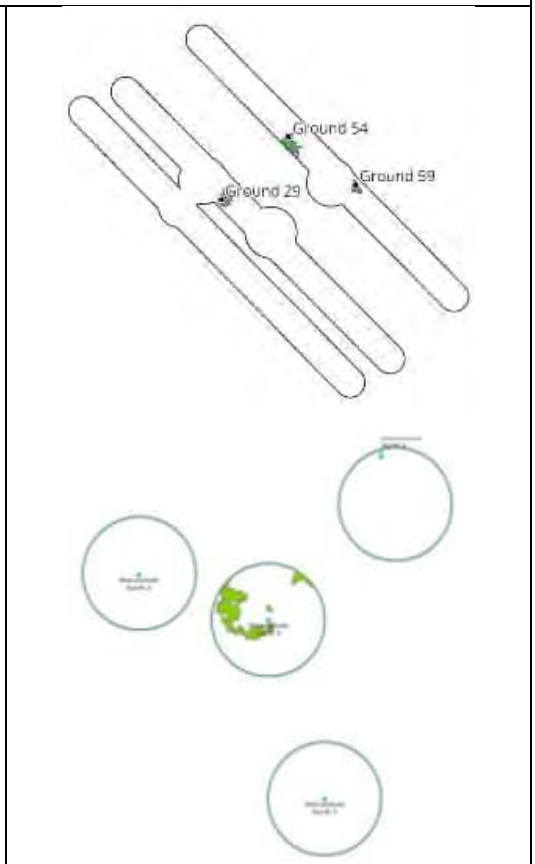
Strata	Modal growth form	Mean cover %	Mean height (m)
Upper U1	Tree	24 (6 – 60)	10.4 (8 – 12)
Mid M1	Shrub	18 (10 – 30)	5
Ground G1	Tussock grass	15 (5 – 25)	0.5

Community 4b - *Corymbia polycarpa, Eucalyptus microtheca* low open woodland, over *Melaleuca nervosa, Hakea arborescens, Melaleuca viridiflora* mid high open shrubland, over *Aristida contorta, Waltheria indica, Eriachne armitii* mid high tussock grassland

Upper 1: Low open woodland dominated by *Corymbia polycarpa, Eucalyptus microtheca*

Mid 1: Mid high open shrubland dominated by *Melaleuca nervosa, Hakea arborescens, Melaleuca viridiflora*

Ground 1: Mid high tussock grassland dominated by *Aristida contorta, Waltheria indica, Eriachne armitii*



No. of sites: (3) Ground 29, Ground 54, Ground 59

Other common species

Upper stratum (U1): -

Mid stratum (M1): *Acacia difficilis, Acacia holosericea, Macropteranthes kekwickii*

Ground stratum (G1): *Aristida hygrometrica, Eulalia aurea, Setaria surgens*

Landform: Drainage floors and relic drainages associated with clay and alluvial soils

Soil: Brown clay soils

Total area of the survey area: 88.79 ha (1.64%)

Community structural summary

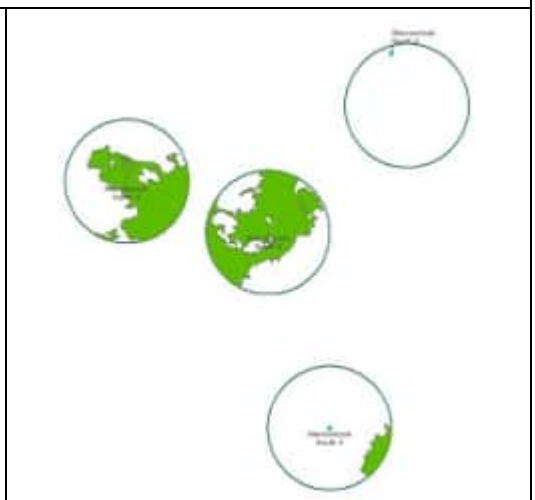
Strata	Modal growth form	Mean cover %	Mean height (m)
Upper U1	Tree	8	9.6 (7 – 12)
Mid M1	Shrub	26.6 (20 – 40)	5.3 (5 – 6)
Ground G1	Tussock grass	31.6 (15 – 60)	0.5

Community 4c - *Melaleuca viridiflora low open woodland +/- Acacia torulosa over Triodia bitextura hummock grassland*

Upper 1: Nil

Mid 1: Open shrubland dominated by *Acacia tumida, Acacia torulosa and Melaleuca viridiflora*

Ground 1: *Triodia bitextura* open hummock grassland



No. of sites: (2) Shenandoah South 4, Shenandoah South 5

Other common species

Upper stratum (U1): Nil

Mid stratum (M1): *Acacia tumida, Acacia torulosa and Melaleuca viridiflora*

Ground stratum (G1): *Triodia bitextura*

Landform: Plain with clay and alluvial soils

Soil: Yellowish brown to Brown sandy clay loam soils

Total area of the survey area: 312.52 ha (5.76%)

Community structural summary

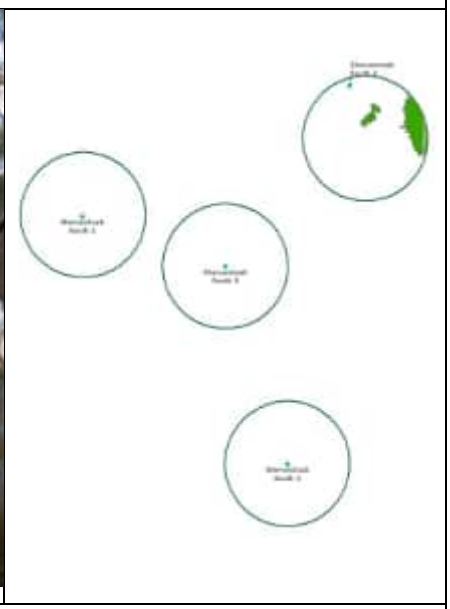
Strata	Modal growth form	Mean cover %	Mean height (m)
Upper U1	Tree	-	-
Mid M1	Shrub	40	1.5-5
Ground G1	Tussock grass	30	0.5

Community 4d - *Eucalyptus camaldulensis* low woodland over *Melaleuca viridiflora* mid high sparse shrubland over *Dactyloctenium radulans, Eragrostis cumingii* mid high open tussock grassland

Upper 1: Low woodland dominated by *Eucalyptus camaldulensis*

Mid 1: Mid high sparse shrubland dominated by *Melaleuca viridiflora*

Ground 1: Mid high open tussock grassland dominated by *Dactyloctenium radulans, Eragrostis cumingii*



No. of sites: (1) Ground 75

Other common species

Upper stratum (U1): -

Mid stratum (M1): -

Ground stratum (G1): -

Landform: Riparian creek lines with sandy and alluvial soils

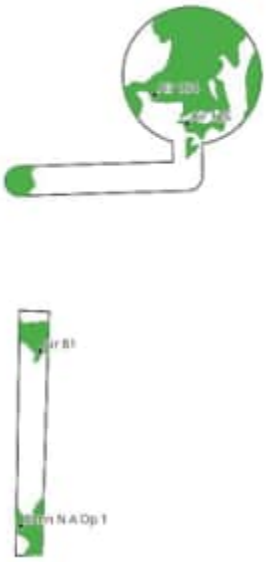
Soil: Brown sandy clay soils.

Total area of the survey area: 6.48 ha (0.81%)

Community structural summary

Strata	Modal growth form	Mean cover %	Mean height (m)
Upper U1	Tree	25	8
Mid M1	Shrub	6	4
Ground G1	Tussock grass	20	0.5

Shenandoah North Well pad Areas

Community 1a - *Acacia shirleyi* mid high woodland over *Macropteranthes kekwickii* ± *Atalaya hemiglauca, Acacia holosericea* mid high open shrubland over *Fimbristylis sp*, *Brachyachne convergens*, *Aristida sp3* mid high open tussock grassland
Upper 1: Mid high woodland dominated by *Acacia shirleyi*
Mid 1: Mid high open shrubland dominated by *Macropteranthes kekwickii*
Ground 1: Mid high open tussock grassland dominated by *Fimbristylis sp, Brachyachne convergens*, *Aristida contorta*

No. of sites: (4) Shen N A Op 1, Air 81, Air 126, Air 134
Other common species
Upper stratum (U1): -
Mid stratum (M1): -
Ground stratum (G1): -
Landform: Lateritic Plains and Rises -associated with deeply weathered profiles (laterite) including sand sheets and other depositional products, sandy and earth soils
Soil: Brown sandy loam kandosol soils.
Total area of the survey area: 325.83 ha (40.65%)
Community structural summary

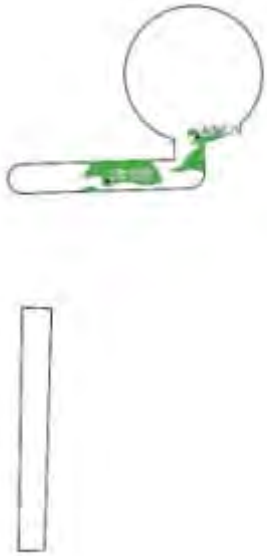
Strata	Modal growth form	Mean cover %	Mean height (m)
Upper U1	Tree	40 (8 – 60)	12
Mid M1	Shrub	20	7
Ground G1	Tussock grass	20	0.5

Community 2a - *Corymbia dichromophloia ± Erythrophleum chlorostachys* mid high open woodland over *Acacia difficilis ± Terminalia canescens, Erythrophleum chlorostachys* mid high open shrubland over *Triodia bitextura, Aristida hygrometrica, Chrysopogon fallax* mid high hummock grassland

Upper 1: Mid high open woodland dominated by *Corymbia dichromophloia*, *Erythrophleum chlorostachys*

Mid 1: Mid high open shrubland dominated by *Acacia difficilis ± Terminalia canescens, Erythrophleum chlorostachys*

Ground 1: Mid high hummock grassland dominated by *Triodia bitextura, Aristida hygrometrica, Chrysopogon fallax*



No. of sites: (2) Air 122, Air 129 (incorporated veg description from Shenandoah South)

Other common species

Upper stratum (U1): *Acacia shirleyi, Eucalyptus chlorophylla*

Mid stratum (M1): *Grevillea parallela, Dodonaea hispidula, Ehretia saligna, Acacia drepanocarpa subsp. latifolia, Acacia thomsonii, Acacia gonoclada, Brachychiton diversifolius, Brachychiton paradoxus, Grewia savannicola, Macropteranthes kekwickii, Persoonia falcata, Petalostigma pubescens, Wrightia saligna*

Ground stratum (G1): *Aristida inaequiglumis, Setaria surgens, Sorghum intrans, Corchorus sidoides, Eriachne ciliata, Mnesithea formosa*

Landform: Lateritic Plains and Rises -associated with deeply weathered profiles (laterite) including sand sheets and other depositional products, sandy and earth soils

Soil: Brown sandy loam kandosol soils.

Total area of the survey area: 66.37 ha (8.28%)

Community structural summary

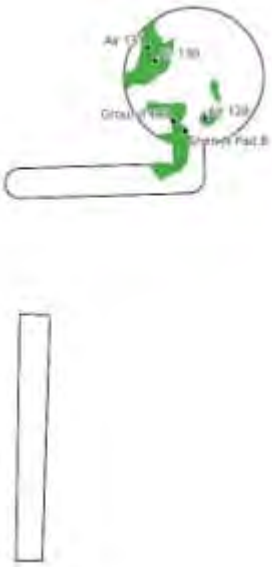
Strata	Modal growth form	Mean cover %	Mean height (m)
Upper U1	Tree	14 (8 – 16)	12.2 (12 – 14)
Mid M1	Shrub	21 (10 – 30)	6.2 (6 – 7)
Ground G1	Tussock grass	37)15 – 70)	0.5

Community 2b - *Acacia shirleyi, Corymbia dichromophloia ± Eucalyptus leucophloia,* mid high open woodland over *Macropteranthes kekwickii, Petalostigma pubescens, Hakea arborescens* mid high open shrubland over *Chrysopogon fallax, Mnesithea formosa, Eriachne ciliata* mid high tussock grassland

Upper 1: Mid high open woodland dominated by *Acacia shirleyi, Corymbia dichromophloia ± Eucalyptus leucophloia,*

Mid 1: Mid high open shrubland dominated by *Macropteranthes kekwickii, Petalostigma pubescens, Hakea arborescens*

Ground 1: Mid high tussock grassland dominated by *Chrysopogon fallax, Mnesithea formosa, Eriachne ciliata*



No. of sites: (5) Shen N Pad B, Ground 135, Air 128, Air 130, Air 131

Other common species

Upper stratum (U1): *Corymbia polycarpa*

Mid stratum (M1): *Calytrix exstipulata, Terminalia volucris*

Ground stratum (G1): -

Landform: Lateritic Plains and Rises -associated with deeply weathered profiles (laterite) including sand sheets and other depositional products, sandy and earth soils

Soil: Brown sandy loam kandosol soils.

Total area of the survey area: 98.78 ha (12.32%)

Community structural summary

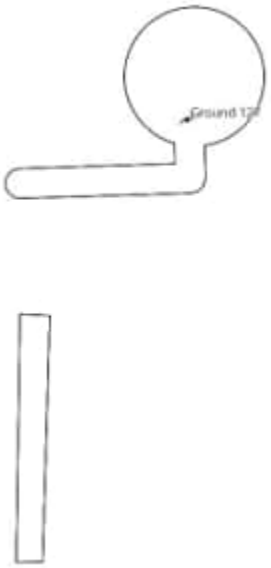
Strata	Modal growth form	Mean cover %	Mean height (m)
Upper U1	Tree	18 (12 – 35)	12
Mid M1	Shrub	17 (7 – 20)	6.5 (5 – 8)
Ground G1	Tussock grass	65 (60 – 70)	0.5

Community 2c - *Eucalyptus leucophloia, Corymbia dichromophloia, Acacia shirleyi* mid high woodland over *Dodonaea hispidula, Calytrix exstipulata* mid high open shrubland over *Triodia bitextura, Eriachne ciliata, Aristida contorta* mid high open hummock grassland

Upper 1: Mid high woodland dominated by *Eucalyptus leucophloia, Corymbia dichromophloia, Acacia shirleyi* mid

Mid 1: Mid high open shrubland dominated by *Dodonaea hispidula, Calytrix exstipulata*

Ground 1: Mid high open tussock grassland dominated by *Triodia bitextura, Eriachne ciliata, Aristida contorta*



No. of sites: (1) Ground 127

Other common species

Upper stratum (U1): -

Mid stratum (M1): -

Ground stratum (G1): -

Landform: Lateritic Plains and Rises -associated with deeply weathered profiles (laterite) including sand sheets and other depositional products, sandy and earth soils

Soil: Brown sandy loam kandosol soils.

Total area of the survey area: 1.77ha (0.22%)

Community structural summary

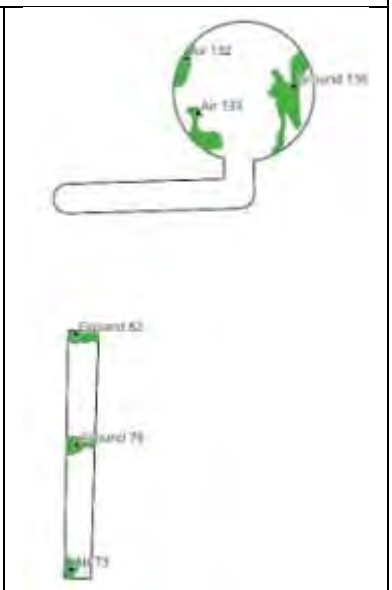
Strata	Modal growth form	Mean cover %	Mean height (m)
Upper U1	Tree	45	10
Mid M1	Shrub	12	5
Ground G1	Tussock grass	30	0.5

Community 3a - *Eucalyptus chlorophylla, Corymbia polycarpa* ± *Corymbia confertiflora* mid high open woodland over *Erythrophleum chlorostachys, Acacia holosericea, Acacia difficilis* mid high open shrubland over *Chrysopogon fallax, Dichanthium fecundum, Sehima nervosum* mid high tussock grassland

Upper 1: Mid high open woodland dominated by *Eucalyptus chlorophylla, Corymbia polycarpa* ± *Corymbia confertiflora*

Mid 1: Mid high open shrubland dominated by *Erythrophleum chlorostachys, Acacia holosericea, Acacia difficilis*

Ground 1: Mid high tussock grassland dominated by *Chrysopogon fallax, Dichanthium fecundum, Sehima nervosum*



No. of sites: (6) Ground 79, Ground 82, Ground 136, Air 73, Air 133, Air 132

Other common species

Upper stratum (U1): *Erythrophleum chlorostachys, Acacia shirleyi*

Mid stratum (M1): -

Ground stratum (G1): -

Landform: Lateritic Plains and Rises -associated with deeply weathered profiles (laterite) including sand sheets and other depositional products, sandy and earth soils

Soil: Brown sandy loam kandosol soils.

Total area of the survey area: 102.38 ha (12.77%)

Community structural summary

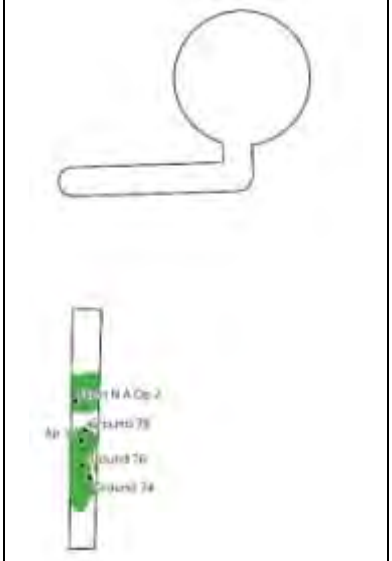
Strata	Modal growth form	Mean cover %	Mean height (m)
Upper U1	Tree	17 (12 – 30)	12.5 (12 – 14)
Mid M1	Shrub	20 (15 – 25)	6 (5 – 8)
Ground G1	Tussock grass	56 (20 – 80)	0.5

Community 4a – *Acacia shirleyi ± Eucalyptus pruinosa, Eucalyptus chlorophylla* mid high woodland over *Melaleuca viridiflora, Eucalyptus pruinosa, Eucalyptus chlorophylla* mid high open shrubland over *Eriachne armitii, Eragrostis cumingii, Aristida contorta* mid high open tussock grassland

Upper 1: Mid high woodland dominated by *Acacia shirleyi ± Eucalyptus pruinosa, Eucalyptus*

Mid 1: Mid high open shrubland dominated by *Melaleuca viridiflora, Eucalyptus pruinosa, Eucalyptus chlorophylla*

Ground 1: Mid high open tussock grassland dominated by *Eriachne armitii, Eragrostis cumingii, Aristida contorta*



No. of sites: (5) Ground 74, Ground 76, Ground 78, Shen N A Op 2, Air 77

Other common species

Upper stratum (U1): -

Mid stratum (M1): *Acacia difficilis, Carissa lanceolata, Macropteranthes kekwickii, Corymbia grandifolia*

Ground stratum (G1): *Brachyachne convergens, Mnesithea formosa*

Landform: Drainage floors and relic drainages associated with clay and alluvial soils

Soil: Brown clay soils

Total area of the survey area: 87.94 ha (10.97%)

Community structural summary

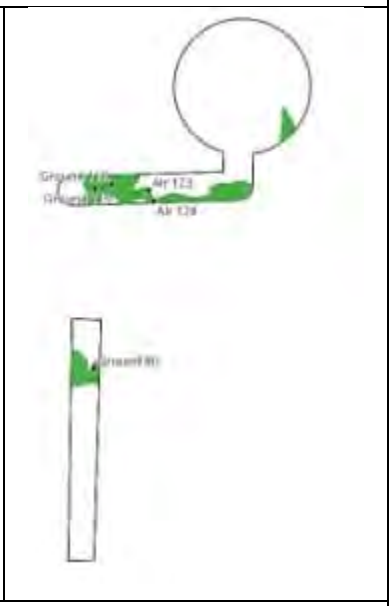
Strata	Modal growth form	Mean cover %	Mean height (m)
Upper U1	Tree	24 (6 – 60)	10.4 (8 – 12)
Mid M1	Shrub	18 (10 – 30)	5
Ground G1	Tussock grass	15 (5-25)	0.5

Community 4b - *Eucalyptus microtheca, Corymbia polycarpa, Eucalyptus camaldulensis* mid high open woodland over *Acacia holosericea, Acacia lysiphloia, Macropteranthes kekwickii* mid high open shrubland over *Eulalia aurea, Panicum mindanaense, Eragrostis cumingii* mid high tussock grassland

Upper 1: Mid high open woodland dominated by *Eucalyptus microtheca, Corymbia polycarpa, Eucalyptus camaldulensis*

Mid 1: Mid high open shrubland dominated by *Acacia holosericea, Acacia lysiphloia, Macropteranthes kekwickii*

Ground 1: Mid high tussock grassland dominated by *Eulalia aurea, Panicum mindanaense, Eragrostis cumingii*



No. of sites: (5) Ground 80, Ground 118, Ground 119, Air 123, Air 124

Other common species

Upper stratum (U1): -

Mid stratum (M1): *Acacia alleniana*

Ground stratum (G1): *Chrysopogon fallax*

Landform: Drainage floors and relic drainages associated with clay and alluvial soils

Soil: Brown clay soils

Total area of the survey area: 109.16 ha (13.62%)

Community structural summary

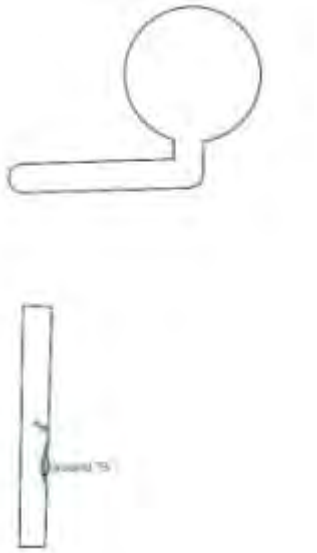
Strata	Modal growth form	Mean cover %	Mean height (m)
Upper U1	Tree	24 (20 – 30)	11.5 (8 – 14)
Mid M1	Shrub	21 (5 – 30)	5.3 (4 – 6)
Ground G1	Tussock grass	36.6 (5 – 80)	0.5 (0.5 – 0.6)

Community 4d - *Eucalyptus camaldulensis* low woodland over *Melaleuca viridiflora* mid high sparse shrubland over *Dactyloctenium radulans, Eragrostis cumingii* mid high open tussock grassland

Upper 1: Low woodland dominated by *Eucalyptus camaldulensis*

Mid 1: Mid high sparse shrubland dominated by *Melaleuca viridiflora*

Ground 1: Mid high open tussock grassland dominated by *Dactyloctenium radulans, Eragrostis cumingii*



No. of sites: (1) Ground 75

Other common species

Upper stratum (U1): -

Mid stratum (M1): -

Ground stratum (G1): -

Landform: Riparian creek lines with sandy and alluvial soils

Soil: Brown sandy clay soils.

Total area of the survey area: 6.48 ha (0.81%)

Community structural summary

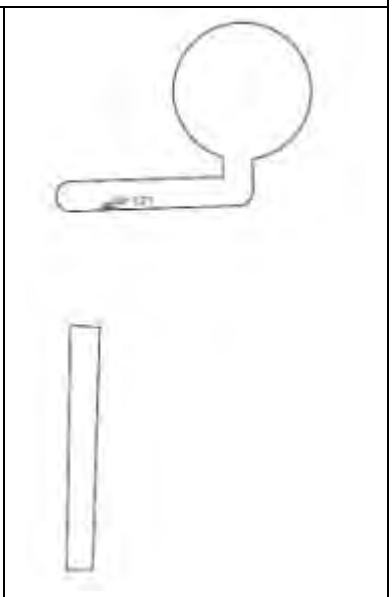
Strata	Modal growth form	Mean cover %	Mean height (m)
Upper U1	Tree	25	8
Mid M1	Shrub	6	4
Ground G1	Tussock grass	20	0.5

Community 4e - *Eucalyptus camaldulensis* mid high open woodland over *Eucalyptus microtheca* mid high open shrubland

Upper 1: Mid high open woodland dominated by *Eucalyptus camaldulensis*

Mid 1: Mid high open shrubland dominated by *Eucalyptus microtheca*

Ground 1: Flooded



No. of sites: (1) Air 121

Other common species

Upper stratum (U1): -

Mid stratum (M1): -

Ground stratum (G1): -

Landform: Closed drainage, waterholes and swamps

Soil: Brown clay soils

Total area of the survey area: 2.94 ha (0.37%)

Community structural summary

Strata	Modal growth form	Mean cover %	Mean height (m)
Upper U1	Tree	15	12
Mid M1	Shrub	10	8
Ground G1	Tussock grass	-	-

Appendix C

Flora Atlas Species Records

Appendix C Flora Atlas Species Records

Table 41 Native flora recorded within 5 km of the project area

Family	Genus	Species
ACANTHACEAE	*Dicliptera*	*armata*
	Hygrophila	*angustifolia*
AMARANTHACEAE	*Achyranthes*	*aspera*
	Alternanthera	*denticulata*
	Alternanthera	*nana*
	Alternanthera	*nodiflora*
	Ptilotus	*fusiformis*
	Ptilotus	*polystachyus*
	Ptilotus	*spicatus*
APOCYNACEAE	*Carissa*	*lanceolata*
	Cynanchum	*viminale*
	Marsdenia	*australis*
	Marsdenia	*geminata*
	Marsdenia	*viridiflora*
	Secamone	*elliptica*
ASTERACEAE	*Bidens*	*bipinnata*
	Pterocaulon	*serrulatum*
	Pterocaulon	*sphacelatum*
BIGNONIACEAE	*Dolichandrone*	*heterophylla*
BORAGINACEAE	*Ehretia*	*saligna*
	Heliotropium	*ramulipatens*
CAPPARACEAE	*Capparis*	*lasiantha*
	Capparis	*umbonata*
CARYOPHYLLACEAE	*Polycarpaea*	*breviflora*
CELASTRACEAE	*Denhamia*	*cunninghamii*
	Denhamia	*obscura*
CLEOMACEAE	*Cleome*	*viscosa*
COMBRETACEAE	*Macropteranthes*	*kekwickii*
	Terminalia	*canescens*
	Terminalia	*volucris*
COMMELINACEAE	*Commelina*	*ciliata*
	Cyanotis	*axillaris*
CONVOLVULACEAE	*Bonamia*	*pannosa*
	Evolvulus	*alsinoides*

CONVOLVULACEAE	*Ipomoea*	*argillicola*
	Ipomoea	*diamantinensis*
	Ipomoea	*eriocarpa*
	Ipomoea	*gracilis*
	Ipomoea	*polymorpha*
	Polymeria	*longifolia*
	Xenostegia	*tridentata*
CUCURBITACEAE	*Cucumis*	*melo*
CYPERACEAE	*Bulbostylis*	*barbata*
	Cyperus	*carinatus*
	Cyperus	*tenuispica*
	Eleocharis	*atropurpurea*
	Eleocharis	*brassii*
	Fimbristylis	*depauperata*
	Fimbristylis	*laxiglumis*
	Fimbristylis	*microcarya*
	Fimbristylis	*phaeoleuca*
	Schoenoplectiella	*dissachantha*
	Schoenoplectiella	*laevis*
ELATINACEAE	*Bergia*	*pedicellaris*
ERIOCAULACEAE	*Eriocaulon*	*cinereum*
EUPHORBIACEAE	*Euphorbia*	*australis*
	Euphorbia	*bifida*
	Excoecaria	*parvifolia*
FABACEAE	*Abrus*	*precatorius*
	Acacia	*ancistrocarpa*
	Acacia	*hammondii*
	Acacia	*lysiphloia*
	Acacia	*monticola*
	Acacia	*shirleyi*
	Acacia	*stenophylla*
	Aeschynomene	*indica*
	Bauhinia	*cunninghamii*
	Chamaecrista	*absus*
	Crotalaria	*medicaginea*
	Crotalaria	*montana*
	Desmodium	*muelleri*
	Dichrostachys	*spicata*

FABACEAE	*Erythrophleum*	*chlorostachys*
	Flemingia	*parviflora*
	Galactia	*tenuiflora*
	Neptunia	*gracilis*
	Neptunia	*monosperma*
	Petalostylis	*cassioides*
	Rhynchosia	*minima*
	Sesbania	*cannabina*
	Sesbania	*muelleri*
	Tephrosia	*brachyodon*
	Vigna	*lanceolata*
	Vigna	*sp. McDonald Downs Station*
	Zornia	*muriculata*
GOODENIACEAE	*Goodenia*	*byrnesii*
	Goodenia	*minutiflora*
	Goodenia	*strangfordii*
	Goodenia	*viscidula*
	Scaevola	*browniana*
	Scaevola	*ovalifolia*
HYDROLEACEAE	*Hydrolea*	*zeylanica*
LAMIACEAE	*Clerodendrum*	*floribundum*
LORANTHACEAE	*Amyema*	*sanguinea*
LYTHRACEAE	*Ammannia*	*multiflora*
	Rotala	*diandra*
MALVACEAE	*Abutilon*	*fraseri*
	Abutilon	*hannii*
	Brachychiton	*paradoxus*
	Corchorus	*aestuans*
	Corchorus	*sidoides*
	Grewia	*retusifolia*
	Herissantia	*crispa*
	Hibiscus	*meraukensis*
	Hibiscus	*sturtii*
	Melhania	*oblongifolia*
	Sida	*brachypoda*
	Sida	*rohlenae*
	Sida	*spinosa*
	Triumfetta	*micracantha*

MALVACEAE	*Waltheria*	*indica*
MARSILEACEAE	*Marsilea*	*angustifolia*
MENISPERMACEAE	*Tinospora*	*smilacina*
MENYANTHACEAE	*Nymphoides*	*crenata*
	Nymphoides	*indica*
MYRTACEAE	*Corymbia*	*dichromophloia*
	Corymbia	*ferruginea*
	Corymbia	*flavescens*
	Corymbia	*polycarpa*
	Corymbia	*setosa*
	Eucalyptus	*chlorophylla*
	Eucalyptus	*cyanoclada*
	Eucalyptus	*microtheca*
	Eucalyptus	*tectifica*
	Lophostemon	*grandiflorus*
NYCTAGINACEAE	*Boerhavia*	*coccinea*
	Boerhavia	*dominii*
ONAGRACEAE	*Ludwigia*	*perennis*
PHRYMACEAE	*Mimulus*	*gracilis*
	Uvedalia	*linearis*
PHYLLANTHACEAE	*Breynia*	*cernua*
	Flueggea	*virosa*
	Margaritaria	*dubium-traceyi*
	Phyllanthus	*exilis*
	Phyllanthus	*hebecarpus*
	Phyllanthus	*maderaspatensis*
	Synostemon	*rhytidospermus*
	Synostemon	*trachyspermus*
PICRODENDRACEAE	*Petalostigma*	*pubescens*
PLANTAGINACEAE	*Bacopa*	*floribunda*
POACEAE	*Acrachne*	*racemosa*
	Aristida	*calycina*
	Aristida	*holathera*
	Aristida	*inaequiglumis*
	Aristida	*latifolia*
	Aristida	*pruinosa*
	Aristida	*queenslandica*
	Brachyachne	*convergens*

POACEAE	*Chrysopogon*	*fallax*
	Cymbopogon	*bombycinus*
	Dactyloctenium	*radulans*
	Dichanthium	*fecundum*
	Dichanthium	*sericeum*
	Digitaria	*brownii*
	Digitaria	*gibbosa*
	Ectrosia	*scabrida*
	Elytrophorus	*spicatus*
	Enneapogon	*decipiens*
	Enneapogon	*lindleyanus*
	Enneapogon	*oblongus*
	Enneapogon	*pallidus*
	Enneapogon	*polyphyllus*
	Enneapogon	*purpurascens*
	Eragrostis	*cumingii*
	Eragrostis	*tenellula*
	Eriachne	*armittii*
	Eriachne	*obtusa*
	Eulalia	*aurea*
	Heteropogon	*contortus*
	Imperata	*cylindrica*
	Iseilema	*macratherum*
	Iseilema	*membranaceum*
	Iseilema	*vaginiflorum*
	Mnesithea	*formosa*
	Oryza	*australiensis*
	Oryza	*rufipogon*
	Panicum	*decompositum*
	Panicum	*effusum*
	Panicum	*latzii*
	Panicum	*mindanaense*
	Paspalidium	*gracile*
	Paspalidium	*rarum*
	Schizachyrium	*fragile*
	Sehima	*nervosum*
	Sorghum	*plumosum*
	Sorghum	*timorense*

POACEAE	*Sporobolus*	*australasicus*
	Themeda	*avenacea*
	Triodia	*bitextura*
	Urochloa	*holosericea*
	Whiteochloa	*capillipes*
POLYGALACEAE	*Polygala*	*barbata*
	Polygala	*longifolia*
	Polygala	*pterocarpa*
PONTEDERIACEAE	*Monochoria*	*cyanea*
PORTULACACEAE	*Portulaca*	*bicolor*
	Portulaca	*filifolia*
PROTEACEAE	*Grevillea*	*parallela*
	Hakea	*arborescens*
PTERIDACEAE	*Cheilanthes*	*nudiuscula*
	Cheilanthes	*tenuifolia*
RHAMNACEAE	*Alphitonia*	*excelsa*
RUBIACEAE	*Spermacoce*	*argillacea*
	Spermacoce	*breviflora*
	Spermacoce	*dolichosperma*
	Spermacoce	*stenophylla*
SANTALACEAE	*Santalum*	*lanceolatum*
SAPINDACEAE	*Atalaya*	*hemiglauca*
	Cardiospermum	*halicacabum*
	Dodonaea	*hispidula*
	Dodonaea	*lanceolata*
	Dodonaea	*physocarpa*
	Dodonaea	*stenophylla*
SOLANACEAE	*Solanum*	*tumulicola*
STYLIDIACEAE	*Stylidium*	*adenophorum*
VITACEAE	*Cayratia*	*trifolia*
ZYGOPHYLLACEAE	*Tribulopis*	*pentandra*
	Tribulus	*terrestris*

Appendix D

Fauna Atlas Species Records

Appendix D Fauna Atlas Species Records

Table 42 Native fauna recorded within 5 km of project area

Scientific Name	Common Name
Birds	
Accipiter fasciatus	Brown Goshawk
Aegotheles cristatus	Australian Owlet-nightjar
Aprosmictus erythropterus	Red-winged Parrot
Apus pacificus	Fork-tailed Swift
Aquila audax	Wedge-tailed Eagle
Ardeotis australis	Australian Bustard
Artamus cinereus	Black-faced Woodswallow
Artamus minor	Little Woodswallow
Burhinus grallarius	Bush Stone-curlew
Calyptorhynchus banksii macrorhynchus	Red-tailed Black-cockatoo (north-western)
Chalcites osculans	Black-eared Cuckoo
Chlamydera nuchalis	Great Bowerbird
Cincloramphus mathewsi	Rufous Songlark
Circus assimilis	Spotted Harrier
Cissomela pectoralis	Banded Honeyeater
Climacteris melanurus	Black-tailed Treecreeper
Colluricincla harmonica	Grey Shrike-thrush
Conopophila rufogularis	Rufous-throated Honeyeater
Coracina maxima	Ground Cuckoo-shrike
Coracina novaehollandiae	Black-faced Cuckoo-shrike
Coracina papuensis	White-bellied Cuckoo-shrike
Corvus bennetti	Little Crow
Corvus orru	Torresian Crow
Coturnix ypsilophora	Brown Quail
Cracticus nigrogularis	Pied Butcherbird
Dacelo leachii	Blue-winged Kookaburra
Daphoenositta chrysoptera	Varied Sittella
Dicaeum hirundinaceum	Mistletoebird
Entomyzon cyanotis	Blue-faced Honeyeater
Eolophus roseicapilla	Galah
Eurystomus orientalis	Dollarbird
Falco berigora	Brown Falcon
Falco cenchroides	Nankeen Kestrel

Scientific Name	Common Name
Gavicalis virescens	Singing Honeyeater
Geopelia cuneata	Diamond Dove
Geopelia humeralis	Bar-shouldered Dove
Geopelia placida	Peaceful Dove
Gerygone olivacea	White-throated Gerygone
Grallina cyanoleuca	Magpie-lark
Gymnorhina tibicen	Australian Magpie
Hamirostra melanosternon	Black-breasted Buzzard
Lalage tricolor	White-winged Triller
Lichmera indistincta	Brown Honeyeater
Malurus lamberti	Variegated Fairy-wren
Malurus melanocephalus	Red-backed Fairy-wren
Manorina flavigula	Yellow-throated Miner
Melanodryas cucullata	Hooded Robin
Melithreptus albogularis	White-throated Honeyeater
Melithreptus gularis	Black-chinned Honeyeater
Merops ornatus	Rainbow Bee-eater
Microeca fascinans	Jacky Winter
Milvus migrans	Black Kite
Myiagra nana	Paperbark Flycatcher
Myiagra rubecula	Leaden Flycatcher
Nymphicus hollandicus	Cockatiel
Ocyphaps lophotes	Crested Pigeon
Oreoica gutturalis	Crested Bellbird
Pachycephala rufiventris	Rufous Whistler
Pardalotus rubricatus	Red-browed Pardalote
Pardalotus striatus	Striated Pardalote
Philemon citreogularis	Little Friarbird
Podargus strigoides	Tawny Frogmouth
Poephila acuticauda	Long-tailed Finch
Poliocephalus poliocephalus	Hoary-headed Grebe
Pomatostomus temporalis	Grey-crowned Babbler
Ptilotula flavescens	Yellow-tinted Honeyeater
Ptilotula keartlandi	Grey-headed Honeyeater
Ptilotula plumula	Grey-fronted Honeyeater
Rhipidura leucophrys	Willie Wagtail
Scythrops novaehollandiae	Channel-billed Cuckoo

Scientific Name	Common Name
Smicrornis brevirostris	Weebill
Struthidea cinerea	Apostlebird
Taeniopygia bichenovii	Double-barred Finch
Todiramphus pyrrhopygius	Red-backed Kingfisher
Turnix pyrrhothorax	Red-chested Button-quail
Turnix velox	Little Button-quail
Mammals	
Lagorchestes conspicillatus	Spectacled Hare-wallaby
Leggadina lakedownensis	Northern Short-tailed Mouse
Onychogalea unguifera	Northern Nailtail Wallaby
Planigale maculata	Common Planigale
Reptiles	
Amalosia rhombifer	Zig-zag Gecko
Ctenotus spaldingi	Straight-browed Ctenotus
Heteronotia binoei	Bynoe's Gecko
Lucasium stenodactylum	Sand-plain Gecko
Rhynchoedura ornata	Western Beaked Gecko
Strophurus ciliaris	Northern Spiny-tailed Gecko
Suta punctata	Little Spotted Snake
Varanus tristis	Black-headed Monitor

Appendix E

Protected Matters Search Report 10 km and 50 km

Appendix E Protected Matters Search Report 10 km

Australian Government

Department of Climate Change, Energy, the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 08-Mar-2024

Summary

Details

- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat

Acknowledgements

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	17
Listed Migratory Species:	13

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	17
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	1
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Listed Threatened Species			[Resource Information]
Status of Conservation Dependent and Extinct are not MNES under the EPBC Act. Number is the current name ID.			
Scientific Name	Threatened Category	Presence Text	Buffer Status
BIRD			
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Erythrotriorchis radiatus Red Goshawk [942]	Endangered	Species or species habitat may occur within area	In feature area
Erythrura gouldiae Gouldian Finch [413]	Endangered	Species or species habitat likely to occur within area	In feature area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat may occur within area	In feature area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat known to occur within area	In feature area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area	In feature area
Tyto novaehollandiae kimberli Masked Owl (northern) [26048]	Vulnerable	Species or species habitat may occur within area	In feature area
MAMMAL			

Scientific Name	Threatened Category	Presence Text	Buffer Status
Macroderma gigas			
Ghost Bat [174]	Vulnerable	Species or species habitat may occur within area	In feature area
Macrotis lagotis			
Greater Bilby [282]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Saccolaimus saccolaimus nudicluniatus			
Bare-rumped Sheath-tailed Bat, Bare-rumped Sheathtail Bat [66889]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Trichosurus vulpecula arnhemensis			
Northern Brushtail Possum [83091]	Vulnerable	Species or species habitat likely to occur within area	In feature area
REPTILE			
Acanthophis hawkei			
Plains Death Adder [83821]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Tiliqua scincoides intermedia			
Northern Blue-tongued Skink [89838]	Critically Endangered	Species or species habitat known to occur within area	In feature area
Varanus mertensi			
Mertens' Water Monitor, Mertens's Water Monitor [1568]	Endangered	Species or species habitat may occur within area	In feature area
Varanus mitchelli			
Mitchell's Water Monitor [1569]	Critically Endangered	Species or species habitat may occur within area	In feature area
SHARK			
Pristis pristis			
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area	In feature area

Listed Migratory Species			[Resource Information]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Migratory Marine Birds			
Apus pacificus			
Fork-tailed Swift [678]		Species or species habitat likely to occur within area	In feature area
Migratory Marine Species			

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Pristis pristis](#) Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area	In feature area
Migratory Terrestrial Species			
[Cecropis daurica](#) Red-rumped Swallow [80610]		Species or species habitat may occur within area	In feature area
[Cuculus optatus](#) Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area	In feature area
[Hirundo rustica](#) Barn Swallow [662]		Species or species habitat may occur within area	In feature area
[Motacilla cinerea](#) Grey Wagtail [642]		Species or species habitat may occur within area	In feature area
[Motacilla flava](#) Yellow Wagtail [644]		Species or species habitat may occur within area	In feature area
Migratory Wetlands Species			
[Actitis hypoleucos](#) Common Sandpiper [59309]		Species or species habitat known to occur within area	In feature area
[Calidris acuminata](#) Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area	In feature area
[Calidris ferruginea](#) Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
[Calidris melanotos](#) Pectoral Sandpiper [858]		Species or species habitat may occur within area	In feature area
[Charadrius veredus](#) Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Glareola maldivarum](#) Oriental Pratincole [840]		Species or species habitat may occur within area	In feature area

Other Matters Protected by the EPBC Act

Listed Marine Species			[Resource Information]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			
[Actitis hypoleucos](#) Common Sandpiper [59309]		Species or species habitat known to occur within area	In feature area
[Anseranas semipalmata](#) Magpie Goose [978]		Species or species habitat may occur within area overfly marine area	In feature area
[Apus pacificus](#) Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area	In feature area
[Bubulcus ibis as Ardea ibis](#) Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area	In feature area
[Calidris acuminata](#) Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area	In feature area
[Calidris ferruginea](#) Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Calidris melanotos](#) Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area	In feature area
[Cecropis daurica as Hirundo daurica](#) Red-rumped Swallow [80610]		Species or species habitat may occur within area overfly marine area	In feature area
[Chalcites osculans as Chrysococcyx osculans](#) Black-eared Cuckoo [83425]		Species or species habitat may occur within area overfly marine area	In feature area
[Charadrius veredus](#) Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area overfly marine area	In feature area
[Glareola maldivarum](#) Oriental Pratincole [840]		Species or species habitat may occur within area overfly marine area	In feature area
[Haliaeetus leucogaster](#) White-bellied Sea-Eagle [943]		Species or species habitat may occur within area	In feature area
[Hirundo rustica](#) Barn Swallow [662]		Species or species habitat may occur within area overfly marine area	In feature area
[Merops ornatus](#) Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area	In feature area
[Motacilla cinerea](#) Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Motacilla flava			
Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area	In feature area
Rostratula australis as Rostratula benghalensis (sensu lato)			
Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area overfly marine area	In feature area

Extra Information

EPBC Act Referrals				[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Not controlled action				
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed	In buffer area only

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

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Appendix E Protected Matters Search Report 50 km

Australian Government

Department of Climate Change, Energy, the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 08-Mar-2024

Summary

Details

- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat

Acknowledgements

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	22
Listed Migratory Species:	13

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	18
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	1
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Listed Threatened Species			[Resource Information]
Status of Conservation Dependent and Extinct are not MNES under the EPBC Act. Number is the current name ID.			
Scientific Name	Threatened Category	Presence Text	Buffer Status
BIRD			
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Erythrotriorchis radiatus Red Goshawk [942]	Endangered	Species or species habitat may occur within area	In feature area
Erythrura gouldiae Gouldian Finch [413]	Endangered	Species or species habitat likely to occur within area	In feature area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat known to occur within area	In feature area
Falcunculus frontatus whitei Crested Shrike-tit (northern), Northern Shrike-tit [26013]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat known to occur within area	In feature area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Polytelis alexandrae](#) Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat may occur within area	In buffer area only
[Rostratula australis](#) Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area	In feature area
[Tyto novaehollandiae kimberli](#) Masked Owl (northern) [26048]	Vulnerable	Species or species habitat may occur within area	In feature area
MAMMAL			
[Dasyurus hallucatus](#) Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat may occur within area	In buffer area only
[Macroderma gigas](#) Ghost Bat [174]	Vulnerable	Species or species habitat may occur within area	In feature area
[Macrotis lagotis](#) Greater Bilby [282]	Vulnerable	Species or species habitat known to occur within area	In feature area
[Saccolaimus saccolaimus nudicluniatus](#) Bare-rumped Sheath-tailed Bat, Bare-rumped Sheathtail Bat [66889]	Vulnerable	Species or species habitat may occur within area	In buffer area only
[Trichosurus vulpecula arnhemensis](#) Northern Brushtail Possum [83091]	Vulnerable	Species or species habitat likely to occur within area	In feature area
REPTILE			
[Acanthophis hawkei](#) Plains Death Adder [83821]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
[Elseya lavarackorum](#) Gulf Snapping Turtle [67197]	Endangered	Species or species habitat may occur within area	In buffer area only
[Tiliqua scincoides intermedia](#) Northern Blue-tongued Skink [89838]	Critically Endangered	Species or species habitat known to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Varanus mertensi			
Mertens' Water Monitor, Mertens's Water Monitor [1568]	Endangered	Species or species habitat may occur within area	In feature area
Varanus mitchelli			
Mitchell's Water Monitor [1569]	Critically Endangered	Species or species habitat may occur within area	In feature area
SHARK			
Pristis pristis			
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area	In feature area

Listed Migratory Species		[Resource Information]	
Scientific Name	Threatened Category	Presence Text	Buffer Status
Migratory Marine Birds			
Apus pacificus			
Fork-tailed Swift [678]		Species or species habitat likely to occur within area	In feature area
Migratory Marine Species			
Pristis pristis			
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area	In feature area
Migratory Terrestrial Species			
Cecropis daurica			
Red-rumped Swallow [80610]		Species or species habitat may occur within area	In feature area
Cuculus optatus			
Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area	In feature area
Hirundo rustica			
Barn Swallow [662]		Species or species habitat may occur within area	In feature area
Motacilla cinerea			
Grey Wagtail [642]		Species or species habitat may occur within area	In feature area
Motacilla flava			
Yellow Wagtail [644]		Species or species habitat may occur within area	In feature area
Migratory Wetlands Species			

Scientific Name	Threatened Category	Presence Text	Buffer Status
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area	In feature area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area	In feature area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area	In feature area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area	In feature area

Other Matters Protected by the EPBC Act

Listed Marine Species			[Resource Information]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area	In feature area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area overfly marine area	In feature area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area	In feature area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area	In feature area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area	In feature area
Cecropis daurica as Hirundo daurica Red-rumped Swallow [80610]		Species or species habitat may occur within area overfly marine area	In feature area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat known to occur within area overfly marine area	In feature area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area overfly marine area	In feature area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area overfly marine area	In feature area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area	In feature area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Merops ornatus](#) Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area	In feature area
[Motacilla cinerea](#) Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area	In feature area
[Motacilla flava](#) Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area	In feature area
[Rostratula australis as Rostratula benghalensis (sensu lato)](#) Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area overfly marine area	In feature area
Reptile			
[Crocodylus johnstoni](#) Freshwater Crocodile, Johnston's Crocodile, Johnstone's Crocodile [1773]		Species or species habitat may occur within area	In buffer area only

Extra Information

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Not controlled action				
[Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia](#)	2015/7522	Not Controlled Action	Completed	In buffer area only

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

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APPENDIX L Cultural Heritage Assessment

Prepared for
Tamboran B2 Pty Ltd
ABN: 28 135 299 062

AECOM

Cultural Heritage Assessment

Amungee North-West, Shenandoah North, Shenandoah South and Kyalla

15-Mar-2024

aecom.com

Delivering a better world

Cultural Heritage Assessment

Amungee North-West, Shenandoah North, Shenandoah South and Kyalla

Client: Tamboran B2 Pty Ltd

ABN: 28 135 299 062

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15-Mar-2024

Job No.: 60623736

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1.0 Introduction

AECOM Australia Pty Ltd (AECOM) has been commissioned by Tamboran B2 Pty Ltd (Tamboran) to conduct heritage assessments of four potential development areas in the Northern Territory: Amungee North-West, Shenandoah North, Shenandoah South, and Kyalla (the Study Areas). The proposed works fall within exploration permit (EP) areas EP98 and EP117, south-east of Daly Waters in the Beetaloo Sub-basin, Northern Territory.

Heritage assessments of these areas were completed in late 2022 and early 2023 in accordance with relevant legislation (see Appendix A). The assessments involved desktop reviews of existing heritage data from the Australian Heritage database, the NT Heritage Branch and archaeological survey reports, as well as targeted field inspections of potential works areas by representatives of AECOM and Bamarrnganja Traditional Owners. The findings of these assessments have previously been reported (AECOM Australia Pty Ltd, 2023a, 2023b, 2023c), but are now combined in this document and updated with current Project details.

This report is prepared for Tamboran B2 Pty Ltd (Tamboran) for the clearing and placement of infrastructure, including: lease pads, gathering lines, pipelines, access tracks, seismic lines, camp pads, helipads, laydown areas, groundwater bores, site turn-ins, firebreaks / fence lines, and associated infrastructure.

This report describes the assessment methodology and outcomes of field surveys for future onshore gas exploration sites.

1.1 Naming Convention

Due to changes in operational requirements, there have been changes to the naming of some Project Areas since the original assessments were completed. The operational names are presented below in Table 1. This document has been updated to reference the current operational names, using abbreviations where relevant.

Table 1 Project Area naming convention

Original Name	Operational or Abbreviated Name
Amungee NW4	Amungee NW-4
Amungee NW-3	Amungee NW-3
Shenandoah North A	Shenandoah N A
Shenandoah North B	Shenandoah N B
Shenandoah South A	Shenandoah S A
Shenandoah South B	Shenandoah S B
Shenandoah South C	Shenandoah S C
Kyalla 117 N1	Kyalla 117 N1
Kyalla 117 N2-1	Kyalla 117 N2
Kyalla 98 S1	Kyalla 98 S1
Kyalla 98 S2	Kyalla 98 S2
Shenandoah South 1	Shenandoah S5
Shenandoah South 2	Shenandoah S2
Shenandoah South 3	Shenandoah S3
Shenandoah South 4	Shenandoah S4
Shenandoah South 5	Currently unnamed

1.2 Project Location and Overview

Tamboran is proposing to undertake a series of activities to expand their gas exploration program in the Beetaloo Sub-basin. As part of these development efforts, heritage site assessments were requested for potential works, comprising 17 potential well pads, three laydown areas, three seismic lines, and three access tracks (the Project). For the purposes of this assessment, these works have been grouped into four Study Areas: Amungee North-West (NW), Shenandoah North, Shenandoah South, and Kyalla (Figure 1). These Study Areas are located across the Shenandoah, Hayfield, and Beetaloo pastoral leases, with all potential works confined to the Shenandoah and Hayfield pastoral leases, within EP98 and EP117 (Figure 2).

The details for proposed Project works within each of the Study Areas are provided in Table 2 and shown on Figure 1. However, it should be noted that these locations are preliminary only, and are subject to change based on the results of this assessment and other factors. It should also be noted that the original field scouting and heritage survey boundaries for the Kyalla and the Shenandoah South Study Areas overlap.

Table 2 Details of potential locations across the Project

Study Area	Project Area	Potential Works Location (Centroid)	Easting*	Northing*
Amungee NW	Amungee NW-4	Well Pad	374604	8186991
		Access Track	375123	8189996
	Amungee NW-3	Well Pad	375511	8195305
		Access Track	375459	8190989
		Laydown Area 1	375690	8194763
		Laydown Area 2	375496	8195343
Shenandoah North	Shenandoah N A	Well Pad	356684	8163762
		Well Pad – Option 2	356717	8165808
	Shenandoah N B	Well Pad	359460	8170477
		Access Track	358400	8169649
Shenandoah South	Shenandoah S A	Well Pad	340333	8134450
		Seismic Line	338996	8135813
	Shenandoah S B	Well Pad	345605	8135477
		Seismic Line	342787	8138337
	Shenandoah S C	Well Pad	343472	8133330
		Laydown Area	341167	8135335
		Seismic Line	339841	8137046
Kyalla	Kyalla 117 N1	Well Pad	344882	8134174
	Kyalla 117 N2	Well Pad	356175	356175
	Kyalla 98 S1	Well Pad	355907	8142955
	Kyalla 98 S2	Well Pad	353457	8143873
	Shenandoah S5	Well Pad	353046	8138627
	Shenandoah S2	Well Pad	355291	8140676
	Shenandoah S3	Well Pad	354041	8135466
	Shenandoah S4	Well Pad	352021	8141797

Study Area	Project Area	Potential Works Location (Centroid)	Easting*	Northing*
	Unnamed	Well Pad	358441	8139666

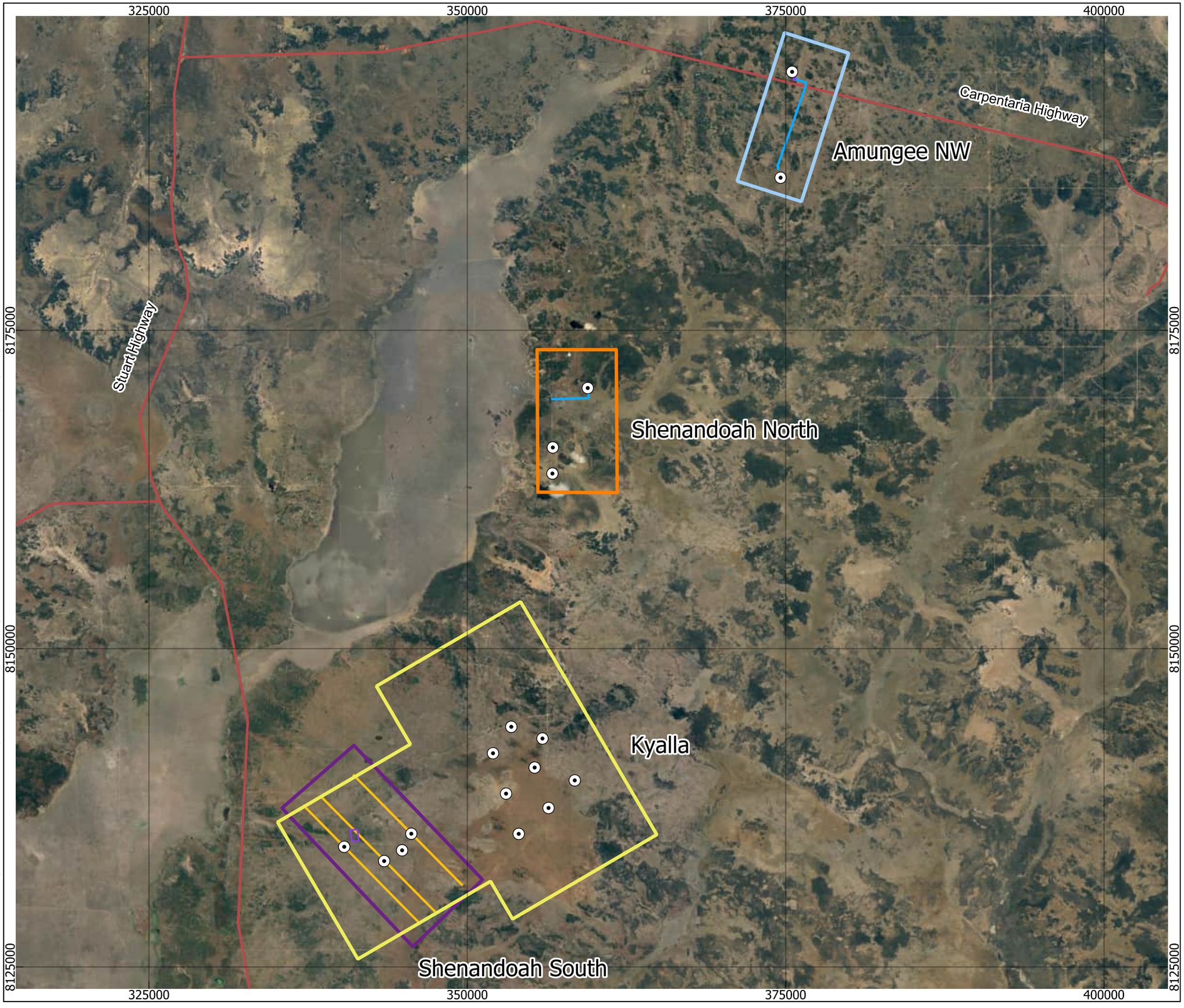
* Datum: GDA94 Zone 53

The proposed activity at each location may include any or all of the regulated activities specified under Regulation 5 of the *Petroleum (Environment) Regulations 2016*.

For the purposes of this assessment, Project Area areas are defined as:

- A 200 metre (m) buffer around each of the access tracks
- A 500 m buffer around each of the seismic lines
- Buffers ranging between 65 m and 2000 m have been established around each of the potential well pad and laydown areas.

These Project Areas have been established to entirely encompass the likely impacts associated with Project works (Figure 3 to Figure 6). The variable buffers established for the potential well pad and laydown areas were provided by Tamboran, and are associated with extenuating constraints upon siting. In total, 16 Project Areas across the four Study Areas were established.



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LEGEND

- Main Roads

Study Areas October 2023

- Amungee NW
- Kyalla
- Shenandoah North
- Shenandoah South

Tamboran Potential Works Locations

- Well Pads
- Laydown Area
- Seismic Lines
- Access Tracks

Data Sources:
AECOM
Google Satellite

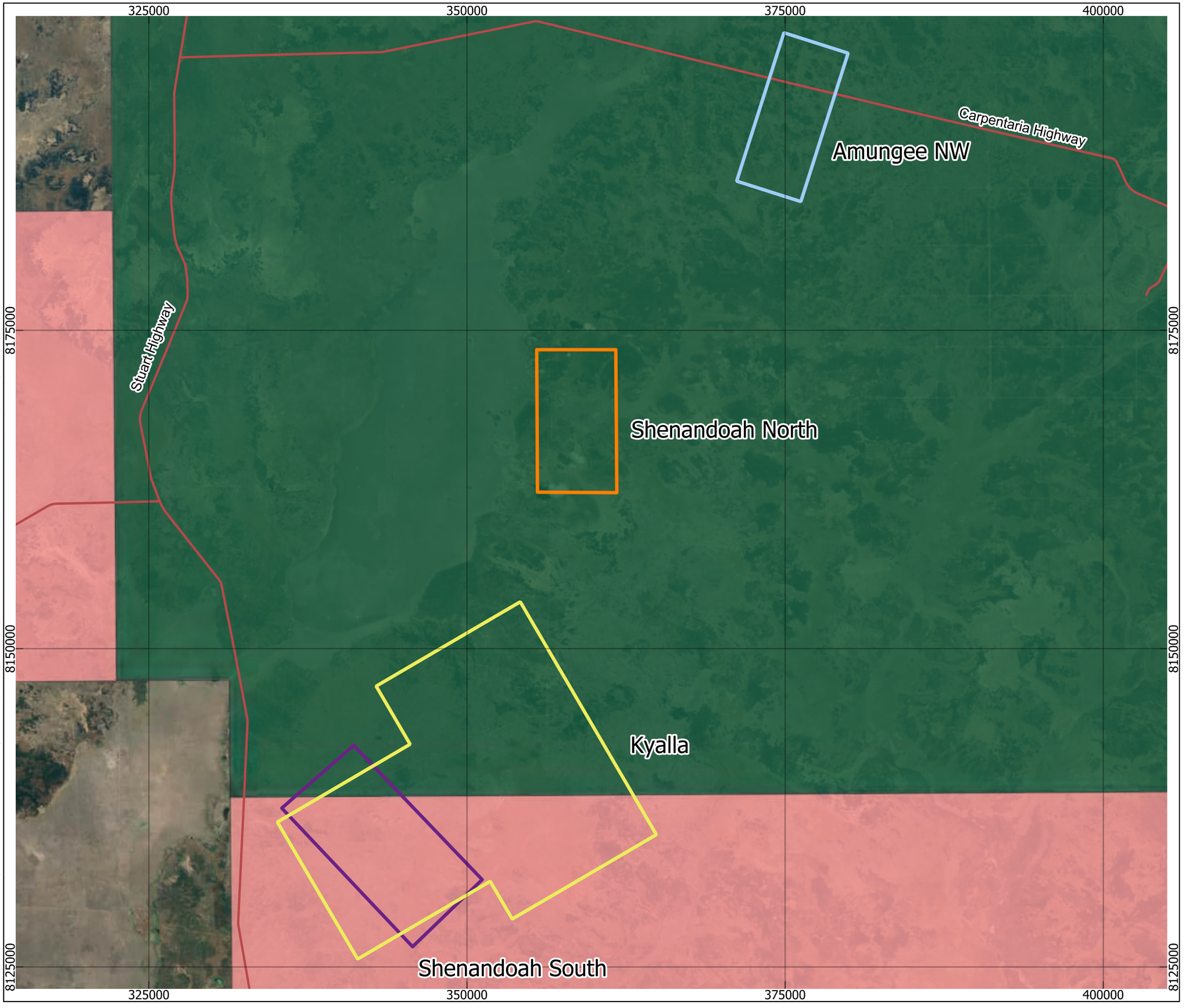
CRS:
GDA94 Zone 53

Tamboran B2 Pty Ltd
2022 - 2023 Heritage Scouting

Project Study Areas

PROJECT ID	60667354
CREATED BY	KC
LAST MODIFIED	13-10-2023
VERSION	1

Figure 1



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LEGEND

Main Roads

Study Areas

- Amungee NW
- Kyalla
- Shenandoah North
- Shenandoah South

Exploration Permits

- EP76
- EP117

Data Sources:
AECOM
Google Satellite

CRS:
GDA94 Zone 53

Tamboran B2 Pty Ltd
2022 - 2023 Heritage Scouting

Exploration Permits relevant to Study Areas

PROJECT ID	60667354
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Figure 2

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LEGEND

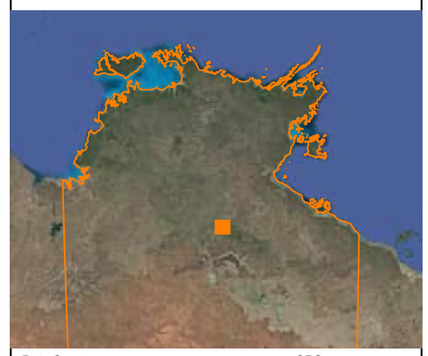
- Main Roads

Study Areas

- Amungee NW

Tamboran Potential Works Locations

- Well Pads
- Laydown Area 1
- Laydown Area 2
- Access Tracks
- Project Area



Data Sources:
AECOM
Google Satellite

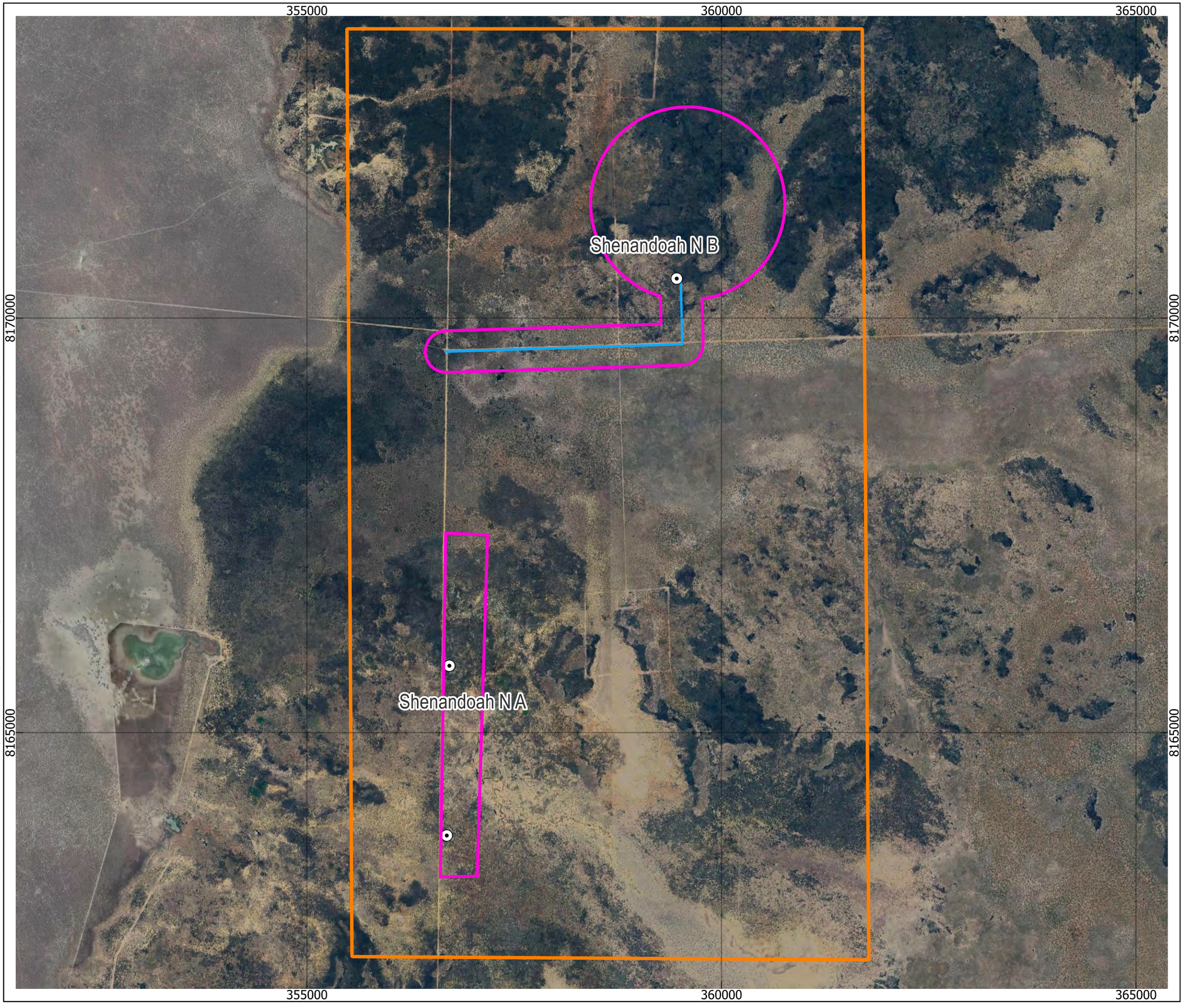
CRS:
GDA94 Zone 53

Tamboran B2 Pty Ltd
2022 - 2023 Heritage Scouting

Amungee NW Project Areas

PROJECT ID	60667354
CREATED BY	KC
LAST MODIFIED	13-10-2023
VERSION	1

Figure 3



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LEGEND

Study Areas

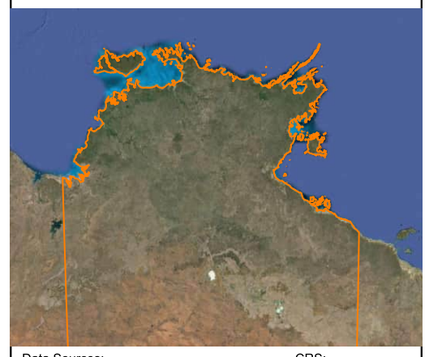
Shenandoah North

Tamboran Potential Works Locations

Well Pads

Access Tracks

Project Area



Data Sources:
AECOM
Google Satellite

CRS:
GDA94 Zone 53

Tamboran B2 Pty Ltd
2022 - 2023 Heritage Scouting

Shenandoah North Project Areas

PROJECT ID	60667354
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VERSION	2

Figure 4

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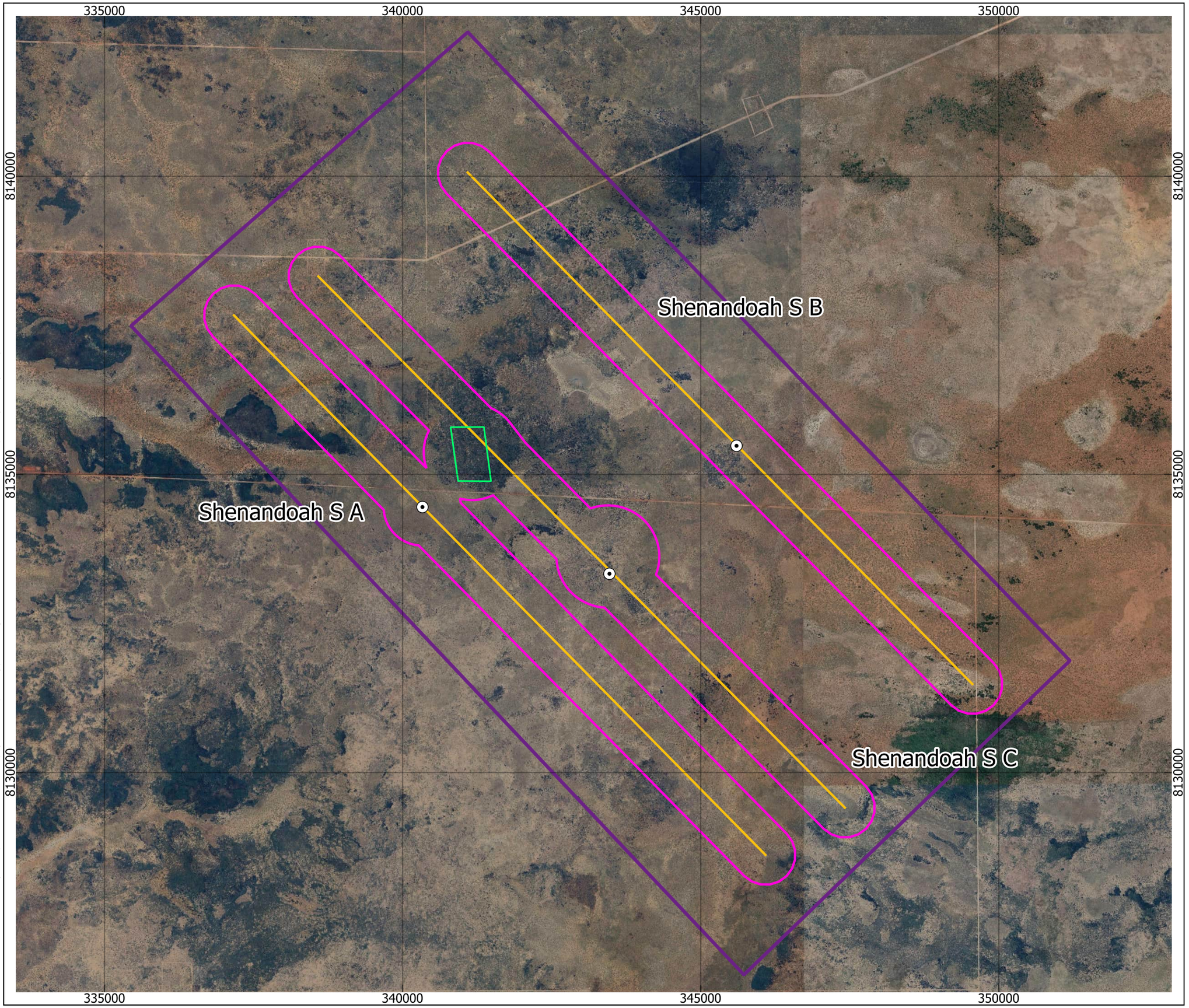

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LEGEND

Study Areas

Shenandoah South

Tamboran Potential Works Locations

Well Pads

Laydown Area

Seismic Lines

Project Area

Data Sources:
AECOM
Google Satellite

CRS:
GDA94 Zone 53

Tamboran B2 Pty Ltd
2022 - 2023 Heritage Scouting

Shenandoah South Project Areas

PROJECT ID	60667354
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Figure 5

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340000 350000 360000

8150000 8140000 8130000

Kyalla 98 S2
Kyalla 98 S1
Shenandoah S4
Shenandoah S2
Unnamed
Shenandoah S5
Kyalla 117 N2
Shenandoah S3
Kyalla 117 N1
Stuart Highway

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LEGEND

Main Roads

Study Areas

Kyalla

Tamboran Potential Works Locations

Well Pads

Project Area

Data Sources:
AECOM
Google Satellite

CRS:
GDA94 Zone 53

Tamboran B2 Pty Ltd
2022 - 2023 Heritage Scouting

Kyalla Project Areas

PROJECT ID	60667354
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Figure 6

2.0 Existing Data Sources

Information on the location of heritage sites across the Study Areas was obtained from a review of:

- Native Title claims and Indigenous Land Use Agreements over the Study Areas
- Commonwealth heritage registers (Australian Heritage Database)
- Registered archaeological sites on the Northern Territory Heritage Register
- Known sacred sites managed by the Aboriginal Areas Protection Authority (AAPA)
- Past archaeological survey reports and assessments undertaken within the local area.

2.1 Native Title

Three Native Title determinations that have been finalised across the Study Areas (see Table 3 and Figure 7). Of these, DCD2012/007and DCD2012/011 are relevant to the Project works.

Table 3 Native title current for Study Areas

Name	Tribunal No	Fed Court Number	Outcome	Native Title Holders
Shenandoah Pastoral Lease	DCD2012/007	NTD21/2010	Native Title exists in parts of the determination area	Kinbininggu; Bamarrnganja;
Hayfield Pastoral Lease	DCD2012/011	NTD26/2010	Native Title exists in parts of the determination area	Kinbininggu. Warranangku; Marlinja
Beetaloo Pastoral Lease	DCD2012/012	NTD27/2010	Native Title exists in parts of the determination area	Karranjinji; Bamarrnganja; Warranangku; Pinda (OT Downs); Lija/Muwartpi

2.2 Australian Heritage Database

A search of the Australia Heritage Database on 7 June 2023 identified that there are no statutory or non-statutory heritage places within the Study Areas.

2.3 Northern Territory Heritage Register

A search of the public aspects of the Northern Territory Heritage Register (NTHR) on 7 June 2023 did not identify any heritage places or artefacts within the proposed impact areas.

Two requests were lodged with the Northern Territory Heritage Branch for a search of confidential aspects of the NTHR, one on 23 February 2023, and one on 27 April 2023. Responses on 6 March 2023 and 11 May 2023 identified that there are no nominated, provisionally declared, or declared Aboriginal archaeological or Macassan heritage places or objects within the Study Areas (Appendix B).

2.4 Aboriginal Areas Protection Authority

Aboriginal Areas Protection Authority (AAPA) Authority Certificate C2023/049 applies to Tamboran exploration activities in the Kyalla well pad area. New Authority Certificates are in process at Shenandoah North and Shenandoah South, and are relevant to Tamboran exploration activities in the defined Study Areas. These AAPA certificates will identify the extent of recognised sacred sites and established Restricted Works Areas which overlap slightly with the Shenandoah N B Project Area, and occur adjacent to proposed activities in Shenandoah N A Project Area (Figure 8 and Figure 9).

2.5 Previous Archaeological Investigations

The majority of archaeological investigations near the Study Areas have been associated with either linear infrastructure parallel to the Stuart Highway, or to natural gas exploration activities associated

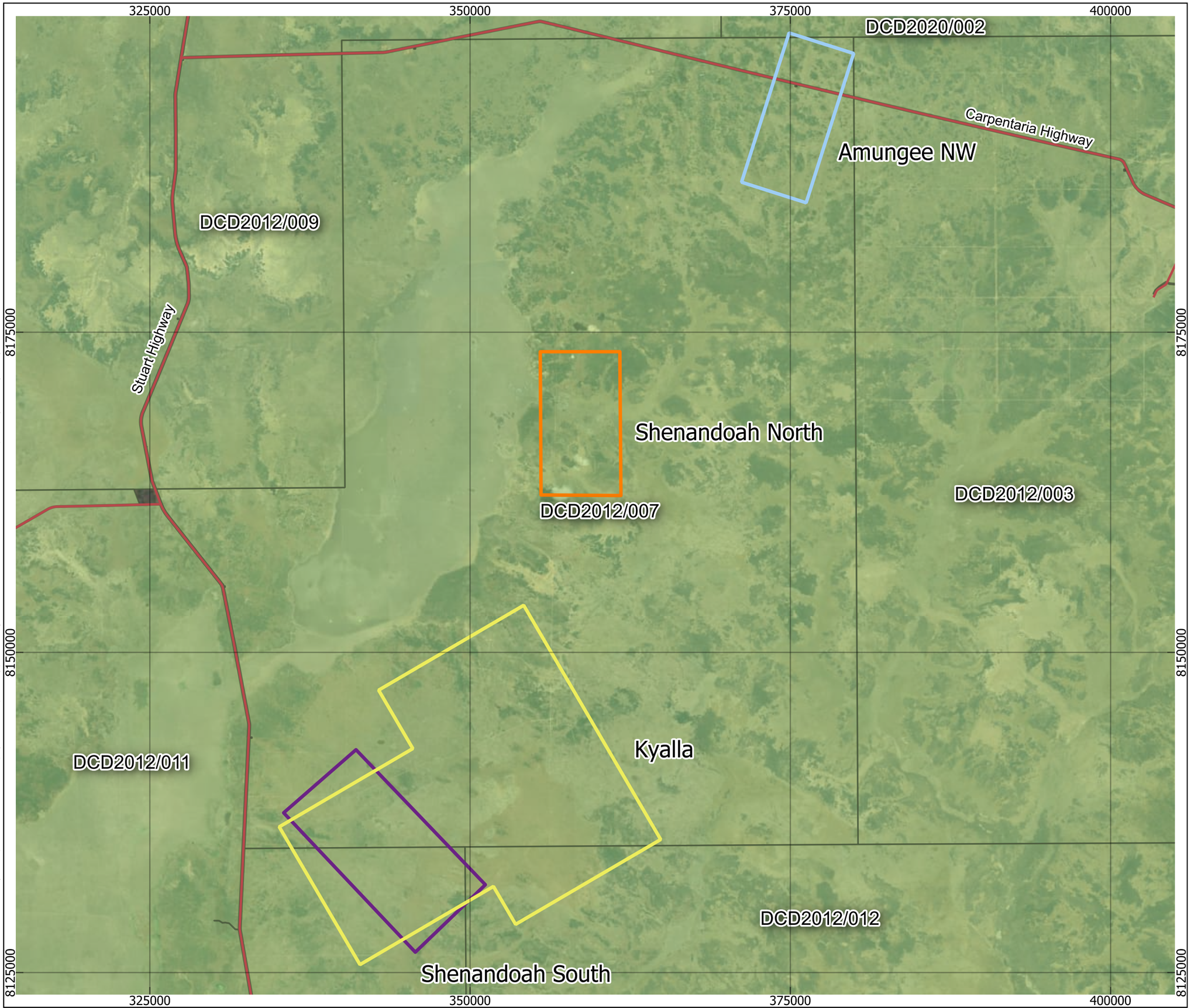
with the Beetaloo Basin. Of the assessments relevant to the Project, the majority of heritage sites identified are artefact scatters composed of commonly found local raw material (quartz, silcrete and quartzite). One stone arrangement has also been recorded. AECOM has been involved in numerous other heritage assessments in the Beetaloo Basin, including assessments on the Shenandoah-Hayfield leases and adjacent properties with similar physiographic contexts.

Table 4 provides a summary of previous archaeological investigations undertaken in the local area.

Table 4 Previous archaeological assessments relevant to the Study Areas

Researchers	Assessment Type	Locality	Key Findings
Smith (1986)	Excavation	Lake Woods	*In situ* artefacts dated to 6,000 years.
Hermes (1986)	Survey	Amadeus Basin to Katherine	Large scale survey for a proposed natural gas pipeline targeting areas of major cultural sensitivity from Daly Waters to Katherine. 32 sites were identified with the majority being artefact scatters associated with watercourses.
Quaternary Archaeological Surveys (1998)	Survey	Stuart Highway to Mataranka Homestead	Large scale survey for a fibre optic cable corridor. Three isolated artefacts and one historic heritage site identified.
Heritage Surveys (1999)	Survey	Daly Waters to McArthur River	Nine archaeological sites identified including rockshelters and artefact scatters.
HLA Envirosciences (HLA) (2006a, 2006b, 2006c, 2006d, 2007)	Survey	Beetaloo Basin	Several archaeological sites identified across the exploration permits including artefact scatters, isolated artefacts and stone cairns. Assessments developed a preliminary predictive model based on site modelling and landform.
AECOM (2011, 2012a, 2012b)	Survey	Beetaloo Basin	Several archaeological sites identified during clearance of seismic lines and exploratory drill locations including large artefact scatters (>1km), quarry sites and isolated artefacts. Predictive model refined and used in the field to identify ‘hot spots’ of Indigenous archaeological significance.
AECOM (2014)	Survey	Beetaloo Basin	Heritage assessment for Origin exploration wells including areas within EP98. One isolated artefact identified.
AECOM (2015)	Survey	Beetaloo Basin	Large scale survey for four drill hole locations. One large artefact scatter and three smaller artefact scatters identified.
AECOM (2019)	Survey	Beetaloo Basin	Heritage assessment for proposed exploration lease areas, including those on the Shenandoah pastoral lease. No surface archaeology was identified within the Shenandoah lease area.

Researchers	Assessment Type	Locality	Key Findings
AECOM (2020)	Survey	Beetaloo Basin	Heritage assessment for seismic survey areas for nearby EP136. Survey assessment identified 25 Aboriginal archaeological sites including large artefact scatters associated with Newcastle Creek. Based on the findings of the assessment, AECOM identified the following landforms as being sensitive for Aboriginal cultural heritage: • Non-flood prone areas adjacent to established watercourses • Areas with distinctive vegetation patterning, such as those areas associated with *Macropteranthes kekwickii* (bullwaddy) • Adjacent to flood plains where a noticeable change in vegetation is identified • On the periphery of lagoons and 'chain of ponds' features.
AECOM (2021)	Survey	Beetaloo Basin	Heritage assessment for seismic survey areas for Amungee NW-1 and Velkerri 76 S2, occurring nearby the Amungee NW Study Area. A targeted survey assessment identified nine Aboriginal archaeological sites. These sites occurred in areas surrounding soaks and depressions, and in non-flood prone areas adjacent to drainage channels.



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LEGEND

Main Roads

Study Areas

Amungee NW
Kyalla
Shenandoah North
Shenandoah South

Native Title Determinations

Native Title Exists (non-exclusive)

Data Sources:
AECOM
Google Satellite

CRS:
GDA94 Zone 53

Tamboran B2 Pty Ltd
2022 - 2023 Heritage Scouting

Native Title Determinations Relevant to Study Areas

PROJECT ID	60667354
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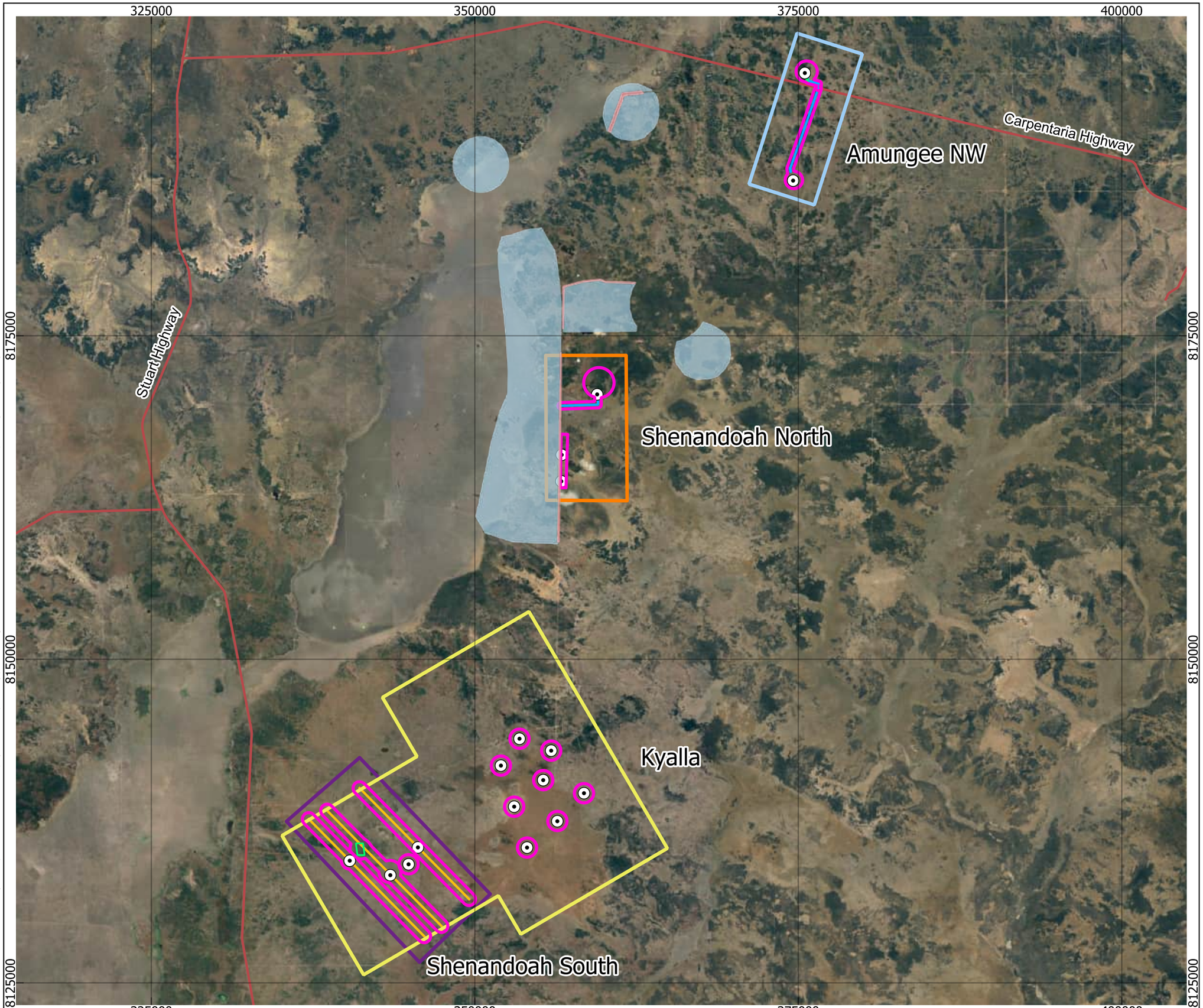
Figure 7



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LEGEND

- Main Roads

Study Areas

- Amungee NW
- Kyalla
- Shenandoah North
- Shenandoah South

Tamboran Potential Works Locations

- Well Pads
- Laydown Areas
- Seismic Lines
- Access Tracks
- Project Area

AAPA Registered Areas

- AAPA Restricted Works Areas
- AAPA Recorded Sacred Site Extent

Data Sources:
AECOM
Google Satellite

CRS:
GDA94 Zone 53

Tamboran B2 Pty Ltd
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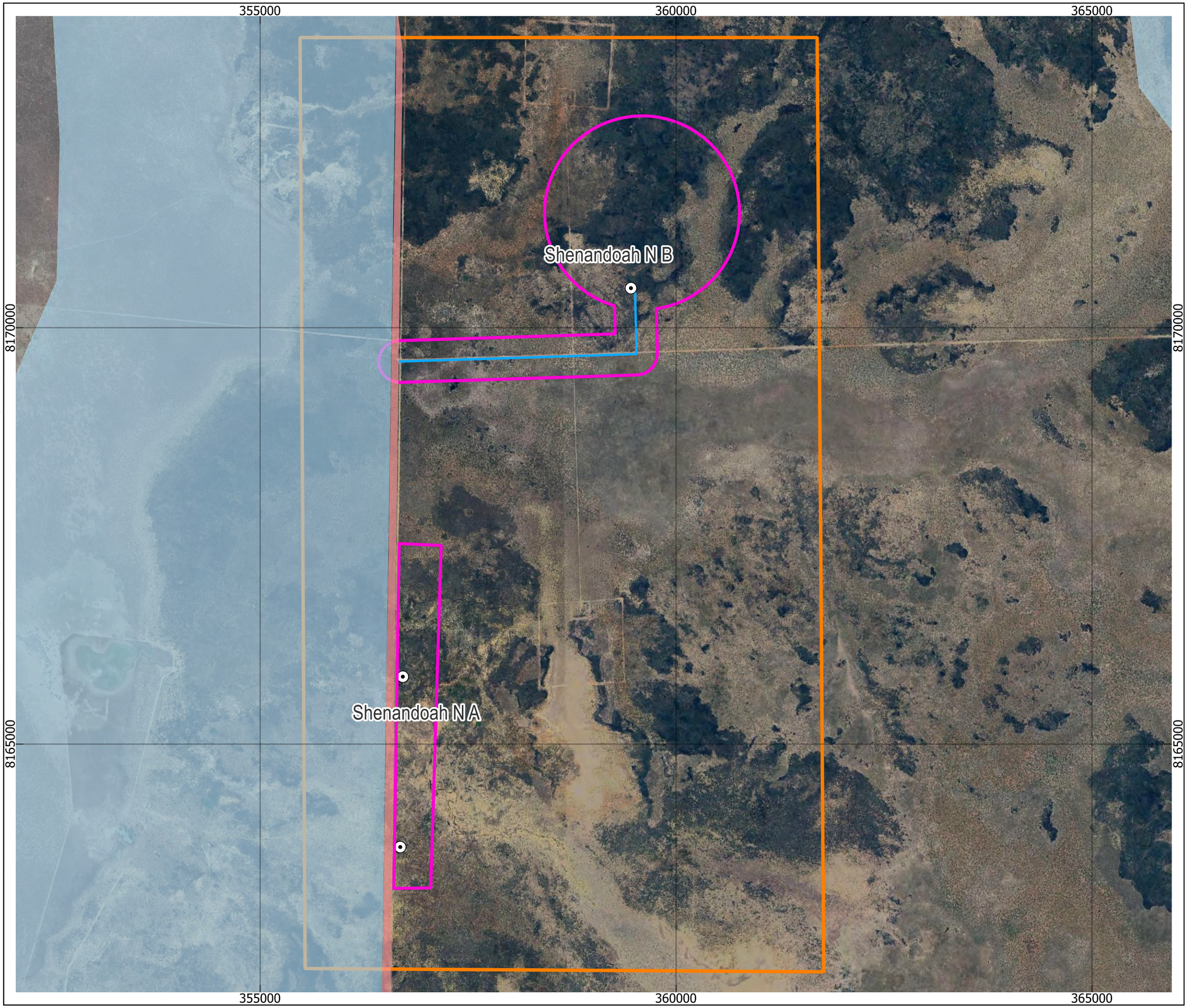
AAPA Registered Areas Relevant to Study Areas

PROJECT ID	60667354
CREATED BY	KC
LAST MODIFIED	13-10-2023
VERSION	1

Figure 8



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LEGEND

Study Areas

Shenandoah North

Tamboran Potential Works Locations

Well Pads

Access Tracks

Project Area

AAPA Registered Areas

AAPA Restricted Works Areas

AAPA Recorded Sacred Site Extent

Data Sources:
AECOM
Google Satellite

CRS:
GDA94 Zone 53

Tamboran B2 Pty Ltd
2022 - 2023 Heritage Scouting

AAPA Registered Areas Relevant to Study Areas

PROJECT ID	60667354
CREATED BY	KC
LAST MODIFIED	11-3-2024
VERSION	2

Figure 9

3.0 Survey Methodology

Following previous work in the area, AECOM undertook a desktop assessment of each Project Area using satellite imagery to identify the presence of landforms with heightened sensitivity for Aboriginal cultural heritage (Figure 10 to Figure 13). Sensitive landforms include areas surrounding soaks and depressions, permanent water sources, non-flooding areas adjacent to established channels, and thick patches of shade providing Lancewood-Bullwaddy Woodland (a distinctive community that combines *Macropteranthes kekwickii* (bullwaddy) and *Acacia shirleyi* (lancewood)) (AECOM Australia Pty Ltd (AECOM), 2012 s4.4 and 7.3; HLA-Envirosciences Pty Ltd, 2006a s5.3). The sensitive landforms relevant to each Project Area are detailed in Table 5.

Across Australia, numerous archaeological studies in different environmental zones and contexts have demonstrated a correlation between the permanence of a water source and the permanence and/or complexity of Aboriginal occupation (e.g. Rowland & Connolly, 2002). Within the Northern Territory and the Beetaloo Basin, previous surveys had also identified heritage sites associated with stands of Bullwaddy and Lancewood-Bullwaddy – primarily these were sacred sites, although artefact scatters were also found (AECOM Australia Pty Ltd, 2020; HLA-Envirosciences Pty Ltd, 2007, 2006a)).

High Priority areas were identified as areas adjacent to a permanent water source associated with a waterhole, soakage or channelised creek.

The heritage surveys focussed on areas of highest sensitivity in proximity to Project works, seeking to validate desktop findings and identify any Aboriginal heritage sites or areas of potential. In all cases, survey combined aerial and pedestrian methodologies, with helicopter flyovers used to gain an appreciation of landscape, and pedestrian transects used to inspect areas of high sensitivity. While this approach was designed to maximise the probability of identifying Aboriginal sites or areas of sensitivity within the Project Areas, it does not achieve total survey coverage of the Project Areas, and there remains the potential for future additional finds.

During the pedestrian surveys of the Project Areas, notes and photographs were taken on landform, ground surface visibility (GSV), and ground surface integrity (GSI) (Appendix D). Attribute data for any identified stone artefacts were entered directly into geospatial database form created for the Project, and all artefacts were left in-situ.

3.1 Kyalla Study Area

A heritage survey of the nine well pad Project Areas in the Kyalla Study Area was undertaken on 14 and 15 December 2022 by AECOM heritage specialist Jessica McNeil, Traditional Owner Jeremy Jackson, and Traditional Owner and Tamboran representative Benjamin Ulamari.

Following a general aerial survey, a pedestrian survey was conducted of proposed well pads to identify any surface heritage features and assess subsurface potential. As the final footprints for proposed works were yet to be established, Project Areas comprising 750 m buffer zones were established around each proposed well pad to encompass the maximum potential impact area of the proposed works (Figure 6).

Sensitive landforms within the Project Areas were prioritised for inspection, with pedestrian survey conducted of all sensitive areas. Project Areas without sensitive landforms were subject to a general pedestrian survey inspection (Table 5, Figure 10).

3.2 Amungee North-West, Shenandoah North, and Shenandoah South Study Areas

The heritage survey of the seven Project Areas in the Amungee North-West, Shenandoah North, and Shenandoah South Study Areas was undertaken on 12 April 2023 and 13 April 2023, and included both aerial and targeted pedestrian components.

The aerial survey was undertaken by AECOM heritage specialist Jessica McNeil conjunction with Traditional Owners Terry Jackson and Jeremy Jackson, and Traditional Owner and Tamboran Indigenous Representative Benjamin Ulamari. The survey comprised a low flyover of all Project Areas with the Traditional Owners, while discussing the planned activities, potential impacts, and areas of

sensitivity. Traditional Owners were able to highlight areas of concern, and point to landscape areas and features that may have cultural significance. This survey portion also allowed for inspection of the total length of the three proposed seismic lines.

The pedestrian heritage assessment was undertaken by AECOM heritage specialist Jessica McNeil, assisted by AECOM representative Jordan Brookes, and included the entirety of all proposed well pad locations and the proposed laydown area. Targeted inspections of sensitive landforms were carried out along the proposed seismic lines and access tracks to identify any surface heritage features and assess subsurface potential (Figure 11, Figure 12, Figure 13). All but one of these seismic line sensitive landforms were inspected during the pedestrian survey. The remaining area located in the Shenandoah S A proposed seismic line, which could not be safely accessed from the ground, was surveyed from the air.

Table 5 Sensitive landforms within the Project Areas

Project Area	Potential Works Location	Sensitive Landforms Present
Amungee NW-4	Well Pad	• None
	Access Track	• Lancewood-Bullwaddy Woodland stands throughout
Amungee NW-3	Well Pad	• Thick vegetation bordering flood plain areas, similar to areas preserving Aboriginal heritage during the 2021 AECOM survey of Amungee NW-1
	Access Track	
	Laydown Area 1	
	Laydown Area 2	
Shenandoah N A	Well Pad	• Linear water source running north-south to the east of both well pads
	Well Pad – Option 2	
Shenandoah N B	Well Pad	• Lancewood-Bullwaddy Woodland through central zone
	Access Track	• Lancewood-Bullwaddy Woodland stands • Edge of seasonal water plain to east • Permanent and/or seasonal soak to east bordered by potential Lancewood-Bullwaddy Woodland stands - Also highlighted by TOs as significant
Shenandoah S A	Well Pad	• Small and isolated Lancewood-Bullwaddy Woodland stand
	Seismic Line	• Lancewood-Bullwaddy Woodland stands bordering seasonal water plains to north
Shenandoah S B	Well Pad	• Lancewood – Bullwaddy Woodland stand
	Seismic Line	• Lancewood-Bullwaddy Woodland stands bordering seasonal water plains to south • Lancewood-Bullwaddy Woodland stands bordering permanent water source and seasonal water plain to north • Isolated Lancewood-Bullwaddy Woodland stands to north
Shenandoah S C	Well Pad	• None
	Laydown Area	• Lancewood-Bullwaddy Woodland stands bordering permanent and/or seasonal water source
	Seismic Line	• Isolated Lancewood-Bullwaddy Woodland stands

Project Area	Potential Works Location	Sensitive Landforms Present
		• Lancewood-Bullwaddy Woodland stands bordering seasonal water plains to north and south
Kyalla 117 N1	Well Pad	• No sensitive landforms within Project Area, potential Bullwaddy stand directly to west
Kyalla 117 N2	Well Pad	• None
Kyalla 98 S1	Well Pad	• Potential Bullwaddy stands
Kyalla 98 S2	Well Pad	• Potential Bullwaddy stands, small soaks, large depression to north-east
Shenandoah S2	Well Pad	• Potential Bullwaddy stands
Shenandoah S3	Well Pad	• None
Shenandoah S4	Well Pad	• Potential Bullwaddy stand
Shenandoah S5	Well Pad	• Potential water edges, Bullwaddy stands
Unnamed	Well Pad	Potential soak

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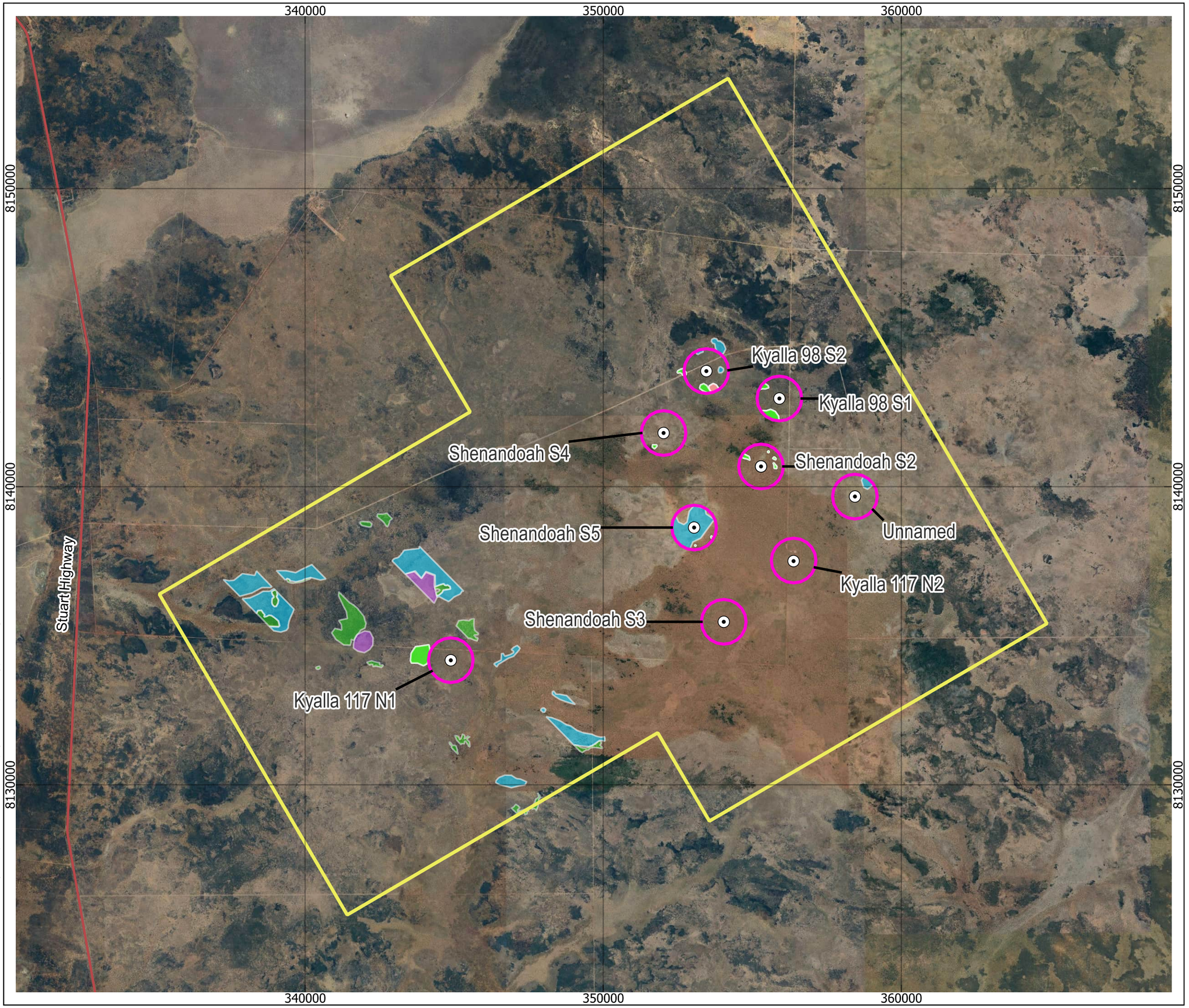

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LEGEND

- Main Roads
- **Study Areas**
- Kyalla
- **Tamboran Potential Works Locations**
- Well Pads
- Project Area
- **Sensitive Landforms**
- Vegetation
- Water Source
- Unknown
- High Priority

Data Sources:
AECOM
Google Satellite

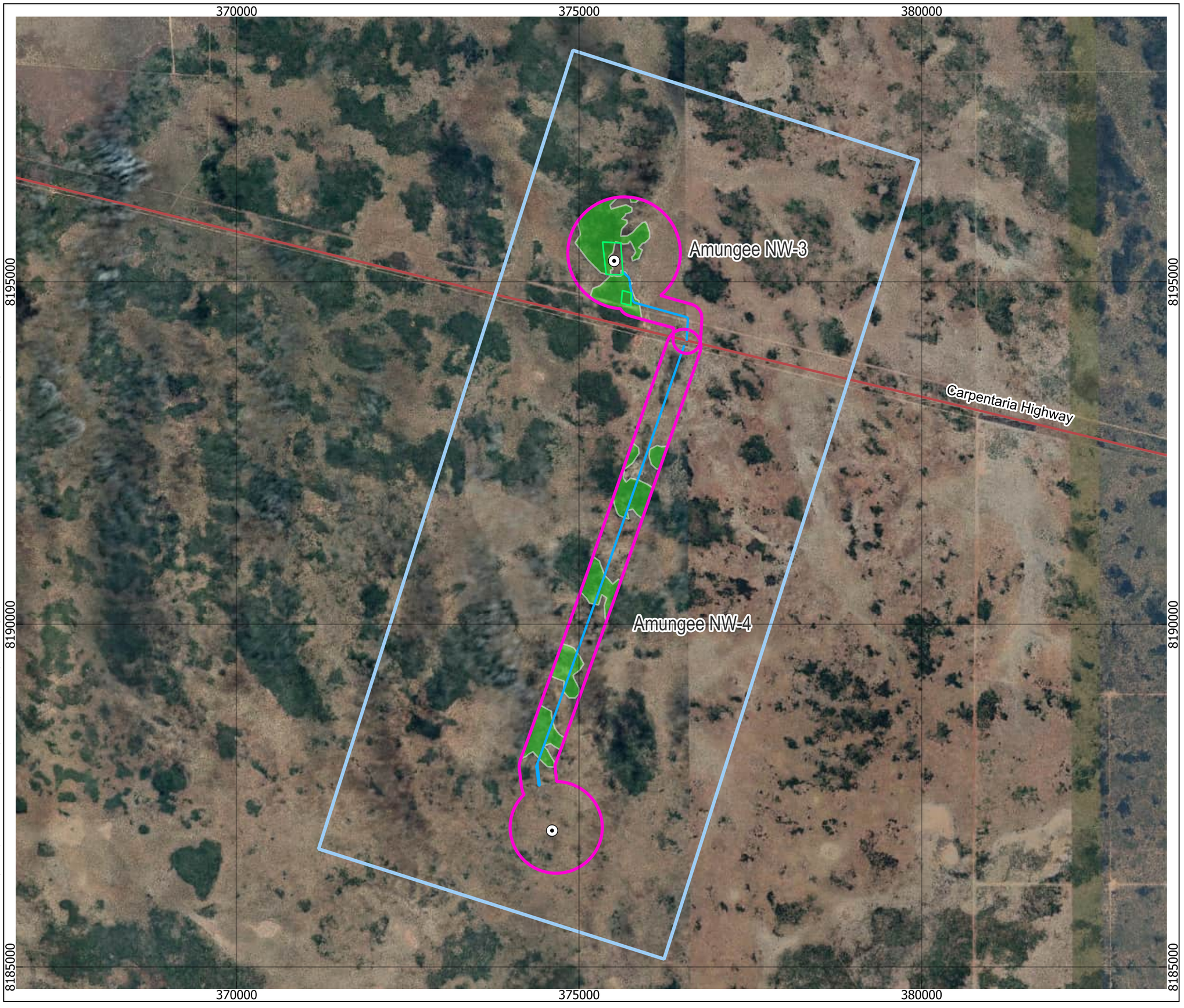
CRS:
GDA94 Zone 53

Tamboran B2 Pty Ltd
2022 - 2023 Heritage Scouting

Kyalla Sensitive Landforms

PROJECT ID	60667354
CREATED BY	KC
LAST MODIFIED	11-3-2024
VERSION	1

Figure 10



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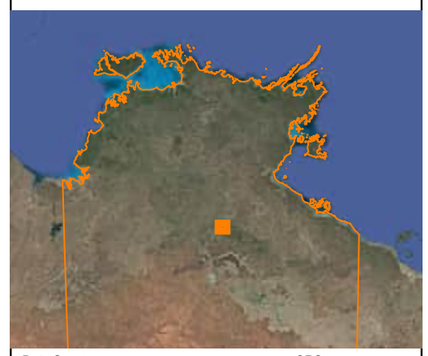
LEGEND

- Main Roads
- **Study Areas**
- Amungee NW
- **Tamboran Potential Works Locations**
- Well Pads
- Laydown Areas combined October 2023
- Access Tracks
- Project Area
- **Sensitive Landforms**
- Vegetation



Data Sources:
AECOM
Google Satellite

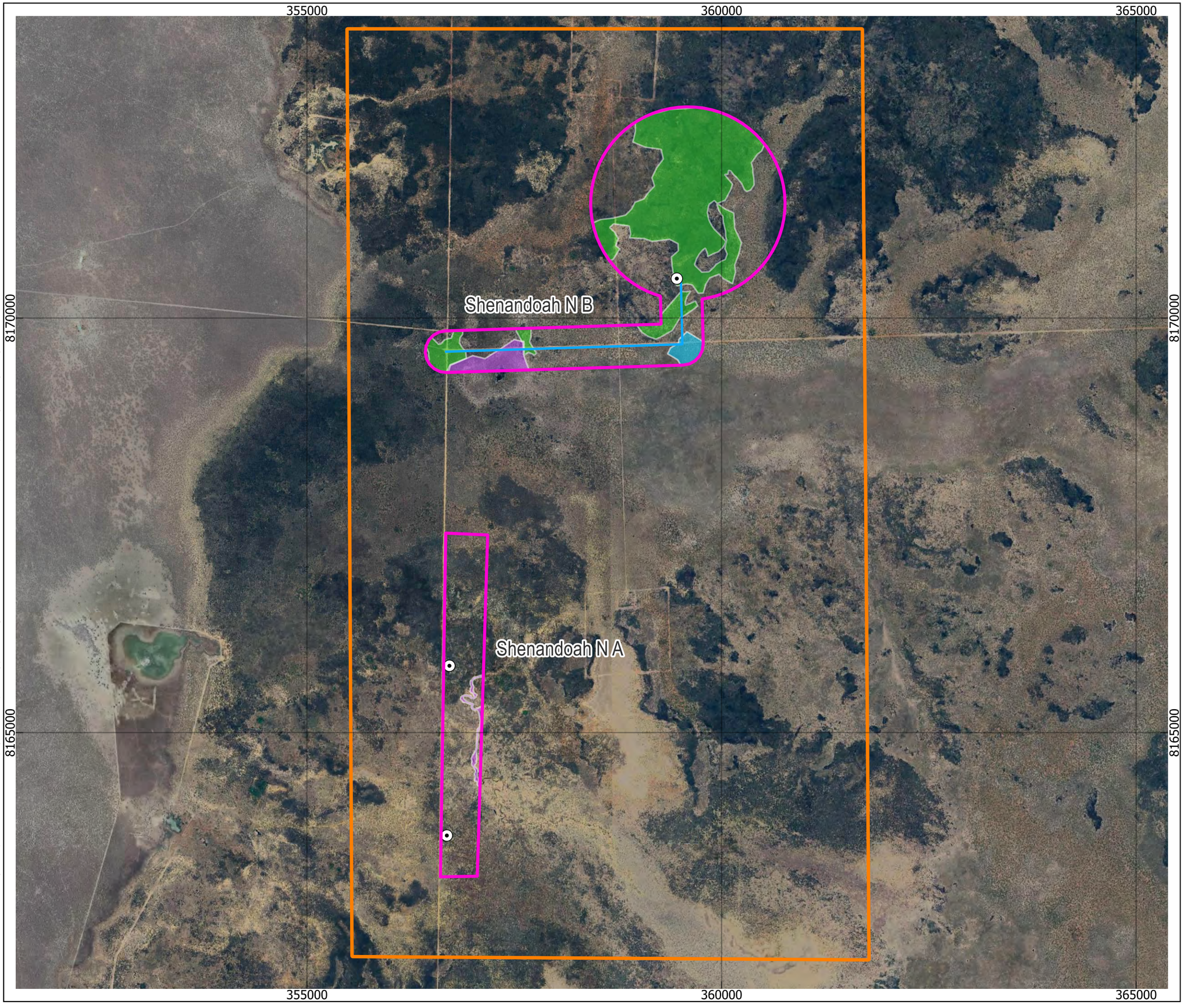
CRS:
GDA94 Zone 53

Tamboran B2 Pty Ltd
2022 - 2023 Heritage Scouting

Amungee NW Sensitive Landforms

PROJECT ID	60667354
CREATED BY	KC
LAST MODIFIED	13-10-2023
VERSION	1

Figure 11



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LEGEND

Study Areas

Shenandoah North

Tamboran Potential Works Locations

Well Pads

Access Tracks

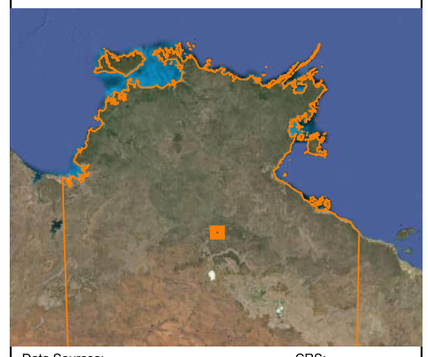
Project Area

Sensitive Landforms

Vegetation

Water Source

High Priority



Data Sources:
AECOM
Google Satellite

CRS:
GDA94 Zone 53

Tamboran B2 Pty Ltd
2022 - 2023 Heritage Scouting Combined Data

Shenandoah North Sensitive Landforms

PROJECT ID	60667354
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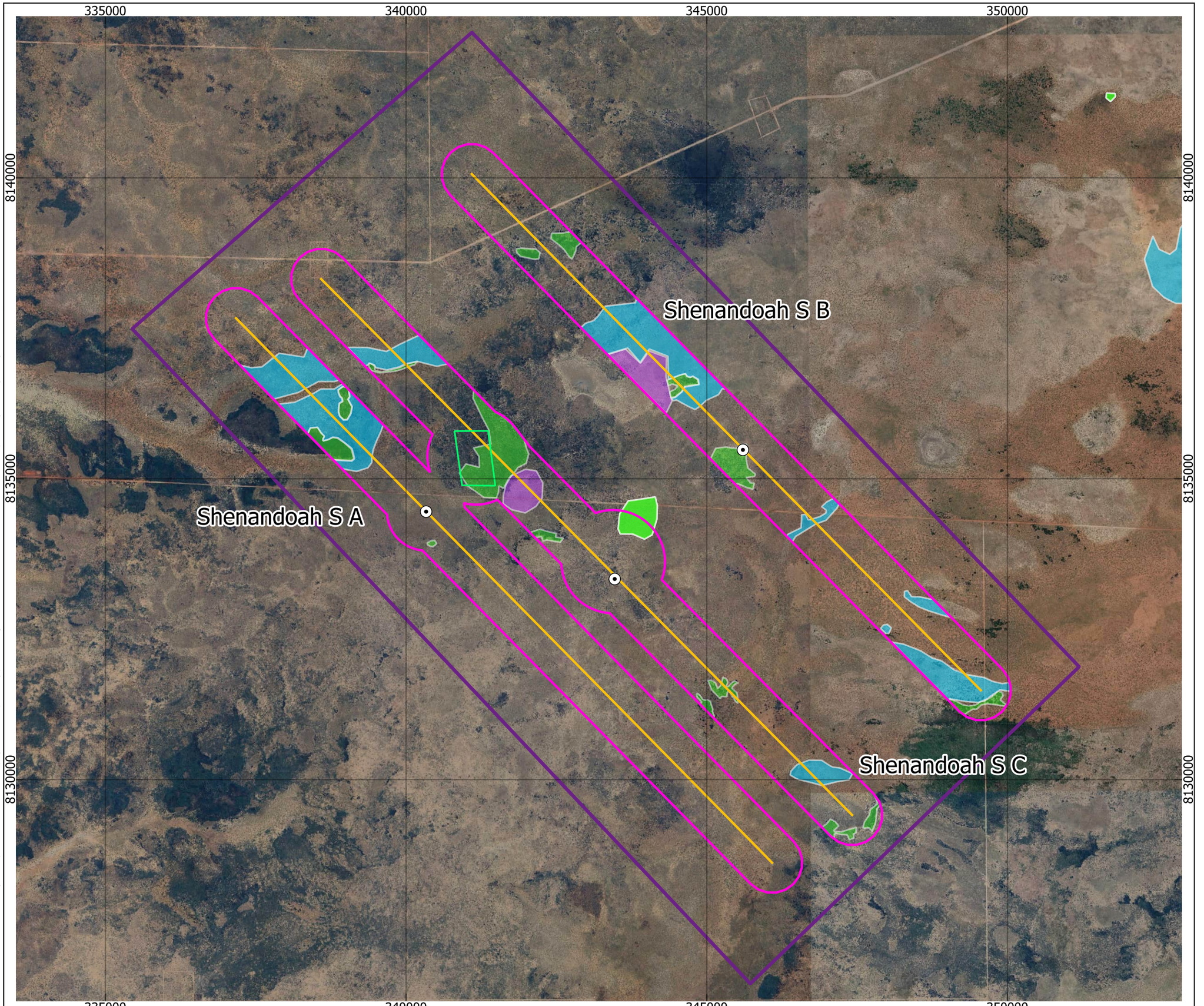
VERSION	2

Figure 12



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LEGEND

Study Areas

Shenandoah South

Tamboran Potential Works Locations

Well Pads

Laydown Area

Seismic Lines

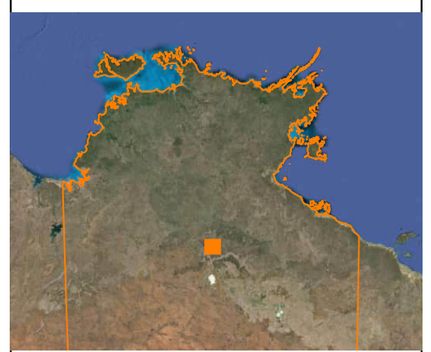
Project Area

Sensitive Landforms

Vegetation

Water Source

High Priority



Data Sources:
AECOM
Google Satellite

CRS:
GDA94 Zone 53

Tamboran B2 Pty Ltd
2022 - 2023 Heritage Scouting

Shenandoah South Sensitive Landforms

PROJECT ID	60667354
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VERSION	2

Figure 13

4.0 Results

4.1 Survey Results

Cultural heritage surveys were conducted for all 16 Project Areas, focussed on 22 locations with sensitive landforms. All but one of these sensitive landforms was subject to pedestrian survey, with the remaining location assessed from the air. In total, two archaeological sites were identified during the surveys, along with one area identified by Traditional Owners as having potential cultural significance.

GSV varied across the surveyed areas, ranging from 0-100%, with visibility impeded in places by substantial plant growth following the wet season. GSI was generally high to moderate, with a lack of previous significant ground disturbance over the majority of the proposed well pads. The main types of ground disturbance observed in the surveyed areas were the grading of fence lines and existing access tracks, and disturbance in low GSI areas was largely caused by cattle accessing water sources and walking across inundated ground. Clearance of vegetation and topsoil were associated with a gravel pit to the south of Amungee NW-3 Project Area.

Table 6 reports the findings of the scouting survey across the Project Areas. Given the size of the surveyed areas, GSV and GSI values varied markedly, and rankings presented are average results.

Plates 1 to 43 provide photographs illustrating the landscape contexts and GSV conditions encountered at each inspected Project Area.

Table 6 Survey results for the Project Areas

Project Area	Potential Works Location	GSV%	GSI	Heritage
Amungee NW-4	Well Pad	50-75	High	No
	Access Track	50-75	High	No
Amungee NW-3	Well Pad	25-50	High	No
	Access Track	25-50	High	No
	Laydown Area	25-50	High	No
	Laydown Area	25-50	High	No
Shenandoah N A	Well Pad	25-50	Moderate	No
	Well Pad – Option 2	75-100	High	TAM_23_AS_01
Shenandoah N B	Well Pad	50-75	Moderate	No
	Access Track	25-50	Low	Cultural Area
Shenandoah S A	Well Pad	25-75	High	No
	Seismic Line	N/A aerial survey only		No. Continuation of landform surveyed in Shenandoah S C. Potential considered to be low.
Shenandoah S B	Well Pad	50-75	High	No
	Seismic Line	50-75	Low-Moderate	No
Shenandoah S C	Well Pad	0-25	Moderate	No
	Laydown Area	25-50	Moderate	No
	Seismic Line	25-50	Low-Moderate	No
Kyalla 117 N1	Well Pad	50-75	High	No
Kyalla 117 N2	Well Pad	Fair	High	No

Project Area	Potential Works Location	GSV%	GSI	Heritage
Kyalla 98 S1	Well Pad	75-100	High	No
Kyalla 98 S2	Well Pad	75-100	Moderate - High	TAM_22_AS_01
Shenandoah South 2	Well Pad	25-50	High	No
Shenandoah South 3	Well Pad	50-75	High	No
Shenandoah South 4	Well Pad	50-75	High	No
Shenandoah South 5	Well Pad	50-75	Moderate	No
Unnamed	Well Pad	50-75	Moderate-High	No

Plate 1 **Amungee NW-4 Well Pad general context looking north**

Plate 2 **Amungee NW-4 Well Pad ground surface visibility**

Plate 3 **Amungee NW-4 Access Track general context looking east**

Plate 4 **Amungee NW-4 Access Track ground surface visibility**

Plate 5 **Amungee NW-3 well pad location general context looking north**

Plate 6 **Amungee NW-3 well pad location ground surface visibility**

Plate 7 **Shenandoah N A Well Pad general context looking east**

Plate 8 **Shenandoah N A Well Pad ground surface visibility**

Plate 9 **Shenandoah N A Well Pad Option 2 general context looking west**

Plate 10 **Shenandoah N A Well Pad Option 2 ground surface visibility**

Plate 11 **Shenandoah N B Well Pad general context looking east**

Plate 12 **Shenandoah N B Well Pad ground surface visibility**

Plate 13 **Shenandoah N B Access Track general context looking east**

Plate 14 **Shenandoah N B Access Track ground surface visibility**

Plate 15 **Shenandoah S A Well Pad general context looking north**

Plate 16 **Shenandoah S A Well Pad ground surface visibility**

Plate 17 **Shenandoah S B Well Pad general context looking east**

Plate 18 **Shenandoah S B Well Pad ground surface visibility**

Plate 19 **Shenandoah South B Seismic Line general context looking north**

Plate 20 **Shenandoah South B Seismic Line ground surface visibility**

Plate 21 **Shenandoah S C Well Pad general context looking south**

Plate 22 **Shenandoah S C Well Pad ground surface visibility**

Plate 23 **Shenandoah S C Laydown Area general context looking west**

Plate 24 **Shenandoah S C Laydown Area ground surface visibility**

Plate 25 **Shenandoah S C Seismic Line general context looking south**

Plate 26 **Kyalla 117 N1 Project Area general context looking south**

Plate 27 **Kyalla 117 N1 Project Area ground surface visibility**

Plate 28 **Kyalla 117 N2 Project Area general context shot**

Plate 29 Kyalla 117 N2 Project Area aerial context shot

Plate 30 Kyalla 98 S1 Project Area general context looking north

Plate 31 Kyalla 98 S1 Project Area ground surface visibility

Plate 32 Kyalla 98 S2 Project Area general context looking north

Plate 33 **Kyalla 98 S2 Project Area ground surface visibility**

Plate 34 **Shenandoah S2 Well Pad general context looking south**

Plate 35 **Shenandoah S2 Well Pad general context looking south**

Plate 36 **Shenandoah S3 Project Area general context looking south**

Plate 37 Shenandoah S3 Project Area ground surface visibility

Plate 38 Shenandoah S4 Project Area general context looking east

Plate 39 Shenandoah S4 Project Area ground surface visibility

Plate 40 Shenandoah S5 Project Area general context looking east

Plate 41 Shenandoah S5 Project Area ground surface visibility

Plate 42 Shenandoah South Unnamed Project Area general context looking north

Plate 43 Shenandoah South Unnamed Project Area ground surface visibility

4.2 Cultural Areas Identified

One sensitive landform was identified during the aerial survey as having potential cultural significance by the Traditional Owners – a waterhole on the southern edge of the Shenandoah N B Access Track (Figure 14). Table 7 provides a summary of the location of this area.

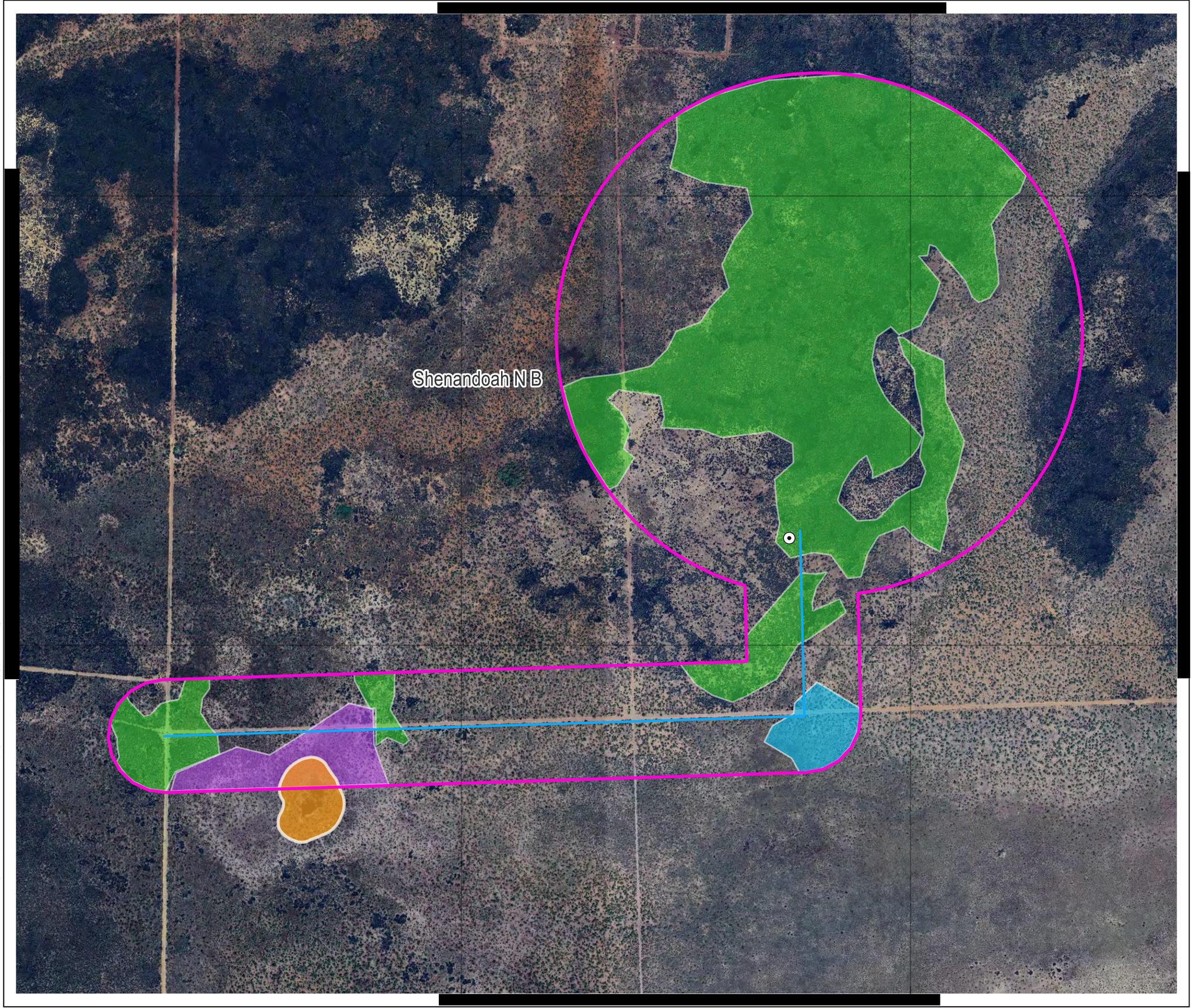
Table 7 Summary of Traditional Owner identified Culturally Significant Areas

Site Type	Project Area	Potential Works Location	Easting*	Northing*
Culturally Significant Area	Shenandoah N B	Access Track	[redacted]	[redacted]

* Datum: GDA94 Zone 53

This area had also been highlighted by AECOM as a sensitive landform (refer to Figure 12). A pedestrian survey of this area was limited by seasonal flooding, which had pushed the northern extent of water across the planned access road. As such, the presence of tangible heritage sites within the identified area was unable to be established.

The area was identified by Traditional Owner Terry Jackson as being significant, potentially related to the AAPA sacred site boundary located 650 m to the west. Traditional Owners requested that impacts to this area be avoided.



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LEGEND

- Identified Culturally Sensitive Area
- **Tamboran Potential Works Locations**
- Well Pads
- Access Tracks
- Project Area
- **Sensitive Landforms**
- Vegetation
- Water Source
- High Priority

Data Sources:
AECOM
Google Satellite

CRS:
GDA94 Zone 53

Tamboran B2 Pty Ltd
2022 - 2023 Heritage Scouting

Shenandoah North Identified Culturally Sensitive Area

PROJECT ID	60667354
CREATED BY	KC
LAST MODIFIED	11-3-2024
VERSION	2

Figure 14

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4.3 Heritage Sites Identified

Two Aboriginal archaeological sites were identified in the Project Areas during the field surveys (Table 8). Detailed records for the sites are provided in the sections that follow.

Table 8 Summary of Aboriginal archaeological sites recorded across the Project Areas

Site ID	Site Type	Project Area	Potential Works Location	Easting*	Northing*
TAM_23_AS_01	Artefact Scatter	Shenandoah N A	Well Pad – Option 2	[redacted]	[redacted]
TAM_22_AS_01	Artefact Scatter	Kyalla 98 S2	Well Pad	[redacted]	[redacted]

* Datum: GDA94 Zone 53

4.3.1 TAM_23_AS_01 – Artefact Scatter

TAM_23_AS_01 ([redacted] is a large, medium density artefact scatter found in the Shenandoah N A Project Area, ~500 m to the south-east of a proposed Well Pad (Figure 15). The site is located within and around an identified sensitive landform zone, adjacent to a linear, seasonal water source.

GSV across the site extent was very good to excellent at 75-100%, with the site extent within the Project Area concentrated on the eastern side of the water source, with limited grass or other vegetation cover (Plate 44 and Plate 45). GSI was generally moderate across the site. Much of the cleared area showed disturbance caused by cattle using the area for water, and erosion from water activity. A distinctive feature of this site was the availability of raw materials of various types and package sizes, both eroding from and available within the water source margins and bed (Plate 46 and Plate 47).

The section of the artefact scatter surveyed comprises more than 100 artefacts, of which 15 were recorded in detail. The full extent of the artefact scatter to the east was not established, as the scatter continued significantly beyond the Project Area boundaries. The artefacts recorded in detail included: one silcrete discoidal core (Plate 49), three mudstone multidirectional cores (examples in Plate 50 to Plate 51), and 11 flakes made on mudstone, chert, quartzite, and silcrete (examples in Plate 52 to Plate 57). Locally derived mudstone was the dominant raw material across the site. None of the recorded flakes showed any sign of retouching.

Flakes and cores were relatively large in size (all >25 mm), and all smaller flakes exhibited signs of post-production breakage, possibly caused by cattle traversing the area. There was evidence for periodic water flow across the site, which gently sloped towards the water source (Plate 46 and Plate 48), suggesting that smaller artefacts may have been winnowed from the assemblage. Concentrations of artefacts were also associated with the areas of deflated iron pan, suggesting palimpsests of deflated material. However, the site as a whole was generally intact, with a range of informal artefact types and sizes above 25 mm present.

Plate 44 **TAM_23_AS_01 – context looking west towards water source**

Plate 45 **TAM_23_AS_01 – context showing ground surface visibility**

Plate 46 **TAM_23_AS_01 – raw material availability in water source bed**

Plate 47 **TAM_23_AS_01 – raw material availability eroding from water source margins**

Plate 48 **TAM_23_AS_01 – evidence of periodic water flow and run off over site**

Plate 49 **TAM_23_AS_01 – silcrete discoidal core**

Plate 50 TAM_23_AS_01 – mudstone preferential face multidirectional core

Plate 51 TAM_23_AS_01 – mudstone multidirectional core

Plate 52 TAM_23_AS_01 – quartzite flake ventral

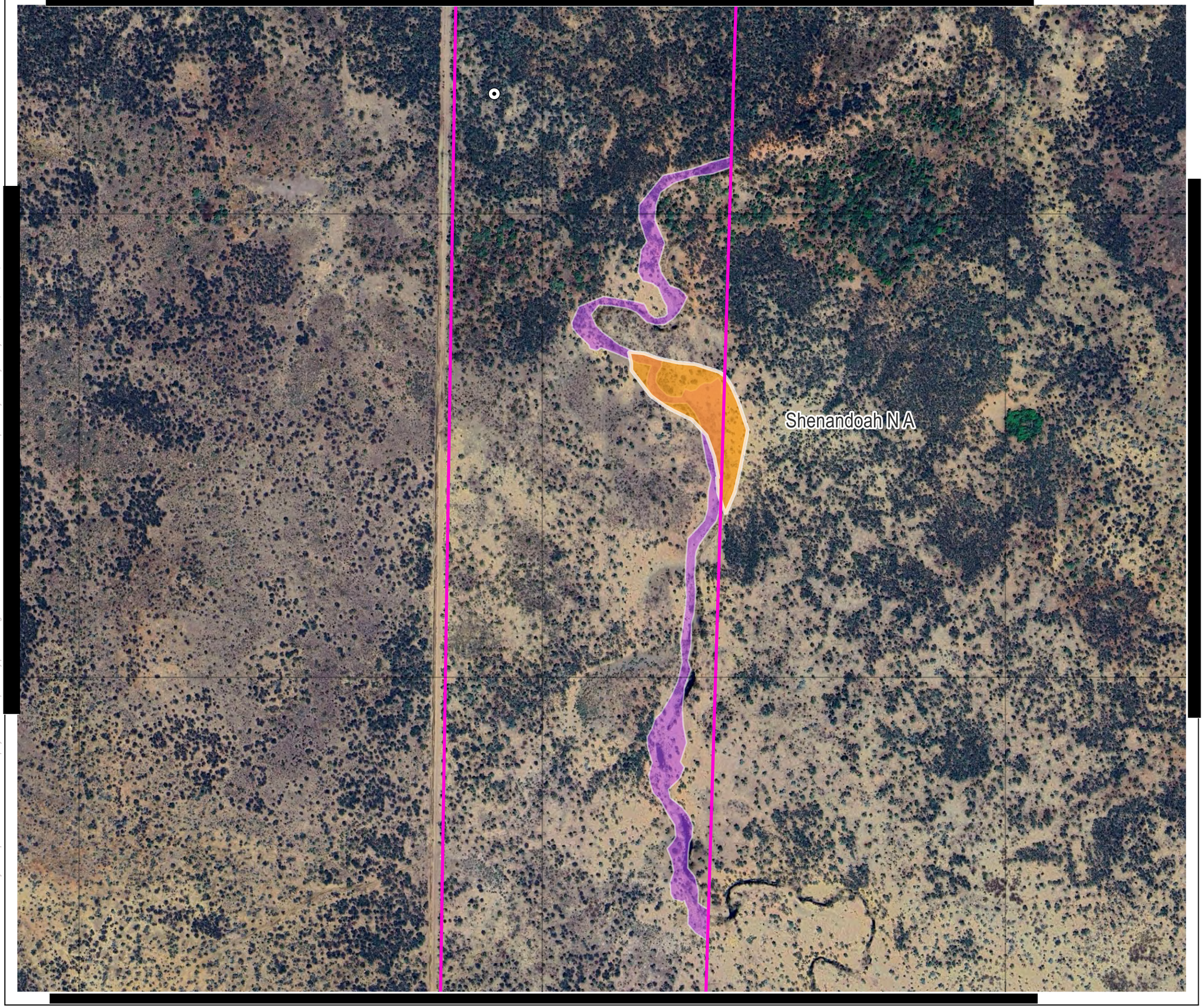
Plate 53 TAM_23_AS_01 – quartzite flake dorsal

Plate 54 TAM_23_AS_01 – chert flake ventral

Plate 55 TAM_23_AS_01 – mudstone flake ventral

Plate 56 TAM_23_AS_01 – mudstone flake ventral

Plate 57 TAM_23_AS_01 – silcrete flake dorsal



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(when printed at A3)

LEGEND

Heritage Site

TAM_23_AS_01

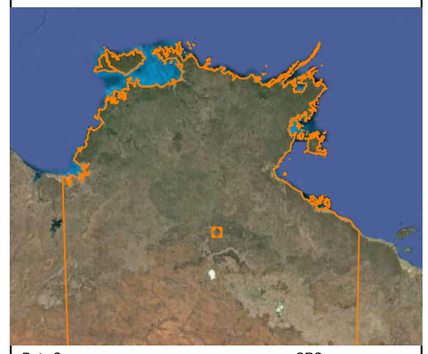
Tamboran Potential Works Locations

Well Pads

Project Area

Sensitive Landforms

High Priority



Data Sources:
AECOM
Google Satellite

CRS:
GDA94 Zone 53

Tamboran B2 Pty Ltd
2022 - 2023 Heritage Scouting

Shenandoah North A Heritage Site
TAM_23_AS_01

PROJECT ID	60667354
CREATED BY	KC
LAST MODIFIED	11-3-2024
VERSION	2

Figure 15

4.3.2 TAM_22_AS_01 – Artefact Scatter

TAM_22_AS_01 ([redacted] is a large, medium density artefact scatter found in the Kyalla 98 S2 Project Area (Figure 16). The site is located within an identified sensitive landform zone, adjacent to a large drainage depression, and surrounded by areas of sparse vegetation (Plate 58) with established stands of Bullwaddy to the north.

GSV across the site extent was very good to excellent at 75-100%, with the site extent concentrated in the clearing with limited grass or other vegetation cover (Plate 59). GSI was ranged from moderate to high across the site. Much of the clearing showed disturbance caused by cattle using the area for water and erosion from water activity. Much of the periphery, however, appeared intact, with minor areas of exposed iron pan creating deflated stable surfaces.

The section of the artefact scatter surveyed comprises more than 200 artefacts, of which 15 were recorded in detail. The extent of the artefact scatter to the north and east was not established, as the scatter continued significantly beyond the well pad buffer zone. The artefacts recorded in detail included: one silcrete side and end scraper (Plate 60, Plate 61), three bifacial thinning flakes made of silcrete and quartzite (Plate 62, Plate 63), two silcrete cores, and nine flakes made of chert, silcrete, and quartzite. Five of the recorded flakes were also retouched. Artefacts closer to drainage depression exhibited a strong pattern of larger size sorting, suggesting that smaller artefacts had been winnowed by periodic water flow (Plate 64). Concentrations of artefacts were also associated with the areas of deflated iron pan around the periphery, suggesting palimpsests of deflated material (Plate 65). However, the site as a whole was generally intact, with a range of artefact types and sizes present.

Plate 58 TAM_22_AS_01 – context looking east

Plate 59 TAM_22_AS_01 – context showing surface visibility

Plate 60 TAM_22_AS_01 – silcrete scraper (dorsal)

Plate 61 TAM_22_AS_01 – silcrete scraper (ventral)

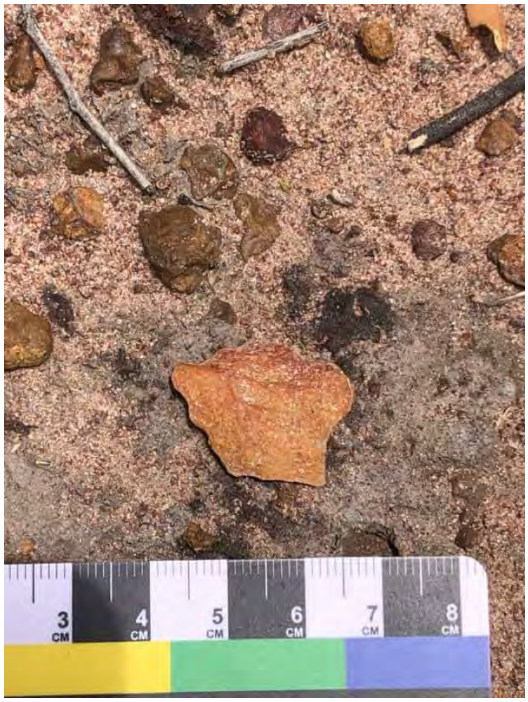
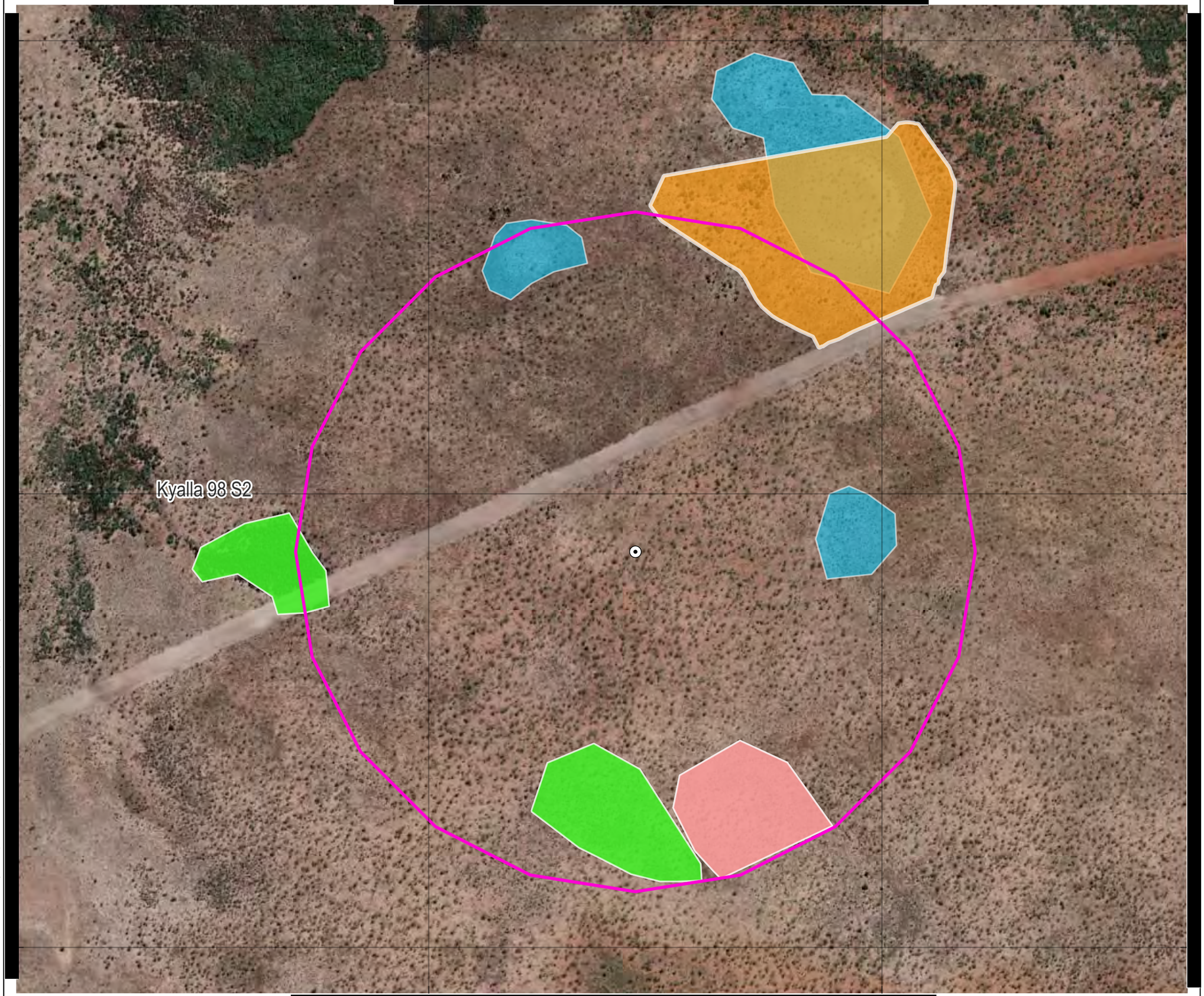


Plate 62 TAM_22_AS_01 – thinning flake (dorsal)

Plate 63 TAM_22_AS_01 – thinning flake (ventral)

Plate 64 TAM_22_AS_01 – size sorting of artefacts closer to drainage depression

Plate 65 TAM_22_AS_01 – density of artefacts occurring on iron pan deflation



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(when printed at A3)

LEGEND

Heritage Site

TAM_22_AS_01

Tamboran Potential Works Locations

Well Pads

Project Area

Sensitive Landforms

Vegetation

Water Source

Unknown

Data Sources:
AECOM
Google Satellite

CRS:
GDA94 Zone 53

Tamboran B2 Pty Ltd
2022 - 2023 Heritage Scouting

Kyalla 98 S2 Heritage Site
TAM_22_AS_01

PROJECT ID	60667354
CREATED BY	KC
LAST MODIFIED	13-10-2023
VERSION	1

Figure 16

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5.0 Significance Assessment of Heritage Sites

5.1 Scientific Significance Assessment

In the absence of formal State/Territory significance assessment guidelines, AECOM employs a standard scientific approach, based on set criteria developed for Australian contexts. These criteria address the principal factors involved in determining a site's significance and consequently the level of management measures required.

For the current assessment, information on the scientific values of the survey area has been obtained through a review of existing environmental and archaeological data. The significance rating of 'scientific significance' is offered based on an assessment of the place's complexity, rarity, representativeness, integrity/place condition and assigned low, moderate, and high values. These criteria are explained in Appendix C.

Table 9 applies the criteria to the sites identified in the Shenandoah N A and Kyalla 98 S2 Project Areas. These sites were determined to be of medium significance.

Table 9 Scientific Significance Assessment for Aboriginal archaeological site at the Shenandoah N A Project Area

Site Name	Site Contents	Rarity	Site Integrity	Overall Scientific Significance
TAM_23_AS_01	Medium – Place contains a large number of artefacts, but not a diverse range of cultural heritage material	Low – Place contains artefacts of common occurrence within the geographic region	Medium	Medium
TAM_22_AS_01	High – Place contains a large number of artefacts and a diverse range of cultural heritage material	Low – Place contains artefacts of common occurrence within the geographic region	Medium	Medium

5.2 Cultural Significance

Cultural value refers to the spiritual, traditional, historical, and contemporary associations and attachments a place or area has for Aboriginal people and can only be identified through consultation with Aboriginal people.

The Traditional Owners were not present during the pedestrian portion of the scouting survey for Shenandoah N A when the TAM_23_AS_01 site was identified. If this area cannot be avoided, additional assessment and consultation with Traditional Owners regarding the site will be required.

The Traditional Owners present during the scouting survey for Kyalla 98 S2identified the TAM_22_AS_01 site as being of value, and recommend that the area be avoided. If this area cannot be avoided, additional assessment and consultation will be required.

6.0 Impact Assessment

The degree of impact an activity will have on a cultural heritage place is assessed in terms of the magnitude of change to the acknowledged heritage values of a place. The final assessment of the significance of impact on a cultural heritage place is a factor of the cultural heritage sensitivity of the place, combined with the predicted magnitude of change.

Table 10 provides an impact assessment for the Aboriginal archaeological site recorded in the Shenandoah N A Project Area, east of the proposed well pad Shenandoah N A – Option 2, and for the Aboriginal archaeological site recorded in the Kyalla 98 S2 Project Area. Given that the final footprints of the well pads have not yet been established, this assessment takes the conservative measure of assuming that works will impact the cultural heritage areas. The significance of the predicted impact is assessed using the rankings established in previous sections. Working under this assumption of impact, the proposed works would have a moderate impact on the sites.

Table 10 Impact assessment for TAM_23_AS_01

Site	Site type	Scientific significance	Type of harm	Degree of harm	Consequence of harm	Magnitude of change prior to mitigation	Significance of impact prior to mitigation
TAM_23_AS_01	Artefact Scatter	Medium	Area clearance and grading for construction of infrastructure and access tracks across sections of site that overlap with potential well pad activities	Partial	Partial loss of value	Medium	Moderate
TAM_22_AS_01	Artefact Scatter	Medium	Area clearance and grading for construction of infrastructure and access tracks across sections of site that overlap with potential well pad	Partial	Partial loss of value	Medium	Moderate

Consultation with Traditional Owners was not possible during the survey of the Shenandoah N A Project Area for the TAM_23_AS_01 site, however discussions regarding similar sites found in the Shenandoah pastoral lease suggests that total avoidance of the site would be the preferred mitigation option.

Consultation with Traditional Owners during the survey of the Kyalla 98 S2 Project Area for the TAM_22_AS_01 site relayed that total avoidance of the site cultural heritage place via the adjustment of works at Kyalla 98 S2 would be the preferred mitigation option.

Table 11 provides an impact assessment for the Aboriginal archaeological site if these mitigation measure is met. If the proposed works at Shenandoah N A and Kyalla 98 S2 were sited to avoid any impacts to the cultural heritage area, proposed works will have a neutral effect.

Table 11 Impact assessment for TAM_23_AS_01 following mitigation

Site	Site type	Scientific significance	Type of mitigation	Degree of harm	Consequence of harm	Magnitude of change prior to mitigation	Significance of impact after mitigation
TAM_23_AS_01	Artefact Scatter	Medium	Proposed well pad Shenandoah N A – Option 2 sited so that no proposed works will directly impact any part of the site	None	No loss of value	Medium	Neutral
TAM_22_AS_01	Artefact Scatter	Medium	Proposed well pad Kyalla 98 S2 sited so that no proposed works will directly impact any part of the cultural heritage place	None	No loss of value	Medium	Neutral

7.0 Key Findings

The key findings of this heritage assessment for the Amungee NW, Shenandoah North, Shenandoah South and Kyalla Study Areas are:

- A review of existing heritage data and reports indicates that there are no previously recorded Aboriginal archaeological sites within the Study Areas
- Project works in Shenandoah North are directly adjacent to AAPA Restricted Works Areas, which are in turn adjacent to registered sacred sites
- Aerial and targeted pedestrian surveys were completed for all 16 Project Areas
- Two Aboriginal archaeological sites, artefact scatter TAM_23_AS_01 and artefact scatter TAM_22_AS_01, were identified during these surveys
- TAM_23_AS_01 is:
  - Located on the eastern side of the Shenandoah N A Project Area, ~500 m south-east of Well Pad Option 2, along a seasonal stream
  - Of medium scientific significance, and likely to be of cultural significance to the Traditional Owners
- TAM_22_AS_01 is:
  - Located on the on the north-eastern side of the Kyalla 98 S2 Project Area, near a drainage line and adjacent to thick and established stands of *Macropteranthes kekwickii* (Bullwaddy)
  - Of medium scientific significance, and of cultural significance to the Traditional Owners
- One sensitive landform, a waterhole along the Shenandoah N B Access Track, was identified by the Traditional Owners as having cultural significance
- This survey did not achieve full coverage of the individual Project Areas, and there remains the potential for future additional finds.

8.0 Recommendations

On the basis of the above findings, the following recommendations are made for Project works:

- Impacts to the identified Aboriginal archaeological sites TAM_23_AS_01 and TAM_22_AS_01 should be avoided wherever possible. Where impacts cannot be avoided, an appropriate clearance protocol should be implemented in consultation with the Northern Land Council and Traditional Owners
  - Preferably, the potential well pad activities at Shenandoah N A – Option 2 and Kyalla 98 S2 should be sited to avoid impact to TAM_23_AS_01 and TAM_22_AS_01
  - If well pad activities at Shenandoah N A – Option 2 and Kyalla 98 S2 are not able to avoid impacts to TAM_23_AS_01 and TAM_22_AS_01, the potential well pad may need to be relocated or a different location option selected
  - If Shenandoah N A – Option 2 or Kyalla 98 S2 are moved to a location not assessed during this scouting survey, further consultation and survey may be required
  - TAM_23_AS_01 and TAM_22_AS_01 should be reported to the NT Heritage Branch. Should this site be declared a heritage object by the NT Heritage Council, a work order may be required for future impacts
- Impacts to the culturally significant waterhole south of the Shenandoah N B Access Track, should be avoided wherever possible. Where impacts cannot be avoided, an appropriate clearance protocol should be implemented in consultation with the Northern Land Council and Traditional Owners

- Project activities across the Shenandoah North Study Area will need to take into consideration the extent of sacred sites and established Restricted Works areas outlined in AAPA Certificate C2023/049 in the Kyalla well pad area, and the new Authority Certificates under development at Shenandoah North and Shenandoah South, and avoid impacts to these areas at all times
- Consultation with AAPA regarding finalised footprints of works may be necessary to ensure that appropriate buffer zones are established
- Appropriate signage, no-go zones, and/or barricades must be in place during any works in areas that are adjacent to Aboriginal sacred sites and AAPA Restricted Works areas
- Consultation with the Northern Land Council and Traditional Owners is recommended to ensure that an appropriate clearance protocol is put in place for the duration of the proposed works, noting the limitations regarding the survey coverage achieved during the scouting survey and the potential for additional finds in the survey areas
- An unexpected heritage finds stop works procedure is to be implemented for the duration of proposed works (see Appendix D)
- Induction of staff on site should include reference to the unexpected finds procedure.

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Appendix A

Legislation

Appendix A Legislation

Commonwealth Legislation

Environment Protection and Biodiversity Conservation Act

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) took effect on the 16 July 2000. Under section 26 of the EPBC Act it is stated that:

> *A person must not take on Commonwealth land an action that has, will have or is likely to have a significant impact on the environment.*

Under section 28 of the EPBC Act it is stated that:

> *The Commonwealth or a Commonwealth agency must not take inside or outside the Australian jurisdiction an action that has, will have or is likely to have a significant impact on the environment inside or outside the Australian jurisdiction.*

An action is defined as a project, development, undertaking, activity, series of activities, or alteration. An action will also require approval if:

- It is undertaken on Commonwealth land and will have or is likely to have a significant impact;
- It is undertaken outside Commonwealth land and will have or is likely to have a significant impact on the environment on Commonwealth land; and
- It is undertaken by the Commonwealth and will have or is likely to have a significant impact.

The EPBC Act defines ‘environment’ as both natural and cultural environments and therefore includes Aboriginal and historic heritage items. Under the Act, protected heritage items are listed on the National Heritage List (items of significance to the nation) or the Commonwealth Heritage List (items belonging to the Commonwealth or its agencies). These two lists replaced the Register of the National Estate (RNE) which is no longer a statutory list.

Aboriginal and Torres Strait Islander Heritage Protection Act 1984

The *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (the ATSIHP Act) provides for the preservation and protection of places, areas and objects of particular significance to Indigenous Australians. The stated purpose of the ATSIHP Act is the 'preservation and protection from injury or desecration of areas and objects in Australia and in Australian waters, being areas and objects that are of particular significance to Aboriginals in accordance with Aboriginal tradition' (section 4).

Under the Act, ‘Aboriginal tradition’ is defined as “the body of traditions, observances, customs and beliefs of Aboriginals generally or of a particular community or group of Aboriginals, and includes any such traditions, observances, customs or beliefs relating to particular persons, areas, objects or relationships” (Section 3). A ‘significant Aboriginal area’ is an area of land or water in Australia that is of ‘particular significance to Aboriginals in accordance with Aboriginal tradition’ (Section 3). A ‘significant Aboriginal object’, on the other hand, refers to an object (including Aboriginal remains) of like significance.

For the purposes of the Act, an area or object is considered to be injured or desecrated if:

- In the case of an area:
  - it is used or treated in a manner inconsistent with Aboriginal tradition;
  - the use or significance of the area in accordance with Aboriginal tradition is adversely affected;
  - passage through, or over, or entry upon, the area by any person occurs in a manner inconsistent with Aboriginal tradition;
- in the case of an object:
  - it is used or treated in a manner inconsistent with Aboriginal tradition.

The ATSIHP Act can override state and territory laws in situations where a state or territory has approved an activity, but the Commonwealth Minister prevents the activity from occurring by making a declaration to protect an area or object. However, the Minister can only make a decision after receiving a legally valid application under the ATSIHP Act and, in the case of long term protection, after considering a report on the matter. Before making a declaration to protect an area or object in a state or territory, the Commonwealth Minister must consult the appropriate Minister of that state or territory (section 13).

Native Title Act 1993

The *Native Title Act 1993* (NT Act) provides for the recognition and protection of native title for Indigenous peoples. The NT Act recognises native title for land over which native title has not been extinguished, and where persons able to establish native title are able to prove continuous use, occupation or other classes of behaviour and actions consistent with a traditional cultural possession of those lands. It also makes provision for Indigenous Land Use Agreements (ILUA) to be formed.

Aboriginal Land Rights (Northern Territory) Act 1976

The *Aboriginal Land Rights Act* (ALRA) changed Aboriginal reserves within the Northern Territory to freehold title held in trust. The Act mandated the formation of Land Councils to act in the interests of Northern Territory Aboriginal people in the areas of land, access to lands, employment and the development of businesses. The Act also defined Sacred Sites as sites that are sacred, or otherwise significant, in the Aboriginal Tradition'. The Act protected these sites from damage, whether accidental or intentional. The NT Aboriginal Sacred Sites Act 1989 uses this definition of sacred in its purpose of protecting these sites outside of Land Trust lands. On Pastoral Lease Lands, the general procedure is for the AAPA to conduct the Sacred Site surveys with the relevant Site Custodians, then issue an Authority Certificate under the Act.

Territory Legislation

Heritage Act 2011

The *Heritage Act 2011* provides for the protection of both natural and cultural heritage (Aboriginal, historical and Macassan heritage) within the Northern Territory. The Act establishes the Heritage Council (consisting of eleven members) and the NT Heritage Register. It sets the process by which places become heritage places and allows for interim protection of places.

It is an offence to remove or damage heritage places or objects or to mislead or obstruct heritage officers regarding the provision of requested information or entry to works, vehicles or premises that are likely to have been involved in an offence against the Heritage Act. Compliance with the requirements of the Act must be adhered to at all times.

Northern Territory Aboriginal Sacred Sites Act 1989

The *Northern Territory Aboriginal Sacred Sites Act* 1989 was established to provide a system that protects sacred sites whilst providing for the development of land.

The Aboriginal Areas Protection Authority (AAPA) is a statutory authority established under the Sacred Sites Act and is responsible for overseeing the protection of sacred sites on land and sea across the whole of Australia's Northern Territory.

The Act establishes the protection of Aboriginal sacred sites through:

- Sacred site avoidance surveys and issuing authority certificates for any development proposals.
- Giving the public information about existing sacred sites through abstracts of Authority records and access to the registers the Authority maintains.
- Establishing and maintaining a Register of Sacred Sites
- Manages the rights of traditional custodians to access Sacred Sites.

The Act also establishes a range of offences and associated penalties that are aimed at protecting sacred sites. It is an offence to desecrate or disturb a site without the approval of the relevant

custodians. A register of known sites exists to assist in identifying the likelihood of disturbance and potential need to obtain approval. The Act also establishes a duty-of-care to notify the AAPA of any potential disturbance to Aboriginal sacred sites.

Appendix B

Heritage Register Searches

McNeil, Jess

From: David Steinberg <David.Steinberg@nt.gov.au> on behalf of Heritage Branch <Heritage.Branch@nt.gov.au>
Sent: Monday, 6 March 2023 12:45 PM
To: McNeil, Jess
Cc: Brigden, Isobel
Subject: RE: Request regarding information about Aboriginal and Macassan places - Tamboran Energy, Betaloo Basin

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Report Suspicious

Hi Jess,

Thank you for your enquiry regarding known archaeological places in the footprint of your project. To confirm your email said 8 possible well pad location and seismic lines and tracks. I counted 9 possible well sites in the GIS layer you provided. I have conducted the search of the 9 locations and tracks and lines as detailed in the GIS layer.

To confirm this response to your enquiry constitutes a basic request for information about known sites. It **cannot** be used for advice relating to work as defined in the *Heritage Act 2011*.

In preparing this advice, the Heritage Branch has referred to the Northern Territory Heritage Register and the Heritage Branch archaeological database which includes known information about Aboriginal and Macassan archaeological places and objects in the Northern Territory. The fact that there are no known archaeological places recorded may be because no archaeological surveys have been conducted in that particular area, and is not necessarily an indication they do not exist.

The search has found that there are no nominated, provisionally declared or declared heritage places or objects within the subject area.

The search has found that there are no known archaeological places within the subject site.

regards

David

Dr David Steinberg
Senior Heritage Officer/Maritime Archaeologist
Heritage Branch
Community Participation and Inclusion
Territory Families, Housing and Communities

Floor 1, JHV2 – Jape Homemaker Village,
356 Bagot Road Millner
PO Box 37037 Winnellie 0821

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McNeil, Jess

From: Fiona Earl <Fiona.Earl@nt.gov.au> on behalf of Heritage Branch <Heritage.Branch@nt.gov.au>
Sent: Thursday, 11 May 2023 10:39 AM
To: McNeil, Jess
Subject: RE: Request regarding information about Aboriginal and Macassan places - Tamboran Energy

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Hi Jess,
This initial advice is provided following a request for information from the Heritage Branch.
For requests related to sacred sites, contact the Aboriginal Areas Protection Authority https://www.aapant.org.au.

Work details

Name of proponent (company or department)	AECOM
Contact person (name and title)	Jess McNeil – Graduate Heritage Specialist
Date enquiry received	27 April 2023
Location of work	Daly Waters (Beetaloo Basin)
Brief description of work as provided	Exploration activities (oil and gas wells)
Date of Heritage Branch response	11 May 2023
Our reference	HCD2023/00236

The context of Heritage Branch advice

The Northern Territory Government's Heritage Branch administers the *Heritage Act 2011* and provides authoritative advice about obligations under the *Heritage Act 2011,* including steps to take to manage the impact of proposed work on Aboriginal and Macassan archaeological places and objects
It is important that advice given by the Heritage Branch is followed. A failure to follow advice received from the Heritage Branch may be considered as evidence in an investigation if damage occurs to an Aboriginal or Macassan archaeological place or object.

Relevant parts of the Northern Territory's *Heritage Act* 2011

Under the Northern Territory's *Heritage Act 2011* (the Act):

1. All Aboriginal or Macassan archaeological places and objects are automatically protected - this includes places and objects not previously recorded;
2. Places and objects include an artefact or thing given shape by a person - examples include stone tools, stone arrangements, fish traps, rock art, modified trees, and shell middens;
3. Ancestral remains are also protected;
4. Underwater Cultural Heritage is protected, up to three nautical miles from the coast;
5. There is an obligation to notify of the discovery of Aboriginal or Macassan archaeological places or objects

Conditions of advice

1. This advice is based on the description of the work provided to the Heritage Branch. If the work expands or changes significantly seek further advice.

2. In preparing this advice, the Heritage Branch has referred to an archaeological database which includes information about Aboriginal and Macassan archaeological places and objects in the Northern Territory. However the database only includes information about known archaeological places. The fact that there are no known archaeological places recorded may be because no archaeological surveys have been conducted in that particular area, and is not necessarily an indication they do not exist.

Actions

The following actions have been taken in relation to the enquiry.

- A search of the Northern Territory Heritage Register;
- A search for known archaeological places located within the subject site on the Heritage Branch archaeological database;
- A search for known archaeological places located within the proximity of the subject site on the Heritage Branch archaeological database;
- The extent of pre-existing ground disturbance;
- The scale and nature of the work proposed (major, moderate or minor);
- Areas identified as being excluded from the work footprint e.g. riparian buffers; and
- An assessment of the likelihood of unrecorded archaeological places existing within the subject site, based on landscape features, known archaeological places in the vicinity, and other predictive tools.

Advice

The search has found that there are no known Aboriginal or Macassan archaeological places within the subject site. However the likelihood of possible unrecorded Aboriginal or Macassan archaeological places has been assessed as *possible or likely*. The extent of pre-existing disturbance and the nature of the work itself has also been considered. The Heritage Branch recommends that an archaeological survey and cultural heritage management plan are required to identify and mitigate the impact to Aboriginal or Macassan archaeological places.

1. The Heritage Branch can provide a list of qualified archaeologists on request.
2. The Heritage Branch can provide advice in regard to the scope of the survey and plan on request.
3. The Heritage Branch must receive a copy of the final report for our records.

Declared Heritage Advice

The search has found that there are no nominated, provisionally declared or declared heritage places or objects within the subject area.

Further comments

Further information can also be found on our website:
https://nt.gov.au/property/building/heritage-properties/heritage-properties-building-works-and-development
Aboriginal heritage information | NT.GOV.AU

Thanks,

Fi

Dr Fiona Earl
Heritage Officer
Heritage Branch
Community Participation and Inclusion
Territory Families, Housing and Communities

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Jape Homemaker Village, 356 Bagot Road Millner
PO Box 37037, Winellie, NT 0821

t. 08 8999 5051

McNeil, Jess

From: David Steinberg <David.Steinberg@nt.gov.au> on behalf of Heritage Branch <Heritage.Branch@nt.gov.au>
Sent: Monday, 6 March 2023 12:45 PM
To: McNeil, Jess
Cc: Brigden, Isobel
Subject: RE: Request regarding information about Aboriginal and Macassan places - Tamboran Energy, Betaloo Basin

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The search has found that there are no nominated, provisionally declared or declared heritage places or objects within the subject area.

The search has found that there are no known archaeological places within the subject site.

regards

David

Dr David Steinberg
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Appendix C

Archaeological Assessment Criteria

Appendix C Archaeological Assessment Criteria

Ground surface visibility and integrity

Table 12 Ground Surface Visibility (GSV) Scheme

GSV rating	Percentage GSV
Nil to poor	0-25%
Poor to good	26-50%
Good to very good	51-75%
Very good to excellent	76-100%

Table 13 Ground Surface Integrity (GSI) Scheme

GSI rating	Definition
Low	Ground surface has been subjected to significant disturbance (e.g. earthworks, excavation). Little to no integrity remains.
Moderate	Ground surface has been subject to moderate disturbance (e.g. native vegetation clearance) but retains a reasonable degree of integrity.
High	An unmodified or minimally modified ground surface.

Significance Assessment

Scientific Value

Scientific value refers to the importance of a place in terms of its rarity, representativeness and the extent to which it may contribute further information (i.e., its research potential).

Research Potential

Research potential can be defined as the potential of an archaeological site to address what Bowdler (1981) has referred to as “timely and specific research questions”. These questions may relate to any number of issues concerning past human lifeways and environments and, as suggested by Bowdler’s quote, will inevitably reflect current trends or problems in academic research (Burke & Smith, 2004). For their part, Bickford and Sullivan (1984) suggest that the research potential of an archaeological site can be determined by answering the following series of questions:

1. Can the site contribute knowledge which no other resource can?
2. Can the site contribute knowledge which no other such site can?
3. Is this knowledge relevant to general questions about human history or other substantiative subjects?

Several criteria can be used to assess the research potential of an archaeological site. Particularly important in the context of Aboriginal archaeology are the intactness or integrity of the site in question, its complexity (place contents) and its representativeness.

Complexity (Place Contents)

The *complexity* of a site refers primarily to the nature or character of the artefactual materials or features that constitute it but also includes site structure (e.g., the physical size of the site, spatial patterning in observed cultural materials). In the case of open artefact sites, for example, the principal criteria used to assess complexity are the site’s size (i.e., number of artefacts and/or spatial extent), the presence, range and frequency of artefact and raw material types, and the presence of features such as hearths. Table 14 provides the assessment criteria for the complexity of the site.

Table 14 Place complexity criteria

Criteria	Value
Place contains 0-10 artefacts	Low - 0

Criteria	Value
Place contains large number of artefacts but limited range of cultural heritage materials	Medium - 1
Place contains large number of artefacts and diverse range of cultural heritage material	High - 2

Rarity and Representativeness

Rarity and r*epresentativeness* are related concepts. Rarity refers to the relative uniqueness of a site within its local and regional context. The scientific significance of a site is assessed as higher if it is unique or rare within either context. Conversely, it is considered to be of lower significance if it is common in one or both. The concept of representativeness, meanwhile, refers to the question of whether or not a site is "a good example of its type, illustrating clearly the attributes of its significance" ((Burke & Smith, 2004). Representativeness is an important criterion as one of the primary goals of cultural heritage management is to preserve for future generations a representative sample of all archaeological site types in their full range of environmental contexts.

In common with rarity, assessments of representativeness within a region are dependent on the state of current knowledge concerning the number and type of archaeological sites present within that region. This is a critical point, for as suggested by Kuskie (2000) and others (Bowdler, 1981; Godwin, 2011; Pearson & Sullivan, 1995), the absence across most of Australia of regional-scale quantitative data for Aboriginal sites and places represents a major constraint in assessments of representativeness and rarity. As stressed by Bowdler 1981 some 40 years ago, detailed regional-scale assessments of the Aboriginal archaeological record of Australia are required to address this issue. Table 15 provides the assessment criteria for the place's rarity.

Table 15 Rarity criteria

Criteria	Value
Common occurrence within the geographical region	Low - 0
Irregular occurrence within the geographical region	Medium - 1
Rare occurrence within the geographical region	High - 2

Integrity/Place Condition

Integrity refers to the extent to which a site has been disturbed by natural and/or anthropogenic phenomena and includes both the state of preservation of particular remains (e.g., animal bones, plant remains) and, where applicable, stratigraphic integrity. Assessments of archaeological integrity are predicated on the notion that undisturbed or minimally disturbed sites are likely to yield higher quality archaeological and/or environmental data than those whose integrity has been significantly compromised by natural and/or anthropogenic phenomena. Establishing levels of preservation or integrity in the context of a surface survey is difficult. Nonetheless, useful rating schemes are available for 'open' sites (Coutts & Witter, 1977) and modified trees (Long, 2003). Table 16 provide the assessment criteria for the place's integrity.

Table 16 Integrity criteria for place's integrity

Criteria	Values
Place demonstrates high degree of disturbance with some cultural materials remaining	Low – 0
Place in good condition with little disturbance	Medium - 1
Place in excellent condition with minimum or no disturbance	High - 2

Impact Assessment

The degree of impact an activity will have on a cultural heritage place is assessed in terms of the magnitude of change to the acknowledged heritage values of a place as summarised in Table 17.

These impacts may be direct, such as the demolition of heritage buildings, or indirect, such as changes to the views or setting of a cultural heritage place. In some cases, indirect impacts might also cause physical damage to a cultural heritage place, such as excessive vibration causing structural damage, or excessive pollution causing damage to surfaces.

Table 17 Determining magnitude of change

Magnitude	Example criteria
Major	Change to all or most significant aspects of the place, such that its heritage values are substantially reduced or destroyed.
Medium	Change to some significant aspects of the place, such that some of its heritage values are partially reduced.
Low	Minor change to significant aspects of the place, such that some of its heritage values are slightly reduced.
Negligible	Changes to insignificant aspects of the places, such that its heritage values are not reduced.
No Change	No change.

The final assessment of the significance of impact on a cultural heritage place is a factor of the cultural heritage sensitivity of the place, combined with the predicted magnitude of change, as outlined in Table 18. A prediction of impact significance can be made both before and after the implementation of identified mitigation measures, allowing the efficacy of the measures to be assessed and revealing residual impacts that need to be taken into account.

Table 18 Estimating impact significance

Significance of impact		Magnitude of change				
		Major	**Medium**	**Low**	**Negligible**	**No change**
Cultural heritage sensitivity	**Extreme**	Very large	Large/very large	Moderate/large	Slight	Neutral
	Very high	Very large	Large/very large	Moderate/large	Slight	Neutral
	High	Large/very large	Moderate/large	Slight/moderate	Slight	Neutral
	Moderate	Moderate/large	Moderate	Slight	Neutral/slight	Neutral
	Low	Slight/moderate	Slight	Neutral/slight	Neutral/slight	Neutral
	Negligible	Slight	Neutral/slight	Neutral/slight	Neutral	Neutral

Appendix D

Unexpected Heritage Finds Procedure

Appendix D Unexpected Heritage Finds Procedure

Aboriginal Cultural Heritage

Aboriginal finds can include the following:

- Stone artefacts - sharp edged rocks that have identifiable features demonstrating evidence of human modification
- Scarred Trees - trees with symmetrical scars that might demonstrate evidence of removal of bark for use in coolamons, shields and huts
- Grindstones - large sandstone items (either fixed in bedrock or mobile) that have manmade grooves in them demonstrating use.
- Stone Axes - heavy hatchet head like stone items, typically with the leading edge sharpened
- Bone & Shell - potential historical food waste dumps (also known as Middens).

Historical Cultural Heritage

Historical finds include the following:

- Glass - coloured glass, bottles (complete or fragmentary etc.)
- Metal - identifiable metallic objects such as cutlery, buckles, framing equipment, woodworking metal equipment etc.
- Ceramic - plates, cups, ink wells, pipes etc.
- Wood - identifiable human manufactured wooden items
- Stone - identifiable human manufactured stone items
- Bone & Shell - potential historical food waste dumps

Unexpected Finds Procedure

The following procedure is to be followed:

1. If an unexpected heritage find is identified during proposed works within the Project Area, work will stop immediately in the immediate area and the Site Project Manager will be notified of the find.
2. A minimum 10 m area radius is to be cordoned off by temporary fencing around the suspected archaeological site.
3. The Site Project Manager should immediately contact the Senior Heritage Officer, NT Heritage Branch on 08 8999 5039. **Note that contacting the NT Heritage Branch is compulsory under the NT *Heritage Act* for any finds.**
4. Do not resume work in the exclusion zone until a clearance is given by the Senior Heritage Officer attending.
    a. If, at any stage in the project, archaeological places or objects cannot be avoided, an Application to Carry Out Works on a heritage place needs to be lodged with the Heritage Council.

Discovery of Human Remains

In all cases when human remains are located it is important to remember:

- The discovery of any human remains must as soon as possible be reported to the NT Police.

- It is an offence to interfere with human remains, whether buried or not.

The following process should be adhered to:

1. Work is to immediately cease, and a 50 m temporary cordon be established.
2. The Site Project Manager must be immediately notified of the find.
3. If human remains are suspected, the Site Project Manager must contact the NT Police assistance line on 131 444 to advise them of the presence of human remains.
4. Police will then take control of the site and establish the area as a potential crime scene.
5. Police will undertake appropriate scientific or other procedures to assist the Coroner in making an appropriate determination about the remains.
6. Police will contact the Senior Heritage Officer, NT Heritage Branch and the CEO of the Aboriginal Areas Protection Authority if necessary.
7. Resume work only after completion of Police and NT Heritage Branch investigations and appropriate removal of remains according to the NT *Coroners Act.*

APPENDIX M Risk Assessment

Ref	Environmental Factor	Risk scenario description	Risk Source	Code of Practice (the Code)	Risk mitigation Measures			Residual Risk Rating			ALARP criteria achieved?	Residual risk ALARP and Acceptable Statement	Acceptable criteria achieved?	Scientific Uncertainty Ranking
					Prevent	Detect	Recover	Consequence	Likelihood	Risk Rating				
1	**Hydrological processes**	Changes in aquifer quality from subsurface (drilling and stimulation) activities impacting a receptor (groundwater user or Groundwater Dependent Ecosystem).	Contamination from drilling fluids. Drilling fluids used to drill through the Cambrian Limestone Aquifer (CLA) are water-based with clay inhibition in the form of KCl. This may result in temporary elevated levels of chlorides in the CLA immediately adjacent to the well bore during the drilling of the top hole section of the well. This risk also includes use ofgroundwater monitoring bore construction.	B.4.10- Drilling fluids B.4.17 Groundwater monitoring	•Drilling fluids used to drill aquifers are low toxic, water-based with addition of bentonite and salt in the form of potassium or calcium chloride for clay inhibition. (Engineering) •Drilling fluids included in chemical risk assessment and determined to be of low concern through adoption of standard chemical management practices (Administration) •Results of existing exploration well will be used to optimise the drilling of all proposed new wells, with fluid systems modified where fluid loss zones are anticipated (Elimination) •Impacted area likely to be localised around the immediate vicinity of each well bore (Elimination) •Karst system likely to result in rapid dilution (Elimination) •Site selection: No pastoralist extraction bores within 1 km. (Elimination) Groundwater monitoring bores constructed in accordance with the Minimum Construction Requirements for Water Bores in Australia utilising low toxicity drilling fluids and muds •No major GDE linked to CLA within 20 km of extraction point, •Raw water supplied via gathering lines that have contained wastewater will not be used when drilling through aquifers, including the CLA (Gum Ridge and Anthony Lagoon Formation) and Bukalara Sandstone (if present). •Stygofauna eDNA has not been detected in the deep Gum Ridge bore; any impact is likely to be minor and localised	•Monitoring of drilling fluid returns to identify fluid losses and modify fluid systems (Engineering) •Impact groundwater monitoring bores constructed in compliance with code of proactive monitoring down gradient of exploration well, with any changes detected rapidly (Engineering)	•Use or loss of circulation material (such as fibres or dissolvable marbles) to mitigate drilling fluid losses when drilling within aquifers (Engineering) • During loss of circulation events, minimal additives used. •Any contamination event to be characterised and have remediation plans developed and executed in accordance with the process outlined in schedule A of the National Environmental Protection (Assessment of site Contamination) Measures (Engineering)	1	3	L	Yes	This risk consequence is managed through the Code requirements that only water based drilling fluids are to be used which will not result in a residual toxic effect to the aquifer. The consequence is anticipated to be "minor", with a locally restricted, rapidly reversible impact. The likelihood is reduced by the type of drilling fluids used to drill through the aquifer, protection of aquifer by cement casing for drilling below aquifer depth, rapid dilution of karst formations and the4km separation distance from the closest pastoral user. The likelihood of contamination at any receptor is considered remote- with a probability lower than 1%.	Yes	Low
2		Cross flow of formation through inappropriate well barrier design and construction.	B.4.10- Drilling fluids B.4.17 Groundwater monitoring	•Each well designed and constructed with multiple (typically 4) casing barriers and specifically-engineered cement in place to protect aquifers from the anticipated pressures and formation quality likely to be encountered (such as formation salinity, corrosion risk, permeability etc.) - this includes the Conductor casing, surface casing,intermediate casing andproduction casing. •Casing shoe for the conductor and surface casing section to be located in the base of each aquifer unit, with cement returned to surface •Any impacted area likely to be localised, around the immediate vicinity of the E&A wells. •No driving head between saline formations (below Gum Ridge) and surface aquifers- cross flow potential is limited •No landholder bores within 1km. • Groundwater monitoring bores constructed in accordance with the Minimum Construction Requirements for Water Bores in Australia •No major GDE linked to CLA within 20 km of extraction point, •Stygofauna eDNA has not been detected in the deep Gum Ridge bore; any impact is likely to be minor and localised	•Well Barrier Integrity Validated (WBIV) through casing pressure tests and Casing shoe integrity leak of test during the construction of each casing string •Monitoring of cement returns to surface, with cement volume sand density as per programme •Cement bond logs(CBL)completed on each well prior to stimulation to confirm integrity •Each well designed, with a Well Barrier Integrity Validation report approved by DITT as part of Well Operations Management Plan (WOMP). •Groundwater monitoring bores installed to detect and trigger response in the case of contamination.	•2 stage cement job completed where fluid losses.1st stage places cement from the casing shoe to the base of the loss zone. 2nd stage places cement 30m above the zone of losses, using an inflatable casing packer coupled with a stage tool assembly. •Cement repair jobs (such as squeeze jobs) to be performed to mitigate poor cement coverage. •Plug and abandonment and re-drilling of new vertical/ horizontal well sections where required.	3	1	L	Yes	The risk of cross formation flow is managed through the Code which provides specific well barrier design and validation requirements to mitigate the risk of aquifer interconnectivity.The well barrier design is submitted to DITT as a part of the WOMP and must be approved prior to the commencement of drilling.The integrity of each well is validated prior to the commencement of hydraulic fracture. the consequence of an interconnectivity event is likely to be "serious", with spatially restricted (to the vicinity of the well), medium term reversible impacts. The Likelihood of multiple casing and cement failures from occurring is considered remote, with a probability lower than 1%. This is confirmed by the NT inquiry that estimated the likely well failure rate (total failure of all barriers) to be less than 0.1%.	Yes	Low
3		Crossflow through fracture growth into aquifer from stimulation activities allowing the migration of fluid and gas.	B.4.3 Well design and barriers B.4.13 Hydraulic Stimulation and Flowback Operations B.4.17 Groundwater monitoring	•Each well designed and constructed with multiple (typically 4) casing barriers and specifically-engineered cement in place to protect aquifers from the anticipated pressures and formation quality likely to be encountered (such as formation salinity, corrosion risk, permeability etc.) - this includes the Conductor casing, surface casing,intermediate casing andproduction casing. •Casing shoe for the conductor and surface casing section to be located in the base (aquitard) of each aquifer unit, with cement returned to surface Geomechanical data collected during drilling of existing wells used to understand fracture gradients. •Geomechanical modelling validated from Amungee NW-1H stimulation results and ensure to appropriate fracture barriers are sufficient to contain the fracture propagation. •Modelling to factor in results of existing wells to optimise stimulation design. •Hydraulic fracture stimulation risk assessment completed prior to stimulation to determine fracture growth. •Minimum 1400 m vertical separation distance between target formation and closest aquifer. •Each horizontal well to be at least 2-400 m separated, with the separation distance determined through the Mechanical earth model and results from stimulation of existing wells. •Overlying aquifers have a higher fracturing pressure reducing the risk of fracture migration out of the target shale.. •Any impacted area likely to be localised, around the immediate vicinity of the E&A wells. •No driving head between saline formations (below Gum Ridge) and surface aquifers- cross flow potential is limited •No landholder bores within 1 km. •No major GDE linked to CLA within 20 km of extraction point •Stygofauna eDNA has not been detected in the deep Gum Ridge bore; any impact is likely to be minor and localised	•Well Barrier Integrity Validated (WBIV) through casing pressure tests and Casing shoe integrity leak of test during the construction of each casing string •Monitoring of cement returns to surface, with cement volume sand density as per programme •Cement bond logs (CBL) completed on each well prior to stimulation to confirm integrity •A Well Barrier Integrity Validation report approved by DITT as part of Well Operations Management Plan (WOMP). • Real time pressure monitoring of stimulation pressure to determine if a fracture has propagated outside the design operating envelope. •Groundwater monitoring bores installed to detect and trigger response in the case of contamination.	•Stimulation activities to cease and be reviewed where fracture propagation extends beyond the target formation (noting a 1400m separation between the closest regional aquifer).Where fracture growth is suspected to reach an aquifer,Stimulation activity on pad suspended until a go forward plan submitted by Tamboran and approved by DITT.	3	1	L	Yes	The risk is managed through the Code requirements for well integrity, validation and stimulation modelling.The consequences of aquifer interconnectivity is further reduced through pressure monitoring during stimulation. Any uncontrolled fracture growth is likely to be detected rapidly using pressure monitoring and managed to prevent growth into aquifers. Management of any pressure indicating interconnection would be investigated and could result in a potential repair and/ or abandonment of the well. Contamination is likely to be serious, with impacts locally restricted to the vicinity of the well and reversible over the moderate term (months to years).The likelihood of a fracture growth into an aquifer is controlled by the stress regime of the overburden and the 600m separation distance between the target formation and overlying aquifers.The likelihood is considered "remote", with a probability of <1%.	Yes	Low
4		Stimulation activity induces seismic activity that enables cross formational flow between shallow aquifers.	B.4.13 Hydraulic Stimulation and Flowback Operations B.4.17 Groundwater monitoring	•Wells are located away from known geohazards, with no significant faults within proximity of activity (Elimination) •Stimulation is not linked to major seismic events (reinjection of wastewater is generally recognised as the main cause). No reinjection of wastewater proposed (Elimination) •Stimulation stages deployment will be away from geohazards to reduce the loss of fluids into any encountered faults (Elimination) • The Beetaloo is not prone to seismic activity and there is no evidence of recent earthquake activity as most faults and the major subsurface structure are confined to Cambrian or older strata.This is supported by the National seismic Hazard Assessments completed by Allen 2018 (Figure 33), which highlight the Beetaloo is located within a low hazard area (Elimination) •Any faults encountered during drilling will be assessed to determine risk of stimulating with appropriate separation distances applied (Elimination). •1400 m separation distance between target Velkerri formation and the Gum Ridge Aquifer. (Elimination) •No landholder bores within 1km(Elimination) •No major GDE linked to CLA within 20 km of extraction point •Stygofauna eDNA has not been detected in the deep Gum Ridge bore; any impact is likely to be minor and localised	•Monitoring of stimulation pressure to detect and respond to anomalies which may indicate fluid being pumped to an open geological structure (Engineering) •Geoscience Australia's Waramungu seismic array located approximately 250km from the proposed area. •Seismometer to be located adjacent to each well pad. It is likely that any material seismic events above a 2 Mlwill be detected via this array if they occur (Administration) •An induced seismicity traffic light system has been adopted and outlined in the WOMP (Administration)	•Where seismic activity is recorded in Tamboran's tenure during hydraulic stimulation activities, the actions in the WOMP Traffic Light System will be enacted as summarised below: Green: Local Magnitude (Ml) <2.0- no action required Orange: ML 2.0- <3.5Ml- Report event to DITT and continue operations Red: ML> 3.5- Stimulation activity on pad suspended until a go forward plan submitted by Tamboran and approved by DITT.	2	1	L	Yes	The consequence of a induced seismicity, based upon evidence from the UK and US, indicates that the consequence is likely to be "moderate", with most events restricted to discrete areas at a size that generally cannot be detected at the surface (below 2 order of magnitude). Larger events are rare and generally a factor of the existing built up stress regime of the area- rather than a factor of the intensity of hydraulic fracturing or wastewater injection. The likelihood of a seismic event is reduced through the geological setting of the Beetaloo Basin itself and the safeguards implemented in the Code requiring geohazard assessment and avoidance. In theBeetaloo, there have been no earthquakes over magnitude 3 measured since records began.The area is not prone to seismic activity and there is no evidence of recent earthquake activity as most faults and the major subsurface structure are confined to Cambrian or older strata.This is supported by the National seismic Hazard Assessments completed by Allen 2018 (Figure 33), which highlight the Beetaloo is located within a low hazard area. The Code requires any geohazard (such as fault) identified prior to drilling (from existing seismic or interpreted data) or encountered during drilling to have a risk assessment to the determine the potential for reactivation.Any faults identified would not be stimulated, with a risk-based buffer applied. Given the number of wells stimulated in the US without issue and geological setting of the Beetaloo basin, the likelihood is considered remote, with a probability less than 0.1%.	Yes	Low
5		Migration via fractures intersecting with offset wells (including the adjacent horizontal wells) or intersecting an existing geohazard.	B.4.13 Hydraulic Stimulation and Flowback Operations	•Proposed sites will be screened for geohazards using seismic before drilling • Wells are located away from known geohazards, with no significant faults within proximity of activity (Elimination) •Results from existing wells confirm the lack of significant faulting or other geohazards •Previous stimulations completed in basin (such as Amungee NW 1H and 2h) without any uncontrolled fracture growth (Elimination) •Fracture modelling undertaken to determine maximum fracture growth prior to the commencement of stimulation activities. • Any faults encountered during drilling will be assessed to determine risk of stimulating with appropriate separation distances applied (Elimination). •Stimulation stages deployment will be away from geohazards to reduce the loss of fluids into any encountered faults (Elimination) •Separation of at least 200 m between each horizontal well, with final separation distance determined through modelling. (Elimination) •Each adjacent well designed and constructed with multiple (4) casing barriers and specifically-engineered cement in place to protect aquifers- this includes the 18.625" Conductor casing, 13.75" surface casing, 9.625" intermediate casing and 5.5" production casing.(Elimination) •1400 m separation distance between target Velkerri formation and the Gum Ridge Aquifer (Elimination) •No landholder bores within 1 km(Elimination) •Closest legacy exploration well 15 km (well is abandoned). •No major GDE linked to CLA within 20 km of extraction point. •Stygofauna eDNA has not been detected in the deep Gum Ridge bore; any impact is likely to be minor and localisedStygofauna eDNA has been detected in the Amungee NW1 bore; impact likely to be localised.	•Monitoring of stimulation pressure to detect and respond to anomalies which may indicate fluid being pumped to an open geological structure or migrating away from target zone (Engineering) • Pressure monitoring undertaken on adjacent wells •Groundwater monitoring bores adjacent to exploration wells (Administration)	•Stimulation activities to cease where fracture propagation is suspected to have interacted with an adjacent well.Stimulation activity on pad suspended until a go forward plan submitted by Tamboran and approved by DITT.	2	1	L	Yes	If an integrity issue was to occur, leakage of gas and flowback would be contained within the inner casing strings of the existing adjacent well , significantly reducing the consequence and likelihood of an event.The likelihood risk is mitigated through the 1) design of adjacent E&A wells which are constructed in accordance with the Code using multiple, verified barriers (Cement and steel casing) 2) the location of the closest historic exploration well is located approximately 20km from the well pad and 3) Geohazards have not been identified during the drilling of the existing wells. The likelihood is considered Remote", with a probability lower than 1%.	Yes	Low
6		Crossflow/well integrity caused by the deviation of an E&A well into the adjacent well during drilling	B.4.1 Well Integrity Management B.4.3 Well design and barriers	•Separation distance between adjacent wells: Vertical separation of >10m and horizontal separation of>200m used to ensure appropriate well separation. (Engineering) •Each adjacent well designed and constructed with multiple (4) casing barriers and specifically-engineered cement in place to protect aquifers- this includes the 18.625" Conductor casing, 13.75" surface casing, 9.625" intermediate casing and 5.5" production casing.(Engineering) • 1400 m separation distance between target Velkerri formation and the Gum Ridge Aquifer. (Elimination) •Subsurface collision of a well during drilling is unlikely to result in formation cross flow, with collision likely at depth (below Aquifers) and flow restricted to the well being drilled. Well being drilled will have multiple barriers (at least the conductor casing and surface casing) and blow out prevention in place during drilling (Engineering/Elimination) • Tamboran has conducted multiwell drilling operations across Australia, including the Cooper, Bowen and Surat Basins. Tamboran and their contractors experience is mature. (Engineering) •No major GDE linked to CLA within 20 km of extraction point, althoughStygofauna eDNA has been detected in the Amungee NW1 bore; impact likely to be localised •Stygofauna eDNA has not been detected in the deep Gum Ridge bore; any impact is likely to be minor and localisedStygofauna eDNA has been detected in the Amungee NW1 bore; impact likely to be localised	•Continuous GPS tracking of the drill bit to detect and respond to vertical and horizontal well deviations during drilling (Engineering) •Pressure monitoring undertaken on adjacent wells (Engineering)	•Well orientation to be actively controlled to prevent deviations into adjacent wells (Engineering) • Wells remediated in accordance with the code of practice (engineering) •Well suspension and abandonment may be required where wells interact during drilling (Engineering)	3	1	L	Yes	The consequence of the vertical or horizontal section of the well deviating into the adjacent well during drilling is primarily a destruction in asset value (potential plug and abandonment of both wells).Any cross flow is likely to be contained within both of the well bores- with casing and cement isolating the relevant aquifers. Given the continuous logging of GPS location of the bit, the likelihood is considered remote, with a probability less than 1%.	Yes	Low
7		Leakage of either flowback, produced water, or hydrocarbons (liquid and gaseous) from suspended or abandoned wells.	B.4.1 Well Integrity Management B.4.2 Aquifer Isolation B.4.3 Well design and barriers B.4.15 Well suspension and decommissioning B.4.17 Groundwater monitoring B.4.15.2 D.5.5 Leak Remediation and Notification	•Each well designed and constructed with multiple (4) casing barriers and specifically-engineered cement in place to protect aquifers- this includes the 18.625" Conductor casing, 13.75" surface casing, 9.625" intermediate casing and 5.5" production casing (Engineering) •Casing shoe for the conductor and surface casing section to be located in the base of each aquifer unit, with cement returned to surface (Engineering) •Well design and Well Barrier Integrity Validation reports submitted to DITT as part of Well Operations Management Plan (WOMP). (Administration) •Cement plugs used to isolate hydrocarbon zones from aquifers •Cement plugs to be tagged to test plug integrity •Casing annuli pressure to be monitored to determine successful formation isolation. •Any impacted area likely to be localised, around the immediate vicinity of the E&A wells. (Elimination) •No landholder bores within 1km. (Elimination) •No major GDE linked to CLA within 20 km of extraction point, although eDNA indicates the presence of stygofauna in the Amungee NW1 bore	•Integrity of isolation validated before and after stimulation and maintained throughout well life (Engineering) •Monitoring of cement returns to surface, with cement volume sand density as per programme (Engineering) •Cement bond logs(CBL)completed on each well prior to stimulation to confirm integrity (Engineering) •A Well Barrier Integrity Validation report approved by DITT as part of Well Operations Management Plan (WOMP) (Administration) •Routine (6 monthly) monitoring of well integrity in accordance with Code (Engineering) •Routine (6 monthly) well leak detection on all wells.	•Any contamination event to be characterised and have remediation plans developed and executed immediately in accordance with the process outlined in schedule A of the National Environmental Protection (Assessment of site Contamination) Measures (Engineering)	3	1	L	Yes	The risk is primarily reduced through the stringent well barrier design, construction and verification requirements outlined in the Code.If an integrity issue was to occur, leakage of gas and flowback would be contained within the inner casing strings significantly reducing the consequence and likelihood of an event.A contamination event is likely to result in "serious", reversible moderate impacts (months to years) restricted to the vicinity of the well pad.The likelihood is reducedby the presence of multiple casing strings, likely low leakage rate and rapid dilution of any contamination. The NT Inquiry concluding the likelihood of this scenario being very low, typically less than 0.1%. This likelihood of thisrisk is therefore considered to be "remote".	Yes	Low

Ref	Environmental Factor	Risk scenario description	Risk Source	Code of Practice (the Code)	Risk mitigation Measures			Residual Risk Rating			ALARP criteria achieved?	Residual risk ALARP and Acceptable Statement	Acceptable criteria achieved?	Scientific Uncertainty Ranking
					Prevent	Detect	Recover	Consequence	Likelihood	Risk Rating				
8		Contamination of aquifer from surface activities (chemical and waste storage, handling, treatment, recycling and spills) impacting a receptor (groundwater user or GDE).	Surface contamination from storage and disposal of drilling fluids, additives, muds and cuttings on-site.	A.4.7 Containment of Contaminants B.4.13 Hydraulic Stimulation and Flowback Operations C.5.1 Drilling Materials C.5.2 Management of produced water from petroleum wells C.8.2 Spill Management Plan C.8.1 Wastewater Management Plan	•Each well cellar to be concrete lined to contain drilling fluids with pumps to prevent overflow •Drill cuttings and muds are not expected to contain high NORMs levels- with validation testing undertaken in accordance with the Code •Open wastewater evaporation tanks and drill sumps to have a 1:1000ARI wet season freeboard (wet season freeboard 1.3m). •Drilling sumps to be lined with an impermeable coletanche liner with a permeability of less than6 x10-14 m/s . •Drilling sump to be designed and operated to handle the drilling of multiple wells •Sump solid levels to be periodically removed from the sump between wells to maintain sump capacity •Any removed drilling muds and cuttings from the sump will be stored on an impermeable liner with a permeability of less than6 x10-14 m/s-any fluid captured and directed to the wastewater tank •Drill cuttings and muds to be tested and either disposed of onsite in accordance with the Code of Practice or disposed of at a licenced waste management facility. •Storage areas to be lined with an impermeable liner (with a permeability of less than6 x10-14 m/s to prevent contamination •Separation between sump and aquifer over 70 m, with interbedded clays present. •Nearest landholder extraction bore 1km. •No major GDE linked to CLA within 20 km of extraction point, althoughStygofauna eDNA has been detected in the Amungee NW1 bore; impact likely to be localised •Drilling waste trial to be completed during the dry season, trial area to be lined as per code, with material to be dried before handling and site bunded to contain residual fluid.	•Inspections of secondary containment to be undertaken daily during the wet season (leak detection may be utilised for liner integrity inspections) and weekly at other times to identify potential liner issues. • Groundwater monitoring bores installed at each exploration well site to detect any potential contamination. •Groundwater monitoring completed quarterly to detect changes in groundwater quality.	•Any damage to sump liner to be repaired as soon as practicable. •Any contamination event to be characterised and have remediation plans developed and executed in accordance with the process outlined in schedule A of the National Environmental Protection (Assessment of site Contamination) Measures (Engineering) • Any spills of drilling fluid and muds to be cleaned up as soon as practicable	2	2	L	Yes	In accordance with the Code, the onsite storage anddisposal of drilling fluids and cuttings can only occur if the activity does not represent an unacceptable environmental hazard. All drilling fluids, muds and cutting will be stored in a lined sump, with testing undertaken prior to final disposal. Sump liner failure is considered to be a low consequence event, with contamination likely to be restricted to the immediate vicinity of the sump due to a lack of hydrological head. Onsite disposal will only occur if determined to be safe by an independent third party.The consequences are therefore likely to be restricted to a Moderate- short term reversible impacts. The likelihood of contamination through drilling fluid, mud and cuttings storage and failure is considered highly unlikely, with the probability below 10%.This is largely due to the separation distance between the underlying aquifer, use of lined sumps andthird partydisposal suitability assessments.	Yes	Low
9			Storage, handling and transportation of produced hydrocarbons (condensate).	A.4.7 Containment of Contaminants C.3.3 Wastewater management legislative requirements C.8.2 Spill Management Plan	•Tanks to be compliant with AS 1692 and double-lined •Spill Management Plan implemented to prevent, detect and respond to spills. •Separation between condensate storages and closest aquifer over 70 m, with interbedded clays likely to limit any contaminant migration. • Any condensate transportation to be undertaken by licenced transporters (for dangerous goods or wastes) •Flare pit to be lined and freeboard maintained to prevent contaminant releases or overflows. •Nearest landholder extraction bore 1 km. •Impact and control groundwater monitoring bores installed to detect any potential contamination. •Spills and leaks to be cleaned upimmediately. •No major GDE linked to CLA within 20 km of extraction point, although stygofauna eDNA has been detected in the Amungee NW1 bore; impact likely to be localised	•Weekly inspections to identify any potential leaks or spills from storage and handling areas. •Daily level monitoring during production •Quarterly groundwater monitoring	•Spill management plan implemented outlining leak classification, response and reporting requirements •All leaks to be cleaned up as soon as practicable •Any contamination event to be characterised and have remediation plans developed and executed in accordance with the process outlined in schedule A of the National Environmental Protection (Assessment of site Contamination) Measures (Engineering)	2	1	L	Yes	The regulatory regime legislating the storage, handling and transportation of dangerous goods and combustible liquids within Australia is mature. Double lined tanks will be used which will reduce the potential for spills/ leaks. Any spillage is likely to be locally restricted, small and rapidly detected.Consequences are considered moderate, with impacts spatially restricted to the well pad, primarily located on the surface (condensate has low mobility) an likely to be of a short term (days to weeks).The likelihood of contamination is influenced by the lack of mobility of condensate, separation distance between aquifer and the surface and likely rapid detection of any spills.The likelihood of a groundwater event from condensate management is consideredremote witha <1% probability.	Yes	Low
10			Surface spills from storage, handling, treatment, recycling and transportation of flowback water (including gathering lines)	A.4.7 Containment of Contaminants B.4.13 Hydraulic Stimulation and Flowback Operations C.5.2 Management of produced water from petroleum wells C.8.2 Spill Management Plan C.8.1 Wastewater Management Plan	•Tanks to be double-lined with impermeable liners with impermeable membrane with coefficient of permeability of less than 10-9 m/s • Liner damage from termites to be managed through deployment of baits and termite deterrents (termites/spraying) • Where extended wastewater evaporation with high EC fluid is proposed, a thicker liner (0.71 to 0.91mm) will be used to reduce the risk of liner tears from salt solids •Leak detection to be located within the interstitial space between the primary and secondary liner to detect any potential leaks. •Chemical storage & handling areas to have secondary containment, with an impermeable membrane with coefficient of permeability of $<10^{-9}$ m/s. • The well pad is compacted to above 100kpa to achieve a permeability of approximately 1x10m-7/s • The site is earthen bunded to prevent offsite release of flowback - an additional level of containment, as the primary and secondary containment is the principle spill risk control. •The earthen bund is constructed in a manner to withstand a tank failure scenario with appropriate compaction and stabilisation applied. •The site earthen bund has a bund wall height of 300 mm capable of managing at least 110% of the largest wastewater tank volume. •Licenced waste transporters to be used for all listed waste transportation •Evaporation tanks storing solid salt to have a higher density liner capable of resisting the puncture of the salt solids. •Based on the Amungee NW-1H well, NORM levels are not anticipated to be significant.- with characterisation of levels within drilling wastewater and flowback undertaken to validate. • All flowback transfer piping to have secondary containment around surface connection points • All piping used to transfer flowback to be appropriately pressure rated, tested and maintained to prevent spills •Separation between chemical storages and closest aquifer over 70 m, with interbedded clays likely to limit any contaminant migration. •Gathering lines designed, constructed and operated in accordance with the APGA Code, with leak detection and shut off valves constructed. • Gathering have a design life of in excess of 50 years • Gatherine line burial depth and hardness of polyethylene pipeline to minimise termite attack •All suspended and decommissioned line sot be purged clean of residual contaminants •No sink holes in vicinity of gathering lines • Nearest landholder extraction bore >1 km. •No major GDE linked to CLA within 20 km of extraction point, although stygofauna eDNA has been detected in the Amungee NW1 bore; impact likely to be localised	•Leak detection to be located within the interstitial space between the primary and secondary liner to detect any potential leaks. • Leak detection alarms to identify when a leak is potentially identified •Daily inspections during wet season and weekly inspections during the dry season to identify any potential leaks. •Impact and control groundwater monitoring bores installed within 20m of exploration wells to detect any potential contamination •Quarterly groundwater monitoring •Sampling for NORMs to characterise and assess levels within drilling wastewater and flowback undertaken.	•Liner leaks to be investigated and liners repaired as soon as practicable •Spills and leaks to be cleaned up and rectified immediately •Any contamination event to be characterised and have remediation plans developed and executed in accordance with the process outlined in schedule A of the National Environmental Protection (Assessment of site Contamination) Measures (Engineering)	2	1	L	Yes	The consequence and likelihood of groundwater contamination are reduced by the duration of the activity,separation of underlying aquifer units for the surface, mandated use of double lined tanks with continuous leak detection and secondary containment for all chemical storage areas. Any spill onsite is therefore likely to be small, restricted to the chemical storage areas and rapidly detected.The potential consequence ofground water contamination event is likely to be "moderate", with potential spill consequences likely to be locally restricted,moderate-short termand reversible.The likelihood is reduced down to remote with a probability of less than 1%.This is primarily influenced by the lack of spill sources, separation distance between aquifers and the surface and spill management plan that will rapidly detect any spills.	Yes	Low
11			Storage, handling and transportation of chemicals, fuels and wastes. Including on unsealed roads during the wet season.	A.4.7 Containment of Contaminants C.3.3 Wastewater management legislative requirements C.8.2 Spill Management Plan	•All chemical, fuel and waste storage, and high risk spill handling areas are to have secondary containment, with an impermeable liner with coefficient of permeability of less than 10-9 m/s •Licenced waste transporters to be used to transport listed wastes. •Chemicals to be transported in accordance with the Australian Dangerous Goods Code and NT Dangerous Goods Act. •No chemical or wastewater transportation during wet season, unless transportation is undertaken in accordance with the following: -Unless a risk assessment determined the activity is safe and low risk -Transportation will not occur on track where the surface is not safe to allow transportation vehicles to drive upon -Wastewater and chemical transportation will not be undertaken through flooded waterways -The transportation of wastewater/ chemicals during rainfall events will be avoided -Driving on unsealed roads and access tracks will be avoided 24 hours following a >20mm rainfall event -After a >20mm rainfall event, or when the integrity of any unsealed road may be compromised due to prolonged rainfall, each unsealed access track proposed to b e used for wastewater/ chemical transportation will be inspected to ensure the integrity of the road is sufficient to allow safe passage of the proposed transport vehicle. •Well sites to be compacted to above 100kpa to achieve a permeability of approximately 1x10m-7/s •The site is earthen bunded to prevent offsite release of flowback.This is considered an additional level of containment, as the primary and secondary containment is the principle spill risk control. •Site earthen bunding will have a minimum bund wall height of 300mm capable of managing at least 110% of the largest wastewater tank volume. •The earthen bund will be constructed in a manner to withstand a tank failure scenario with appropriate compaction and stabilisation applied. •All transportation of listed wastes and dangerous goods to be undertaken via licenced contractors. •Area is remote with major urban areas to be avoided during the transportation of dangerous goods and wastes in accordance with the NT Dangerous Goods Act. •Separation between chemical stores and closest aquifer over 70m, with interbedded clays likely to limit any potential contaminant migration. •Nearest landholder extraction bore 1km. •Depth of aquifers generally below known stygofauna distribution range (elimination)	•Daily inspections during wet season when chemicals are stored and weekly thereafter to identify and respond to any potential leaks. •Impact and control groundwater monitoring bores installed around exploration wells to detect any potential contamination. •Groundwater monitoring of controland impact monitoring bores on a quarterly basis	•Liner leaks to be investigated and liners repaired as soon as practicable •Spills and leaks to be cleaned up and rectified immediately •Any contamination event to be characterised and have remediation plans developed and executed in accordance with the process outlined in schedule A of the National Environmental Protection (Assessment of site Contamination) Measures (Engineering)	2	2	L	Yes	The storage, handling and management of chemicals is a standard activity that is managed through a mature nationally uniform regulatory setting.The Code further reduces the likelihood/consequence of chemical spills and contamination, through the mandated use of secondary containment, a spill management plan and groundwater monitoring. Any spills are likely to be locally restricted and rapidly detected (hours to days). The consequence of a spill/ leak is therefore considered to be "moderate", with moderate short term(days). Given the requirement for a spill management plan, secondary containment requirements and 70m separation distance to aquifers, the likelihood of a spill/leak reaching an aquifer is considered remote with a probability of less than 1%.	Yes	Low
12			Overtopping of drilling sumps and flowback tanks (including during wet season)	A.4.7 Containment of Contaminants C.6 Monitoring mandatory requirements C.8.2 Spill Management Plan	•Drilling sump to be designed and operated to handle the drilling of multiple wells •Sump solid levels to be periodically removed from the sump between wells (or as required) to maintain sump capacity •Covered tanks to manage flowback storage, with enough enclosed storage onsite to manage all stored flowback. •Results from previous well testing used to optimise available tank capacity to allow for multiple wells •Additional tank capacity to be installed as required, with new tank capacity taking less than 14 days (subject to access and resource availability) •Open wastewater evaporation tanks and drill sumps to have a 1:1000ARI wet season freeboard (wet season freeboard 1.3m). •All flowback wastewater (other than the minimum volume required to integrity of the open tank liner) to be transferred to enclosed tanks prior to the onsite of a *significant rainfall event (>300mm of forecasted rain over a 4 day periodic) • Wastewater transfers into any tank/ sump will cease prior to fluid levels exceed the relevant freeboard level . Wastewater transfers into a open tank/sump will not occur until levels return to below the relevant freeboard. •Sufficient pumps available onsite to meet volume transfer requirements, with available pump redundancy in case of mechanical issues. •Well sites to be compacted to above 100kpa to achieve a permeability of approximately 1x10m-7/s •The site is earthen bunded to 300 mm to prevent offsite release of flowback.This is an additional level of containment, as the primary and secondary containment is the principle spill risk control. Site earthen bunding capable of managing at least 110% of the largest wastewater tank volume. The earthen bund will be constructedto withstand a tank failure scenario with appropriate compaction and stabilisation applied. •Site is manned at all times or have telemetered level logging during wastewater storage, with helicopters to be used to fly in staff when road access is prevented. •Separation between underlying aquifers >70m, with interbedded clays likely to limit any potential contaminant migration. •Nearest landholder extraction bore 1 km. •Depth of aquifers generally below known stygofauna distribution range (elimination) • all gathering lines constructed in accordance with Code of Practice for Upstream Polyethylene Gathering Network in the CSG Industry, Version 5, August 2019 (APGA 2019). •Gathering lines hydrotested to confirm integrity, with leak detection used to identify leaks.	•Daily monitoring of tank and sump levels (along with available storage space)during the wet season and weekly at all other times •Daily significant rainfall monitoring during the wet season. •Spill Management Plan implemented to prevent, detect and respond to spills. •Impact and control groundwater monitoring bores installed within 20m of exploration wells to detect any potential contamination, with monitoring completed quarterly • Monthly inspections of right of way to identify leaks	•All flowback (other than the volume required to maintain the integrity of an open tank liner) to be transferred to enclosed tanks 8 hours before the onset of a significant rainfall event (defined as >300mm of rain over a 4 day period) •Operations (flowback and drilling) to cease prior towastewater (sump or flowback storage) freeboards being exceeded or prior to the capacity of enclosed tank storage being insufficient to manage all flowback. • No additional drilling fluids or wastewater shall be added to the sump/tank once the freeboard has been met. Any flowback stored within an open top tank above the freeboard level must be transferred to the enclosed tanks onsite immediately. •DEPWS to be notified within 48 hours where the freeboard of a tank or sump has been exceeded and the forward monitoring and management strategies to prevent an overtopping event (including revised action and reporting triggers) •Drilling fluids to be transferred to wastewater tanks,removed from site or other actions implemented(such as deployment of covers etc.) to minimise the risk of overtopping to ensure the sump freeboard level remains above 1:1000 ARI 7-day rainfall event (580mm)- unless otherwise agree to with prior approval from DEPWS to account for forecasted risk mitigation factor (such as forecasted climatic/seasonal factors) •Flowback activities to cease and new wastewater tanks to be constructed onsite if flowback wastewater storage volumes areinsufficient to maintain the required enclosed freeboard levels • Any contamination event to be characterised and have remediation plans developed and executed in accordance with the process outlined in schedule A of the NEPM (Assessment of site Contamination)(Engineering)	2	1	L	Yes	The Code provides onerous regulatory requirements that essentially eliminate the risk of wastewater storage overtopping events.The consequences of an overtopping event are limited through the construction of earthen bunds and compaction of the well pad.A wastewater management plan, spill management plan and emergency response plan is implemented to further ensure any overtopping events are prevented, detected and responded to. In the event of an overtopping incident, such spill is likely to be contained onsite and rapidly responded to. The consequence of an overtopping event is therefore considered to be "moderate", with moderate short term (weeks-months) contamination.Given the requirements for enclosed tanks and a1*1000 wet season freeboard, the potential for overtopping are considered remote, with a probability less than 1%.	Yes	Low

Ref	Environmental Factor	Risk scenario description	Risk Source	Code of Practice (the Code)	Risk mitigation Measures			Residual Risk Rating			ALARP criteria achieved?	Residual risk ALARP and Acceptable Statement	Acceptable criteria achieved?	Scientific Uncertainty Ranking
					Prevent	Detect	Recover	Consequence	Likelihood	Risk Rating				
13			Failure of flowback storage tank, including structural failure	A.4.1 Site selection and planning c.5.2 Management of produced water from petroleum wells C.8.2 Spill Management Plan	•Wastewater Management Plan implemented in accordance with the Codes of Practice to mitigate the risk associated with wastewater generation and management. •Spill Management Plan implemented to prevent, detect and respond to spills- including requirements for daily wastewater tank inspections during the wet season and weekly at all other times. •Tanks designed and engineered to AS3990 Mechanical Equipment- Steel Work, AS 1170.1 Hydrostatic loading, AS1170.2 Wind Rating (cyclonic wind rating) •Wastewater tank liner with impermeable membrane with coefficient of permeability of less than 10-9 m/spermeability, 120N picture resistance and 49N tear resistance •Covered wastewater tanks and condensate tanks to have vents to prevent pressure build up. •Sufficient pump capacity available to recover any spilled wastewater. •Well sites to be compacted to above 100kpa to achieve a permeability of approximately 1x10m-7/s •The wastewater storage area is earthen bunded to 300 mm to prevent offsite release of flowback.This is an additional level of containment, as the primary and secondary containment is the principle spill risk control. Site earthen bunding capable of managing at least 110% of the largest wastewater tank volume. The earthen bund will be constructedto withstand a tank failure scenario with appropriate compaction and stabilisation applied. •Separation between well pad and closest aquifer over 70m, with interbedded clays likely to limit any potential contaminant migration. •Nearest landholder extraction bore 1 km. •No major GDE linked to CLA within 20 km of extraction point, althoughStygofauna eDNA has been detected in the Amungee NW 1 bore; impact likely to be localised	•Weekly wastewater tank integrity inspections during wastewater storage to detect •Impact and control groundwater monitoring bores installed within 20m of exploration wells to detect any potential contamination. •Quarterly groundwater monitoring completed to detect potential contamination.	•Wastewater tank structural defects to be rectified as soon as practicable. •Wastewater to be transferred from defective tanks to alternative tanks onsite until repairs completed. •Pumps located onsite to recover fluid and transfer into existing tanks, with spills and leaks to be cleaned up and rectified immediately •Earth moving equipment available regionally to clean up spills •Any contamination event to be characterised and have remediation plans developed and executed in accordance with the process outlined in schedule A of the National Environmental Protection (Assessment of site Contamination) Measures (Engineering	3	1	L	Yes	The consequences of a tank failure are negated through the use of double lined, engineered above ground tank which have continuous leak detection and alarms. Tanks and their liners are designed with sufficient structural integrity to withstand cyclonic winds, extreme temperatures and loading stress forces under a range of conditions.A spill management pan is in force to detect, prevent and respond to potential spills of wastewater. If a storage failure was to occur, the wastewater would be restricted to the well pad.Flowback would be pumped into available enclosed and open tank storage, with contaminated soil removed from site. the consequences are likely to be "serious", being locally restricted, moderate duration (weeks) and reversible.The likelihood is reduced by the Code requirements , tank design separation distancesto the underlying aquifer. The likelihood is considered Remote, withe a probability less than 1%.	Yes	Low
14		Unsustainable groundwater extraction impacts landholders and groundwater dependent ecosystems.	Over extraction of groundwater for civils, drilling, stimulation and seismicactivities.	B.4.17 Groundwater monitoring	•Groundwater extraction for activities to be restricted to the minimum water required (220ML per site (110ML per well)). (Elimination) •All water take licenced in accordance with NT Water Act under Water Extraction Licence (WEL) GRF 10285 (Administration) •Drawdown from the activities and other users assessed by DEPWS as a part of WEL; impacts to closest receptor not anticipated (Administration/ Elimination) Karst system is under allocated, with sufficient available capacity to support proposed water extraction requirements. (Elimination) •Closest pastoral bore is >1 km from extraction point (Elimination)	•Continuous flow meters to monitor take and water balance implemented to ensure compliance with WEL (Administration) •Groundwater monitoring completed to identify impacts associated with water extraction (Engineering)	•Groundwater extraction to cease where sustained drawdown post pumping exceeds 1 m (Administration)	3	1	L	Yes	The extraction of groundwater for the proposed activities requires all take to be licenced.The proposed take is assessed as a part of the licence application, with the assessment considering current and future water take levels.Based on this assessment, it was determined that the extraction rate would not impact upon adjacent users.The risk consequence is determined to be "serious"- given any impact is likely to cause pastoralist and broader community concern.The likelihood of such a consequence from occurring is considered remote (probability <1%) due to the quality of the Cambrian limestone aquifer, separation distance from surrounding users and under utilisation of the targeting aquifer.	Yes	Low
15	**Inland water environmental quality**	Contamination of surface water from surface activities.	Failure of flowback storage tank.	A.4.1 Site selection and planning c.5.2 Management of produced water from petroleum wells C.8.2 Spill Management Plan	•Wastewater Management Plan implemented in accordance with the Codes of Practice to mitigate the risk associated with wastewater generation and management. •Spill Management Plan implemented to prevent, detect and respond to spills- including requirements for daily wastewater tank inspections during the wet season and weekly at all other times. •Tanks designed and engineered to AS3990 Mechanical Equipment- Steel Work, AS 1170.1 Hydrostatic loading, AS1170.2 Wind Rating (cyclonic wind rating) •Wastewater tank liner with impermeable membrane with coefficient of permeability of less than 10-9 m/spermeability, 120N picture resistance and 49N tear resistance •Higher density liners used for evaporation tanks where long term evaporation could generate solid salt that could puncture a liner. • Liner damage from termites to be managed through deployment of baits and termite deterrents (termites/spraying) •Covered wastewater tanks and condensate tanks to have vents to prevent pressure build up. •Well sites to be compacted to above 100kpa to achieve a permeability of approximately 1x10m-7/s •The site is earthen bunded to 300 mm to prevent offsite release of flowback.This is an additional level of containment, as the primary and secondary containment is the principle spill risk control. Site earthen bunding capable of managing at least 110% of the largest wastewater tank volume. The earthen bund will be constructedto withstand a tank failure scenario with appropriate compaction and stabilisation applied. • No mapped watercoursesin proximity to gathering lines or sites containing flowback. Closest stream order 1 ~12km away with closest major wetland >90 km away (Lake Woods). •Firebreaks maintained and lids to be flooded with water to combat ember attack damaging liner	•Weekly wastewater tank integrity inspections during wastewater storage to detect •Routine level monitoring and alarms	•Wastewater tank structural defects to be rectified as soon as practicable. •Wastewater to be transferred from defective tanks to alternative tanks onsite until repairs completed. •Pumps located onsite to recover fluid and transfer into existing tanks, with spills and leaks to be cleaned up and rectified immediately •Earth moving equipment available regionally to clean up spills •Emergency response plan implemented. • Any contamination event to be characterised and have remediation plans developed and executed in accordance with the process outlined in schedule A of the National Environmental Protection (Assessment of site Contamination) Measures (Engineering)	3	1	L	Yes	The consequence and likelihood of a containment failure are negated through onerous wastewater management requirements stipulated in the Code. The well pad is bunded, preventing the offsite release of wastewater in the event of a failure.A spill management plan is required to be implemented to prevent, detect and respond to spills to prevent offsite releases.The spill is therefore likely to be smaller, with any spillage restricted to the well pad. The consequence of a spill is therefore considered to be "serious", with moderate short term (weeks-months) contamination. The area is not in close proximity to major watercourse with at least 12 km separation distance for sites storing flowback and drilling fluid.Shenandoah South is 450m from an intermittent stream order 1- with no long term storage proposes..Given the separation distance and bunding, the likelihood is considered remote, with the probability of occurring less than 1%.	Yes	Low
16			Overtopping of drilling sumps and flowback tanks (including wet season operations)	A.4.7 Containment of Contaminants C.6 Monitoring mandatory requirements c.5.2 Management of produced water from petroleum wells C.8.2 Spill Management Plan	•Drilling sump to be designed and operated to handle the drilling of multiple wells •Sump solid levels to be periodically removed from the sump between wells (or as required) to maintain sump capacity •Covered tanks to be used to manage flowback storage, with enough enclosed storage onsite to manage all stored flowback. •Results from previous well testing have been used to optimise available tank capacity to allow for multiple wells •Additional tank capacity to be installed as required, with new tank capacity taking less than 14 days (subject to access and resource availability) •Open wastewater evaporation tanks and drill sumps to have a 1:1000ARI wet season freeboard (wet season freeboard 1.3m). •All flowback wastewater (other than the minimum volume required to integrity of the open tank liner) to be transferred to enclosed tanks prior to the onsite of a "significant rainfall event (>300mm of forecasted rain over a 4 day periodic) • Wastewater transfers into any tank/ sump will cease prior to fluid levels exceeding the relevant freeboard level. Wastewater transfers into a open tank/sump will not occur until levels return to below the relevant freeboard. •Sufficient pumps available onsite to meet volume transfer requirements, with available pump redundancy in case of mechanical issues. •Well sites to be compacted to above 100kpa to achieve a permeability of approximately 1x10m-7/s •The site is earthen bunded to 300 mm to prevent offsite release of flowback.This is an additional level of containment, as the primary and secondary containment is the principle spill risk control. Site earthen bunding capable of managing at least 110% of the largest wastewater tank volume. The earthen bund will be constructedto withstand a tank failure scenario with appropriate compaction and stabilisation applied. •Site is manned at all times or have telemetered level logging during wastewater storage, with helicopters to be used to fly in staff when road access is prevented. •Separation between well pad and closest aquifer over 70m, with interbedded clays likely to limit any potential contaminant migration. •Nearest landholder extraction bore 1 km. •Depth of aquifers generally below known stygofauna distribution range (elimination)	•Daily monitoring of tank and sump levels (along with available storage space)during the wet season and weekly at all other times •Daily significant rainfall monitoring during the wet season. •Spill Management Plan implemented to prevent, detect and respond to spills. •Impact and control groundwater monitoring bores installed within 20m of exploration wells to detect any potential contamination, with monitoring completed quarterly	•All flowback (other than the volume required to maintain the integrity of an open tank liner) to be transferred to enclosed tanks 8 hours before the onset of a significant rainfall event (defined as >300mm of rain over a 4 day period) •Operations (flowback or drilling) to cease prior to the wastewater (sump or flowback storage)open tank freeboard being exceeded or beforeenclosed tank capacity is insufficient to manage all flowback stored on the site. • No additional drilling fluids or wastewater shall be added to the sump/tank once the freeboard has been exceeded. Any flowback stored within an open top tank above the freeboard level must be transferred to the enclosed tanks onsite within 24 hours. •DEPWS to be notified within 48 hours where the freeboard of a tank or sump has been exceeded and the forward monitoring and management strategies to prevent an overtopping event (including revised action and reporting triggers) •Drilling fluids to be transferred to wastewater tanks,removed from site or other actions implemented(such as deployment of covers etc.) to minimise the risk of overtopping where the sump freeboard level is below 1:1000 ARI 7-day rainfall event- unless otherwise agree to with prior approval from DEPWS to account for forecasted risk mitigation factor (such as forecasted climatic/seasonal factors) •New wastewater tanks to be constructed onsite if flowback wastewater storage volumes areinsufficient to maintain the required enclosed freeboard levels •Operations (flowback and drilling) to cease if insufficient wastewater (sump or flowback storage) is available to meet freeboard and enclosed tank availability requirement. • Any contamination event to be characterised and have remediation plans developed and executed in accordance with the process outlined in schedule A of the NEPM (Assessment of site Contamination) (Engineering)	2	1	L	Yes	The consequence and likelihood of a wastewater storage overflowing are minimised through the onerous wastewater management requirements stipulated in the Code. This includes well pad bunding, tank level alarms, tank freeboard requirements and use of a wastewater management plan.Any overflow is likely to be restricted to the well pad, rapidly detected and promptly cleaned up.The use of enclosed tanks, freeboard and well pad bunding essentially eliminates the likelihood potential for a wastewater storage tank to overflow.Given the onerous regulatory requirements, the likelihood of an overtopping event is considered Remote, with a <1% probability of occurring.	Yes	Low
17		Transportation accident releasing chemical or wastewater (drilling fluid and flowback).	A.4.7 Containment of Contaminants C.8.2 Spill Management Plan	•No chemical or wastewater transportation during wet season, unless transportation is undertaken in accordance with the following: •Transportation will not occur on track where the surface is not safe to allow transportation •Wastewater and chemical transportation will not be undertaken through flooded waterways •Unless a risk assessment determined the activity is safe and low risk •The transportation of wastewater/ chemicals during rainfall events will be avoided •Driving on unsealed roads and access tracks will be avoided 24 hours following a >20mm rainfall event •After a >20mm rainfall event, or when the integrity of any unsealed road may be compromised due to prolonged rainfall, each unsealed access track proposed to b e used for wastewater/ chemical transportation will be inspected to ensure the integrity of the road is sufficient to allow safe passage of the proposed transport vehicle •All wastes to be transported in accordance with the NT Waste Management and Pollution Control Act. •All dangerous goods to be transported in accordance with the NT Dangerous Goods Act and Australian Dangerous Goods Code. •Transportation route to avoid major urban areas •All drivers to be appropriately licenced •Fatigue management plan implemented, requiring journey management plans and drivers to rest every 2 hours •Strict drug and alcohol policy implemented, with routine testing and zero tolerance policy to alcohol (0.00% limit) and drugs •Area is remote with major urban centres to be avoided. •Risk to any receptor is identical to that of normal diesel or petroleum tankers. •Training of Tamboran supervisors regarding chain of responsibility requirements to minimise the risk of driver fatigue •The transportation of waste and chemicals across Australia is a standard practice with mature codes and legislation in place.the transportation of fuels, chemicals and wastes occurs every year in the NT to support existing industry's during the wet season.	•Transport incident statistics collected and monitored. •Onsite assurances and fit for work assessments completed periodically on transport companies.	•Spill Management Plan and Emergency Response Plan implemented to prevent, detect and respond to spills. •Contractor performance reviews completed where breaches in requirements are escalated and actions implemented to rectify defects.	3	1	L	Yes	The transportation of wastes and chemicals is a tightly controlled industry with mature practices designed to prevent, detect and respond to transportation spills. Any accident is likely to be restricted to road corridors and result in "serious", short term (days-weeks) reversible impacts.All contractors must be appropriately licenced, with National uniform legislation in place to offer a high level of regulatory protection.This risk is considered identical to that of bulk diesel and other dangerous goods transportation- a common activity throughout Australia.Fuel and chemical transport accidents are rare given the number of transportation movements in Australia. The likelihood of an event occurring is therefore considered "remote", what a probability of less than 1%.	Yes	Low
18		Storage and handling of chemicals and fuel.	A.4.7 Containment of Contaminants C.8.2 Spill Management Plan	•All areas where chemicals and fuels are stored, will have secondary containment with a coefficient of permeability of less than 10-9 m/s • Secondary containment to be maintained in a good working order •Spill Management Plan implemented to prevent, detect and respond to spills. •Well sites to be compacted to above 100kpa to achieve a permeability of approximately 1x10m-7/s •The site is earthen bunded to prevent offsite release of contaminants, with all stormwater directed to an onsite retention pond for testing prior to offsite release. The earthen bund will be constructed to withstand a tank failure scenario with appropriate compaction and stabilisation applied. •Area is remote with closest homestead approximately 16 km away.	•Daily inspections will be implemented during the wet season and spills rectified immediately	•All spills to be cleaned up as soon as practicable (within the shift that spill was observed) •Any contamination event to be characterised and have remediation plans developed and executed in accordance with the process outlined in schedule A of the National Environmental Protection (Assessment of site Contamination) Measures (Engineering)	2	1	L	Yes	The storage, handling and management of chemicals is a standard activity that is managed through a mature regulatory setting.The Code further reduces the likelihood and consequence of chemical spills and contamination, through the mandated use of secondary containment, a spill management plan and groundwater monitoring. A spill event is likely to result in moderate, short term reversible impacts restricted to the existing well pad.The likelihood is further reduced down to remote (<1% probability of occurring) based onthe 12 km separation distance from the sites stoning flowback/ drilling wastewater, with no long-term storage at Shenandoah N A.	Yes	Low

Ref	Environmental Factor	Risk scenario description	Risk Source	Code of Practice (the Code)	Risk mitigation Measures			Residual Risk Rating			ALARP criteria achieved?	Residual risk ALARP and Acceptable Statement	Acceptable criteria achieved?	Scientific Uncertainty Ranking
					Prevent	Detect	Recover	Consequence	Likelihood	Risk Rating				
19			Release of contaminated stormwater from activities to surface water, including during flooding	A.4.1 Site selection and planning A.4.3 Erosion and sediment control and hydrology	•Erosion and sediment controls implemented around the sites to minimise erosion and sediment releases (Engineering) •Stockpiled debris to be used to discourage water concentration. (Engineering) •Well pad to be earthen bunded to prevent offsite release of stormwater from exposed surfaces (Engineering) •Sites to be maintained, with vegetation cover on exposed bunds/ stockpiles established and erosion and sediment controls kept in working order (Elimination) •Contaminated stormwater to be retained on-site, treated and disposed off-site at a licenced disposal facility (Administration/ Engineering) •A sediment sock to be used to reduce sediment levels within stormwater releases. (Engineering) •Clean stormwater to be reused or released off-site in a manner that reduces the risk of erosion (Elimination) •Well pad located away from watercourses or regional flow paths. (Elimination) •Area is remote with closest major watercourse at least 12 km away from any site storing flowback . Shenandoah N A located 450m from an intermittent stream order 1- with no long term storage of drilling wastes. (Elimination)	•Pre-wet season site assessment completed to identify any maintenance requirements (Administration) •Stormwater captured in sediment basin to be tested and released offsite in a controlled manner (Engineering) • Drilling waste compost area to be inspected weekly.	•Maintenance to be undertaken on erosion and sediment controls to ensure ongoing functionality (Engineering) •Corrective actions implemented where releases of water from drilling waste compost area is detected.	1	2	L	Yes	All stormwater retained onsite during well testing will be collected in a purpose built sediment basin and tested prior to release. Releases must comply with the stipulated criteria to ensure contaminants are not released from site. The release of stormwater will also be via a "Sediment sock", with a reasonable consequence of minor, localised reversible impacts. The likelihood is reduced down to remote (<1% probability of occurring) based onthe 12 km separation distance from the sites storing flowback/ drilling wastewater, with no long-term storage at Shenandoah N A.	Yes	Low
20			Runoff from sewage treatment irrigation areas.	A.4.1 Site selection and planning	•Irrigation areas located away from watercourses (Elimination) •A wastewater suitability acceptance assessment has been completed and a design approval for wastewater disposal received in accordance with the NT Department of Health Code for On-site Wastewater Management (July 2014) (Engineering) •Wastewater irrigation to comply with DOH requirement (Engineering) •Areas appropriately sized to accommodate irrigation volume (Engineering) •Area is remote with closest major watercourse at least 12 km away fromthe Shenandoah Sth locations . Shenandoah N A located 450m from an intermittent stream order 1- with no long termcamp activities. (Elimination)	•Wastewater system performance to be monitored in accordance with the manufacturers requirements (Administration)	•Where wastewater specifications are exceeded, corrective actions will be implemented to ensure wastewater is returned back into specification (Engineering)	1	1	L	Yes	The management of sewerage and greywater is mature with various NT wastewater management guidelines. Due to the temporary nature of the activity, the maximum contamination resulting from sewerage and grey water irrigation is likely to be minor, with any impacts locally restricted and temporary in nature.The closest watercourse isat least 450 away from Shenandoah N A, with 12km from the next closest site.Shenandoah N A doe snot have long erm activity planned. The potential contamination of these features considered remote (probability <1%).	Yes	Low
21			Uncontrolled release of formation fluid encountered during drilling, stimulation, barrier failure	B.4.1 Well integrity management B.4.3 Well design and barriers B.4.13 Hydraulic Stimulation and flow back operations D.5.8 Venting and flaring	•Drilling overbalanced to reduce the inflows of hydrocarbons and fluids (Engineering) •Blow out prevention in place to manage well failure and uncontrolled gas/ fluid/pressure influxes (Engineering) •Blow out preventor pressure rating and testing •All equipment will be API compliant to handle expected conditions (Engineering) •Site manned during operation (Administration) •Well suspended with multiple cement and casing barriers in place- with 4 casing section utilised (conductor, surface, intermediate and production).(Engineering) •Barricading to be used to protect each exploration well from vehicle collision during multi-well drilling activities. (Engineering)	•Process monitoring to detect events that could potentially result in a uncontrolled release of gas/fluids/pressure (such as fluid balances, well head pressure etc.) (Engineering) •Routine (monthly) well inspections (Administration	•An emergency as diverter and flare to be used during drilling to manage gas ingress (Engineering) •Contracts in place with emergency well intervention specialists (such as Boots and Cootes) (administration) •Emergency response plan implemented (administration)	2	2	L	Yes	The Code and standard drilling, stimulation and well testing safety controls are designed to prevent the uncontrolled release of hydrocarbons and produced fluids. The consequence are anticipated to be moderate, with impacts likely to be moderate, restricted in duration (minutes to hours).The likelihood is considered highly unlikely with a occurrence probability less than 10%, based on the well designed, construction and operations requirements mandated by the Code.	Yes	Low
22			Uncontrolled release of wastewater, chemicals or fuel from site due to regional flooding.	A.4.1 Site selection and planning A.4.3 Erosion and sediment control and hydrology	•Area is remote with closest major watercourse at least 12 km away from any site storing flowback. Shenandoah N A located 450m from an intermittent stream order 1- with no long term storage of drilling wastes. No sites impacted by regional flooding (Elimination) • No major wetlands, with Longreach lagoon 50km+, Lake Woods 90km+ • Flood modelling of well pad completed to optimise site location (Elimination) •Activity located away from regional flow paths with low erosivity of flood anticipated (Elimination) •Erosion and sediment controls implemented around the sites to minimise erosion and sediment releases, including diversion bunds (Engineering) •Stockpiled debris to be used to discourage water concentration. (Engineering) •Well pad to be earthen bunded to prevent offsite release of water and to prevent flood impacts- bunds to be sized to accommodate 1:100 AEP flood (Engineering) • Stormwater retained onsite to be tested and regularly discharged to maintain the integrity of the site during flowback wastewater storage. •Clean stormwater to be reused where possible or released off-site in a manner that reduces the risk of erosion (Elimination) •Contaminated stormwater to be retained on-site, treated and disposed off-site at a licenced disposal facility (Administration/ Engineering) •Sites to be maintained, with vegetation cover on exposed bunds/ stockpiles established and erosion and sediment controls kept in working order (Elimination) •Well pad located away from watercourses or regional flow paths. (Elimination) •Wastewater Management Plan implemented in accordance with the Codes of Practice to mitigate the risk associated with wastewater generation and management. •Spill Management Plan implemented to prevent, detect and respond to spills- including requirements for daily wastewater tank inspections during the wet season and weekly at all other times. •Tanks designed and engineered to AS3990 Mechanical Equipment- Steel Work, AS 1170.1 Hydrostatic loading, AS1170.2 Wind Rating (cyclonic wind rating) •Wastewater tank liner with impermeable membrane with coefficient of permeability of less than 10-9 m/spermeability, 120N picture resistance and 49N tear resistance •Higher density liners used for evaporation tanks where long term evaporation could generate solid salt that could puncture a liner. • Liner damage from termites to be managed through deployment of baits and termite deterrents (termites/spraying) •Well sites to be compacted to above 100kpa to achieve a permeability of approximately 1x10m-7/s •The site is earthen bunded to 300 mm to prevent offsite release of flowback.This is an additional level of containment, as the primary and secondary containment is the principle spill risk control. Site earthen bunding capable of managing at least 110% of the largest wastewater tank volume. The earthen bund will be constructedto withstand a tank failure scenario with appropriate compaction and stabilisation applied •Gathering lines are not to be operated where the line is affected by flood waters. • Regional flooding would involve order of magnitude larger volume of low Electrical conductivity water (many GL) mixing with relatively small volumes (< 11MLfor flowback or smaller volume of chemical/ fuel release)- Dilution would reduce the impact down to negligible.	•Pre-wet season site assessment completed to identify any maintenance requirements (Administration) •Stormwater captured in sediment basin to be tested and released offsite in a controlled manner (Engineering)	•Maintenance to be undertaken on erosion and sediment controls to ensure ongoing functionality (Engineering)	1	2	L	Yes	All stormwater retained onsite during well testing will be collected in a purpose built sediment basin and tested prior to release. Releases must comply with the stipulated criteria to ensure contaminants are not released from site. The release of stormwater will also be via a "Sediment sock", with a reasonable consequence of minor, localised reversible impacts. The likelihood is reduced down to remote (<1% probability of occurring) based onthe 12 km separation distance from the sites storing flowback/ drilling wastewater, with no long-term storage/ activity at Shenandoah N A.	Yes	Low
23			Failure or leak from wastewater gathering line network, including from sabotage	A.4.1 Site selection and planning A.4.7 Containment of Contaminants C.3.3 Wastewater management legislative requirements c.5.2 Management of produced water from petroleum wells C.8.2 Spill Management Plan	• Selection and placement of gathering line easement(s) - co-location with access tracks. •Gathering lines are used, these will be designed, constructed and maintained in accordance with "Code of Practice for Upstream Polyethylene Gathering Networks in the CSG Industry, Version 5", August 2019 (APGA 2019) • Gathering have a design life of in excess of 50 years • Gatherine line burial depth and hardness of polyethylene pipeline to minimise termite attack • Gathering lines are located in remote areas with limited access, minimising the risk of sabotage •PE pipes shall be manufactured in accordance with AS/NZS 4130 and shall be third-party certified by a JAS-ANZ accredited certifier under the StandardsMark, GasMark or WaterMark schemes or equivalent. •Pipes to be pressure tested/ hydrotested to confirm integrity. • Marking and product traceability shall be in accordance with the Standard. Appendix A of AS/NZS 4130 shall be used as the basis for demonstrating conformity. • Pipes for gathering networks shall be Series 1 conforming to AS/NZS 4130. A design, risk assessment and testing regime, inline with the PEGN code, will ensure suitable material selection and selection of facility overpressure protection equipment to reduce the probability of leaks to ALARP •Aboveground gathering lines to be temporary (<12 months), with no transfers where fires or severe weather events are predicted • Identification and signage to prevent excavation damage • Emergency shutdown systems and response procedures to investigate and manage loss of containment. • Flowline / gathering networks will be fitted with manifolds and valves to isolate it into sections. Valves will be locked at all times unless attended by authorised personnel to prevent unintentional operation. •upon cessation of use/ suspension (triggered after 3 months of no use),gathering lines will be purged of any residual wastewater • Fuel loads within right of ways to be kept low to reduce fire risks. Overhanging trees that could fall on pipelines will be removed. • No mapped watercourses or wetlands in proximity to gathering lines, Closest stream order 1 ~12km away with closest major wetland >90 km away (Lake Woods). •Upon cessation of use,gathering lines will be purged of wastewater- wastewater should not be stored in pipework • Fuel loads within right of ways to be kept low to reduce fire risks. Overhanging trees that could fall on pipelines will be removed. • Prior to the abandonment of gathering lines, each line is to be purged clean of contaminants and pigged as required to remove scale. Testing to confirm no residual contaminants.	• Remote monitoring of pressure, flow and leaks on gathering networks • Remotely operated isolation at mid line valves on gathering networks • Monthly gathering line inspections during continual operations or where batch transfer is proposed, before and during each batch transfer.	• Emergency response and spill management plans enacted to respond to spills •Pumps located onsite to recover fluid and transfer into existing tanks, with spills and leaks to be cleaned up and rectified immediately •Earth moving equipment available regionally to clean up spills •Gathering network system will not be restarted until the leak is repaired and an investigation is carried out as to how the leak occurred and how it will be prevented from re-occurring •Emergency response plan implemented. • Any contamination event to be characterised and have remediation plans developed and executed in accordance with the process outlined in schedule A of the National Environmental Protection (Assessment of site Contamination) Measures (Engineering)	2	2	L	Yes	All flowlines will be constructed and installed in accordance with Australian Standards. The flow/ pipeline pressure readings from the flow meters will continually be compared to detect an imbalance in inflow and outflow volumes. If there is an imbalance of 1% of flow (noting temperature and flow meter accuracy is a limiting factor), the system will alarm and transfer operations stopped until the imbalance in flow is investigated and rectified. The likelihood of such a consequence from occurring is considered highly unlikely(probability <1%) due to the multiple failsafe's installed on the flowline networks and separation distance from surround users.	Yes	Low
24			Release of contaminated leachate to surface water from the composting of drilling mineral waste	C.5.1 Drilling Materials A.4.7 Containment of Contaminants C.8.2 Spill Management Plan	•The composting of drilling wastes will only be undertaken during the dry season (May to September), with any storage beyond this point to require lining and covers to prevent leachate formation and run off. •Drilling waste willrequire to be dry, with no ponding of water present in the trial area or leachate present. •The trial area willhave an earthen bund and graded sufficiently to prevent both run-on and run-off of stormwater • any fluids within the trial area to be removed immediately. • Any fluids beyond the trail area will be considered a spill in accordance with the Spill management plan and managed accordingly. •The trial area willhave an earthen bund and graded sufficiently to prevent both run-on and run-off of stormwater •Upon completion of the trial, the composted drilling material will be either a) returned to the sump b) stockpiled on a liner with a cover will additional approvals are sought to re-use the material or c) trucked offsite to a licenced landfill.	•Weekly inspections completed on the trail area to detect ponding and releases form the trial area	•Where ponding or releases are identified, controls implement to mitigate future release by a) redesigning trial location b) removing wastes from area c) drying out the waste material further before use or d) implementing other controls to prevent the incident form re-occurring as appropriate.	1	3	L	Yes	The composting trial will be undertaken in the dry season to reduce (virtually eliminate) the risk of runoff form the site.Dry drilling waste will be utilised, further reducing the potential for leachate generation.The site will be bunded and contoured to contain any residual fluids if present/generated, with any fluid removed asap.The site will be cleaned up and tested to ensure any residual contaminants are removed. Given the controls, the level of potential contamination and risk to soils is considered minor (1) and likelihood unlikely	Yes	Low
25		Changes in surface water hydrology resulting in vegetation dieback from ponding and diversions away from natural surface systems with environmental and cultural value.	Infrastructure located on regional flow path resulting in changes to surface water flow.	A.4.1 Site selection and planning A.4.3 Erosion and sediment control and hydrology	•Well pad located away from watercourses and regional flow paths. (Elimination) •Well pads designed to divert stormwater around, without impeding natural surface water flows (Engineering) •Stockpiled debris to be used to discourage water concentration, with vegetation establish on stockpiles to reduce exposed surfaces •Area is remote with closest major watercourse at least 12 km away from any site storing flowback . Shenandoah N A located 450m from an intermittent stream order 1- with no long term storage of drilling wastes. (Elimination) •The well site is flat, with water to be diverted around the perimeter of the site. (Elimination)	•Erosion and Sediment Control Plan in place with routine pre and post wet season inspection and maintenance (administration)	•Maintenance to be undertaken on erosion and sediment controls to ensure ongoing functionality (Engineering)	1	2	L	Yes	Due to the lack of major water courses, and impact is likely to "minor", locally restricted and reversible. The likelihood is reduced down to highish unlikely (probability <10%) due to the absent of watercourses and controls implemented in accordance with NT Land Clearing Guidelines to avoid changes in the hydrological setting.	Yes	Low

Ref	Environmental Factor	Risk scenario description	Risk Source	Code of Practice (the Code)	Risk mitigation Measures			Residual Risk Rating			ALARP criteria achieved?	Residual risk ALARP and Acceptable Statement	Acceptable criteria achieved?	Scientific Uncertainty Ranking
					Prevent	Detect	Recover	Consequence	Likelihood	Risk Rating				
26			Changes to terrestrial ground surface levels associated with seismic activity.	B.4.13 Hydraulic Stimulation and Flowback Operations	•Wells are located away from known geohazards, with no significant faults within proximity of activity (Elimination) • Amungee NW-1H stimulation completed without inducing seismic activity (Elimination) •Stimulation is not linked to major seismic events (reinjection of wastewater is generally recognised as the main cause). No reinjection of wastewater proposed (Elimination) •Stimulation stages deployment will be away from geohazards to reduce the loss of fluids into any encountered faults (Elimination) •TheBeetaloo is not prone to seismic activity and there is no evidence of recent earthquake activity as most faults and the major subsurface structure are confined to Cambrian or older strata.This is supported by the National seismic Hazard Assessments completed by Allen 2018 (Figure 33), which highlight the Beetaloo is located within a low hazard area (Elimination) •Any faults encountered during drilling will be assessed to determine risk of stimulating with appropriate separation distances applied (Elimination). •Any induced seismicity likely to be minor(<3 Ml) and not at a level capable of altering earths surface.	•Monitoring of stimulation pressure to detect and respond to anomalies which may indicate fluid being pumped to an open geological structure (Engineering) •Geoscience Australia's Waramungu seismic array located approximately 300km of the sites. Seismometer to be deployed at each site.It is likely that any material seismic events above a 2 Mlwill be detected via this array if they occur (Administration) •An induced seismicity traffic light system has been adopted and outlined in the WOMP (Administration)	•Where seismic activity is recorded in Tamboran's tenure during hydraulic stimulation activities, the actions in the WOMP Traffic Light System will be enacted as summarised below: Green: Local Magnitude (Ml) <2.0- no action required Orange: Ml 2.0- <3.5Ml- Report event to DITT and continue operations Red: Ml> 3.5- Stimulation activity on pad suspended until a go forward plan submitted by Tamboran and approved by DITT.	1	1	L	Yes	The consequence of a induced seismicity, based upon evidence from the UK and US, indicates that the consequence is likely to be "minor", with most events restricted to discrete areas at a size that generally cannot be detected at the surface (below 2 order of magnitude). This limits the potential for changes in terrestrial surface level. Larger events are rare and generally a factor of the existing built up stress regime of the area- rather than a factor of the intensity of hydraulic fracturing or wastewater injection. The likelihood of a seismic event is reduced through the geological setting of the Beetaloo Basin itself and the safeguards implemented in the Code requiring geohazard assessment and avoidance. In theBeetaloo, there have been no earthquakes over magnitude 3 measured since records began.The area is not prone to seismic activity and there is no evidence of recent earthquake activity as most faults and the major subsurface structure are confined to Cambrian or older strata.This is supported by the National seismic Hazard Assessments completed by Allen 2018 (Figure 33), which highlight the Beetaloo is located within a low hazard area. The Code requires any geohazard (such as fault) identified prior to drilling (from existing seismic or interpreted data) or encountered during drilling to have a risk assessment to the determine the potential for reactivation.Any faults identified would not be stimulated, with a risk-based buffer applied. Given the number of wells stimulated in the US without issue and geological setting of the Beetaloo basin, the likelihood is considered remote, with a probability less than 0.1%.	Yes	Low
27	**Terrestrial environmental quality**	Loss in long-term soil productivity and viability.	Soil compaction from access tracks,leases and2D seismic.	A.4.1 Site selection and planning	• Clearing will be limited to the minimum necessary to extend well pad, camp lease and install helipad, laydown yard and fence line/ firebreak and seismic lines (Engineering) •All well pads, camp pads, helipads to be stripped of topsoil (Elimination) •Areas to be rehabilitated to reduce impacts associated with compaction (Engineering) •Disturbance area is small (<0.01% of EP 98 and <0.006% of total tenure area) (Elimination)	•Rehabilitation monitoring to assess soil productivity impacts (Administration)	•Areas with poor rehabilitation will be maintained to reduce impact (Engineering)	1	3	L	Yes	During the construction/operation of well pads, access tracks , camp pads etc., these sites will be compacted. Long term impacts of this compaction will be addressed during the rehabilitation of the sites.A loss of productivity is anticipated in the earlier stages of rehabilitation, returning back to pre-disturbed state within ~10 years.This will be accelerated through removal of hard stand areas, riping and scarifying compacted surface.the consequences is likely to be "moderate", being locally restricted, with a moderate- long (years) recovery time.The likelihood of long term productivity impairment is considered "unlikely" (probability <30%), given the observed rehabilitation from previous disturbance activities.	Yes	Low
28			Soil erosion from cleared areas (access tracks, well pads, camp pads and 2D seismic).	A.4.3 Erosion and sediment control and hydrology	•Clearing limited to minimum necessary to extend well well pad, camp well pad and install helipad, laydown yard and fence line/firebreak(Engineering) •Erosion and Sediment Control Plan in place and maintained in functioning condition (Engineering) •Sites to be maintained, with erosion and sediment controls kept in working order (Engineering) •Stockpiled debris to be used to discourage water concentration. (Engineering) •Areas to be rehabilitated to reduce impacts associated with compaction (Engineering) •Disturbance area is small (less than 0.005% of total tenure area) (Elimination) •Clearing of slopes >2% will be avoided.	•Pre and post wet season erosion and sediment control inspections. •Rehabilitation monitoring to assess soil productivity impacts (Administration)	•Maintenance completed on areas where erosion is occurring or where the controls are defective (Engineering) •Areas with poor rehabilitation will be maintained to reduce impact (Engineering)	1	3	M	Yes	The erosion and sediment release from cleared area is a well-documented impact. The consequences of sediment releases are likely to be minor, a function of the low risk nature of the site soils types, design of well pads and ongoing inspection and maintenance programs.The likelihood of these minor locally restricted releases of sediment is considered likely (Probability 90%).	Yes	Low
29		Long term surface disturbance from 2D seismic detonation charges	Soil erosion and instability from 2D seismic detonation charges	A.4.3 Erosion and sediment control and hydrology	• Charges are only laid within the designated seismic lines (Elimination) •Charges are small and placed 15 - 20 m below the ground surface (Engineering) •The blast zone is underground resulting in no visible surface disturbance (Engineering)	•Pre and post wet season erosion and sediment control inspections. •Rehabilitation monitoring to assess soil productivity impacts (Administration)	•Maintenance completed on areas where erosion is occurring or where the controls are defective (Engineering) •Areas with poor rehabilitation will be maintained to reduce impact (Engineering)	1	1	L	Yes	The charges are small and the detonation zone is subsurface, resulting in no long surface disturbance or blast impact sites.	Yes	Low
30		Soil contamination due to spills and leaks of chemicals, wastes or wastewater.	Spills/leaks from the on-site storing,handling, treatment, recycling and disposal of fuels. Condensate, hydrocarbons, drilling additives, stimulation additives,flowback fluid,solid wastes, storage, transportation of wastes and during 2D seismic	A.4.7 Containment of Contaminants c.5.2 Management of produced water from petroleum wells C.8.2 Spill Management Plan	•All chemical, fuel and waste storage, and high risk spill handling areas are to have secondary containment, with an impermeable liner with coefficient of permeability of less than 10-9 m/s • Liner damage from termites to be managed through deployment of baits and termite deterrents (termites/spraying) • Where extended wastewater evaporation with high EC fluid is proposed, a thicker liner (0.71 to 0.91mm) will be used to reduce the risk of liner tears from salt solids •Licenced waste transporters to be used to transport listed wastes. •Chemicals to be transported in accordance with the Australian Dangerous Goods Code and NT Dangerous Goods Act. •No chemical or wastewater transportation during wet season, unless a risk assessment determined the activity is safe and low risk •Evaporation tanks storing solid salt to have a higher density liner capable of resisting the puncture of the salt solids. •Well sites to be compacted to above 100kpa to achieve a permeability of approximately 1x10m-7/s •The site is earthen bunded to prevent offsite release of flowback.This is considered an additional level of containment, as the primary and secondary containment is the principle spill risk control. •Site earthen bunding will have a minimum bund wall height of 300mm capable of managing at least 110% of the largest wastewater tank volume. •The earthen bund will be constructed in a manner to withstand a tank failure scenario with appropriate compaction and stabilisation applied. • All flowback transfer piping to have secondary containment around connection points • All piping used to transfer flowback to be appropriately pressure rated, tested and maintained to prevent spills •All transportation of listed wastes and dangerous goods to be undertaken via licenced contractors. •Area is remote with major urban areas to be avoided during the transportation of dangerous goods and wastes in accordance with the NT Dangerous Goods Act. •All vehicles mechanically maintained and free of oil leaks. •Portable storage bunding and spill kits on hand during seismic.	•Daily inspections during wet season and weekly thereafter to identify and respond to any potential leaks.	•Liner leaks to be investigated and liners repaired as soon as practicable •Spills and leaks to be cleaned up and rectified immediately •Any contamination event to be characterised and have remediation plans developed and executed in accordance with the process outlined in schedule A of the National Environmental Protection (Assessment of site Contamination) Measures (Engineering)	2	2	L	Yes	The storage, handling and management of chemicals is a standard activity that is managed through a mature regulatory setting.The Code further reduces the likelihood and consequence of chemical spills and contamination, through the mandated use of secondary containment, a spill management plan and groundwater monitoring. A spill event is likely to result in moderate, short term reversible impacts restricted to the existing well pad.The likelihood is further reduced down to highly unlikely(<10% probability of occurring) based onthe use of secondary containment, rapid spill detection and rehabilitation requirements.	Yes	Low
31			Drill sump and flowback tank overtopping.	A.4.7 Containment of Contaminants C.5.1 Drilling Materials C.5.2 Management of produced water from petroleum wells C.6 Monitoring mandatory requirements C.8.2 Spill Management Plan	•Drilling sump to be designed and operated to handle the drilling of multiple wells •Sump solid levels to be periodically removed from the sump between wells (or as required) to maintain sump capacity •Covered tanks to be used to manage flowback storage, with enough enclosed storage onsite to manage all stored flowback. •Results from previous well testing have been used to optimise available tank capacity to allow for multiple wells •Additional tank capacity to be installed as required, with new tank capacity taking less than 14 days (subject to access and resource availability) •Open wastewater evaporation tanks and drill sumps to have a 1:1000 ARI wet season freeboard (wet season freeboard 1.3m). •All flowback wastewater (other than the minimum volume required to integrity of the open tank liner) to be transferred to enclosed tanks prior to the onsite of a "significant rainfall event (>300mm of forecasted rain over a 4 day periodic) • Wastewater transfers into any tank/ sump will cease prior to fluid levels exceed the relevant freeboard level. Wastewater transfers into a open tank/sump will not occur until levels return to below the relevant freeboard. •Sufficient pumps available onsite to meet volume transfer requirements, with available pump redundancy in case of mechanical issues. •Well sites to be compacted to above 100kpa to achieve a permeability of approximately 1x10m-7/s •The site is earthen bunded (300 mm high) to prevent offsite release of flowback.This is an additional level of containment, as the primary and secondary containment is the principle spill risk control. Site earthen bunding will be capable of managing at least 110% of the largest wastewater tank volume. The earthen bund will be constructed to withstand a tank failure scenario with appropriate compaction and stabilisation applied. •Site is manned at all times or have telemetered level logging during wastewater storage, with helicopters to be used to fly in staff when road access is prevented. •Separation between well pad and closest aquifer over 70m, with interbedded clays likely to limit any potential contaminant migration. •Nearest landholder extraction bore 1 km. •Depth of aquifers generally below known stygofauna distribution range (elimination)	•Daily monitoring of tank and sump levels (along with available storage space)during the wet season and weekly at all other times •Daily significant rainfall monitoring during the wet season. •Spill Management Plan implemented to prevent, detect and respond to spills. •Impact and control groundwater monitoring bores installed within 20m of exploration wells to detect any potential contamination, with monitoring completed quarterly	•All flowback (other than the volume required to maintain the integrity of an open tank liner) to be transferred to enclosed tanks 8 hours before the onset of a significant rainfall event (defined as >300mm of rain over a 4 day period) •Operations (flowback and drilling) to cease if insufficient wastewater (sump or flowback storage) is available to meet freeboard and enclosed tank availability requirement. • No additional drilling fluids or wastewater shall be added to the sump/tank once the freeboard has been exceeded. Any flowback stored within an open top tank above the freeboard level must be transferred to the enclosed tanks onsite within 24 hours. •DEPWS to be notified within 48 hours where the freeboard of a tank or sump has been exceeded and the forward monitoring and management strategies to prevent an overtopping event (including revised action and reporting triggers) •Drilling fluids to be transferred to wastewater tanks,removed from site or other actions implemented(such as deployment of covers etc.) to minimise the risk of overtopping where the sump freeboard level is below 1:1000 ARI 7-day rainfall event- unless otherwise agree to with prior approval from DEPWS to account for forecasted risk mitigation factor (such as forecasted climatic/seasonal factors) •New wastewater tanks to be constructed onsite if flowback wastewater storage volumes areinsufficient to maintain the required enclosed freeboard levels •Operations (flowback and drilling) to cease if insufficient wastewater (sump or flowback storage) is available to meet freeboard and enclosed tank availability requirement. • Any contamination event to be characterised and have remediation plans developed and executed in accordance with the process outlined in schedule A of the NEPM (Assessment of site Contamination) (Engineering)	2	1	L	Yes	The consequence and likelihood of a wastewater storage overflowing are minimised through the onerous wastewater management requirements stipulated in the Code. This includes well pad bunding, tank level alarms, tank freeboard requirements and use of a wastewater management plan.Any overflow is likely to be restricted to the well pad, rapidly detected and promptly cleaned up.The use of enclosed tanks, freeboard and well pad bunding essentially eliminates the likelihood potential for a wastewater storage tank to overflow.Given the onerous regulatory requirements, the likelihood of an overtopping event is considered Remote, with a <1% probability of occurring.	Yes	Low
32			Uncontrolled release of formation fluid encountered during drilling, stimulation, barrier failure	B.4.1 Well integrity management B.4.3 Well design and barriers B.4.13 Hydraulic Stimulation and flow back operations D.5.8 Venting and flaring	•Drilling overbalanced to reduce the inflows of hydrocarbons and fluids (Engineering) •Blow out prevention in place to manage well failure and uncontrolled gas/ fluid/pressure influxes (Engineering) •Blow out preventor pressure rating and testing •All equipment will be API compliant to handle expected conditions (Engineering) •Site manned during operation (Administration) •Well suspended with multiple cement and casing barriers in place- with 4 casing section utilised (conductor, surface, intermediate and production),(Engineering) •Barricading to be used to protect each exploration well from vehicle collision during multi-well drilling activities. (Engineering)	•Process monitoring to detect events that could potentially result in a uncontrolled release of gas/fluids/pressure (such as fluid balances, well head pressure etc.) (Engineering) •Routine (monthly) well inspections (Administration	•An emergency as diverter and flare to be used during drilling to manage gas ingress (Engineering) •Contracts in place with emergency well intervention specialists (such as Boots and Cootes) (administration) •Emergency response plan implemented (administration)	2	2	L	Yes	The Code and standard drilling, stimulation and well testing safety controls are designed to prevent the uncontrolled release of hydrocarbons and produced fluids. The consequence are anticipated to be moderate, with impacts likely to be moderate, restricted in duration (minutes to hours).The likelihood is considered highly unlikely with a occurrence probability less than 10%, based on the well designed, construction and operations requirements mandated by the Code.	Yes	Low

Ref	Environmental Factor	Risk scenario description	Risk Source	Code of Practice (the Code)	Risk mitigation Measures			Residual Risk Rating			ALARP criteria achieved?	Residual risk ALARP and Acceptable Statement	Acceptable criteria achieved?	Scientific Uncertainty Ranking
					Prevent	Detect	Recover	Consequence	Likelihood	Risk Rating				
33			Chemical and waste transportation accident.	A.4.7 Containment of Contaminants C.8.2 Spill Management Plan	•Risk assessment completed for all wet season transportation of chemicals and wastes (Administration) •All wastes to be transported in accordance with the NT Waste Management and Pollution Control Act. (Administration) •All dangerous goods to be transported in accordance with the NT Dangerous Goods Act and Australian Dangerous Goods Code.(Administration) •No chemical or wastewater transportation during wet season, unless a risk assessment determined the activity is safe and low risk •Transportation route to avoid major urban areas •All drivers to be approximately licenced (Administration) • Fatigue management plan implemented, requiring journey management plans and drivers to rest every 2 hours (Administration) •Access track maintained to allow periodic wet weather access •Strict drug and alcohol policy implemented, with routine testing and 0 zero tolerance policy to alcohol (0.00% limit) and drugs (Administration) •Area is remote with major urban centres to be avoided. (Elimination) •Risk to any receptor is identical to that of normal diesel or petroleum tankers. •Training of Tamboran supervisors regarding chain of responsibility requirements to minimise the risk of driver fatigue (Administration) •The transportation of waste and chemicals across Australia is a standard practice with mature codes and legislation in place.the transportation of fuels, chemicals and wastes occurs every year in the NT to support existing industry's during the wet season.(Engineering)	•Transport incident statistics collected and monitored. (Administration) •Onsite assurances and fit for work assessments completed periodically on transport companies (Administration)	•All transport spills to be cleaned up immediately (engineering) •Contractor performance reviews completed where breaches in requirements are escalated and actions implemented to rectify defects.(administration)	3	1	L	Yes	The transportation of wastes and chemicals is a tightly controlled industry with mature practices designed to prevent, detect and respond to transportation spills. Any accident is likely to be restricted to road corridors and result in "serious", short term (days-weeks) reversible impacts.All contractors must be appropriately licenced, with National uniform legislation in place to offer a high level of regulatory protection.This risk is considered identical to that of bulk diesel and other dangerous goods transportation- a common activity throughout Australia.Fuel and chemical transport accidents are rare given the number of transportation movements in Australia. The likelihood of an event occurring is therefore considered ""highly unlikely", what a probability of less than 10%.	Yes	Low
34			On-site disposal of drill muds and cuttings.	C.5.1 Drilling Materials	• Drilling muds, water basedare low residual toxicity.(Elimination) • Sodium and Chloride levels to be reduced through segregation of drilling fluids from muds and mixing with clean material onsite •Drilling muds and cuttings from the sump maybe transferred and stored in a pit/sump on site that is compliant with C.4.1.2 for the storage of drilling muds and cuttings to dry the cuttings and reduce waste volumes. •Drilling muds (water-based) to be tested and a disposal strategy developed by a suitably qualified third-party in a manner that minimises the risk to the environment. •Drilling muds (water-based) removed from site where onsite disposal is unsafe. •DEPWS engaged to confirm final disposal strategy. • Rehabilitation monitoring to monitor ongoing site rehabilitation	•Drilling muds (water based) to be tested and a disposal strategy developed by a suitably qualified third-party in a manner that minimises the risk to the environment. Rehabilitation monitoring completed on all disposal areas	•Additional rehabilitation actions implemented where rehabilitation objectives are not being met.	2	2	L	Yes	In accordance with the Code, the onsite storage anddisposal of drilling fluids and cuttings can only occur if the activity does not represent an unacceptable environmental hazard. All drilling fluids, muds and cuttings will be stored in a lined sump, with testing undertaken prior to final disposal.Onsite disposal will only occur if determined to be safe by an independent third party.The consequences are therefore likely to be restricted to a Moderate- short term reversible impacts. The likelihood of contamination through drilling fluid, mud and cuttings storage and failure is considered highly unlikely, with the probability below 10%.This is largely due to the separation distance between the underlying aquifer, use of lined sumps andthird partydisposal suitability assessments.	Yes	Low
35			Failure or leak from wastewater gathering line network, including from sabotage.	A.3 Surface activities mandatory requirements requirements A.3.8 Containment of Contaminants C.4.2 Management of produced water and flowback fluid C.7.2 Spill Management	• Selection and placement of gathering line easement(s) - co-location with access tracks. •Gathering lines are used, these will be designed, constructed and maintained in accordance with "Code of Practice for Upstream Polyethylene Gathering Networks in the CSG Industry, Version 5", August 2019 (APGA 2019) • Gathering line burial depth and hardness of polyethylene pipeline to minimise termite attack • Gathering lines are located in remote areas with limited access, minimising the risk of sabotage •PE pipes shall be manufactured in accordance with AS/NZS 4130 and shall be third party certified by a JAS-ANZ accredited certifier under the StandardsMark, GasMark or WaterMark schemes or equivalent. •Pipes to be pressure tested/ hydrotested to confirm integrity. •Marking and product traceability shall be in accordance with the Standard. Appendix A of AS/NZS 4130 shall be used as the basis for demonstrating conformity. •Pipes for Gathering Networks shall be Series 1 conforming to AS/NZS 4130. A design, risk assessment and testing regime, inline with the PEGN code, will ensure suitable material selection and selection of facility overpressure protection equipment to reduce the probability of leaks to ALARP •aboveground gathering lines to be temporary (<12 months), with no transfers where fires or severe weather events are predicted • Identification and signage to prevent excavation damage • Emergency shutdown systems and response procedures to investigate and manage loss of containment. • Flowline / gathering networks will be fitted with manifolds and valves to isolate it into sections. Valves will be locked at all times unless attended by authorised personnel to prevent unintentional operation. •upon cessation of use/ suspension (triggered after 3 months of no use),gathering lines will be purged of any residual wastewater •Fuel loads within right of ways to be kept low to reduce fire risks. Overhanging trees that could fall on pipelines will be removed. •Prior to the abandonment of gathering lines, each line is to be purged clean of contaminants and pigged as required to remove scale. Testing to confirm no residual contaminants. • Gathering line damage from termites to be managed through deployment of baits and termite deterrents (termites/spraying)	• Remote monitoring of pressure, flow and leaks on gathering networks (pressure and leak detection) • Remotely operated isolation valves on gathering networks • Monthly gathering line inspections during continual operations or where batch transfer is proposed, before and during each batch transfer.	• Emergency response and spill management plans enacted to respond to spills •Pumps located onsite to recover fluid and transfer into existing tanks, with spills and leaks to be cleaned up and rectified immediately •Earth moving equipment available regionally to clean up spills •Gathering network system will not be restarted until the leak is repaired and an investigation is carried out as to how the leak occurred and how it will be prevented from re-occurring •Emergency response plan implemented. • Any contamination event to be characterised and have remediation plans developed and executed in accordance with the process outlined in schedule A of the National Environmental Protection (Assessment of site Contamination) Measures (Engineering)	2	2	L	Yes	The risk of a flowline failure is minimised by being constructed to a relevant code, including material selection, certification and system design.Industry standard welding techniques and QA/QC protocols will be implemented to ensure compliance with the APGA code. Hydrotesting will be completed to confirm the integrity of the system and detect any leaks prior to commissioning.Leak detection will be implemented on the gathering line system with leaks able to be rapidly (instantaneously) detected. Telemetered valves will allow remote shut down of gathering lines should leaks be detected. Flowlines to be used for long term deployment will be buried.Any surface lines will be temporary and will be removed when not in use. Pipelines will not be used during periods of bushfire or extreme weather. Burying permanent flow lines ensures there is added protection against fire, flood, cyclonic winds, extreme temperatures and loading stress forces under a range of conditions. A spill management pan is in force to detect, prevent and respond to potential spills of wastewater and gas. If a failure was to occur, the wastewater would be restricted to the immediate vicinity of the gathering line.given the leak detection and remote shut in procedures- The potential leak rate is likely to be lower than 1000L which would mainly be restricted to within the gathering line right of way. The likelihood of such a consequence from occurring is considered highly unlikely (probability <10%) due to the multiple failsafe's installed on the gathering networks.The consequence is considered moderate, given the likely size of the spill.	Yes	Low
36			Failure of a flowback tank or catastrophic failure of liner.	A.4.1 Site selection and planning A.4.7 Containment of Contaminants C.8.2 Spill Management Plan	•Tanks designed and engineered to AS3990 Mechanical Equipment- Steel Work, AS 1170.1 Hydrostatic loading, AS1170.2 Wind Rating (cyclonic wind rating) •Wastewater tank liner with impermeable membrane with coefficient of permeability of less than 10-9 m/spermeability, 120N picture resistance and 49N tear resistance •Higher density liners used for evaporation tanks where solid salt crystals/ crusts are anticipated to form •Covered wastewater tanks and condensate tanks to have vents to prevent pressure build up. •Well sites to be compacted to above 100kpa to achieve a permeability of approximately 1x10m-7/s •The site is earthen bunded to prevent offsite release of flowback.This is considered an additional level of containment, as the primary and secondary containment is the principle spill risk control. •Site earthen bunding will have a minimum bund wall height of 300mm capable of managing at least 110% of the largest wastewater tank volume. •The earthen bund will be constructed in a manner to withstand a tank failure scenario with appropriate compaction and stabilisation applied. •firebreaks maintained and lids to be flooded with water to combat ember attack damaging liner • Termite baits and spraying to be used to prevent termite damage to liners	•Weekly wastewater tank integrity inspections during wastewater storage to detect •Routine level monitoring and alarms	•Wastewater tank structural defects to be rectified as soon as practicable. •Wastewater to be transferred from defective tanks to alternative tanks onsite until repairs completed. •Pumps located onsite to recover fluid and transfer into existing tanks, with spills and leaks to be cleaned up and rectified immediately •Earth moving equipment available regionally to clean up spills •Emergency response plan implemented. •Any contamination event to be characterised and have remediation plans developed and executed in accordance with the process outlined in schedule A of the National Environmental Protection (Assessment of site Contamination) Measures (Engineering)	3	1	L	Yes	The consequences of a tank failure are negated through the use of double lined, engineered above ground tank which have continuous leak detection and alarms. Tanks and their liners are designed with sufficient structural integrity to withstand cyclonic winds, extreme temperatures and loading stress forces under a range of conditions.A spill management pan is in force to detect, prevent and respond to potential spills of wastewater. If a storage failure was to occur, the wastewater would be restricted to the well pad.Flowback would be pumped into available enclosed and open tank storage, with contaminated soil removed from site. the consequences are likely to be "serious", being locally restricted, moderate duration (weeks) and reversible.The likelihood is reduced by the Code requirements , tank design separation distancesto the underlying aquifer. The likelihood is considered Remote, withe a probability less than 1%.	Yes	Low
37		Soil contamination from the drift of saline wastewater offsite from mechanical evaporation units.	Wastewater evaporation mist transported offsite during wastewater treatment.	A.4.1 Site selection and planning	• Units to be operated in daylight hours with manual imitation • Units to be inspected daily for drift. •Automated wind speed and direction cut offs to be implemented to prevent drift outside of the wastewater tank(Engineering) •Evaporators located within the wastewater tank considering the predominant wind direction (from the SE) to ensure no drift outide of the wastewater tanks (Engineering) •No homesteads, sacred sites or sensitive environmental areas in the vicinity of the proposed well pads (Elimination)	•Daily monitoring to detect drift (Engineering)	•Evaporation units to cease operation where drift identified (Engineering) •Any driftto be reported as an incident with the spill management plan followed. (Administration) •Evaporators to be modified/ repositioned to control drift (Engineering)	2	2	L	Yes	The use of enhanced evaporators to manage wastewater is a well-known technology used through multiple mining and wastewater treatment industries.Evaporators were used successfully on the Amungee NW-1H well to reduce fluid levels decreasing offsite trucking volumes. The prevention of wastewater drift from outside of the wastewater tank is restricted through wind speed and direction cut offs and the location of the evaporator within the wastewater storage.The sites are continuously manned during well testing, thus the risk of drift and associated impacts is anticipated to be moderate, with short term, reversible impacts. Given the aforementioned controls, the likelihood of moderate impacts is reduced to Highly unlikely, with a potential of lower than 10%.	Yes	Low
38		Soil contamination from the composting of drilling mineral waste	Leachate or runoff from composted material contaminates soil	A.4.7 Containment of Contaminants C.8.2 Spill Management	•The composting of drilling wastes will only be undertaken during the dry season (May to September), with any storage beyond this point to require lining and covers to prevent leachate formation and run off. •A dedicated trial area on a well pad/ laydown yard will be demarcated and signed •The trial area will be a compacted clay liner or geomembrane type liner meeting the requirements of clause B.4.16.2(h) and C.4.1.2 (b) of the code. •Drilling waste willrequire to be dry, with no ponding of water present in the trial area or leachate present. • any fluids beyond the trail area will be considered a spill in accordance with the Spill management plan and managed accordingly. •The trial area willhave an earthen bund and graded sufficiently to prevent both run-on and run-off of stormwater •Waste material will be blended with manure and using a front end loader/ tractor/bob cat onsite at to stabilise it (such as 1 part waste: 1 part manure etc.) •The material will be tested in accordance with the suite in Table 9 of the Code of Practice •Upon completion of the trial, the composted drilling material will be either a) returned to the sump b) stockpiled on a liner with a cover will additional approvals are sought to re-use the material or c) trucked offsite to a licenced landfill. • The trial area will have all contaminated soil/ material removed, with testing completed to determine the site is free of contamination.	•Weekly inspections completed on the trail area to detect ponding and releases form the trial area •Monitoring of soils post trial andsite clean up to demonstrate no contamination	•Where ponding or releases are identified, controls implement to mitigate future release by a) redesigning trial location b) removing wastes from area c) drying out the waste material further before use or d) implementing other controls to prevent the incident form re-occurring as appropriate.	1	2	L	Yes	The composting trial will be undertaken in the dry season to reduce (virtually eliminate) the risk of runoff form the site.Dry drilling waste will be utilised, further reducing the potential for leachate generation.The site will be bunded and contoured to contain any residual fluids if present/generated, with any fluid removed asap.The site will be cleaned up and tested to ensure any residual contaminants are removed. Given the controls, the level of potential contamination and risk to soils is considered minor (1) and likelihood unlikely	Yes	Low
39		Soil contamination from the disposal of greywater and sewerage from camp activities.	Greywater and sewerage disposal (camps).	C.4.2 Management of flowback water	•Sewerage wastewater irrigated as per Department of Health Code for On-site Wastewater Management (July 2014) (Engineering)(Elimination) •A wastewater suitability acceptance assessment has been completed and a design approval for wastewater disposal received in accordance with the NT Department of Health Code for On-site Wastewater Management (July 2014) (Engineering) •Wastewater irrigation to comply with DOH requirement (Engineering) •Areas appropriately sized to accommodate irrigation volume (Engineering) • Area is remote with closest watercourse at least 12 km awayfor sites in Shenandoah South and 450m away for Shenandoah North (no long term activity at this location (Elimination)	•Wastewater system performance to be monitored in accordance with the manufacturers requirements (Administration)	•Where wastewater specifications are exceeded, corrective actions will be implemented to ensure wastewater is returned back into specification (Engineering)	1	2	L	Yes	The management of sewerage and greywater is mature with various NT wastewater management guidelines. Due to the temporary nature of the activity, the maximum contamination resulting from sewerage and grey water irrigation is likely to be minor, with any impacts locally restricted and temporary in nature. The closest watercourse is at least 450m away form Shenandoah N A and 12km to the next closest site. Potential contamination of these features considered remote (probability <1%).	Yes	Low

Ref	Environmental Factor	Risk scenario description	Risk Source	Code of Practice (the Code)	Risk mitigation Measures			Residual Risk Rating			ALARP criteria achieved?	Residual risk ALARP and Acceptable Statement	Acceptable criteria achieved?	Scientific Uncertainty Ranking
					Prevent	Detect	Recover	Consequence	Likelihood	Risk Rating				
40	**Terrestrial ecosystems**	Impact to listed threatened habitats and listed threatened flora and fauna, including habitatfragmentation, impacts to non-listed fauna and livestock from exploration activities.	Land clearing impacts listed threatened species and/or their habitat	A.3.1 Site selection and planning A.3.5 Biodiversity protection	•Areas scouted by qualified ecologist prior to clearance to identify threatened flora and fauna and high valued habitat that may be impacted by proposed activities (Elimination) •Areas are not considered high conservation value, are not threatened/endangered and not significantly fragmented, with impacts unlikely to result in significant disturbance to threatened/endangered species. (Elimination) •Existing pastoral access tracks used to avoid additional habitat fragmentation (Elimination) •Land clearing to be minimised through the sharing of infrastructure to reduce the number of tanks required to manage flowback at each site (i.e. centralised sites, less land clearing) (elimination) • Low impact seismic priorities, with avoidance of clearing large trees (>25 cm trunk at 1.3 m)(Elimination) •Pre-clearance walk downs with cultural managers experienced in identifying native wildlife to identify and avoid clearing large trees(>25 cm trunk at 1.3 m), potential falcon nests (with 300 m buffer applied where possible) or threatened species. (Elimination) •Areas to be pegged out post walk down with optimised route selected. •Work will stop to allow listed species to move on, with work only commencing once listed threatened species has left the immediate area of clearing (Elimination) •No clearing of riparian vegetation or within wetlands (Elimination) • Experienced personnel with native wildlife identification used to inspect all proposed cleared areas immediately before clearing to identify potential grey falcon nests and other listed threatened fauna (Elimination) • Fences to be minimised to areas of proposed activity (Elimination)	• Disturbance survey using global position system (GPS) (Administration) •Fauna interaction logs to be kept to record fauna deaths and interactions (Administration) • Records of large trees cleared and avoided retained (administration)	•Where impacts are identified, practices will be reviewed and modified to reduce impact on fauna (Administration/ engineering) .	1	2	L	Yes	The areas for proposed clearing have been surveyed by ecologists who have not identified listed threatened species.Suitable habitat in the area exists and this will be avoided through practices defined in the NTG Land Clearing Guideline including avoidance of clearing to riparian vegetation, wetlands,large habitat trees and trees where suspected Grey flacon nests are present. The consequence of the activity causing material impacts to listed species is considered minor based on limited area of clearing, low probability of impacting multiple individual listed species an the availability of habitat locally/ regionally.The likelihood is considered highly unlikely with a <10% chance of impacts to listed threatened species occurring.	Yes	Low
41			Activity (vehicle and machinery) noise and lighting on well pads and access tracks.	A.4.1 Site selection and planning A.4.2 Noise	•Site location avoids areas of high conservation value as a priority (Elimination) •Areas are not considered high conservation value, are not threatened/endangered and not fragmented, with impacts unlikely to result in significant disturbance to threatened/endangered species. (Elimination) •Impacts likely to be temporal, with fauna able to move to adjacent areas to escape impacts. (Elimination) •Fauna monitoring at Kyalla has not identified any impacts, with fauna identified in areas around operations. (Engineering)	•Anecdotal evidence form pastoralists and Traditional Owners (Administration) •Impacts arelikely to be temporal, with detection extremely difficult.	•Where impacts are identified, practices will be reviewed and modified to reduce impact on fauna (Administration/ engineering) .	1	3	L	Yes	Fauna may be disturbed through transport movements along access tracks and drilling, stimulation and well testing activities around the well pad. The consequence of activity nuisance is anticipated to be minor, with localised, short term impacts to areas immediately adjacent to access tracks.The likelihood of the risk is reduced through the isolated location (lack of environmental and community receptors), regionally extensive vegetation communities (good outside refuge away from access tracks and limited transport movements during the evenings. The impact to fauna is considered highly unlikely given the ability of fauna to move to other areas of refuge away from E&A activities.	Yes	Low
42			Failure of flowback storage tanks.	A.4.1 Site selection and planning A.4.7 Containment of Contaminants c.5.2 Management of produced water from petroleum wells C.8.2 Spill Management Plan	•Tanks designed and engineered to AS3990 Mechanical Equipment- Steel Work, AS 1170.1 Hydrostatic loading, AS1170.2 Wind Rating (cyclonic wind rating) •Wastewater tank liner with impermeable membrane with coefficient of permeability of less than 10-9 m/spermeability, 120N picture resistance and 49N tear resistance •Higher density liners used for evaporation tanks where solid salt crystals/ crusts are anticipated to form •Covered wastewater tanks and condensate tanks to have vents to prevent pressure build up. •Well sites to be compacted to above 100kpa to achieve a permeability of approximately 1x10m-7/s •The site is earthen bunded to prevent offsite release of flowback.This is considered an additional level of containment, as the primary and secondary containment is the principle spill risk control. •Site earthen bunding will have a minimum bund wall height of 300mm capable of managing at least 110% of the largest wastewater tank volume. •The earthen bund will be constructed in a manner to withstand a tank failure scenario with appropriate compaction and stabilisation applied. •firebreaks maintained and lids to be flooded with water to combat ember attack damaging liner • Termite baits and spraying to be used to prevent termite damage to liners	•Weekly wastewater tank integrity inspections during wastewater storage to detect (administration) •Routine level monitoring and alarms (Engineering)	•Wastewater tank structural defects to be rectified as soon as practicable. (Engineering) •Wastewater to be transferred from defective tanks to alternative tanks onsite until repairs completed. (Engineering) •Pumps located onsite to recover fluid and transfer into existing tanks, with spills and leaks to be cleaned up and rectified immediately (Engineering) •Earth moving equipment available regionally to clean up spills (Engineering) •Emergency response plan implemented (Administration) •Any contamination event to be characterised and have remediation plans developed and executed in accordance with the process outlined in schedule A of the National Environmental Protection (Assessment of site Contamination) Measures (Engineering)	3	1	L	Yes	The consequences of a tank failure are negated through the use of double lined, engineered above ground tank which have continuous leak detection and alarms. Tanks and their liners are designed with sufficient structural integrity to withstand cyclonic winds, extreme temperatures and loading stress forces under a range of conditions.A spill management pan is in force to detect, prevent and respond to potential spills of wastewater. If a storage failure was to occur, the wastewater would be restricted to the well pad.The consequences are likely to be "serious", being locally restricted, moderate duration (weeks) and reversible.The likelihood is reduced by the Code requirements , tank design, separation distances to sensitive places and the well pad bunding.. The likelihood is considered Remote, with a probability less than 1%.	Yes	Low
43			Failure or leak from wastewater gathering line network (including from sabotage) impacting on terrestrial flora and fauna and surrounding vegetation communities	A.3 Surface activities mandatory requirements requirements A.3.8 Containment of Contaminants C.4.2 Management of produced water and flowback fluid C.7.2 Spill Management	• Selection and placement of gathering line easement(s) - co-location with access tracks. •Gathering lines are used, these will be designed, constructed and maintained in accordance with "Code of Practice for Upstream Polyethylene Gathering Networks in the CSG Industry, Version 5", August 2019 (APGA 2019) • Gathering lines are located in remote areas with limited access, minimising the risk of sabotage •PE pipes shall be manufactured in accordance with AS/NZS 4130 and shall be third-party certified by a JAS-ANZ accredited certifier under the StandardsMark, GasMark or WaterMark schemes or equivalent. •pipes to be pressure tested/ hydrotested to confirm integrity. •Marking and product traceability shall be in accordance with the Standard. Appendix A of AS/NZS 4130 shall be used as the basis for demonstrating conformity. •Pipes for Gathering Networks shall be Series 1 conforming to AS/NZS 4130. A design, risk assessment and testing regime, inline with the PEGN code, will ensure suitable material selection and selection of facility overpressure protection equipment to reduce the probability of leaks to ALARP •aboveground gathering lines to be temporary (typically <12 months), with no transfers where fires or severe weather events are predicted • Identification and signage to prevent excavation damage • Emergency shutdown systems and response procedures to investigate and manage loss of containment. • Flowline / gathering networks will be fitted with manifolds and valves to isolate it into sections. Valves will be locked at all times unless attended by authorised personnel to prevent unintentional operation. •upon cessation of use/ suspension (triggered after 3 months of no use),gathering lines will be purged of any residual wastewater •Fuel loads within right of ways to be kept low to reduce fire risks. Overhanging trees that could fall on pipelines will be removed.	• Remote monitoring of pressure, flow and leaks on gathering networks (pressure and leak detection) • Remotely operated isolation valves on gathering networks • monthly gathering line inspections during continual operations or where batch transfer is proposed, before and during each batch transfer.	• emergency response and spill management plans enacted to respond to spills •Pumps located onsite to recover fluid and transfer into existing tanks, with spills and leaks to be cleaned up and rectified immediately •Earth moving equipment available regionally to clean up spills •Gathering network system will not be restarted until the leak is repaired and an investigation is carried out as to how the leak occurred and how it will be prevented from re-occurring •Emergency response plan implemented. • Any contamination event to be characterised and have remediation plans developed and executed in accordance with the process outlined in schedule A of the National Environmental Protection (Assessment of site Contamination) Measures (Engineering)	2	2	L	Yes	The risk of a flowline failure is minimised by being constructed to a relevant code, including material selection, certification and system design.Industry standard welding techniques and QA/QC protocols will be implemented to ensure compliance with the APGA code. Hydrotesting will be completed to confirm the integrity of the system and detect any leaks prior to commissioning.Leak detection will be implemented on the gathering line system with leaks able to be rapidly (instantaneously) detected. Telemetered valves will allow remote shut down of gathering lines should leaks be detected. Flowlines to be used for long term deployment will be buried.Any surface lines will be temporary and will be removed when not in use. Pipelines will not be used during periods of bushfire or extreme weather. Burying permanent flow lines ensures there is added protection against fire, flood, cyclonic winds, extreme temperatures and loading stress forces under a range of conditions. A spill management pan is in force to detect, prevent and respond to potential spills of wastewater and gas. If a failure was to occur, the wastewater would be restricted to the immediate vicinity of the gathering line.given the leak detection and remote shut in procedures- The potential leak rate is likely to be lower than 1000L which would mainly be restricted to within the gathering line right of way. The likelihood of such a consequence from occurring is considered highly unlikely (probability <10%) due to the multiple failsafe's installed on the gathering networks.The consequence is considered moderate, given the likely size of the spill.	Yes	Low
44			Uncontrolled release of formation fluid encountered during drilling, stimulation, barrier failure	B.4.1 Well integrity management B.4.3 Well design and barriers B.4.13 Hydraulic Stimulation and flow back operations D.5.8 Venting and flaring	•Drilling overbalanced to reduce the inflows of hydrocarbons and fluids (Engineering) •Blow out prevention in place to manage well failure and uncontrolled gas/ fluid/pressure influxes (Engineering) •Blow out preventor pressure rating and testing •All equipment will be API compliant to handle expected conditions (Engineering) •Site manned during operation (Administration) •Well suspended with multiple cement and casing barriers in place- with 4 casing section utilised (conductor, surface, intermediate and production),(Engineering) •Barricading to be used to protect each exploration well from vehicle collision during multi-well drilling activities. (Engineering)	•Process monitoring to detect events that could potentially result in a uncontrolled release of gas/fluids/pressure (such as fluid balances, well head pressure etc.) (Engineering) •Routine (monthly) well inspections (Administration	•An emergency as diverter and flare to be used during drilling to manage gas ingress (Engineering) •Contracts in place with emergency well intervention specialists (such as Boots and Cootes) (administration) •Emergency response plan implemented (administration)	2	2	L	Yes	The Code and standard drilling, stimulation and well testing safety controls are designed to prevent the uncontrolled release of hydrocarbons and produced fluids. The consequence are anticipated to be moderate, with impacts likely to be moderate, restricted in duration (minutes to hours).The likelihood is considered highly unlikely with a occurrence probability less than 10%, based on the well designed, construction and operations requirements mandated by the Code.	Yes	Low
45			Introduction and spread of weeds in the area (including civil construction, seismic and E&A activities) .	A.4.5 Weed management	•All equipment and vehicles to be washed-down and to have a Biosecurity Declaration Certificate prior to access to site (Elimination) •Areas of proposed exploration have been surveyed and are deemed to have low weed abundance (elimination) •Activity will be restricted to defined well pads and camp pads (Elimination)	•6 monthly monitoring implemented around infrastructure to detect the spread/ introduction of weed species (administration) •Tamboran assurance activities to target equipment wash-down certificates to ensure standards are being met. (Administration)	•Where weed outbreaks are identified associated with Tamboran's activities, infestations will be treated in accordance with the Weed Management Plan. (elimination) •Corrective actions implemented where ongoing biosecurity breaches are identified.	2	3	M	Yes	The area in the vicinity sites is free of weeds. Weeds are present across the broader property. Any introduction of weeds is likely to result in localised impact, with weed management requirements likely to reduce the consequence down to "moderate, short term.Due to the inherent nature of weed prevention the risk likelihood is considered unlikely, witha probability less than <30%.	Yes	Low
46			Accidental ignition of fire from exploration activities (drilling, stimulation, flaring, seismic and general access).	A 4.6 Fire management	•Bushfire management plan implemented to prevent and respond to bushfires- including establishment of communication and fire response protocols with pastoralists (Administration) •Bushfire awareness included in site inductions. (Administration) •Designated smoking areas on-site (Elimination) •Firefighting equipment to be available to deal with fires (Engineering). •Fire breaks have been constructed around the well site and camp pads (Engineering) •Minimum of 45m separation distances between flares and surrounding vegetation (Engineering) •Ignition sources placed outside of the hazardous area. (Elimination) •Intrinsically safe equipment used in hazardous area. (Elimination) •Hazardous area drawing will provide classification of hazardous zones while drilling. (Elimination) •No flaring during periods of total fire ban (Elimination) •Activities will comply with landholder and regional bushfire management plans. (Elimination) •Area in the vicinity of well sites have had recent (within 1-2 years) fire activity, reducing the fuel load (Elimination) Fire tender to be used during seismic clearing, with a spotter to identify and respond to any ignition events (Elimination)	•Annual fire preparedness assurance activities completed where activities are proposed during high fire risk periods (administration) •Daily monitoring of bushfires in the region during periods of high fire danger (administration) •Annual fire frequency mapping using the Northern Australia Fire Information fire history database (administration)	•Fire hazard reduction strategies (such as back burning) to be implemented to reduce the risk of fire ignition/ impact as required (Elimination) •Where a bushfire is started and cannot be controlled, Tamboran to engage with pastoralist to coordinate response activities	3	2	M	Yes	Fire is a common occurrence within the Barkly Region. A fire is likely to have a serious impact, with moderate term reversible impacts (years).With the appropriate controls, such as separation distances, firebreaks, and adherence to total fire bans, the likelihood of causing a fire from drilling, stimulation and well testing is anticipated to be highly unlikely, with a predicted occurrence of <10%.	Yes	Low
47			Poor rehabilitation of the site reduces regional habitat and promotes weed invasions (including civil construction,seismic and E&A activities)	A.4.8 Rehabilitation	•A site specific Rehabilitation Plan has been developed and will be implemented progressively (Engineering) •Areas will have infrastructure and wastes removed, sumps and pits backfilled, topsoil respread and vegetation re-introduced. (Engineering) •Rehabilitation timing will consider seasonal constraints, with rehab completed prior to the wet season to maximise revegetation chance.(Engineering) •Rehabilitation to commence within 4 weeks upon completion of seismic activities.	•Rehabilitation monitoring to be undertaken to track rehabilitation progress (Administration)	•Maintenance will be undertaken periodically to fix any defects (Engineering)	1	3	L	Yes	Risks associated with rehabilitation are well known. Knowledge of rehabilitation within the Beetaloo Basin has been gained, based on previous seismic line rehabilitation programs.	Yes	Low
48			Trapping and drowning of fauna in storage tanks and sumps.	C.5.1 Drilling Materials	•Wastewater tank walls are 2m high with minimal risk of animals accessing tanks (elimination) •Well pads fenced to prevent stockaccess (engineering) •Sump coletanche liner is rough, with fauna able to climb out of sump (Engineering) •Sump fenced when not in use in a manner to reduce fauna access to sump(Engineering) •Limited habitat for threatened fauna in area surrounding site (Elimination) •Wastewater saline, with freshwater tanks to be preferred by birds • Previous fauna cameras installed around well pads have not detected significant wildlife presence in and around operating sites. (Elimination)	•Weekly inspections during wastewater storage. •Monitoring of fauna interaction with wastewater	•Where ongoing fauna interactions with wastewater are identified through monitoring, additional controls shall be implemented as appropriate (such as additional fencing, deterrents etc.) (Engineering)	2	2	L	Yes	Risks associated with potentially trapping and drowning fauna in storage tanks and sumps are well understood. Tamboran has extensive experience in managing sumps, ponds and tanks to prevent fauna ingress.	Yes	Low

Ref	Environmental Factor	Risk scenario description	Risk Source	Code of Practice (the Code)	Risk mitigation Measures			Residual Risk Rating			ALARP criteria achieved?	Residual risk ALARP and Acceptable Statement	Acceptable criteria achieved?	Scientific Uncertainty Ranking
					Prevent	Detect	Recover	Consequence	Likelihood	Risk Rating				
49			Contaminants in water and soil pass through the food chain and bioaccumulate in fauna causing detrimental impacts to local species and communities	A.4.7 Containment of Contaminants C.5.2 Management of produced water from petroleum wells C.8.2 Spill Management Plan	•All chemicals stored in designated areas with secondary containment (Engineering) •Chemical risk assessments with no chemicals considered above low concern levels when used in accordance with standard procedures and controls (Elimination) •The site is earthen bunded to prevent offsite release of flowback.This is considered an additional level of containment, as the primary and secondary containment is the principle spill risk control. (Engineering) •Site earthen bunding will have a minimum bund wall height of 300mm capable of managing at least 110% of the largest wastewater tank volume. (Engineering) •The earthen bund will be constructed in a manner to withstand a tank failure scenario with appropriate compaction and stabilisation applied. (Engineering) •Wastewater evaporation to have drift controls to prevent drift beyond the wastewater tank (engineering) •No offsite wastewater discharge (elimination) •Chemical mixing units and operating procedures designed to mitigated the formation of chemical airborne particulate matter (Engineering/ Administration) •Onsite burial of drilling waste can only occur where no material impacts to flora and fauna are anticipated (engineering) •Salt is the main hazard and does not bioaccumulate- UV and oxidation of organic compounds and metals in wastewater likely to degrade chemicals rapidly (within days)(Elimination) •Well pads fenced to prevent livestock accesses (engineering) •Sump fenced to prevent fauna access. (engineering) •Gathering lines designed, constructed, tested and operated in accordance with Code of Practice: Upstream Polyethylene Gathering Networks- CSG industry (APGA2019)	•Routine site weekly inspections to identify poor chemical handling or wastewater storage practices (engineering) •Monitoring of fauna interactionwith wastewater tanks and area surrounding the site (Administration) • monthly gathering line inspections •Gathering line leak detection used to identify leaks	•Where ongoing fauna interactions with wastewater or chemicals are identified through monitoring, additional controls shall be implemented as appropriate to reduce the potential for exposure (such as additional fencing, deterrents etc.) (Engineering) •All spills are to be cleaned up immediately, preventing the exposure to livestock and fauna	2	1	L	Yes	A chemical risk assessment and flowback characterisation program ensures all potential chemicals that are persistent, bio accumulative and toxic at high concentrations are identified and appropriate management strategies implemented. The risks associated with fauna ingestion of chemicals is well known and measures to prevent ingestion (such as fences and separation distances to activity) are deployed as standard practice. Tamboran has extensive operational experience in drilling and stimulating of conventional and unconventional petroleum wells with no evidence of impacts on biota from chemicals. Gathering lines will be designed, constructed, tested and operated in accordance with well accepted standards to prevent leaks and releases to the environment. Leak detection and routine inspections are utilised to identify leaks. Given the saline nature of wastewater, bioaccumulation is not considered likely based on the lack of palatability. Combined in the availability of habitat in the area which would-be impacted by a release/ spill- the risk is considered minor, with the likelihood remote.	Yes	Low
50			Vehicle and machinery collisions with fauna during civiland maintenance activities – fauna mortality results in a localised impact to listed threatened species .	A.4.4 Biodiversity protection	•Vegetation clearing at exploration sitesto be conducted with visual checks to identify fauna/fauna habitat during clearing •Vehicle speed limited to 60km/hr to be reduced around areas of high risk of fauna collision (Administration) •Vehicle movements to avoid driving at night (Elimination) •Fauna collisions observed during the existing activities have been minimal, with collision restricted to several wallabies along access track (Elimination) • Absence of listed threatened species identified in the vicinity of the well pad,access tracks and seismic lines. •Large trees and habitat trees to be avoided during seismic clearing through line deviation.	•Fauna mortality data is collected as part of Tamboran's incident and observation management procedures (Administration)	•Where ongoing fauna collisions are reported, additional controls shall be investigated, such as reduced speed limits in high risk areas will be implemented. (Administration)	1	3	L	Yes	Fauna collisions with vehicles are a commonly associated with roads. It is anticipated that a small number of fauna collisions will be experienced during the activity (1-2 animals per month), with minor, short term, reversible impacts to local fauna species. The likelihood of causing a localised decline in species abundance is considered remote.	Yes	Low
51			Encouragement of feral animals and other pest species increases leading to competition with native species.This includes the introduction of cane toads.	A.4.4 Biodiversity protection	•Camp wastes to be storage to be animal proof (Engineering) •All food scraps to be removed from site and disposed of at a licenced facility (Elimination) •Food scraps to be frozen and stored within freezer during wet season (Elimination) •Experience from existing activities has not detected increased feral animal prevalence, with only 1 feral dog identified in 6 months of camp operations. (Elimination)	•Feral fauna observation data is collected as part of Tamboran's incident and observation management procedures (Administration)	•Where ongoing feral animal presence is detected, additional controls will be investigated in consultation with the pastoralist (such as fencing, removal of water sources etc.) (Engineering)	1	3	L	Yes	Feral animals may be increased through the provision of access to water, food (camps) and hunting habitat (such as road corridors). The use of the existing site and access tracks limits the additional risk associated with provision of additional hunting habitat.Food scraps and waste will be frozen and disposed of offsite which will reduce the food availability for pests. Wastewater is too saline for cane toads to survive, with the design of the tanks likely to restrict toad habitat. The anticipated consequence is minor, with the potential pest species increase anticipated to be small. The likelihood is determined to be unlikely, with a probability of less than 30%.	Yes	Low
52			Activity (vehicle, machinery and seismic activity) noise & vibration during 2D seismic acquisition.	A.4.1 Site selection and planning A.4.2 Noise	•Seismic lines avoid areas of high conservation value as a priority (Elimination) •Areas are not considered high conservation value, are not threatened/endangered and not fragmented, with impacts unlikely to result in significant disturbance to threatened/endangered species. (Elimination) •Impacts likely to be temporal, with fauna able to move to adjacent areas to escape impacts. (Elimination) •Avoid vegetation clearing as much as practicable •In open woodlands, limit clearing to grasses and shrubs (Avoidance) •During seismic surveys, detonations will not occur when cattle are in proximity (Elimination) •Cattle will be mustered way from seismic area in consultation with pastoralist (Elimination) •During detonation, a short sharp thud will be heard, and potential small level vibration field within 1 km of charge going off. Tamboran will work with pastoralist to ensure cattle are mustered away from the activity. (Elimination)	•Anecdotal evidence from pastoralists and Traditional Owners (Administration) •Impacts arelikely to be temporal, with detection extremely difficult.	•Where impacts are identified, practices will be reviewed and modified to reduce impact on fauna (Administration/ engineering)	1	3	L	Yes	Fauna may be disturbed through transport movements along access tracks and seismic lines. The consequence of activity nuisance is anticipated to be minor, with localised, short term impacts to areas immediately adjacent to access tracks. The likelihood of the risk is reduced through the isolated location (lack of environmental and community receptors), regionally extensive vegetation communities (good outside refuge away from access tracks, seismic activity and limited transport movements during the evenings. The impact to fauna is considered highly unlikely given the ability of fauna to move to other areas of refuge away from seismic activities and ongoing engagement with pastoralists re cattle.	Yes	Low
53			Introduction and spread of weeds in the area during 2D seismic.	A.4.5 Weed management	•All equipment and vehicles to be washed-down and to have a Biosecurity Declaration Certificate prior to access to site (Elimination) •Areas of proposed exploration have been surveyed and are deemed to have low weed abundance (elimination) •Activity will be restricted to defined seismic lines and camp sites (Elimination) •Vegetation pushed during seismic line preparation will be placed back over cleared areas immediately after seismic recording (Engineering) •Preparation of seismic lines will minimise the removal of vegetation, rootstock, topsoil and seed bank, increasing the rate of vegetation recovery (Engineering) •Avoid seismic lines in water courses (unless co-located with an access track)	•6 monthly monitoring implemented around infrastructure to detect the spread/ introduction of weed species (administration) •Tamboran assurance activities to target equipment wash-down certificates to ensure standards are being met. (Administration)	•Where weed outbreaks are identified associated with Tamboran's activities, infestations will be treated in accordance with the Weed Management Plan. (elimination) •Corrective actions implemented where ongoing biosecurity breaches are identified.	2	3	M	Yes	The area in the vicinity sites is free of weeds. Weeds are present across the broader property. Any introduction of weeds is likely to result in localised impact, with weed management requirements likely to reduce the consequence down to "moderate, short term.Due to the inherent nature of weed prevention the risk likelihood is considered unlikely, witha probability less than <30%	Yes	Low
54			Accidental ignition of fire during 2D seismic acquisition and general access.	A 4.6 Fire management	•Bushfire management plan implemented to prevent and respond to bushfires- including establishment of communication and fire response protocols with pastoralists (Administration) •Bushfire awareness included in site inductions. (Administration) •Designated smoking areas on-site (Elimination) •Firefighting equipment to be available to deal with fires (Engineering). •Vehicles to be equipped with fire extinguishers. •Fire response to be implemented during seismic program, with spotters and fire trailers utilised to put out spot fires during work •Activities will comply with landholder and regional bushfire management plans. (Elimination) •Area in the vicinity of the seismic activity have had recent (within 1-2 years) fire activity, reducing the fuel load (Elimination)	•Annual fire preparedness assurance activities completed where activities are proposed during high fire risk periods (administration) •Daily monitoring of bushfires in the region during periods of high fire danger (administration) •Annual fire frequency mapping using the Northern Australia Fire Information fire history database (administration)	•Fire hazard reduction strategies (such as back burning) to be implemented to reduce the risk of fire ignition/ impact as required (Elimination) •Where a bushfire is started and cannot be controlled, Tamboran to engage with pastoralist to coordinate response activities	3	2	M	Yes	Fire is a common occurrence within the Barkly Region. A fire is likely to have a serious impact, with moderate term reversible impacts (years).With the appropriate controls, such as separation distances, firebreaks, and adherence to total fire bans, the likelihood of causing a fire from drilling, stimulation and well testing is anticipated to be highly unlikely, with a predicted occurrence of <10%	Yes	Low
55			Poor rehabilitation of the 2D seismic lines reduces regional habitat and promotes weed invasions	A.4.8 Rehabilitation	•A site specific Rehabilitation Plan has been developed and will be implemented progressively (Engineering) •Vegetation pushed during seismic line preparation will be placed back over cleared areas immediately after seismic recording (Engineering) •Preparation of seismic lines will minimise the removal of vegetation, rootstock, topsoil and seed bank, reducing the risk of erosion and increasing the rate of vegetation recovery (Engineering)	•Rehabilitation monitoring to be undertaken to track rehabilitation progress (Administration)	•Maintenance will be undertaken periodically to fix any defects (Engineering)	1	4	M	Yes	Risks associated with rehabilitation are well known. Knowledge of rehabilitation within the Beetaloo Basin has been gained, based on previous seismic line rehabilitation programs.	Yes	Low
56			Poor rehabilitation of the gathering lines reduces regional habitat, promotes weed invasions and results in minimal ecological function of the right of way	A.4.8 Rehabilitation	• Gathering lines purged and flushed of all wastewater •Gathering lines inspected and pigged to remove scale •Lines flushed and tested to confirm contamination removal •Surface infrastructure removed, including valve pits, drains, and signs to 750mm below ground •Pipe left insitu to avoid disturbance and avoid erosion/ impacts to established vegetation •HDPE has sufficient mechanical strength to avoid long term subsidence • reseeding of gathering line with locally sourced woody trees as required	• rehabilitation monitoring to identify erosion, poor vegetation re-establishmentand weeds	• periodic maintenance completed on areas of poor rehabilitation.	1	2	L	Yes	The risk associated with leaving HDPE in place is largely associated with contaminant removal.The risk associated with disturbing the soils and clearing vegetation to remove the pipe is not considered ALARP as this increasing the risk of erosion and subsidence.. By removing all contaminants and surface infrastructure, the gathering line right of way can be allowed to be re-established with woody vegetation to return back to pre-established conditions.As the gathering line is likely to have substantial grass/ shrub coverage already, the impacts are considered minor (1) and likelihood considered unlikely.	Yes	Low
57			Vehicle and machinery collisions with fauna during 2D seismic activities – fauna mortality results in a localised impact to listed threatened species	A.4.4 Biodiversity protection	•Pre-clearance site inspections (October - March) to minimise impacts to breeding / fledging of the Crested Shrike Tit. (Elimination) •Vegetation clearing of seismic lines to be conducted with visual checks to identify fauna/fauna habitat during clearing. •Vehicle speeds during seismic acquisition limited to <60 km/hrand mostly occurring at walking pace (Administration) •Vehicle movements to avoid driving at night (Elimination) •Fauna collisions observed during the existing activities have been minimal, with collision restricted to several wallabies along access track (Elimination)	•Fauna mortality data is collected as part of Tamboran's incident and observation management procedures (Administration)	•Where ongoing fauna collisions are reported, additional controls shall be investigated, such as reduced speed limits in high risk areas will be implemented. (Administration)	1	3	L	Yes	Fauna collisions with vehicles are a commonly associated with roads. It is anticipated that a small number of fauna collisions will be experienced during the activity (1-2 animals per month), with minor, short term, reversible impacts to local fauna species. The likelihood of causing a localised decline in common or listed threatened species abundance is considered remote.	Yes	Low
58	**Culture and heritage**	Disturbance of sacred site or culturally sensitive area, loss of spiritual connection with land and decline in environmental value of area used for hunting, foraging and enjoyment.	Sites disturbed directly by exploration activities	A.4.1 Site selection and planning	•Exploration Agreements with Determined Traditional owners covering all proposed exploration activities. •All areas of the proposed activity to be cleared by NLC and Archaeologist (Appendix L) (Elimination) •AAPA certificates for proposed work program have been granted (Elimination) •The location of infrastructure has considered proximity to sacred sites and cultural heritage artefacts (Elimination) •Areas of cultural heritage to be avoided during construction through the use of Cultural managers (Elimination) •Areas of cultural significance are identified through Restricted Work Areas (Elimination) •Implementation of the unexpected finds protocol (Administration).	•Archaeologists complete Cultural Heritage Assessment to identify culturally sensitive areas. •Tamboran completes 6 monthly assurance programs to confirm access to sacred sites has not occurred.	•N/A- no access to sacred sites anticipated. (Elimination)	3	1	L	Yes	All sites of the proposed activity must have Traditional Owner clearance via the NLC and informed by Cultural Heritage Assessment by a trained archaeologist. AAPA certificates are required for all activities to ensure sacred sites are not impacted by activities. The remote location of the activity, lack of sacred sites in the vicinity of the sites and contractual requirements prohibiting access reduce the likelihood down to "highly unlikely", with a probability lower than 10%.	Yes	Low

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					Prevent	Detect	Recover	Consequence	Likelihood	Risk Rating				
59			Accidental ignition by site activities (civil works, drilling, grinding) or site personnel.	A 4.6 Fire management	•Bushfire management plan implemented to prevent and respond to bushfires- including establishment of communication and fire response protocols with pastoralists (Administration) •Bushfire awareness included in site inductions. (Administration) •Designated smoking areas on-site (Elimination) •Firefighting equipment to be available to deal with fires (Engineering). •Fire breaks have been constructed around the lease and camp pads (Engineering) •Minimum of 45m separation distances between flares and surrounding vegetation (Engineering) •Ignition sources placed outside of the hazardous area. (Elimination) •Intrinsically safe equipment used in hazardous area. (Elimination) •Hazardous area drawing will provide classification of hazardous zones while drilling. (Elimination) •No flaring during periods of total fire ban (Elimination) •Activities will comply with landholder and regional bushfire management plans. (Elimination)	•Annual fire preparedness assurance activities completed where activities are proposed during high fire risk periods (administration) •Daily monitoring of bushfires in the region during periods of high fire danger (administration) •Annual fire frequency mapping using the Northern Australia Fire Information fire history database (administration)	•Fire hazard reduction strategies (such as back burning) to be implemented to reduce the risk of fire ignition/ impact as required (Elimination) •Where a bushfire is started and cannot be controlled, Tamboran to engage with pastoralist to coordinate response activities	3	2	M	Yes	Fire is a common occurrence within the Barkly Region. A fire is likely to have a serious impact, with moderate term reversible impacts (years).With the appropriate controls, such as separation distances, firebreaks, and adherence to total fire bans, the likelihood of causing a fire from drilling, stimulation and well testing is anticipated to be highly unlikely, with a predicted occurrence of <10%	Yes	Low
60			Flowback tank structural/ catastrophic liner failure.	A.4.1 Site selection and planning A.4.7 Containment of Contaminants C.5.2 Management of produced water from petroleum wells C.8.2 Spill Management Plan	•Tanks designed and engineered to AS3990 Mechanical Equipment- Steel Work, AS 1170.1 Hydrostatic loading, AS1170.2 Wind Rating (cyclonic wind rating) (Engineering) •Wastewater tank liner with impermeable membrane with coefficient of permeability of less than 10-9 m/s permeability, 120N picture resistance and 49N tear resistance (Engineering) • Higher density liners to be used for evaporation tanks where solid salt may be generated due to long term wastewater evaporation •Covered wastewater tanks and condensate tanks to have vents to prevent pressure build up. (Engineering) •The well pad is compacted to above 100 kpa to achieve a permeability of approximately 1x10m-7/s (Engineering) •The site is earthen bunded to prevent offsite release of flowback.This is considered an additional level of containment, as the primary and secondary containment is the principle spill risk control. (Engineering) •The site earthen bund has a minimum bund wall height of 300 mm capable of managing at least 110% of the largest wastewater tank volume.(Engineering) •The earthen bund is constructed in a manner to withstand a tank failure scenario with appropriate compaction and stabilisation applied.(Engineering) •Sacred site areas mapped as restricted work areas with no access permitted (Elimination, Administration) •Firebreaks maintained and lids to be flooded with water to combat ember attack damaging liner • Termite baits and spraying to be used to prevent termite damage to liners	•Weekly wastewater tank integrity inspections during wastewater storage to detect (administration) •Routine level monitoring and alarms (Engineering)	•Wastewater tank structural defects to be rectified as soon as practicable. (Engineering) •Wastewater to be transferred from defective tanks to alternative tanks onsite until repairs completed. (Engineering) •Pumps located onsite to recover fluid and transfer into existing tanks, with spills and leaks to be cleaned up and rectified immediately (Engineering) •Earth moving equipment available regionally to clean up spills (Engineering) •Emergency response plan implemented (Administration) •Any contamination event to be characterised and have remediation plans developed and executed in accordance with the process outlined in schedule A of the National Environmental Protection (Assessment of site Contamination) Measures (Engineering)	3	1	L	Yes	The consequences of a tank failure are negated through the use of double lined, engineered above ground tank which have continuous leak detection and alarms. Tanks and their liners are designed with sufficient structural integrity to withstand cyclonic winds, extreme temperatures and loading stress forces under a range of conditions.A spill management pan is in force to detect, prevent and respond to potential spills of wastewater. If a storage failure was to occur, the wastewater would be restricted to the well pad, limiting the impact on adjacent pastoral activities and community. Flowback would be pumped into available enclosed and open tank storage, with contaminated soil removed from site. The consequences are likely to be "serious", being locally restricted, moderate duration (weeks) and reversible (requiring rehabilitation).The likelihood is reduced by the Code requirements , tank design separation distancesto the underlying aquifer. The likelihood is considered Remote, with a probability less than 1%.	Yes	Low
61			Failure or leak from wastewater gathering line network, including from sabotage.	A.3 Surface activities mandatory requirements requirements A.3.8 Containment of Contaminants C.4.2 Management of produced water and flowback fluid C.7.2 Spill Management	• Selection and placement of gathering line easement(s) - co-location with access tracks. •Gathering lines are used, these will be designed, constructed and maintained in accordance with "Code of Practice for Upstream Polyethylene Gathering Network in the CSG Industry, Version 5", August 2019 (APGA 2019) • Gathering lines are located in remote areas with limited access, minimising the risk of sabotage • Gathering have a design life of in excess of 50 years •PE pipes shall be manufactured in accordance with AS/NZS 4130 and shall be thirdparty certified by a JAS-ANZ accredited certifier under the StandardsMark, GasMark or WaterMark schemes or equivalent. •pipes to be pressure tested/ hydrotested to confirm integrity. •Marking and product traceability shall be in accordance with the Standard. Appendix A of AS/NZS 4130 shall be used as the basis for demonstrating conformity. •Pipes for Gathering Networks shall be Series 1 conforming to AS/NZS 4130. A design, risk assessment and testing regime, inline with the PEGN code, will ensure suitable material selection and selection of facility overpressure protection equipment to reduce the probability of leaks to ALARP •aboveground gathering lines to be temporary (typically <12 months), with no transfers where fires or severe weather events are predicted • Identification and signage to prevent excavation damage • Emergency shutdown systems and response procedures to investigate and manage loss of containment. • Flowline / gathering networks will be fitted with manifolds and valves to isolate it into sections. Valves will be locked at all times unless attended by authorised personnel to prevent unintentional operation. •upon cessation of use/ suspension (triggered after 3 months of no use),gathering lines will be purged of any residual wastewater •Fuel loads within right of ways to be kept low to reduce fire risks. Overhanging trees that could fall on pipelines will be removed.	• Remote monitoring of pressure, flow and leaks on gathering networks (pressure and leak detection) • Remotely operated isolation valves on gathering networks • monthly gathering line inspections during continual operations or where batch transfer is proposed, before and during each batch transfer.	• emergency response and spill management plans enacted to respond to spills •Pumps located onsite to recover fluid and transfer into existing tanks, with spills and leaks to be cleaned up and rectified immediately •Earth moving equipment available regionally to clean up spills •Gathering network system will not be restarted until the leak is repaired and an investigation is carried out as to how the leak occurred and how it will be prevented from re-occurring •Emergency response plan implemented. • Any contamination event to be characterised and have remediation plans developed and executed in accordance with the process outlined in schedule A of the National Environmental Protection (Assessment of site Contamination) Measures (Engineering)	2	2	L	Yes	The risk of a flowline failure is minimised by being constructed to a relevant code, including material selection, certification and system design.Industry standard welding techniques and QA/QC protocols will be implemented to ensure compliance with the APGA code. Hydrotesting will be completed to confirm the integrity of the system and detect any leaks prior to commissioning.Leak detection will be implemented on the gathering line system with leaks able to be rapidly (instantaneously) detected. Telemetered valves will allow remote shut down of gathering lines should leaks be detected. Flowlines to be used for long term deployment will be buried.Any surface lines will be temporary and will be removed when not in use. Pipelines will not be used during periods of bushfire or extreme weather. Burying permanent flow lines ensures there is added protection against fire, flood, cyclonic winds, extreme temperatures and loading stress forces under a range of conditions. A spill management pan is in force to detect, prevent and respond to potential spills of wastewater and gas. If a failure was to occur, the wastewater would be restricted to the immediate vicinity of the gathering line.given the leak detection and remote shut in procedures- The potential leak rate is likely to be lower than 1000L which would mainly be restricted to within the gathering line right of way. The likelihood of such a consequence from occurring is considered highly unlikely (probability <10%) due to the multiple failsafe's installed on the gathering networks.The consequence is considered moderate, given the likely size of the spill.	Yes	Low
62			Personnel unauthorised access to sacred site.	A.4.1 Site selection and planning	•Restricted work areas are not located in close proximity to explorational activities (Elimination) •All staff to be inducted covering restricted work areas and cultural heritage (Administration) •Access off lease not permitted. (Elimination)	•Tamboran completes 6 monthly assurance programsto confirm access to sacred sites has not occurred.	• N/A- no access to sacred sites anticipated. (Elimination)	2	2	L	Yes	All sites of the proposed activity must have Traditional Owner clearance via the NLC. AAPA certificates are required for all activities to ensure sacred sites are not impacted by activities.The remote location of the activity, lack of sacred sites in the vicinity of the sites and contractual requirements prohibiting access reduce the likelihood down to "highly unlikely", with a probability lower than 10%.	Yes	Low
63			Sites disturbed directly by 2D seismic activities	A.4.1 Site selection and planning	•Exploration Agreements with Determined Traditional owners covering all proposed exploration activities. •All areas of the proposed activity to be cleared by NLC. (Elimination) •AAPA certificates for proposed work program have been granted (Elimination) •The location of seismic lines has considered proximity to sacred sites (Elimination) •Areas of cultural heritage to be avoided during the activity (Elimination) •Implementation of the unexpected finds protocol (Administration).	•Tamboran completes 6 monthly assurance programs to confirm access to sacred sites has not occurred.	•N/A- no access to sacred sites anticipated. (Elimination)	3	1	L	Yes	All sites of the proposed activity must have Traditional Owner clearance via the NLC. AAPA certificates are required for all activities to ensure sacred sites are not impacted by activities.The remote location of the activity, lack of sacred sites in the vicinity of the sites and contractual requirements prohibiting access reduce the likelihood down to "highly unlikely", with a probability lower than 10%.	Yes	Low
64			Accidental ignition during 2D seismic activities.	A 4.6 Fire management	•Bushfire management plan implemented to prevent and respond to bushfires- including establishment of communication and fire response protocols with pastoralists (Administration) •Bushfire awareness included in site inductions. (Administration) •Designated smoking areas on-site (Elimination) •Firefighting equipment to be available to deal with fires (Engineering). •Vehicles to be equipped with fire extinguishers. •Fire response to be implemented during seismic program, with spotters and fire trailers utilised to put out spot fires during work •Activities will comply with landholder and regional bushfire management plans. (Elimination) •Area in the vicinity of the seismic activity have had recent (within 1-2 years) fire activity, reducing the fuel load (Elimination)	•Annual fire preparedness assurance activities completed where activities are proposed during high fire risk periods (administration) •Daily monitoring of bushfires in the region during periods of high fire danger (administration) •Annual fire frequency mapping using the Northern Australia Fire Information fire history database (administration)	•Fire hazard reduction strategies (such as back burning) to be implemented to reduce the risk of fire ignition/ impact as required (Elimination) •Where a bushfire is started and cannot be controlled, Tamboran to engage with pastoralist to coordinate response activities	3	2	M	Yes	Fire is a common occurrence within the Barkly Region. A fire is likely to have a serious impact, with moderate term reversible impacts (years).With the appropriate controls, such as separation distances, firebreaks, and adherence to total fire bans, the likelihood of causing a fire from drilling, stimulation and well testing is anticipated to be highly unlikely, with a predicted occurrence of <10%.	Yes	Low
65			Contaminants in water and soil pass through the food chain and bioaccumulate in fauna (livestock and native animals) causing detrimental impacts to local species and communities that rely on the animals for food/ livelihood / spiritual connection.	A.4.7 Containment of Contaminants C.5.2 Management of produced water from petroleum wells C.8.2 Spill Management Plan	• Stakeholder engaging with NTH and community to provide descriptions of regulated activity and controls. •All chemicals stored in designated areas with secondary containment (Engineering) •Chemical risk assessments with no chemicals considered above low concern levels when used in accordance with standard procedures and controls (Elimination) •The site is earthen bunded to prevent offsite release of flowback.This is considered an additional level of containment, as the primary and secondary containment is the principle spill risk control. (Engineering) •Site earthen bunding will have a minimum bund wall height of 300mm capable of managing at least 110% of the largest wastewater tank volume. (Engineering) •The earthen bund will be constructed in a manner to withstand a tank failure scenario with appropriate compaction and stabilisation applied. (Engineering) •Wastewater evaporation to have drift controls to prevent drift of wastewater beyond the wastewater tank (engineering) •No offsite wastewater discharge (elimination) •Chemical mixing units and operating procedures designed to mitigated the formation of chemical airborne particulate matter (Engineering/ Administration) •Onsite burial of drilling waste can only occur where no material impacts to flora and fauna are anticipated (engineering) •Salt is the main hazard and does not bioaccumulate- UV and oxidation of organic compounds and metals in wastewater likely to degrade chemicals rapidly (within days)(Elimination) •Well pads fenced to prevent livestock accesses (engineering) •Sump fenced to prevent fauna access. (engineering) •Gathering lines designed, constructed, tested and operated in accordance with Code of Practice: Upstream Polyethylene Gathering Networks- CSG Industry, Version 5 (APGA 2019)	•Routine site weekly inspections to identify poor chemical handling or wastewater storage practices (engineering) •Monitoring of fauna interactionwith wastewater tanks and area surrounding the site (Administration) • monthly gathering line inspections •Gathering line leak detection used to identify leaks	•Where ongoing fauna interactions with wastewater or chemicals are identified through monitoring, additional controls shall be implemented as appropriate to reduce the potential for exposure (such as additional fencing, deterrents etc.) (Engineering) •All spills are to be cleaned up immediately, preventing the exposure to livestock and fauna	2	1	L	Yes	A chemical risk assessment and flowback characterisation program ensures all potential chemicals that are persistent, bio accumulative and toxic at high concentrations are identified and appropriate management strategies implemented. The risks associated with fauna ingestion of chemicals is well known and measures to prevent ingestion (such as fences and separation distances to activity) are deployed as standard practice. Tamboran has extensive operational experience in drilling and stimulating of conventional and unconventional petroleum wells with no evidence of impacts on biota from chemicals. Gathering lines will be designed, constructed, tested and operated in accordance with well accepted standards to prevent leaks and releases to the environment. Leak detection and routine inspections are utilised to identify leaks. Given the slime nature of wastewater, bioaccumulation is not considered likely based on the lack of palatability. Combined in the availability of habitat in the area which would-be impacted by a release/ spill- the risk is considered minor, with the likelihood remote.	Yes	Low
66			Personnel unauthorised access to sacred site during 2D seismic activities.	A.4.1 Site selection and planning	•Restricted work areas are not located in close proximity to explorational activities (Elimination) •All staff to be inducted covering restricted work areas and cultural heritage (Administration) •Access off lease not permitted. (Elimination)	•Tamboran completes 6 monthly assurance programsto confirm access to sacred sites has not occurred.	• N/A- no access to sacred sites anticipated. (Elimination)	2	2	L	Yes	All sites of the proposed activity must have Traditional Owner clearance via the NLC. AAPA certificates are required for all activities to ensure sacred sites are not impacted by activities.The remote location of the activity, lack of sacred sites in the vicinity of the sites and contractual requirements prohibiting access reduce the likelihood down to "highly unlikely", with a probability lower than 10%.	Yes	Low

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67	**Community and economy**	Loss of visual amenity, experience and sense of place for landholder, community members and tourists.	Industrialisation of landscape.	A.4.1 Site selection and planning A.4.1.1 Well pad specific site selection	•Existing location used to reduce footprint, with multi- well pads needed to minimise the impact of a future development (if feasible) •Site is located away from and, environmental and community receptors and not clearly visible: slight glow may be experienced during well testing (similar to a small town) (Elimination) •Level of clearing for infrastructure is small (Elimination) •Progressive rehabilitation to occur when sites are no longer required for future operations (engineering) •Activity intensity is restricted to specific periods, with most activity restricted to the well pad. •Workers are flown in and out of Daly waters from Darwin. Buses are used to limit vehicle transport movements between the Daly Waters airport and remote camps- there is limited Drive In/Drive Out workers into the Beetaloo- except where local or regional contractors are utilised. •Camps utilised to minimise impact on local accommodation and tourism. •2D seismic acquisition only occurs during daylight hours (Elimination) •Clearing for 2D seismic lines is minimal (Avoid)	•Ongoing community engagement to monitor performance and identify potential impacts from activity on local amenity.	•N/A- site location and activity intensity is unable to be changed.	1	1	L	Yes	The proposed explorational activities are located away from major transport routes, homesteads and communities. The consequences of activities may result in minor changes in to aesthetics through visibility of exploration activities (flare glows at night, presence of workers and vehicles).The probability that the activity will result in an industrialisation of the landscape is considered remote, with a probability less than 1%.	Yes	Low
68			Increased traffic.	A.4.1 Site selection and planning	•Traffic impact assessment completed assessing the increased traffic levels as negligible: reflective of limited size and scope of activity. •Traffic impacts are expected to small and temporary with rig located onsite or moved via internal road. •Access route is away from Copee Hill and Hayfields Homesteads. •Capacity of road and level of service will not be impacted materially. •Workers are flown in and out of Daly waters from Darwin. Busses are used to limit vehicle transport movements between the Daly Waters airport and remote camps- there is limited Drive In/Drive Out workers into the Beetaloo- except where local or regional contractors are utilised.	•Ongoing community engagement to monitor performance and identify potential impacts from activity on traffic.	•Complaints regarding traffic will be dealt through Tamboran's complaint resolution process.Where valid complaints are received, additional controls will be implemented to address community complaints (such as changes to vehicle load movements etc.)	2	1	L	Yes	The increased traffic from the activity is likely to be short term and within the Level of service of the existing roads.Increases in traffic are anticipated to have a "moderate" consequence (increase in traffic observable, but temporary). Traffic issues were not previously identified during the well drilling and stimulation campaigns for the existing wells and the increase in traffic is approximately 2%. The likelihood of causing a loss of experience from the E&A activities is considered"Highly unlikely", with an anticipated probability of less than 10%.	Yes	Low
69			Light emissions impact on community receptor (such as pastoralist)	A.4.1 Site selection and planning	•Sites are located awayfrom homesteads that may be visible during flaring. This is likely to be consistent with a small town and only visible during the night. (Elimination) •Flaring is of short duration, generally less than 90 days. (Elimination) No complaints received from flaring activities to date.	•Ongoing pastoralist engagement to monitor performance and identify potential impacts from activity on local amenity. (Administration)	•Complaints regarding light emissions will be dealt through Tamboran's complaint resolution process.Where valid complaints are received, additional controls will be implemented to address community complaints (such as shrouds,Changes to flare configuration etc.)	1	1	L	Yes	The remote location and separation distances between receptors is likely to result in minor light emissions. Light may be visible from activities (such as flaring), but will not be of sufficient intensity to cause any material impact to the health and wellbeing of community members.The likelihood of impacts is a function of separation distance and is therefore predicted to be remote, with a probability less than 1%.	Yes	Low
70			Influx of workers to region	N/A	•Work temporary in nature and uses existing regional contractors where available (Elimination) •Engagement with the pastoralists and directly affected community completed to communicate scope of work (administration) •Site camps utilised to minimise workers within local community (Elimination)	•Ongoing community engagement to monitor performance and identify potential impacts from activity on local communities.	•Complaints regarding work influx are unlikely and will be dealt through Tamboran's complaint resolution process.Where valid complaints are received, additional controls will be implemented to address community complaints.	2	1	L	Yes	The limited scope and duration of activities reduces the risk and uncertainty associated with risk.Most workers will be located away from communities, meaning there is unlikely to be a major increase in people.	Yes	Low
71			Noise emissions from activities.	A.4.1 Site selection and planning A.4.2 Noise	•Sites are away from homesteads. Noise impacts will not reach community receptors, with QLD experience on rig and stimulation noise indicating noise levels approaching background levels approximately <2 km from the activity. (Elimination) •No complaints received from flaring activities to date (Administration).	•Ongoing pastoralist engagement to monitor performance and identify potential impacts from activity on local amenity. (Administration)	•Complaints regarding noise emissions will be dealt through Tamboran's complaint resolution process.Where valid complaints are received, additional controls will be implemented to address community complaints (such as shrouds, changes to flare configuration etc.)	1	1	L	Yes	The remote location and separation distances between receptors is likely to result in "minor" noise impacts. The likelihood of impacts is a function of separation distance and is therefore predicted to be remote, with a probability less than 1%.	Yes	Low
72			Noise emissions and vibration from 2D seismic activities.	A.4.1 Site selection and planning A.4.2 Noise	•Seismic located >10 km from pastoralist homestead. •Noise impacts will not reach community receptors (Elimination) •During detonation, a short sharp thud will be heard, and potential small level vibration field within 1 km of charge going off.	•Ongoing pastoralist engagement to monitor performance and identify potential impacts from activity on local amenity. (Administration)	•Complaints regarding noise emissions will be dealt through Tamboran's complaint resolution process.	1	1	L	Yes	The remote location and separation distances between receptors is likely to result in "minor" noise impacts. The likelihood of impacts is a function of separation distance and is therefore predicted to be remote, with a probability less than 1%.	Yes	Low
73		Reduction in land productivity.	Introduction and spread of weeds in the area.	A.4.5 Weed management	•All equipment and vehicles to be washed-down and to have a Biosecurity Declaration Certificate prior to access to site (Elimination) •Areas of proposed exploration have been surveyed and are deemed to have low weed abundance (elimination) •Activity will be restricted to defined well pads and camp pads (Elimination)	•6 monthly monitoring implemented around infrastructure to detect the spread/ introduction of weed species (administration) •Tamboran assurance activities to target equipment wash-down certificates to ensure standards are being met. (Administration)	•Where weed outbreaks are identified associated with Tamboran's activities, infestations will be treated in accordance with the Weed Management Plan	2	3	M	Yes	The area in the vicinity of the sites is free of weeds. Weeds are present across the broader property. Any introduction of weeds is likely to result in localised impact, with weed management requirements likely to reduce the consequence down to "moderate, short term.Due to the inherent nature of weed prevention the risk likelihood is considered unlikely, witha probability less than <30%.	Yes	Low
74			Over extraction of groundwater.	A.4.1.1 Well pad specific site selection requirements B.4.17 Groundwater monitoring	•Groundwater extraction for activities to be restricted to the minimum water required. (Elimination) •Groundwater bores are metered for groundwater take. (Engineering) •All water take licenced in accordance with NT Water Act under Water Extraction Licence (WEL) GRF 10285 (Administration) •Drawdown from the activities and other users assessed by DEPWS as a part of WEL; impacts to closest receptor not anticipated (Administration/ Elimination) •Karst system is under allocated, with sufficient available capacity to support proposed water extraction requirements. (Elimination) •Closest receptor is >5 km from extraction point (Elimination)	•Continuous flow meters to monitor take and water balance implemented to ensure compliance with WEL (Administration) • Groundwater monitoring completed to identify impacts associated with water extraction (Engineering)	•Groundwater extraction to cease where sustained drawdown post pumping exceeds 1 m (Administration)	1	1	L	Yes	The extraction of groundwater for hydraulic fracturing activities requires all take to be licenced.The proposed take is assessed as a part of the licence application, with the assessment considering current and future water take levels.Based on this assessment, it was determined that the extraction rate would not impact upon adjacent users.The risk consequence is determined to be "serious"- given any impact is likely to cause pastoralist and broader community concern.The likelihood of such a consequence from occurring is considered remote (probability <1%) due to the quality of the Cambrian limestone aquifer, separation distance from surrounding users and under utilisation ofaquifer.	Yes	Low
75			Impact to surface hydrology changes water flows impacting the land use/productivity	A.4.3 Erosion and sediment control and hydrology A.4.1 Site selection and planning	•Well pad located away from watercourses and regional flow paths. (Elimination) •Well pads designed to divert stormwater around, without impeding natural surface water flows (Engineering) •gathering lines and access tracks not designed to impede water flow (elimination) •Stockpiled debris to be used to discourage water concentration, with vegetation establish on stockpiles to reduce exposed surfaces •Area is remote with closest watercourse being 450m away form Shenandoah N A and 12km from Shenandoah S C.. (Elimination) •The well site is flat, with water to be diverted around the perimeter of the site. (Elimination) •reinstated gathering lines to be monitored for subsidence/ poor vegetation cover and repaired promptly.	•Erosion and Sediment Control Plan in place with routine pre and post wet season inspection and maintenance (administration)	•Maintenance to be undertaken on erosion and sediment controls to ensure ongoing functionality and the controls are adequate (Engineering)	1	1	L	Yes	The existing well pad will be utilised for all activities, with no additional construction required.The existing well pad has been located outside the major regional flow paths and designed to divert stormwater around the infrastructure.The consequence is anticipated to be minor, with the likelihood remote (based on the site being existing).	Yes	Low
76			Bushfire from accidental ignition by site activities (civil works, drilling, flaring grinding) or personnel.	A 4.6 Fire management	•Bushfire management plan implemented to prevent and respond to bushfires- including establishment of communication and fire response protocols with pastoralists (Administration) •Bushfire awareness included in site inductions. (Administration) •Designated smoking areas on-site (Elimination) •Firefighting equipment to be available to deal with fires (Engineering). •Fire breaks will be installed around infrastructure (Engineering) •Minimum of 45 m separation distances between flares and surrounding vegetation (Engineering) •Ignition sources placed outside of the hazardous area. (Elimination) •Intrinsically safe equipment used in hazardous area. (Elimination) •Hazardous area drawing will provide classification of hazardous zones while drilling. (Elimination) •No flaring during periods of total fire ban (Elimination) •Activities will comply with landholder and regional bushfire management plans. (Elimination)	•Annual fire preparedness assurance activities completed where activities are proposed during high fire risk periods (administration) •Daily monitoring of bushfires in the region during periods of high fire danger (administration) •Annual fire frequency mapping using the Northern Australia Fire Information fire history database (administration)	•Fire hazard reduction strategies (such as back burning) to be implemented to reduce the risk of fire ignition/ impact as required (Elimination) •Where a bushfire is started and cannot be controlled, Tamboran to engage with pastoralist to coordinate response activities	3	2	M	Yes	Fire is a common occurrence within the Barkly Region. A fire is likely to have a serious impact, with moderate term reversible impacts (years).With the appropriate controls, such as separation distances, firebreaks, and adherence to total fire bans, the likelihood of causing a fire from drilling, stimulation and well testing is anticipated to be highly unlikely, with a predicted occurrence of <10%.	Yes	Low
77			Poor rehabilitation/ reinstatement of exploration infrastructure.	A.4.8 Rehabilitation	•A site specific Rehabilitation Plan has been developed and will be implemented progressively Engineering) •Areas will have infrastructure and wastes removed, sumps and pits backfilled, topsoil respread and vegetation re-introduced. (Engineering) •Rehabilitation timing will consider seasonal constraints, with rehab completed prior to the wet season to maximise revegetation chance (Engineering) • Reinstated gathering lines will be inspected 6 monthly to identify and repair any subsidence/ poor vegetation cover. •Gathering lines to be removed of contaminants and left insitu with all surface infrastructure removed to reduce potential risks of subsidence, erosion and poor vegetation re-establishment.	•Rehabilitation monitoring to be undertaken to track rehabilitation progress (Administration)	•Maintenance will be undertaken periodically to fix any defects (Engineering)	2	2	L	Yes	Rehabilitation success will be determined through the timing of rehabilitation, with rehab activities undertaken before the wet season to maximise success.Ongoing monitoring and maintenance of rehabilitated areas will be critical to identify and repair areas where rehabilitated success is poor,Consequences are likely to be moderate, with impacts likely to have moderate, locally restricted and medium to long term (1-5 years).The likelihood is influenced by the requirement for security provisions, rehabilitation plan requirements and Code conditions.The likelihood is anticipated to be highly unlikely, with a probability below 10%.	Yes	Low
78			Loss of sense of place and connection to land	A.4.1 Site selection and planning A.4.3 Erosion and sediment control and hydrology A.4.8 Rehabilitation	• All exploration activities are undertaken under Exploration agreements with Native Title holders (administration) • Exploration agreements have specific environmental and reporting requirements • Native title holders receive royalties and employment from exploration activities • On country meetings held to discuss activities, risk and controls • Site inspections held with Native Title Holders to inspect activities • Cultural managers used or perform sacred site clearances and heritage surveys to identify features required to be protected. • Cultural managers used for pre-clearance surveys and during groundwater monitoring	•Routine meetings are held with Native Title Holders to discuss activities, with any concerns raised responded to.	•Complaints regarding Tamboran's activities will be dealt through Tamboran's complaint resolution process.Where complaints are received, Tamboran will investigate and work with the party to attempt to come to a amicable resolution.	2	1	L	Yes	Exploration Agreements under the Native title Act are required to be in force covering all exploration activities. These dictate ongoing engagement and consent processes with Native title holders.Tamboran provides information on their proposed activities, including the avoidance of impacts and risk mitigation strategies .The Code of practice outlines extensive controls which fundamentally protect the environment and therefore the interests of Native Title holders.		
79			Disruption of agricultural operations due to ongoing access, traffic, helicopter movements, gathering lines locations etc.	A.4.1 Site selection and planning A.4.2 Noise	•All activities require engagement with pastoralists (Administration) •Well site has been located to avoid disruption to agriculture operations and infrastructure. (Elimination) •Engagement will be undertaken in accordance with NT Petroleum (Environment) Regulations (Administration) •Traffic levels are anticipated to be small- as per Traffic Impact Assessment,(Elimination) •Helicopter movements to be restricted to wet season when landholder activities are minimal (Elimination) •Helicopter movements to be undertaken in consultation with leaseholder to avoid impacts to livestock, cattle yards, watering points, homesteads and other sensitive areas as advised by leaseholder. (Elimination) •2D seismic activities are of a limited size and scope of the activity (e.g. 10 vehicles for 30 - 45 days). •Detonation of explosives within limited area, with engagement with pastoralists undertaken to ensure activities do not impact on pastoral operations. •Gathering lines located below 750mm with no deep ripping or intensive agriculture in the area.	•Ongoing pastoralist engagement to monitor performance and identify potential impacts from activity on local amenity. (Administration)	•Complaints regarding Tamboran's activities will be dealt through Tamboran's complaint resolution process.Where complaints are received, Tamboran will investigate if additional controls are needed and implement to address the complaint (such as shrouds,Changes to flare configuration etc.) (administration/engineering)	1	1	L	Yes	Tamboran has extensive experience in co-existing its activities with agricultural users. Consultation with pastoralists is undertaken to ensure impacts on their activities are mitigated.These impacts are addressed in the compensation agreements and access guidelines. It is noted that there is an impact on stakeholder in regards to working with proponents to plan E&A activities.this is unavoidable and required to ensure the activities can be designed to accommodate the activities of both parties.Consequences are anticipated to be minor for E&A activities, with the likelihood unlikely. The likelihood is reduced through compensation agreements which consider the pastoralist time when negotiating agreements.	Yes	Low

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80		Safety hazard to pastoralists, community (including native title holders) and tourists from activity	Unexploded ordinance impacts future pastoralist and native title holder activity	N/A	• The seismic charges are installed between 15-20m below ground- with no interaction with community members, pastoralists or native title holders. •All activities require engagement with pastoralists (Administration) •Activities are located away from the main pastoralist areas, with low likelihood of activity occurring in the region over the foreseeable future. • Should a seismic charge misfire, then a second charge will be detonated within 2m to instigate a sympathetic detonation or at least damage the explosive to speed up the bioremediation process. • The explosives are manufactured with freeze dried microorganisms which are activated when wet.These are likely to be activated in the wet season and will result in the bioremediation of any unexploded ordinance reducing the future hazard. • Where sympathetic detonation not be confirmed, a steel marker shall be erected to identfiy the locatoon of the potentially undetonated charge. • Records of suspended undetonated charges to be provided to pastoralists and DEPWS.	Records of misfires and the success of sympathetic detonations will be retained. (administration)	Should excessive misfires be recorded, the program will be stopped to review the root cause and implement corrective actions.	1	1	L	Yes	The use of explosive charged for seismic activities is a standard practice and is considered best practice in jurisdictions such as NZ to minimise land disturbance . The risk of unexploded ordinance to the safety of the community is considered low based on the consequence being minor and likelihood being remote.this is driven by the location of the dynamite (10-15m below ground level, the lack of future activity in the area, the use of sympathetic discharge and the microbial degradation of the explosive.	Yes	Low
81			Gathering line fire/explosion caused by bushfire	A 4.6 Fire management	• Gathering lines located in signed right of ways to identify ignition hazard • right of ways to be free of woody vegetation to reduce fuel load accumulation •Gathering lines not operated within 12 hours of a predicted fire • surface pipework's to be temporary •Permanent pipework to be buried •Gathering liens not to be located within 2km of sensitive receptors, like a house or community •HPV, valve pits and LPD's to be located in concrete rings as protection. • No gathering lines within 1km of a watercourse or stream • Th removal of surface pipelines where a local fire is present will be prioritised, subject to response prioritisation (i.e. there may be other higher priority action items such as the protection of people and community)	•Gathering lines to be inspected post fire or significant rainfall event prior to commencement of fluid transfer. •Monthly inspection for buried gathering lines, weekly for surface lines.	• All gathering lines to be rectified once any defect is identified. • All spills cleaned dup and reported a per spill management plan • Emergency response plan •Isolation valves located to isolate pipework.	1	2	L	Yes	10'000's of Km's of gathering lines have been operating in Queensland with impacts associated with fire rare. Management of woody vegetation and fuel loads reduces risk of fire, with LPD/HPV and valve pits the most exposed pieces of infrastructure.These are protected with concrete pipe rings. As gathering lines will not be operated during fire/ extreme weather, permanent lines are buried and the right of ways will be essentially a fire break, the impact is likely to be localised (restricted to a HPV/LPD) and minor in nature.the likelihood is considered Very unlikely based on QLD operational experience.	Yes	Low
82			Increased risk of vehicle accident	A.4.1 Site selection and Planning	•Traffic impact assessment completed, with traffic levels are anticipated to be small (Elimination) •Fatigue management policy implemented for transport companies, with breaks required every two hours (Administration) •Alcohol and drug policy implemented with zero tolerance (0.00% BAC and no illicit substances) (Elimination) •Workers are flown in and out of Daly waters from Darwin. Busses are used to limit vehicle transport movements between the Daly Waters airport and remote camps- there is limited Drive In/Drive Out workers into the Beetaloo- except where local or regional contractors are utilised. (Elimination) •The camp is located away from major roads with most movements internal between camp lease and drill site (Elimination) •Stuart Highway intersection design approved by DIPL with appreciate line of site provided for vehicles to identify turning vehicles. (Engineering)	•Ongoing community engagement to monitor performance and identify potential impacts from activity on local amenity. (Administration)	•Complaints regarding Tamboran's activities will be dealt through Tamboran's complaint resolution process.Where valid complaints are received, additional controls will be implemented to address community complaint (Administration)	3	1	L	Yes	E&A activities will increase traffic levels up to 44 vehicles per day during the peak.This traffic volume is well below the Level of Service for the highway, which is estimated to be above 1100 vehicles per hour. Accidents from truck turning into access tracks or from general vehicle accidents are anticipated to have a seriousconsequence, with an injury to community members/ tourist requiring hospitalisation.Smaller volumes of traffic are required for Beetaloo, combined with the lack of road users, traffic management plan for all access track turn ins, zero tolerance for alcohol and drugs and use of trained drivers, the likelihood is considered Remote, with a probability less than 1%.	Yes	Low
83		Labour competition with local businesses and agricultural procedures.	Exploration activities compete with agricultural industry for resources.	N./A	•Proposed activity is temporary with no major labour requirements- stakeholders engaged to ensure they know the temporal nature of work (Administration) •Local and regional contractors will be utilised where available (Elimination) •All work to be short-term with predominantly skilled workforce sourced regionally/interstate. •Contracts will be structured to reduce 'boom and bust' cycle (clear understanding of limited scope of work).	•Ongoing community engagement to monitor performance and identify potential impacts from activity on local amenity. (Administration)	•Complaints regarding Tamboran's activities will be dealt through Tamboran's complaint resolution process.Where valid complaints are received, additional controls will be implemented to address community complaint (Administration)	1	1	L	Yes	Labour competition is a consequence that may occur in a full scale shale development and is not anticipated to have a major impact during exploration.Exploration activities are generally short term campaigns and are completed similar to most small infrastructure projects (such as road upgrades). Local contractors are to be used where available, with a priority on using Traditional Owner businesses.The consequence of labour competition during E&A is minor, with a likelihood of remote (<1% probability).	Yes	Low
84	**Air quality**	Reduction in air quality associated with exploration emissions (Civil, Drilling, Stimulating and Well Testing).	Emissions from the combustion of diesel.	A.4.1 Site selection and planning D.5.1 Baseline assessment	•Low emission equipment to be utilised (Engineering) •All equipment to be maintained in accordance with the manufacturer's recommendations (Engineering) • Flares onsite to combust hydrocarbons (Engineering) •No environmental or community receptors within 8 km (Elimination)	•Equipment condition and maintenance to be built into contract (Administration) •Routine site inspections and assurance undertaken to ensure equipment is maintained and operated as per manufacturers requirements. (Engineering)	•All equipment defects identified by site inspection and assurances to be rectified promptly.(Engineering)	1	1	L	Yes	Impacts to environmental or community receptors are not anticipated, with the closest receptor at least 8 km away.Flares will be utilised to minimise the release of VOC's.The potential consequence from E&A activities is predicted to be minor.The likelihood is a function of source (lack of) and separation distance between the activity and receptors. The likelihood of a receptor being exposed to emissions from E&A activities above the NEPM guidelines are remote (<1%).	Yes	Low
85			Air emissions from gas and condensate flaring.	A.4.1 Site selection and planning D.5.1 Baseline assessment B.4.13 Hydraulic Stimulation and flowback operations D.5.8 Venting and flaring	•Flares have been designed and will be operated in compliance with the US EPA 40 CFR § 63.18 to achieve a 98% combustion efficiency (Engineering) •Emissions of NOx, CO and TVOC are small and not anticipated to reduce ambient air quality as there are no regional sources (Elimination) •Vertical flare stack used for gas- maximising dispersion.(Engineering) •Flares to be designed and operated to minimise smoking (Engineering) •Site located away from receptors (Elimination) •No environmental or community receptors within 8 km (Elimination)	•Flares will be inspected as a part of weekly routine site inspection to rectify any excessive smoke production from flares (noting condensate flaring may produce small quantities of ongoing smoke due to the higher molecular weight of the hydrocarbons). (Administration)	•Where excessive smoking of flares is identified, the flare operating status will be reviewed and optimise to reduce particulate generation (Engineering)	1	2	L	Yes	Risks associated with emissions from flares are well known within literature, and Australia and International policy/standards exist (such as NGERS and various US EPA technical guidance notes). The location of the activity is likely to limit the potential exposure to receptors, with consequences likely to beminor, localised and short term (days base on wind direction and atmospheric boundary conditions).The likelihood is predominantly reduced through the separation distance between the activity and receptors, with a likelihood of remote (<1% predicted).	Yes	Low
86			Air emissions from chemical releases during drilling and stimulation activities.	A.4.1 Site selection and planning B.4.16 Well site layout and housekeeping b.4.13 Hydraulic Stimulation and flowback operations	•National Occupational Health and Safety Codes: Code of Practice for the Control of Workplace Hazardous Substances. (Administration) •Chemical Risk Assessment completed on all chemicals used for stimulation (Elimination/Administration) •Chemical handling and mixing practices to reduce particulate emissions. (Engineering) •No environmental or community receptors within 8 km (Elimination)	•Routine site inspections and assurance undertaken to ensure ongoing chemical handling and mixing practices do not result in an offsite release of substances (Administration)	•Corrective actions implemented to address poor chemical handling and mixing practices. (Engineering)	1	1	L	Yes	Risks associated with air emissions from petroleum activities are well known, with various risk assessment and emissions estimation technical guidance notes available within Australia and internationally (such as the National Pollutant Inventory and the US EPA).Due to overriding occupational health safety requirements to limit worker exposure and lack of local receptors, the consequence is anticipated to be minor.The likelihood is reduced to remote, given the large separation distances between the activity and closest receptors.	Yes	Low
87		Reduction in air quality associated with 2D seismic activities	Emissions from the combustion of diesel, detonation of charges and dust from clearing.	A.4.1 Site selection and planning D.5.1 Baseline assessment	•Low emission equipment to be used where practicable (Engineering) •All equipment to be maintained in accordance with the manufacturer's recommendations (Engineering) •No environmental or community receptors within 8 km (Elimination) •Short term activity (e.g. 10 vehicles for 30 - 45 days)	•Equipment condition and maintenance to be built into contract (Administration) •Routine site inspections and assurance undertaken to ensure equipment is maintained and operated as per manufacturers requirements. (Engineering)	•All equipment defects identified by site inspection and assurances to be rectified promptly.(Engineering)	1	1	L	Yes	Impacts to environmental or community receptors are not anticipated, with the closest receptor at least 8 km away.Flares will be utilised to minimise the release of VOC's.The potential consequence from E&A activities is predicted to be minor. The likelihood is a function of source (lack of) and separation distance between receptors. The likelihood of a receptor being exposed to emissions from E&A activities above the NEPM guidelines are remote (<1%).	Yes	Low
88		Increased nuisance from dust andparticulate emissions associated with exploration activities caused impacts to regional ecosystems and fauna	Civil activities, drilling operations, well testing and 2D seismic activities.	A.4.1 Site selection and planning	•Water trucks will be used to decrease dust emissions. (Engineering) •Roads maintained to prevent bull dust generation (Engineering) •No environmental or community receptors within 8 km (Elimination)	•Routine site inspections and assurance undertaken to identify and rectify high dust emissions (Administration)	•Dust control to be implemented whereunacceptable dust from transport activities occur (Engineering)	1	5	M	Yes	Dust will be generated through transport movements along access tracks and around well pads.The consequence of dust is anticipated to be moderate, with localised, short term impacts to areas immediately adjacent to access tracks.The likelihood of the risk is reduced through the isolated location (lack of environmental or community receptors), regionally extensive vegetation communities (good outside refuge away from access tracks and use of dust suppression.As dust generation has been observed, and is commonly associated with dirt tracks, the likelihood of an impact is considered likely.	Yes	Low
89			Bushfire from accidental ignition by site activities (civil works, drilling, flaring, grinding), during 2D seismic clearing or by personnel.	A 4.6 Fire management	•Bushfire management plan implemented to prevent and respond to bushfires- including establishment of communication and fire response protocols with pastoralists (Administration) •Bushfire awareness included in site inductions. (Administration) •Designated smoking areas on-site (Elimination) •Firefighting equipment to be available to deal with fires (Engineering). •Fire breaks will be installed around infrastructure(Engineering) •Minimum of 45 m separation distances between flares and surrounding vegetation (Engineering) •Ignition sources placed outside of the hazardous area. (Elimination) •Intrinsically safe equipment used in hazardous area. (Elimination) •Hazardous area drawing will provide classification of hazardous zones while drilling. (Elimination) •No flaring during periods of total fire ban (Elimination) •Activities will comply with landholder and regional bushfire management plans. (Elimination) •Vehicles to be equipped with fire extinguishers. •Fire response to be implemented during 2D seismic program, with spotters and fire trailers utilised to put out spot fires during work •Activities will comply with landholder and regional bushfire management plans. (Elimination	•Annual fire preparedness assurance activities completed where activities are proposed during high fire risk periods (administration) •Daily monitoring of bushfires in the region during periods of high fire danger (administration) •Annual fire frequency mapping using the Northern Australia Fire Information fire history database (administration)	•Fire hazard reduction strategies (such as back burning) to be implemented to reduce the risk of fire ignition/ impact as required (Elimination) •Where a bushfire is started and cannot be controlled, Tamboran to engage with pastoralist to coordinate response activities (Administration/ engineering)	3	2	M	Yes	Fire is a common occurrence within the Barkly Region. A fire is likely to have a serious impact, with moderate term reversible impacts (years).With the appropriate controls, such as separation distances, firebreaks, and adherence to total fire bans, the likelihood of causing a fire from drilling, stimulation and well testing is anticipated to be highly unlikely, with a predicted occurrence of <10%.	Yes	Low
90	**Atmospheric processes**	Greenhouse Gas emissions from the activity have a direct and measurable adverse impact on climate	Combustion of diesel for all exploration activities, including 2D seismic.	A.4.1 Site selection and planning	•Australian emission standards for equipment ensures minimum operating efficiency (Engineering) •All equipment to be maintained in accordance with the manufacturer's recommendations (Engineering) •No environmental or community receptors within 8 km (Elimination)	•Equipment condition and maintenance to be built into contract (Administration) •Routine site inspections and assurance undertaken to ensure equipment is maintained and operated as per manufacturers requirements. (Engineering)	•All equipment defects identified by site inspection and assurances to be rectified promptly.(Engineering)	2	1	L	Yes	The risks associated with Greenhouse Gas generation through diesel combustion are well documented in literature and domestic/international greenhouse policy (such as NGERS and IPCC). The consequences of GHG generation from exploration activities is moderate, with less than 1% of the NT emissions generated. The likelihood of the level of GHG production being unsustainable is considered remote, with a probability less than 1%.	Yes	Low

Ref	Environmental Factor	Risk scenario description	Risk Source	Code of Practice (the Code)	Risk mitigation Measures			Residual Risk Rating			ALARP criteria achieved?	Residual risk ALARP and Acceptable Statement	Acceptable criteria achieved?	Scientific Uncertainty Ranking
					Prevent	Detect	Recover	Consequence	Likelihood	Risk Rating				
91			Flaring of gas and condensate during well testing.	B.4.13 Hydraulic Stimulation and flowback operations D.5.8 Venting and flaring	•Venting to be minimised with all venting reported under NGERS. •Flares have been designed and will be operated in compliance with the US EPA 40 CFR § 63.18 to achieve a 98% combustion efficiency. •Emissions from source rock during drilling are negligible. •Condensate will be flare and/or transported offsite for sale if permissible. •Total worst case emissions from activity are not significant- being~1.3% of NT's Total GHG emissions and 0.05% of Australia's GHG emissions	•Flares will be inspected as a part of weekly routine site inspection to rectify any excessive smoke production from flares (noting condensate flaring may produce small quantities of ongoing smoke due to the higher molecular weight of the hydrocarbons). (Administration)	•Where excessive smoking of flares is identified, the flare operating status will be reviewed and optimise to reduce particulate generation (Engineering)	2	2	L	Yes	The risks associated with Greenhouse Gas generation through diesel combustion are well documented in literature and domestic/international greenhouse policy (such as NGERS and IPCC). The consequences of GHG generation from exploration activities is moderate, with less than 1% of the NT emissions generated. The likelihood of the level of GHG production being unsustainable is considered remote, with a probability less than 1%.The well testing will also allow for natural gas to be used as a transition fuel.	Yes	Low
92			Uncontrolled release of gas encountered during drilling, stimulation, barrier failure, operator error or vehicle collision under a multi-well scenario	B.4.1 Well integrity management B.4.3 Well design and barriers B.4.13 Hydraulic Stimulation and flow back operations D.5.8 Venting and flaring	•Drilling overbalanced to reduce the inflows of hydrocarbons (Engineering) •Blow out prevention in place to manage well failure and uncontrolled gas influxes (Engineering) •Blow out preventor pressure rating and testing •All equipment will be API compliant to handle expected conditions (Engineering) •Site manned during operation (Administration) •Well suspended with multiple cement and casing barriers in place- with 4 casing section utilised (conductor, surface, intermediate and production).(Engineering) •Barricading to be used to protect each exploration well from vehicle collision during multi-well drilling activities. (Engineering)	•Process monitoring to detect events that could potentially result in a uncontrolled release of gas (such as fluid balances, well head pressure etc.) (Engineering) •Routine (monthly) well inspections (Administration	•An emergency as diverter and flare to be used during drilling to manage gas ingress (Engineering) •Contracts in place with emergency well intervention specialists (such as Boots and Cootes) (administration) •Emergency response plan implemented (administration)	2	2	L	Yes	The Code and standard drilling, stimulation and well testing safety controls are designed to prevent the uncontrolled release of hydrocarbons.Flares are used during drilling and well testing to manage any encountered hydrocarbons The consequence are anticipated to be moderate, with impacts likely to be moderate, restricted in duration (minutes to hours).The likelihood is considered highly unlikely with a occurrence probability less than 10%, based on the well designed, construction and operations requirements mandated by the Code.	Yes	Low
93			Uncontrolled release of gas from well due to sabotage.	D.5.8 Venting and flaring	•Multiple barriers used during well suspension/operation- including downhole suspension plugs, suspension fluid and surface valves (Engineering) •Sites manned during operation (Administration) •Security cameras located on sites (Engineering) •Sites locked (Engineering) •Valves locked (Engineering)	•Routine (monthly) well inspections (Engineering)	•Contracts in place with emergency well intervention specialists (such as Boots and Cootes) Administration) •Emergency response plan implemented(Administration)	2	2	L	Yes	The risks associated with Greenhouse Gas generation through well sabotage is anticipated to be moderate, with impacts likely to be restricted in duration (hours to days). The likelihood is considered remote (probability <1%), with the site remoted and multiple valves locked on the well to prevent tampering.	Yes	Low
94			Leak of gas from wells and/or gathering line	B.4.1 Well integrity management B.4.3 Well design and barriers D.5.4 Emission detection and management D.5.5 Leak remediation and notification	•Well design considers multiple (4) specifically-engineered cement and steel casing barriers in place between hydrocarbon-bearing zone and surface.This includes conductor casing, surface casing, intermediate casing and production casing intervals (Engineering) • Well design and Well Barrier Integrity Validation reports submitted to DITT as part of Well Operations Management Plan (WOMP). (Administration/ engineering) •Wells constructed and suspended with barriers in place and verified as per governing code (engineering) •Limited gas production time only to extended production test.(Elimination)	•Routine 6 monthly well leak detection (Engineering) •Routine (monthly) well inspections (Administration)	•Any leaking wells to be reported and remediated at a frequency consistent with the Code depending on severity(Engineering)	1	2	L	Yes	The consequence of a well leak are anticipated to be minor with impacts likely to be small (<1000L/hour) and restricted in duration (days to weeks).The likelihood is considered highly unlikely with a occurrence probability less than 10%, based on the well designed, construction and operations requirements mandated by the Code.Leak detection and reporting requirements are also controls to ensure any leaks are promptly identified and fixed.	Yes	Low
95	Cumulative risk	Cumulative impacts on groundwater quantity.	Groundwater take from surrounding land users exceeds the natural recharge rate of the Basin.	Water extraction licences under the NT Water Act	•Groundwater take authorised under a Water Allocation Plan which considers cumulative current and future groundwater users (Elimination) • Petroleum allocation of WAP is 8,000GL/year- 4% of total allocation. •Water Extraction Licence value of 450ML/year is 0.001% of total available resource The total quantity of • existing petroleum activity groundwater extraction licences for the region is 752.5 ML/year. •Cumulative impacts considered in the water extraction licence under the NT Water Act. (Elimination) •Groundwater extraction volumes are monitored and kept below WEL (Elimination) •Strategic Regional Environmental Baseline Assessment (SREBA) completed to collected baseline environmental data, with Environmental Impact Assessments completed to address cumulative impacts from industry (Administration/ Engineering/ elimination)	•Groundwater monitoring of control and impactmonitoring bores will detect localised groundwater depressurisation before regional impacts occur (Engineering)	•Where sustained groundwater depletion is observed in regional aquifers, alternative water supplies may be required, such as deeper aquifers with limited extraction (Elimination) •Water Act make good provisions to ensure any impacts on users from exploration activities are "made good"	2	1	L	Yes	The regional understanding of the CLA is sufficient to understand the risks associated with groundwater extraction. The absence of users and small exploration take reduces the uncertainty of the activity.This risk has been assessed as a part of the WEL application and approval.Due to the lack of receptors, the consequence is considered moderate (i.e. 1 user within 16km) and likelihood remote (probability less than 1%.	Yes	Low
96		Cumulative impacts on terrestrial ecology.	Impacts from exploration activities and existing agricultural activities results in impacts to vegetation communities, fragmentation and poses a threat to protected flora and fauna.	A.4.1 Site selection and planning A.4.1.1 Well pad specific site selection A.4.4 Biodiversity Protection	•Area has limited development with no widespread land clearing or other pressures from agriculture or other users. (Elimination) •Petroleum activity is limited in scale (0.0227% of total area) and will not material decrease availability of habitat across the region (Elimination) • Cumulative clearing impact from petroleum exploration order of magnitude lower than existing land users (~900 hectares versus ~26,000 ha) • Proposed sites are located in close proximity to existing access track to minimise amount of disturbance and habitat fragmentation (Elimination) •Low disturbance seismic proposed, with avoidance of land clearing prioritised to minimise disturbance and habitat fragmentation. •Strategic Regional Environmental Baseline Assessment (SREBA) completed to collected baseline environmental data, with Environmental Impact Assessments completed to address cumulative impacts from industry (Administration/ Engineering/ Elimination)	•Ongoing scouting and infrastructure design will be undertaken to ensure scope creep doesn't result in increased habitat fragmentation	•All disturbance to be rehabilitated to pre-existing levels.	2	1	L	Yes	The region has low land clearing pressure with no applications for large scale land clearing present. The level of disturbance proposed is small, with field ecological scouting confirming ecological communities present.	Yes	Low
97		Cumulative impacts on amenity.	Exploration activities further reduces amenity (visual, noise, traffic and lighting) through additional landscape modification, dust, noise, light and traffic.	A.4.1 Site selection and planning A.4.1.1 Well pad specific site selection	• Well sites are located in a remote/rural landscape, away from environmental and community receptors (Elimination) •Rig equipment located onsite/ within the adjacent property (Elimination) • Cumulative clearing impact from petroleum exploration order of magnitude lower than existing land users (~900 hectares versus ~26,000 ha) •Flaring may create a visible hue on the horizon consistent with that of a small town. impact will be temporary •Additional traffic volumes are anticipated to be small (44 additional vehicles during peak mobilisation) ,well below existing industries and will not impact on the level of service of the Stuart Highway. (Elimination) •A Traffic Management Plan covering the intersection upgrade work will be submitted to DPIL for approval prior to the commencement of works . (Elimination) •Low level of development activity within the region, with activity unlikely to cause declines in amenity. (Elimination)	•Community complaints regarding nuisance (including dust, traffic etc.) to be used to detect cumulative impacts (Administration)	•Complaints are to be investigated and additional controls implemented where appropriate. (Administration/ engineering)	1	2	L	Yes	The region is underdeveloped with the activity located away from major transportation routes, homesteads and communities. The activity is of a small size and unlikely to result in any loss of amenity. Any loss of amenity is therefore likely to be minor, with a likelihood of highly unlikely.	Yes	Low
98		Cumulative impacts on surface water quality.	Exploration activities in addition to existing surrounding land use (agriculture) reduces surface water quality.	A.4.1 Site selection and planning A.4.1.1 Well pad specific site selection A.4.3 Erosion and sediment control and hydrology	•No surface water take or wastewater releases permitted with controls in place to mitigate spills and offsite releases. (Elimination) •Area has limited development with no widespread land clearing pressures from agriculture or other users likely to reduce water quality. (Elimination) •Land clearing practices and erosion and sediment controls ensure impacts to surface water from sediment and changes in hydrology are reduced to ALARP. •Avoid traversing vehicles (access tracks, seismic) or establishing well pads on Palustrine Systems (depressions) or Flood Plain Systems where possible (Elimination). Where unavoidable, Tamboran to implement additional controls to ensure any impacts are of short duration and reversable. A Permit to Interfere with a Waterway under the Water Act 1992 would be obtained from DEPWS Water Resources as required (Administration/Engineering). It is noted that the regulated activities will either not cause a material change or alteration (Not Material) or occur generally in lower stream order 1 or 2 (Low). •No surface water take or wastewater releases permitted. (Elimination) •Strategic Regional Environmental Baseline Assessment (SREBA) completed to collect baseline environmental data, with Environmental Impact Assessments completed to address cumulative impacts from industry (Administration/ Engineering/ Elimination) •Strategic Regional Environmental Baseline assessment completed (Administration)	N/A- no increased impact o surface waters anticipated	N/A- no increased impact to surface waters anticipated	1	1	L	Yes	The region is underdeveloped with the activity located away from major flow pathways with limited topographic variation.. The activity is of a small size and unlikely to result in any material increase in sediment loads to surface waters.	Yes	Low
99		Cumulative impacts- greenhouse gas emissions from the Beetaloo have a direct and measurable adverse impact on climate	The release of GHG emissions during exploration activities materially increase Northern Territory's and Australia Greenhouse Gas emissions increasing climate change impacts on the environment	B.4.1 Well integrity management B.4.3 Well design and barriers B.4.13 Hydraulic Stimulation and flow back operations D.5.8 Venting and flaring	•Total greenhouse gas emissions for the Beetaloo Sub-basin are low compared to the total NT and Broader Australia Greenhouse gas emissions. •The percentage of total NT and Australian GHG emissions is estimated at 1.35% and 0.04% respectively. •Climate change is a global issue resulting from a culmination of human activities and natural processes across the planet. This activity will not cause climate change, but will contribute to the carbon budget of the atmosphere. •Management of climate related impacts are required at a national and internal level.Tamboran will abate a % of residual GHG emissions in alignment with the NT net zero by 2050 trajectory. For example, emission offsets will increase year on year by 3.7%based on a baseline FY of 2023 to achieve net zero by 2050 •All emissions over 100KTCO2 to be offset using ACCU's in accordance withthe NGERS Safeguard Mechanisms •Activities required to prove up natural gas resources, with all available technology used to reduced emission intensity of exploration activities •Flaring required to mitigate emissions from the activity versus venting (Engineering) •Full development (if technically and commercially viable) likely to provide a viable transition fuel with up to 50% emissions of coal (Engineering) •Full development to be scope 1 neutral •Strategic Regional Environmental Baseline Assessment (SREBA) completed , with an Environmental Impact Assessment completed to address cumulative impacts from industry (Administration/ Engineering/ elimination)	N/A- Greenhouse gas emissions are approved prior to commencement of activity	N/A- Greenhouse gas emissions are approved prior to commencement of activity	1	1	L	Yes	Tamboran has aligned its emission reductions strategies in accordance with the NT code or Practice, NT Large Emitters policy, Tn net zero objective and Commonwealth NGERS safeguard mechanism emission requirements. The role natural gas plays as a low carbon intensitytransition fuel to support renewable energy use is well known. Broad adoption of natural gas within the US has replaced coal in energy production and has been responsible for a continued decline in carbon emissions. The use of natural gas is one of the lowest carbon intensity fuels required to reduce carbon emissions int eh near term, with wide recognition of the importance of ensuring energy security during the energy transition..	Yes	Low