EMP IMP3-4 Imperial O&G 2021 Carpentaria 1 Program Appendices

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01.02– Groundwater Investigation

01.02.1 Summary of monitoring bore sampling

Imperial has supplied DEPWS with six months of local baseline data for water quality indicators as part of the Drilling EMP activities, in line with Table 7 of the Code, and the required analyte testing from the Preliminary Guideline: Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-basin. A summary of the sampling results is shown in Table 1.

Table 1: Baseline Water sampling results summary

Analyte grouping/Analyte	Units	LOR	RN027848				RN039574			
			AVERAGE	25%ILE	75%ILE	Outlier	AVERAGE	25%ILE	75%ILE	Outlier
pH Value	pH Unit	0.01	7.22	7.14	7.3	7.54	7.25	7.18	7.31	7.505
Electrical Conductivity @ 25Â°C	µS/cm	1	1120	1090	1130	1190	1029.86	1010	1040	1085
Chloride	mg/L	1	56.28571	54	59	66.5	47.14	46	49	53.5
Arsenic	mg/L	0.001	<0.001				<0.001			
Mercury	mg/L	0.0001	<0.0001				<0.0001			
Gross alpha	Bq/L	0.05	0.21	0.2	0.22	0.25	0.20	0.2	0.23	0.275
Gross beta activity - 40K	Bq/L	0.1	<0.10				<0.10			
Total Dissolved Solids @180Â°C	mg/L	10	684.29	649	740	876.5	630.57	584	626	689
Suspended Solids (SS)	mg/L	1	<5				<5			
Hydroxide Alkalinity as CaCO3	mg/L	1	<1				<1			
Carbonate Alkalinity as CaCO3	mg/L	1	<1				<1			
Bicarbonate Alkalinity as CaCO3	mg/L	1	7	467	481	502	463	454	480	519
Total Alkalinity as CaCO3	mg/L	1	7	467	481	502	463	454	480	519
Sulfate as SO4 - Turbidimetric	mg/L	1	7	93	111	138	68.86	64	70	79
Calcium	mg/L	1	7	113	126	145.5	107.86	102	114	132
Magnesium	mg/L	1	7	48	53	60.5	48.29	45	51	60
Sodium	mg/L	1	7	41	46	53.5	34.71	31	37	46
Potassium	mg/L	1	7	8	9	10.5	7.43	7	8	9.5
Barium	mg/L	0.001	7	0.07	0.08	0.09	0.09	0.083	0.096	0.1155
Cadmium	mg/L	0.0001	<0.0001				<0.0001			
Chromium	mg/L	0.001	<0.001				<0.001			
Copper	mg/L	0.001	0.001				<0.001			
Lead	mg/L	0.001	<0.001				<0.001			
Lithium	mg/L	0.001	7	0.07	0.08	0.09	0.05	0.05	0.05	0.07
Manganese	mg/L	0.001	<0.001				0.007			
Selenium	mg/L	0.01	<0.01				<0.01			
Silver	mg/L	0.001	<0.001				<0.001			
Strontium	mg/L	0.001	7	0.38	0.46	0.57	0.47	0.442	0.499	0.5845
Zinc	mg/L	0.005	<0.006				0.72			
Boron	mg/L	0.05	7	0.10	0.11	0.13	0.09	0.08	0.1	0.13
Iron	mg/L	0.05	0.11				0.1			
Reactive Silica	mg/L	0.05	7	29.20	30.30	31.95	25.4	25.2	25.7	26.45
Fluoride	mg/L	0.1	6	0.50	0.60	0.75	0.42	0.4	0.425	0.4625
Nitrite as N	mg/L	0.01	<0.01				<0.01			
Nitrate as N	mg/L	0.01	7	0.08	0.09	0.105	0.08	0.05	0.09	0.15
Nitrite + Nitrate as N	mg/L	0.01	7	0.08	0.1	0.13	0.08	0.05	0.09	0.15
Total Anions	meq/L	0.01	7	12.9	13.6	14.65	12.01	11.8	12.4	13.3
Total Cations	meq/L	0.01	7	11.6	12.7	14.35	11.04	10.5	11.7	13.5
Ionic Balance	%	0.01	7	1.64	5.95	12.415	4.17	0.56	7.49	17.885
Methane	µg/L	10	<10				<10			
Ethane	µg/L	10	<10				<10			
Propane	µg/L	10	<10				<10			
C6 - C9 Fraction	µg/L	20	<20				<20			
C10 - C14 Fraction	µg/L	50	<50				<50			
C15 - C28 Fraction	µg/L	100	<100				<100			
C29 - C36 Fraction	µg/L	50	<50				<50			
C10 - C36 Fraction (sum)	µg/L	50	<50				<50			
C6 - C10 Fraction	µg/L	20	<20				<20			
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20				<20			
>C10 - C16 Fraction	µg/L	100	<100				<100			
>C16 - C34 Fraction	µg/L	100	<100				<100			
>C34 - C40 Fraction	µg/L	100	<100				<100			
>C10 - C40 Fraction (sum)	µg/L	100	<100				<100			
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100				<100			
Benzene	µg/L	1	<1				<1			
Toluene	µg/L	2	<2				<2			
Ethylbenzene	µg/L	2	<2				<2			
meta- & para-Xylene	µg/L	2	<2				<2			
ortho-Xylene	µg/L	2	<2				<2			
Total Xylenes	µg/L	2	<2				<2			
Sum of BTEX	µg/L	1	<1				<1			
Naphthalene	µg/L	5	<5				<5			
3-Methylcholanthrene	µg/L	0.1	<0.1				<0.1			
2-Methylnaphthalene	µg/L	0.1	<0.1				<0.1			
7.12-Dimethylbenz(a)anthracene	µg/L	0.1	<0.1				<0.1			

Analyte grouping/Analyte	Units	LOR	AVERAGE	25%ILE	75%ILE	Outlier	AVERAGE	25%ILE	75%ILE	Outlier
Acenaphthene	µg/L	0.1	<0.1				<0.1			
Acenaphthylene	µg/L	0.1	<0.1				<0.1			
Anthracene	µg/L	0.1	<0.1				<0.1			
Benz(a)anthracene	µg/L	0.1	<0.1				<0.1			
Benzo(a)pyrene	µg/L	0.05	<0.05				<0.05			
Benzo(b+j)fluoranthene	µg/L	0.1	<0.1				<0.1			
Benzo(e)pyrene	µg/L	0.1	<0.1				<0.1			
Benzo(g.h.i)perylene	µg/L	0.1	<0.1				<0.1			
Benzo(k)fluoranthene	µg/L	0.1	<0.1				<0.1			
Chrysene	µg/L	0.1	<0.1				<0.1			
Coronene	µg/L	0.1	<0.1				<0.1			
Dibenz(a.h)anthracene	µg/L	0.1	<0.1				<0.1			
Fluoranthene	µg/L	0.1	<0.1				<0.1			
Fluorene	µg/L	0.1	<0.1				<0.1			
Indeno(1.2.3.cd)pyrene	µg/L	0.1	<0.1				<0.1			
Naphthalene	µg/L	0.1	<0.1				<0.1			
Perylene	µg/L	0.1	<0.1				<0.1			
Phenanthrene	µg/L	0.1	<0.1				<0.1			
Pyrene	µg/L	0.1	<0.1				<0.1			
Sum of PAHs	µg/L	0.05	<0.05				<0.05			
Benzo(a)pyrene TEQ (zero)	µg/L	0.05	<0.05				<0.05			

01.02.2 EP187 Groundwater Investigation

EP187 GROUNDWATER INVESTIGATION

Report IG-02

May 2019

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Executive Summary

A baseline groundwater monitoring program was undertaken within the western portion of Exploration Permit (EP) area EP187 in the Northern Territory. The objectives of the baseline assessment are to provide:

- Comply with recommendations from the *Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, April 2018*
- Establish a baseline groundwater quality profile prior to proposed exploration works on EP187

Groundwater samples were collected from five (5) existing pastoralist bores. Bores were selected based on their location within the extent of proposed seismic and exploration activities. Samples were analysed for a range of contaminants which are relevant for exploration purposes. No stygofauna (GDE) monitoring was undertaken.

Naturally occurring elevated heavy metal concentrations (zinc) above trigger levels were reported in House Bore (HB-1), No. 5 Bore (5B-1) and No. 4 Bore (4B-1). This is consistent with the natural ore bodies in the area and is expected. Total petroleum hydrocarbons (TPH), total recoverable hydrocarbons (TRH) fractions and benzene, toluene, ethyl-benzene and xylenes (BTEX) were less than the laboratory level of reporting (LOR) from all samples collected. Physical parameters (pH, conductivity and TDS), major cations and total hardness were consistent with historical results.

The groundwater monitoring program undertaken provides a baseline understanding of the groundwater aquifer in the western portion of EP187. It provides a sound basis on which to conduct further groundwater monitoring and assessment. The groundwater bores were selected to provide a representative spread across the western portion of EP187 where exploration activities are proposed.

1 INTRODUCTION

The hydraulic fracturing Panel (*Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, April 2018*) assessed the risk of groundwater contamination from leaky wells and on-site surface spills as 'low'. This was assessed by using historical data from previous exploration activities and operations in other regions. Nonetheless, the Panel is prevented from making a definitive assessment of the fate of some contaminants and their risk to groundwater and aquatic ecosystems (groundwater dependent ecosystems (GDE)) due to a lack of baseline information and knowledge of groundwater (and surface water and GDE) systems in the Northern Territory.

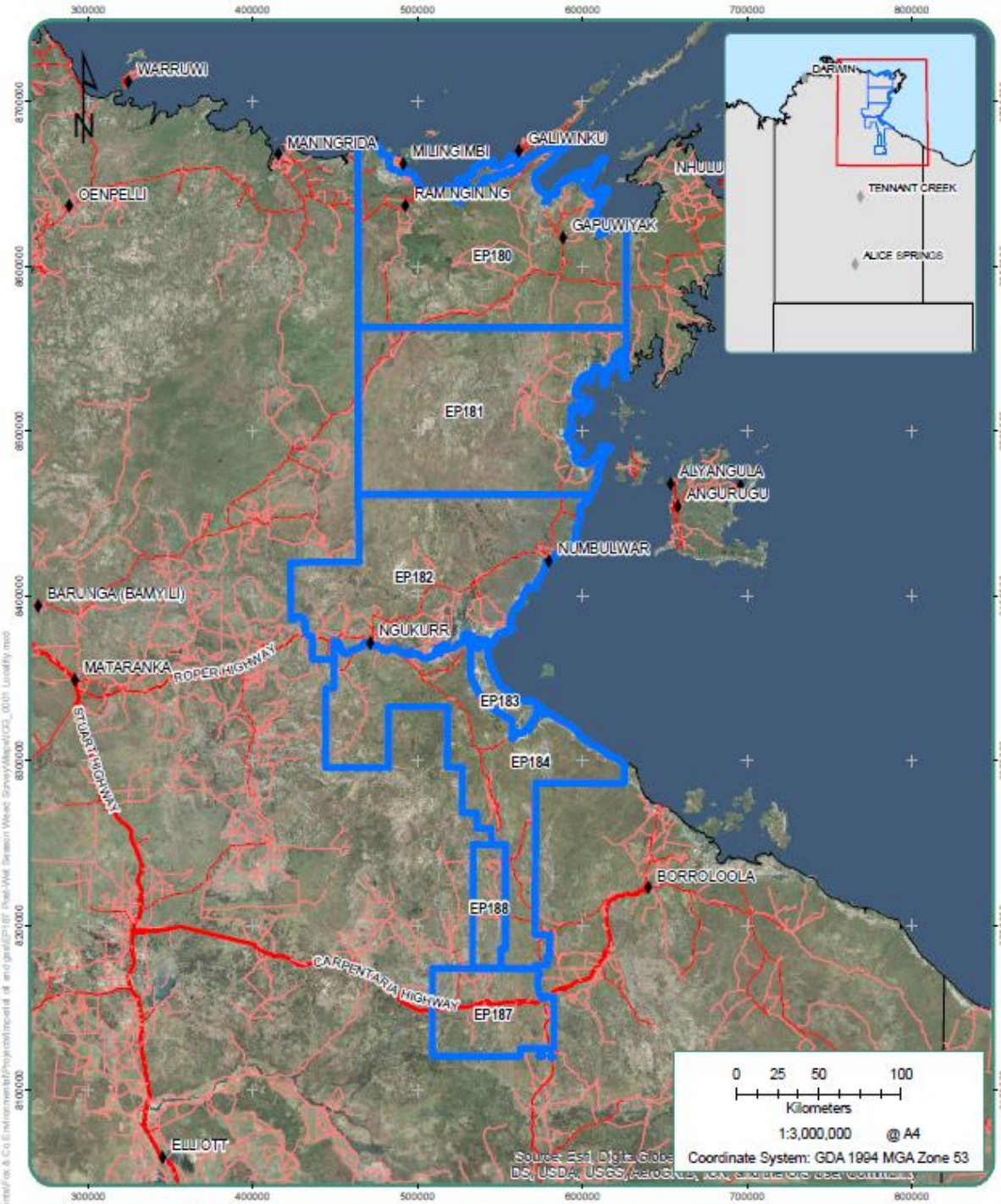
In this regard, to be proactive and demonstrate good environmental stewardship, IOG commissioned Fox & Co Environmental Pty Ltd to commence a baseline groundwater monitoring program on EP187. The focus of the survey was to gain an understanding of the groundwater quality in the area on EP187 associated with proposed exploration activities.

The investigation was undertaken on 10-11 April 2019 across the western portion of the tenement.

1.1 Location

EP187 is situated in the upper reaches of the McArthur River in proximity to the Barkly Tablelands. The tenement lies to the west of the Tablelands Highway and is crossed east to west by the Carpentaria Highway. **Figure 1** displays the location of the tenement area in relation to the broader region. The main access within the tenement is along the Carpentaria Highway and the Broadmere Road.

The groundwater monitoring program targeted existing bores proximate to the proposed 2019 IOG exploration program, in the western portion of the tenement. **Table 1** provides the latitude and longitude coordinates of the five (5) bores sampled during April 2019. **Figure 2** provides a map of the sampled bores. **Figure 3** shows the registered groundwater bores on EP187.



TITLE:

Locality Map

MAP NO: IOG_0001

PROJECT: EP187 Groundwater Investigation

LEGEND

Populated places
Australian State Boundaries
Roads
Tenements
Principal Road
Secondary Road
Minor Road
Track

FOX & CO ENVIRONMENTAL

Data Source:

Date: 19/04/2019

2 METHODS

The following methods were utilised to collect representative groundwater samples of the aquifer. The baseline groundwater sampling program was undertaken in accordance with the Northern Territory Methodology for Sampling of Ground Waters (Methodology for the Sampling of Ground Waters. Advisory Note AA7-024. Northern Territory Government (Resources, 2009)).

2.1 Existing Groundwater Bores Monitored in April 2019

The groundwater monitoring program targeted existing bores proximate to the proposed 2019 IOG exploration program. Bores with existing infrastructure were also targeted to assist with the collection of the samples. **Table 1** provides the latitude and longitude coordinates of the five (5) bores sampled during April 2019. **Figure 2** provides a map of the sampled bores. **Figure 3** shows all the registered groundwater bores on EP187.

Table 1: Groundwater bores (decimal degrees), April 2019

Well ID	Common / Pastoralist Well Name	NT DENR Well ID	Latitude	Longitude
HWY-1	Highway Bore	RN027848	-16.7338	135.1815
HB-1	House Bore	RN039575	-16.7491	135.2964
RCB-1	Relief Creek Bore	RN027945	-16.8348	135.3193
5B-1	No. 5 Bore	RN007699	-16.6484	135.3243
4B-1	No. 4 Bore	RN007696	-16.6567	135.2070

NB: All coordinates are provided in decimal degrees. Positional data was collected with a handheld Garmin eTrex Global Positioning System (GPS) unit, with accuracy between 4 and 8 m.

2.2 Desktop Assessment

Prior to commencing the field program, local pastoralists responsible for installing and equipping groundwater bores were contacted to obtain relevant, area specific and bore specific information such as:

- Groundwater bores proximate and accessible to the western portion of EP187
- Which bores were equipped with existing and functional bore infrastructure (ie. Generators and pumps)
- Type of pump (eg. Solar powered submersible)
- Historical and recent information on groundwater levels
- Pump rates

The Northern Territory Department of Natural Resources (DENR), Natural Resource Maps (NR Maps) were accessed to review existing groundwater bore information in the area. The original bore logs for the five (5) bores sampled are provided in **Appendix A**.

2.3 Sampling

Groundwater bores were purged using submersible pumps to remove standing water within the well in order to gain a representative sample of the aquifer. A flow-through cell was used with real-time in-situ physical parameter readings (temperature, pH and conductivity). Once the physical parameters stabilised, a groundwater sample was collected.

Field parameters collected included pH, temperature, conductivity and total dissolved solids (TDS).

Samples were collected in analyte specific containers (ie. with analyte specific preservatives). Once collected, the samples were immediately labelled and stored within a portable refrigerator.

Samples were sent to Australian Laboratory Services (ALS) a National Association of Testing Authorities (NATA) approved laboratory for the analysis performed.

The following analysis was undertaken for each groundwater bore:

- Suspended Solids (SS)
- Total Hardness as $CaCO_3$
- Dissolved Major Cations
  - Calcium
  - Magnesium
  - Sodium
  - Potassium
- Dissolved Metals
  - Arsenic
  - Cadmium
  - Chromium
  - Copper
  - Lead
  - Nickel
  - Zinc
- Dissolved Mercury
- Nitrogen
  - Nitrite + Nitrate as N
  - Total Kjeldahl Nitrogen as N
  - Total Nitrogen as N
- Total Phosphorus as P
- Laboratory Quality Assurance / Quality Control
- Total Petroleum Hydrocarbons
  - C6 - C9 Fraction
  - C10 - C14 Fraction
  - C15 - C28 Fraction
  - C29 - C36 Fraction
  - C10 - C36 Fraction (sum)
- Total Recoverable Hydrocarbons
  - C6 - C10 Fraction
  - C6 - C10 Fraction minus BTEX (F1)
  - >C10 - C16 Fraction
  - >C16 - C34 Fraction
  - >C34 - C40 Fraction
  - >C10 - C40 Fraction (sum)
  - >C10 - C16 Fraction minus Naphthalene (F2)
- BTEXN
  - Benzene
  - Toluene
  - Ethylbenzene
  - meta- & para-Xylene
  - ortho-Xylene
  - Total Xylenes
  - Sum of BTEX
  - Naphthalene
- TPH(V)/BTEX Surrogates
  - 1.2-Dichloroethane-D4
  - Toluene-D8
  - 4-Bromofluorobenzene

Appendix B provides the laboratory results, chain of custody and sample receipt.

2.3.1 Adopted Assessment Criteria

The following assessment criteria was adopted for the purpose of assessing baseline surface water quality:

- National Environment Protection Council *National Environment Protection (Assessment of Site Contamination) Measure 1999*, as amended by the National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1), May 2013
- Australian and New Zealand Environment and Conservation Council/Agriculture and Resource Management Council of Australia and New Zealand (Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, 2000) 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality

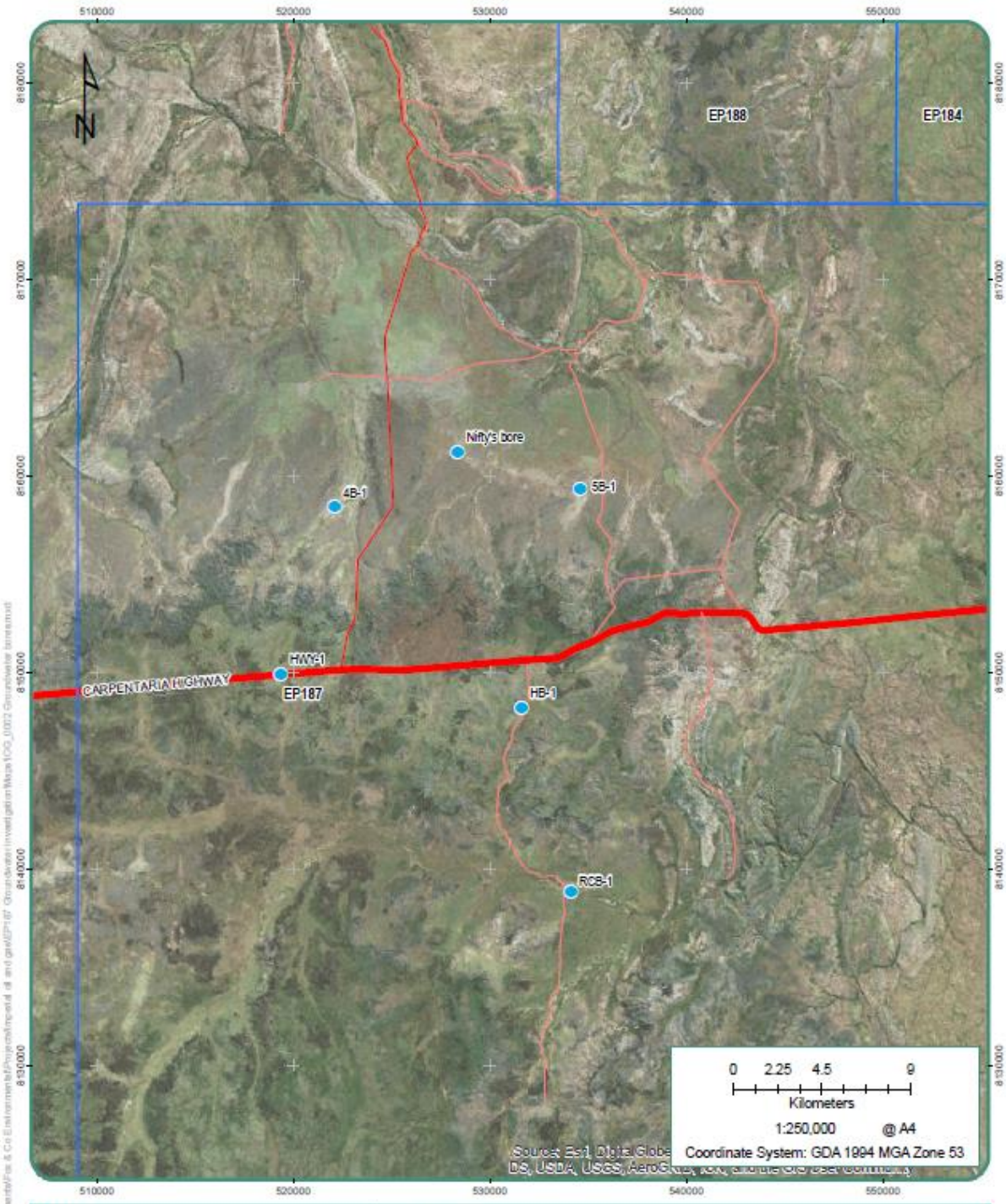
2.3.2 Quality Control

The field and laboratory QA/QC program is to validate the data to ensure it is reasonable and of sufficient quality to meet the data quality objectives for this baseline ground water investigation. Certified laboratory documentation including chain of custodies, sample receipt notifications, certificates of analysis and laboratory QA/QC reports are provided in **Appendix B**.

2.3.3 Study Limitations

The baseline groundwater assessment was undertaken using existing, equipped pastoralist groundwater bores. As the bores are working pastoralist bores with equipped pipes, pumps and generators, groundwater probes are unable to fit down the well to measure the exact standing water level (as the top of the bores are steel cased). As such, discussions were held with each pastoralist and persons responsible for equipping the bores to ascertain the approximate standing water level. Historical logs were also reviewed which correlated with the anecdotal evidence.

It is also noted, while no hydrocarbons were recorded above the laboratory level of reporting (LOR) (refer **Table 2**), anecdotal evidence reported practices of pouring diesel down bores during construction to lubricate augers, while diesel and engine oils have also been historically poured on the ground surface around the bores, to keep the stand-pipe clear of grass. Other anecdotal evidence also reported observations of diesel overspilling generators during filling and also entering the localised bore area (refer **Table 4**).



TITLE:

Groundwater Bores

MAP NO: IOG_0002

PROJECT: EP187 Groundwater Investigation

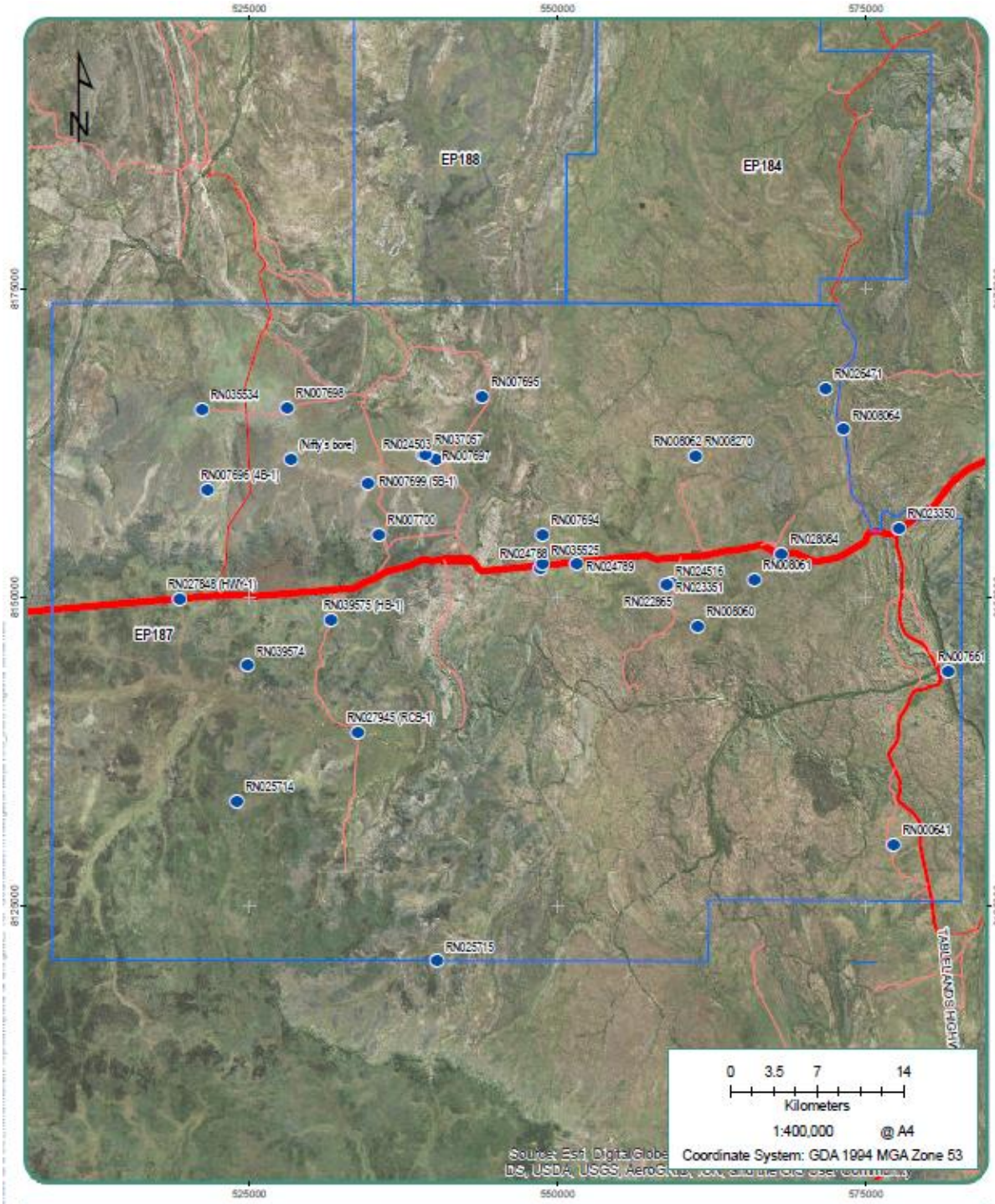
LEGEND

- Bores
- Tenements
- Roads
  - Principal Road
  - Secondary Road
  - Minor Road
  - Track

Data Source:

FOX & CO ENVIRONMENTAL

Date: 26/04/2019



TITLE:

Regional Bores

MAP NO: IOG_0003

PROJECT: EP187 Groundwater Investigation

LEGEND

- Regional bores
- Tenements
- Roads
  - Principal Road
  - Secondary Road
  - Minor Road
  - Track

FOX & CO ENVIRONMENTAL

Data Source:

Date: 26/04/2019

3 RESULTS

Table 2 provides the laboratory results from the five (5) groundwater bores sampled. Results were consistent across all groundwater bores sampled, and where comparison was possible, also consistent with historical groundwater bore data.

Table 2 Annual Action Plan

		Sample date	9/4/19	9/4/19	9/4/19	9/4/19	10/4/19
Analyte grouping Analyte	**Units**	**Investigation Level**	**HWY-1**	**HB-1**	**RCB-1**	**5B-1**	**4B-1**
EA025: Total Suspended Solids dried at 104 ± 2°C							
Suspended Solids (SS)	mg/L		<5	<5	<5	17	23
EA065: Total Hardness as CaCO							
Total Hardness as CaCO3	mg/L		528	495	439	537	576
ED093F: Dissolved Major Cation							
Calcium	mg/L	700[3]	124	114	100	126	120
Magnesium	mg/L	2000[4]	53	51	46	54	67
Sodium	mg/L	180[3]	45	36	4	44	45
Potassium	mg/L		8	8	3	8	8
EG020F: Dissolved Metals by ICP MS							
Arsenic	mg/L	0.007[1]	0.001	<0.001	0.001	<0.001	<0.001
Cadmium	mg/L	0.002[1]	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.05[1]	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	2[1]	<0.001	<0.001	0.002	<0.001	<0.001
Lead	mg/L	0.01[1]	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	0.02[1]	<0.001	<0.001	0.001	<0.001	<0.001
Zinc	mg/L	0.008[2]	<0.005	**1.53**	<0.005	**0.581**	**0.126**
EG035F: Dissolved Mercury by FIMS							
Mercury (total)	mg/L	0.001[1]	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK050G: Nitrite plus Nitrate as (NOx) by Discrete Analyser							
Nitrite + Nitrate as N	mg/L	0.005[5]	**0.11**	**0.05**	**0.13**	**0.03**	**0.05**
EK061G: Total Kjeldahl Nitrogen Discrete Analyser							
Total Kjeldahl Nitrogen as N	mg/L		<0.1	<0.1	<0.1	<0.1	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser							
Total Nitrogen as N	mg/L	0.2-0.3[5]	0.1	<0.1	0.1	<0.1	<0.1
EK067G: Total Phosphorus as P Discrete Analyser							
Total Phosphorus as P	mg/L	0.01[5]	<0.01	<0.01	<0.01	<0.01	**0.03**
EP080/071: Total Petroleum Hydrocarbons							
C6 - C9 Fraction	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L		<100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L		<50	<50	<50	<50	<50

		Sample date	9/4/19	9/4/19	9/4/19	9/4/19	10/4/19
Analyte grouping Analyte	**Units**	**Investigation Level**	**HWY-1**	**HB-1**	**RCB-1**	**5B-1**	**4B-1**
C10 - C36 Fraction (sum)	µg/L		<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions							
C6 - C10 Fraction	µg/L		<20	<20	<20	<20	<20
C6 - C10 Fraction minus BTEX (F1)	µg/L		<20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L		<100	<100	<100	<100	<100
>C34 - C40 Fraction	µg/L		<100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L		<100	<100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN							
Benzene	µg/L	950[2]	<1	<1	<1	<1	<1
Toluene	µg/L	800[1]	<2	<2	<2	<2	<2
Ethylbenzene	µg/L	300[1]	<2	<2	<2	<2	<2
meta- & para-Xylene	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	µg/L	350[2]	<2	<2	<2	<2	<2
Total Xylenes	µg/L	600[1]	<2	<2	<2	<2	<2
Sum of BTEX	µg/L		<1	<1	<1	<1	<1
Naphthalene	µg/L	16[2]	<5	<5	<5	<5	<5
EN055: Ionic Balance							
Total Anions	meq/L		13.2	10.8	8.11	12.4	12.4
Total Cations	meq/L		12.7	11.6	9.03	12.8	13.7
Ionic Balance	%		2.07	3.98	5.36	1.76	4.86
Field Measurements							
Temperature	oC		35.2	34.1	32.5	31.1	32.0
Electrical Conductivity	µS/cm	20-250	1236	1134	864	1250	1285
pH		6-8.0	6.60	6.65	6.78	6.50	6.50
TDS	ppm		-	737	562	810	839

[1] – Investigation Level for Drinking Water. Schedule B(1) – Guideline on Investigation Levels for Soil and Groundwater (NEPM, 2013).
[2] - Investigation Level for Fresh Water (95% species protection). Schedule B(1) – Guideline on Investigation Levels for Soil and Groundwater (NEPM, 2013). Used in absence of IL for Drinking Water (1)
[3] –Groundwater, Explanatory notes to the Groundwater Map of the Northern Territory (DNREAS, 2008)
[4] - In high doses magnesium can cause scouring and diarrhoea in cattle. Levels up to 2000 mg/L have been observed to have no adverse effects. There is insufficient information available at present to set a guideline value (DNREAS, 2008)
[5] - ANZECC Water Quality Guidelines (2000) for belowland streams of Tropical North Australia.

3.1 QA/QC

The below table provides a summary of data quality compliance for the project. The data quality objectives (DQOs) and methods were developed using those recommended in *NEPM Schedule B (2) Guideline on Data Collection, Sample Design and Reporting*. The guideline nominates the implementation of the DQO process in Section 5 of AS4482.1-2005.

Table 3 Summary of QA/QC Compliance

Task	Objective	Reference	Outcome	Achieved Compliance
Compare field data and analytical data	Visual and olfactory evidence relates to laboratory results		Field observations relate to laboratory results	Yes
Calibration of water quality meter	Adhere to machine specifications	AS4482.1-2005	Yes. Field pH compares to historical bore data in addition to calibration	Yes
Chain of Custody documentation	Completed		Completed and provided in Appendix B.	Yes
Sample analysis and extraction holding times	Comply with holding times	AS4482.1-2005/NEPM(2013)	Yes. Refer Appendix B.	Yes
Sample preservation	Samples collected in appropriate preserved sample bottles		Yes. Refer Appendix B.	Yes

3.2 *Photo Log*

Table 4 Groundwater Bores Sampled in April 2019

Groundwater Bore	Plate
Highway Bore (HWY-1), RN027848 Location: -16.7338, 135.1815	

Groundwater Bore	Plate
House Bore (HB-1), RN039575 Location: -16.7491, 135.2964	
Relief Creek Bore (RCB-1), RN007696 Location: -16.6567, 135.2070	

Groundwater Bore	Plate
No. 5 Bore (5B-1), RN007699 Location: -16.6484, 135.3243 Note historical oil and diesel staining on the surface.	
No. 4 Bore (4B-1), RN007699 Location: -16.6484, 135.3243 Note historical oil and diesel staining /spills on the unsealed ground surface.	

4 DISCUSSION AND INTERPRETATION OF RESULTS

Zinc was reported above the adopted trigger level in 3 of the 5 bores. Groundwater bores HB-1, 5B-1 and 4B-1 reported concentrations of 1.53mg/L, 0.581mg/L and 0.126 mg/L, respectively. All other samples reported heavy metal (arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), lead (Pb), zinc (Zn) and mercury (Hg)) concentrations below the laboratory LOR or only marginally above the laboratory LOR.

Major cations (calcium (Ca), magnesium (Mg), sodium (Na) and potassium (K)) were less than the adopted trigger levels for human and livestock consumption.

All samples reported concentrations of total petroleum hydrocarbons (TPH), total recoverable hydrocarbons (TRH) and benzene, toluene, ethyl-benzene and xylenes (BTEX) below the laboratory LOR.

Comparison of historical physical parameters (pH, conductivity and TDS) of groundwater samples collected with the recent round of samples reported consistent results. Similarly, historical groundwater results (only a reduced suite of analytes have historically been analysed including major cations and total hardness) are consistent with the recent round of results.

5 CONCLUSION

Concentrations of zinc above the trigger levels in regional groundwater is not unexpected. The McArthur River Mine located in the region, is one of the world's largest zinc, lead and silver mines and the zinc in the groundwater is likely associated with these natural ore bodies.

Despite historical oil and fuel spills around the groundwater bores, all samples reported concentrations of hydrocarbons less than the laboratory LOR. The samples collected from the April 2019 investigation are consistent with previous historical results (physical parameters, major cations and total hardness). Only a reduced suite of analytes has historically been analysed, therefore comparison is limited, however this investigation provides a more comprehensive baseline for interpretation of future trends.

This investigation is limited to assessing the existing contamination status and groundwater quality within the western portion of EP187. Little is known about stygofauna (animals that live exclusively in aquifers) and groundwater dependent ecosystems (GDE) in the region. It is recommended future groundwater investigations include stygofauna monitoring as they are an indicator of groundwater health.

6 WORKS CITED AND RELEVANT REFERENCE DOCUMENTS

Australian and New Zealand Environment and Conservation Council/Agriculture and Resource Management Council of Australia and New Zealand (Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, 2000) 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality

Department of Natural Resources, Environment, the Arts and Sport (June 2008), Groundwater Explanatory notes to the Groundwater Map of the Northern Territory.

National Environment Protection Council *National Environment Protection (Assessment of Site Contamination) Measure 1999*, as amended by the National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1), May 2013

Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, Summary of the Final Report, April 2018.

Refer to Attachment 4 for the full report on groundwater survey including appendixes

Appendix 01.03 - Environmental Summary Report

EP187 Environmental Assessment Report
2019 Seismic and Drilling Program

Report IG-02

May 2019

FOX & CO
ENVIRONMENTAL

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DOCUMENT AUTHORISATION					
Revision	**Rev. Date**	**Report Details**			
a	1 June 2019	Draft report			
Prepared By		**Reviewed By**		**Authorised By**	
P.F				P. Fox	

Executive Summary

Imperial Oil & Gas Pty Ltd (Imperial) proposes to undertake an exploration program in the geographic area of the Northern Territory known as the Central Southern McArthur Basin. This region is covered by the tenement EP187 and is located in the southern and western gulf areas known as the Gulf Fall and Coastal Plain.

A number of previous environmental investigations have been undertaken on EP187 to gain an understanding of seasonal baseline surface water quality and also landscape values across the tenement. This was undertaken in accordance with Imperial's commitment to environmental stewardship and to inform potential exploration areas with consideration of environmental values and sensitive areas.

A revised desktop assessment and further targeted surveys were undertaken in October 2018, November 2018 and April 2019 with specific focus on Imperial's proposed seismic lines and well pads. The ecological assessment was carried out to identify weeds, key ecological characteristics and potential constraints to the proposed seismic and drilling activities on EP187 in the Northern Territory.

No threatened fauna or flora species were observed during on-ground surveys. Habitat exists for some conservation significant species in the area, however given the narrow linear nature of disturbance (and localised disturbance regarding well pads), species habitat requirements and likelihood of occurrence, impacts from proposed seismic and well pad construction are considered low.

This report was prepared by Mr P. Fox (BSc (App. Env Sci)(Hons)). Mr Fox is a Principal Ecologist with over 20 years experience in undertaken environmental assessments across Australia and Papua New Guinea. He has undertaken numerous surveys in the McArthur River catchment since 2011. He was involved in the field surveys on EP187 during previous employment.

1 INTRODUCTION

Imperial Oil & Gas Pty Ltd (Imperial) proposes to undertake an exploration program in the geographic area of the Northern Territory known as the Central Southern McArthur Basin. This region is covered by the tenement EP187 and is located in the southern and western gulf areas known as the Gulf Fall and Coastal Plain.

Several environmental investigations have previously been undertaken across EP187, including targeted flora (including weeds) and fauna surveys along the proposed seismic lines and well pads. Other investigations have involved developing baseline surface water quality data, targeted waterway assessments and landscape scale environmental assessments. During weed surveys undertaken in 2018 and 2019, concurrent biodiversity assessments were undertaken including the likelihood of occurrence of Northern Territory and Commonwealth listed threatened flora and fauna species. Previous environmental reporting focussed on the weed assessment for the seismic and wells pads, or at a broader landscape level. This report provides addition site specific assessment with particular focus on the proposed 2019 seismic and well pad exploration programs in relation to biodiversity and environmental values.

The following reports and material have been used to prepare this report:

- *Weed Management Plan, 2018 Seismic Program, EP187, Premise (15 November 2018), Report No. 1802587 (rev e)*
- *Environmental Assessment Report, EP184 and EP187, Premise (August 2018), Report No. 1802426 (rev a)*
- *Preliminary Ecological Assessment Report, EP184 and EP187, End of Dry Season 2015, O2Ecology (February 2016), Report No. R002499b*
- *Previous survey data collected during weed surveys.*

A desktop investigation and ecological assessment was carried out to identify key ecological characteristics and potential constraints to the proposed seismic and well development activities. The scope of the study was to provide:

- habitat and vegetation community descriptions;
- locations and photos of communities and species present;
- locations of fauna breeding places and other habitat features; and
- likelihood of targeted threatened species to occur within or adjacent to the proposed seismic and drilling activities.

This report presents the field survey methods, survey limitations, the results of desktop investigations and findings.

1.1 *Location*

EP187 is situated in the upper reaches of the McArthur River in proximity to the Barkly Tablelands. The tenement lies to the west of the Tablelands Highway and is crossed east to west by the Carpentaria Highway. The main access within the tenement is along the Carpentaria Highway and the Broadmere Road.

1.2 Proposed Seismic and Exploration Program Location

The proposed work program will occur in the 2019 dry season (June/July). A number of historical pastoral access ways exist through the area as well as newer access ways developed by pastoralists holding S19 permits (under the *Aboriginal Land Rights (Northern Territory) Act*). Where available access to seismic lines will utilize the existing roadways and pastoral tracks.
Table 1 and **Table 2** provides the latitude and longitude coordinates of the start and end of the seismic lines and proposed well pads. **Figure 1** provides a map of the proposed route of the seismic lines and well pads.

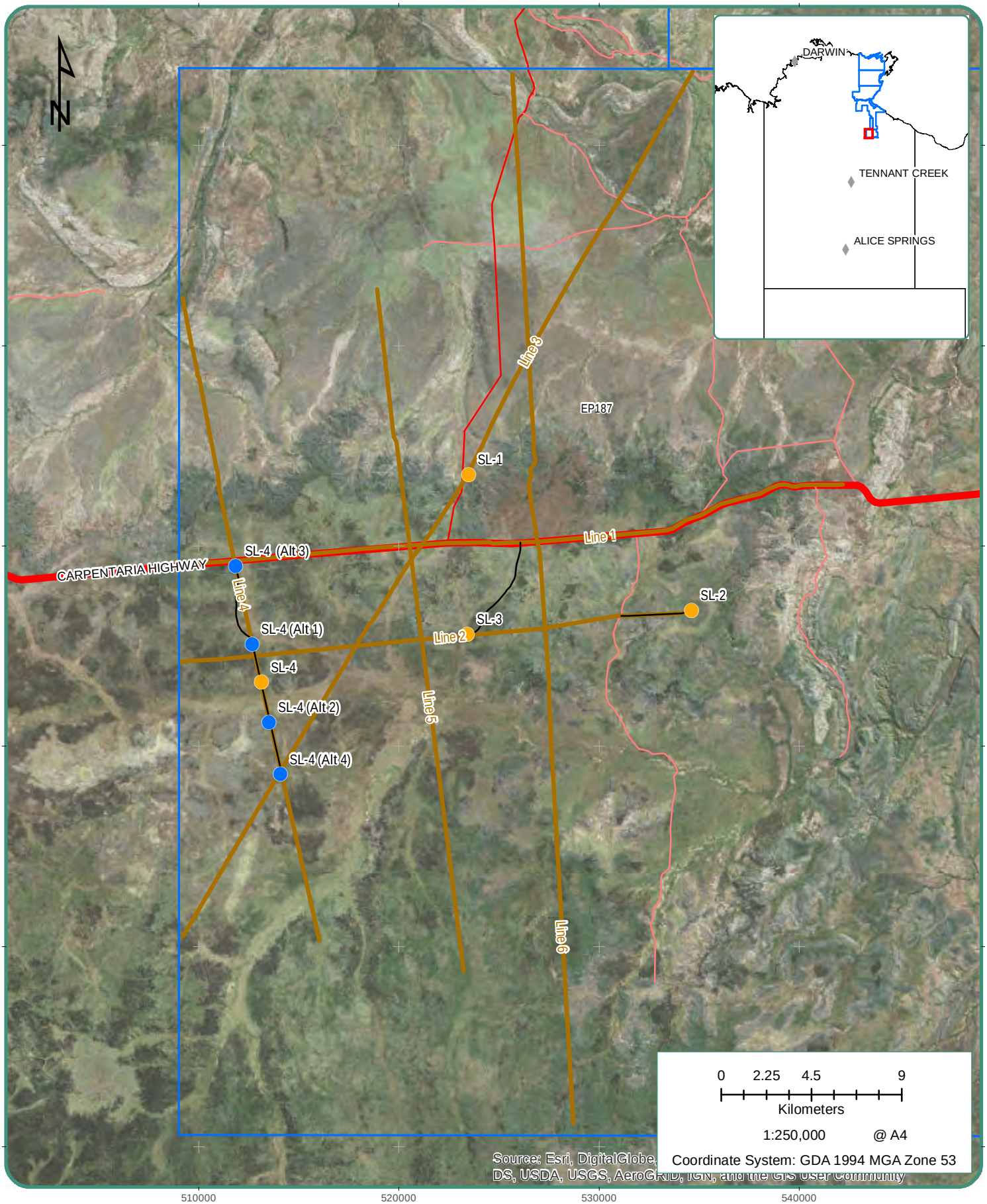
Table 1: Seismic line coordinates for start and end (decimal degrees)

Line	Start Longitude	Start Latitude	End Longitude	End Latitude	Length (km)
1	135.0863884	-16.7411125	135.3952893	-16.71437661	32.9
2	135.0853852	-16.78513537	135.3213451	-16.76289145	25.1
3	135.0864645	-16.90880039	135.3249762	-16.51846278	49.8
4	135.1159045	- 6.94503599	135.0861566	-16.6214288	35.9
5	135.2179975	-16.92453057	135.1772632	-16.61601824	34.2
6	135.2696648	-16.9932462	135.2404939	-16.51967737	52.2

NB: All coordinates are provided in decimal degrees.

Table 2 Coordinates for proposed well pads (options depending on seismic and avoiding sensitive areas)

SITE	Latitude (decimal degrees)	Longitude (decimal degrees)
Exploration bore(s)		
SL-1	-16.700640°	135.220163°
SL-2	-16.761726°	135.324698°
SL-3	-16.772641°	135.219816°
SL-4	-16.794398°	135.123266°
SL-4 (Alt 1)	-16.778475	135.1194361
SL-4 (Alt-2)	-16.8139167	135.1276611
SL-4 (Alt-3)	-16.74204167	135.11109167
SL-4 (Alt-4)	-16.83641	135.1328472
Grid: GDA94 Zone 53K		



TITLE:

EP187 Overview

MAP NO: IOG_0001

PROJECT: EP187 Environmental assessment.

LEGEND

- Exploration bores
- Exploration bores alternate locations
- Proposed bore access
- Seismic lines
- Tenements

Roads

- Principal Road
- Secondary Road
- Minor Road
- Track

FOX & CO ENVIRONMENTAL

Data Source:

Date: 30/05/2019

Document Path: C:\Users\s.vale\OneDrive\Documents\Fox & Co Environmental\Projects\Imperial oil and gas\EP187 Flora Fauna\Maps\IOG_0001 Environmental report.mxd

2 METHOD

This section outlines the methods undertaken to describe the existing environmental values of the Seismic Lines and Well Pad Areas. A combination of desktop assessment and field survey was conducted as part of this study. The desktop assessments included a review of previous investigations in EP187, relevant literature, mapping and database searches. The field survey obtained ecological information and opportunistic observations relevant to the seismic lines and well pads.

2.1 Desktop Assessment

Desktop assessments of available Northern Territory and Commonwealth databases were undertaken prior to the commencement of the field survey to identify records or potential occurrences of conservation significant species and vegetation communities within the study area. A review of previous desktop assessments was undertaken in addition to a revised search of the following databases:

- Commonwealth Department of Environment protected matters search tool (-16.73095, 135.2186)
- The Atlas of Living Australia (ALA) database
  - Australia's Virtual Herbarium (AVH)
  - Online Zoological Collections of Australian Museums (OZCAM)
- BirdLife Australia's Birdata
- Northern Territory Government Department of Environment and Natural Resources (DENR) NR Maps

2.2 Likelihood of Occurrence

An assessment was undertaken of the likelihood of occurrence for threatened fauna and flora species identified through the desktop review. The field survey further informed and verified this likelihood of occurrence assessment. The DOE and the Northern Territory DENR do not have prescriptive likelihood of occurrence guidelines within their policies but rather clarify the scale of assessment required to determine the level of impact (e.g. level of assessment, previous record searches, and distribution maps). The below criteria have been developed with the aim of considering this scale of assessment in order to identify the likelihood of occurrence for threatened species:

- **Low potential to occur** – the species has not been recorded in the region (no records from desktop searches) and/or current known distribution does not encompass study area and/or suitable habitat is generally lacking from the study area.
- **Moderate potential to occur** – the species has been recorded in the region (desktop searches) however suitable habitat is generally lacking from the study area or species has not been recorded in the region (no records from desktop searches) however potentially suitable habitat occurs at the study area.
- **High potential to occur** – the species has been recorded in the region (desktop searches) and suitable habitat is present at the study area.
- **Known to occur** – the species has been recorded on-site in the recent past (i.e. last 5-10 years) and the site provides suitable habitat for it.

2.3 Field Assessments

Surface water quality and landscape scale environmental surveys were undertaken over EP187 in December 2015 and June 2018. Targeted surveys were undertaken in relation to the proposed seismic and drilling activities on EP187 in October 2018, November 2018 and April 2019.

Due to previous restrictions on site access in EP187, ecological assessments undertaken in December 2015 and June 2018 consisted of opportunistic assessments at each water quality sampling location and from the vantage of the helicopter for a broader landscape scale perspective of the study areas. The location of the on-ground assessments during these surveys was therefore in areas adjacent to water. The December 2015 and June 2018 assessments included broad descriptions of vegetation communities, identification of dominant flora species (including weeds) present and habitat

assessments (including aquatic). Opportunistic fauna observations, identification of observed breeding places and targeted threatened species searches were also carried out to help inform subsequent surveys.

Targeted surveys were undertaken in October 2018 along seismic lines and well pads using All-Terrain Vehicles (ATV's) supplied by the DENR weeds branch. DENR weed officers also undertook the surveys with the Premise field teams. Seismic Line 1 was surveyed using a standard 4WD vehicle as it is located immediately adjacent to the Carpentaria Highway. Additional surveys were undertaken using a helicopter in December 2018 and April 2019.

3 EXISTING ENVIRONMENT

A detailed description of the existing environment is provided in the previous environmental assessment reports.

The following provides a more detailed assessment of the areas relevant to the proposed seismic and drilling program.

3.1 Conservation Significant Species

Conservation significant flora and fauna species are those species listed under the provisions of the *Commonwealth EPBC Act* and/or the *Territory Parks and Wildlife Conservation Act 2000* (TPWC Act) including threatened species as well as internationally protected wildlife and migratory species. Threatened species include those with conservation status listed as Endangered, Vulnerable or Near Threatened (EVNT) under the EPBC Act or Extinct in the Wild, Critically Endangered, Endangered or Vulnerable under the TPWC Act. Potentially occurring threatened flora and fauna species are listed in **Appendix B** with an account of their likelihood of presence within the study area based on known records, species biology and ecology and habitats available within the study area. Not all of the threatened species indicated through desktop information are expected to occur within the study area due to the absence of suitable habitat for some species.

No threatened flora species have been previously recorded within the search area. Two (2) threatened fauna species have previously been recorded within the study area. One (1) species (*Mesembriomys macrurus* (golden-backed tree rat)) was recorded over 100 years ago and is now considered locally extinct. The second threatened fauna species (*Erythrura gouldiae* (Gouldian Finch)) was not identified through NT or Commonwealth database searches, but rather is included due to anecdotal evidence.

Table 3 lists the threatened (or significant) fauna and flora species that have previously been recorded within the study area.

Table 4 lists the migratory fauna species that are at least moderately likely to occur within the study area based on the likelihood of occurrence assessment. Species which are specialists of tidal areas are not included.

The following sections summarise findings from each of the databases.

3.1.1 EPBC Protected Matters

A revised Protected Matters Search Tool (PMST) has been undertaken and included in the attached. The Commonwealth Department of the Environment (DoEE) Protected Matters search tool (PMST) was used to identify threatened species and vegetation communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) that may occur within the search area. The PMST is a predictive database that identifies EPBC Act listed flora and fauna species with a Moderate Potential to Occur in a given search area based on bioclimatic modelling. The search area was defined by the latitude/longitude coordinates –16.73095, 135.2186 with a 50 km buffer.

The EPBC PMST identified the search area as having potential habitat for no nationally threatened flora species, 13 threatened terrestrial species and 15 migratory species listed under the EPBC Act (**Appendix A**). Nine (9) of the 15 migratory species are specialist marine species and have therefore been excluded from the assessment (including estuarine crocodiles as no suitable habitat exists within the project area).

No Threatened Ecological Communities (TEC), World Heritage Properties, National Heritage Places, Wetlands of International Importance, Great Barrier Reef Marine Park or Commonwealth Marine Area's occur within the study area.

3.1.2 Birdata

BirdLife Australia's Birdata (**Appendix A**) shows records of 92 bird species observed within the search area. Of those, 1 species *Ardeotis australis* (Australian bustard) is listed as Near Threatened (DD) under TPWC Act and 1 species *Merops ornatus* (Rainbow Bee-eater) is a migratory species under the EPBC Act.

3.1.3 Atlas of Living Australia

The ALA database returned records for 3 significant and/or threatened fauna species *Ardeotis australis* (Australian bustard), *Onychogalea unguifera* (Northern nailtail wallaby) and *Mesembriomys macrurus* (golden-backed tree rat) listed under the EPBC Act and/or TPWC Act within the search area.

3.1.4 DENR NR Maps

The Northern Territory Government (NR Maps) http://nrmaps.nt.gov.au/nrmaps.html was used to identify threatened flora and fauna species, sites of conservation significance and sites of botanical significance recorded in EP187.

A query of the DENR NR Maps database returned 5 Data Deficient (DD) plant species and 8 fauna species (9 fauna listed in the below table due to anecdotal observation of Gouldian Finch) that have been historically recorded within the study area. There are no historical records for threatened flora species within the search area. Data Deficient species while not considered threatened species under the EPBC Act or TPWC Act, they are considered Significant Species under the TPWC Act.

Table 3 Threatened species previously recorded in the study area

Class	Species Name	Common Name	EPBC Act Status	TPWC Act Status
Birds	*Erythrura gouldiae*	Gouldian finch[1]	E	V
Birds	*Ardeotis australis*	Australian bustard	-	NT
Birds	*Merops ornatus*	Rainbow bee-eater	migratory	LC
Birds	*Malurus coronatus macgillivrayi*	Purple-crowned fairy-wren	-	NT
Birds	*Burhinus grallarius*	Bush Stone-curlew	-	NT
Mammals	*Onychogalea unguifera*	Northern nailtail wallaby	-	NT
Mammals	*Mesembriomys macrurus*	Golden-backed Tree-rat[2]		CE
Reptiles	*Demansia quaesitor*	Sombre whipsnake	-	DD
Reptiles	*Tiliqua scincoides*	Common blue-tongued lizard	-	DD
Plant	*Eriachne squarrosa*	Eriachne, Wanderrie Grass		DD
Plant	*Ammannia crinipes*	Nesaea		DD
Plant	*Eriocaulon carpentariae*	Eriocaulon		DD
Plant	*Polygala petrophila*	Polygala		DD
Plant	*Dodonaea barklyana*	Distichostemon		DD

EPBC Act (species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), Aust.): CE = Critically Endangered, E = Endangered, V = Vulnerable, M = Migratory, Ma = Marine
TPWC Act (species listed under the *Territory Parks and Wildlife Conservation Act 2000* (TPWC Act), NT): CE = Critically Endangered, E = Endangered, V = Vulnerable, NT=Near Threatened, DD = Data Deficient
[1] – anecdotal.
[2] – records from 1901 and presumed locally extinct

Table 4 Migratory species likely to occur within the study area

Class	Species Name	Common Name	EPBC Act Status	TPWC Act Status
Birds	*Apus pacificus*	Fork-tailed swift	Ma, M	-
Birds	*Cecropis daurica*	Red-rumped swallow	M, Ma	-
Birds	*Cuculus optatus*	Oriental cuckoo	Ma	-
Birds	*Hirundo rustica*	Barn swallow	M, Ma	-
Birds	*Motacilla cinerea*	Grey wagtail	M, Ma	-
Birds	*Motacilla flava*	Yellow wagtail	M, Ma	-
Birds	*Merops ornatus*	Rainbow bee-eater	Ma, M	-

EPBC Act (species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), Aust.): M = Migratory, Ma = Marine
TPWC Act (species listed under the *Territory Parks and Wildlife Conservation Act 2000* (TPWC Act), NT): NT=Near Threatened

Appendix B provides a table of the species reported in search results with an assessment of their likelihood of occurrence within the seismic and drilling areas. Near Threatened (NT) and/or DD species are not included in the threatened species table.

3.1.5 Weeds and Pests

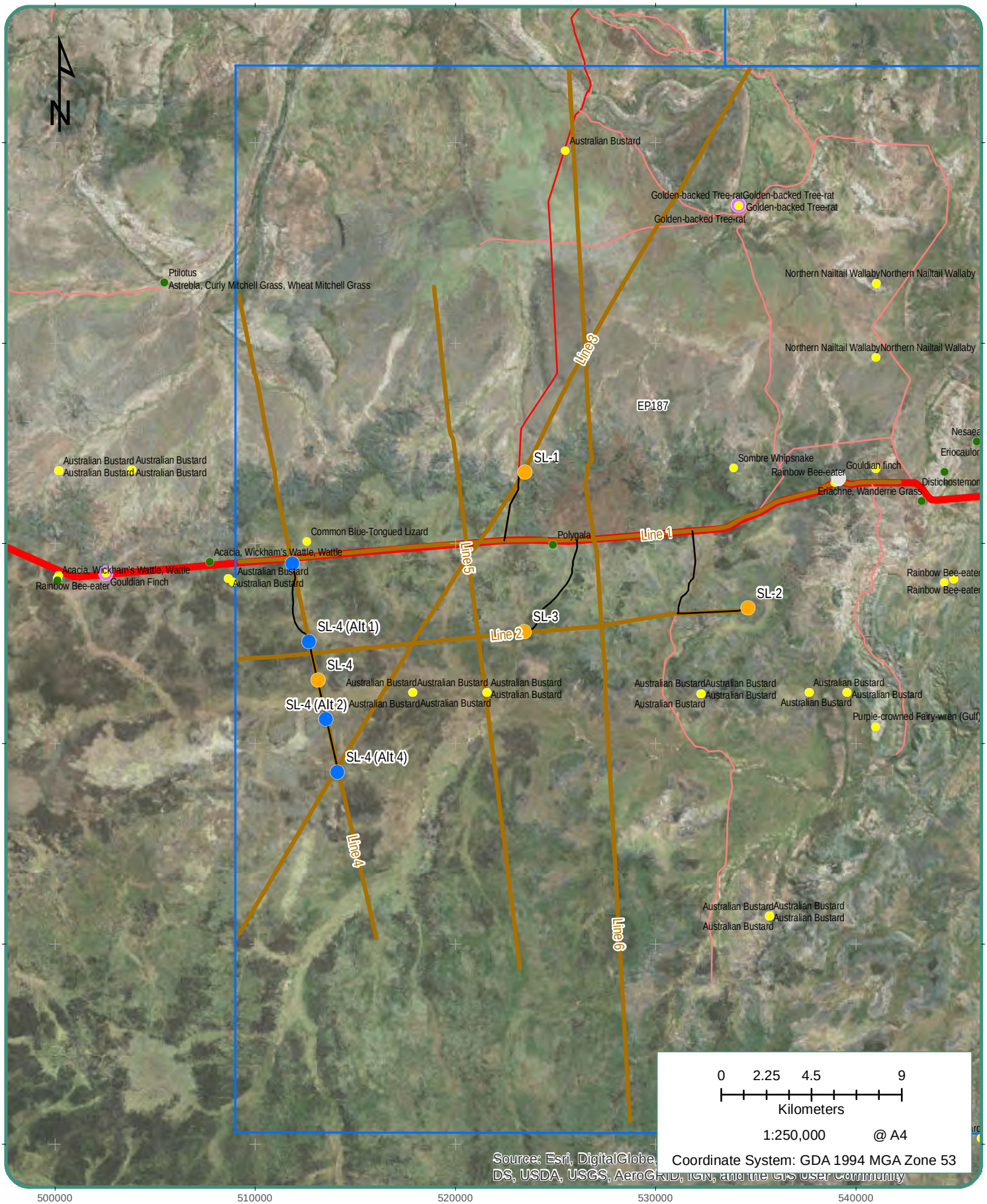
Details of the weeds occurring in relation to the proposed seismic are included in the Weed Management Plan (WMP) prepared by Premise (*Weed Management Plan, 2018 Seismic Program, EP187, Premise Environment, 15 November 2018, Report # 1802587e*). A revised WMP will be prepared to include the proposed well pads and access tracks.

Table 5 provides the weeds reported during 2018 and 2019 surveys

Table 5 Weeds recorded in the survey areas

Species	Common Name	WONS	NT Class
Hyptis suaveolens	Hyptis	-	B
Parkinsonia aculeata	Parkinsonia	-	B
Tribulus sp.	Caltrop	-	B

Refer **Appendix C** for weed survey reports and weed management plan (WMP).



Document Path: C:\Users\s.vale\OneDrive\Documents\Fox & Co Environmental\Projects\Imperial oil and gas\EP187 Flora Fauna\Maps\IOG_0002 Significant recorded species.mxd

TITLE:

EP187 Significant or threatened recorded species

MAP NO: IOG_0002

PROJECT: EP187 Environmental assessment.

LEGEND

- Gouldian finch
- Species Atlas-Significant Flora
- Species Atlas-Threatened Flora
- Species Atlas-Significant Fauna
- Species Atlas-Threatened Fauna
- Exploration bores
- Exploration bores alternate locations
- Proposed bore access
- Tenements
- Seismic lines

Roads

- Principal Road
- Secondary Road
- Minor Road
- Track

FOX & CO ENVIRONMENTAL

Date: 30/05/2019

Data Source:
Fauna Atlas N.T., 2011-11-01, Department of Environment and Natural Resources
Flora Atlas N.T. , 2007-03-01, Department of Environment and Natural Resources

4 FIELD ASSESSMENT RESULTS

4.1 Threatened Species

No threatened flora or fauna species were observed.
Anecdotal evidence from local pastoralists reported a sighting [unknown date] of Gouldian Finch at the rest area located approximately 500m north of the eastern most extent of Seismic Line 1 (refer **Figure 2**).

4.2 Habitat Descriptions

The following table describes the habitats that occur within the seismic line impact area, including adjacent areas and proposed well pad options. The areas of intact vegetation provide a range of habitats that may support a diversity of fauna species.

Table 6 Habitat Descriptions

Ephemeral Waterways and Riparian Vegetation

Plate 1 Ephemeral waterway and riparian vegetation

Riparian areas often have significantly higher fauna diversity than surrounding areas. Whilst the riparian vegetation in the study area is predominantly sparse woodland (as per the above photo), habitat values include:

- Provides water (in wet season) and supports flowering and seeding vegetation as well as prey (aquatic species, invertebrates and small vertebrates) for small mammals, birds and reptiles
- Riparian vegetation provides refuge, sheltered movement corridors for fauna and shade for creeks and pools
- No pools will be present during proposed works given the 'dry' 2018/19 wet season and the highly ephemeral nature of the drainage lines and waterways in relation to the project areas.
- Riparian woodlands associated with Balbirini Creek and Relief Creek have some hollows which are important for hollow-dependent animals (e.g. parrots, bats)
- Drainage lines and waterways were impacted by cattle, pigs and buffalo
- Potential habitat for Gouldian finch (*Erythrura gouldiae*) where eucalypt and paperbark woodlands, usually with a grassy understorey, occur in the vicinity
- Potential habitat for painted honeyeater (*Grantiella picta*) where riparian woodlands have an abundance of mistletoes.

Woodland or Shrubland

Plate 2 Low open woodland, *Eucalyptus pruinosa* woodland

Woodland or shrubland habitat values include:

- Woodland trees and shrubs provide food for sap and nectar eaters and supports prey (invertebrates and small vertebrates) for small mammals, birds and reptiles
- Provide shelter and protected areas for breeding for a variety of fauna, including live vegetation and fallen woody debris
- Woodlands with hollow bearing trees are of critical importance for hollow-dependent animals (e.g. parrots, bats)
- Potential habitat for painted honeyeater (*Grantiella picta*) where woodlands have an abundance of mistletoes, usually where *Acacia* spp. dominate.
- Potential habitat for spectacled hare-wallaby (*Lagorchestes conspicillatus leichardti*) dry *Eucalyptus* and *Acacia* in open forests, open woodland, tall shrublands, tussock grasslands and hummock grasslands

Sandstone Jump-ups and plains. Rocky outcrops.

Plate 3 Rocky habitats

Rocky slopes, stony hills and rock outcrops. Habitat values include:

- Provide shelter and protected areas for breeding for a variety of fauna
- The rocky habitats are largely unaffected by human impacts such as grazing
- Potential habitat for small mammals and reptiles

Open Grassland Plains with Sparse Woodland

Plate 4 Open grassland

Open grassland on alluvial plains provide:

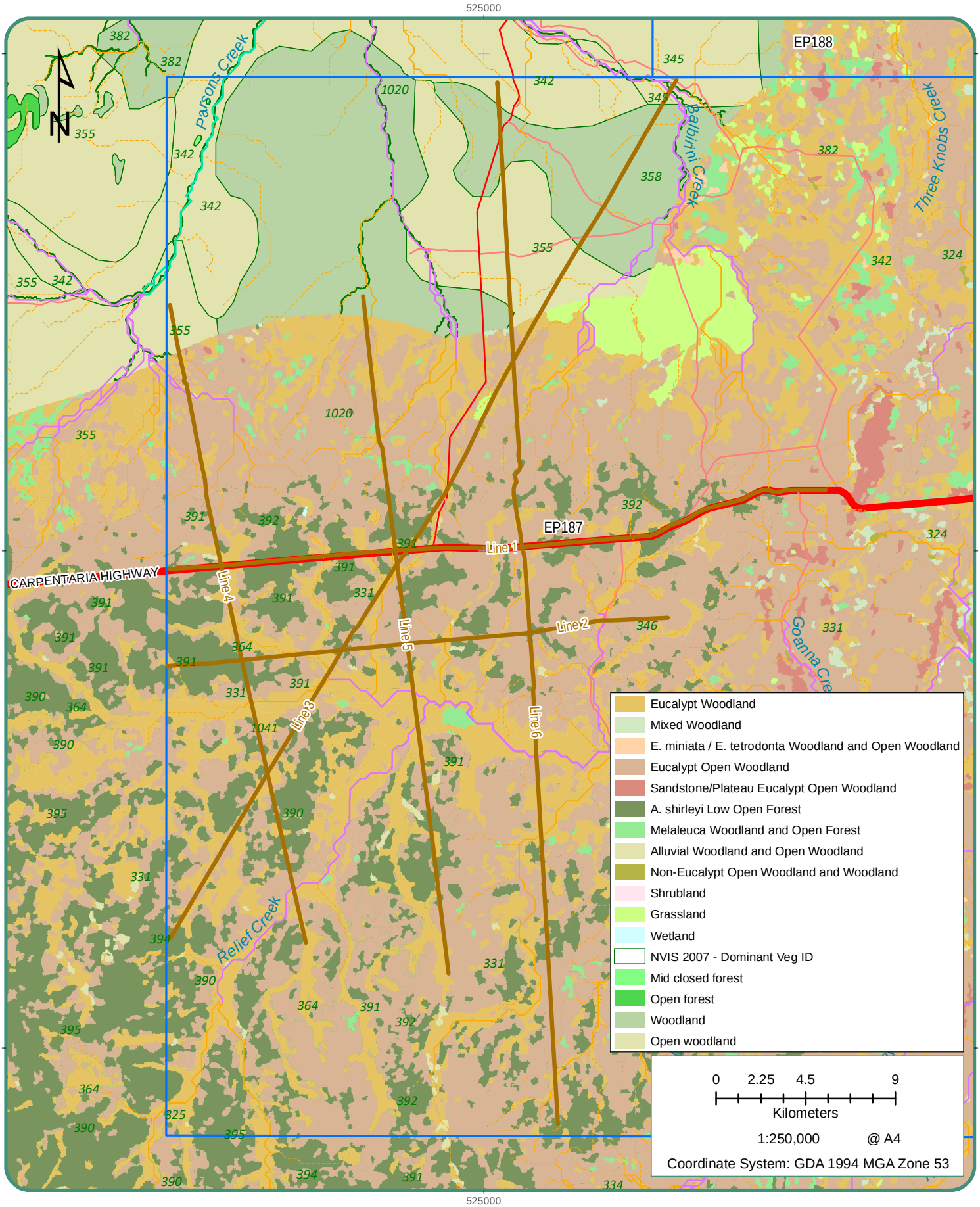
- deep cracks in dry alluvials which provides refuge for reptiles, amphibians and small mammals
- Large areas open for cattle grazing
- Open areas for raptor foraging

***Acacia shirleyi* (lancewood)**

Plate 5 Lancewood patches

Lancewood patches provide the thickest vegetation cover in the landscape and therefore provides:

- Shade for a variety of fauna species
- Fallen branches provide ground cover and refugia for small mammals and reptiles
- Open areas for raptor foraging
- Potential habitat for painted honeyeater (*Grantiella picta*) where woodlands have an abundance of mistletoes, usually where *Acacia* spp. dominate.



TITLE:

Habitats

MAP NO: IOG_0003

PROJECT: EP187 Investigation

LEGEND

- Seismic lines (30m corridor)
- Tenements

Roads

- Principal Road
- Secondary Road
- Minor Road
- Track

Stream Order

Intermittant Streams

- 1
- 2

Creeks

- 3

Rivers

- 4
- 5
- 6
- 7

FOX & CO ENVIRONMENTAL

Date: 29/05/2019

Data Source:
Vegetation Survey of McArthur River Catchment, Northern Territory, 2011-12-01, Department of Environment and Natural Resources
NVIS Version 3.1 National Vegetation Information System, NT Data Compilation, 2000-01-14, Department of Environment and Natural Resources

Document Path: C:\Users\s.vale\OneDrive\Documents\Fox & Co Environmental\Projects\Imperial oil and gas\EP187 Clearing plan\Maps\IOG_0001 Clearing plan.mxd

5 CONCLUSION

A number of previous environmental investigations have been undertaken on EP187 to gain an understanding of seasonal baseline surface water quality and also landscape values across the tenement. This was to inform potential exploration areas and no-go areas in relation to environmental values.

A revised desktop assessment and further targeted surveys were undertaken with specific focus on Imperial's proposed seismic lines and well pads. The ecological assessment was carried out to identify weeds, key ecological characteristics and potential constraints to the proposed seismic and drilling activities on EP187 in the Northern Territory.

No threatened fauna or flora species were observed during on-ground surveys. Habitat exists for some conservation significant species in the area, however given the narrow linear nature of disturbance (and localised regarding well pads), habitat requirements and likelihood of occurrence, impacts from proposed seismic and well pad construction are considered low.

6 RECOMMENDATIONS

Some additional access tracks have been proposed since field surveys were undertaken in 2018 and April 2019. Additional access tracks have been selected to avoid slopes greater than 2%, waterways/drainage lines and sensitive areas as per the DENR Land Clearing Guidelines, February 2019.

Nonetheless, the following is recommended to ensure compliance with regulatory provisions:

- Undertake additional weed survey on new areas prior to works proceeding.
- Undertake concurrent environmental assessments including threatened / significant species assessment, vegetation and soil descriptions and general assessment of biodiversity and sensitive areas.
- Undertake works in accordance with approved clearing permits and environmental management plans.

7 WORKS CITED AND RELEVANT REFERENCE DOCUMENTS

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Curtis, L.K. & Dennis, A.J. eds., 2012. Queensland's Threatened Animals, Collingwood, VIC, Australia: CSIRO Publishing.

Department of the Environment (2019). *Erythrotriorchis radiatus* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Thu, 30 May 2019 12:45:32 +1000.

Department of the Environment, 2015h. *Erythrura gouldiae* in Species Profile and Threats Database. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=413 [Accessed May 27, 2015]

Department of the Environment, 2016d. *Falcunculus frontatus whitei* in Species Profile and Threats Database.

Department of the Environment, 2015m. *Macrotis lagotis.* Species Profile and Threats Database. Available at: http://www.environment.gov.au/sprat [Accessed January 20, 2015].

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Department of the Environment, 2016k. *Saccolaimus saccolaimus nudicluniatus* in Species Profile and Threats Database.

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APPENDIX A

Search Results

Australian Government
Department of the Environment and Energy

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.

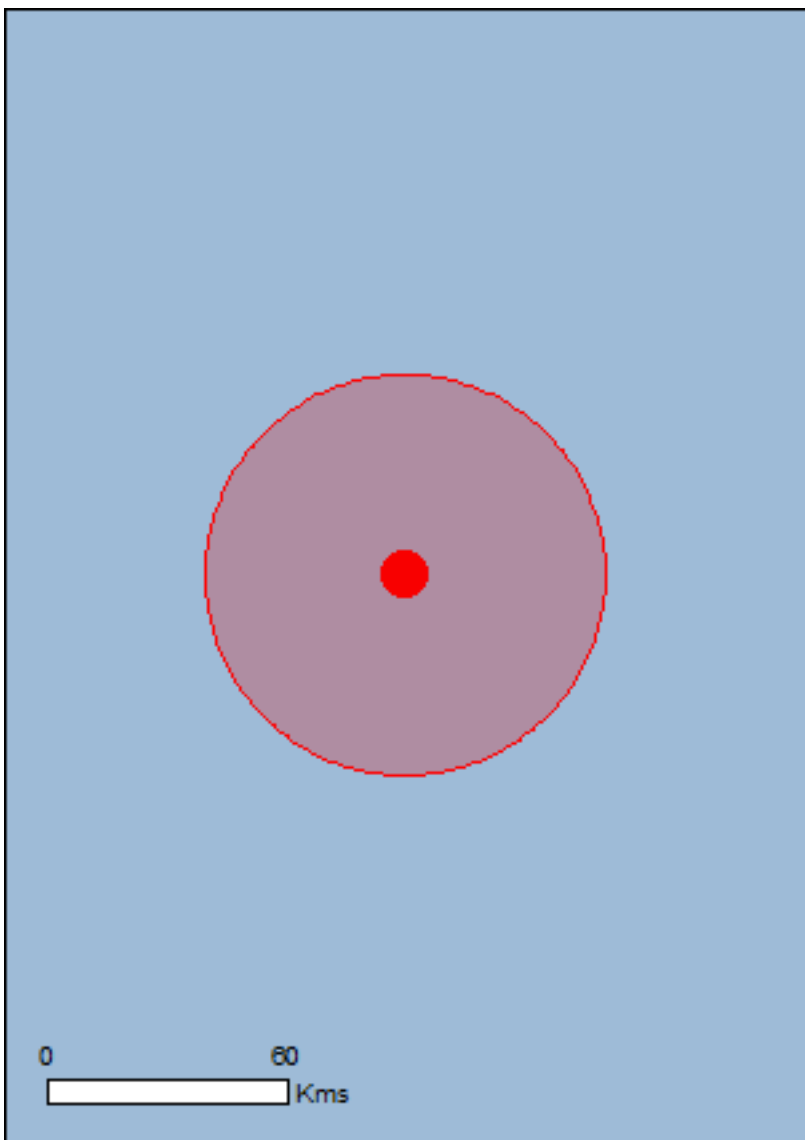
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 16/05/19 10:05:56

Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

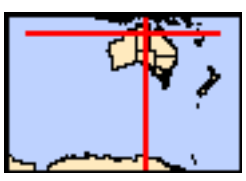
Caveat
Acknowledgements



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates

Buffer: 50.0Km



Summary

Matters of National Environmental 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:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	13
Listed Migratory Species:	15

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 http://www.environment.gov.au/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 Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	21
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	1
Regional Forest Agreements:	None
Invasive Species:	16
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Erythrura gouldiae Gouldian Finch [413]	Endangered	Species or species habitat known to occur within area
Falcunculus frontatus whitei Crested Shrike-tit (northern), Northern Shrike-tit [26013]	Vulnerable	Species or species habitat likely to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted-snipe, Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Tyto novaehollandiae kimberli Masked Owl (northern) [26048]	Vulnerable	Species or species habitat likely to occur within area
Mammals		
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat likely to occur within area
Saccolaimus saccolaimus nudicluniatus Bare-rumped Sheath-tailed Bat, Bare-rumped Sheathtail Bat [66889]	Vulnerable	Species or species habitat may occur within area
Reptiles		
Acanthophis hawkei Plains Death Adder [83821]	Vulnerable	Species or species habitat may occur within area
Elseya lavarackorum Gulf Snapping Turtle [67197]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Sharks		
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Marine Species		
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Migratory Terrestrial Species		
Cecropis daurica Red-rumped Swallow [80610]		Species or species habitat may occur within area
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur

Name	Threatened	Type of Presence within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundo daurica Red-rumped Swallow [59480]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Reptiles		
Crocodylus johnstoni Freshwater Crocodile, Johnston's Crocodile, Johnston's River Crocodile [1773]		Species or species habitat may occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
Limmen	NT

Invasive Species	[Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Frogs		

Name	Status	Type of Presence
Rhinella marina Cane Toad [83218]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Bubalus bubalis Water Buffalo, Swamp Buffalo [1]		Species or species habitat likely to occur within area
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Plants		
Acacia nilotica subsp. indica Prickly Acacia [6196]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Vachellia nilotica Prickly Acacia, Blackthorn, Prickly Mimosa, Black Piquant, Babul [84351]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, 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 distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for 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 reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-16.73095 135.2186

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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NT Significant and Threatened Fauna in relation to IOG 2019 EP187 Proposed Seismic Program

Scientific Name	Common Name	Latitude	Longitude	Date	TWPCA	EPBCA
Demansia quaesitor	Sombre Whipsnake	-16.6986	135.3179	1994-11-01	DD	(not listed)
Malurus coronatus macgillivrayi	Purple-crowned Fairy-wren (Gul	-16.8152	135.3845	1985-06-28	NT	(not listed)
Onychogalea unguifera	Northern Nailtail Wallaby	-16.6152	135.3845	1986-08-24	NT	(not listed)
Onychogalea unguifera	Northern Nailtail Wallaby	-16.6986	135.3845	1986-08-24	NT	(not listed)
Onychogalea unguifera	Northern Nailtail Wallaby	-16.6486	135.3845	1986-08-24	NT	(not listed)
Tiliqua scincoides	Common Blue-Tongued Lizard	-16.7319	135.1179	1994-11-29	DD	(not listed)
Ardeotis australis	Australian Bustard	-17.0008	135.4347	2000-11-01	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.9007	135.335	2000-11-01	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.8003	135.3028	2000-11-01	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.8002	135.1677	2000-11-01	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.8	135.2023	2000-11-01	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.7998	135.3535	2000-11-01	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.7997	135.3713	2000-11-01	NT	(not listed)
Onychogalea unguifera	Northern Nailtail Wallaby	-16.6486	135.3845	1986-07-21	NT	(not listed)
Onychogalea unguifera	Northern Nailtail Wallaby	-16.6152	135.3845	1986-07-21	NT	(not listed)
Onychogalea unguifera	Northern Nailtail Wallaby	-16.6986	135.3845	1986-07-21	NT	(not listed)
Merops ornatus	Rainbow Bee-eater	-16.7486	135.4212	1978-04-06	LC	(not listed)
Burhinus grallarius	Bush Stone-curlew	-16.7486	135.4212	1978-01-23	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.7486	135.0812	1980-06-04	NT	(not listed)
Mesembriomys macrurus	Golden-backed Tree-rat	-16.58	135.32	1901-10-25	CR	(NL)
Mesembriomys macrurus	Golden-backed Tree-rat	-16.58	135.32	1901-10-25	CR	VU
Ardeotis australis	Australian Bustard	-16.8003	135.3028	2000-11-01	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.9007	135.335	2000-11-01	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.7998	135.3535	2000-11-01	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.7997	135.3713	2000-11-01	NT	(not listed)
Ardeotis australis	Australian Bustard	-17.0008	135.4347	2000-11-01	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.7486	135.0812	1980-06-04	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.8002	135.1677	2000-11-01	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.8	135.2023	2000-11-01	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.7486	135.0812	1980-06-04	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.8002	135.1677	2000-11-01	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.8	135.2023	2000-11-01	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.8003	135.3028	2000-11-01	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.9007	135.335	2000-11-01	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.7998	135.3535	2000-11-01	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.7997	135.3713	2000-11-01	NT	(not listed)
Ardeotis australis	Australian Bustard	-17.0008	135.4347	2000-11-01	NT	(not listed)
Merops ornatus	Rainbow Bee-eater	-16.7047	135.3675	2015-05-17	LC	(not listed)
Ardeotis australis	Australian Bustard	-16.5556	135.2389	2006-07-01	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.705	135.3653	2002-04-26	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.75	135.0833	1980-06-04	NT	(not listed)
Merops ornatus	Rainbow Bee-eater	-16.75	135.4167	1978-04-06	LC	(not listed)
Ardeotis australis	Australian Bustard	-16.9007	135.335	2000-11-02 08:06	NT	(not listed)
Ardeotis australis	Australian Bustard	-17.0008	135.4347	2000-11-02 08:38	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.7997	135.3713	2000-11-02 07:52	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.7998	135.3535	2000-11-02 07:52	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.8003	135.3028	2000-11-02 07:50	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.8	135.2023	2000-11-02 07:46	NT	(not listed)
Ardeotis australis	Australian Bustard	-16.8002	135.1677	2000-11-02 07:45	NT	(not listed)

Significant Flora in Relation to IOG 2019 EP187 Seismic Program

Family	Scientific Name	Common Name	Date	Latitude	Longitude	TPWCA	EPBCA	Threatened Species	Significant Species	Endemic to NT	Restricted Range	Growth Form
POACEAE	*Eriachne squarrosa*	Eriachne, Wanderrie Grass	1981-07-06	-16.71333235	135.40612	DD	-	No	Yes	No	N	Tussock grass
LYTHRACEAE	*Ammannia crinipes*	Nesaea	2004-08-04	-16.6864	135.4317	DD	-	No	Yes	No		Forb
ERIOCAULACEAE	*Eriocaulon carpentariae*	Eriocaulon	2004-08-04	-16.6864	135.4317	DD	-	No	Yes	No	N	Forb
POLYGALACEAE	*Polygala petrophila var. petrophila*	Polygala	1947-05-13	-16.73333333	135.23333	DD	-	No	Yes	No	N	Forb
SAPINDACEAE	*Dodonaea barklyana*	Distichostemon	1971-06-04	-16.7	135.41667	DD	-	No	Yes	No		Shrub

APPENDIX B

Likelihood of Occurrence

Table 7 Likelihood of Occurrence

Species Name	EPBC Act Status	TPWC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
AVES					
Erythrura gouldiae Gouldian Finch	E	V	NT	Inhabits open woodlands that are dominated by Eucalyptus trees and support a ground cover of Sorghum and other grasses. Often found in vegetation along watercourses and mangrove edges. Critical components of suitable core habitat for the Gouldian Finch include the presence of favoured annual and perennial grasses (especially Sorghum), a nearby source of surface water and, in the breeding season, unburnt hollow-bearing Eucalyptus trees (especially *E. tintinnans*, *E. brevifolia* and *E. leucophloia*) Its breeding habitat is usually confined to ridges and rocky foothills, probably due to the presence of Sorghumgrasses(Department of the Environment 2015h; Morcombe 2003).	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present along Balbarini and Relief Creek. This species has been recorded at the rest area (anecdotal evidence), adjacent to the eastern end of Seismic Line 1. No clearing is proposed in this area as the seismic activity runs parallel to the Carpentaria Highway. Risk of impact is considered low.
Falcunculus frontatus whitei Crested Shrike-tit (northern), Northern Shrike-tit	V	-	-	Generally found in open Eucalypt woodlands dominated by Bloodwood, Darwin Box and Roughleaf Cabbage Gum. Species has been recorded in areas with grassy and shrubby understoreys. Seasonally waterlogged areas may attract the species. (Department of the Environment 2016d)	**Low potential to occur** species has not been recorded in the region (no records from desktop searches) and lack of potentially suitable habitat occurs
Grantiella picta Painted Honeyeater	V	V	VU	Sparsely distributed from southern Victoria and south-eastern South Australia to far northern Queensland and eastern Northern Territory where it inhabits forests, woodlands and dry shrublands, often with abundant mistletoe (Birdlife; Morcombe, 2003)	**Low to Moderate potential to occur** the species has been recorded in the region (desktop searches) however not within the study area. Suitable habitat is present anywhere mistletoe is present. Is likely a rare visitor from Qld. Dependent on mistletoe. Avoid clearing Acacia and Eucalypt with mistletoe. Risk of impact is considered low.
Tyto novaehollandiae kimberli Masked Owl (northern)	V	V		Inhabits tall, open Eucalypt forests (particularly those dominated by Eucalyptus miniata and E. tetrodonta). Forages in open vegetation and grasslands and typically roosts and nests in tree hollows, though there are recordings of roostings in monsoon rainforests. Home range is estimated to be 5-10 km^2. Very similar in appearance to the Barn Owl (*Tyto alba*), though the Masked Owl is larger, darker and has more feathering on the feet (Higgins 1999)	**Low to Moderate potential to occur** species has not been recorded in the region (no records from desktop searches) and marginal potentially suitable habitat occurs No large hollows are in the proposed seismic area. No clearing of hollow-

Species Name	EPBC Act Status	TPWC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
					bearing trees (HBT) will occur. Risk of impact is considered low.
Erythrotriorchis radiatus Red goshawk	V	V	NT	Occurs in coastal and sub-coastal areas in riverine, wooded and forested lands of tropical and warm-temperate Australia. Known to prefer forest and woodland with a mosaic of vegetation types, large prey populations (birds), and permanent water. The vegetation types include eucalypt woodland, open forest, tall open forest, gallery rainforest, swamp sclerophyll forest, and rainforest margins. The Red Goshawk nests in large trees, frequently the tallest and most massive in a tall stand, and nest trees are invariably within one km of permanent water (Department of the Environment, 2014b).	**Low potential to occur** No previous records and no suitable habitat
MAMMALIA					
Macroderma gigas Ghost Bat	V	NT		Ghost bats use several roosts or perches each night but often return to the same daytime roost, often in a deep crack or cave. Territory they have been recorded throughout the mainland Top End north of approximately 17⁰ latitude (north of the study area which is 16⁰ latitude) as well as Elcho Island, Groote Eylandt and other nearby islands.	**Low potential to occur** current known distribution does not encompass study area and no suitable habitat in study area.
Macrotis lagotis Greater Bilby	V	V	V	The greater bilby occupies primarily the flat to gently undulating clay areas, but also some stony plains, of the Channel Country amongst a diverse range of annual and perennial grasses and forbs (Curtis & Dennis 2012). The main Queensland population mostly occurs within the Astrebla Downs National Park. Extant population of the Greater Bilby occur in a variety of habitats, usually on landforms with level to low slope topography and light to medium soils. It occupies three major vegetation types; open tussock grassland on uplands and hills, mulga woodland/shrubland growing on ridges and rises, and hummock grassland in plains and alluvial areas. Laterite and rock feature substrates are an important part of Greater Bilby habitat. These habitat support shrub species, such as *Acacia kempeana*, *A. hilliana* and *A. rhodophylla*, which have root-dwelling larvae that provide a constant food source for the Greater Bilby. They also contain Spinifex hummocks which are quite uniform and discrete, providing runways between hummocks, enabling easier movement and foraging. Greater bilbies occurrence is strongly associated with higher rainfalls and temperatures, particularly as these conditions may not be	**Low potential to occur** current known distribution does not encompass study area

Species Name	EPBC Act Status	TPWC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
				favoured by foxes, which are one of their main threats. (Department of the Environment 2015m)	
Mesembriomys macrurus Golden-backed Tree-rat	V	CE	LC	Inhabits a variety of habitat types. Woodlands over tussock or hummock grasses on volcanic country, black soil plains and rugged sandstone country are common, though the Golden-backed Tree-rat has also been associated with mangroves and grasslands on some islands (Department of the Environment 2016g)	**Low potential to occur** current known distribution does not encompass study area Previous records over 100 years old, now considered likely extinct from local area
Saccolaimus saccolaimus nudicluniatus Bare-rumped Sheathtail Bat	CE	-	-	Inhabits mostly lowland areas where woodland, forest and open areas are present. Foraging has been suggested to take place in habitat edges and clearings, though no information is available on changes in behaviour between wet and dry seasons. Roosting has been solely recorded to occur in tree hollows (Department of the Environment 2016k)	**Low potential to occur** current known distribution does not encompass study area
REPTILIA					
Acanthophis hawkei Plains Death Adder	V	V	-	Found in earth fissures during the dry season and shelters underground debris in the wet season. It is said to be confined to the Barklay Tablelands on the black soil Mitchell grass plains(Cogger 2014).	***Low* potential to occur** No previous records. No potential habitat on seismic or well pad areas. Risk considered low due to lack of suitable habitat.
Varanus panoptes Yellow-spotted Monitor	-	V	-	Ground dwelling lizard, feeds mainly on insects and small vertebrates. Can grow to 1.2 metres. Occupies a range of habitats such as coastal beaches, grasslands, floodplains and woodlands (Cogger 2014).	**Moderate potential to occur** Has potential to occur due to wide range of occurrence and wide rangeof habitats. Highly mobile species. Low risk of impact.

EPBC Act (species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), Aust.): CE = Critically Endangered, E = Endangered, V = Vulnerable, M = Migratory, Ma = Marine

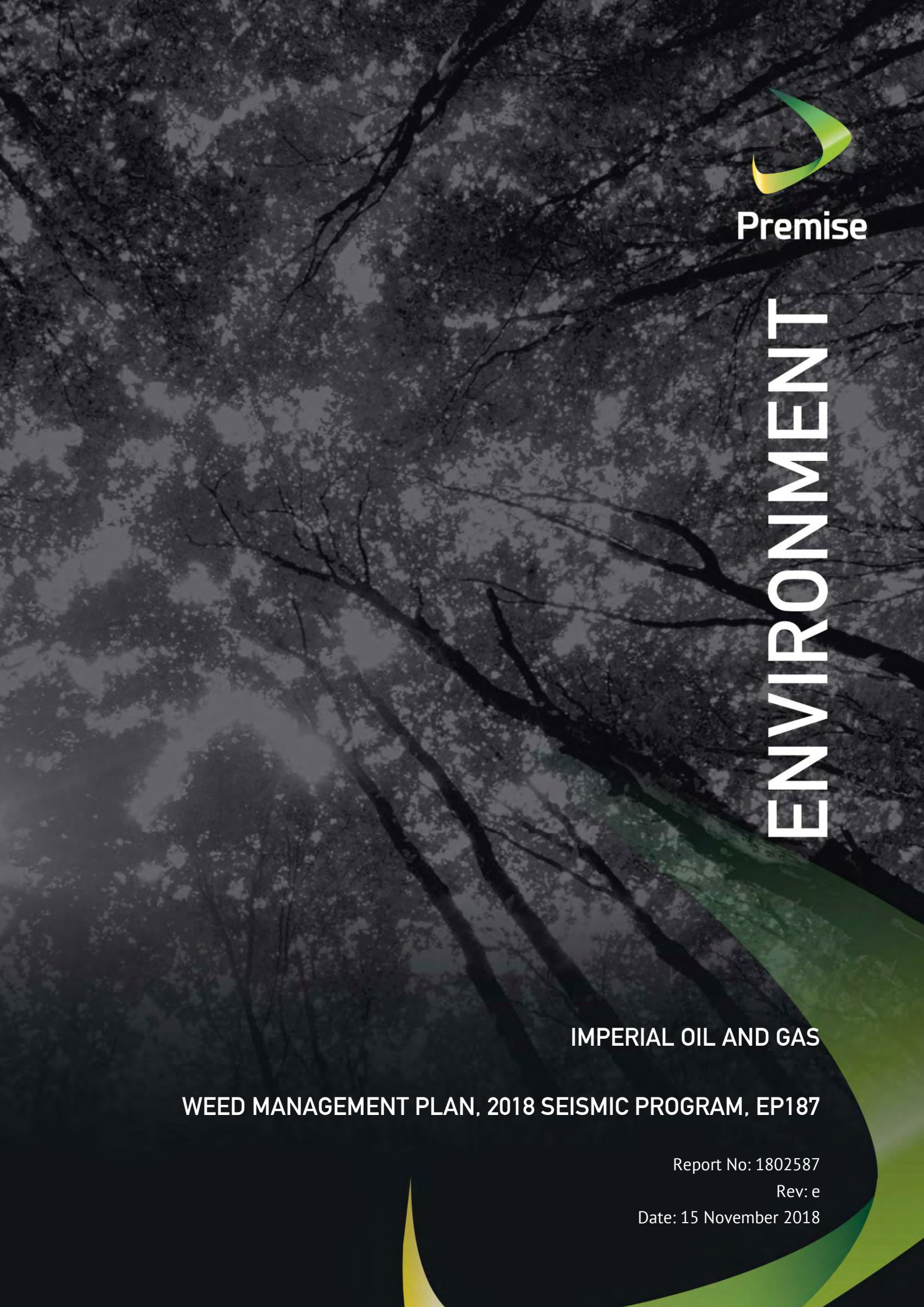
TPWC Act (species listed under the *Territory Parks and Wildlife Conservation Act 2000* (TPWC Act), NT): CE = Critically Endangered, E = Endangered, V = Vulnerable, NT=Near Threatened

IUCN (species listed under the International Union for Conservation of Nature (IUCN) Red List of Threatened Species): EX= Extinct, EW= Extinct in the Wild, CR= Critically Endangered, EN= Endangered, VU= Vulnerable, NT=Near Threatened, LC= Least Concern

Endangered, VU= Vulnerable, NT=Near Threatened, LC= Least Concern

APPENDIX C

Weed Management Plan



Premise

ENVIRONMENT

IMPERIAL OIL AND GAS

WEED MANAGEMENT PLAN, 2018 SEISMIC PROGRAM, EP187

Report No: 1802587

Rev: e

Date: 15 November 2018

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DOCUMENT AUTHORISATION					
Revision		**Rev. Date**		**Report Details**	
DRAFT		September 2018		Weed Management Plan	
a		September 2018		Minor amendments as per NT DENR review	
b		October 2018		Updated following field surveys	
c		November 2018		Updated following NT DENR final review	
d		12 November 2018		Update following additional field survey	
e		15 November 2018		Update following NT DENR wash/blow down comments	
Prepared By		**Reviewed By**		**Authorised By**	
P.F		A.F		P. Fox	

Executive Summary

Premise conducted a weed assessment on the Imperial Oil and Gas Limited (Imperial) exploration tenement EP187. The focus of the survey was seismic lines proposed for the 2018 seismic program. A desktop assessment was undertaken to identify all declared flora species that have previously been recorded in the area, or at risk of being introduced. A field survey at each proposed seismic line locations was undertaken on the 5-7 October 2018 and 8 November 2018.

Two weed species were recorded during the field survey. Both weeds are Class B declared weeds in the Northern Territory (*Hyptis suaveolens* (Hyptis) and *Parkinsonia aculeata* (Parkinsonia)). Hyptis was primarily recorded along the Carpentaria Highway (and also in some areas along Broadmere Road) in disturbed areas while Parkinsonia was recorded at a stock water bore (No. 3 bore) north of the Carpentaria Highway.

A range of mitigation measures and monitoring protocols have been recommended to reduce the risk and associated impacts of new weed introductions on the tenement.

1 INTRODUCTION

Premise conducted a weed survey on EP187 between 5-7 October 2018 and 8 November 2018. The focus of the survey was approximately 230 kilometres of proposed 2D seismic across the western portion of the tenement. A desktop assessment was undertaken of known weed records and the Northern Territory Department of Environment and Natural Resources (DENR) was consulted to determine which species were considered priority weeds (based on known occurrence and threat of introduction) and the following were named of prime concern:

Mesquite (*Prosopis spp),* Prickly acacia (*Vachellia nilotica),* Parkinsonia (*Parkinsonia aculeata),* Chinee apple (*Ziziphus mauritiana),* Mimosa (*Mimosa pigra),* Bellyache bush (*Jatropha gossypiifolia),* Gamba grass (*Andropogon gayanus),* Neem (*Azadirachta indica),* Grader grass (*Themeda quadrivalvis),* Snake weed (*Stachytarpheta spp),* Devils claw (*Martynia annua),* Hyptis (*Hyptis suaveolens),* Khaki weed (*Alternanthera pungens),* Sida (*Sida acuta, Sida cordifolia, Sida rhombifolia),* Lion's tail (*Leonotis nepetifolia),* Parthenium (*Parthenium hysterophorus)* and Rubber vine (*Cryptostegia spp.).*

A weed is defined as any plant that requires some form of action to reduce its harmful effects on the economy, the environment, human health and amenity. (Natural Resource Management Ministerial Council, 2006). There are two types of invasion: introduction of exotic plants and movement by native species into new areas well outside their native range. Weeds have an adverse effect on an area's environmental values and ecological functioning for the following reasons:

- Competition with native species;
- Change in the structure of a plant community through addition or removal of strata;
- Repress recruitment of native species;
- Change the natural fire fuel characteristics, which can change the natural fire regime to the detriment of native species, often resulting in the loss of native species;
- Change the food sources and habitat values available to native fauna, reducing some and increasing others;
- May change geomorphological processes such as erosion; and
- May lead to changes in the hydrological cycle.

Weed species considered to be of greatest threat to natural and economic values on a national basis have been ranked as Weeds of National Significance (WONS) (Thorp and Lynch 1999). Weed significance at a national level was assessed using four major criteria:

- Invasiveness;
- Impacts;
- Potential for spread; and
- Socio-economic and environmental impacts.

At the Northern Territory level, the *Weeds Management Act* (the Act) identifies those weed species that represent a threat to primary industries, natural resources and the environment. The Act enables the following weed declaration classes:

- Class A – to be eradicated
- Class B – growth and spread to be controlled
- Class C* –Not to be introduced into the Northern Territory

* All Class A and B weeds are also Class C

1.1 Location

EP187 is situated in the upper reaches of the McArthur River in proximity to the Barkly Tablelands. The tenement lies to the west of the Tablelands Highway and is crossed east to west by the Carpentaria Highway. **Figure 1** displays the location of the tenement area. Access within the tenement is along the Carpentaria Highway and the Broadmere Road.

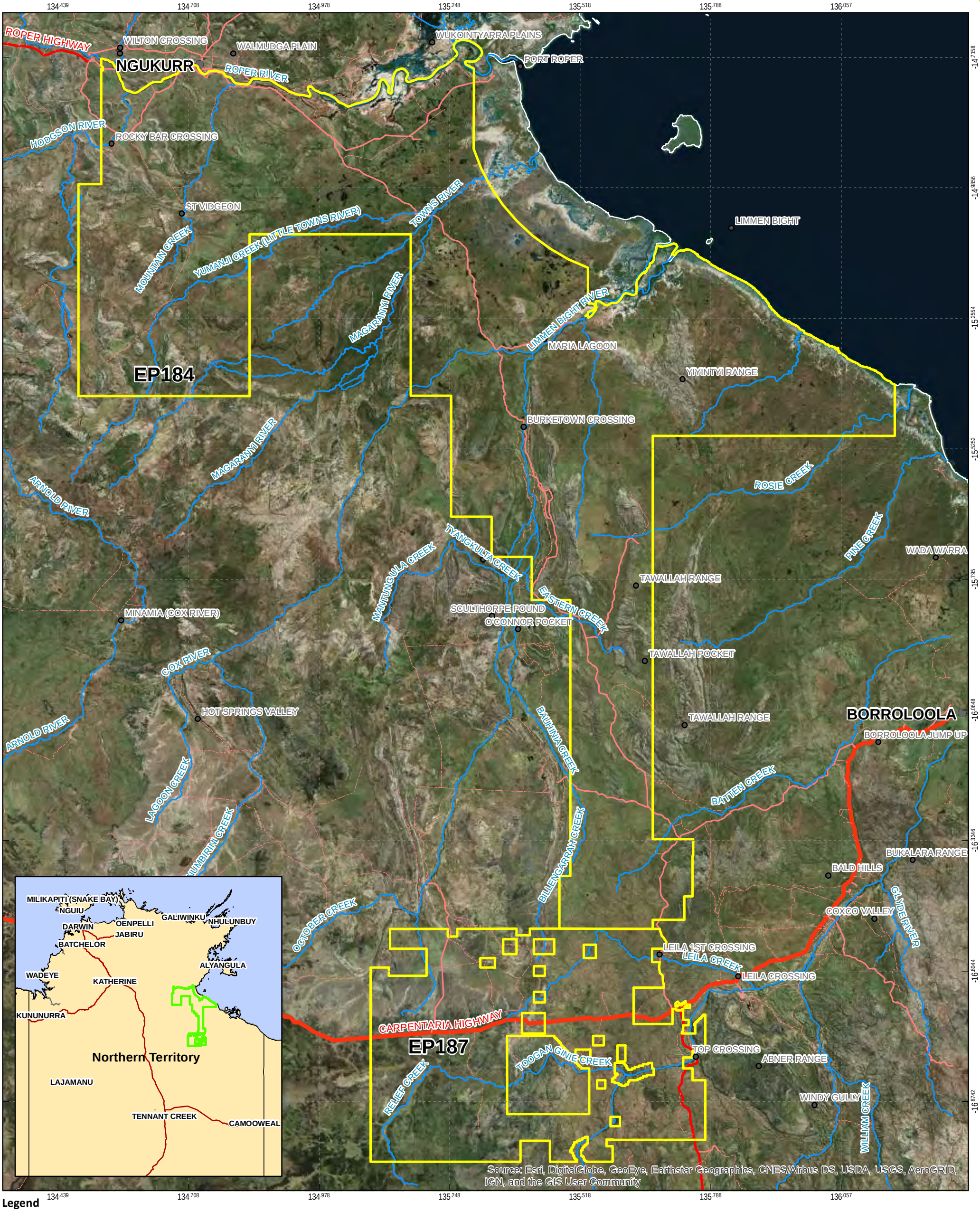
1.2 Proposed Seismic Program Location

The proposed work program will occur late in the 2018 dry season as soon as practical for machinery and personnel to enter the region after approvals have been received. A number of historical pastoral access ways exist through the area as well as newer access ways developed by pastoralists holding S19 permits (under the *Aboriginal Land Rights (Northern Territory) Act*). Where available access to seismic lines will utilize the existing roadways and pastoral tracks.
Table 1 provides the latitude and longitude coordinates of the start and end of the seismic lines. **Figure 2** provides a map of the proposed route of the seismic lines.

Table 1: Seismic line coordinates for start and end (decimal degrees)

Line	Start Longitude	Start Latitude	End Longitude	End Latitude	Length (km)
1	135.0863884	-16.7411125	135.3952893	-16.71437661	32.9
2	135.0853852	-16.78513537	135.3213451	-16.76289145	25.1
3	135.0864645	-16.90880039	135.3249762	-16.51846278	49.8
4	135.1159045	16.94503599	135.0861566	-16.6214288	35.9
5	135.2179975	-16.92453057	135.1772632	-16.61601824	34.2
6	135.2696648	-16.9932462	135.2404939	-16.51967737	52.2

NB: All coordinates are provided in decimal degrees.



Legend

Locality	**Road Network**
Populated Place	Principal Road
Imperial Tenements	Secondary Road
Major Watercourse	Minor Road
NT Border	Track

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0 2.5 5 10 15 20 25
Kilometres

1:825,000 at A3

Horizontal Datum: GDA 1994
Grid: GCS GDA 1994

Weed Management Plan EP187
Imperial Oil and Gas

Regional Location

Figure 1

26 Jul 2018 Z:\GIS\ECO15_0074\GIS\Maps\Working (Optional)\v3_premise\ECO15_0074_01_locality.mxd

135.248 135.518 135.788

-16.3346 -16.6044 -16.8742 -17.144

OCTOBER CREEK
LIMMEN BIGHT RIVER
THREE KNOBS CREEK
BILLENGARRAH CREEK
BATTEN CREEK
LEILA 1ST CROSSING
LEILA CREEK
FAVENC RANGE
CARPENTARIA HIGHWAY
Line 1
Line 2
Line 3
Line 4
Line 5
Line 6
RELIEF CREEK
TOOGANGINIE CREEK
TOP CROSSING
MCARTHUR RIVER
SANDY CREEK
TABLELANDS HIGHWAY
KILGOUR RIVER

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

- Locality
- Populated Place
- Major Watercourse
- Minor Watercourse

Road Network

- Principal Road
- Secondary Road
- Minor Road
- Track

- EP187
- Watercourse Area
- Lake
- Seismic Line
- EP187

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1:350,000 at A3

Horizontal Datum: GDA 1994
Grid: GCS GDA 1994

Weed Management Plan
2018 Seismic, EP187
Imperial Oil and Gas

Seismic Lines

Figure 2

14 Nov 2018 Z:\GIS\OG_0001\GIS\Maps\Working (Optional)\IGO_0001_02_SEISMIC___.mxd

1.3 Legal Requirements

A review of the overall legislative requirements is provided in **Section 9** of the EMP. Of particular relevance to this WMP is the Northern Territory *Weeds Management Act* (the Act)

1.3.1 Weeds Management Act

The purpose of the Act is:

I. to prevent the spread of weeds in, into and out of the Territory and to ensure that the management of weeds is an integral component of land management in accordance with the Northern Territory Weeds Management Strategy 1996 – 2005 or any other strategy adopted to control weeds in the Territory
II. to ensure there is community consultation in the creation of weed management plans; and
III. to ensure that there is community responsibility in implementing weed management plans.

The Act enables the following weed declaration classes:

- Class A – to be eradicated
- Class B – growth and spread to be controlled
- Class C* –Not to be introduced into the Northern Territory

* All Class A and B weeds are also Class C

1.4 Recommendations from Scientific Inquiry

1.4.1 Imperial Weed Officer

As per recommendation 8.3 of the *Scientific Inquiry into Hydraulic Fracturing,* gas companies must have a dedicated weed officer for each gas field. To ensure the required weed management outcomes, the weed officer must have relevant skills and experience and availability to successfully manage weed related issues for the project, including:

- Knowledge of the biology/ecology of local weeds including but not limited to gamba and grader grass
- Knowledge of relevant weed management frameworks including NT legislation and plans, the EPBC Act; and
- Understanding of existing weed management arrangements being undertaken by landholders

As per **Section 7** of the EMP, the Site Coordinator (SC) will be responsible for weed related issues.

Contact: Raymond (Lou) Daniel
Title: IOG Site Coordinator
Location: Relief Creek
Contact Details: 0428 719 314, Raymond.andrew@outlook.com

1.4.2 DENR Weed Officer

Recommendation 8.3 of the *Scientific Inquiry into Hydraulic Fracturing* requires a dedicated Government weed officer who is responsible for:

- coordinating regional weed baseline assessments and subsequent weed surveillance; and

- overseeing strategic and effective management of any weed incursions by gas companies.

This WMP has been prepared in consultation with the Northern Territory (DENR).

Contact: Tahnee Hill
Title: DENR Katherine Regional Weeds Officer
Location: Katherine, NT
Contact Details: Tahnee.Hill@nt.gov.au

2 WEED INTRODUCTION AND RISKS

Section 1 of the EMP describes the seismic program and activities. In summary the seismic operation involves the following:

- Surveyors – pegging seismic lines
- Line preparation - caterpillar H140 Grader will be used to sweep the ground surface of large rocks and fallen timber.
- Seismic survey
- Stick raking and slashing (Carpentaria Highway)
- Rehabilitation

Table 2 Activities and Risk

Project stage	Risk		Mitigation measures
	Introduction of new weeds	Spread of existing weeds	
Seismic Operations	Machinery and equipment sourced from other locations infested with weed species not found in or around EP area	Traversing of weed infested areas with machinery	KD Machinery of Broadmere Station has been retained to provide the seismic line clearance. These operations with be supported by the indigenous contractor PDG-NT from Borroloola who will provide traffic control where required and additional labour and traditional owners as cultural monitors for the duration of the project. Machinery wash/blow down plans agreed with land owner / manager and implemented. Hygiene: vehicle wash down and inspection/certification of process adhered to and documented. All machinery will be inspected and certified as clean before entry into the project area. All contractors will be required to adhere to this process. Records of the certification will be retained by Imperial and made available immediately should it be requested.

Project stage	Risk		Mitigation measures
	Introduction of new weeds	Spread of existing weeds	
			Mark no-go areas if infestations of WONS and/or Class A/C weeds are found within the seismic lines. GPS marking of blown down sites. GPS records of all wash and blow down sites will be recorded by all operators in the field. These GPS records will be retained by Imperial and the sites inspected as soon as practicable following the wet season to check for weed incursions and to undertake management actions as required.
	Personnel unable to identify weeds or unaware of weed species present in areas where machinery and equipment is sourced from	Existing weed distribution not known due to: insufficient survey effort, survey effort conducted at wrong time of year, persons undertaking survey not familiar with / unable to identify declared weed species	Premise and DENR weed surveys undertaken in October/November 2018 prior to seismic to map known weed distribution. Site operators to undergo weed identification training and reporting (onsite training delivered by DENR weed officer). Training for KD Machinery operators.
	Pushing tracks off from the Carpentaria Highway and Broadmere Road into weed free areas	Pushing tracks from identified weed areas into clean weed free areas. Hyptis observed in disturbed areas along Carpentaria Highway and some areas along Broadmere Road.	Ensure to push tracks towards disturbed areas from clean weed free areas. If access is an issue, machinery inspections and washdowns if pushing tracks off Carpentaria Highway and Broadmere Road. Mark weed free areas to be used for access. Clearing, stick raking and slashing off Carpentaria Highway is undertaken last to avoid spreading weeds from the Highway to weed free areas. Wet season spray operations to occur along the Carpentaria highway and Broadmere road to mitigate potential of hyptis spread.

3 WEED SPECIES

The DENR Natural Resource (NR) maps database was used to identify all introduced flora species that have previously been recorded within the area of the tenement associated with the proposed seismic program. Weeds along the Carpentaria Highway between Cape Crawford (Heartbreak Hotel) were also identified as this is the road upon which contractors will be travelling each day. **Figure 3** shows the

historical weed locations and weeds identified during the October 2018 survey. **Figure 4** shows the recent (2018) fire scars over the project area with the recent weed survey results. Hyptis was generally not observed along the Carpentaria Highway (Seismic Line 1) in burnt areas. **Figure 5** shows the additional areas surveyed during the November 2018 seismic weed survey. It should be assumed Hyptis (and potentially other weeds) are present along the burnt disturbed area and mitigation measures should be adhered to.

3.1 Regional Priorities

The DENR *Katherine Regional Weed Management Plan 2015-2020* is guided by three (3) regional priorities to manage weeds. These are:

I. Priority weeds;
II. Priority landscape areas; and
III. Priority pathways of spread

The below table lists weeds that have previously been recorded in the area and also priority weed species as per the *Katherine Regional Weed Management Plan 2015-2020*.

Table 3 Known and/or Priority Weeds

Scientific name	Common name	Declaration	Where located (e.g. on EP, machinery source location, extractive proppant/s, corridors)
*Prosopis spp.**	Mesquite*	WONS, Class A, Class C	Not recorded. Priority weed
*Vachellia nilotica (previously Acacia nilotica)**	Prickly acacia	WONS, Class A, Class C	Previous records. Refer Figure 3.
Parkinsonia aculeata	Parkinsonia	WONS, Class B	Previous and recent (October 2018 survey) records. Refer Figure 3.
*Ziziphus mauritiana**	Chinee apple	Class A, Class C	Not recorded. Priority weed
*Mimosa pigra**	Mimosa	WONS, Class A, Class C	Not recorded. Priority weed
*Jatropha gossypiifolia**	Bellyache bush	WONS, Class A, Class C	Previous records along Carpentaria Highway. Refer Figure 3
*Andropogon gayanus**	Gamba grass	WONS, Class A, Class C	Not recorded. Priority weed
Azadirachta indica	Neem	Class B	Not recorded. Priority weed
Themeda quadrivalvis	Grader grass	WONS, Class B	Not recorded. Priority weed
Stachytarpheta spp	Snake weed	Class B	Not recorded. Priority weed
Martynia annua	Devils claw	Class A	Not recorded. Priority weed
Hyptis suaveolens	Hyptis	Class B	Previous and recent (October 2018 survey) records along Carpentaria Highway. Refer Figure 3
Alternanthera pungens	Khaki weed	Class B	Previous records. Refer Figure 3.
Sida acuta, Sida cordifolia, Sida rhombifolia	Sida	Class B	Previous records. Refer Figure 3.

Leonotis nepetifolia	Lion's tail	Class B, Class C	Previous records. Premise surveys 2015, 2018

*- subject to Statutory Weed Management Plan

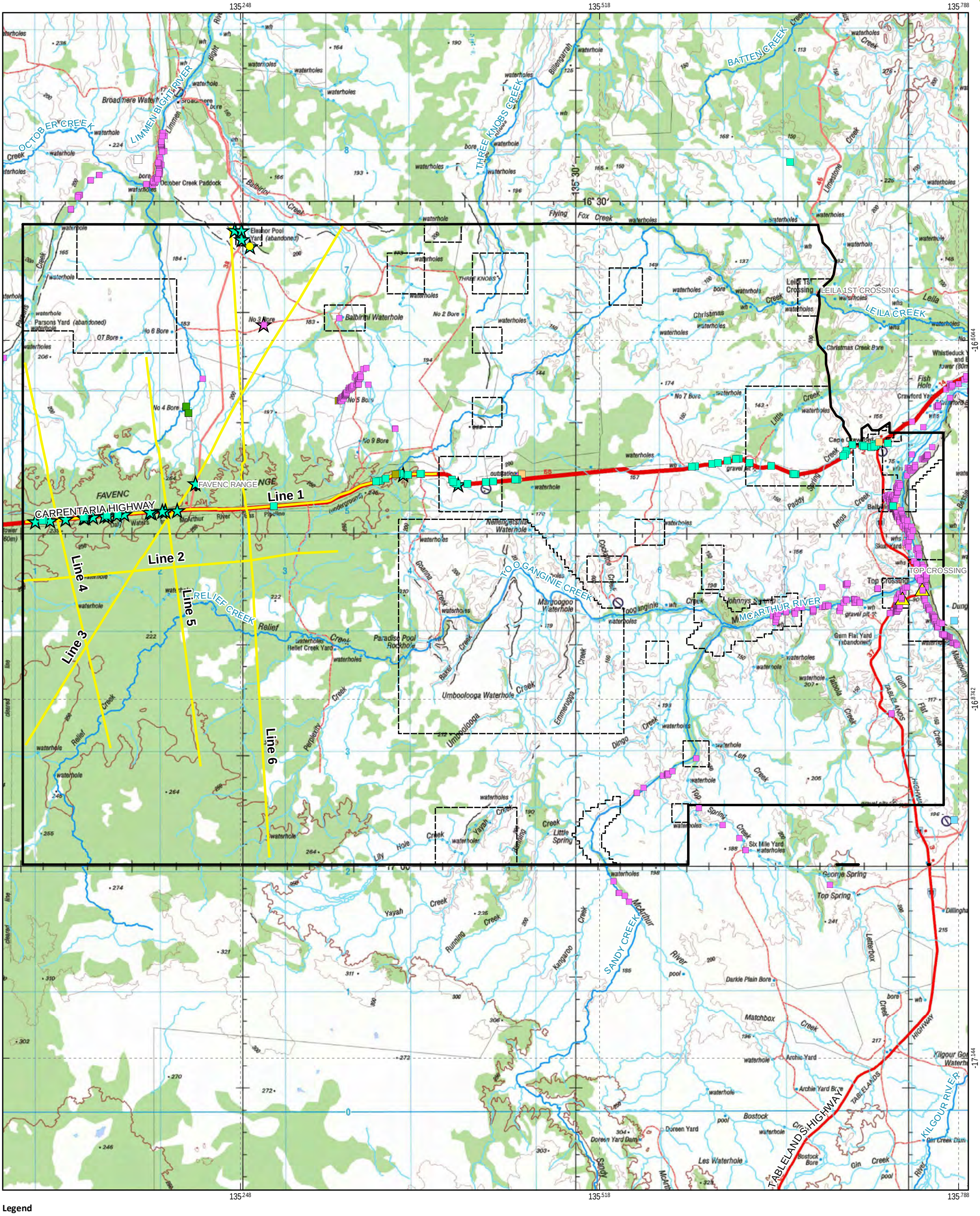
Table 4 lists weed alert species as per the *Katherine Regional Weed Management Plan 2015-2020*. These species are not yet naturalised in the region, however have the potential to have a high level of impact to the region.

Table 4 Weed Alert Species

Scientific name	Common name
Annona glabra	Pond apple
Eichhornia crassipes	Water hyacinth
Cabomba caroliniana	Cabomba
Salvinia molesta	Salvinia
Schinus terebinthifolius	Brazilian pepper
Parthenium hysterophorus	Parthenium
Chromolaena odorata	Siam weed
Cryptostegia spp.	Rubber vine

Parthenium hysterophorus (parthenium) and *Cryptostegia spp* (rubber vine) are of particular concern as they are considered to be a very high risk of introduction to this area of the Northern Territory. This area of the Northern Territory is often accessed from Queensland where these two (2) weed species are well established and have had detrimental impacts to the Queensland beef industry.

On the 14th November 2018, the NT DENR issued a media release stating that Parthenium was recently detected in the Katherine region. Weed management officers are currently controlling and eradicating the occurrence with assistance from the landholder. This recent finding in the region highlights the high risk of introduction of this weed in the area.



Legend

- Locality
- Populated Place
- Major Watercourse
- Minor Watercourse

Road Network

- Principal Road
- Secondary Road
- Minor Road
- Track

- EP187
- Watercourse Area
- Lake
- Seismic Line
- EP187

Weed name

- Bellyache bush
- Burr - Star
- Caltrop - terrestris
- Hyptis
- Khaki weed
- Neem
- Parkinsonia
- Prickly acacia
- Sida - Spiny head
- Sida sp

October 2018 weed survey

- Hyptis
- Parkinsonia
- Lions tail

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N W E S

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Kilometres

1:300,000 at A3

Horizontal Datum: GDA 1994
Grid: GCS GDA 1994

Weed Management Plan
2018 Seismic, EP187
Imperial Oil and Gas

Weeds

Figure 3

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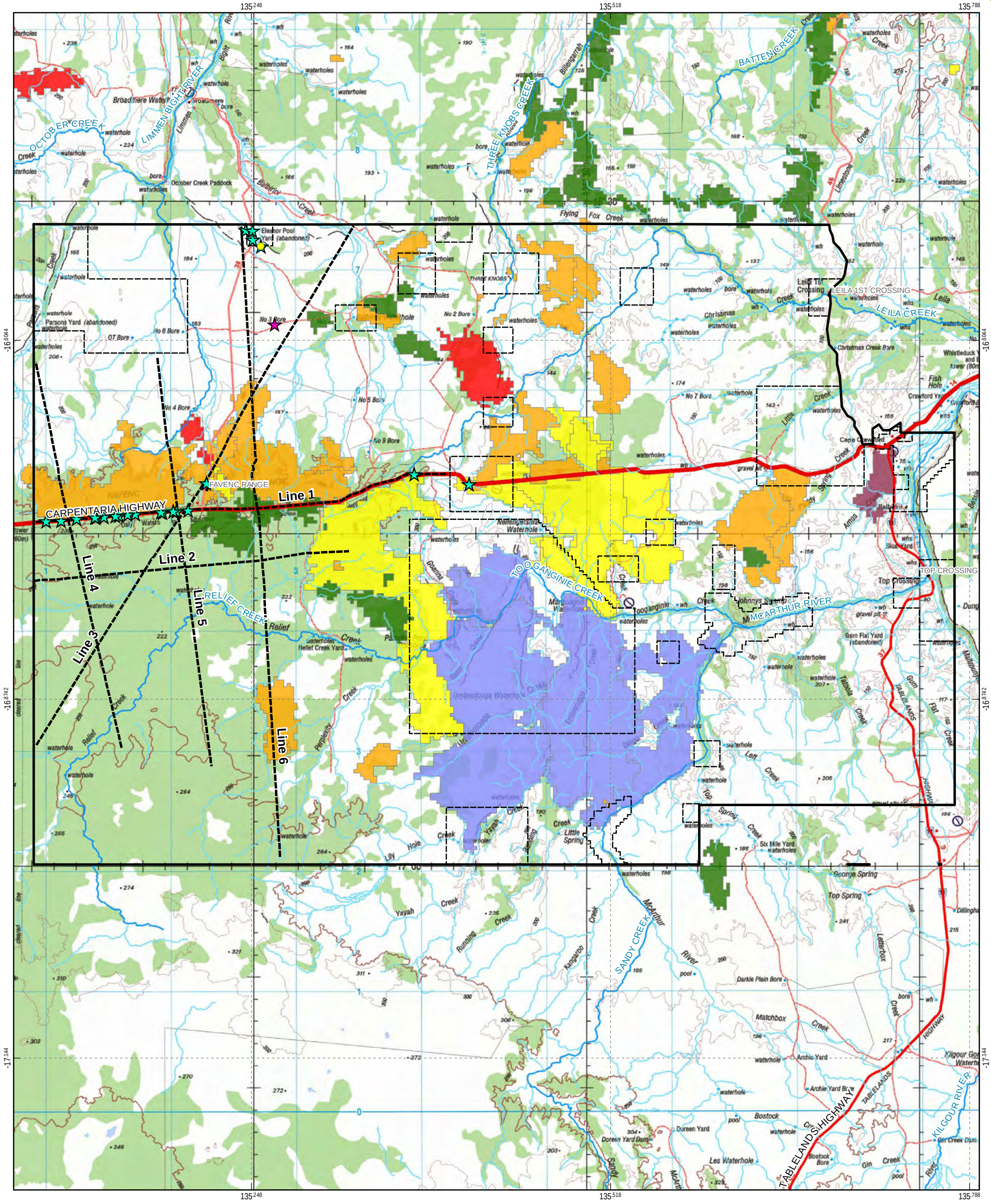

Legend

- Locality
- Populated Place
- Major Watercourse
- Minor Watercourse

Road Network

- Principal Road
- Secondary Road
- Minor Road
- Track

- EP187
- Watercourse Area
- Lake
- Seismic Line
- EP187

October 2018 weed survey

- Hyptis
- Parkinsonia
- Lions tail

Fire Scars (2018)

- January
- February
- March
- April
- May
- June
- July
- August
- September
- October (up to 15th)

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0 1 2 4 6 8 10
Kilometres

1:300,000 at A3

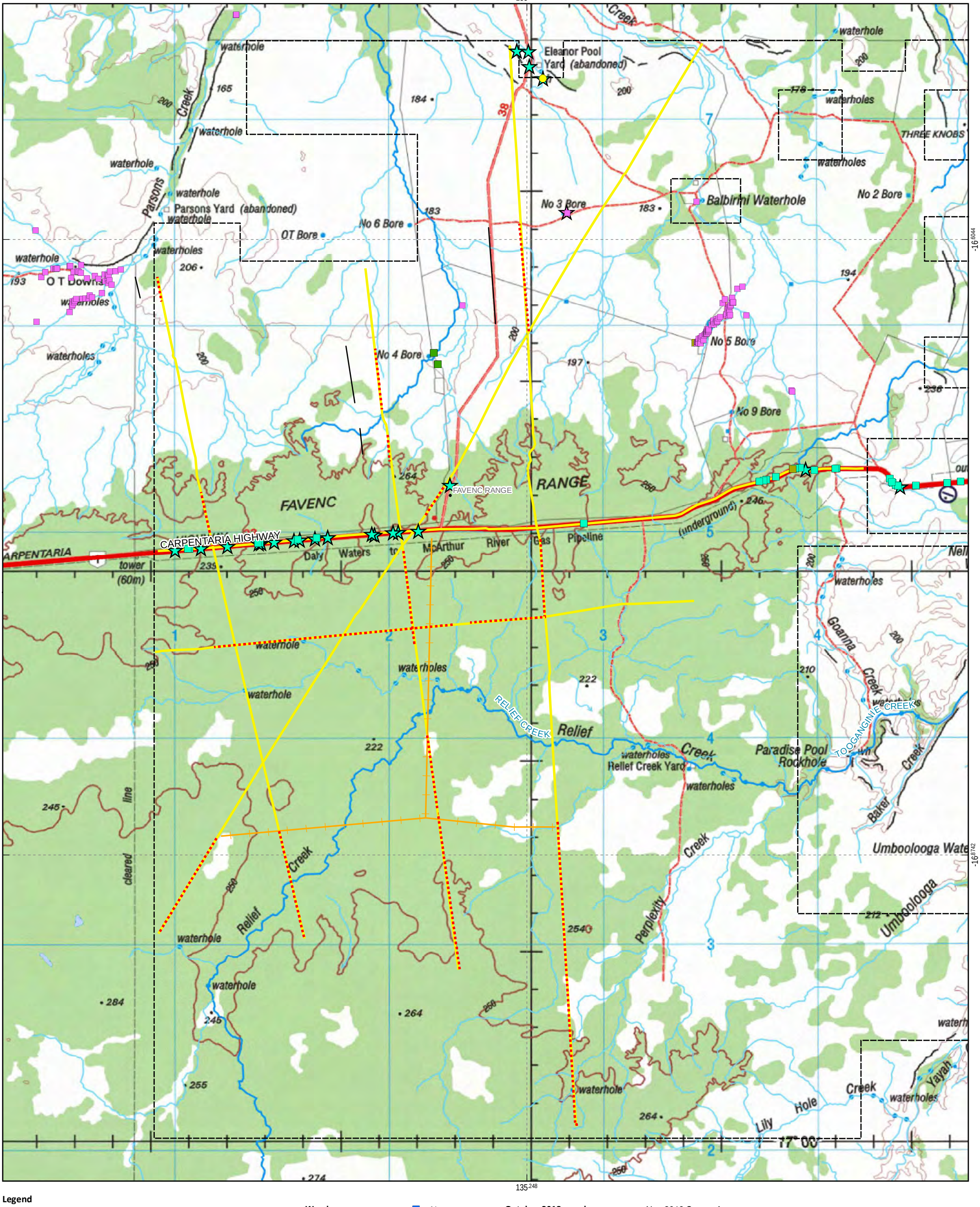
Horizontal Datum: GDA 1994
Grid: GCS GDA 1994

Weed Management Plan
2018 Seismic, EP187
Imperial Oil and Gas

Fire Scars

Figure 4

14 Nov 2018 Z:\GIS\IOG_0001\GIS\Maps\Working (Optional)\IGO_0001_04_FIRE_.mxd



Legend

- Locality
- Populated Place
- Major Watercourse
- Minor Watercourse

Road Network

- Principal Road
- Secondary Road
- Minor Road
- Track

- EP187
- Watercourse Area
- Lake

Weed name

- Bellyache bush
- Burr - Star
- Caltrop - terrestris
- Hyptis
- Khaki weed
- Neem
- Parkinsonia
- Prickly acacia
- Sida - Spiny head
- Sida sp

October 2018 weed survey

- Hyptis
- Parkinsonia
- Lions tail

- Nov 2018 Survey Areas
- Stock fences
- Seismic Line
- EP187

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N W E S

0 0.5 1 2 3 4 5
Kilometres

1:175,000 at A3

Horizontal Datum: GDA 1994
Grid: GCS GDA 1994

Weed Management Plan
2018 Seismic, EP187
Imperial Oil and Gas

November 2018 Weed Survey Areas

Figure 5

14 Nov 2018 Z:\GIS\OG_0001\GIS\Maps\Working (Optional)\IGO_0001_05_resurvey.mxd

4 ANNUAL ACTION PLAN

Control options will be undertaken in accordance with the species-specific Statutory Weed Management Plans and also the Northern Territory Weed Management Handbook (2018).

Table 5 Annual Action Plan

Weed Management Area	Weed species	Management objective	Survey time/s	Treatment time/s	Control method/s	Herbicide
Seismic Line 1	Khaki Weed *Alternanthera pungens* (not observed in October 2018 survey)	No spread. No introduction of new weed species.	End of wet season	Immediately upon identification	Foliar spray	Glyphosate (various trade names)
	Hyptis *Hyptis suaveolens*	No spread. No introduction of new weed species.	End of wet season	Immediately upon identification	Foliar spray	Metsulfuron methyl
Seismic Line 2	None observed in October 2018	No introduction of new weed species.	End of wet season	tba	tba	tba
Seismic Line 3	Parkinsonia east of line 3 at No. 3 Bore. Hyptis *(H. suaveolens)* is present in proximity to where Line 3 crosses Line 1 (Carpentaria Highway) and also where it crosses Broadmere Road	No spread No introduction of new weed species.	End of wet season	immediately upon identification	Ground applied	Tebuthiuron (Graslan^{R}) for Parkinsonia. Metsulfuron methyl for Hyptis
Seismic Line 4	Hyptis *(H. suaveolens)* is present in proximity to where Line 4 crosses Line 1 (Carpentaria Highway)	No spread. No introduction of new weed species.	End of wet season	Immediately upon identification	Foliar spray	Metsulfuron methyl

Weed Management Area	Weed species	Management objective	Survey time/s	Treatment time/s	Control method/s	Herbicide
Seismic Line 5	Hyptis *(H. suaveolens)* is present in proximity to where Line 5 crosses Line 1 (Carpentaria Highway)	No spread. No introduction of new weed species.	End of wet season	Immediately upon identification	Foliar spray	Metsulfuron methyl
Seismic Line 6	Hyptis *(H. suaveolens)* is present along Broadmere Road (northern end). Lion's tail has also been previously observed around the large Elenor Pool.	No spread. No introduction of new weed species.	End of wet season	Immediately upon identification	Foliar spray	Metsulfuron methyl 2,4-D amine (various trade names) for Lion's tail

*Treatment times and herbicide mixing rates are provided in the *Northern Territory Weed Management Handbook 2018*

5 MITIGATION MONITORING

Field surveys were undertaken along each proposed seismic line to determine weed species presence. Other information such as presence of feral animals and vegetation community / species were described along the proposed seismic lines.

Follow-up monitoring (e.g. timeframes following treatment) is species specific and will be undertaken in accordance with the species-specific Statutory Weed Management Plans for the priority weeds (if identified on site) listed in
Table 3.

A post-wet season (2019) survey will be undertaken to actively determine treatment success and weed presence (if any) along the seismic lines. All data will be supplied to DENR.

5.1 Mitigation

Weed mitigation measures should include hygiene protocols to minimise the likelihood of introduction and spread of environmental, agricultural and declared weeds. These should include:

- Vehicle wash-down procedures and facilities to avoid the potential for weed spread including inspection by a certified weed inspector and certification.

- Requirement that all equipment/machinery arrives on site clean of plant and soil matter. This will include inspection by a certified weed inspector and records of weed hygiene certificates for all vehicles and plant arriving on site.
- Require that all equipment/machinery is clean of plant and soil matter before demobilising from one site and working on another.
- Restrict movement of topsoil from sites where significant or declared weeds are known to exist to prevent the spread of weeds on the lot.
- Immediately control and/or remove all weeds that have been introduced or exacerbated by the works.
- Develop weed identification material to be made available to staff and contractors while working on the lot. Problem weeds can be defined during pre-work toolboxes.
- Compulsory site inductions will present information to staff and contractors working on site on problem weed species and protocols to minimise risk of introduction including wash down locations and procedures, certification of plant and machinery before entering site, weed hygiene measures, non-compliance and reporting procedures
- Use existing and designated tracks where possible. Restrict access to areas outside of the cleared footprint to limit the disturbance area to within the approved footprint
- Conduct post-wet season weed surveys to determine whether any weed introductions have occurred and to monitor existing weed populations. Take the appropriate and government authority preferred corrective actions where necessary.
- Rehabilitate seismic lines and tracks.
- Monitoring data of weed populations based on pre-seismic presence and abundance around the seismic lines and tracks.

If weed monitoring indicates new introductions and/or detrimental changes in existing weed species density and abundance, the following should be undertaken:

- Immediate notification to DENR
- Determine the cause of the incident and review the process to ensure that the incident does not re-occur.
- Assess and implement the appropriate course of action in consultation with relevant authorities and landholder

6 NOTIFICATION PROCEDURE

Should a new weed species in the project area be identified, the DENR (Katherine) Regional Weeds Officer (refer **Section 1.4.2**) will be contacted within 48hrs of discovery. Initial notification will be via telephone and subsequently followed up with an email (written notification) within seven (7) working days with details of species, location (latitude and longitude), abundance and any other relevant details such as life stage.

7 RECORDING

During weed surveys over the EP187 seismic lines, weed data was collected in accordance with the DENR *Weed Data Collection Field Guide*.
Information was collected using Arc Collector. Arc Collector is utilised with Arc GIS Online web map viewer. The advantage to using this application includes:

- Real time field data collection updates to Arc GIS online map.

- Efficient and quality data capture capability. A project specific form was established for the EP187 seismic weed survey.
- Allows multiple field crew to capture at the same time and ensures data consistency and reduces processing time back in office.
- Ability to geo tag photos and videos to data capture location.
- Data export compatible with council's ESRI applications so data supply to Imperial and DENR is easy. Also, ability to export as Excel, KML etc.
- Ability to record track log.
- Compatible with iOS, Android, Windows smartphone or tablet

As a backup, data was also collected using a combination of manual field sheets and Garmin handheld GPS units.

All weed data was supplied to the DENR Katherine Weed Management Branch.

8 REPORTING

Following the post-wet season survey, an annual report will be submitted to DENR. The report will include the following:

a) Details of activities implemented to address weed spread and introduction risks (e.g. vehicle wash down / blow down locations, examples of track construction from working from weed free areas into weed infested areas to reduce spread)

b) Submission of all weed data collected

c) Details of survey and monitoring events, including dates, personnel, maps and track data; and

d) Overview of weed control events and success rates (weed control should be captured in detail through the data collection process and submitted as a component of (a))

9 WORKS CITED AND RELEVANT REFERENCE DOCUMENTS

Department of Environment and Natural Resources, (2015) Katherine Regional Weed Management Plan

Department of Environment and Natural Resources, (2018) Draft Weed Management Planning Guide, Onshore Shale Gas Development Projects

Department of Environment and Natural Resources, (2018) Weed Management Plan for Gamba Grass (*Andropogon gayanus*)

Department of Land Resource Management. (2015) Weed Management Plan for Mesquite (*Prosopis* spp.)

Department of Land Resource Management, (2013) Weed Management Plan for Mimosa (*Mimosa pigra*)

Department of Land Resource Management, (2015) Weed Management Plan for Prickly Acacia (*Acacia nilotica*)

Department of Land Resource Management, (2016) Weed Management Plan for Grader Grass (*Themeda quadrivalvis*)

Department of Land Resource Management, (2015) Weed Management Plan for Chinee Apple (*Ziziphus mauritiana*)

Department of Land Resource Management (2013), Weed Management Plan for Bellyache Bush (*Jatropha gossypiifolia)*

Weed Management Branch, Northern Territory Government, (2015) Northern Territory Weed Data Collection Manual - Northern Territory Government of Australia, Darwin

Northern Territory Government, (2018) Northern Territory Weed Management Handbook

Scientific Inquiry into Hydraulic Fracturing in the Northern Territory (2018) Final Report

Natural Resource Management Ministerial Council, 2007. The Australian Weeds Strategy, Canberra: The Department of the Environment and Water Resources

Thorp, J. R. & Lynch, R., 2000. The Determination of Weeds of National Significance, Launceston: National Weeds Strategy Executive Committee

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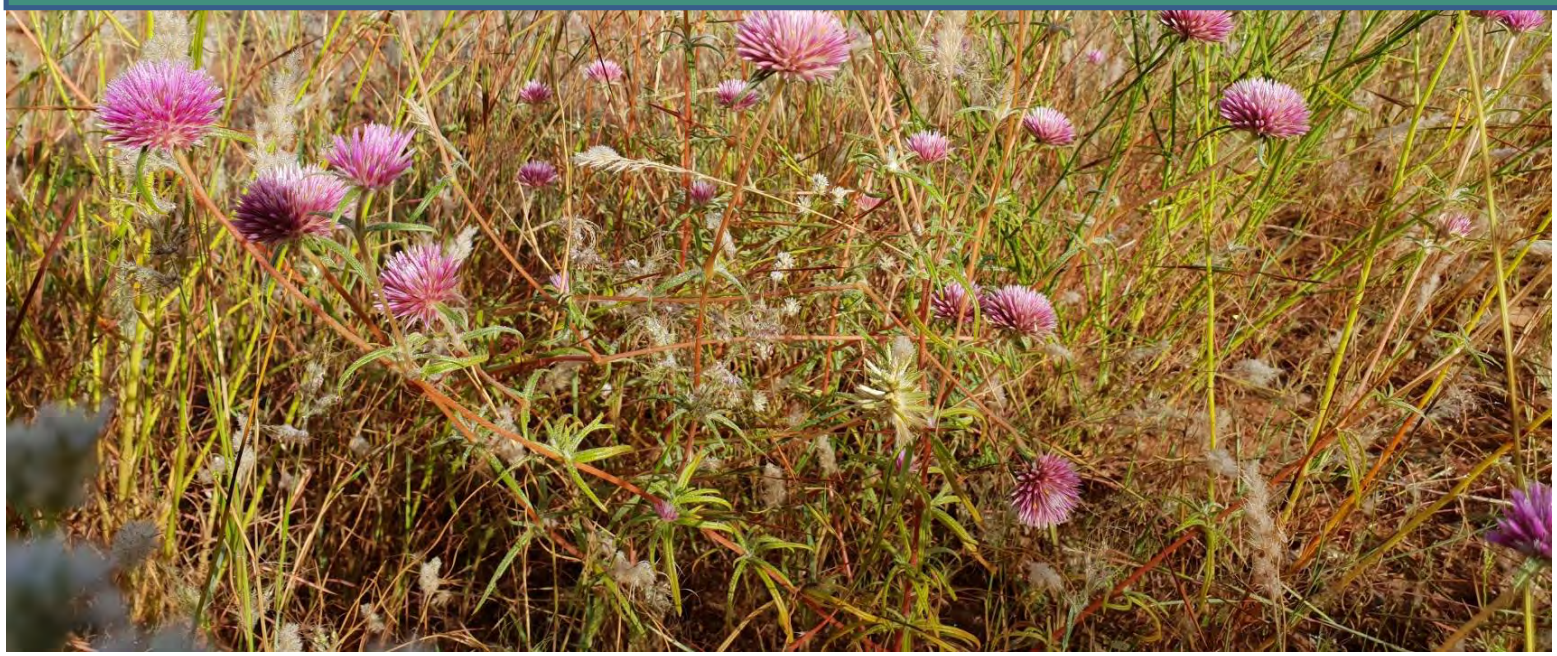
ENGINEERING ENVIRONMENT AGRIBUSINESS WATER

Appendix 14: Post 2018/19 Wet Season Weed Survey

EP187 POST-WET SEASON WEED SURVEY

Report IG-01

April 2019



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Executive Summary

Previous weed assessments have been undertaken on the Imperial Oil and Gas Limited (IOG) exploration tenement EP187 in relation to a proposed seismic program. Previous surveys were undertaken in dry season conditions (October and November 2018). The timing of these surveys was sub-optimal due to weed die-off and fires during that time of the year in the Northern Territory. Nonetheless, surveys were undertaken under approval by the Northern Territory Department of Environment and Natural Resources (DENR) to assist with obtaining approval for a 2018 seismic program, under condition that an additional weed survey was undertaken post-wet season 2019 in conditions more conducive to observing weed presence and abundance. The 2018 seismic program did not proceed however a post-wet weed survey was undertaken to assist IOG with their 2019 approvals and to fully understand the current weed status associated with the proposed seismic operations. This report details the findings of the 2019 post-wet season weed survey.

A review of the previous Weed Management Plan (WMP) prepared by Premise (*Weed Management Plan, 2018 Seismic Program, EP187, Premise Environment, 15 November 2018, Report # 1802587e*) was undertaken. A summary of different survey results between seasons is provided. Any changes in mitigation measures and monitoring protocols as a result of the revised 2019 weed survey are summarised in this report and the annual action plan.

This addendum report should be read in conjunction with the Premise WMP which provides information on the work program, activities and risks, known and/or priority weeds (including weed alert species), DENR and IOG contacts, mitigation measures and recording/reporting procedures.

Introduction

An independent ecologist in company with a weeds officer of the Northern Territory Department Environment Natural Resources conducted a post-wet season weed survey on EP187 on 10 April 2019. The focus of the survey was approximately 230 kilometres of proposed 2D seismic across the western portion of the tenement.

A desktop assessment and review of the following documents and reference material was undertaken prior to the survey to familiarise with existing information and any changes (if any) of weed listing status:

- DENR known weed records;
- DENR information alerts;
- *Weed Management Plan, 2018 Seismic Program, EP187, Premise Environment, 15 November 2018, Report # 1802587e*

Weeds considered prime concern in relation to IOG's proposed seismic operations, based on known occurrence and threat of introduction include:

Mesquite (*Prosopis spp),* Prickly acacia (*Vachellia nilotica),* Parkinsonia (*Parkinsonia aculeata),* Chinee apple (*Ziziphus mauritiana),* Mimosa (*Mimosa pigra),* Bellyache bush (*Jatropha gossypiifolia),* Gamba grass (*Andropogon gayanus),* Neem (*Azadirachta indica),* Grader grass (*Themeda quadrivalvis),* Snake weed (*Stachytarpheta spp),* Devils claw (*Martynia annua),* Hyptis (*Hyptis suaveolens),* Khaki weed (*Alternanthera pungens),* Sida (*Sida acuta, Sida cordifolia, Sida rhombifolia),* Lion's tail (*Leonotis nepetifolia),* Parthenium (*Parthenium hysterophorus)* and Rubber vine (*Cryptostegia spp.).*

Location

EP187 is situated in the upper reaches of the McArthur River in proximity to the Barkly Tablelands. The tenement lies to the west of the Tablelands Highway and is crossed east to west by the Carpentaria Highway. **Figure 1** displays the location of the tenement area in relation to the broader region. The main access within the tenement is along the Carpentaria Highway and the Broadmere Road.

Proposed Seismic Program Location

The proposed work program will occur in the 2019 dry season (June/July). A number of historical pastoral access ways exist through the area as well as newer access ways developed by pastoralists holding S19 permits (under the *Aboriginal Land Rights (Northern Territory) Act*). Where available access to seismic lines will utilize the existing roadways and pastoral tracks.
Table provides the latitude and longitude coordinates of the start and end of the seismic lines. **Figure 2** provides a map of the proposed route of the seismic lines.

Table 1: Seismic line coordinates for start and end (decimal degrees)

Line	Start Longitude	Start Latitude	End Longitude	End Latitude	Length (km)
1	135.0863884	-16.7411125	135.3952893	-16.71437661	32.9
2	135.0853852	-16.78513537	135.3213451	-16.76289145	25.1
3	135.0864645	-16.90880039	135.3249762	-16.51846278	49.8
4	135.1159045	- 6.94503599	135.0861566	-16.6214288	35.9
5	135.2179975	-16.92453057	135.1772632	-16.61601824	34.2
6	135.2696648	-16.9932462	135.2404939	-16.51967737	52.2

NB: All coordinates are provided in decimal degrees.

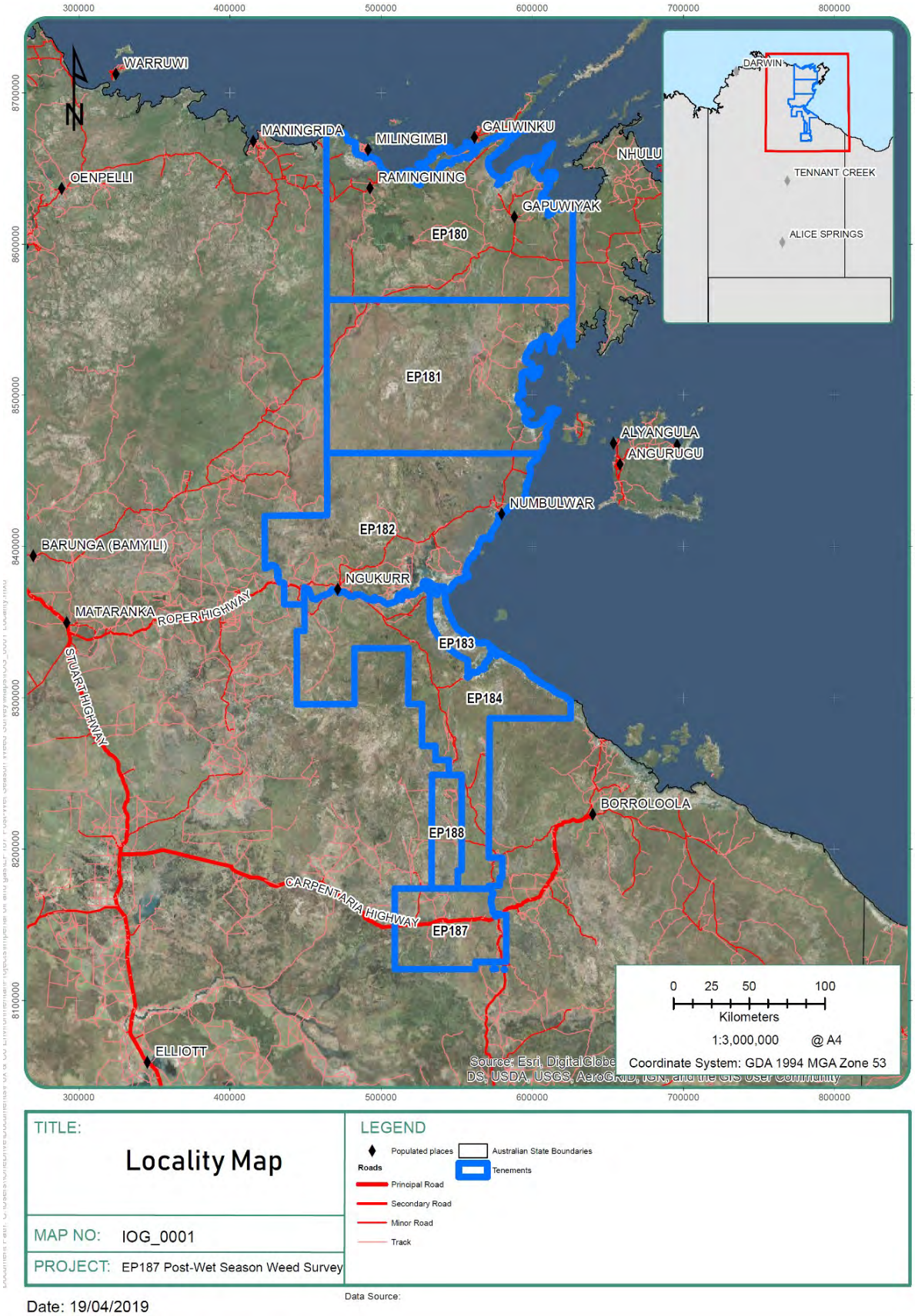


Figure 1 – Location of EP187

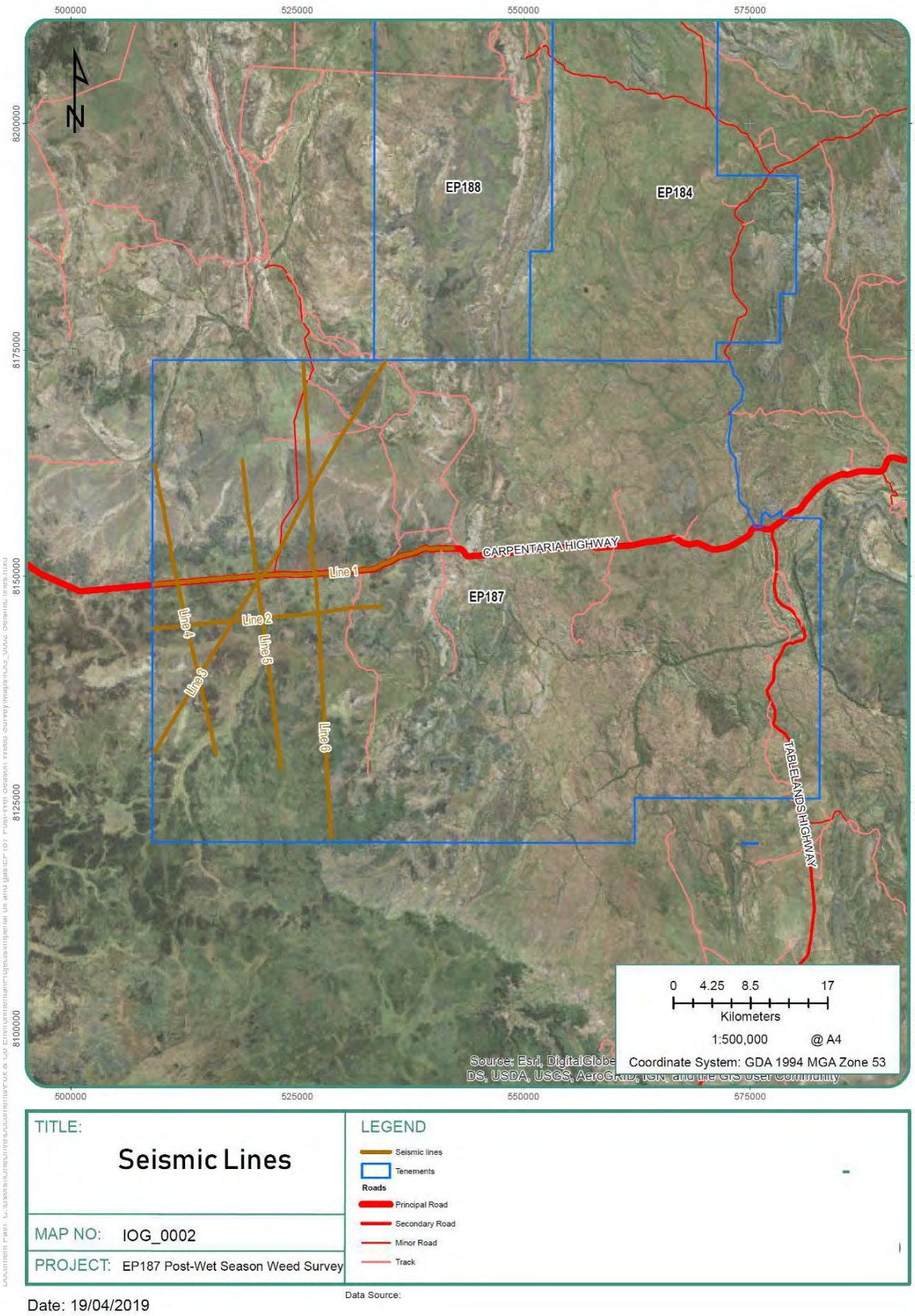


Figure 2 – Proposed Seismic Lines on EP187

2019 POST-WET season Weed survey results

Two weed species were recorded during the 2019 post-wet season field survey (*Hyptis suaveolens* (Hyptis) and *Tribulus sp.* (Caltrop). Both weeds are herbaceous Class B declared weeds in the Northern Territory.

Figure 3 shows the 2018 dry season weed survey results and the 2019 post-wet season survey results. **Figure 4** shows the survey tracks. As expected, more Hyptis was identified in the 2019 survey as conditions were more conducive to weed growth and therefore observation. As per the 2018 dry season survey, Hyptis was primarily recorded along the Carpentaria Highway in disturbed areas and drainage culverts while Caltrop was recorded at the jump-up picnic area adjacent to the Carpentaria Highway at the eastern end of Seismic Line 1.

Hyptis records along the Carpentaria Highway west of Line 3/Line 1 intersection (ie. West of Broadmere Road) were comparable between seasons. Only two (2) Hyptis locations were recorded east of the Line 3/Line 1 intersection along Seismic Line 1 (Carpentaria Highway) during the 2018 weed surveys, in contrast to 11 locations recorded during the recent 2019 post-wet season survey. The locations where Hyptis was identified during the recent survey were comparable to historical records of Hyptis along the Carpentaria Highway.

Appendix A provides a table of the post-wet season survey results. These results were supplied to DENR in the required format within 7 days of undertaking the weed survey.

Table 2 Weeds Observed During 2019 Post-wet Season Weed Survey

Weed	Plate
Hyptis suaveolens (Hyptis). Class B herbaceous weed. Hyptis was observed along the Carpentaria Highway in disturbed areas (ie. Truck rest stops) or drainage lines. Location: -16.710633, 135.349883	

Weed	Plate
Tribulus sp. (Caltrop). Class B herbaceous weed. Caltrop was observed at the picnic area at the jump-up proximate to the eastern end of Seismic Line 1, just off the Carpentaria Highway. Location: -16.703183, 135.366863	

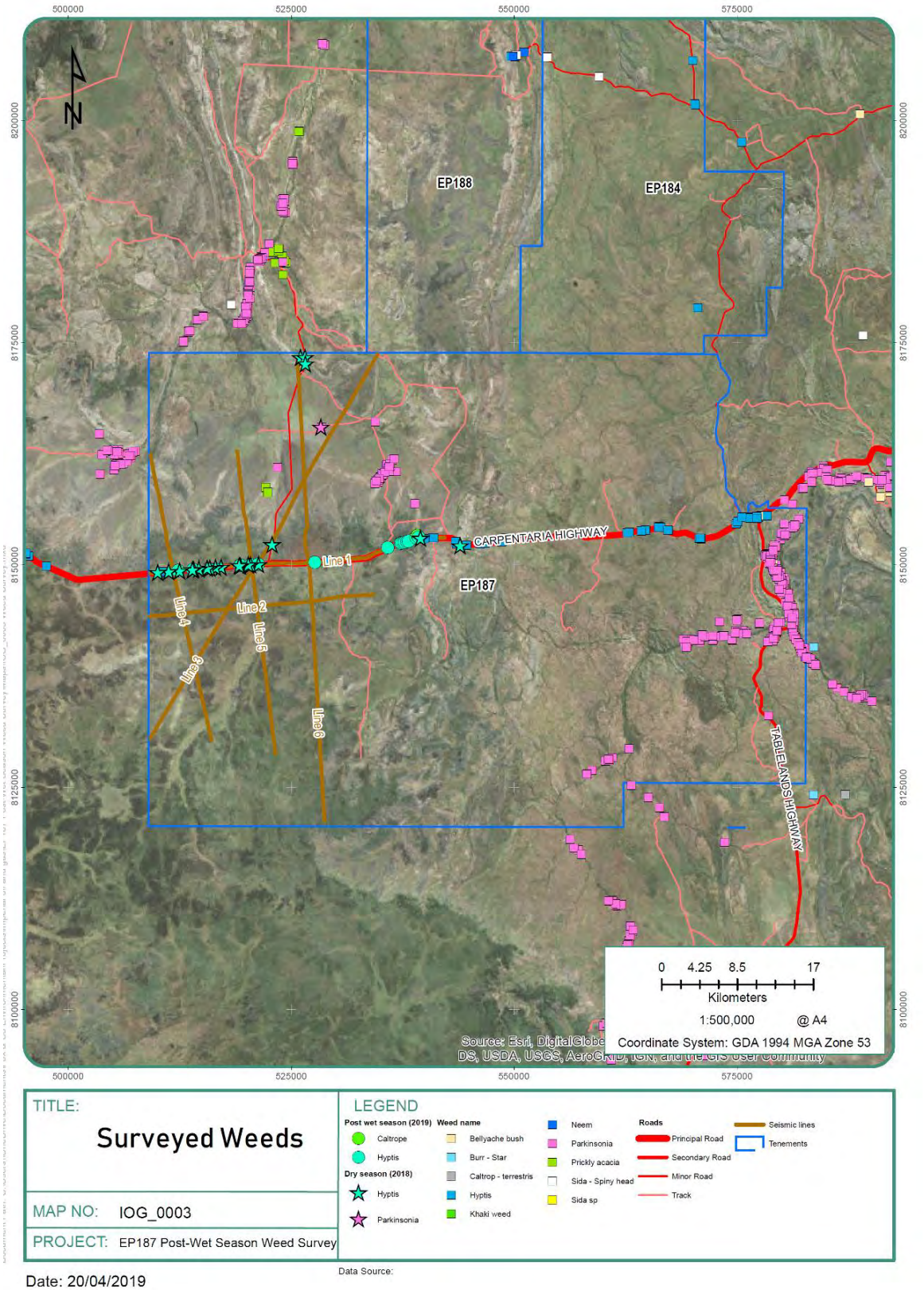


Figure 3 – Location of Identified Weeds

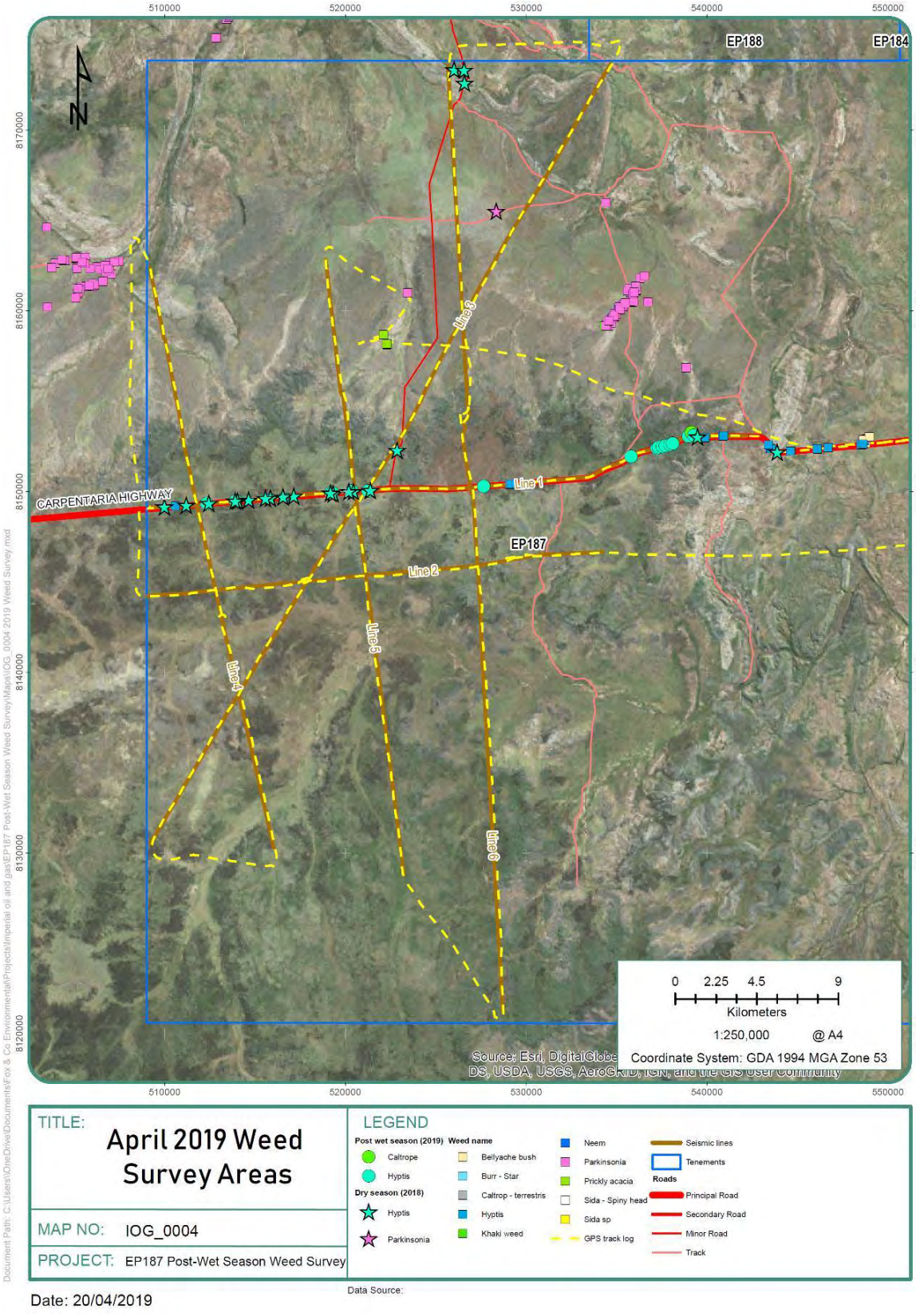


Figure 4 – Survey Tracks

Updated Annual action plan

The annual action plan has been updated to reflect the additional survey results obtained during the post-wet survey (April 2019).

Control options will be undertaken in accordance with the species-specific Statutory Weed Management Plans and also the Northern Territory Weed Management Handbook (2018).

Table 3: Annual Action Plan

Weed Management Area	Weed species	Management objective	Survey time/s	Treatment time/s	Control method/s	Herbicide
Seismic Line 1	Khaki Weed *Alternanthera pungens* (not observed in October 2018 survey or 2019 post-wet survey)	No spread. No introduction of new weed species.	End of wet season	Immediately upon identification	Foliar spray	Glyphosate (various trade names)
	Hyptis*Hyptis suaveolens*	No spread. No introduction of new weed species.	End of wet season	Immediately upon identification	Foliar spray	Metsulfuron methyl
	Caltrop (*Tribulus sp.)*	No spread. No introduction of new weed species.	End of wet season	Immediately upon identification	Foliar spray	Glyphosate (various trade names)
Seismic Line 2	None observed in October 2018 or 2019 post-wet survey	No introduction of new weed species.	End of wet season	tba	tba	tba
Seismic Line 3	Parkinsonia east of line 3 at No. 3 Bore. Hyptis *(H. suaveolens)* is present in proximity to where Line 3 crosses Line 1 (Carpentaria Highway) and also where it crosses Broadmere Road	No spread No introduction of new weed species.	End of wet season	immediately upon identification	Ground applied	Tebuthiuron (Graslan^{R}) for Parkinsonia. Metsulfuron methyl for Hyptis
Seismic Line 4	Hyptis *(H. suaveolens)* is present in proximity to where Line 4 crosses Line 1 (Carpentaria Highway)	No spread. No introduction of new weed species.	End of wet season	Immediately upon identification	Foliar spray	Metsulfuron methyl
Seismic Line 5	Hyptis *(H. suaveolens)* is present in	No spread. No introduction of new weed	End of wet season	Immediately upon identification	Foliar spray	Metsulfuron methyl

Weed Management Area	Weed species	Management objective	Survey time/s	Treatment time/s	Control method/s	Herbicide
	proximity to where Line 5 crosses Line 1 (Carpentaria Highway)	species.				
Seismic Line 6	Hyptis *(H. suaveolens)* is present along Broadmere Road (northern end). Lion's tail has also been previously observed around the large Eleanor Pool.	No spread. No introduction of new weed species.	End of wet season	Immediately upon identification	Foliar spray	Metsulfuron methyl 2,4-D amine (various trade names) for Lion's tail

*Treatment times and herbicide mixing rates are provided in the *Northern Territory Weed Management Handbook 2018*

Mitigation monitoring

No further changes or amendments are required to the Activities and Risk table in the WMP (2018). No further mitigation or management measures proposed other than what is recommended in the WMP (2018).

Works Cited and relevant reference documents

- Department of Environment and Natural Resources, (2015) Katherine Regional Weed Management Plan
- Northern Territory Government, (2018) Northern Territory Weed Management Handbook
- Weed Management Plan 2018 Seismic Program EP187 (15 November 2018) Premise Environment. Report # 1802587e

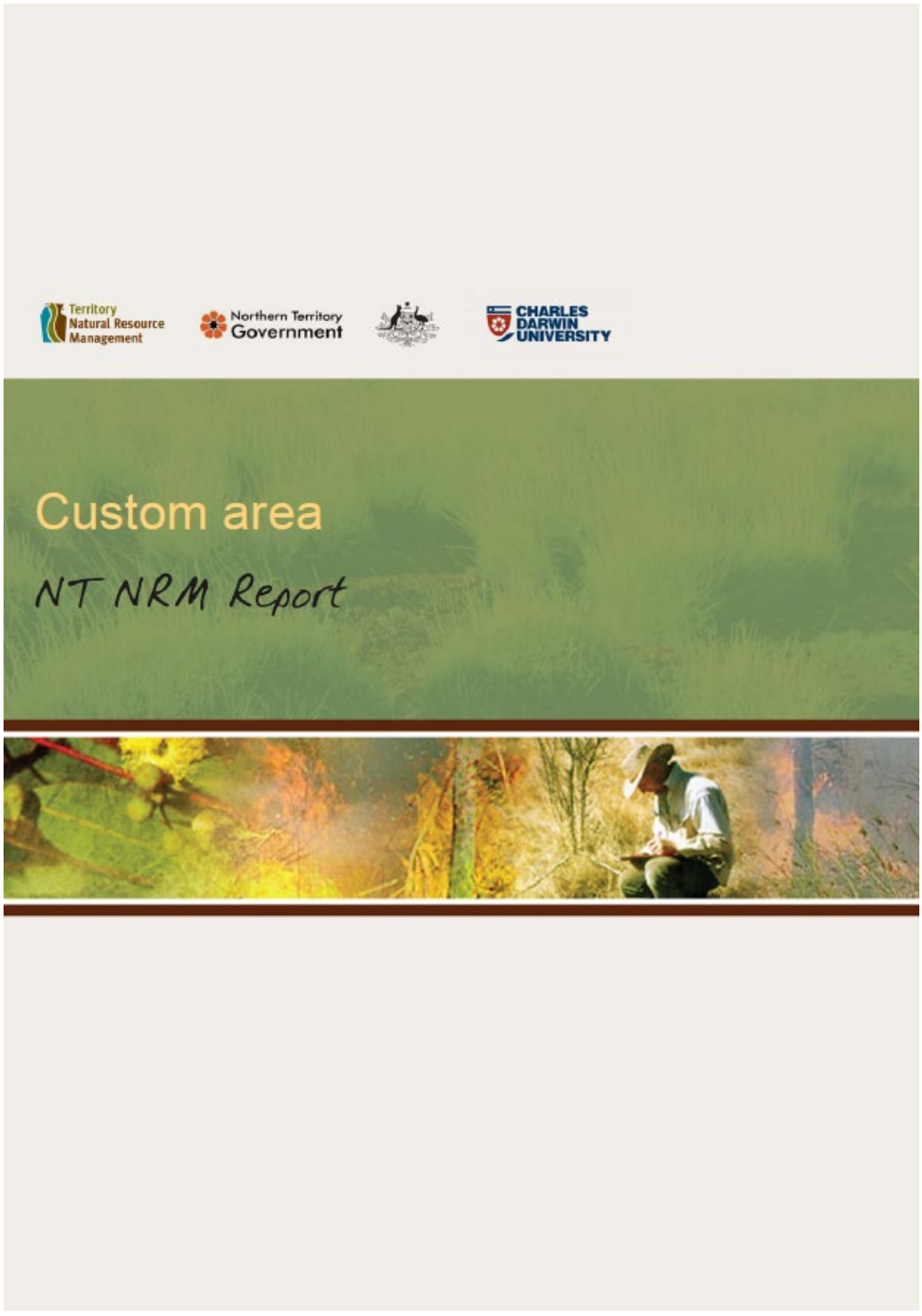
Weed Survey Data , April 2019

RECORDER:					PROJECT:		Imperial Oil & Gas Baseline Weed Survey for Proposed Seismic					LOCALITY:	EP187 proposed seismic lines	
ORG_NAME:		Imperial Oil and Gas			GPS NAME/MODEL:		Garmin etex touch 25					RECORDING METHOD :	Handheld GPS	
SITE_ID	DATE_REC	LAT_G94	LONG_G94	WEED_NAME	SIZE_DIA_M	DENS_CAT	SEEDLINGS	JUVENILES	ADULTS	SEED_PRES	PAST_TREAT	TREATMENT	HERBICIDE	COMMENTS
920	10/04/2019	16.73900	135.11538	Hyptis suaveolens	20	3	Yes	Yes	Yes	Yes	No	No treatment		baseline
921	10/04/2019	16.73742	135.13055	Hyptis suaveolens	20	3	Yes	Yes	Yes	Yes	No	No treatment		baseline
922	10/04/2019	16.733450	135.180000	Hyptis suaveolens	20	3	Yes	Yes	Yes	Yes	No	No treatment		baseline
923	10/04/2019	16.733533	135.180700	Hyptis suaveolens	20	2	Yes	Yes	Yes	Yes	No	No treatment		baseline
924	10/04/2019	16.732683	135.190933	Hyptis suaveolens	20	4	Yes	Yes	Yes	Yes	No	No treatment		baseline
925	10/04/2019	16.732500	135.199283	Hyptis suaveolens	50	3	Yes	Yes	Yes	Yes	No	No treatment		baseline
926	10/04/2019	-16.730200	135.259183	Hyptis suaveolens	50	3	Yes	Yes	Yes	Yes	No	No treatment		baseline
927	10/04/2019	-16.715150	135.335533	Hyptis suaveolens	20	3	Yes	Yes	Yes	Yes	No	No treatment		baseline
928	10/04/2019	-16.710883	135.349150	Hyptis suaveolens	50	3	Yes	Yes	Yes	Yes	No	No treatment		baseline
929	10/04/2019	-16.710533	135.350267	Hyptis suaveolens	50	3	Yes	Yes	Yes	Yes	No	No treatment		baseline
930	10/04/2019	-16.710633	135.349883	Hyptis suaveolens	20	4	Yes	Yes	Yes	Yes	No	No treatment		baseline
931	10/04/2019	-16.710133	135.351983	Hyptis suaveolens	20	4	Yes	Yes	Yes	Yes	No	No treatment		baseline
932	10/04/2019	-16.709800	135.353433	Hyptis suaveolens	20	3	Yes	Yes	Yes	Yes	No	No treatment		baseline
933	10/04/2019	-16.709150	135.355767	Hyptis suaveolens	20	3	Yes	Yes	Yes	Yes	No	No treatment		baseline
934	10/04/2019	-16.708633	135.357300	Hyptis suaveolens	20	3	Yes	Yes	Yes	Yes	No	No treatment		baseline
935	10/04/2019	-16.705017	135.365317	Hyptis suaveolens	20	3	Yes	Yes	Yes	Yes	No	No treatment		baseline
936	10/04/2019	-16.703183	135.366883	Caltrop sp	20	3	Yes	Yes	Yes	Yes	No	No treatment		old records. Likely previous treatment in this
938	10/04/2019	-16.704700	135.368100	Hyptis suaveolens	20	3	Yes	Yes	Yes	Yes	No	No treatment		baseline

FOX & CO
ENVIRONMENTAL

Appendix 01.04 - Natural Resource Management Report

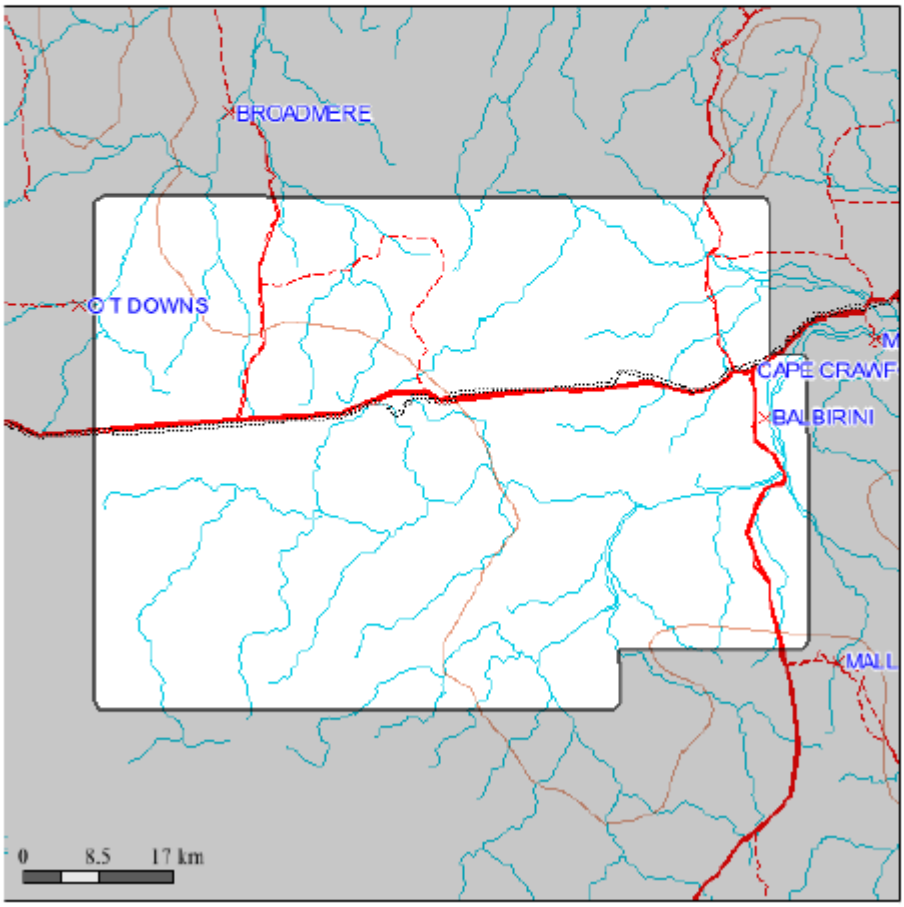
01.04 – Natural Resources Management Report



EP187

EP187 encompasses an area of 4148.62 sq km extending from 16 deg 30.0 min to 17 deg 1.0 min S and 135 deg 3.0 min to 135 deg 47.0 min E.
EP187 is located in the Gulf Fall and Uplands, Sturt Plateau, bioregion(s)

Location of EP187

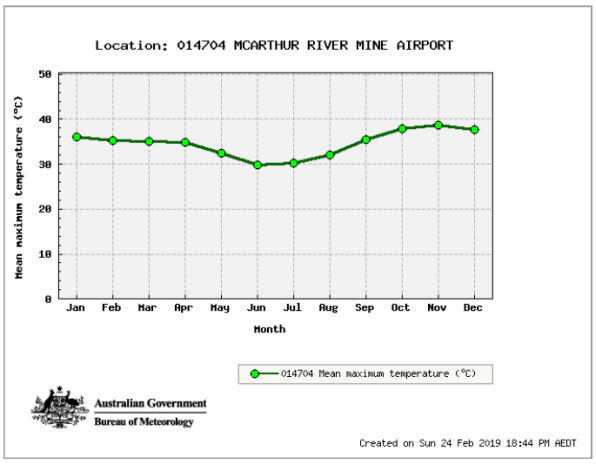


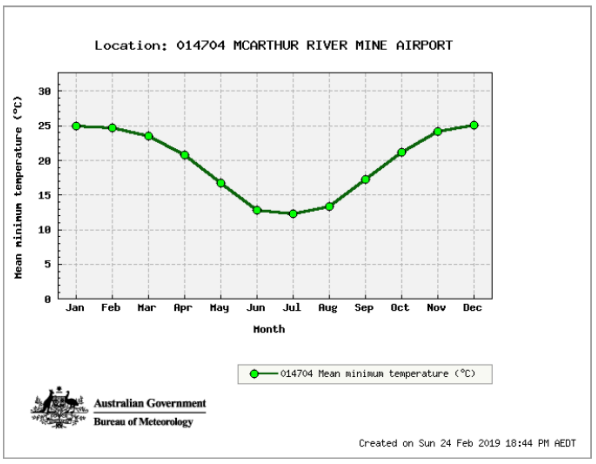
Custom area Climate

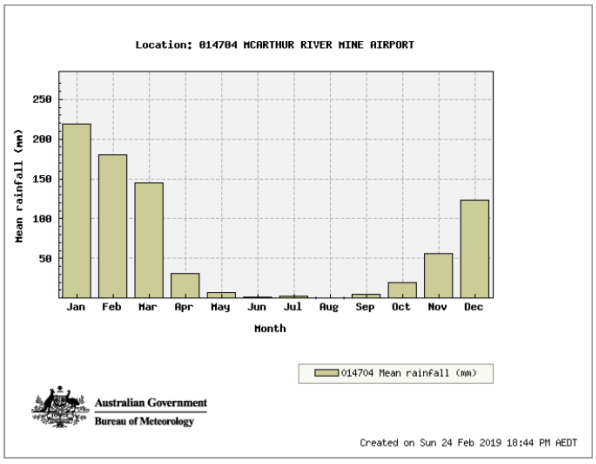
The closest long-term weather station is MCARTHUR RIVER MINE (16 deg 26.0 min S, 136.076E) 80 km NE of the center of selected area

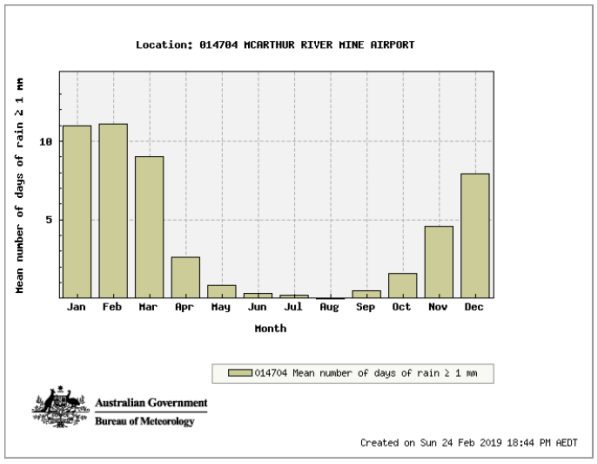
Statistics	Annual Values	Years of record
Mean max temp (deg C)	34.6	41
Mean min temp (deg C)	19.8	41
Average rainfall (mm)	766.9	41
Average days of rain	49.6	47

Climate summaries from Bureau of Meteorology (www.bom.gov.au)


Location: 014704 MCARTHUR RIVER MINE AIRPORT
Mean maximum temperature (°C)
0
10
20
30
40
50
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month
014704 Mean maximum temperature (°C)
Australian Government
Bureau of Meteorology
Created on Sun 24 Feb 2019 18:44 PM AEDT

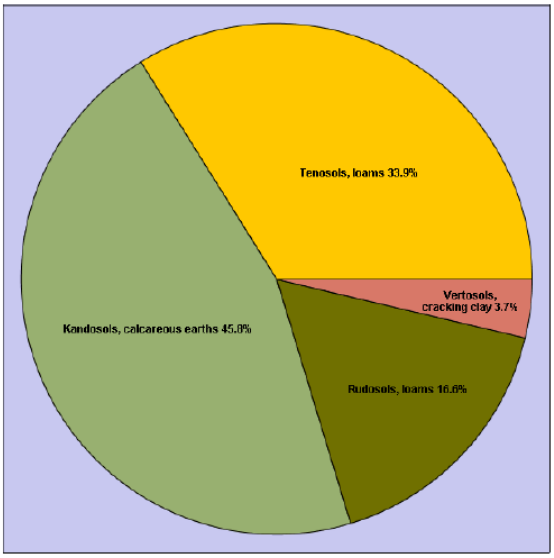

Location: 014704 MCARTHUR RIVER MINE AIRPORT
Mean minimum temperature (°C)
0
5
10
15
20
25
30
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month
014704 Mean minimum temperature (°C)
Australian Government
Bureau of Meteorology
Created on Sun 24 Feb 2019 18:44 PM AEDT


Location: 014704 MCARTHUR RIVER MINE AIRPORT
Mean rainfall (mm)
50
100
150
200
250
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month
014704 Mean rainfall (mm)
Australian Government
Bureau of Meteorology
Created on Sun 24 Feb 2019 18:44 PM AEDT


Location: 014704 MCARTHUR RIVER MINE AIRPORT
Mean number of days of rain ≥ 1 mm
5
10
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month
014704 Mean number of days of rain ≥ 1 mm
Australian Government
Bureau of Meteorology
Created on Sun 24 Feb 2019 18:44 PM AEDT

Custom area Soils

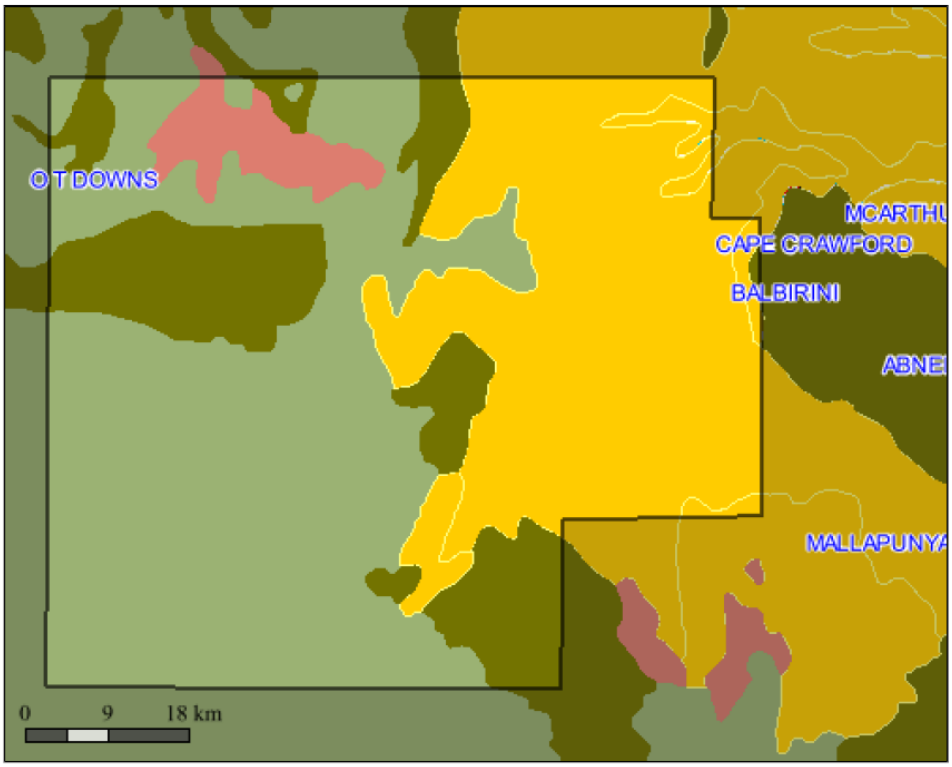
Soil Types



Area of soil types (Northcote Factual Key)

Category	Area sq km	Area%
Kandosols, calcareous earths	2053.05	45.81
Tenosols, loams	1518.69	33.88
Rudosols, loams	744.49	16.61
Vertosols, cracking clay	165.89	3.70

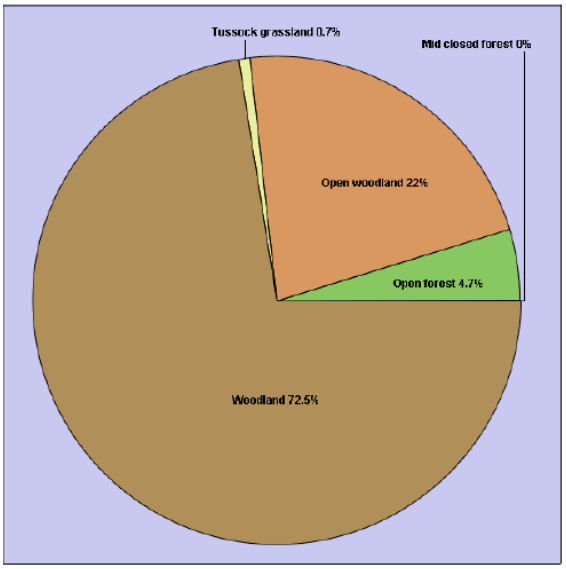
Soil Types



Soils 1:2M Layer is a copy of the NT portion (1:2,000,000 scale dataset) of the CSIRO Atlas of Australian Soils - K.H. Northcote et al. Data scale: 1:2,000,000 ANZLIC Identifier: 2DBCB771205D06B6E040CD9B0F274EFE
More details: Go to www.lrm.nt.gov.au/nrmapsnt/ and enter the ANZLIC identifier in the Spatial Data Search

Custom area Vegetation

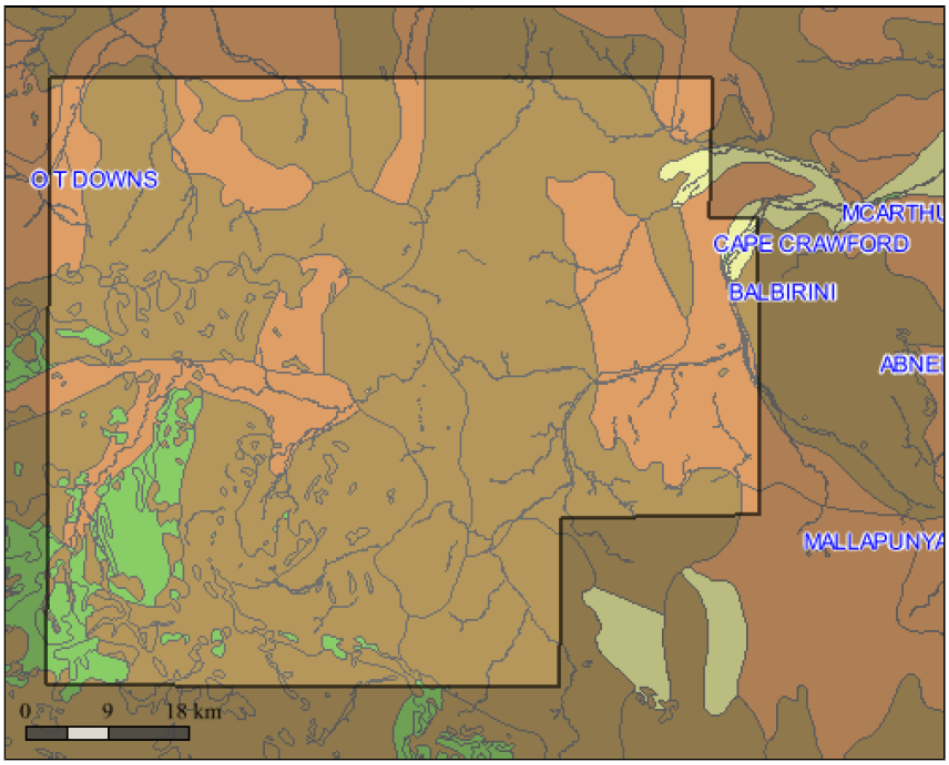
Vegetation Communities



Area of vegetation communities

Category	Area sq km	Area%
Woodland	3251.73	72.55
Open woodland	987.17	22.02
Open forest	210.61	4.70
Tussock grassland	31.91	.71
Mid closed forest	.70	.02

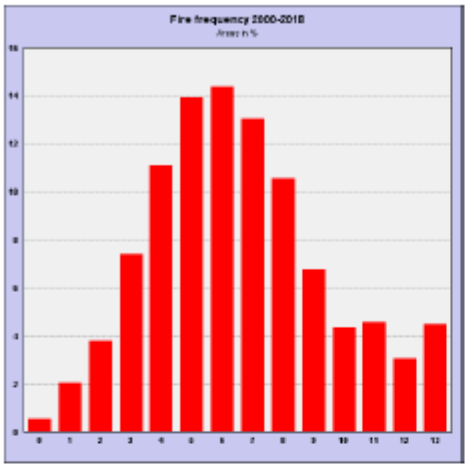
Vegetation Communities



The NVIS 2005 Layer is compiled from a number of vegetation and land unit survey maps that were recoded and re-attributed for the National Vegetation Information System (NVIS)
Data scale variable depending on location. ANZLIC Identifier:2DBCB771207006B6E040CD9B0F274EFE
More details:Go to www.lrm.nt.gov.au/nrmapsnt/ and enter the ANZLIC identifier in the Spatial Data Search

Custom area Fire History

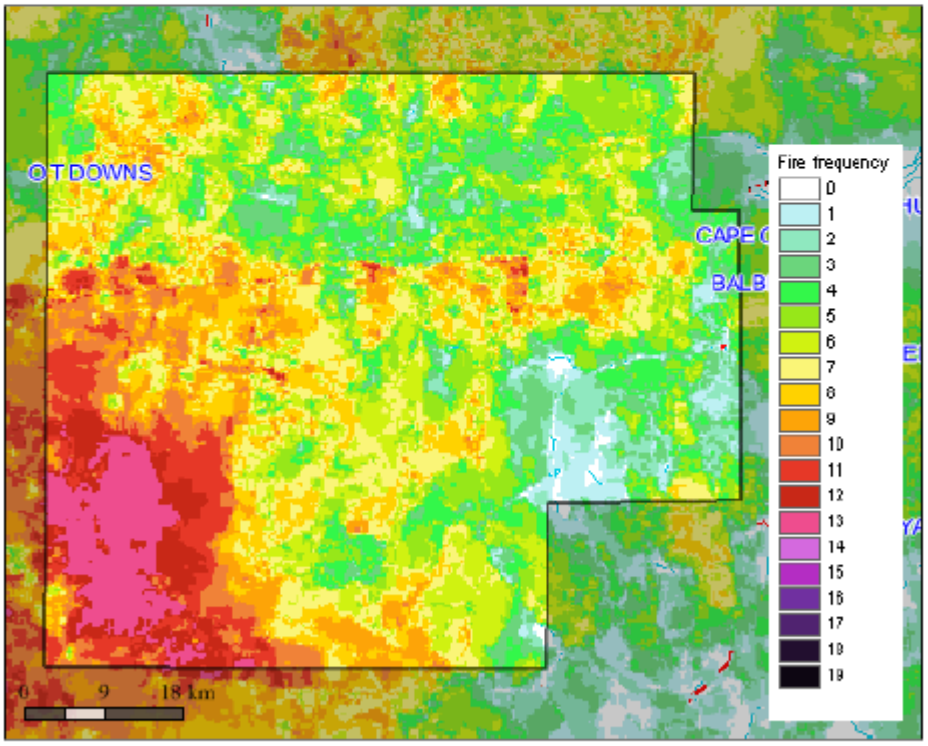
Fire frequency 2000-2018



area burnt for each fire frequency category 2000-2018

Category	Area sq km	Area%
0	23.78	.53
1	90.62	2.02
2	169.34	3.78
3	331.73	7.40
4	497.62	11.10
5	624.57	13.93
6	644.30	14.37
7	584.42	13.04
8	473.23	10.56
9	303.39	6.77
10	195.63	4.36
11	205.37	4.58
12	136.99	3.06
13	201.13	4.49

Fire frequency 2000-2018



The fire frequency(250m) Layer is derived from satellite imagery sourced from the Moderate Resolution Imaging Spectroradiometer (MODIS) on the NASA Terra satellite Spatial Resolution: 250m x 250m pixels (at Nadir).

Custom area Threatened Species

Threatened species recorded in Custom area (Records Updated: Sept 2013)

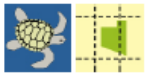
Group	Common Name	Scientific Name	NT Status	National Status	ID	#Observations (Latest)	#Specimens (Latest)	#Surveys (Latest)
Reptiles	Mitchell`s Water Monitor	*Varanus mitchelli*	VU	.	.	0 (Unknown)	1 (1975)	0 (Unknown)
Birds	Painted Honeyeater	*Grantiella picta*	VU	VU	.	1 (1978)	0 (Unknown)	0 (Unknown)
Birds	Gouldian Finch	*Erythrura gouldiae*	VU	EN	176370	1 (1976)	0 (Unknown)	1 (2001)
Mammals	Golden-backed Tree-rat	*Mesembriomys macrurus*	CR (PE)	VU	176951	4 (Unknown)	1 (1901)	0 (Unknown)

EX = Extinct
EW = Extinct in the Wild
ER = Extinct in the NT
EN = Endangered
EN/VU = One Endangered subspecies/One Vulnerable subspecies
VU=Vulnerable
VU/- = One or more subspecies vulnerable EN/- = One or more subspecies endangered

Survey = this category refers to data collected using systematic survey methodology
Specimen = this category refers to museum or other records where a specimen has been collected and lodged
Observation = this category refers to all other incidental recordings where systematic methodology may not have been used consistently.

More species info: Go to www.landmanager.org.au/view/index.aspx?id=####
where #### is the ID number from the tables above for the species of interest.

Custom area Threatened Species Grid



Threatened species recorded in the grid cell(s) in which Custom area occurs (Records Updated: Sept 2013)

Group	Family Name	Scientific Name	Common Name	NT Status	National Status	#Observations	Latest Observation Date	#Specimens	Latest Specimen Date	#Surveys	Latest Survey Record
Reptiles	Varanidae	*Varanus mitchelli*	Mitchell`s Water Monitor	VU		0	Unknown	2	1976	0	Unknown
Reptiles	Varanidae	*Varanus panoptes*	Yellow-spotted Monitor	VU		0	Unknown	0	Unknown	1	1990
Reptiles	Elapidae	*Acanthophis hawkei*	Plains Death Adder	VU	VU	0	Unknown	4	1980	0	Unknown
Birds	Columbidae	*Geophaps smithii*	Partridge Pigeon	VU	VU	3	1911	0	Unknown	0	Unknown
Birds	Tytonidae	*Tyto novaehollandiae kimberli*	Masked Owl (northern mainland)	VU	VU	0	Unknown	1	1913	0	Unknown
Birds	Maluridae	*Amytornis dorotheae*	Carpentarian Grasswren	EN	EN	2	1994	4	1917	0	Unknown
Birds	Meliphagidae	*Grantiella picta*	Painted Honeyeater	VU	VU	1	1978	3	1917	0	Unknown
Birds	Estrildidae	*Erythrura gouldiae*	Gouldian Finch	VU	EN	7	2009	0	Unknown	1	2001
Mammals	Phalangeridae	*Trichosurus vulpecula vulpecula*	Common Brushtail Possum (southern)	EN		1	1969	0	Unknown	0	Unknown
Mammals	Muridae	*Mesembriomys macrurus*	Golden-backed Tree-rat	CR (PE)	VU	4	Unknown	1	1901	0	Unknown

EX = Extinct
EW = Extinct in the Wild
ER = Extinct in the NT
EN = Endangered
EN/VU = One Endangered subspecies/One Vulnerable subspecies
VU=Vulnerable
VU/- = One or more subspecies vulnerable EN/- = One or more subspecies endangered

Survey = this category refers to data collected using systematic survey methodology
Specimen = this category refers to museum or other records where a specimen has been collected and lodged
Observation = this category refers to all other incidental recordings where systematic methodology may not have been used consistently.

More species info: Go to www.landmanager.org.au/view/index.aspx?id=####
where #### is the ID number from the tables above for the species of interest.

Custom area Weeds and Potential Weeds

Introduced plants recorded in the grid cell(s) in which Custom area occurs and that have been identified as problem weeds in one or more locations in northern Australia. Occurrence based on Northern Territory Government databases.

Family Name	Scientific Name	Common Name	NT Status	National Status	Other Status	#Surveys	Latest Record
Asteraceae	*Acanthospermum hispidum*	Starburr	*B C*			6	2001
Amaranthaceae	*Alternanthera pungens*	Khaki Weed	*B C*		*DEU NSW SA*	3	2001
Poaceae	*Cenchrus echinatus*	Mossman River Grass	*B C*		*NSW*	0	Unknown
Poaceae	*Cenchrus pedicellatus*	Mission Grass (annual)			*WeedsAus*	0	Unknown
Cucurbitaceae	*Citrullus lanatus*	Camel Melon			*G&M*	0	Unknown
Cucurbitaceae	*Cucumis melo*	Ulcardo Melon			*DEU*	18	1991
Poaceae	*Echinochloa colona*	Awnless Barnyard Grass			*DEU*	3	2001
Amaranthaceae	*Gomphrena celosioides*	Gomphrena Weed			*DEU*	0	Unknown
Boraginaceae	*Heliotropium indicum*	Indian Heliotrope			*DEU*	0	Unknown
Lamiaceae	*Hyptis suaveolens*	Hyptis	*B C*		*G&M*	1	1993
Malvaceae	*Malvastrum americanum*	Spiked Malvastrum			*DEU*	4	2008
Fabaceae	*Parkinsonia aculeata*	Parkinsonia	*B C*	*WONS*	*MP K2 WA1 WA4 Q2 G&M CYP DEU NSW SA*	5	2001
Fabaceae	*Prosopis pallida*	Mesquite	*A C*	*WONS*	*K2 WA1 WA2 WA4 Q2 G&M NSW SA*	1	1990
Plantaginaceae	*Scoparia dulcis*	Bitter Broom			*DEU*	0	Unknown
Malvaceae	*Sida acuta*	Spiny-head Sida	*B C*		*WA1 G&M*	0	Unknown
Malvaceae	*Sida cordifolia*	Flannel Weed	*B C*		*WA1 G&M DEU*	1	1993
Malvaceae	*Sida rhombifolia*	Paddy`s Lucerne	*B C*		*MP G&M DEU*	4	1994
Malvaceae	*Sida spinosa*	Spiny Sida			*DEU*	9	1999
Poaceae	*Sporobolus fertilis*	Giant Parramatta Grass			*Q2 G&M NSW*	0	Unknown
Fabaceae	*Stylosanthes hamata*	Caribbean Stylo			*DEU*	3	2001
Fabaceae	*Stylosanthes humilis*	Townsville Lucerne			*DEU*	0	Unknown
Zygophyllaceae	*Tribulus terrestris*	Caltrop	*B C*		*CYP SA*	0	Unknown
Fabaceae	*Vachellia farnesiana*	Sweet Acacia			*DEU*	9	2010
Fabaceae	*Vachellia nilotica*	Prickly Acacia	*A C*	*WONS*	*MP K2 Q2 G&M DEU NSW*	0	Unknown
Asteraceae	*Xanthium strumarium*	Noogoora Burr	*B C*		*MP WA1 WA2 WA4 DEU NSW SA*	0	Unknown

Status Codes:
1. NATIONAL STATUS CODES
Alert, Alert List for Environmental Weeds (Please call Exotic Plant Pest Hotline 1800 084 881 if you think you have seen this weed)
Sleeper, National Sleeper Weed
Target,Targeted for eradication. (www.landmanager.com.au/view/index.aspx?id=449837)
WONS, Weeds of National Significance

2. NT STATUS CODES
A, NT Class A Weed (to be eradicated)
B, NT Class B Weed (growth & spread to be controlled)

C, NT Class C Weed (not to be introduced) (www.landmanager.com.au/view/index.aspx?id=449869)

3. OTHER STATUS CODES
C&E, Csurhes, S. & Edwards, R. (1998) Potential Environmental Weeds in Australia. Candidate Species for Preventative Control. Environment Australia, Canberra (www.landmanager.com.au/view/index.aspx?id=394504)
CYP, Draft Cape York Peninsula Pest Management Plan 2006-2011 (www.landmanager.com.au/view/index.aspx?id=371200)
DEU, Plants listed as environmental weeds by the Desert Uplands Strategic Land Resource
Assessment (www.landmanager.com.au/view/index.aspx?id=332123)
G&M, Grice AC, Martin TG. 2005. The Management of Weeds and Their Impact on Biodiversity in the Rangelands. Cooperative Research Centre (CRC) for Australian Weed Management and CSIRO Sustainable Ecosystems. Commonwealth Australia (www.landmanager.com.au/view/index.aspx?id=163572)
Gr, Groves et al. 2003. Weed categories for natural and agricultural ecosystem management. Bureau of
Rural Sciences (www.landmanager.com.au/view/index.aspx?id=388018)
K0, High Priority Weeds not yet established in the Katherine region
K1, High Priority Weeds posing environmental threats in the Katherine region
K2, High Priority Weeds posing existing threats in the Katherine region, as described in the Katherine Regional Weed Management Strategy 2005-2010 (www.landmanager.com.au/view/index.aspx?id=130286)
MP, Northern Territory Parks & Conservation Masterplan (www.landmanager.com.au/view/index.aspx?id=144141)
NAQS, North Australian Quarantine Strategy Target List (www.landmanager.com.au/view/index.aspx?id=449416)
NSW, Declared Noxious Weed in NSW (www.landmanager.com.au/view/index.aspx?id=449983)
Q1, QLD Class 1 Weed (not to be introduced, kept or supplied-
Q2, Class 2 Weed (eradicate where possible, not to be introduced, kept or supplied)
Q3, Qld Class 3 Weed (to be controlled near environmentally sensitive areas- not to be supplied/sold without a permit) (www.landmanager.com.au/view/index.aspx?id=190714)
SA, Declared Plant in South Australia (www.landmanager.com.au/view/index.aspx?id=449996)
WeedsAus, Listed as a significant weed by Weeds Australia (www.landmanager.com.au/view/index.aspx?id=14576)
WA1, WA Weed Class P1 (movement prohibited)
WA2, WA Weed Class P2 (aim to eradicate)
WA3, WA Weed Class P3 (control infestations)
WA4, WA Weed Class P4 (prevent spread)
WA5, WA Weed Class P3 (control infestations on public land) (www.landmanager.com.au/view/index.aspx?id=449884).

Survey = this category refers to data collected using systematic survey methodology
Specimen = this category refers to museum or other records where a specimen has been collected and lodged
Observation = this category refers to all other incidental recordings where systematic methodology may not have been used consistently.

More species info: Go to www.landmanager.org.au/view/index.aspx?id=####
where #### is the ID number from the tables above for the species of interest.

Plants listed in the table above were recorded from all the grid cells shown below (red/blue line) that overlap Custom area

Custom area Pest and Potential Pest Animals

Animals with pest potential recorded in the grid cell(s) in which Custom area occurs. Occurrence based on Northern Territory Government databases.

Common Name	Scientific Name	NT Status	National Status	ID	#Observations (Latest)	#Specimens (Latest)	#Surveys (Latest)
Cane Toad	*Rhinella marina*	P	.	183252	5 (2006)	5 (2006)	6 (1996)
Asian House Gecko	*Hemidactylus frenatus*	P	.	188964	0 (Unknown)	2 (2006)	0 (Unknown)
Rock Dove	*Columba livia*	P	.	183336	1 (1978)	0 (Unknown)	0 (Unknown)
Red-tailed Black-cockatoo	*Calyptorhynchus banksii macrorhynchus*	N	.	223765	31 (2000)	4 (1913)	0 (Unknown)
Sulphur-Crested Cockatoo	*Cacatua galerita*	N	.	223772	25 (2001)	2 (1913)	3 (1993)
House Sparrow	*Passer domesticus*	P	.	183322	1 (1978)	0 (Unknown)	0 (Unknown)
Agile Wallaby	*Macropus agilis*	N	.	223786	1 (1986)	0 (Unknown)	0 (Unknown)
Dingo / Wild dog	*Canis lupus*	N	.	183280	3 (1989)	16 (1969)	0 (Unknown)
Cat	*Felis catus*	P	.	183259	2 (1985)	1 (1978)	1 (1990)
Donkey	*Equus asinus*	P	.	183287	0 (Unknown)	0 (Unknown)	1 (1993)
Horse	*Equus caballus*	P	.	183315	9 (1988)	0 (Unknown)	0 (Unknown)
Cattle	*Bos taurus*	P	.	183266	4 (1988)	0 (Unknown)	3 (1993)

NT STATUS CODES:
Int, Introduced species (all non-prohibited vertebrates, and all other exotic species (www.landmanager.com.au/view/index.aspx?id=280771)
N, Native species with pest potential.
P, Prohibited species (all exotic vertebrates except those listed as non-prohibited (www.landmanager.com.au/view/index.aspx?id=450509)

Survey = this category refers to data collected using systematic survey methodology
Specimen = this category refers to museum or other records where a specimen has been collected and lodged
Observation = this category refers to all other incidental recordings where systematic methodology may not have been used consistently.

More species info: Go to www.landmanager.org.au/view/index.aspx?id=####
where #### is the ID number from the tables above for the species of interest.

Appendix 01.05 - EPBC Report

Australian Government

Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

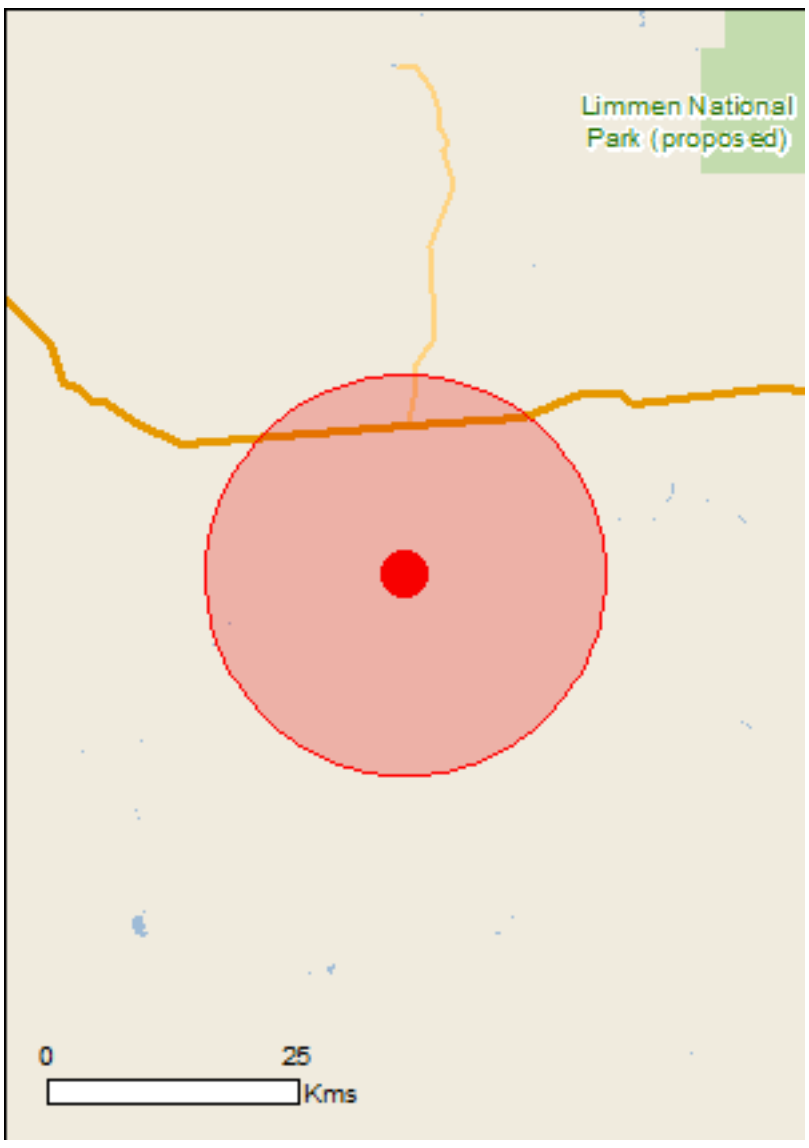
This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 16/12/20 14:59:12

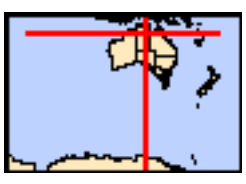
Summary
Details
Matters of NES
Other Matters Protected by the EPBC Act
Extra Information
Caveat
Acknowledgements



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2015

Coordinates

Buffer: 20.0Km



Summary

Matters of National Environmental 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:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	11
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 http://www.environment.gov.au/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 Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	20
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	11
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Erythrura gouldiae Gouldian Finch [413]	Endangered	Species or species habitat known to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area
Falcunculus frontatus whitei Crested Shrike-tit (northern), Northern Shrike-tit [26013]	Vulnerable	Species or species habitat likely to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Tyto novaehollandiae kimberli Masked Owl (northern) [26048]	Vulnerable	Species or species habitat may occur within area
Mammals		
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat may occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat may occur within area
Reptiles		
Elseya lavarackorum Gulf Snapping Turtle [67197]	Endangered	Species or species habitat may occur within area

Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Cecropis daurica Red-rumped Swallow [80610]		Species or species habitat may occur within area
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species	[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.	
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
[Apus pacificus](#) Fork-tailed Swift [678]		Species or species habitat likely to occur within area
[Ardea alba](#) Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
[Ardea ibis](#) Cattle Egret [59542]		Species or species habitat may occur within area
[Calidris acuminata](#) Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
[Calidris ferruginea](#) Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
[Calidris melanotos](#) Pectoral Sandpiper [858]		Species or species habitat may occur within area
[Charadrius veredus](#) Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
[Chrysococcyx osculans](#) Black-eared Cuckoo [705]		Species or species habitat may occur within area
[Glareola maldivarum](#) Oriental Pratincole [840]		Species or species habitat may occur within area
[Haliaeetus leucogaster](#) White-bellied Sea-Eagle [943]		Species or species habitat may occur within area
[Hirundo daurica](#) Red-rumped Swallow [59480]		Species or species habitat may occur within area
[Hirundo rustica](#) Barn Swallow [662]		Species or species habitat may occur within area
[Merops ornatus](#) Rainbow Bee-eater [670]		Species or species habitat may occur within area
[Motacilla cinerea](#) Grey Wagtail [642]		Species or species habitat may occur within area
[Motacilla flava](#) Yellow Wagtail [644]		Species or species habitat may occur within area
[Pandion haliaetus](#) Osprey [952]		Species or species habitat may occur within area
[Rostratula benghalensis (sensu lato)](#) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Reptiles		
[Crocodylus johnstoni](#) Freshwater Crocodile, Johnston's Crocodile,		Species or species

Name	Threatened	Type of Presence
Johnston's River Crocodile [1773]		habitat may occur within area

Extra Information

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Bubalus bubalis Water Buffalo, Swamp Buffalo [1]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Plants		
Acacia nilotica subsp. indica Prickly Acacia [6196]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur

Name	Status	Type of Presence within area
Vachellia nilotica Prickly Acacia, Blackthorn, Prickly Mimosa, Black Piquant, Babul [84351]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, 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 distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for 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 reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-16.86091 135.20888

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 02 - Project Activities

2. - Regulated Activities

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2.1 Foreward

This appendix gives an overview of the regulated activities to be carried out under this EMP.

2.2 Land Clearing & Civil Construction

2.2.1 Overview

Timber and vegetation is cleared from the site utilising a bulldozer and stockpiled for future rehabilitation and land restoration activities. The site is levelled and compacted utilising on-site materials, the footprint for any above-ground tanks will be compacted and tested to the tank supplier's requirements. Erosion and sediment controls will be constructed as per Appendix 05 (Erosion and Sediment Control Plan). The site will be fenced to exclude livestock. Site diagrams and schematics can be seen in the EMP.

2.3 Completion

2.3.1 Overview

A completion is a generic term used to describe the events and equipment necessary to bring a wellbore into production once drilling operations have been concluded, including but not limited to the assembly of downhole tubulars and equipment required to enable safe and efficient production from an oil or gas well.

A completion will be run into the well for well testing after the open hole fracture stimulation. The completion will be run using a workover rig.; this will involve the following activities:

- Ensure the well is dead using appropriately weighted fluid
- Cleanout the wellbore by running tubing into the well and circulating out any debris from the wellbore including proppant and plugs
- Run tubing into the well
- Land the tubing in a hanger in the wellhead
- Set a packer to isolate the tubing annulus
- Install surface master valves and pressure test wellhead seals
- Install Flowback and EPTsurface equipment for well testing.

The well will be completed after the fracture stimulation of the vertical wellbore and then re-completed after the fracture stimulation of the lateral section.

2.4 Perforation

2.4.1 Overview

To provide communication between the wellbore and the formation target zones, the casing at the identified formation is perforated. The method of perforation selected will depend on the size, penetration depth and type of hole required to allow recoverable flow.

There are three primary methods of perforation that can be used as described below:

- Hydro-jetting – uses sand and water jetted through small holes in the bottom hole assembly to create holes in the casing across the target formation – there is no perforating charge. Hydro- jetting allows for targeted or pinpoint perforating, creating between 3 and 4 holes per event,
- Wireline Conveyed Perforating (WCP) – the most widely used perforating technique in the Cooper Basin. As the name suggests, WCP uses wireline to deploy the perforating charge, and
- Tubing Conveyed Perforating (TCP) – uses the same technology as conventional wireline perforating but is run using a coiled tubing unit or jointed tubing (not wireline). TCP is the preferred perforating method when operating in underbalanced or overbalanced conditions.

2.5 Hydraulic Fracturing

2.5.1 Overview

Hydraulic fracturing (HF) is an oil and gas well development process that typically involves injecting a slurry of water, sand, and chemicals under high pressure into a bedrock formation via the well. This process is intended to create new fractures in the rock as well as increase the size, extent, and connectivity of existing fractures. HF is a well-stimulation technique used commonly in low-permeability rocks like tight sandstone, shale, and some coal beds to increase oil and/or gas flow to a well from petroleum-bearing rock formations

During Hydraulic Fracturing activities HF fluid is pressurised by high-pressure pumping units and directed downhole via a manifold to discrete target intervals along the vertical or horizontal wellbore (referred to as "stages"). Each stage is isolated and perforated using a plug and perforation gun assembly deployed via wireline. As the pressure is sustained, the fractures propagate radially from the well, through the target formation. Once optimal fracture propagation has been achieved, the proppant (sand) is pumped down the well and into the open fractures. This process is repeated for each stage. The final number of stages pumped is dependent on the useable length of the wellbore and in-situ geological conditions. Once all stages are complete, the well is suspended awaiting completion and well testing activities.

Wellbore pressures are monitored during each HF to ensure operations have not compromised the integrity of the production casing or the cement barriers.

HF fluid primarily consist of water and sand (proppant), plus chemicals that are commonly found in food and other household domestic products.

All fluid additives (water and chemicals) and sand are mixed on the surface as required through HF equipment. The mixture and pumping schedules (rates, volumes and proppant) are based on an HF model which determines the desire fracture attributes. The HF model will be completed before the commencement of HF activities and will be underpinned by a Mechanical Earth Model (MEM). The MEM will be generated from data collected during drilling, wireline logging, core analysis and DFIT tests. The HF fluid mixture and pumping schedule is continuously updated during and after each stage to ensure optimal outcomes are achieved. An example of the process and of a modelled side view fracture is illustrated in Figure 2 and Figure 3.

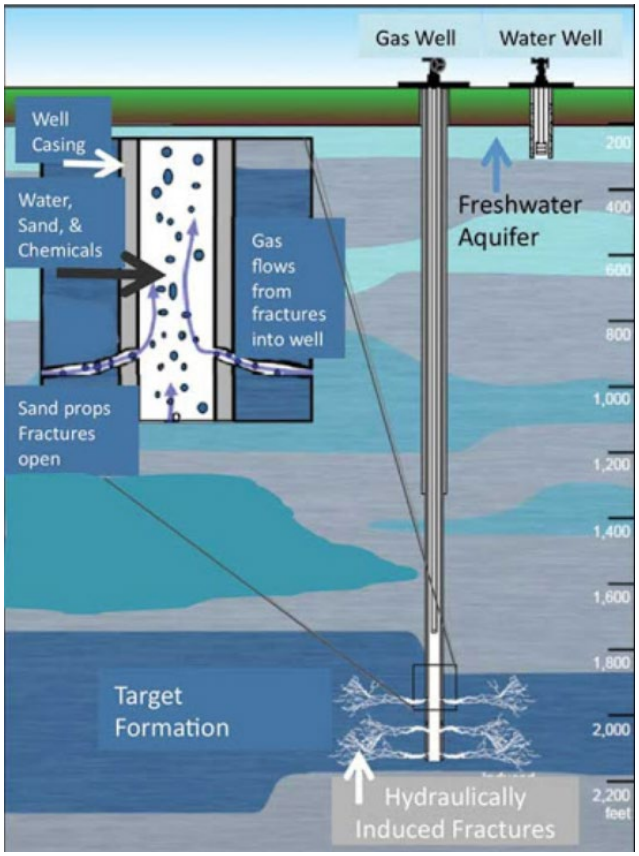

Figure 1: Hydraulic fracture schematic

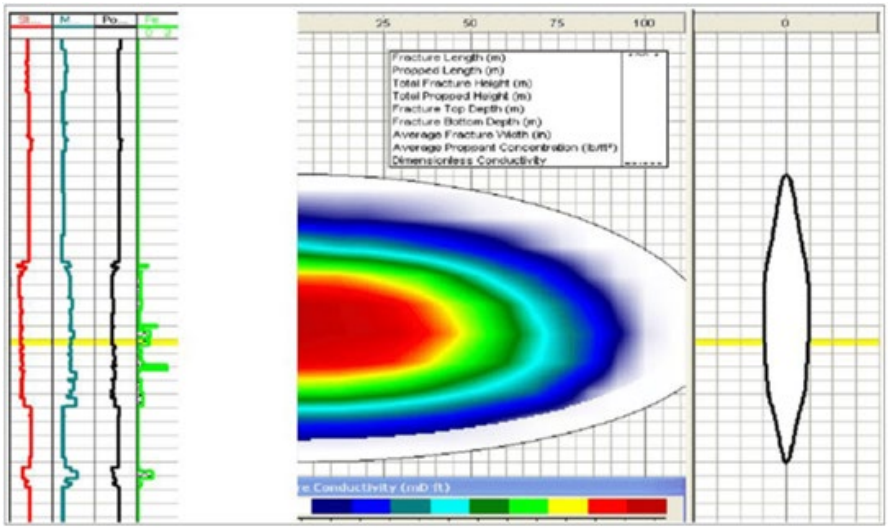

Figure 2: Example HF Model

Imperial will undertake all HF activities per the Code and relevant NT and Federal Government legislation and regulations.

2.5.2 Proppant and Chemical Additives

The chemicals used for hydraulic fracture HF account for less than 1% of the mixture to assist in carrying and dispersing the sand in the low permeability rock, the balance is freshwater and sand. These chemicals are also commonly used in household products, including food additives, soap, cosmetics and toothpaste.

All chemicals added to HF fluid perform a specific purpose, including:

- **Acids and bases**: controls pH and clear perforations before HF
- **Chemical inhibitors**: such as scale prevention
- **Biocides**: controls or eliminates bacteria in the fluid to ensure that it isn't introduced to the target formation
- **Clay Control**: prevents clays from swelling
- **Corrosion inhibitors**: prevents equipment from rusting,
- **Friction reducers**: reduces friction between the HF fluid and piping allowing the fluid to be injected further without pressure drop
- **Surfactants**: reduces the surface tension of the hydraulic fracturing fluid this allows the HF fluid to injected further without pressure drop
- **Viscosity regulators**: increases or decreases the thickness of a fluid

All transportation, handling, storage and disposal of chemicals will comply with the required NT regulations. This includes:

- **Transportation**: from the supplier warehouse to the wellpad and between wellpads (Transport of Dangerous Goods by Road and Rail (National Uniform Legislation)),
- **Use**: handling, blending, injecting etc. (NT Dangerous Goods Act, Work Health and Safety Act and the Code),
- **Storage**: storage of chemicals and recovery of fluids (including storage in produced water and flowback fluid treatment tanks) at the well pad and associated vendor chemicals. (NT Dangerous Goods Act, Work Health and Safety Act and the Code), and
- **Disposal**: recovered vendor chemical additives in wastes and hydraulic fracturing flowback (NT Waste Management and Pollution Control Act 1998).

  For further information see Appendix 06 (wastewater Management Plan)and Appendix 7 (Spill Management Plan)

2.5.3 Tracers

Unique ID tracers can be detected at extremely low concentrations (ppb), and are used to determine the performance of each fracture stage. In doing this, the knowledge learnt allows for optimisation of resource extraction in future campaigns. The presence and concentration of chemical tracers detected during flowback can be measured to determine the relative contribution of fluid recovery from each stage.

Tracers are harmless chemicals designed to be unique in composition per every well and able to be absorbed into both the water or gas phase.

2.5.4 HF Equipment

Fracturing equipment is operated across a range of different pressures and injection rates which are specific to the well. The equipment is highly mobile designed to comply with state, territory and federal regulation and fitted with safeguards to ensure compliance and safety systems.

2.5.5 Wellhead

The wellhead is the portion of the well's anatomy that shows above ground. It is made up of housings and valves that cap the wellbore and serve as a point used to inject into and control the well. The wellhead provides the primary surface barriers for well control; an example is shown in Figure 4.

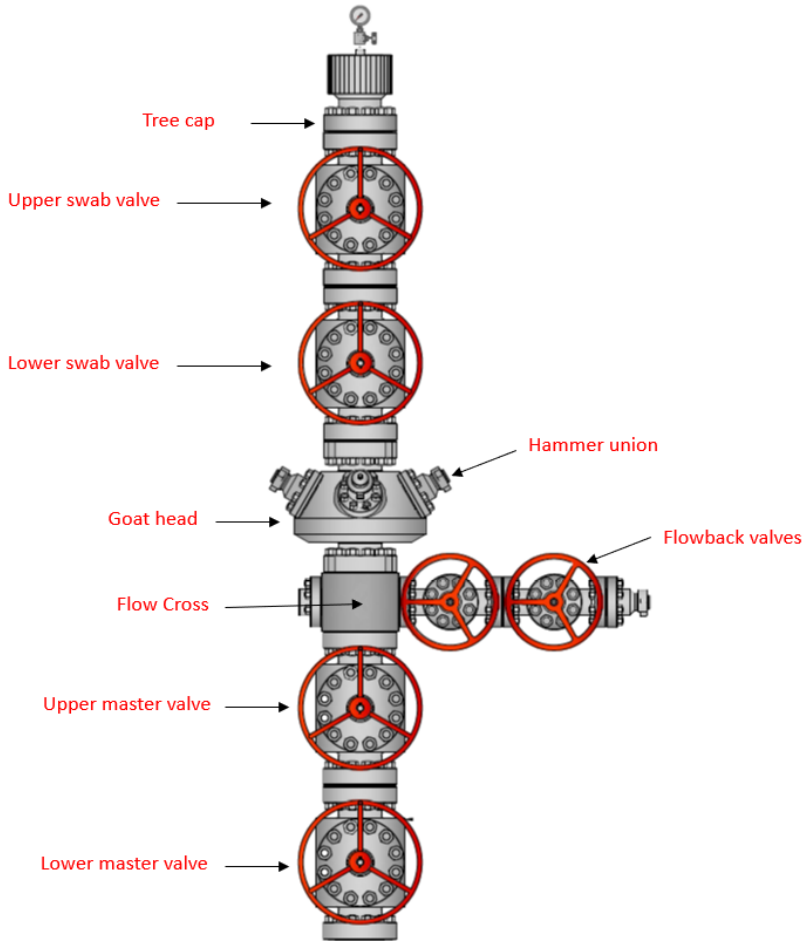

Figure 3: Typical HF Wellhead

During the fracturing operations, the wellhead integrity will be regularly verified by testing conductivity pressure against the main wellhead valves. Additionally, pressure will be recorded of the secondary seals and the seals between the tubing head and spool.

Once the fracturing operations are completed the upper valves (above the production flow-cross) can be removed as they are not required for flowback or appraisal (production) test operations.

2.5.6 Above ground storage tanks

Temporary water storage tanks will be utilised on-site for use during the hydraulic HF process. Various open and enclosed tanks will be used for either store flowback wastewater or potable water. Small dosages of biocide are added to control algal growth, particularly under warm and stagnant conditions.

All flowback fluids will be stored in above-ground tanks, with enough capacity on-site to manage all predicted flowback volumes.

2.5.7 Sand Trailer Units

Sand trailers are large storage, and delivery trailer units used to hold the proppant (sand or ceramic material) needed for the HF operations.

2.5.8 Blender Units

Blender units are used to mix the proppant and fluid additives before its injection to the well. The blended HF fluid, without proppant, is referred to as the "clean fluid". The blended HF fluid, with proppant added, is referred to as "slurry". Chemical additives are precisely measured, controlled and recorded by the blender units throughout the HF treatment process.

2.5.9 High-Pressure Pumps

High-pressure pumps are required to inject the hydraulic fracturing fluid mixtures from the Blender Unit down the well, via the surface lines and wellhead or coiled tubing unit. The pumps contain programmable pressure triggers (kick-outs) to prevent pressure from exceeding the wellbore design limits. High pressure treating iron (pipes, manifolds, connectors, etc.) connecting the HF pumps and the wellhead also contains pressure safety valves (PSVs) that are set to open at a pre-set pressure to ensure the well components are protected.

2.5.10 Control and Data Acquisition Unit

An on-site mobile office is connected to all units during hydraulic HF treatment to monitor, record and plot all data received throughout the treatment. Supervisors will continually monitor and control the treatment to ensure the process goes according to the design.

2.6 Flow-back and Extended Production Testing Activities.

2.6.1 Overview

Flowback and Extended Production Testing (EPT) activities are carried out to remove the HF fluid from the formation, and to validate the well production rates. A three-phase separator is connected to the outlet of the wellhead; the separator splits the well flowback fluids into gas, oil and water by gravity level controllers.

Once split the gas is directed to flare, the water component is sent to the flowback tanks, and the condensate is directed to either storage tanks or flare depending on the composition. All gas, water and condensate flow volumes are measured and recorded. A generic layout of a flowback and EPT package is shown in Figure 5 below.

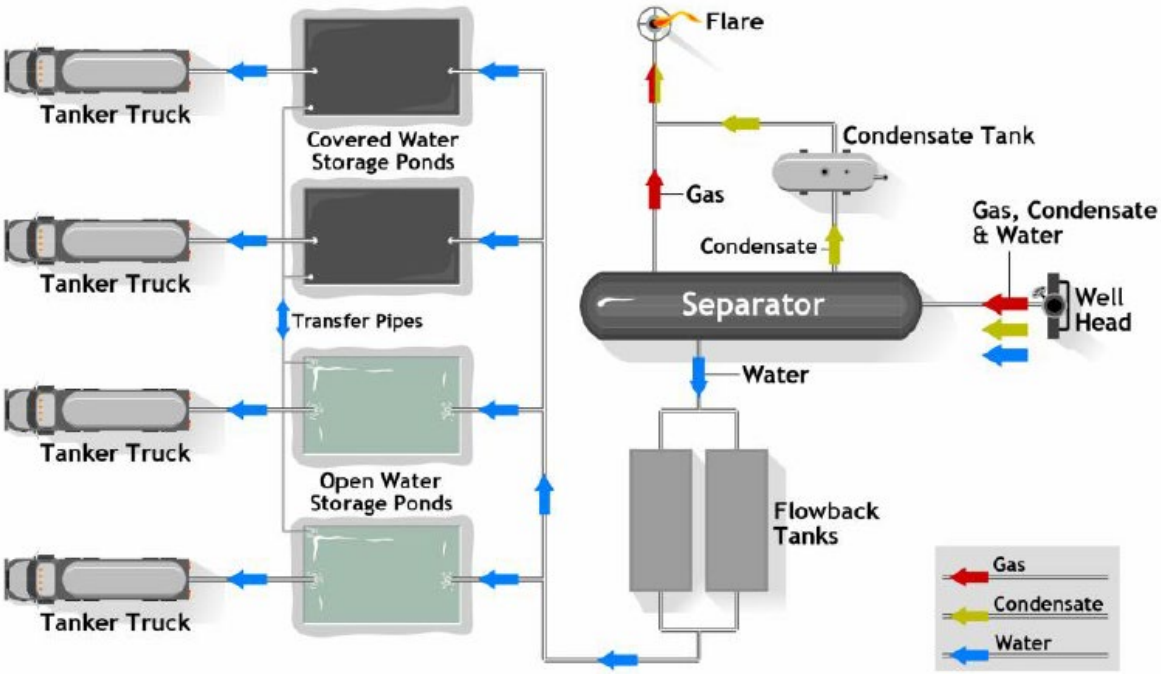

Figure 4: Example of Well Test Equipment Schematic

2.6.2 Flowback and EPT Equipment

2.6.2.1 Separator

The rate of flowback will be regulated to optimise the flowing conditions and clean-up the well. Once split the gas is directed to flare, the water component is sent to the flowback tanks, and the condensate is directed to either storage tanks or flare depending on the composition. All gas, water and condensate flow volumes are measured and recorded.

2.6.2.2 Above ground storage tanks

Temporary water storage tanks will be utilised on-site for use during the hydraulic flowback and EPT process. Various open and enclosed above-ground tanks will be used for either store flowback fluids. Closed top tanks will be appropriately vented to eliminate over pressurisation, and the freeboard in tanks will be managed to prevent overtopping in rainfall events.

Once the tanks are decommissioned, the associated residual solids, brines and liners will be removed and disposed of at an appropriately licensed waste disposal facility. Wastewater that requires to be transferred interstate will comply with the respective consignment authority before the movement of waste between administration boundaries. See appendix Wastewater Management Plan X for more details.

2.6.2.3 Flare

Produced gas, and pending results, potentially condensate, during EPT will be sent to a flare system to allow a controlled release and burning of gas. It is equipped with an autoignition system that provides electrical impulses to generates a spark every 1.3 seconds to ensure that the flare is always operational.

Appendix 03 - Environmental Risk Assessment framework

3. - Environmental Risk Assessment framework

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3.1 Definition

As defined by the Petroleum (Environment) Regulation; Environmental risk means "the chance of something happening that will have an environmental impact, measured in terms of the environmental consequences and the likelihood of those consequences occurring". This assessment is measured in terms of environmental consequences and likelihood of occurrence. Furthermore, an Environmental Impact can be described as any adverse change, or potential adverse change, to the environment resulting wholly or partly from a regulated activity.

3.2 Overview of the Environmental Risk Assessment Process

An environmental risk assessment involves the analysis of the activities (or elements of activities) that have the potential for environmental impact. In that process, the EMP must demonstrate that all activities associated with the proposed activity will be reduced to a level that is ALARP and acceptable.

A risk can be considered to have been reduced to ALARP when all reasonably practicable control measures have been identified and implemented to reduce the risk of identified hazards. As described in the Petroleum (Environment) Regulations an explanatory guide, ALARP is demonstrated when the good practice is followed. Good practice is defined as the recognised risk management practices and measures that are used by competent organisations to manage well-understood hazards arising from their activities.

It is important to note when discussing ALARP and risk acceptance that practicability and the reasonability of control measures can change over time due to changes in technology, industry standards and community acceptance.

To determine whether potential environmental risks and inputs are "acceptable" at the time of evaluation is a matter of judgment that depends on issues such as the nature and scale of impacts and the social or economic benefits. As part of this process, the Regulations requires that the environmental management approach includes the principles of ESD; to ensure that all works conducted does not impact the future amenity of the environment. The summary of this approach is:

- Identification of all environmental hazards or risk source associated with operations,
- Identification of the environmental receptors in the project area
- Consideration of the potential impact upon environmental factors or receptors for each hazard or risk source
- The determination of each environmental hazards inherent risk ranking is undertaken. This is done by assessing the likelihood and the consequence of the risk source to come to an inherent resultant risk rating by using the Table 3 below.
- To achieve a status of ALARP, each risk source must have its risk profile lowered to a level that meets the classifications of ALARP.
- Through the implementation of controls and the Code of Practice (management controls) a re-assessment of the likelihood and the consequence is undertaken, taking into account the new management controls.

- The residual risk rating is reviewed for acceptability. If the environmental hazard, post risk management controls, has a residual risk which meets the criteria to ALARP or not.

- If ALARP is not achieved, then consideration of further risk control measures to be implemented to reduce the risk to ALARP or an otherwise acceptable residual risk level.

- Final classifications around the effectiveness of the controls is undertaken, and a review of the uncertainty within each risk sources assessment and risk reduction is undertaken.

- If either the effectiveness of controls or the uncertainty is too high, then the risk sources elements are again re-reviewed until determined as suitable.

3.3 Identification of risk events

Imperial has identified the sources of risk, i.e. those activities or incidents that could result in an environmental impact. The risk sources have been categorised into those arising from routine operations and those arising from incidents.

3.4 Identification of the environment that may be affected

The potential environment to be affected is categorised by the EPA Factors (2018) and sourced from the description in Appendix 01 (Description of the existing environment for the Project Area).

3.5 Identification of Particular Values and Sensitivities

A review of the existing environment was performed using Imperial's and publicly available information. This allowed for the identification of the environmental values and/or sensitivities and their potential to occur within the Project area. Appendix 01 provides a summary of these values and sensitivities. The environmental values and sensitivities are input into the risk assessment to provide the potential worst-case consequence value.

3.6 Identification and Evaluation of Potential Environmental Impacts

The known and potential impacts to the identified environmental receptors were evaluated based on the findings of Imperial's on-ground research of the region and the publicly available information. Specifically, consideration was given to:

- Receptor sensitivity to identified risk source
- Extent and duration of the potential impact

3.7 Pre-treatment Risk Ranking – Before controls applied

The risk evaluation process assesses the risks in terms of likelihood and consequence (Section 3.9-3.10) of the risk sources impact occurring, also helps to define the management actions required to reduce the risk to ALARP.

3.8 Control Measure Identification and ALARP Decision Framework

As part of Imperial's risk assessment process, each risk is mitigated to ALARP. A risk can be considered to have been reduced to ALARP when all reasonably practicable control measures have been identified and implemented to reduce the risk of identified hazards (Figure 1). As described in numerous ALARP guidance documents; ALARP is demonstrated when good practice is followed. Good practice is defined as the recognised risk management practices and measures that are used by competent organisations to manage well-understood hazards arising from their activities. ALARP is not a final position over the life of a project.

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

As part of Imperial's risk process, risk acceptance is completed following each ALARP assessment. To achieve the outcomes and meet the community expectations, Imperial's risk acceptance considers:

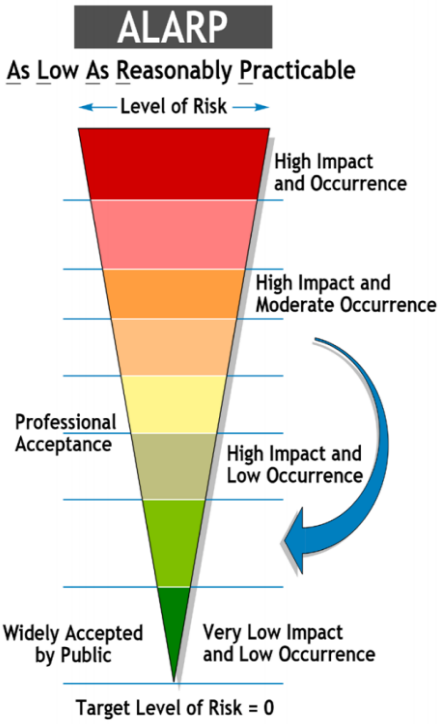


Figure 1:Risk Acceptance Model

- The impact of the hazard on the environment (nature and extent)
- The overall social or economic benefits of the operation
- Feasibility of new technologies to reduce risk profiles
- Effectiveness of the mitigation measures

It is important to note when discussing ALARP and risk acceptance that practicality and the reasonability of control measures can change over time due to changes in technology, industry standards and community acceptance.

3.9 Determination of Severity of Consequence

The potential level of impact (consequence) is evaluated and assigned in line with potential hazards and receptors, using Imperial's Consequence Classification" (Table 1) from Imperial's Risk Matrix, the consequence level for each identified hazard is disclosed in the risk assessment table in Appendix 04.

Table 1: Imperial Environmental Consequence Classification

Consequence	Environmental consequence
Slightly	Negligible financial consequences, localised and short-term impact to an area, plants or animals of environmental value, Readily treated, and Release to environment (lt/kg) <10
Minor	Localised and medium-term or extensive and short-term impact to areas, plants or animals of significant environmental value, Remediation may be difficult or expensive, and Release to environment (lt/kg) <100
Considerable	Extensive and medium-term or localised and long-term impact to an area, plants or animals of recognised environmental value, Remediation possible but may be difficult or expensive, and Release to environment (lt/kg) <1,000
Major	Destruction of an important population of plants, animals or an area of significant environmental value, Complete remediation might not be practical or possible, and Release to environment (lt/kg) <10,000
Massive	Regional and long-term impact on an area of significant environmental value, Destruction of an important population of plants and animals with recognised conservation value, Complete remediation might be impossible, or Release to environment (lt/kg) <10,000

3.10 Determination of Likelihood

Likelihood relates to the potential for a consequence to occur; this includes the likelihood of an event occurring and the subsequent potential consequence. This is defined using Imperial's Likelihood Descriptors (Table 2) from Imperial Operational Risk Matrix.

Table 2: Imperial Likelihood Classification

Level	Criteria
Practically Impossible	Rare or practically impossible, no known incidence or rare. Frequency >10 years
Unlikely	Not likely, uncommon Frequency 1-10 years
Possible	Could happen or possible; has happened in the past but not common. Frequency > 1 year
Likely	Has happened or likely, recent history indicates that it has happened. Frequency >1 month
Almost Certain	Common or almost certain; expected to occur in most circumstances Frequency > 1 week.

3.11 Residual Risk Ranking

Risk is expressed in terms of a combination of the consequence of an impact and the likelihood of the impact occurring. Imperial uses the Corporate Risk Matrix (Table 3) and its components (

Table 4 & Table 5) to measure the hazard probability (chance of occurrence), consequence severity (seriousness of consequences) and the risk ranking associated to it.

The risk ranking identified in Appendix 04 assists with the determination of the level of controls required to reduce the risk or impact. Based on the identified impacts and the ranking of their pre-treatment risk; control measures are determined to eliminate, prevent, reduce or mitigate consequences associated with each of the associated environmental impacts. When determining whether the risk or impact has been reduced to ALARP, it must be asked whether the environmental risk can be lowered further without a disproportionate increase in impost.

Table 3: Imperial Risk Matrix

Consequence		Likelihood				
		1	2	3	4	5
		Practically Impossible	Unlikely	Possible	Likely	Almost Certain
1	Slightly	Low	Low	Low	Moderate	High
2	Minor	Low	Moderate	Moderate	High	High
3	Considerable	Moderate	Moderate	High	High	Extreme
4	Major	Moderate	High	High	Extreme	Extreme
5	Massive	High	High	Extreme	Extreme	Extreme

Table 4: Imperial Risk Significance Rating

Risk Level	Mitigation/Investigation Focus
Low	Risk in this category should be handled by the normal manager structure.
Medium	Risk in this category should be handled by the Risk Committee (through the management structure).
High	Risk in this category should be handled by the Board (through the management structure and Risk Committee) monthly.
Extreme Risk	Risk in this category should be handled by the Board (through the management structure and Risk Committee) monthly.

3.12 Determination of Impact and Risk Acceptability

To determine whether potential environmental risks and inputs are "acceptable" is a matter of judgement that depends on issues such as the nature and scale of impacts and the social or economic benefits. In determining acceptability, the Regulations require consideration of the principles of ESD and the Precautionary Principle, and the risk assessment performed by suitably qualified people.

Impact and risk identification must include consideration of uncertainty, which is qualitatively assessed using a generic means of ranking data available per Figure 1 and Table 5.

Table 5: Acceptability and Scientific Uncertainty

Score (Uncertainty Type)	Acceptability	Uncertainty Description (DEFRA, 2013)
Low (A)	Residual risk is acceptable, and it is assumed that ALARP has been achieved	• Comprehensive data with strong evidence in multiple peer-reviewed data • Little disagreement between authors or experts • Considerable and consistent on-ground experience and/or monitoring
Moderate-High (B)	Residual risk is acceptable provided that ALARP has been achieved and demonstrated	• Some or incomplete data available • Evidence provided based on a small number of references • Authors or experts' conclusions vary • Limited on-ground experience and/or monitoring
Extreme (C)	Residual risk is intolerable and must not be accepted or approved by Management.	• Scarce or no data available; evidence provided in unpublished reports • Few on-ground observations • Authors and experts' conclusions vary considerably

In addition to the requirements detailed above, for petroleum activities, impacts and risk to the environment are considered broadly acceptable if:

- The residual risk is determined to be Low, and ALARP Uncertainty Type (A) selected and good practice control measures applied; or
- The residual risk is determined between Moderate and High and ALARP can be demonstrated
- The following have been met:
    - Principles of ecologically sustainable development
    - Legal and other requirements
    - Imperial policies and standards
    - Stakeholder expectations

3.13 Risk Determination and the Code

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

3.14 Discussion on ALARP, acceptability to Ecological Sustainable Development (ESD)

As discussed in Section 3.11, Imperial uses a model to determine the acceptance of residual risk., this is specified in Imperial's Residual Risk Acceptance Model. To summarise:

- A Level 5 residual risk is intolerable and must not be accepted or approved by Management
- A Level 2 – 4 residual risk is acceptable provided that ALARP has been achieved and demonstrated
- A level 1 residual risk is acceptable, and it is assumed that ALARP has been achieved

In addition to the requirements detailed above, for petroleum activities, impacts and risk to the environment are considered acceptable if:

- The residual risk is determined to be 1 (and ALARP Decision Type A selected and good practice control measures applied), or
- The residual risk is determined between two and four, and ALARP can be demonstrated
- The following have been met:
    - Principles of ESD
    - Legal and other requirements
    - Stakeholder expectations.

All the residual risks in the risk assessment in Appendix 01 are between 1 and 2, which means that they are acceptable, ALARP and have considered elements of ESD. In the risk assessment, all risks have been considered a decision "Type A", meaning that they are well understood and that are established practices in place to manage these risks.

3.15 Referrals to DAWE and NT EPA

1.15.1 Significant Impact test for EPBC listed species

Conservation significant flora and fauna species are those species listed under the provisions of the Commonwealth EPBC Act or the Territory Parks and Wildlife Conservation Act 2000 (TPWC Act) including threatened species as well as internationally protected wildlife and migratory species.

Threatened species include those with conservation status listed as Endangered, Vulnerable or Near Threatened (EVNT) under the EPBC Act or Extinct in the Wild, Critically Endangered, Endangered or Vulnerable under the TPWC Act. Potentially occurring threatened flora and fauna species are listed in the EP187 Environmental Assessment Report 2019 Seismic and Drilling Program. This document also provides an account of their likelihood of presence within the study area based on public records, species biology and ecology and habitats available within the study area.

No threatened flora species have been previously recorded within the search area. Two (2) threatened fauna species have previously been recorded within the study area. One (1) species (Mesembriomys macrurus (golden-backed tree rat)) was recorded over 100 years ago and is now considered locally extinct. The second threatened fauna species (Erythrura gouldiae (Gouldian Finch) was not identified through NT or Commonwealth database searches, but instead is included due to anecdotal evidence. The DoE Matters of National Environmental Significance (MNES) Significant Impact Guidelines 1.1 (2013) were used to assess the potential for impacts. Carpentaria 1 and its access is outside of the known critical habitat for Gouldian Finch (refer Appendix 01.03 for likelihood of occurrence and risk assessment for impacts to MNES).

1.15.2 Significant impact test for Environmental Assessments Act

Petroleum activities that could reasonably be considered capable of having a significant effect on the environment are referred to the NT EPA. Using the guideline 'Referring a proposal to the NT EPA: A guide for proponents and referral agencies' (NT EPA 2018), a detailed review of and assessment against each prescribed Environmental Objectives for each Environmental Factor was conducted in relation to the proposed HF Program and is included in Table 6 below. The results of the assessment demonstrate that the proposed activities have been suitably managed, and risks addressed, the controls proposed in Appendix 04 shows how the objectives can be met.

Table 6: Environmental Objectives for each Environmental Factor

Aspect	Environmental Factor	Objective	Relevance to EMP	Potential significant effect on an environmental factor
Land	Terrestrial Flora and Fauna	Protect flora and fauna so that biological diversity and ecological integrity are maintained.	The proposed activities are unlikely to result in significant impacts to vegetation or native fauna. The mitigation measures outlined in the risk assessment table will be implemented to manage these risks to a level that is ALARP and acceptable.	No. Activity is unlikely to result in significant impacts on high valued vegetation communities or threatened flora and fauna or areas of essential habitat.
	Terrestrial Environmental Quality	Maintain the quality of the land and soils.	Should a release occur, the proposed activities are likely to result in only minor localised impacts to the land. The mitigation measures	No. Assessment indicates activity unlikely to result in significant impacts from increased

Aspect	Environmental Factor	Objective	Relevance to EMP	Potential significant effect on an environmental factor
			outlined in the risk assessment table will be implemented to manage these risks to a level that is ALARP and acceptable.	erosion and sediment releases.
	Landforms	Conserve the variety and integrity of distinctive physical landforms.	Given the implementation of the mitigation measures outlined in the risk assessment table, it is unlikely that distinct physical landforms will be impacted. There is currently no potential for a significant effect on landforms.	No. No significant modification to the surrounding landform is predicted
Water	Aquatic Ecosystems	Protect aquatic ecosystems to maintain the biological diversity of flora and fauna.	It is unlikely aquatic ecosystems will be impacted by the purposed activities, given that no sensitive vegetation will be disturbed and there is a lack of permanent surface waters and aquatic GDEs in the Project area. Furthermore, the mitigation measures outlined in the risk assessment table will be employed to ensure that potential risks and impacts are managed and further mitigated.	No. Activities are not anticipated to impact on the environmental factor.
	Water Environmental Quality	Maintain the quality of groundwater and surface water so that environmental values are protected.	Given the lack of permanent surface waters and the turbid nature of surface waters during times of flood, in conjunction with the mitigation measures outlined in the risk assessment table, it is unlikely the inland water quality will be impacted.	No. Assessment indicates activity unlikely to result in significant impacts to groundwater.

Aspect	Environmental Factor	Objective	Relevance to EMP	Potential significant effect on an environmental factor
	Hydrological Processes	Maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.	It is unlikely hydrological regimes of groundwater or surface waters will be altered by the proposed activities. The area of planned disturbance requires minimal volumes of groundwater extraction less than 5 ML. Control measures outlined in the risk assessment will be implemented to ensure that these potential risks and impacts are managed and further mitigated.	No. Assessment indicates activity unlikely to result in significant impacts to groundwater or surface water.
Air	Air Quality and Greenhouse Gases	Maintain air quality and minimise emissions and their impact so that environmental values are protected.	The proposed activities have the potential to result in localised, short-term minor effects on air quality through planned atmospheric emissions. The mitigation measures outlined in the risk assessment table. Based on the small nature of operations, it is unlikely there will be significant effects on air quality and greenhouse gases.	No. Assessment indicates activity unlikely to result in significant impacts to air quality of greenhouse gas generation.
People and Community	Social, Economic and Cultural Surroundings	Protect the social, economic, cultural and heritage values of the region.	The proposed activities have the unlikely potential to result in disturbance to culturally sensitive sites and/landholders through lighting, weeds, fire, planned physical disturbance, and unplanned stakeholder interactions. The control mitigation measures outlined in risk assessment table will be implemented to manage these risks, such as the	No. Low-intensity activity not anticipated to have significant impacts on the local community or tourism.

Aspect	Environmental Factor	Objective	Relevance to EMP	Potential significant effect on an environmental factor
			areas proposed to be disturbed have been surveyed for sacred sites and cultural heritage significance and an AAPA certificate is in place.	
	Human Health	Ensure that the risks to human health are identified, understood and adequately avoided and mitigated.	The proposed activities have the unlikely potential to result in human health impacts due to the inhalation of dust.	No. Low-intensity activity with limited receptors.

Appendix 04 - Environmental Risk Assessment

4. - Environmental Risk Assessment

An environmental risk assessment was undertaken by suitably qualified personnel for the proposed activities using the methodology outlined in Appendix 03 (Overview of the Environmental Risk Assessment Framework), and the results are reported in the Table below.

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
Terrestrial Flora and Fauna	1	Vehicle and plant movements	Disturbance, injury or death to terrestrial fauna Smothering of flora	5	1	High	A.3.1 Site selection and planning A.3.5 Biodiversity protection	• Adhere to road speed limits or to weather conditions, whichever is the lowest • Water trucks will be used for dust suppression as appropriate • Driving on designated areas only.	1	1	Low	Yes	Risks well understood. Management practices established and proven.
Terrestrial Flora and Fauna	2	Civil Constrcution for seismic, wellpads, access tracks and flowlines (raking, grading, ground disturbance)	Introduction or spread of weeds impacting native flora and fauna Native fauna fatality Loss of conservation of significant flora and fauna Loss of riparian vegetation	4	3	High	A.3.1 Site selection and planning A.3.5 Biodiversity protection A.3.6 Weed management	• No new weeds or non-native plants introduced, and appropriate weed management implemented as per Approved Weed Management Plan • New tracks shall be constructed at the minimum practical width to allow the safe travel of the seismic equipment • Minimise clearing of new access tracks to sticks, logs and larger rocks necessary to ensure safe access wherever possible • Photographic monitoring before and after disturbance • Track fauna strike/ near-miss in the fauna control register to enable knowledge sharing across Imperial personnel and contractors • Activities will adhere to the guidelines within the NT Weed Management Handbook and "Preventing weed spread is everybody's business" (https://denr.nt.gov.au/__data/assets/pdf_file/0011/257987/preventing-weed-spread.pdf) • Hygiene procedures are implemented and enforced to minimise risk of weed spread • Weed desktop and field-based surveys undertaken to identify existing weed areas • Major equipment moves will be planned from weed-free areas to infested areas and not the other way around	3	2	Moderate	Yes	Risks well understood. Management practices established and proven.

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
						High		• Weed survey conducted before and after any disturbance or clearing operations to determine if new noxious species present • Native fauna is mobile. Machinery noise might help disperse vagile fauna • Buffer distances from riparian vegetation, waterways and drainage lines to be applied in accordance to "Recommended Widths for Riparian Buffers of the LCG (2019) ○ 1st order streams and Drainage lines = 25m buffer from outer edge of drainage depression or riparian vegetation ○ 2nd order streams = 50m buffer ○ 3rd order creeks = 100m buffer ○ There are no 4th order or higher creeks or rivers in the project area. • Vehicle and machinery to undergo weed cleaning and compliance checks before mobilised to site • Larger trees (including Corymbia and Eucalypt species) with a trunk diameter greater than 25cm at 1.3m above the ground are avoided whenever practical during clearing for seismic lines, to minimise disturbance to potential nesting trees for the Crested Shrike-tit and Gouldian Finch • Respread any removed vegetation to encourage regrowth of native flora • Monitor rehabilitated areas un undertake further work as required.			Moderate		
Terrestrial Flora and Fauna	3	Bushfire associated with project activities	Native fauna fatality Increased incident and intensity of bushfires leading to vegetation degradation and habitat modification	3	4	High	A.3.5 Biodiversity Protection A.3.7 Fire Management	• Fire extinguishers fitted to all vehicles • Appropriate firefighting equipment available and serviced • No burning of waste • Availability of water to assist in fire control • Staff induction to include emergency response procedures and communications with neighbours maintained • Designated smoking areas with appropriate waste receptacles • Monitor weather and fire danger to plan operations accordingly	1	4	Moderate	Yes	Risks well understood. Management practices established and proven.
	4	Drilling, Completion, Hydraulic Fracture & Production Test activities	Disturbance to native fauna	2	2	Moderate	A.3.1 Site selection and planning A.3.3 Noise	• Location selected to avoid impacts to conservation areas • Weed management plan implemented • Engine/machinery will have noise suppression devices where practicable, and	2	1	Low	Yes	Risks well understood. Management practices

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
							A.3.5 Biodiversity protection	• Engines/machinery to be maintained as per planned maintenance system.					established and proven.
Terrestrial Flora and Fauna	5	Drilling, Completion, Hydraulic Fracture & Production Test activities Including lighting at night from camp	Disturbance to native fauna due to light from project activities	5	2	High	A.3.1 Site selection and planning A.3.2 Well pad selection requirements	• Lighting required for well operations will be limited to the direct area immediately around the wellhead location • Lighting will be faced toward the wellhead and work areas • Task focussed lighting will be used, and all boundary lighting for the camp (if applicable) will be positioned inwards • Majority of vehicle movements will be limited to daylight hours.	2	1	Low	Yes	Risks well understood. Management practices established and proven.
	6	Entrapment in open ponds and tanks	Disturbance, injury or death to terrestrial fauna	4	1	Moderate	A.3.5 Biodiversity protection A.3.8. Containment of contaminants D.4.3 Routine periodic atmospheric monitoring programme	• Fauna ladders will be installed at all open ponds and tanks • Daily checks of open ponds and tanks throughout the site operation • Weekly inspections of open ponds and tanks during periods of site inactivity • Open ponds that are left open during periods of site inactivity will be fitted with mesh panel fencing of not greater than 150mm x 150mm opening to prevent livestock and large fauna entry • Open-top tanks to have vertical walls with no clear access points for fauna.	2	1	Low	Yes	Risks well understood. Management practices established and proven
	7	Spread of weeds through vehicle movements.	Loss of native vegetation through competition for resources	3	3	High	A.3.6 Weed management A.5.3 Biodiversity protection	• Equipment and vehicles to be washed-down and to have a biosecurity Declaration Certificate before access to the site • Weed management plan in place (Appendix 09), and • Adherence to mitigation measures described in the Weed Management Plan for the project.	1	2	Low	Yes	Baseline weed survey completed. Approved Weed Management Plan in place Risks well understood. Management practices established and proven.

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
8	9	Ignition sources from plant and machinery Inappropriate disposal of cigarettes. Well blow out	Disturbance or death to terrestrial fauna, loss of terrestrial flora due to fire	2	2	Moderate	A.3.7 Fire Management	• Vehicles will be equipped with fire extinguishers and operational VHF or UHF radio transceivers • All personnel to be trained and informed before the commencement of the activity relating to: ○ Restricted smoking areas and requirements ○ Firefighting equipment operation and communication ○ Emergency Response Plan and procedures during a fire emergency ○ Alert of fire risk level for the day • Smoking only in designated areas and fit with appropriate bins, no disposal of cigarette butts to land • Implementation of Fire Management Plan (Appendix 08) • Machinery and vehicles should be parked in areas of low fire risk.	1	1	Low	Yes	Risk associated with bushfire are well known, with numerous literature and NT government mapping and management plans in place
	9	Extended Production testing, flaring	Disturbance or death to terrestrial fauna, loss of terrestrial flora due to fire	2	2	Moderate	D.4.1 Baseline Methane assessment D.5.1 Emissions management Plan D.5.9 Venting and Flaring	• Flaring to have an appropriate buffer, with proper barriers to prevent access by wildlife • Firebreaks to be implemented around the well pad with minimum setbacks to infrastructure based on flaring design • Flare stack will be monitored during flaring • Flare pit and flare stack to be positioned as per hazardous area classification • The fire protection zone surrounding the well pad and flare will be devoid of trees, and • Flares or flare stacks must be designed, prepared and operated following industry standards.	1	2	Low	Yes	Risk associated with bushfires are well known, with numerous literature and NT government mapping and management plans in place
	10	Crossflow during hydraulic fracture (HF), Faults or major structures enables crossflow Well blow out	Impacts to groundwater dependant ecosystems	2	3	Moderate	B.4.1 Well integrity management B.4.2 Aquifer protection B.4.3 Well design and barriers B.4.6 Casing and tubing B.4.7 Primary cementing B.4.9 Well control	• A WOMP in place and approved. Activities will not commence until approval received from the regulator • Groundwater bores monitored before hydraulic fracture operations. Baseline monitoring conducted six months before and after hydraulic fracture operations • Installation of blow-out prevention equipment systems • Well is located away from major faults and structures based on seismic data control • A geohazard assessment has been performed to mitigate for subsurface hazards such as abnormal pressure zones, shallow gas, lost circulation and potential zones of instability • Chemical Risk Assessment of all chemical used in the proposed HF (Appendix 06.01)	1	1	Low	Yes	Through the adoption of the controls with the Code, and the mitigation measures outlined in the EMP meets the industry best practice requirements of the Code, API standards and the Water Act.

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
							B.4.13 Hydraulic HF and flowback operations B.4.17 Groundwater monitoring C.4.2 Management of Produced water and Flowback Fluid C.7.2 Spill management plan	• Distance of target shale formations (Velkerri formation) from the nearest high-quality aquifer (Cambrian Limestone aquifer) is over 600m • Cementing casing, following the Code requirements, will prevent aquifer crossflow once well is constructed and passes well acceptance criteria • Hydraulic fracture diagnostics, including chemical tracers, is used to determine the spatial extent and orientation of the induced fracture, and • Shallow aquifers isolated behind cemented concentric casing strings.					Chemical risk assessment conducted. Control and monitoring bores as per preliminary guidelines: Groundwater monitoring bores for exploration petroleum wells in the Beetaloo Sub-Basin Also, the CSIRO regional baseline monitoring program is underway, and the knowledge of the regional aquifers is well established.
Terrestrial Flora and Fauna	11	Waste stored inappropriately attracting native fauna	Fauna attracted to waste Fauna comes in contact with HF waste water	5	2	High	C.7.1 Wastewater management plan	• Only waste from approved wastewater systems and greywater will be disposed of to land • Licenced waste contractor will be used for any offsite transfer or disposal • Waste will be segregated and stored onsite, and all putrescible waste material will be held in fauna proof containers • Half-life of drilling fluid biocides used <5 days in water, and less than 14 days in sediment. • The hazard quotient for all the assessed avian species was orders of magnitude less than the threshold hazard quotient level of 1 (Appendix F, Appendix 06.01).	1	1	Low	Yes	The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the Code and NT Waste Management and Pollution Control Act 1998. Controls above best practice are unlikely to reduce further the risk

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
													associated with waste management. Based upon the risk being ranked as "low", the risk is determined to be ALARP and acceptable.
Terrestrial Environmental Quality	12	Vehicles damaging access tracks from driving while waterlogged	Disturbance to soil	5	1	High	A.3.1 Site selection and planning A.3.4 Erosion and sediment control and hydrology	• Access track alignment selected to avoid low lying areas • Access tracks will be assessed daily during periods of site activity for the impacts of wet weather • Access tracks will be closed to Imperial heavy vehicles, light vehicles or both, based on this assessment • Load Bearing capacity of access tracks will be assessed after rain events • Imperial will utilise a helicopter if required to carry out personnel movements in case of road closures.	2	1	Low	Yes	Risk well understood.
	13	Civil Constrcution for seismic, wellpads, access tracks and flowlines (raking, grading, ground disturbance)	Disruption on landform and soils	3	2	Moderate	A.3.1 Site selection and planning A.3.4 Erosion and sediment control	• No establishment of hard surfaces around water storage areas • No driving off unformed tracks • Implementation of the Erosion and Sediment Control Plan (Appendix 05) • Active inspection and monitoring of the effectiveness of erosion and sediment control measures adopted across the site. Maintain as required • Preference to use previously disturbed areas • Disturbed areas will be re-contoured • All drains to be flat bottom and cleaned out following significant rainfall events, to ensure that laminar surface flow is maintained • Roads and tracks required will be developed along the contour where possible. • No unauthorised clearing • Diversion banks and rollover banks developed across the contour to disperse runoff away from the tracks as required. • After significant rainfall inspect areas to confirm: ○ No erosion ○ No sedimentation ○ No blocking of drainage line	2	1	Low	Yes	Risks well understood. Management practices established and proven.

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
								• Conduct progressive rehabilitation to minimise the total area open					
Terrestrial Environmental Quality	14	Vehicles leave the previously constructed roads or work areas	Disturbance to soil	5	1	High	A.3.1 Site selection and planning A.3.4 Erosion and sediment control	• People trained before activity commencement • Driving is only permitted in designated areas, and • Traffic impact assessment completed highlighting vehicle traffic impacts.	2	1	Low	Yes	Risk well understood.
	15	Chemical spills and leaks associated with inappropriate storage or handling of hazardous substances, including Drilling Muds, HF fluid and flowback fluid wastewater Poor refuelling or fuel transfer practices	Localised contamination of soil	3	2	Moderate	A.3.8 Containment of contaminants B.4.16 Site material and fluid management C.4.2 Management of Produced water and Flowback Fluid C.7.2 Spill management plan	• Any spills contained and remediated • A WOMP in place and approved. Activities will not commence until approval received from the regulator • Chemical Risk Assessment of all chemical used in the proposed HF (Appendix 06.01) • Implementation of the Wastewater Management Plan (Appendix 06) • All HF work tanks are enclosed • Use of drip trays for refuelling and transfers • Implementation of the Spill Management Plan (Appendix 07) • Appropriate bunding in use for storage of chemicals and where required adherence to standards • Bunded containment for the storage of chemical materials • Drilling fluid and HF fluid system mixed, contained and monitored in engineered fluid storage tanks. • Spill management kits located onsite for response to any small-scale spills • Pre-spud checks / Pre-job checks when transferring fluids • Fuel and other lubricants will be appropriately stored and managed per industry standards • An assessment carried out as part of the Chemical Risk Assessment showed that In the context of a potential release scenario of 100,000L outside of the containment and storage area, the maximum affected area of spreading would be less than 4.7ha and limited to the proximity of the release area (Appendix 06.01-appendix B)	1	2	Low	Yes	The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the Code, Imperial Spill management plan, Wastewater management plan and the National Environment Protection (Assessment of Site Contamination) Measure.

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
Terrestrial Environmental Quality	16	Transport vehicle accident due to weather, Transport vehicle stuck due to mechanical or weather events.	Localised contamination of soil	2	2	Moderate	A.3.8 Containment of contaminants	• Access track alignment selected to avoid low lying areas • Access tracks will be assessed daily during periods of site activity for the impacts of wet weather • Access tracks will be closed to Imperial heavy vehicles, light vehicles or both, based on this assessment • Imperial will utilise a helicopter if required to carry out personnel movements in case of road closures • In the event of a truck being stuck due to mechanical or weather reason, transfer or recovery will only occur once safe, and the risk of spills are ALARP • The proposed activity has a Land Access and Compensation Agreement in place with the landholder • Road conditions for heavy vehicle transport will be assessed before mobilisation on unsealed roads. If the conditions are assessed to be unsuitable for heavy vehicle transport, there will be no transport of chemicals or wastewater • A risk assessment of road conditions for heavy vehicle transport will be conducted before mobilisation on unsealed roads using detailed weather forecasting • Only licenced waste transporters to be used to transport listed wastes, and • Transport of wastewater will only occur in double-lined enclosed tanks to minimise the risk of spills • Implementation of the Waste Management Plan (Appendix 06) and the Spill Management Plan (Appendix 07) to reduce potential consequences.	1	2	Low	Yes	The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the Code and NT Waste Management and Pollution Control Act 1998.
Terrestrial Environmental Quality	17	Overflow of fluid storage and treatment tanks, Sumps or cuttings pits Leaching from storage tanks or treatment ponds Flowline failure Well blow out	Impact to soil quality	3	2	Moderate	C.6.1. Water and Wastewater tracking and reporting C.7.2 Spill management plan	• Wellpad site located away from areas of concentrated overland flow • Ponds will be appropriately designed and constructed with a 0.5m of bund to prevent entry of overland flow • Wastewater storage ponds and open topped wastewater storage tanks will be marked with 1.1m of freeboard during the wet season, and 0.5m during the dry season • Open-topped wastewater treatment tanks will be marked with 1.1m of freeboard during the wet season, and 0.5m of freeboard during the dry season	2	1	Low	Yes	The risk was assessed as being a "low". The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the CODE and NT Waste Management and Pollution

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
						Moderate		• Closed-topped tanks will be marked with 0.5m of freeboard • Wastewater tank and pond levels will be monitored daily during operations so that levels are maintained below the marked freeboard level • Wastewater tanks and ponds will be inspected daily to check integrity during periods of site operations • Wellpad activities to cease if freeboard is not maintained in wastewater tanks and ponds, unless authorised by DEPWS to continue operations • Wastewater tanks and ponds that are left operational over the wet season during periods of site inactivity will be fitted with level monitoring telemetry that reports back to the operations team • Wastewater tanks and ponds will be inspected weekly to check integrity during periods of site inactivity • Tankpad to be compacted to engineering design specifics of Original Equipment Manufacturer (OEM) • If required, rainwater will be pumped from bunded tankpad area to freshwater pond • Open-top ponds and open-topped tanks that are left operational over the wet season during periods of site inactivity will be fitted with level monitoring telemetry that reports back to the operations team • Open-top ponds and open-topped tanks will be inspected weekly to check integrity during periods of site inactivity • Bunded tank pad will accommodate 110% of the volume of the largest tank • Daily monitoring of weather and for predicted significant rainfall events will be undertaken • Implementation of an approved Spill Management Plan and Wastewater Management Plan, and • Code of Practice: Onshore Petroleum Activities (the Code) will be implemented.					Control Act 1998. Controls above best practice are unlikely to reduce further the risk associated with waste management.
Terrestrial Environmental Quality	18	Leaching from ponds	Impact to soil quality	3	2	Low	A.3.8 Containment of contaminants B.4.16 Site material and fluids management	• Ponds will be appropriately designed and constructed with an impermeable containment barrier • Ponds will be inspected daily to check integrity during periods of site operations • Ponds that are left open over the wet season during periods of site inactivity will be fitted with mesh	2	1	Low	Yes	The risk was assessed as being a "low". The risk mitigation measures outlined in the EMP meet the

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
							C.4.2 Management of produced water and flowback fluid C.7.2 Spill management plan	panel fencing of not greater than 150mm x 150mm opening to prevent livestock and large fauna entry • Ponds that are left open over the wet season during periods of site inactivity will be fitted with level monitoring telemetry that reports back to the operations team • Ponds will be inspected weekly to check integrity during periods of site inactivity • Cuttings blending and burial or isolation and removal will be subject to sampling results and on the advice of an independent environmental consultant.					industry best practice requirements of the NT Petroleum Codes of Practice and NT Waste Management and Pollution Control Act 1998. Controls above best practice are unlikely to reduce further the risk associated with waste management.
	19	Use of groundwater for project activities	Reduction in groundwater quantity and quality	2	2	Moderate	A.3.1 Site Selection and Planning B.4.17 Groundwater monitoring	• Valid water extraction licence in place before extraction • Compliance with water extraction licence limits and conditions • Bore numbers and estimated extraction volumes will be provided to DITT and DEPWS	1	2	Low	Yes	The risk to groundwater resources from extraction and contamination is ranked as "Low". Imperial will meet the industry best practice requirements of the NT through the adoption of the controls stipulated in this EMP.
Terrestrial Environmental Quality	20	Fracture growth into aquifer from HF activities Well blow out	Crossflow – migration of fluids and gas	4	3	High	B.4.13 Hydraulic HF and Flowback Operations B.4.17 Groundwater monitoring	• Risk assessment completed before HF to determine fracture growth • Real-time pressure monitoring to determine if a fracture has propagated outside the design operating envelope • Overlying sequences have a higher fracturing pressure reducing the risk of fracture migration out of the target shale	2	1	Low	Yes	The risk to groundwater resources from extraction and contamination is ranked as "Low". Imperial will meet the industry best

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
								• Pressure monitoring during HF to identify anomalies indicating fluid loss aquifers, and • Well designed with multiple well barriers in place to protect aquifers.					practice requirements of the NT through the adoption of the controls stipulated in this EMP.
	21	HF activity induces seismic activity Well blow out	Cross formational flow between shallow aquifers	3	2	Moderate	B.4.13 Hydraulic HF and Flowback Operations B.4.17 Groundwater monitoring	• HF is not linked to major seismic events (reinjection of wastewater is generally recognised as the main cause). No reinjection of wastewater proposed • HF stages deployment will be away from geohazards to reduce the loss of fluids into any encountered faults • No significant faults within proximity of activity, and • Any faults encountered during drilling will be assessed to determine the risk before HF operations	1	2	Low	Yes	The risk to groundwater resources from extraction and contamination is ranked as "Low". Imperial will meet the industry best practice requirements of the NT through the adoption of the controls stipulated in this EMP.
	22	Surface activities (chemical and waste storage, handling and spills)	Contamination of aquifer impacting a receptor (groundwater user or GDE)	4	2	High	A.4.7 Containment of Contaminants B.4.13 Hydraulic HF and Flowback Operations C.5.2 Management of produced waterfrom petroleum wells C.8.2 Spill Management Plan C.8.1 Wastewater Management Plan	• Wellpad site located away from areas of concentrated overland flow • Ponds will be appropriately designed and constructed with a 0.5m of bund to prevent entry of overland flow • Wastewater ponds will be marked with 1.1m of freeboard during the wet season, and 0.5m during the dry season • Open-topped wastewater treatment tanks will be marked with 1.1m of freeboard during the wet season, and 0.5m of freeboard during the dry season • Closed-topped tanks will be marked with 0.5m of freeboard • Wastewater tank and pond levels will be monitored daily during operations so that levels are maintained below the marked freeboard level • Wastewater tanks and ponds will be inspected daily to check integrity during periods of site operations • Wellpad activities to cease if freeboard is not maintained in wastewater tanks and ponds, unless authorised by DEPWS to continue operations	1	2	Low	Yes	The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the Code, Imperial Spill management plan, Wastewater management plan and the National Environment Protection (Assessment of Site

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
								• Wastewater tanks and ponds that are left operational over the wet season during periods of site inactivity will be fitted with level monitoring telemetry that reports back to the operations team • Wastewater tanks and ponds will be inspected weekly to check integrity during periods of site inactivity • Bunded tank pad will accommodate 110% of the volume of the largest tank • Daily monitoring of weather and for predicted significant rainfall events will be undertaken • An assessment carried out as part of the Chemical Risk Assessment showed the travel times for surface releases to reach groundwater are very long, thereby providing ample opportunity for containment and remedial action. Therefore, the potential for impacts to groundwater are considered low. (Appendix 06.01-appendix B) • Implementation of an approved Spill Management Plan and Wastewater Management Plan, and • Code of Practice: Onshore Petroleum Activities (the Code) will be implemented.					Contamination) Measure.
Hydrological Processes	23	Civil Constrcution for seismic, wellpads, access tracks and flowlines (raking, grading, ground disturbance)	Surface spills	4	2	High	A.4.7 Containment of Contaminants B.4.13 Hydraulic HF 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 leak detection • High-risk chemical storage and handling areas to have secondary containment • Weekly inspections to identify any potential leaks • Licenced waste transporters to be used • Secondary containment utilised for storage of onsite chemicals • Spill Management Plan implemented to prevent, detect and respond to spills • Wastewater Management Plan • NORMS levels are not anticipated to be significant- with characterisation of levels within flowback undertaken to validate • From Appendix B of Appendix 06.01 - long travel times for surface releases to reach groundwater allow for ample time for containment and remedial action • Appendix 06.01 states “Given the planned management control of the construction of a bunded area surrounding treatment tanks, the potential for a complete exposure pathway to surface water bodies associated with runoff from an accidental release is considered unlikely and not assessed further	1	2	Low	Yes	The regulatory regime legislating the storage, handling and transportation of controlled wastes in the NT and Australia is mature. Imperial will adhere to the measures outlined in the EMP, Code and Management Plans.

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
Inland water environmental quality	24	Civil Constrcution for seismic, wellpads, access tracks and flowlines (raking, grading, ground disturbance)	Impact to hydrological systems (reduce quality and/or ecological function). Increase in sediment load in watercourse. Contamination of soil or surface water body	3	3	High	A.3.1 Site selection and planning A.3.2 Well pad site selection A.3.4 Erosion and sediment control and hydrology	• No establishment of hard surfaces around water storage areas • Surface contouring of land will ensure free drainage • Clearing for seismic lines avoids riparian vegetation and additional disturbance to watercourses. • Rainfall events, to ensure that laminar surface flow is maintained • Buffer distances from riparian vegetation, waterways and drainage lines to be applied in accordance to "Recommended Widths for Riparian Buffers of the LCG (2019). ○ 1st order streams and Drainage lines = 25m buffer from outer edge of drainage depression or riparian vegetation ○ 2nd order streams = 50m buffer ○ 3rd order creeks = 100m buffer ○ There are no 4th order or higher creeks or rivers in the project area • Install buffer zones and distances into onsite tablets, so machine operators have visual and audible alert when reaching buffer distances. • Conduct progressive rehabilitation to minimise the total area open • Scrapes will be filled and compacted to prevent future formation of depressions or rendered shallow and self-draining • Active inspection and monitoring of the effectiveness of erosion and sediment control measures adopted across the site. • Seismic acquisition will occur only in the dry season to reduce the potential for erosion and offsite transport of sediments	2	1	Low	Yes	The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the Code
Inland water environmental quality	25	Chemical spills and leaks associated with Inappropriate storage or handling of hazardous substances, including HF fluid and flowback fluid wastewater. Poor refuelling or fuel transfer practices.	Reduction in groundwater and surface water quality	3	2	Moderate	A.3.8 Containment of contaminants B.4.16 Site material and fluid management C.3 Well site water management C.4.2 Management of Produced water and Flowback Fluid	• Any spills contained and remediated • A WOMP in place and approved. Activities will not commence until approval received from the regulator • Chemical Risk Assessment of all chemical used in the proposed HF (Appendix 06.01) • Implementation of the Wastewater Management Plan (Appendix 06) • All HF work tanks are enclosed • Use of drip trays for transfers • Weekly inspections to identify any potential leaks • Daily inspection of tanks to check integrity during periods of site operations	1	2	Low	Yes	The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the Code, Imperial Spill management plan, Wastewater management plan and the

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
							C.7.2 Spill management plan	• Implementation of the Spill Management Plan (Appendix 07) • Appropriate bunding in use for storage of chemicals and where required adherence to standards • Bunded containment for the storage of liquid hydraulic fracturing materials • Hydraulic fracture fluid system mixed into small volumes as needed, contained and monitored in engineered fluid storage tanks • Spill management kits located onsite for response to any small-scale spills • Pre-spud checks / Pre-job checks when transferring fluids • Fuel and other lubricants will be appropriately stored and managed per industry standards.					National Environment Protection (Assessment of Site Contamination) Measure.
Inland water environmental quality	26	Crossflow during drilling and HF, operations, testing and decommissioning Faults or major structures enables crossflow. Well blow out	Reduction in groundwater and surface water quality	2	3	Moderate	B.4.1 Well integrity management B.4.2 Aquifer protection B.4.3 Well design and barriers B.4.6 Casing and tubing B.4.7 Primary cementing B.4.9 Well control B.4.13 Hydraulic HF and flowback operations B.4.17 Groundwater monitoring C.4.2 Management of Produced water and Flowback Fluid C.7.2 Spill management plan	• A WOMP in place and approved. Activities will not commence until approval received from the regulator • Groundwater bores monitored before HF operations. Baseline monitoring conducted before and after hydraulic fracture operations • Installation of blow-out prevention equipment systems • Code of Practice: Onshore Petroleum Activities (the Code) will be implemented • Well is located away from major faults and structures based on seismic data control • A geohazard assessment has been performed to mitigate for subsurface hazards such as abnormal pressure zones, shallow gas, lost circulation and potential zones of instability • Chemical Risk Assessment of all chemical used in the proposed HF (Appendix 06.01) • Distance of target shale formations (Velkerri formation) from the nearest high-quality aquifer (Cambrian Limestone aquifer) is over 600m • Cementing casing, following the Code requirements, will prevent aquifer crossflow once well is constructed and passes well acceptance criteria • HF diagnostics, including chemical tracers, is used to determine the spatial extent and orientation of the induced fracture • Shallow aquifers isolated behind cemented casing strings.	1	2	Low	Yes	Through the adoption of the controls with the Code, and the mitigation measures outlined in the EMP meets the industry best practice requirements of the Code, API standards and the Water Act. Chemical risk assessment conducted. Control and monitoring bores as per preliminary guidelines: Groundwater monitoring bores for exploration petroleum wells

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
													in the Beetaloo Sub-Basin CSIRO regional baseline monitoring program is complete, and the knowledge of the regional aquifers is well established.
	27	Overflow of fluid storage and treatment tanks, Sumps or cuttings pits Leaching from storage tanks or treatment ponds Flowline failure Well blow out	Impact to soil quality	3	2	Moderate	C.6.1. Water and Wastewater tracking and reporting C.7.2 Spill management plan	• Wellpad site located away from areas of concentrated overland flow • Ponds will be appropriately designed and constructed with a 0.5m of bund to prevent entry of overland flow • Wastewater ponds will be marked with 1.1m of freeboard during the wet season, and 0.5m during the dry season • Open-topped wastewater treatment tanks will be marked with 1.1m of freeboard during the wet season, and 0.5m of freeboard during the dry season • Closed-topped tanks will be marked with 0.5m of freeboard • Wastewater tank and pond levels will be monitored daily during operations so that levels are maintained below the marked freeboard level • Wastewater tanks and ponds will be inspected daily to check integrity during periods of site operations • Wellpad activities to cease if freeboard is not maintained in wastewater tanks and ponds, unless authorised by DEPWS to continue operations • Wastewater tanks and ponds that are left operational over the wet season during periods of site inactivity will be fitted with level monitoring telemetry that reports back to the operations team • Wastewater tanks and ponds will be inspected weekly to check integrity during periods of site inactivity • Tankpad to be compacted to engineering design specifics of Original Equipment Manufacturer (OEM)	2	1	Low	Yes	The risk was assessed as being a "low". The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the CODE and NT Waste Management and Pollution Control Act 1998. Controls above best practice are unlikely to reduce further the risk associated with waste management.

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
								• If required, rainwater will be pumped from bunded tankpad area to freshwater pond • Open-top ponds and open-topped tanks that are left operational over the wet season during periods of site inactivity will be fitted with level monitoring telemetry that reports back to the operations team • Open-top ponds and open-topped tanks will be inspected weekly to check integrity during periods of site inactivity • Bunded tank pad will accommodate 110% of the volume of the largest tank • Daily monitoring of weather and for predicted significant rainfall events will be undertaken • Implementation of an approved Spill Management Plan and Wastewater Management Plan, and • Code of Practice: Onshore Petroleum Activities (the Code) will be implemented.					
Inland water environmental quality	28	Use of groundwater for project activities	Reduction in groundwater quality	2	2	Moderate	A.3.1 Site Selection and Planning B.4.17 Groundwater monitoring	• Compliance with water extraction licence limits and conditions • Volumes and bore numbers provided to the DITT and DEPWS • Valid water extraction licence in place, and • Water bore management plan in place and approved	1	2	Low	Yes	Ongoing groundwater monitoring undertaken Regional understanding of the CLA is sufficient to understand the risks
	29	Disposal of domestic wastewater from treatment units	Reduction in surface water and groundwater quality	1	2	Low	A.3.1 Site Selection and Planning C.7.1 Wastewater management plan	• Wellpad and campsite site located away from areas of concentrated overland flow • Implementation of an approved Spill Management Plan (appendix 06)and Wastewater Management Plan (Appendix 07) • Disposal of wastewater is to occur in a benign area away from water drains, or creek beds, • Only licenced waste transporters to be used to transport listed wastes	1	2	Low	Yes	The risk was assessed as being a "low". The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the NT Petroleum Codes of Practice and NT Waste

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
													Management and Pollution Control Act 1998. Controls above best practice are unlikely to reduce the risk associated with waste management.
Air Quality and Greenhouse Gases	30	Vehicle and plant movements	Increase in dust particles, reduction in air quality. Creation of atmospheric emissions.	2	2	Moderate	A.3.1. Site Selection and Planning	• Vehicles and plant machinery maintained in good working order and as per manufactures manual • Dust suppression will be utilised, especially near sensitive receptors • Greenhouse gas emissions shall be measured and reported per the National Greenhouse and Energy Reporting Scheme (NGERS) National Greenhouse and Energy Reporting (Measurement) Determination 2008. • Monitor road conditions to ensure, deterioration with possible increase in dust creation does not occur and undertake road rehabilitation as required	1	1	Low	Yes	Methods for estimating emissions are available via the National Pollutant Inventory and NGERS Risks associated with diesel combustion are well known, both within Australia and Internationally.
	31	Civil Constrcution for seismic, wellpads, access tracks and flowlines (raking, grading, ground disturbance)	Increase in dust particles, reduction in air quality. Health respiratory stress.	3	2	Moderate	A.3.1. Site Selection and Planning A.3.2 Well pad site selection requirements	• Activity intensity low, with no local sensitive receptors within 50km • Vehicles and plant machinery maintained in good working order and as per manufactures manual • Crew mobilisation by dual cab vehicles, avoid extra vehicle movement whenever possible • Dust suppression will be utilised, especially near sensitive receptors • Implement plant and vehicle speed restrictions (60km/hr on unsealed roads in proximity (<200m) to sensitive receptors) • Monitor road conditions to ensure deterioration with possible increase in dust creation does not occur and undertake road rehabilitation as required.	2	1	Low	Yes	The risk from dust emissions on air quality is ranked as a "low". The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the NT Petroleum Codes of Practice; with site selection

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
													being the primary control.
	33	Fugitive emissions	Reduction in air quality. Creation of atmospheric emissions.	2	2	Moderate	A.3.1 Site Selection and Planning Part D – Methane emissions monitoring, leak management, detection and reporting D.4.1 Baseline Methane Assessment D.5.1 Methane Emissions management plan D.5.9.4 Other fugitive emissions	• No burning on site • Activity intensity low, with no local sensitive receptors within 50km • All flaring and venting to be reported as per the National Greenhouse and Energy Reporting Scheme and Petroleum Codes of Practice. • The Methane Emissions Management Plan (Appendix 10) will be implemented • Wells to be constructed with cement isolation • Cement placement modelling conducted before the job including but not limited to casing standoff, drilling fluid displacement, anticipated job pressures and equivalent circulating densities • All cement slurries to be laboratory tested to ensure slurry is fit for purpose • Operational wells to be tested six-monthly for any leaks • Gas detection monitoring will be conducted during all phases of the hydraulic fracturing operations • CSIRO completed baseline methane monitoring before commencing HF as per the Code. • Equipment to be compliant with relevant pollution control device requirements and maintained to minimise emissions.	1	1	Low	Yes	Emissions during petroleum activities are estimated using the NGERS estimation tools. Risks and impacts associated are well known.
Air Quality and Greenhouse Gases	34	Extended Production Test flaring	Reduction in air quality. Creation of atmospheric emissions.	5	2	High	Part D – Methane emissions monitoring, leak management, detection and reporting D.5.9 Venting and Flaring D.4.1 Baseline Methane assessment D.4.3 Routine periodic atmospheric	• Flaring will be used rather than venting • Flaring will not be carried out on Fire Ban days • All flaring will be measured • The Methane Emissions Management Plan (Appendix 10) will be implemented • Gas detection monitoring will be conducted during all phases of the flowback and extended production testing operations, and • Activity intensity low, with no local sensitive receptors within 50km • All flaring and venting to be reported as per the National Greenhouse and Energy Reporting Scheme and Petroleum Codes of Practice.	3	1	Moderate	Yes	Risks and impacts associated with flaring activities are well understood, and proven management practices are established.

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
							monitoring programme D.5.1 Methane Emissions management Plan						
Social, economic and cultural surroundings	35	Vehicles leave the previously constructed roads or work areas	Disturbance to Aboriginal archaeological sites	2	2	Low	A.3.1 Site Selection and Planning	• Driving only in designated areas • People trained and inducted before work • Archaeological surveys completed before activity commencement • No Aboriginal archaeological or historical sites/relics will be encountered or impacted by proposed activities as indicated by the archaeological report	1	1	Low	Yes	Risk well understood, No Aboriginal archaeological or historical sites/relics will be encountered or impacted by proposed activities
	36	Use of groundwater for project activities	Reduction in groundwater available for other users	2	3	Moderate	B.4.17 Groundwater monitoring	• Compliance with water extraction licence limits and conditions • Volumes and bore numbers provided to the DITT and DEPWS • Valid water extraction licence in place • Water bore management plan in place and approved	1	3	Moderate	Yes	Ongoing Groundwater monitoring. Regional understanding of the CLA sufficient to understand the risk
	37	Vehicle and plant movements	Loss of amenity	5	1	High	A.3.1 Site Selection and Planning A.3.5 Erosion and Sediment control	• Dust suppression as appropriate • Adhere to road speed limits at all times or the weather conditions, whichever is the lowest • Driving only in designated areas • Sealed turnoff intersection of the Carpentaria-1 well site access track and the Carpentaria Highway	1	1	Low	Yes	Risks well understood. Management practices established and proven
	38	Drilling and Hydraulic fracture activities	Noise and vibration causing disturbance to landholders	3	2	Moderate	A.3.1 Site selection and planning A.3.3 Noise	• Well are located at more than 10km distance from the closest household • Hydraulic fracturing activity and the majority of vehicle movement will be limited to daylight hours whenever possible • Engine/machinery will have noise suppression devices where practicable • Engines/machinery to be maintained as per manufacturers.	2	1	Low	Yes	Land access agreements in place and ongoing stakeholder engagement. Risks well understood. Management

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
													practices established and proven.
Social, economic and cultural surroundings	39	Night activities, Lightning at night from camp.	Disturbance to landholders	5	1	High	A.3.1 Site selection and planning A.3.2 Well pad Site selection requirements	• Wells is located at more than 10km distance from the closest household • Task focussed lighting will be used • All boundary lighting will be positioned to face inwards.	2	1	Low	Yes	Land access agreements in place and ongoing stakeholder engagement. Risks well understood. Management practices established and proven.
	40	Animal entrapment	Disturbance, injury or death to fauna	4	1	Moderate	A.3.5 Biodiversity protection A.3.8 Containment of contaminants	• Daily checks of infrastructure throughout the hydraulic fracture program • Pits and dams will be fenced • Relevant landowners will be notified before the commencement of the activity • Adhere to road speed limits at all times or the weather conditions, whichever is the lowest	3	1	Low	Yes	Risks well understood. Management practices established and proven
	41	Spread of weeds through vehicle movements.	Loss of pasture species through competition for resources	3	2	Moderate	A.4.5 Weed management	• Equipment and vehicles to be washed-down and to have a biosecurity Declaration Certificate before access to the site • Weed management plan in place (Appendix 09) • Adhere to mitigation measures described in the Weed Management Plan for the project	1	2	Low	Yes	Baseline weed survey completed. Approved Weed Management Plan in place Risks well understood. Management practices established and proven.
	42	Ignition sources from plant and machinery	Injury or death to livestock, loss of pasture, dwellings and infrastructure	3	3	Moderate	A.3.7 Fire Management	• Vehicles will be equipped with fire extinguishers and operational VHF or UHF radio transceivers • Smoking only in designated areas and fit with appropriate bins. Not disposal of butts to land	2	1	Low	Yes	Baseline weed survey completed.

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
		Inappropriate disposal of cigarettes. Well blow out						• Implementation of Fire Management Plan (Appendix 08) • Machinery and vehicles should be parked in areas of low fire risk • All personnel to be trained and informed before the commencement of the activity relating to: ○ Restricted smoking areas and requirements ○ Firefighting equipment operation and communication ○ Emergency Response Plan and procedures during a fire emergency ○ Alert of fire risk level for the day.					Approved Weed Management Plan in place Risks well understood. Management practices established and proven.
Social, economic and cultural surroundings	43	Extended Production testing, flaring	Injury or death to livestock, loss of pasture, dwellings and infrastructure	3	3	High	A.3.7 Fire Management D.5.9 Venting and Flaring	• Flaring to have an appropriate buffer, with proper barriers to prevent access by wildlife • Flare will be located with at least 20m from vegetation to ensure safe operations during fire danger periods • Firebreaks to be implemented around the well pad with minimum setbacks to infrastructure based on flaring design • Flare stack will be monitored during flaring • Implementation of Fire Management Plan (Appendix 08) • Implementation of the Emergency Response Plan. • Flare pit and flare stack to be positioned as per hazardous area classification • The fire protection zone surrounding the well pad and flare will be devoid of trees • Flares and flare stacks will be designed, prepared and operated per industry standards	1	2	Low	Yes	Risks associated with bushfire are well known, with numerous literature and NT Government mapping
Social, economic and cultural surroundings	44	Civil Constrcution for seismic, wellpads, access tracks and flowlines (raking, grading, ground disturbance)	Disturbance or impedance of stakeholder use of the land	3	3	High	A.3.1 Site selection and planning A.3.2 Well pad Site selection requirements	• Stakeholder to be notified of all planned activities well in advance • Communication programs to be implemented • Install and maintain adequate warning signs and fences • Ongoing rehabilitation of disturbed areas not in use • Implementation of the Rehabilitation Management Plan • Consult with surrounding stakeholders when major activities occur • Install and maintain adequate warning signs and fences to exclude people from sensitive areas • All activities to stay within the approved exploration licence • Only stakeholder approved access routes to be used	1	3	Low	Yes	Risks well understood. Management practices established and proven

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
								• A full stakeholder communication log will be maintained					
	45		Loss of visual amenity	3	2	Moderate	A.3.1 Site selection and planning A.3.2 Well pad Site selection requirements	• Minimise the extent to which the operations would be visible by the community or public by utilising natural topography and vegetation • Utilise natural barriers wherever possible. Locate sites preferably behind visual barrier such as tree line or hill • Locate seismic sites and sites of operation ad distances at least 1km from sensitive receptors, with consideration to topographical and vegetative screening • Only stakeholder approved access routes to be used • A full stakeholder communication log will be maintained • NLC clearances and AAPA certificates in place	1	2	Low	Yes	The risk of the activity on local amenity is ranked as 'low'. The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the NT Petroleum Codes of Practice; with the location of the activity being the primary control.
	46		Fall to identify opportunities to deliver benefits to the local community	3	2	Moderate	A.3.1 Site selection and planning	• Where possible, local and/or indigenous people employed • Where possible, local facilities and suppliers to be used • Communication programs to be implemented	2	1	Low	Yes	Risks well understood. Management practices established and proven
Social, economic and cultural surroundings	47	Noise and vibration generated during seismic activities,	Noise generation	3	2	Moderate	A.3.3 Noise	• Ongoing communication with stakeholders and the community especially when major works are planned • Locate seismic sites and sites of operation ad distances at least 1km from sensitive receptors, with consideration to topographical and vegetative screening • All complaints responded to and, where appropriate, corrective action taken	2	1	Low		The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the NT Petroleum Codes of Practice;

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
	48	Civil Constrcution for seismic, wellpads, access tracks and flowlines (raking, grading, ground disturbance) Bushfire caused by project activites	Disturbance to cultural heritage sites	4	3	High	A.3.1 Site selection and planning A.3.2 Well pad Site selection requirements	• Retention of Traditional Aboriginal Owners to monitor and advise on Culturally Sensitive Locations • Site Specific Fire Management Plan implemented • No operations to occur within 200m of a known Culturally Sensitive or Sacred area without • Cultural Heritage Clearance (and identification of artefacts of Aboriginal significance in conjunction with the NLC and TOs) will be conducted prior to commencement of disturbance activities, • Ensure that all activities stay within the approved operating areas • First disturbance monitoring by TOs • Exclusion zones established and fenced off to not be damaged • All personnel to be inducted to highlight any areas of cultural significance and no-go zones. • No unauthorised clearing • Upon identification of a potential culturally significant object, work will cease until the supervisor has investigated and called the relevant advisor.	1	3	Moderate		The risk of the activity on local amenity is ranked as 'low'. The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the NT Petroleum Codes of Practice; with the location of the activity being the primary control.
	49	Vehicle and plant movements	Disturbance to landholders' activities Damage to or loss of public infrastructure, private infrastructure and equipment or community lands Road uses, local community and landholder's discontent	3	2	Moderate	A.3.1 Site selection and planning 4.3.2 Well pad site selection requirements	• Comply with Native Title Agreement provisions and all other legal obligations • All activities to stay within the approved exploration licence • An agreement will be reached with affected stakeholders to ensure that management strategies are agreed and adhered to on vehicle traffic. • Communication programs to be implemented • Install and maintain adequate warning signs and fences to exclude people • Do not disadvantage other uses of existing public roads and tracks • Traffic control will be implemented to permit to flow of traffic as much as possible • Vehicle movement along gravel roadways will be restricted in wet or adverse conditions • Only approved access routes to be used • Implementation of the Traffic Management Plan • Adhere to road speed limits at all times or to the weather conditions, whichever is the lowest • System in place for logging public/landholder, complaints to ensure that issues are addressed	1	2	Low	Yes	Land access agreements in place and ongoing stakeholder engagement. Risks well understood. Management practices established and proven

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
								• Relevant landowners and occupiers are notified before the activity of preparation of campsites and undertaking operations • Inductions for all employees and contractors cover pastoral, conservation, legislation and infrastructure issues • Sealed turnoff intersection of the Carpentaria-1 well site access track and the Carpentaria Highway.					
Human Health	50	Vehicle and plant movements. Drilling, stimulation and well testing activities	Public ingesting dust Depletion in air quality due to emissions	3	2	Moderate	A.3.1 Site Selection and Planning A.3.4 Erosion and sediment control Part D- Methane emissions monitoring, leak management, detection and reporting D.4 Regional methane monitoring D.5 Emissions detection and management D.6 Reporting	• Dust suppression as appropriate • Only necessary vehicles will be utilised • Adhere to road speed limits at all times or the weather conditions, whichever is the lowest • Driving only in designated areas • Sealed turnoff intersection of the Carpentaria-1 well site access track and the Carpentaria Highway • Closest receptor is over 50km from activity. • Flaring used to reduce pollutants associated with venting. Chemical risk assessment completed • A reduced emission completion to be used to minimise greenhouse gas emissions and pollutant generation	1	1	Low	Yes	Risks well understood. Management practices established and proven
	51		Increased potential for accidents	3	3	High	A.3.1 Site Selection and Planning A.3.4 Erosion and sediment control	• All work crews will contain at least one qualified senior first aid provider • An agreement will be reached with affected stakeholders to ensure that management strategies are agreed and adhered to on vehicle traffic • Drive fatigue management policy will be implemented as per Journey Management Plan rest stops. • All loads to and from the site will be covered to prevent the loss of materials • Only necessary vehicles will be utilised • Do not disadvantage other uses of existing public roads and tracks • Vehicle movement along gravel roadways will be restricted in wet or adverse conditions	1	2	Low	Yes	Risks well understood. Management practices established and proven

Environmental Factors or receptors	Risk Number	Risk source or environmental hazard	Potential Impact	Inherent Risk			Code of Practice	Risk Management Controls	Residual Risk			Effective Controls	Uncertainty Type
				L	C	R			L	C	R		
								• Consult with surrounding stakeholders when major activities occur • Traffic control will be implemented to permit to flow of traffic as much as possible. • Drive only on designated access roads or tracks • Driving will be avoided where practical following significant rainfall • Adherence to speed limits 60km/hr in unsealed roads except in the event of an emergency • No unauthorised third-party access. • No driving under the influence of alcohol or drugs • Ensure vehicles are inspected regularly and have working lights and/or spotlights. • Limited driving at dawn and dusk • One designated spotter appointed per truck • Seismic contractor to provide current and valid licence from drivers • All vehicles to drive with lights on at all times • All traffic and transport issues identified to be discussed at pre-spud meetings • Adherence to Journey Management Plan • Implementation of Traffic Management Plan					
	52	Workers handling chemicals	Worker ingesting chemicals	3	2	Moderate	B.4.10 Drilling Fluids B.4.13 Hydraulic Stimulation and Flowback Operations B.4.16 Site Material and Fluids Management	• Chemical Risk Assessment completed • Trained Personel • Safety Data Sheets • Personal Protective Equipment • Closest receptor is over 50km from activity • Appendix E of Appendix 06.01 Tier 2 Assessment found that exposure to chemicals in each HF system were considered of low health concern to workers	1	1	Low	Yes	Risks well understood. Management practices established and proven

Appendix 05 – Erosion and Sediment Control Plan

EROSION AND SEDIMENT CONTROL PLAN

IMPERIAL DRILLING 2020

CLIENT: IMPERIAL OIL AND GAS PTY LTD

DOCUMENT NUMBER: 19-0109/R1030

VERSION: D

DATE: 9/11/20

1 SCOPE

Topo were engaged by Imperial Oil and Gas Pty Ltd (Imperial) to develop a CPESC certified Erosion and Sediment Control Plan (ESCP) for works associated with the Imperial Drilling Exploration 2020 project located near Borroloola, Northern Territory. This revision of the ESCP has been prepared to provide guidance for expansion of the SL4 drill pad to allow for upcoming fracking work.

1.1. GUIDELINES

This ESCP has been prepared in accordance with the following documents:

- Environmental Assessment Act 1982
- The Petroleum Act 2016
- Waste Management and Pollution Control Act 1998
- Soil Conservation and Land Utilisation Act 1969
- Imperial Environment Management Plan 2019 for Drilling Program Rev C
- Best Practice Erosion and Sediment Control (IECA, 2008)
- Soil, land and vegetation guidelines and fact sheets (NT.GOV.AU)
- Land Clearing Guidelines (Department of Environment and Natural Resources)

1.2. OBJECITVES

This ESCP is part of a hierarchy of documentation prepared to minimise the potential environmental impacts associated with Imperial's 2020 drilling exploration program.

With respect to ESC, this plan has been prepared specifically to assist the project in achieving the following objectives:

1. Ensure that the clearing of native vegetation does not unreasonably contribute to environmental degradation of the locality
2. Avoid impacts on environmental significant or sensitive vegetation
3. Avoid impacts on drainage areas, wetland and waterways
4. Avoid impacts on highly erodible soils
5. Take all reasonable and practicable measures to minimise actual or potential environmental harm resulting from soil or water movement as a consequence of either the construction or operational phases (with regard to soil erosion and land rehabilitation) of exploration
6. Maintain, and where practical, enhance the land use capabilities of disturbed areas with respect to land's soil, water and vegetation attributes
7. Ensure temporary ESC measures do not unreasonably impact upon the economic and safety-related attributes of the project

Preliminary slope data derived from SRTM Digital Elevation Modelling (DEM) identified a number of locations across the greater project where slopes exceeded 2%, and in places 5%. The Land Clearing Guidelines class slope of 2-3% and >3% as having an associated high and very high risk of erosion, respectively (refer Table 1).

Table 1 - Acceptability of erosion risk associated with clearing works based on slope gradient (DENR Land Clearing Guidelines)

Slope (%)	Erosion risk	Recommendation
0 to 1%	Low	Risk is acceptable; management required.
1 to 2%	Moderate	
2 to 3%	High	Required management is prohibitive; clearing not recommended.
>3%	Very High	

The project has previous demonstrated that exclusion of land with slopes greater than 2% is unfeasible. This ESCP has been prepared to demonstrate how the risk will be mitigated and thus satisfy DENR requirements.

1.3. CERTIFICATION

I Tom Bailey certify that this Erosion and Sediment Control Plan (ref: R1030) has been prepared to satisfy the following requirements:

- The intent and outcomes conditioned within the approved Land Clearing Plan (LCP);
- The intent and minimum standards nominated within the IECA (2008) Best Practice Erosion and Sediment Control Guideline and relevant supporting Appendices (IECA, 2015).

If implemented correctly, it will assist Imperial in meeting environmental obligations defined in the Environmental Protection Act (1994) – s440zg, the Environmental Protection (Water) Policy (2009) and the aforementioned LCP conditions.

CPESC 6374

1.4. REVISION

VERSION	DATE	AUTHOR	REVIEWER	APPROVED
A	14/10/19	T. Bailey	J. Bennet	T. Bailey
B	20/11/19	R. Kleijn	T. Bailey	T. Bailey
C	19/06/20	T. Bailey	T. Bailey	T. Bailey
D	9/11/20	T. Bailey	R. Kleijn	T. Bailey

2 PROJECT DESCRIPTION

2.1. LOCATION

The project works are located across the eastern margin of the Beetaloo Sub-Basin within Exploration Permit (EP) 187, approximately 85km south-west of Borroloola within the Carpentaria and Macarthur Basin in the Northern Territory. EP187 is situated in the upper reaches of the McArthur River, lies to the west of the Tablelands Highway, and is crossed east to west by the Carpentaria Highway.

This ESCP has been developed for the vegetation clearing works associated with drilling of up to two wells (SL-3 and SL-4) at two separate locations, with associated access tracks within EP187. Proposed drilling locations and access tracks are presented in Figure 1. As there is currently no seismic data for the area where the wells are to be drilled there are 5 possible locations for wellpad SL-4 (the preferred location and 4 alternates), only one of these locations will be cleared and drilled based on the results of the seismic survey. The SL-4 access track will go to the chosen wellpad and no further.

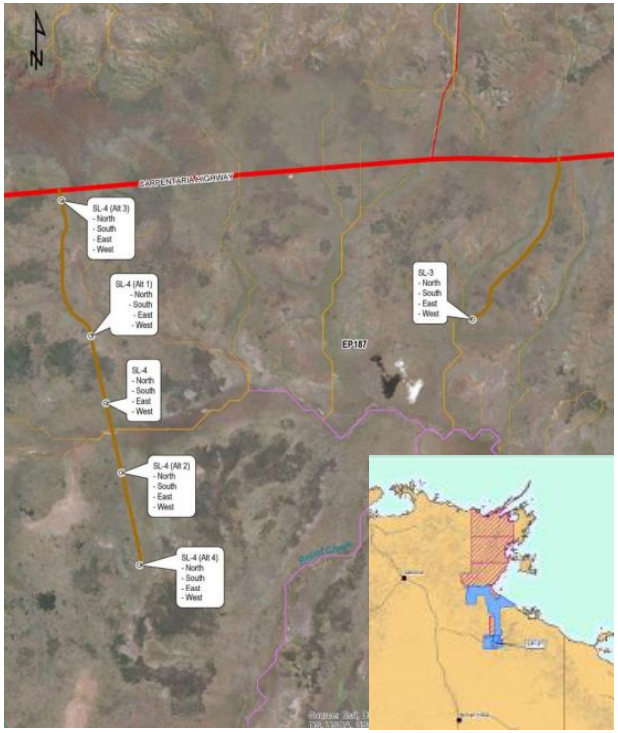


Figure 1 – Site Location (Source: Fox & Co)

2.2. PROJECT WORKS

Projects works will involve the following major activities:

- Construction of new access tracks, including clearing a 6m wide track within the 30m access corridor.
- Clearing of vegetation and drilling of well, pending acquisition of seismic survey data. Instalment of a well pad and associated structures and infrastructure (location to be confirmed). Each well pad will cover approximately 1.4ha.
- Topsoil will not be stripped from the well pads, with no earthworks (cut or fill) undertaken
- Expansion of SL-4 for upcoming fracking

Additional detail on the approved clearing areas are presented in Table 2. The land type map is presented as Figure 2.

Table 2 – Access Track and Drill Pad Clearing Areas (source: Imperial's Land Clearing Permit Supporting Information)

Component	Dimensions (m)	Area (ha)
SL-3 Access Track	5490 x 6	3.75
SL-4 Access Track	6490 x 6	4.5
SL-4 (Alt 4) Access Track	4470 x 6	3.25
SL-3 Well Pad	120 x 120	1.4
SL-4 Well Pad	120 x 120	1.4
SL-4 Fracking	215 x 235	5

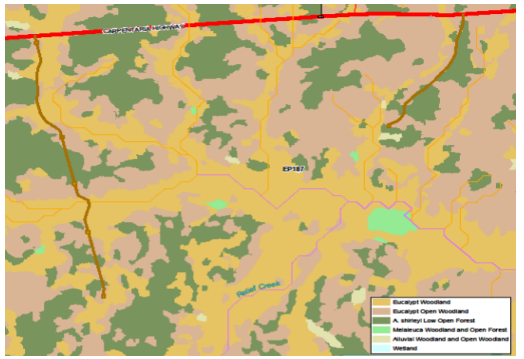


Figure 2 – Land types (Source: Fox & Co)

2.3. CLIMATE

The historic monthly rainfall for the region is presented below in Figure 3. Initial estimates projected works to commence and be completed within the dry season, however delays to the program now indicate that works are likely to extend up to the start of the wet season (mid-November). This revision of the ESCP has been prepared to address the associated impacts.

The climate is described as a tropical savannah climate which can experience rainfall of between 600-800mm per year during the summer wet.

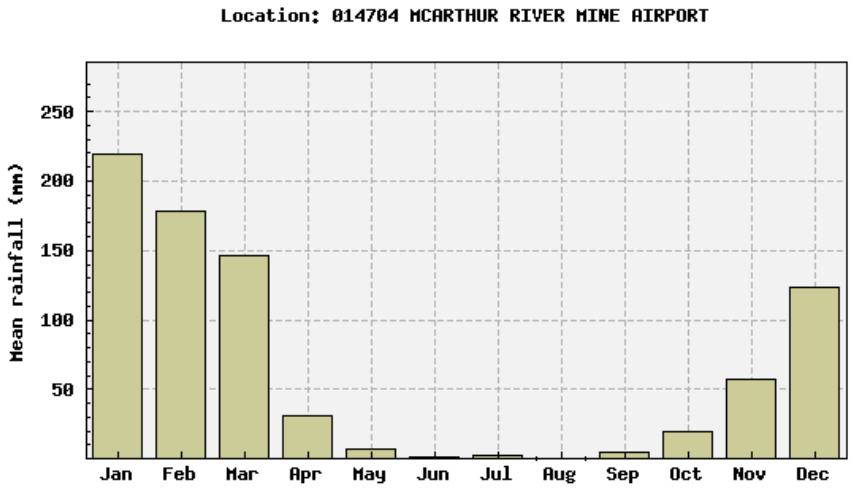


Figure 3 – Historic rainfall (Source: BoM)

2.4. TOPOGRAPHY AND DRAINAGE

The project area is predominantly situated on grassy woodland and the land is generally flat with slopes below 2%. There are some mapped streams within the area of works, with stream order 3 being the maximum. Unmapped flow paths are present within the area and have been identified in the control plans in Appendix A. Regional topography and major flow paths are presented in Figure 4, with additional detail presented in Appendix A.

Where practicable the seismic program alignments (Refer separate report R0940) have been utilised for the Access to SL-4 (and its alternates), the access alignment deviates to the west for approximately 2km to avoid low lying country that has sinkholes in it. The access to SL-3 does not follow the seismic alignments as they cross multiple watercourses, to avoid water course crossings and clearing in riparian areas a separate alignment has been chosen from the north, generally following the top of an undulation to reduce overland flow impacts. The access track between SL-4 and SL-4 Alt 2 crosses a stream order 2 water course, there are reportedly no alterative access alignments that avoids crossing this stream.

A key consideration in plan development was the orientation of tracks and pads with respect to local fall. The impact that these orientations have on drainage, erosion and sediment control is presented in Appendix A.

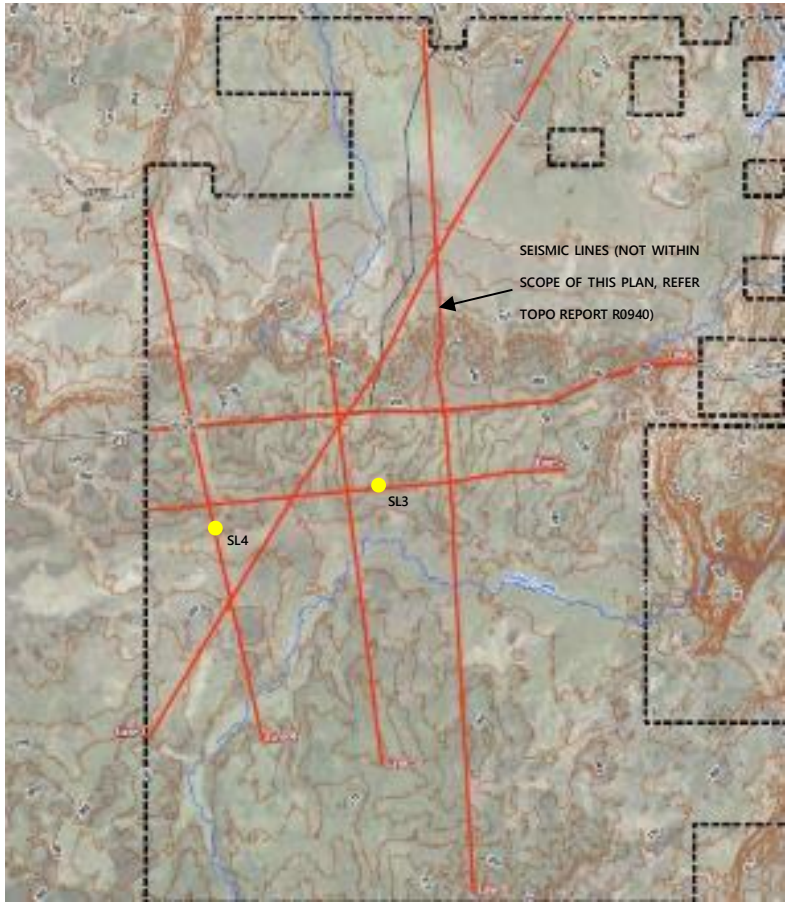


Figure 4 – Regional topography and major drainage paths

2.5. SOILS

The Northern Territory Natural Resource Management report (2015) indicates that soils of the Upper McArthur River catchment are dominated by Kandosols and calcareous earths (40%), Tenosol loams (38%), Rudosol loams (19%) and Vertosols (2%).

The parent rocks of most of the soils are on at least their second cycle of erosion or are deeply weathered or both and are generally arenaceous (composed of sand sized particles). This has produced mainly very infertile soils with a near neutral reaction. Large areas are underlain by a laterite sheet, and the laterite is exposed or at shallow depth over some of the area. These 'soils' are akin to alluvial soils in that they show no profile development.

Tenosols have only weak soil profile development and are often shallow. In the Australian Soil Classification, they are defined as having limited subsoil (B horizon) development (less than 15% clay content). These soils may merge with Kandosols as the clay content can be slightly higher than specified as the upper limit for Tenosols (i.e. 15%). Kandosols soils lack strong texture contrast and have massive or only weakly structured B horizons. The B2 horizon is well developed and has maximum clay content in some part of the Horizon which exceeds 15%. They are also not calcareous throughout.

Shallow stony soils with a low moisture holding capacity are widespread. Most of the soil chemical limitations are due to low soil fertility, and soil physical problems are mostly due to sandy or massive and brittle topsoils.

For the purpose of this report, soil maps were extracted from the CSIRO 'Maps of Australian soil loss by water erosion derived using the RUSLE'.

These data sets are described in the following publication; Teng H, Viscarra Rossel RA, Shi Z, Behrens T, Chappell A and Bui E 2016 Assimilating satellite imagery and visible-near infrared spectroscopy to model and map soil loss by water erosion in Australia - Environmental Modelling & Software 77: 156-167.

3 EROSION RISK ASSESSMENT

An erosion risk assessment has been conducted using the Revised Universal Soil Loss Equation (RUSLE). The calculated soil loss is then used to determine the level of sediment control required, as well as stabilisation and staging requirements.

$$A = K \times R \times LS \times P \times C$$ Equation 1 (IECA 2008)

Where:

A is the predicted soil loss per hectare per year
K is the soil erodibility factor
R is the rainfall erosivity factor
LS is the slope length/gradient factor
P is the erosion control practice factor
C is the ground cover and management factor

3.1. K-FACTOR – SOILS

The soil erodibility factor (K factor) is a measure of the susceptibility of soil particles to detachment and transport by rainfall and runoff. Soil texture is the principle component affecting the K factor, but soil structure, organic matter and profile permeability also contribute.

Based on the description and maps discussed in section 2.5 and based on Table E5 Best Practice Erosion and Sediment Control (IECA, 2008) K-factors ranging between 0.028 and 0.030 were adopted for this risk assessment.

We note that the factors presented in the CSIRO mapping is consistent with the DLRM K-factors derived for a range of soil families in the Northern Territory.

3.2. R- FACTOR – RAINFALL

The rainfall erosivity factor (R factor), is a measure of the ability of rainfall to cause erosion. The R factor is defined as the mean annual sum of individual storm rainfall intensity (EI30) values - EI30 being the total storm energy (E) multiplied by the maximum 30 minute rainfall intensity (I30). Under otherwise identical conditions, soil loss is directly proportional to EI30 (Renard et al 1997).

Rainfall data for the site was obtained using the Bureau of Meteorology (BoM) Design Rainfall Data System (2016). Intensity Frequency Duration (IFD) data was extracted over the study area between 500310.2871 (E), 8118456.8329 (N) and 547935.2872(E), 8178252.6663(N). Using the ascii data provided, a rainfall map was created

representing the spatial variation of rainfall intensity over the study area. Rainfall mapping is presented in Appendix A.

3.3. LS - SLOPE-LENGTH

Slope length and slope gradient have substantial effects on soil erosion by water. The two effects are represented by the slope length factor (L) and the slope steepness factor (S). In application of RUSLE the two are evaluated together as a numerical representation of the length-slope combination (LS factor).

The CSIRO Data Portal provides a set of maps that represent the RUSLE factors. Reference was made to the Maps of Australian soil loss by water erosion derived using the RUSLE, and data for the combined length and slope (LS) factor was obtained. Using the data provided, a map representing the combined length-slope factor over the study area was created. The resulting LS map is illustrated in Appendix A.

3.4. COVER (C) AND PRACTICE (P) FACTORS

Within RUSLE, the C and P factors are used to describe management of the site with respect to reducing soil loss. The C factor measures the combined effect of all the interrelated cover and management variables adopted over the site. It also represents non-structural methods for controlling erosion (i.e. covering exposed areas with various erosion control products to minimise raindrop impact or stabilisation by temporary or permanent vegetation).

The P factor measures the combined effect of all support practices and management variables. P factor is reduced by practices that reduce both the velocity of runoff and the tendency of runoff to flow directly downhill. It also represents structural methods for controlling erosion.

Unlike seismic operations it is anticipated that at some point both access tracks and well pads will be entirely exposed, with high traffic areas compacted and smooth. To represent these conditions default factors of 1 and 1.3 have been adopted for C and P factors respectively.

3.5. ESTIMATED SOIL LOSS

Using Global Mapper GIS software, the aforementioned factors were multiplied to calculate the resulting soil loss for the site, indicating a very low erosion risk (20-40t/ha/yr) for the entire site according to Table 4.4.7 of IECA, 2008. Figure 5 and Table 3 below indicate the determined erosion risk for the site and surrounding areas.

Table 3 – Soil Loss Legend

Colour	Erosion Risk (t/ha/yr)
Green	0-10
Yellow	10-20
Orange	20-30
Red	30-40
Dark Red	40-50

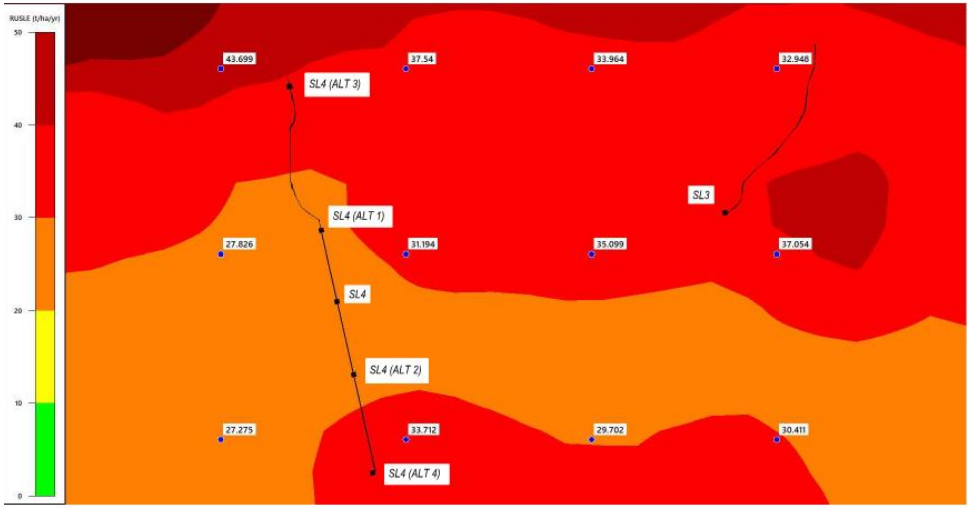


Figure 5 – Soil Loss Results

4 SEDIMENT CONTROL

The sediment control standard is typically determined using Table 4.5.1 (IECA, 2008) which defines the sediment control standard based on catchment area and soil loss rate. The revised Table 4.5.1 (IECA, 2008) provided in Appendix B (IECA, 2018) as Table B1 is provide below as Table 4. The revised table includes an additional area limit trigger of 1 hectare to increase the sediment control standard for large sites with an estimated soil loss exceeding 75 t/ha/yr.

Table 4 – Sediment Control Standard (Table B1 Appendix B IECA 2018)

AREA LIMIT (m^2)	SOIL LOSS RATE LIMIT (T/HA/YR)		
	TYPE 1	TYPE 2	TYPE 3
1000	N/A	N/A	All cases
2500	N/A	> 75	75
> 2500	> 150	150	75
> 10000	>75	N/A	75

Based on Table 4 (IECA, 2018), the calculated soil losses (which are very low) permit the use of Type 3 sediment control measures throughout site. Specific Type 3 controls have been selected as suitable depending on the scope of works.

4.1. ACCESS TRACKS

It has been proposed that grass, rocks, branches and shrubs be raked to the downslope extent of works, establishing a control similar to a mulch bund. Where installed as a mulch bund, this control is likely to be considerably effective in trapping the coarse sediment (sandy particles) comprising the site area.

However, it is also acknowledged that the bund may be inconsistent in some areas (based on material found on site) and the grading of material (grass, leaves, branches and rocks) is unlikely to achieve effective ponding or filtering.

Alternatives typically associated with linear projects such as sediment fence, topsoil bunding with rock filter dams or mulched vegetation bunds are either impractical for the length of the project or unsuited to the proposed scope of works.

Rather, the windrow of cleared material is considered the most suitable form of sediment control, with the varying level of effectiveness addressed by greatly increasing the level of erosion control above the minimum standard required for calculated soil loss.

As works extend towards November with a potential increase in rainfall, local roads and access tracks will be monitored and closed to Heavy Vehicles, Light Vehicles (or both) based on individual condition assessment. A similar condition assessment will be utilised to inspect and monitor internal areas for disturbance and degradation of the surface conditions, with additional matting added to stabilise high traffic areas.

4.2. WELL PADS

Sediment controls installed on the downslope extent of disturbance may include:

Option 1 – Mulch Berm

- Placed along a line of constant elevation
- Be a minimum of 0.5m high
- Ensure 100% contact with soil surface

Option 2 - Coir log sediment trap

- Installed in accordance with the standard drawing
- Extended upslope enough to ensure the ground level is at least 100mm higher than the spill-through weir

A series of returns have been proposed for installation where bunds are aligned down slope to maximise ponding and reduce flow velocity along the face.

5 EROSION CONTROL

The minimum erosion control requirements for various risk ratings in accordance with IECA (2008) guidelines are presented in Table 5.

Table 5 – Minimum erosion control requirements according to IECA (2008) - adapted from Table 4.4.7

EROSION RISK RATING	SOIL LOSS RATE (T/HA/YEAR)	ADVANCE LAND CLEARING ALLOWED (WKS WORK)	MAX DAYS TO STABILISATION (DAYS - % COVER)	STAGED CONSTRUCTION AND STABILISATION OF EARTH BATTERS >6H:1V	STOCKPILES STABILISED
Very Low	0 to 150	8	30 (60%)		
Low	150 to 225	8	30 (70%)		
Moderate	225 to 500	6	20 (70%)	✓	
High	500 to 1500	4	10 (75%)	✓	✓
Extreme	> 1500	2	5 (80%)	✓	✓

With consideration given to the sediment control described in Section 4, and seasonal variability in rainfall discussed in Section 2.3 it is proposed that operations adopt an erosion control management standard that far exceeds the minimum in Table 5. Proposed measures are presented in Table 6.

Table 6 – Proposed minimum erosion control standards to be adopted above that in Table 4.4.7 of IECA (2008)

EROSION CONTROL ELEMENT	DRY SEASON	WET SEASON
Advance land clearing (max)	30 days	5 days
Rainfall forecast trigger for stabilisation of exposed surfaces	> 60% chance of > 50mm	> 50% chance of > 20mm
Minimum ground cover required for stabilisation	70%	90%
Reinstatement/revegetation timeframes	30 days	5 days
Stabilisation of material stockpiles (drill pad)	7 days	1 day

In addition to these requirements, erosion controls shall include:

- Geolocation and warning signals utilised to prevent any disturbance outside the clearing easement or within nominated buffer areas
- Stabilisation of any high traffic areas within drill pads using gravel
- Retention of existing ground cover within the pad area (excluding high traffic areas). Any exposed areas are to be stabilised with gravel or soil binder until rehabilitation.
- Establishing stabilised entry/exit points where access tracks intersect public roadways
- Utilising existing tracks wherever possible
- Adapting the alignment of the access tracks within the 30m easement to a path of least disturbance
- Restricting access tracks to 5m width where located within 25m of a watercourse

It is noted that the proposed track construction methodology has been adopted to minimise disturbance of existing ground cover wherever possible, including restricting the maximum width of clearing to 6m and using machinery to limit ground disturbance wherever possible (refer methodology in Section 5.1).

This ESCP has been prepared on the basis that topsoil shall not be stripped from the well pads, nor shall any earthworks be completed (cut or fill).

Condition assessments will be undertaken as works approach November to inspect and monitor internal areas for disturbance and degradation of the surface conditions, with additional matting added to stabilise high traffic areas.

5.1. ACCESS TRACK CONSTRUCTION METHODOLOGY

Access track construction is to comply with the following requirements by priority:

1) Erosion control – restricting disturbance to a 6m track width, following a path of least disturbance and complying with erosion control requirements identified in Table 6
2) Drainage control – installing and maintaining track drainage in accordance with DLRM requirements

To address these priorities the following methodology is to be adopted.

Step 1: Assess site and select path of least disturbance for 6m width of clearing within 30m corridor.

Step 2: Program alignment into clearing machinery to prevent over-disturbance or intrusion of buffer zones

Step 3: Commence clearing, ensuring timeframes between clearing and scheduled constructions works do not exceed those indicated in Table 6.

Step 4: Windrow cleared vegetation on the extent of disturbance

Step 5: Install drainage controls in accordance with the DLRM Road Drainage Factsheet reproduced in Appendix A.

Step 6: Complete works and re-establish minimum ground cover % within minimum timeframes indicated in Table 6 through permanent rehabilitation measures approved in the EMP.

Note that the specific details of track construction may vary along the alignment, however this methodology, and the arrangements presented in Drawings D8 to D11 (Appendix A) shall be adapted and utilised for all scenarios.

6 DRAINAGE CONTROL

Drainage control considers three main principles; diverting external flow before it enters site, directing site runoff to an appropriate sediment control, and ensuring runoff is conveyed in a non-erosive manner.

6.1. ACCESS TRACKS

Flow diversion for linear sites is typically achieved using topsoil bunding or excavated catch drains. Given that a) no topsoil will be stripped on site, and b) drain excavation would result in more exposure than required for work there are limited options for diversion. Additionally, retention of ground cover wherever possible, including topsoil and roots reduces the potential impact associated with lack of diversion of external catchments. Adoption of windrowed vegetation and rock, similar to a mulch bund, as a primary sediment control will maintain sheet flow conditions, except where used for contour bunds. In these locations it is proposed that the windrow be returned upslope and flattened to restore sheet flow conditions (similar to level spreader).

Access track drainage has been considered to specifically address runoff over a variety of topography (discussed in Section 2.4) whether the alignment is orientated perpendicular or parallel to slope, or passing diagonally up/down the slope, with the resulting control arrangements presented in Appendix A.

Another key consideration was the presence of mapped, and unmapped watercourses. Control measures and management practices are presented below:

Mapped waterway	Inspect site, noting that actual waterway may not align with mapped waterway. Adjust width restriction buffer to suit. Retain buffer width in accordance with Land Clearing Permit (width varies) Install cleared vegetation windrows or woah boys on either side of flow path.
Unmapped flow path	Retain a 25m wide buffer (or adapt to suit flow path (if defined). Establish stable flow path crossing either through minimal disturbance traffic practices, ground cover mattress or applying heavy application of soil binder (min. Stonewall 2L/m2 or equiv.) Install cleared vegetation windrows or woah boys on either side of flow path.

As works extend towards November with a potential increase in rainfall, local roads and access tracks will be monitored and closed to Heavy Vehicles, Light Vehicles (or both) based on individual condition assessment.

Further detail of proposed drainage, including the layout of temporary measures and flow path crossings has been provided in Appendix A.

6.2. WELL PADS

Specific measures have been described to address drainage control within and around the proposed drill pads identified as SL3 and SL4 with the arrangements presented in Appendix A. If alternative locations are selected this plan shall be updated to suit.

Clean Water Diversion

Coir logs are to be used on the upslope side of the pad to divert runoff around the pad or to dissipate runoff prior to it entering the pad.

Dirty Water Diversion

Pad runoff is to be dissipated through the use of coir logs or a mulch berm. The control is to be installed along the contour to promote sheet flow leaving the site. Where the berm (or bund) is aligned downslope returns shall be installed to maximise ponding and minimise flow velocity along the berm.

Intra-Site Drainage

Given the level of disturbance and size of site runoff will be allowed to sheet flow to sediment controls without the installation of intra-site drainage.

7 ROLES AND RESPONSIBILITIES

Table 7 outlines the responsibilities of project personnel in respect to ESC.

Table 7 - Roles and responsibilities

ROLE	RESPONSIBILITY
Project Manager	+ Overall responsibility for environmental compliance (including ESC implementation)
Construction Superintendent/Manager	+ Notify the Environmental Manager immediately of any non-compliance with ESCP; + Provide resources to ensure installation, maintenance and operation of ESC devices on ground.
Site Supervisor/Foremen	+ Ensure ESC measures are installed prior to commencing any disturbance activities; + Conduct site inspections as required to ensure ESC measures are operational and in good order; + Monitor daily rainfall; + Notify Environmental Advisor when runoff generating rainfall occurs in the previous 24 hours; + Treat, test and dispose of captured runoff as per operation procedures;
Environmental Manager/ Advisor	+ Conduct site inspections and audits as required; + Prepare audit reports based in inspections; + Provide advice, as required regarding ESC site improvement. + Conduct in-situ monitoring as required; + Collect and submit samples to laboratory as required; + Collate results and prepare reports as required; + Maintain current records of rainfall, water quality, treatment practices, discharge activities.
All Personnel	+ Report any damage to ESC devices and any potential or actual environmental harm in line with Duty to Notify under the requirements of the Environmental Protection Act 1994

8 SITE INSPECTION AND MONITORING

Site inspections and monitoring is to be undertaken in accordance with Sections 6.17 and 7.4 of the Best Practice Erosion and Sediment Control Document (IECA, 2008) as detailed below. When a site inspection detects a notable failure in the adopted ESC measures, the source of this failure must be reported, investigated and appropriate amendments made to the site and the ESCP.

ESCPs should be considered live documents that in some instances will require review and updating as site conditions change, or if the adopted measures fail to achieve the required treatment standard.

Best practice site management requires all ESC measures to be inspected at the following frequencies and include the following checks as a minimum:

Daily site inspections (during rainfall)

+ All drainage, erosion and sediment control measures
+ Occurrences of excessive sediment deposition (whether on-site or off-site)
+ All site discharge points (including dewatering activities as appropriate)

Weekly site inspections (even if work is not occurring on-site)

+ All drainage, erosion and sediment control measures
+ Occurrences of excessive sediment deposition (whether on-site or off-site)
+ Occurrences of construction materials, litter or sediment placed, deposited, washed or blown from the site, including deposition by vehicular movements
+ Litter and waste receptors
+ Oil, fuel and chemical storage facilities

Prior to anticipated runoff producing rainfall (within 24 hours of expected rainfall)

+ All drainage, erosion and sediment control measures
+ All temporary flow diversion and drainage works

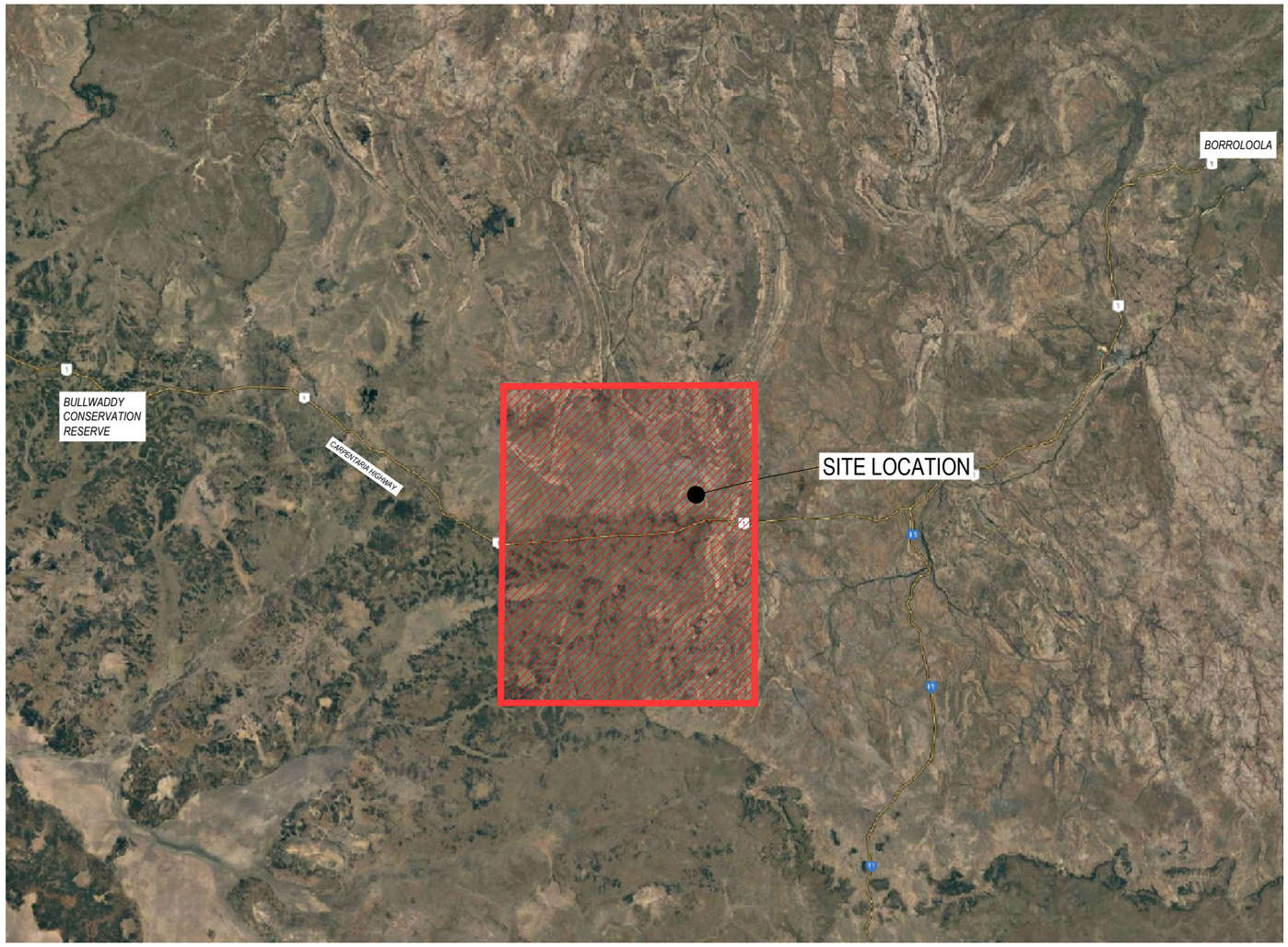
Following runoff producing rainfall (within 18 hours of rainfall event)

+ All drainage, erosion and sediment control measures
+ Occurrences of excessive sediment deposition (whether on-site or off-site)
+ Occurrences of construction materials, litter or sediment placed, deposited, washed or blown from the site, including deposition by vehicular movements

APPENDIX A

EROSION AND SEDIMENT CONTROL DRAWINGS

EROSION AND SEDIMENT CONTROL DRAWINGS
IMPERIAL SEISMIC 2019 - DRILL PADS



DRAWING LIST:

D00 - COVER SHEET
D01 - OVERVIEW OR WORKS
D02 - R FACTOR
D03 - K FACTOR
D04 - LS FACTOR
D05 - SOIL LOSS (RUSLE)
D06 - LOW RISK DRILL PAD SL4 CONTROLS
D07 - LOW RISK DRILL PAD SL3 CONTROLS
D08 - TRACK CONTROLS
D09 - TRACK CONTROLS - FLOW PATH
D10 - DRAINAGE NOTES SHEET 1/2
D11 - DRAINAGE NOTES SHEET 2/2
D12 - COIR ROLLS NOTES
D13 - DRILL PAD SL4 AS CONSTRUCTED CONTROLS
D14 - DRILL PAD SL4 FRACKING EXPANSION

REFER TO REPORT **R1040** FOR ADDITIONAL DETAILS RELATING TO GUIDELINES USED, PROJECT AND SITE DESCRIPTION, CLIMATE, TOPOGRAPHY, SOILS, EROSION RISK ASSESSMENT, EROSION, SEDIMENT AND DRAINAGE CONTROL SPECIFICATIONS, ROLES AND RESPONSIBILITIES AND SITE INSPECTION AND MONITORING.

REVISION	DESCRIPTION	APPROVED BY	DATE
E	ADDED D14	TB	09/11/20
D	ADDED D13	TB	26/10/20
C	UPDATED FOR 2020 DELAYS	TB	19/06/20
B	AMENDED NOTES AND DETAILS	TB	20/11/19

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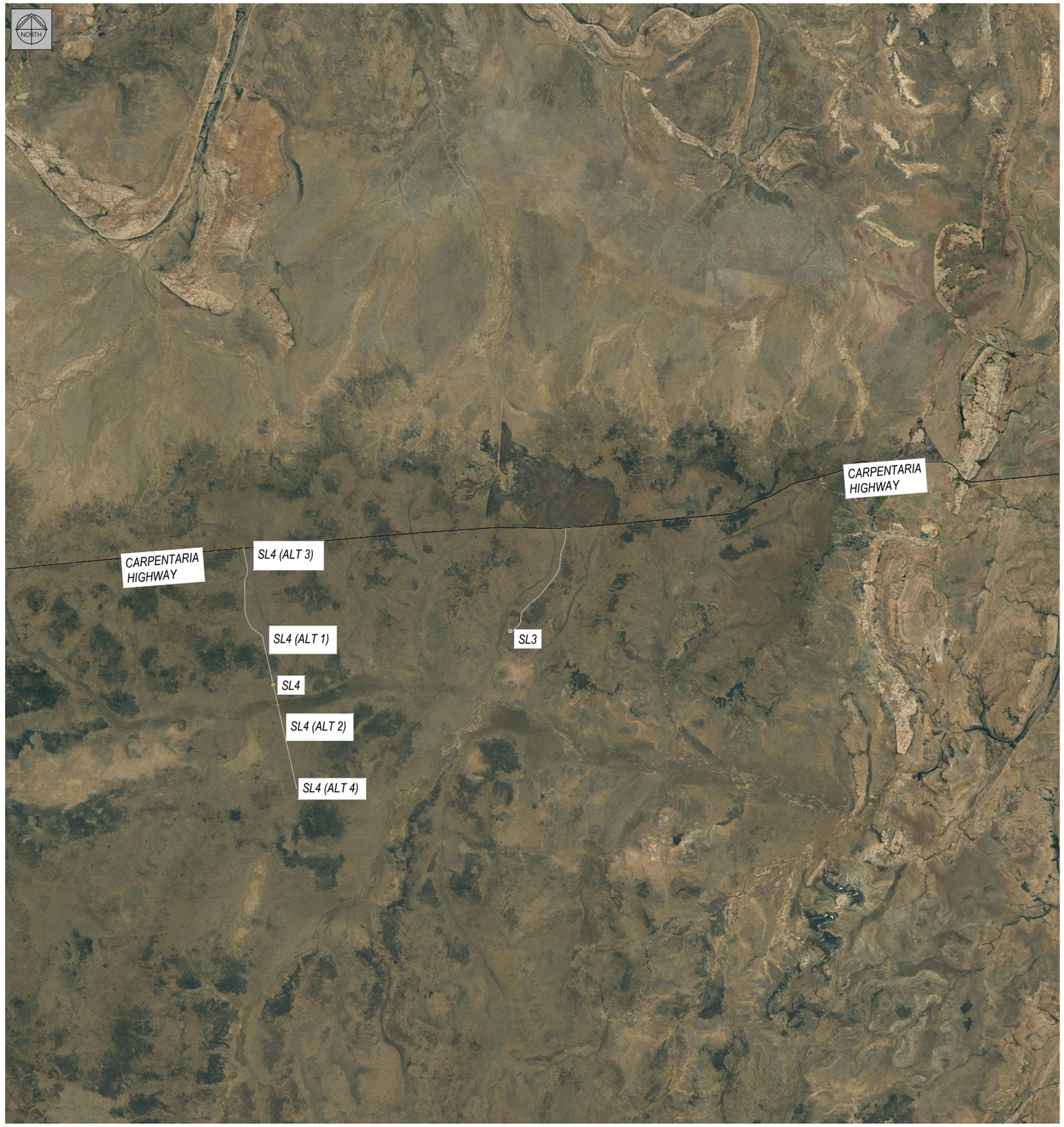
PROJECT: IMPERIAL SEISMIC 2019 - DRILL PADS

DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN COVER SHEET

PROJECT No	DRAWING No	REVISION
19-0109	D00	D



EXTENT OF WORKS

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PROJECT: IMPERIAL SEISMIC 2019 - DRILL PADS

DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN
OVERVIEW OF WORKS

PROJECT No	DRAWING No	REVISION
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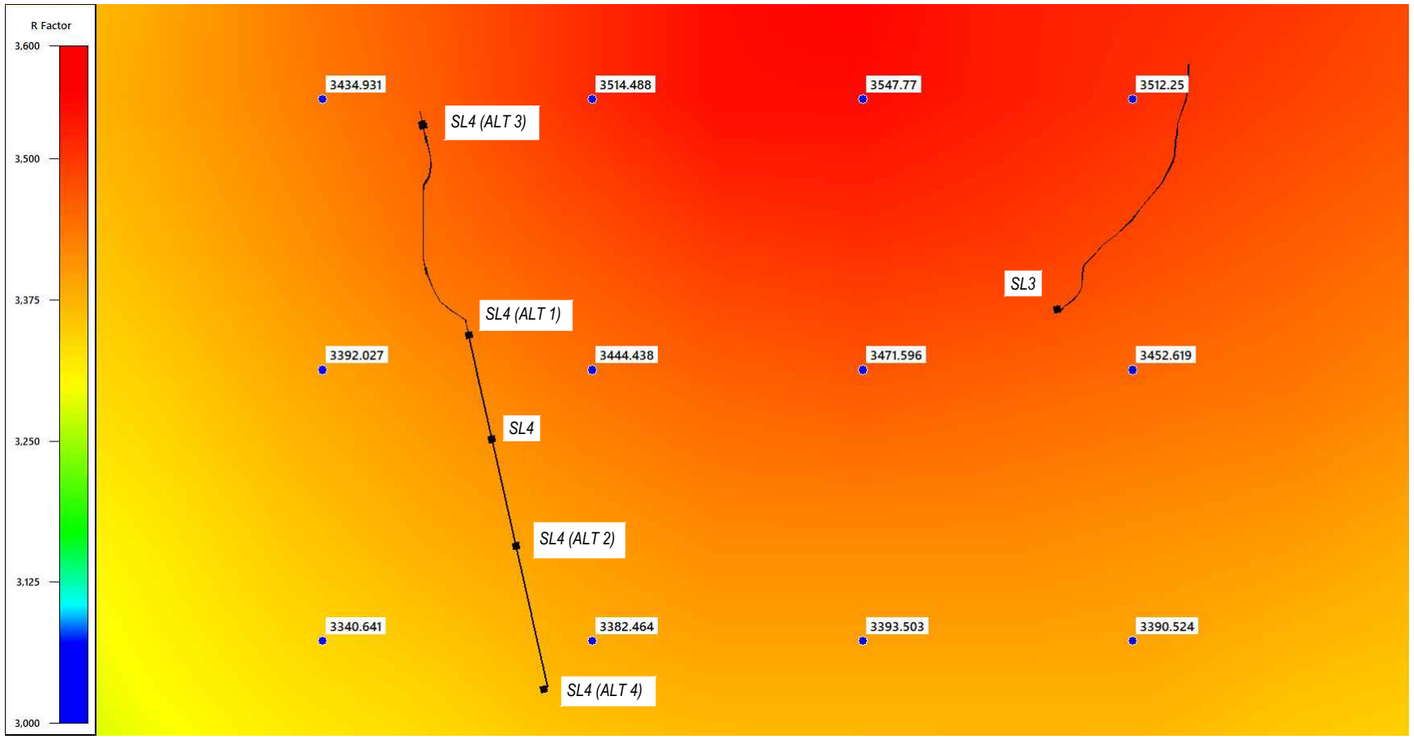

R FACTOR

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PROJECT: IMPERIAL SEISMIC 2019 - DRILL PADS
DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN
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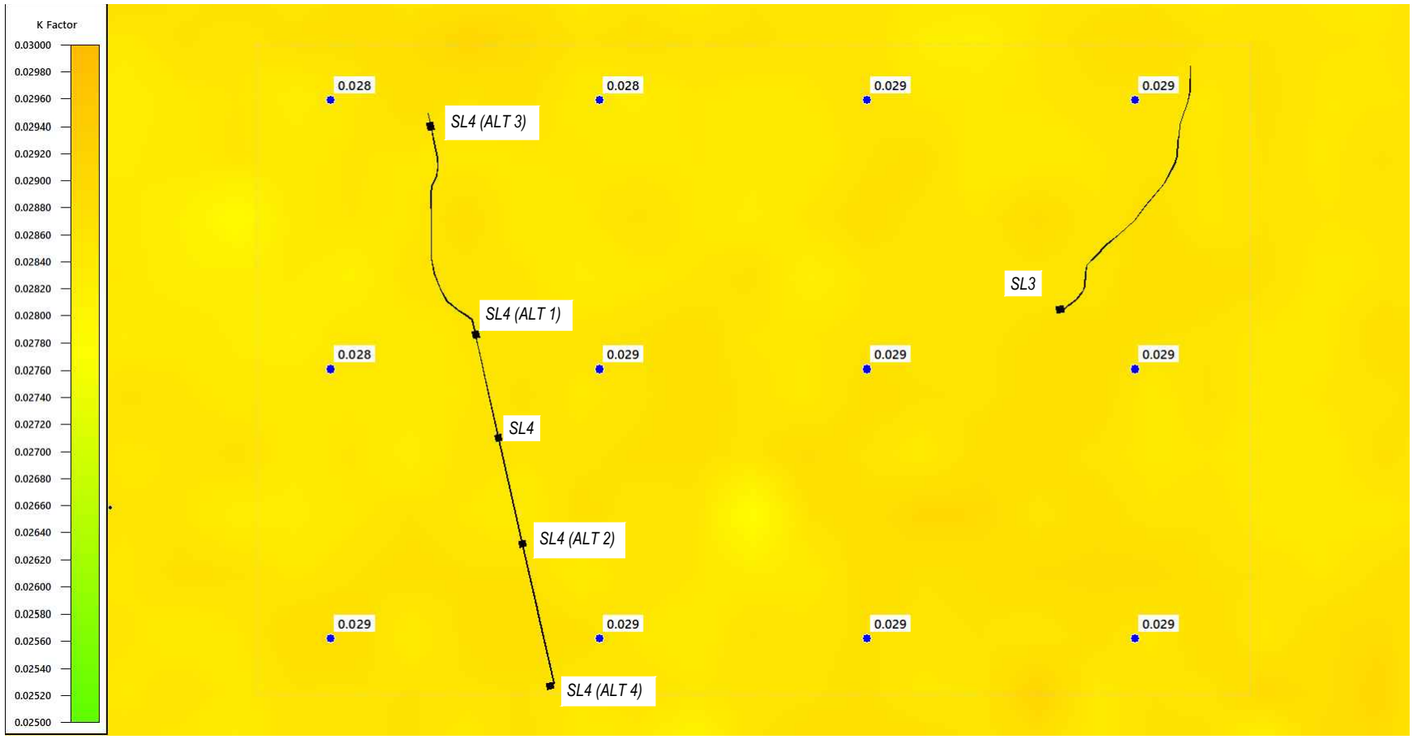

K FACTOR

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PROJECT: IMPERIAL SEISMIC 2019 - DRILL PADS
DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN
K FACTOR
PROJECT No: 19-0109 | DRAWING No: D03 | REVISION: A

LS FACTOR

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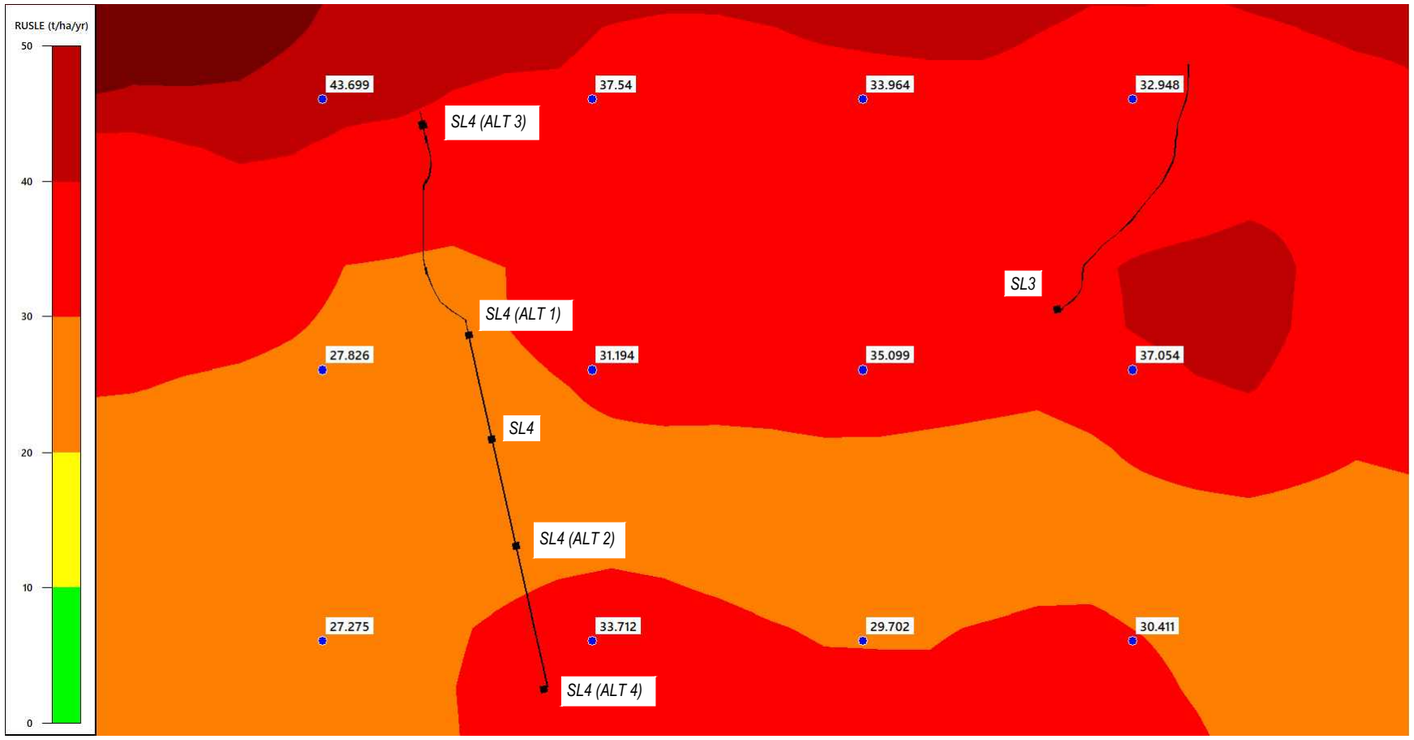
PROJECT: IMPERIAL SEISMIC 2019 - DRILL PADS
DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN
LS FACTOR
PROJECT No: 19-0109 | DRAWING No: D04 | REVISION: A

NOTES:

C FACTOR - 1.0
EXPOSED SOIL

P FACTOR - 1.3
COMPACTED AND SMOOTH (DEFAULT CONSTRUCTION PHASE CONDITION)



SOIL LOSS (RUSLE)

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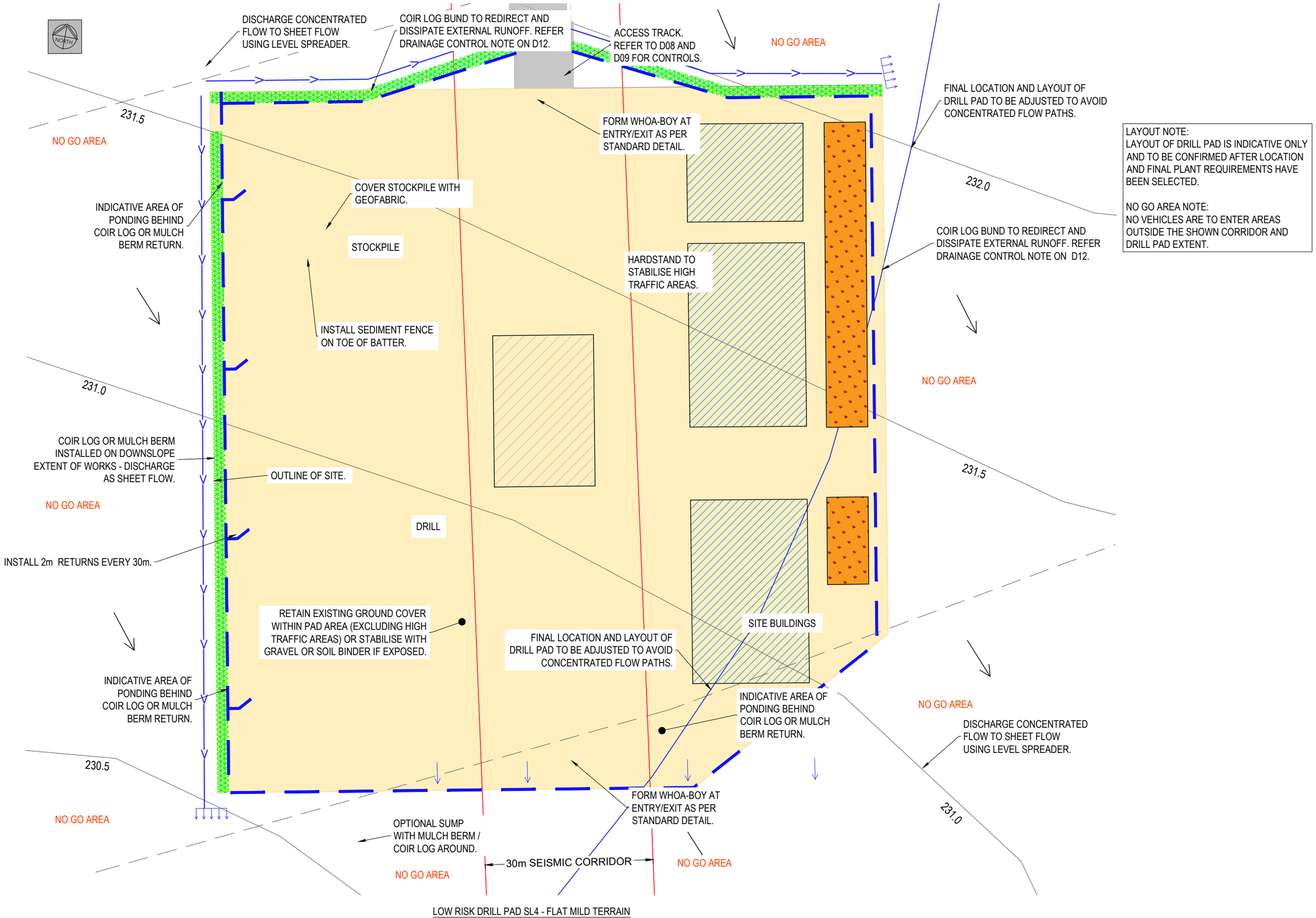
PROJECT: IMPERIAL SEISMIC 2019 - DRILL PADS
DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN SOILS LOSS (RUSLE)
PROJECT No: 19-0109 | DRAWING No: D05 | REVISION: A



LOW RISK DRILL PAD SL4 - FLAT MILD TERRAIN

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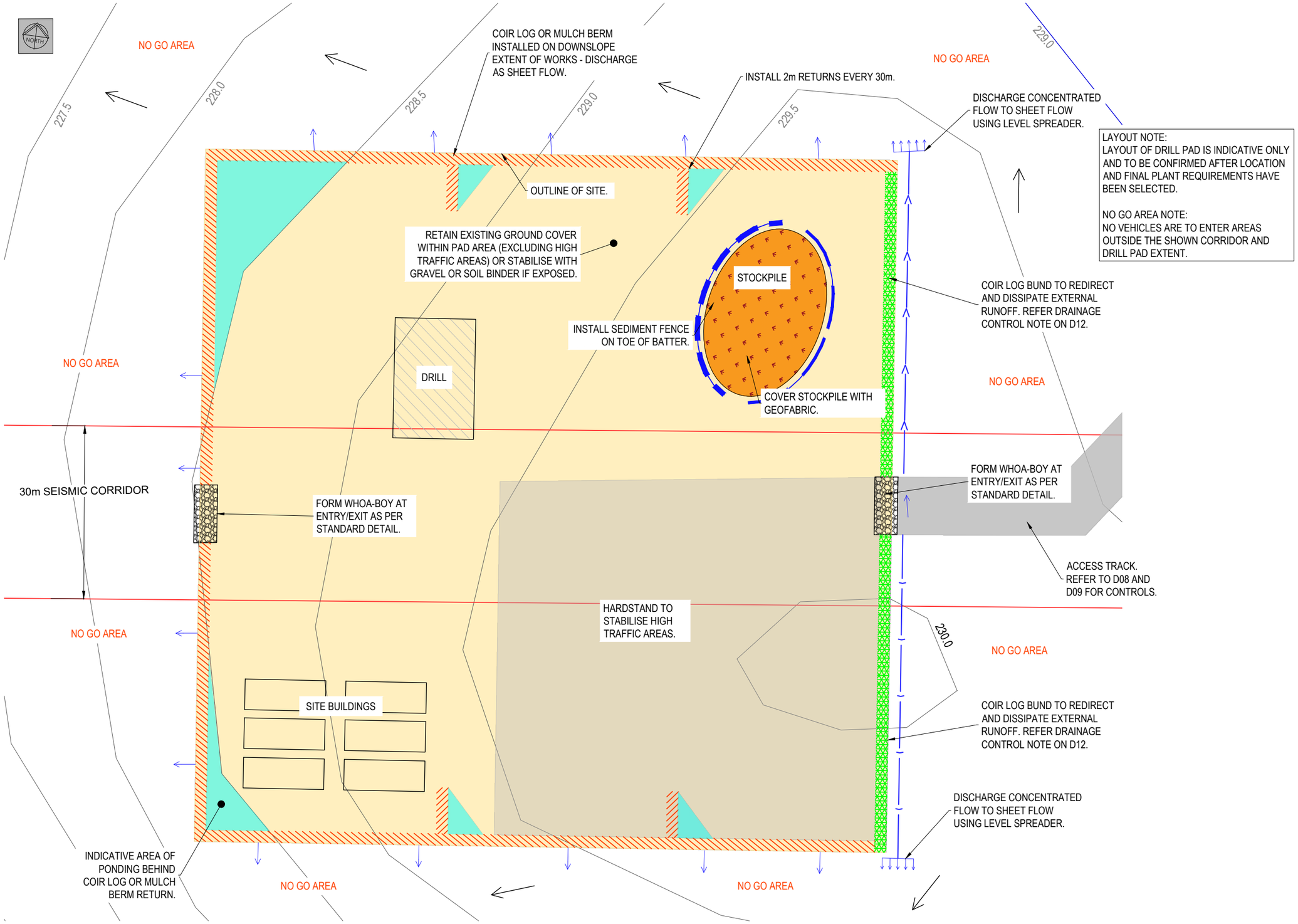
PROJECT: IMPERIAL SEISMIC 2019 - DRILL PADS

DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN
LOW RISK DRILL PAD SL4 CONTROLS

PROJECT No: 19-0109 | DRAWING No: D06 | REVISION: B



LOW RISK DRILL PAD SL3- FLAT MILD TERRAIN

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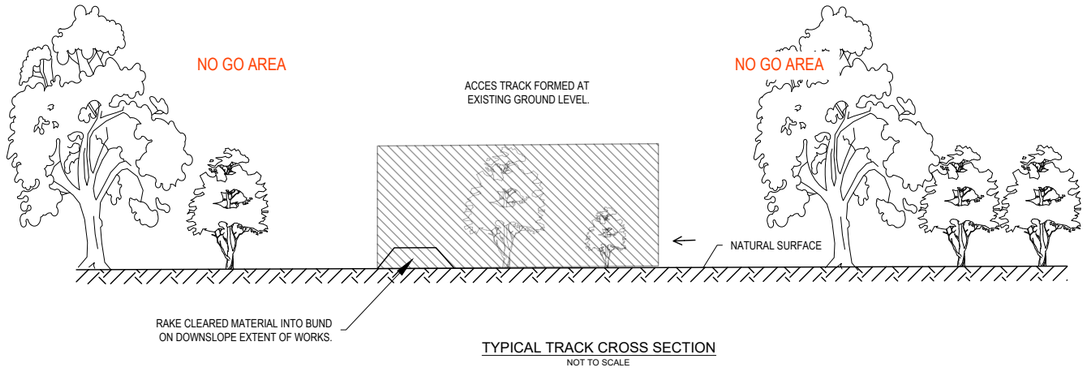
PROJECT: IMPERIAL SEISMIC 2019 - DRILL PADS

DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN
LOW RISK DRILL PAD SL3 CONTROLS

PROJECT No	DRAWING No	REVISION
19-0109	D07	B



TYPICAL TRACK CROSS SECTION
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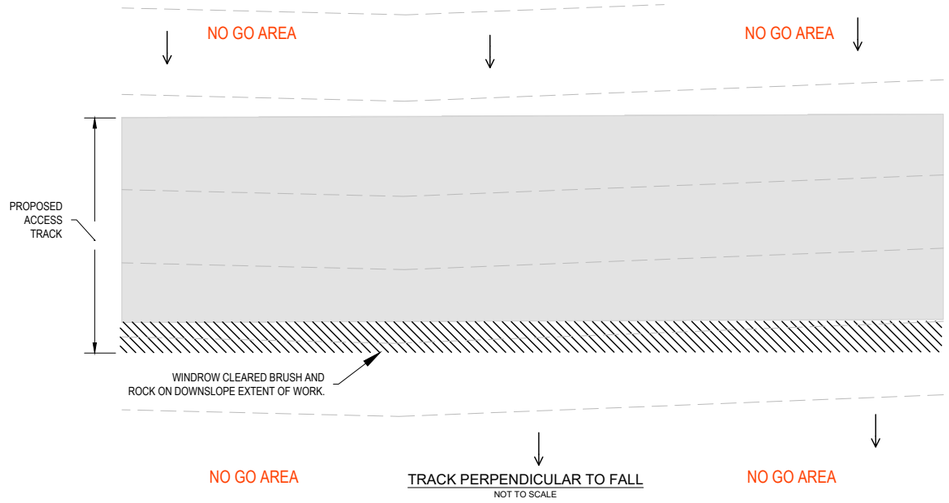

TRACK PERPENDICULAR TO FALL
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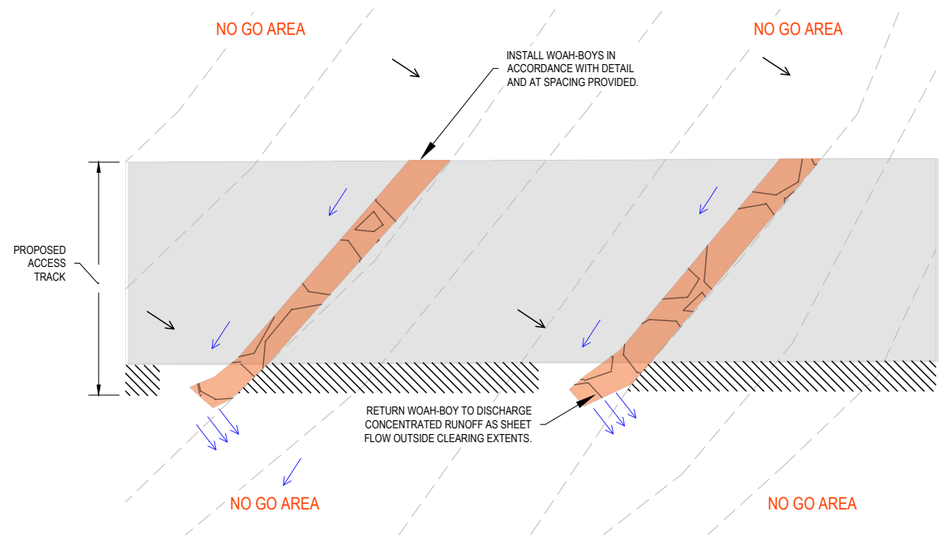

TRACK DIAGONAL TO FALL
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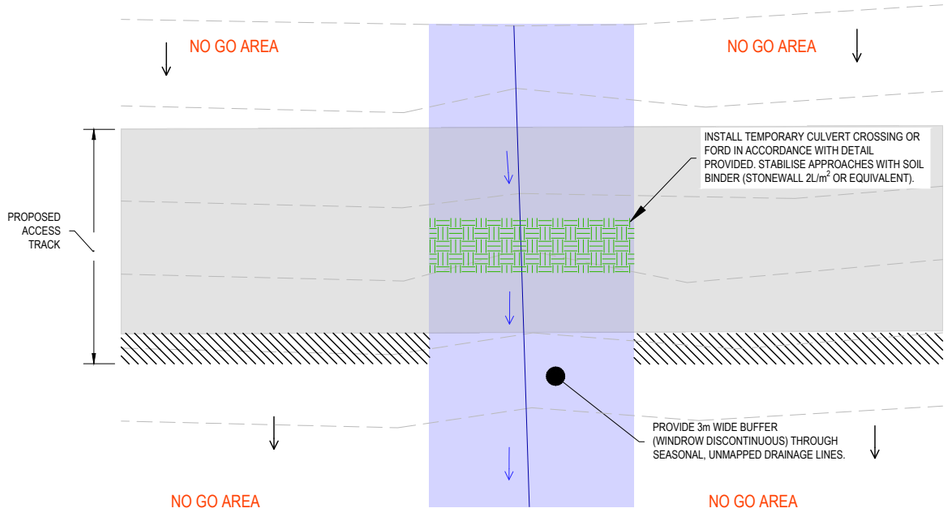
PROJECT: IMPERIAL SEISMIC 2019 - DRILL PADS

DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN
TRACK CONTROLS

PROJECT No	DRAWING No	REVISION
19-0109	D08	B



TRACK PERPENDICULAR TO FALL - UNMAPPED FLOW PATH CROSSING

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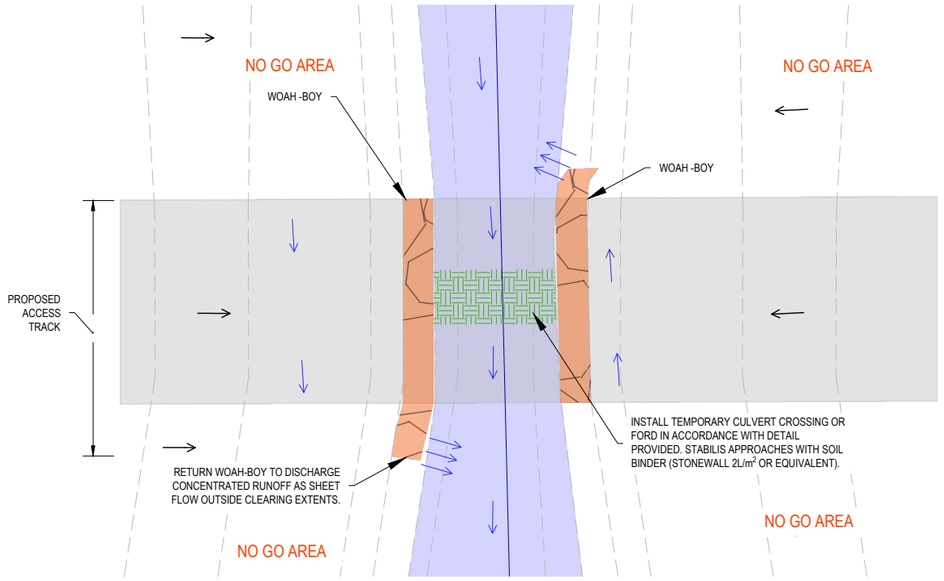

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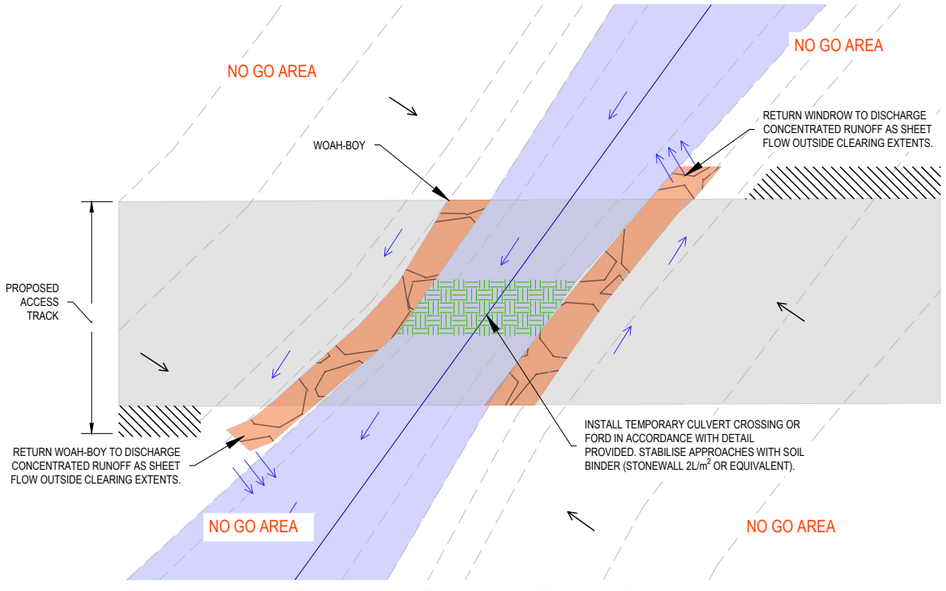

TRACK DIAGONAL TO FALL - UNMAPPED FLOW PATH CROSSING

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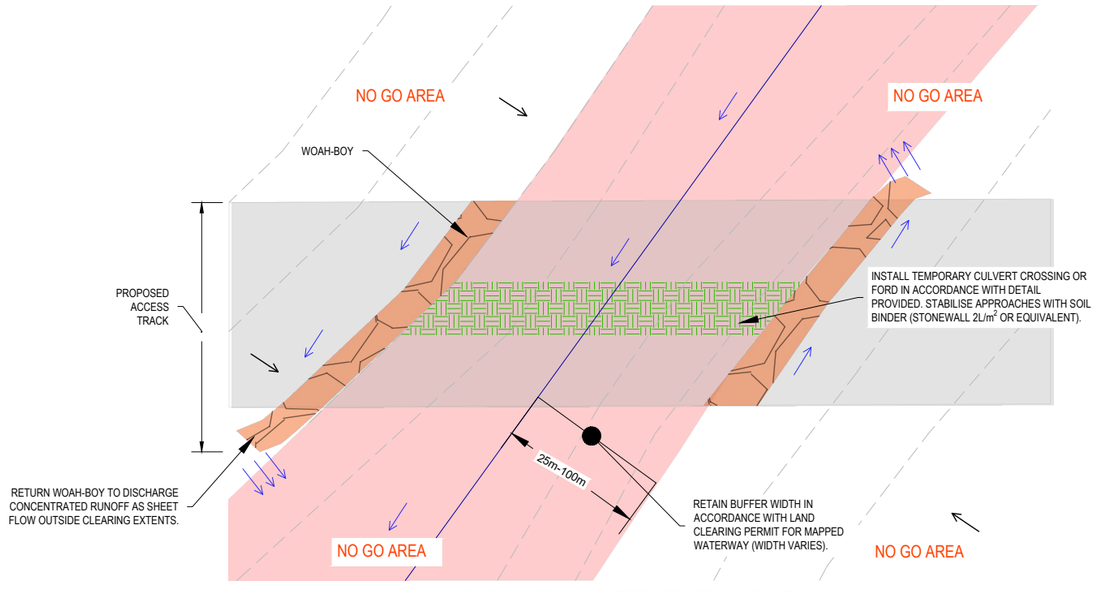

MAPPED WATERWAY BUFFER - TRAFFICABLE WITH NO FORMED BANKS AND NO SURFACE WATER EVIDENT

NOT TO SCALE

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PROJECT: IMPERIAL SEISMIC 2019 - DRILL PADS

DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN
TRACK CONTROLS - FLOW PATH

PROJECT No: 19-0109 | DRAWING No: D09 | REVISION: B

ROAD CROWNING
CROWNING PROVIDES A LOW-GRADE FALL ENABLING DRAINAGE FROM BOTH SIDES OF THE CENTRE OF THE ROAD (SEE FIGURE 1). THIS METHOD IS ONLY EFFECTIVE IF THE CROWN IS SLIGHTLY HIGHER THAN THE NATURAL SURFACE.

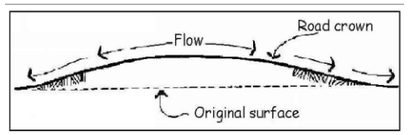

Figure 1: Crowning

ROAD CROWNING SHOULD BE AVOIDED IN AREAS WHERE WATER NATURALLY CROSSES THE ROAD SUCH AS BROAD DRAINAGE FLOORS. FLOODWAYS ARE REQUIRED IN THESE CASED.

INFALL AND OUTFALL DRAINAGE
WHEN ROADS ARE BUILT ACROSS THE SLOPE CONSIDERATION MUST BE GIVEN TO TAKING WATER FROM THE UP SLOPE SIDE OF THE ROAD TO THE DOWN SLOPE SIDE OF THE ROAD. WHEN YOU INSTALL CROSS DRAINAGE YOU MUST MAKE SURE THAT IT DOES NOT CAUSE EROSION OF THE ROAD SURFACE.

CROSSFALL/OUTFALL DRAINAGE
THE SIMPLEST METHOD IS BY PROVIDING THE ROAD SURFACE WITH A CROSSFALL IN THE SAME DIRECTION AS THE SLOPE (OUTFALL DRAINAGE), THEREBY DIRECTING WATER OVER THE ROAD SURFACE TO DISPOSAL AREAS ON THE LOWER SIDE OF THE ROAD (SEE FIGURE 2).

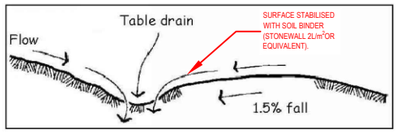

Figure 2: Crossfall/outfall drainage

THE OTHER METHOD IS BY PROVIDING THE ROAD SURFACE WITH INFALL DRAINAGE BACK INTO THE SLOPE, DIRECTING WATER BACK TO THE UP SLOPE SIDE OF THE ROAD (SEE FIGURE 3). IF INFALL DRAINAGE IS NECESSARY THEN TABLE DRAINS, CULVERTS OR INVERTS NEED TO BE CONSTRUCTED. THESE WILL SAFELY DIRECT WATER TO THE DOWN SLOPE SIDE OF THE ROAD.

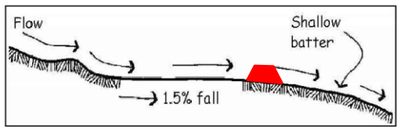

Figure 3: Infall drainage

OUTFALL DRAINAGE IS PREFERRED TO INFALL DRAINAGE AS THERE IS GENERALLY NO NEED FOR OTHER DRAINAGE WORKS SUCH AS CULVERTS, INVERTS, TABLE AND MITRE DRAINS.

WHEN INSTALLING OUTFALL DRAINAGE ON STEEPER SLOPES, BATTERS ON THE DOWNSLOPE SIDE OF THE ROAD MUST NOT BE TOO STEEP. STEEP BATTERS MAY ERODE, IMPACTING ON THE ROAD ITSELF.

THE CROSSFALL OF THE ROAD SURFACE SHOULD BE KEPT AS FLAT AS POSSIBLE TO ENSURE GOOD DRAINAGE. FOR OUTFALL DRAINAGE IT IS RECOMMENDED THAT THE MAXIMUM CROSSFALL SLOPE BE IN THE ORDER OF 1.5 – 2%, WHEREAS INFALL DRAINAGE SLOPES CAN BE AS GREAT AS 4%.

SIDE DRAINAGE

TABLE DRAINS
TABLE DRAINS ARE EXCAVATED OPEN CHANNELS THAT ARE BUILT PARALLEL TO ROADS AND TRACKS. THESE DRAINS DIRECT RUNOFF TO DISPOSAL AREAS FURTHER DOWNSLOPE. TABLE DRAINS SHOULD ONLY BE USED WHEN NATURAL RUN-OFF IS NOT POSSIBLE.

FILL OBTAINED FROM CONSTRUCTING TABLE DRAINS CAN BE USED TO BUILD UP ROAD SURFACES. THE DESIGN OF TABLE DRAINS DEPENDS ON A NUMBER OF FACTORS, INCLUDING THE SIZE AND NATURE OF THE CATCHMENT, THE SLOPE AND WATER VOLUMES AND FLOW. LARGER TABLE DRAINS MAY NEED TO BE DESIGNED BY ENGINEERS OR OTHER SUITABLY QUALIFIED PROFESSIONALS.

TABLE DRAINS SHOULD BE CONSTRUCTED WITH A FLAT BOTTOM (TRAPEZOID SHAPE) (SEE FIGURE 4). IN GENERAL THEY SHOULD BE 0.5 TO 1.0M WIDE AT THE BASE. AVOID USING V SHAPED DRAINS AS THEY MAY CAUSE EROSION IN THE CHANNEL.

WHERE POSSIBLE TABLE DRAINS SHOULD BE REVEGETATED AS SOON AS POSSIBLE AFTER CONSTRUCTION, AND REGULARLY SLASHED. TABLE DRAINS SHOULD NOT BE GRADED.

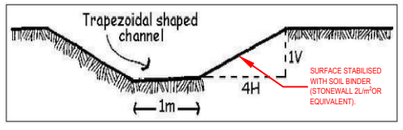

Figure 4: Table & Mitre drain cross section

MITRE DRAINS
WATER SHOULD BE TAKEN OUT OF TABLE DRAINS AT REGULAR INTERVALS USING MITRE (OFFSHOOT) DRAINS. MITRE DRAINS TAKE RUNOFF OUT OF TABLE DRAINS OR DIRECTLY OFF ROAD SHOULDERS WHERE TABLE DRAINS ARE ABSENT. THESE DRAINS DISPOSE OF WATER IN AREAS AWAY FROM THE ROAD (SEE FIGURE 5).

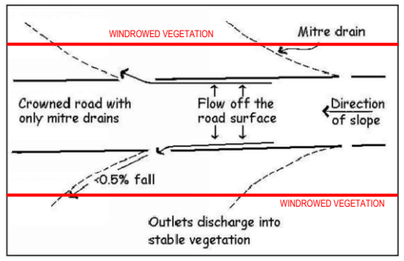

Figure 5: Crowned road with only mitre drains

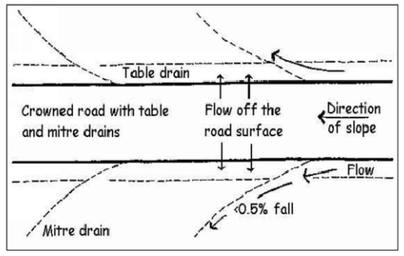

Figure 6: Crowned road witrh table and mitre drains

MITRE DRAINS STOP WATER ACCUMULATING IN TABLE DRAINS OR ON THE ROAD SHOULDER. IDEALLY MITRE DRAINS
SHOULD BE CONSTRUCTED SO THAT THEY HAVE A BROAD FLAT BASE AT LEAST 1M WIDE. MITRE DRAINS ALSO SHOULD NOT BE GRADED TO PRODUCE A V.
MITRE DRAINS SHOULD SLOPE TO DIRECT THE FLOW OF WATER AWAY FROM THE ROAD. TO MINIMISE EROSION THE SLOPE SHOULD BE NO GREATER THAN 0.5% ON ERODIBLE SOILS OR 1% ON STABLE SOILS. MITRE DRAIN OUTLETS EFFECTIVELY CONCENTRATE RUNOFF, FOR THIS REASON THEY SHOULD BE LOCATED IN STABLE UNDISTURBED AREAS.

MITRE DRAIN SPACING IS DEPENDENT ON:
- THE GRADE OF THE TABLE DRAIN OR ROAD
- SOIL TYPE AND ERODIBILITY
- RAINFALL

Table 1: Recommended mitre drain spacing

Slope		Mitre Drain 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	50 - 55
10	1 : 10	40 - 45

CROSS DRAINAGE

ENGINEERED, STABLE CROSS DRAINAGE SUCH AS INVERTS, FLOODWAYS OR CULVERTS CAN BE USED TO COLLECT WATER FROM UPSLOPE TABLE DRAINS, OR DRAINAGE LINES. IT IS GENERALLY MORE CONOMICAL AND PRACTICAL TO FORD DRAINAGE LINES USING FLOODWAYS OR INVERTS THAN TO USE MAJOR CULVERTS OR
BRIDGES. ON STEEPER COUNTRY, WHERE CREEKS AND DRAINAGE LINES ARE DEEPER, CULVERTS MAY BE MORE PRACTICAL.

INVERTS AND FLOODWAYS
CARE MUST BE TAKEN IN THE DESIGN AND CONSTRUCTION OF FLOODWAYS AND INVERTS IN ORDER TO CAUSE MINIMAL INTERFERENCE TO NATURAL FLOWS. INVERTS AND FLOODWAYS ARE DESIGNED TO BE TEMPORARILY OVER TOPPED BY WATER FLOW AND MINIMISE BANK AND BED EROSION. THEY SHOULD BE SITED AT LOW POINTS IN THE BANK AND AT RIGHT ANGLES TO THE DIRECTION OF FLOW.

INVERTS
INVERTS SHOULD BE CONSTRUCTED WITH THE FINISHED SURFACE AT, OR JUST BELOW THE LEVEL OF THE EXISTING STREAM BED. CONSTRUCTION OF AN INVERT IS GENERALLY BASED ON EXCAVATING SOFT, ERODIBLE MATERIAL. AT LEAST 300MM SHOULD BE REMOVED, GEOTEXTILE MAY BE NECESSARY AS A BASE. EXCAVATED MATERIAL IS THEN REPLACED WITH COMPACTED GRANULAR MATERIAL TO
PROVIDE A TRAFFICABLE SURFACE (SEE FIGURE 7).

TEXT AND IMAGES SOURCED FROM NORTHERN TERRITORY 'ROAD DRAINAGE FACT SHEET', DEPARTMENT OF LAND RESOURCE MANAGEMENT (www.lrm.nt.gov.au)

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DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN
DRAINAGE NOTES SHEET 1/2
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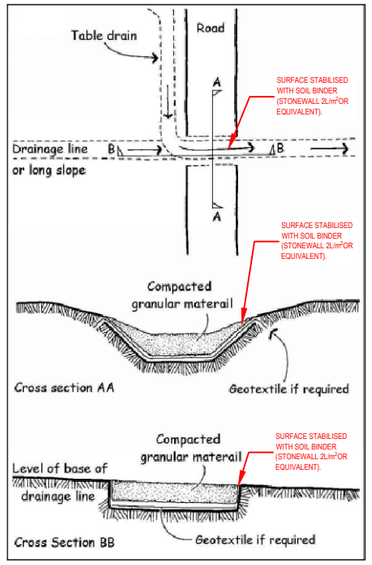

Figure 7: Inverts

FLOODWAYS

FLOODWAYS ARE USUALLY ELEVATED ABOVE THE BED LEVEL OF THE CHANNEL AND OFTEN INCORPORATE CULVERTS TO TAKE "NORMAL" FLOWS WITH THE ROAD ONLY BEING OVERTOPPED DURING FLOOD EVENTS, AS ILLUSTRATED IN FIGURE 8.

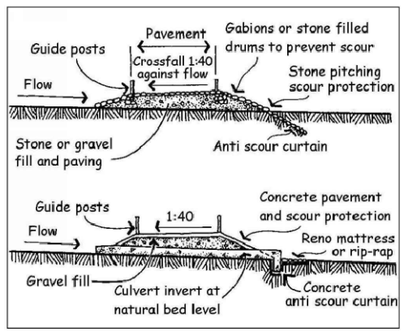

Figure 8: Floodways (Australian Road Research Board, 1993)

THE DESIGN SHOULD HAVE ENDS OF THE STRUCTURE THAT ARE WELL ANCHORED INTO THE BANKS AND OBSTRUCTION TO FLOW KEPT TO A MINIMUM BY USING GENTLE BATTER SLOPES ON THE UP- AND DOWNSTREAM FACES. WHEN IT IS NECESSARY TO CONSTRUCT AN ELEVATED FLOODWAY IT IS RECOMMENDED THAT SPECIALIST ADVICE BE SOUGHT.

AS FLOODWAYS ARE GENERALLY ELEVATED ABOVE BED LEVEL PROTECTION WORKS ARE REQUIRED ON THE DOWNSTREAM SIDE OF THE FLOODWAY TO PREVENT EROSION.

CULVERTS

WHEN CULVERTS ARE USED THEY SHOULD BE ANGLED DOWNWARD AT BETWEEN 1 AND 3%. THIS WILL MINIMISE SILTING OF THE PIPE AND PREVENT EXCESSIVE SCOURING AT THE OUTFLOW. ON DRAINAGE LINES THE CULVERT SHOULD BE KEYED INTO THE STREAMBED BY DIGGING A TRENCH AND SEATING THE CULVERT INTO IT.

THE AREA BELOW THE OUTLET WILL NEED PROTECTION TO PREVENT EROSION. THIS PROTECTION CAN BE ACHIEVED BY ARMOURING (EG: ROCK MATTRESS) THE DRAIN DOWNSTREAM OF THE OUTLET, OR BY CONSTRUCTING A DISSIPATING DEVICE (SEE FIGURE 9).

PROTECTION MAY ALSO BE REQUIRED AT THE INLET. THE LOCATION, SPACING, SIZE AND TYPE OF CULVERT MAY VARY. ADVICE SHOULD BE SOUGHT PRIOR TO CONSTRUCTION.

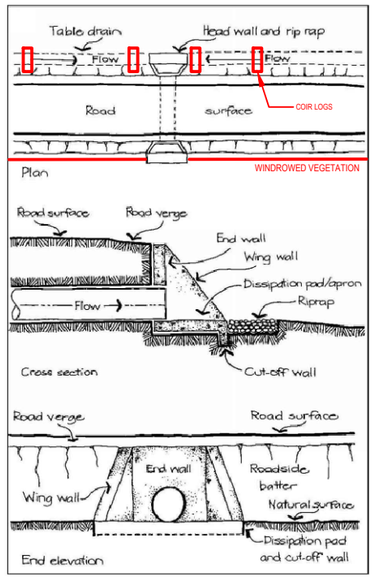

Figure 9: Culverts

WHOA BOYS ON VEHICLE TRACKS

WHOA BOYS CAN VARY IN SIZE. THEY CAN BE A COUPLE OF METRES LONG AND ONLY 10–30CM HIGH ON WALKING TRACKS, OR THEY MAY BE LARGE, GENTLY SLOPING BANKS
UP TO 30-40M AND UP TO 3M HIGH ON DEEPLY ERODED AREAS.

WHOA BOYS CAN BE CONSTRUCTED IN TWO WAYS:

1. BY CUT AND FILL – LINES ARE RIPPED ACROSS THE AREA AT A GRADE OF 0.3 %. A SHALLOW CHANNEL SHOULD BE CUT ALONG THIS LINE. 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 (SEE FIGURE 10).

2. USING IMPORTED SOIL MATERIAL TO CONSTRUCT A BANK WITH A GRADE OF BETWEEN 0.3 AND 0.5% ALONG THE UP SLOPE EDGE OF THE BANK.

TO AID TRAFFICABILITY, AN APPROACH AND DEPARTURE RAMP CAN BE CUT INTO THE BANK (SEE FIGURE 11). THE BANK SHOULD BE RUN OFF 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).

ALTERNATIVELY A LEVEL SILL CAN BE CONSTRUCTED AT THE END OF THE BANK TO ENHANCE THE SPREAD OF WATER.

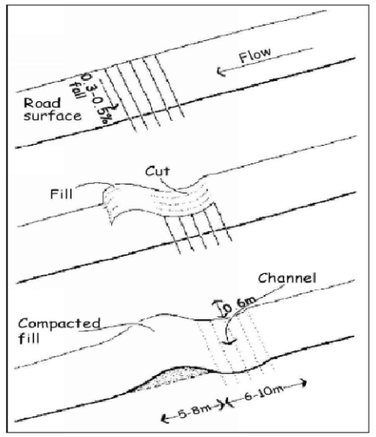

Figure 10: Whoa boy construction

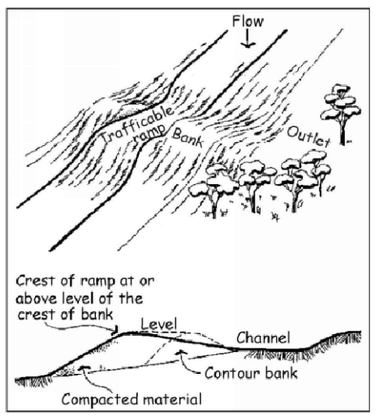

Figure 11: Whoa boy - vehicle track

TEXT AND IMAGES SOURCED FROM NORTHERN TERRITORY 'ROAD DRAINAGE FACT SHEET', DEPARTMENT OF LAND RESOURCE MANAGEMENT (www.lrm.nt.gov.au)

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PROJECT No: 19-0109 | DRAWING No: D11 | REVISION: A

MATERIALS

FIBRE ROLLS: TYPICALLY 200 TO 250mm JUTE, COIR OR STRAW ROLL TIED WITH SYNTHETIC OR BIODEGRADABLE MESH.

STAKES: MINIMUM 25 x 25mm TIMBER STAKES

INSTALLATION

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

2. WHEN PLACED ACROSS NON-VEGETATED OR NEWLY SEEDED SLOPES, THE ROLLS MUST BE PLACED ALONG THE CONTOUR.

3. IF PLACED ON OPEN OR LOOSE SOIL, ENSURE THE FIBRE ROLLS ARE TRENCHED 75 TO 125mm IN SANDY SOILS AND 50 TO 75mm IN CLAYEY SOILS.

4. ENSURE THE OUTER MOST ENDS OF THE FIBRE ROLLS ARE TURNED UP THE SLOPE TO ALLOW WATER TO ADEQUATELY POND UP-SLOPE OF THE ROLL, AND TO MINIMISE FLOW BYPASSING.

5. WHEN PLACED ACROSS THE INVERT OF MINOR DRAINS, ENSURE THE SOCKS ARE PLACES SUCH THAT:

(I) THE CREST OF THE DOWNSTREAM ROLL IS LEVEL WITH THE CHANNEL INVERT AT THE IMMEDIATE UPSTREAM SOCK (IF ANY);
(II) EACH ROLL EXTENDS UP THE CHANNEL BANKS SUCH THAT THE CREST OF THE FIBRE ROLL AT ITS LOWEST POINT IS LOWER THAN THE GROUND LEVEL AT EITHER END OF THE ROLL.

6. ENSURE THAT THE ANCHORING STAKES ARE DRIVEN INTO THE END OF EACH ROLL AND ALONG THE LENGTH OF EACH ROLL AT A SPACING NOT EXCEEDING 1.2m OR SIX TIMES THE ROLL DIAMETER, WHICHEVER IS THE LESSER. A MAXIMUM STAKE SPACING OF 0.3m APPLIES WHE USED TO FORM CHECK DAMS.
7. ADJOINING ROLL MUST BE OVERLAPPED AT LEAST 450mm, NOT ABUTTED.

MAINTENANCE

1. INSPECT ALL FIBRE ROLLS PRIOR TO FORECAST RAIN, DAILY DURING EXTENDED PERIODS OF RAINFALL, AFTER SIGNIFICANT RUNOFF PRODUCING STORMS OR OTHERWISE AT WEEKLY INTERVALS.
2. REPAIR OR REPLACE DAMAGED FIBRE ROLLS.
3. REMOVE COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. ALL EXCESSIVE SEDIMENT TRAPPED BY THE ROLLS MUST BE REMOVED FROM THE DRAIN OR SLOPE IF SUCH SEDIMENT IS LIKELY TO BE WASHED AWAY BY THE EXPECTED FLOWS.
2. DISPOSE OF COLLECTED SEDIMENT IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.
3. THE BIODEGRADABLE CONTENT OF THE STRAW ROLLS MAY NOT NECESSARILY NEED TO BE REMOVED FROM THE SITE.
4. ALL SYNTHETIC (PLASTIC) MESH OR OTHER NON READILY BIO-DEGRADABLE MATERIAL MUST BE REMOVED FROM THE SITE ONCE THE SLOPE IF DRAIN IS ESTABLISHED, OR THE ROLLS HAVE DETERIORATED TO A POINT WHERE THEY ARE NO LONGER PROVIDING THEIR INTENDED DRAINAGE OR SEDIMENT CONTROL FUNCTION.

Source: www.austieca.com.au/documents/item/124

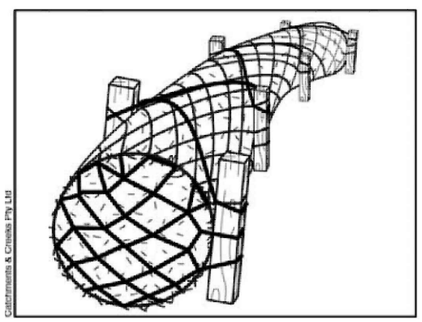
DRAINAGE CONTROL

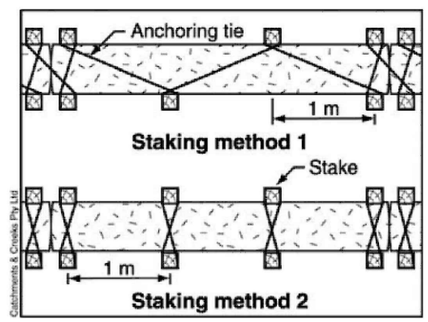
IN THIS CASE, COIR LOGS WILL ALSO BE USED AS DRAINAGE CONTROL. THIS HAS BEEN CONSIDERED A PREFFERED OPTION OVER CUTTING A DRAIN OR INSTALLING A BUND, BOTH OF WHICH REQUIRE SOIL DISTURBANCE. WHERE COIR LOGS ARE USED AS DRAINAGE CONTROL:

1. THE ENDS OF THE FIBRE ROLLS MUST BE STRAIGHT TO ALLOW WATER TO FLOW PAST THE ROLLS TO A LEVEL SPREADER.
2. ENSURE THE FIBRE ROLLS ARE TRENCHED 100mm INTO THE SOIL.
3. FIBRE ROLLS MUST BE OVERLAPPED AT LEAST 450mm IN THE DIRECTION OF THE FLOW AND NOT ABUTTED.
4. THE FLOWPATH ALONG THE ROLLS MUST BE CHECKED AFTER RAINFALL TO ENSURE EXTERNAL RUNOFF IS NOT ENTERING THE ACTIVE WORK SITE. AN ADDITIONAL ROW OF LOGS WILL NEED TO BE PLACED IF THIS IS THE CASE.

Source: www.westernexcelsior.com/products.html

Source: www.catchmentsandcreeks.com/docs/Log-1.pdf





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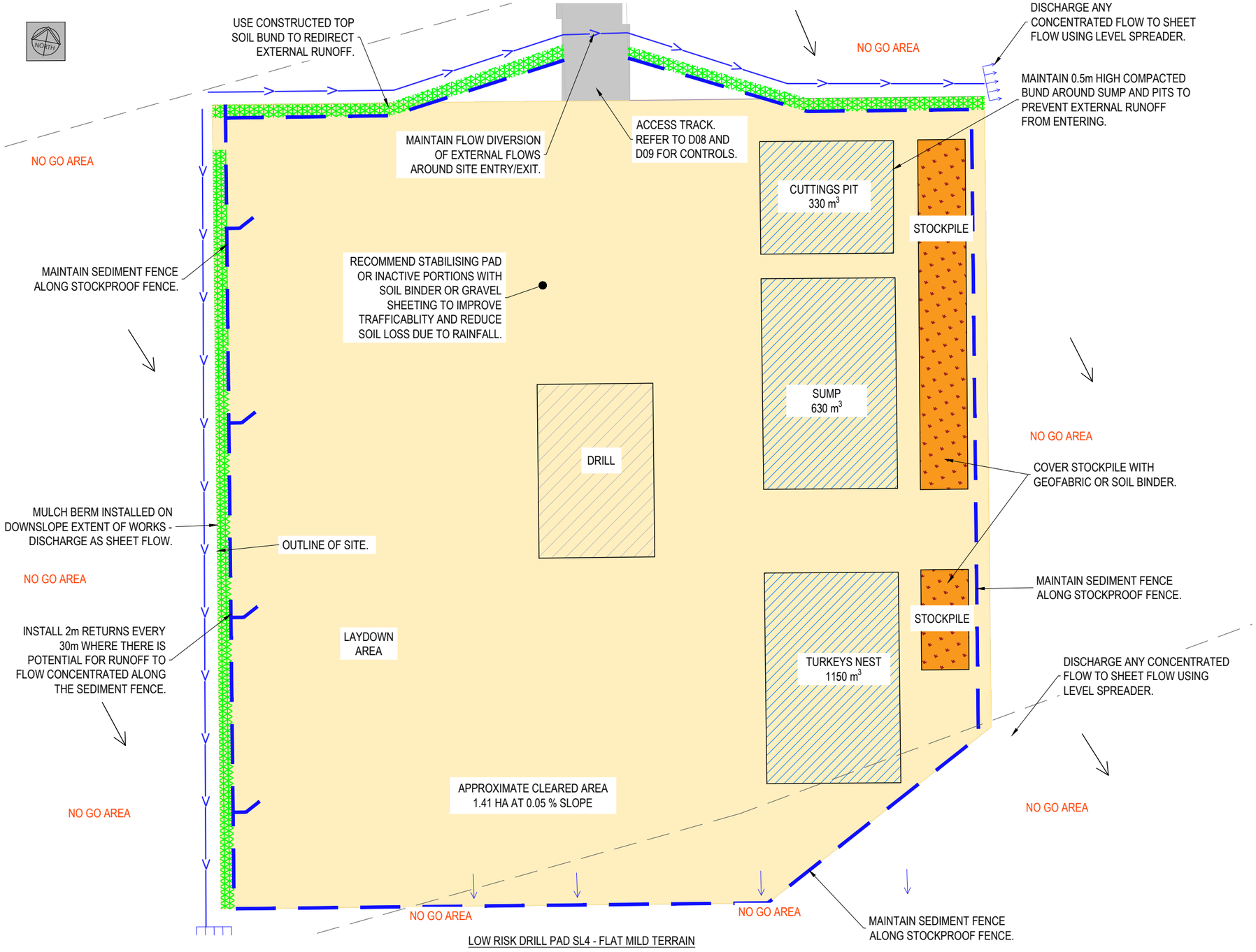

LAYOUT NOTE:
LAYOUT OF DRILL PAD IS APPROXIMATE BASED ON PROVIDED SKETCH AND IMAGE.

NO GO AREA NOTE:
NO VEHICLES ARE TO ENTER AREAS OUTSIDE THE SHOWN CORRIDOR AND DRILL PAD EXTENT.

LOW RISK DRILL PAD SL4 - FLAT MILD TERRAIN

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DRILL PAD SL4 AS CONSTRUCTED CONTROLS

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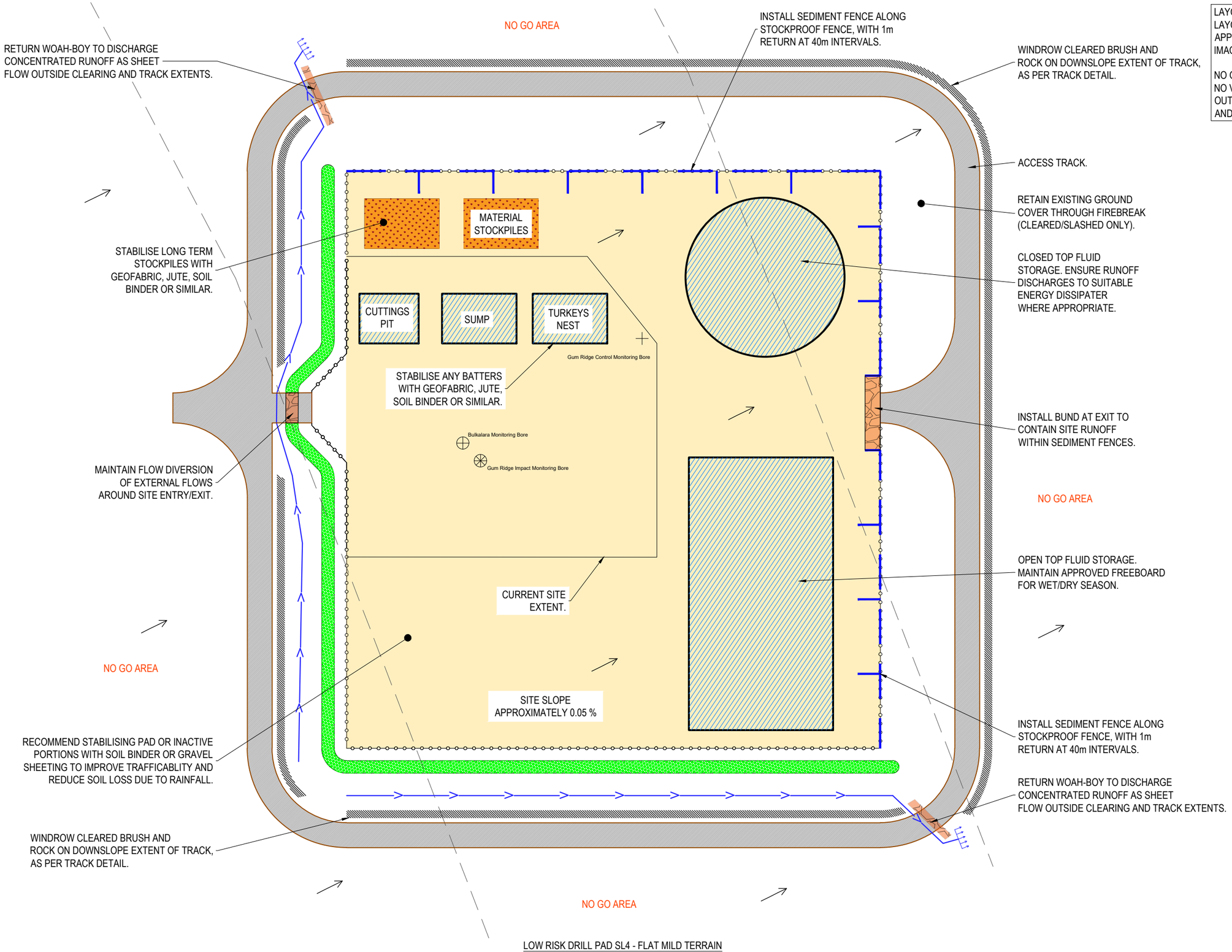

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LOW RISK DRILL PAD SL4 - FLAT MILD TERRAIN

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DRILL PAD SL4 FRACKING EXPANSION

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