Appendix 13. Weed Management Plan

Weed Management Plan, 2019 Seismic Program EP187. Report No. 1802587 Rev: D

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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	
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.

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. 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.

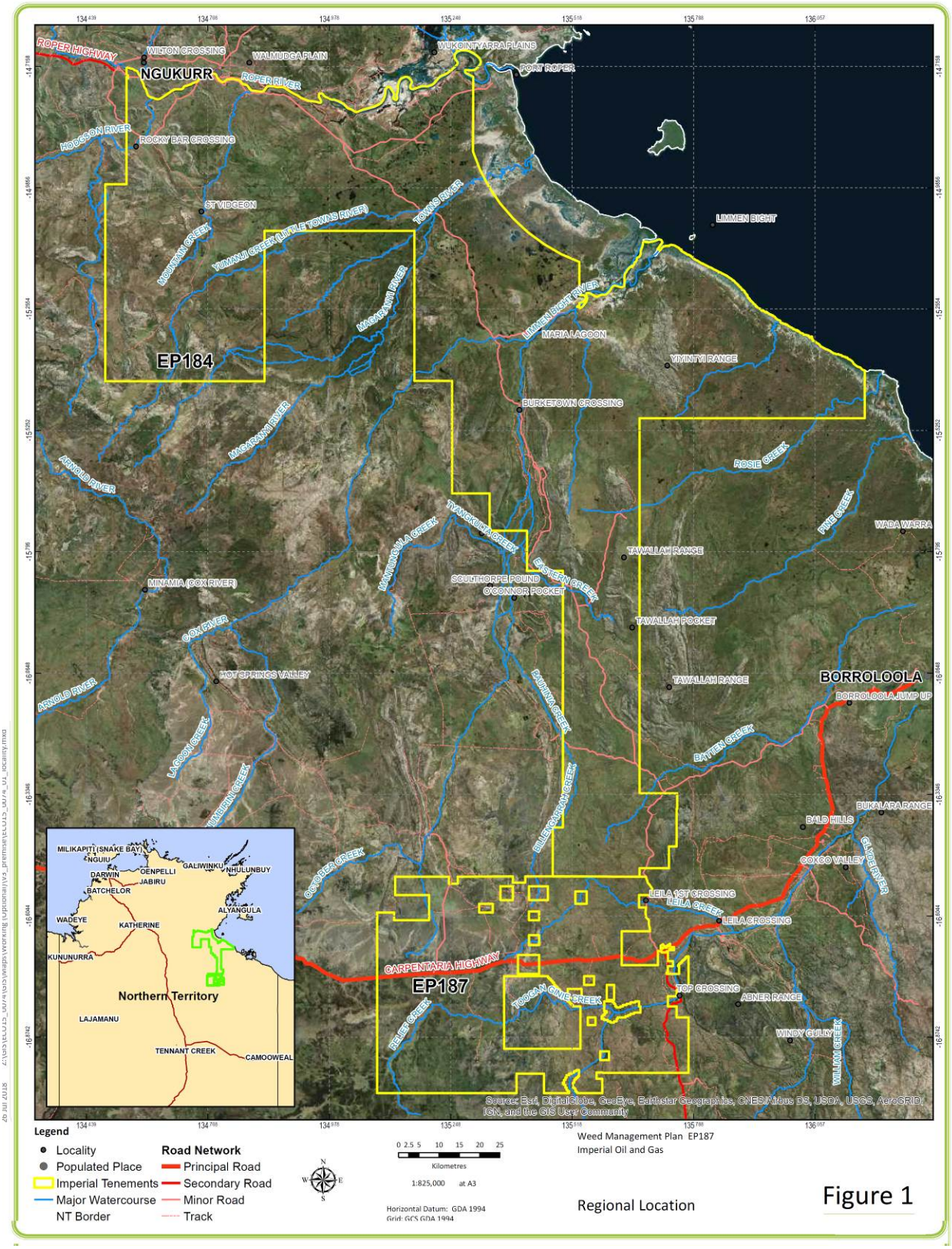
1.2 Proposed Seismic Program Location

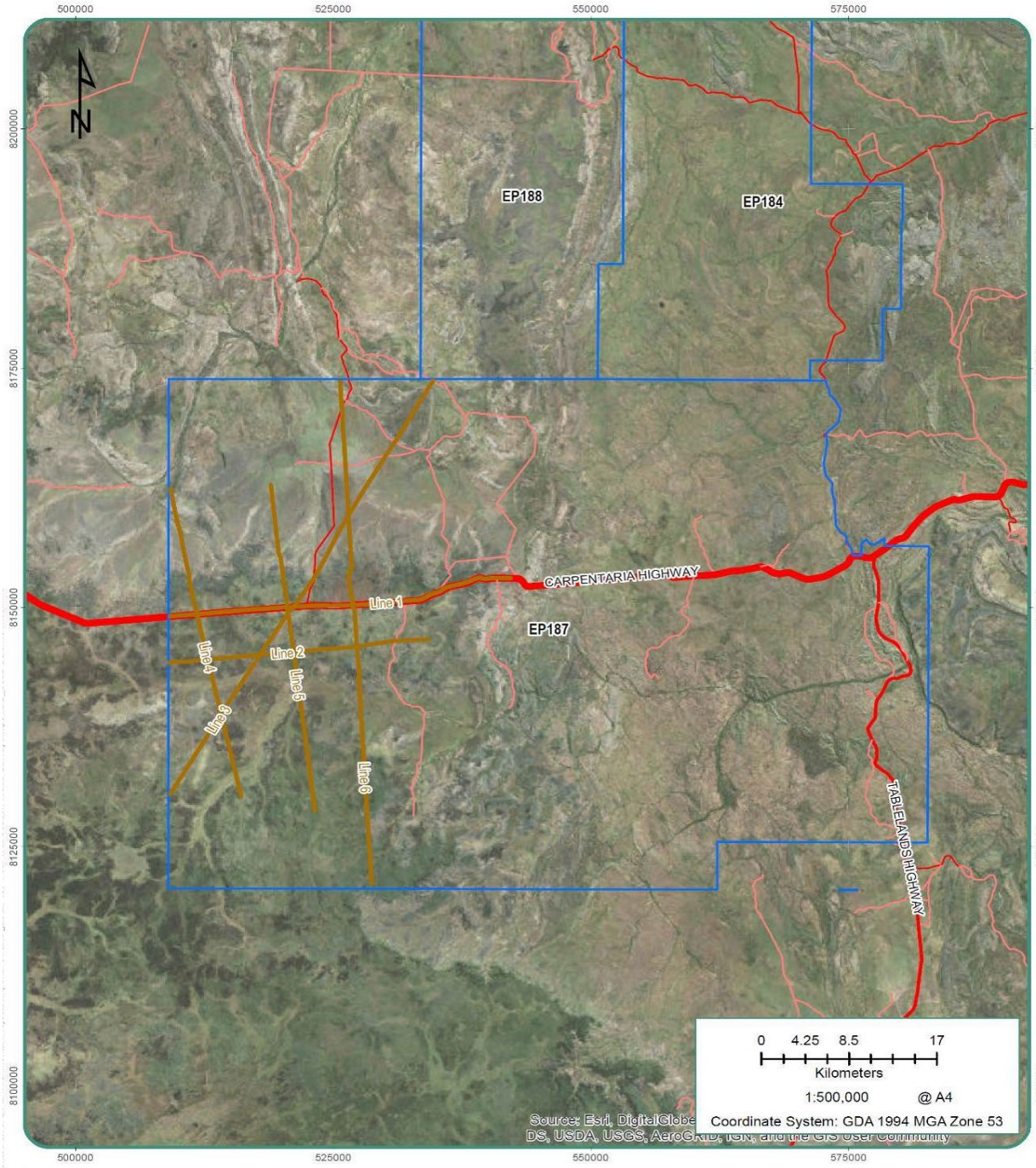
The proposed work program will occur late in the 2018 dry season as soon as practical for machinery and personnel to enter the region after approvals have been received. A number of historical pastoral access ways exist through the area as well as newer access ways developed by pastoralists holding S19 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.


ROPER HIGHWAY
WILTON CROSSING
NGUKURR
WALMUDGA PLAIN
ROPER RIVER
WUKONITYARRA PLAINS
PORT ROPER
HODGSON RIVER
ROCKY BAR CROSSING
ST VIDGEON
TOWNS RIVER
LIMMEN BIGHT
YUMANJI CREEK (LITTLE TOWNS RIVER)
MOUNTAIN CREEK
MACARTHUR RIVER
LIMMEN BIGHT RIVER
MARIA LAGOON
YIMINTYI RANGE
EP184
BURKETOWN CROSSING
MACARTHUR RIVER
ROSIE CREEK
ARNOLD RIVER
TYANGKUMA CREEK
PINE CREEK
WADA WARRA
TAWALLAH RANGE
HAMMOND GULA CREEK
SCULTHORPE POUND
O'CONNOR POCKET
EASTERN CREEK
MINAMIA (COX RIVER)
TAWALLAH POCKET
COX RIVER
HOT SPRINGS VALLEY
TAWALLAH RANGE
BORROLOOLA
BORROLOOLA JUMP UP
ARNOLD RIVER
LAWUNWA CREEK
BATTEN CREEK
LAGOON CREEK
BUKALARA RANGE
BALD HILLS
BILLENGKAN CREEK
OCTOBER CREEK
COXCO VALLEY
CALVERT RIVER
LEILA 1ST CROSSING
LEILA CREEK
LEILA CROSSING
CARPENTARIA HIGHWAY
EP187
TOP CROSSING
TOOGANGANIE CREEK
ABNER RANGE
RELIEF CREEK
WINDY GULLY
WILLIAM CREEK
MILIKAPITI (SNAKE BAY)
NGUIU
DARWIN
GENPELLI
GALIWINKU
NHULUNBUY
JABIRU
BATCHELOR
ALYANGULA
WADEYE
KATHERINE
KUNUNURRA
Northern Territory
LAJAMANU
TENNANT CREEK
CAMOOWEAL
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Legend
Locality
Populated Place
Imperial Tenements
Major Watercourse
NT Border
Road Network
Principal Road
Secondary Road
Minor Road
Track
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



TITLE:

Seismic Lines

MAP NO: IOG_0002

PROJECT: EP187 Weed Survey

LEGEND

- Seismic lines
- Tenements

Roads

- Principal Road
- Secondary Road
- Minor Road
- Track

Figure 2

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) Dardel
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. 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.
	Personnel unable to identify weeds or unaware of weed species present in	Existing weed distribution not known due to: insufficient survey	Premise and DENR weed surveys undertaken in October/November 2018 prior to seismic to map known weed distribution.

	areas where machinery and equipment is sourced from	effort, survey effort conducted at wrong time of year, persons undertaking survey not familiar with / unable to identify declared weed species	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. 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

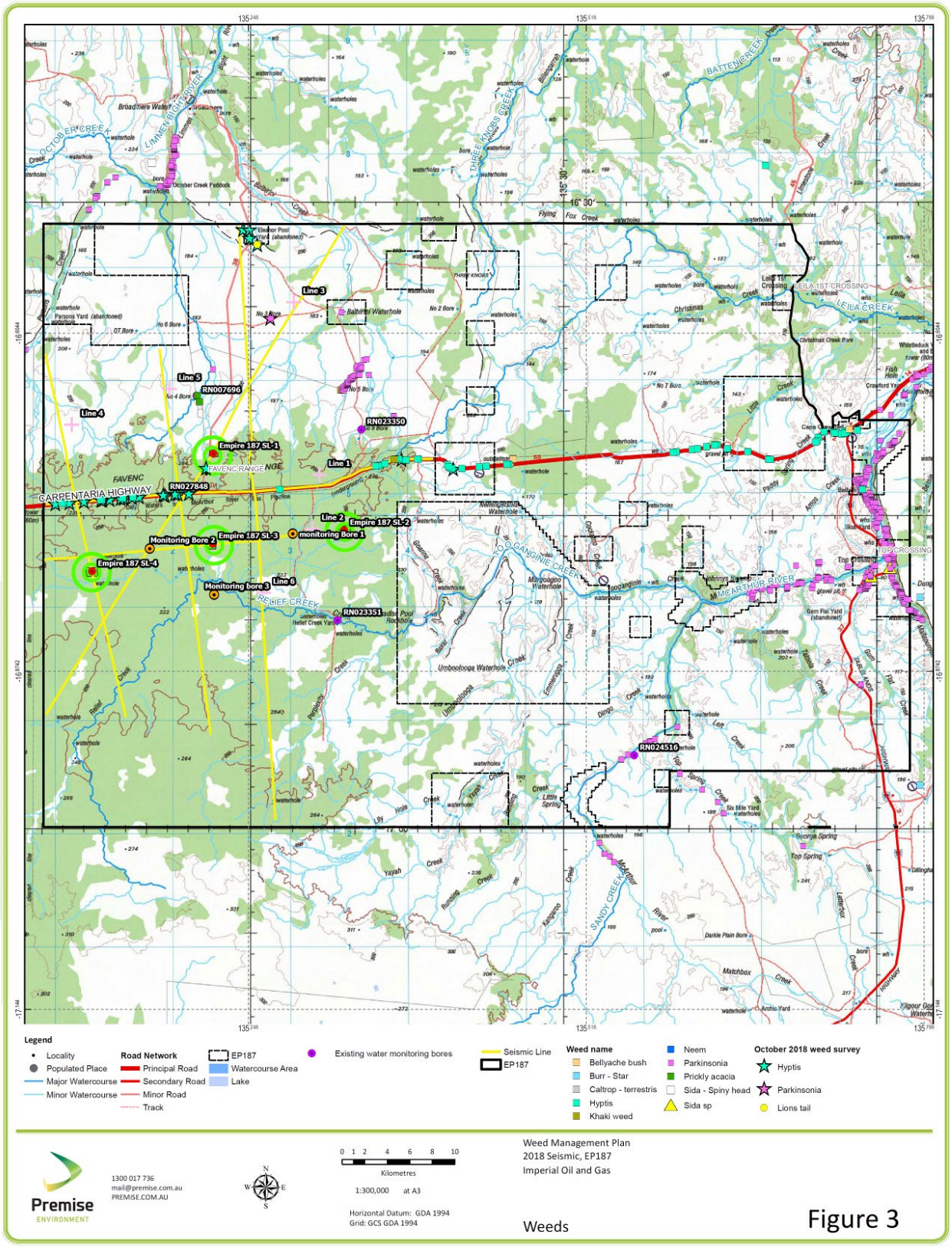
*- subject to Statutory Weed Management Plan

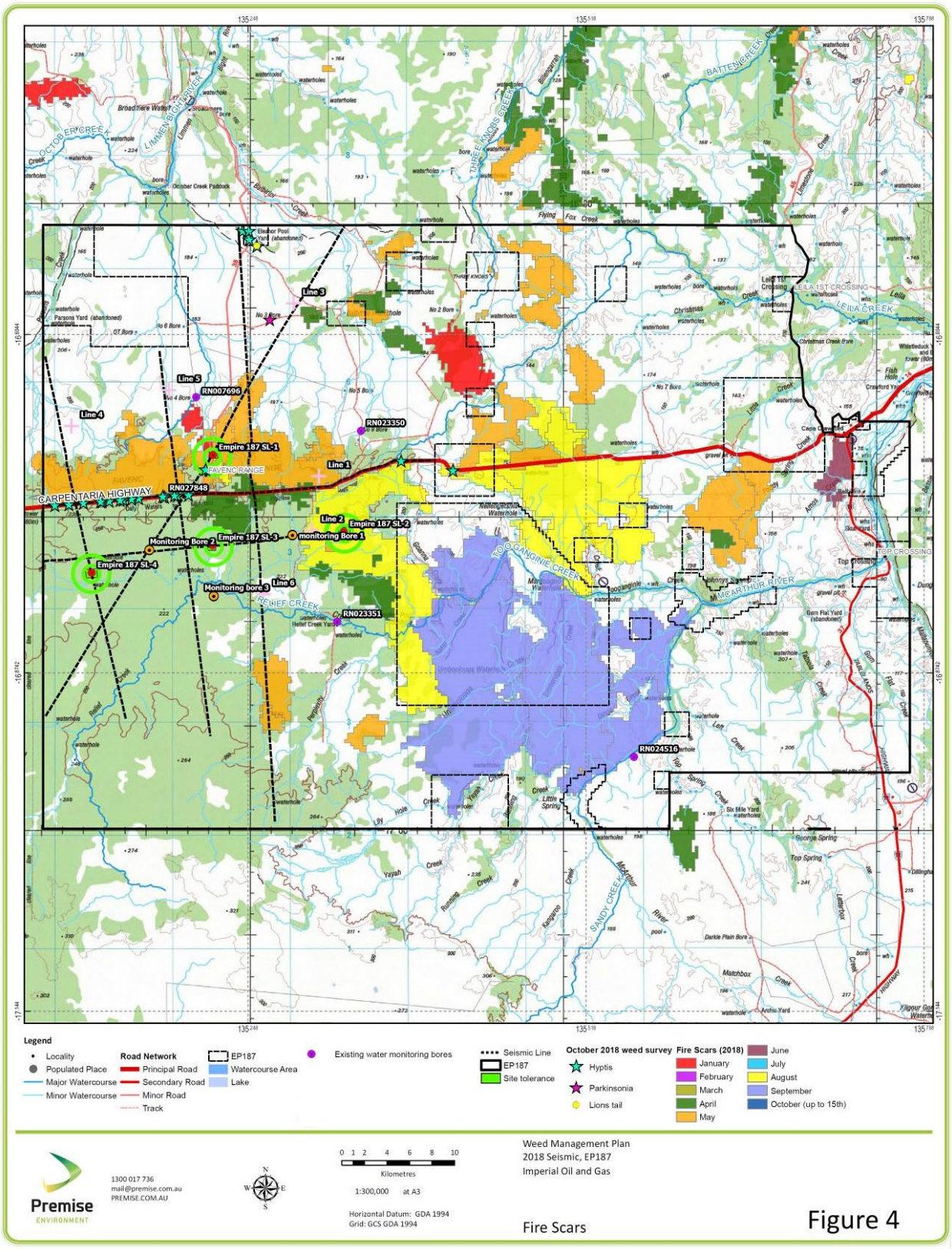
Table 4 lists weed alert species as per the *Katherine Regional Weed Management Plan 2015-2020*. These species are not yet naturalised in the region, however have the potential to have a high level of impact to the region.

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.


Legend
Locality
Populated Place
Major Watercourse
Minor Watercourse
Road Network
Principal Road
Secondary Road
Minor Road
Track
EP187
Watercourse Area
Lake
Existing water monitoring bores
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
Premise
ENVIRONMENT
1300 017 736
mail@premise.com.au
PREMISE.COM.AU
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
Weeds
Figure 3


Legend
Locality
Populated Place
Major Watercourse
Minor Watercourse
Road Network
Principal Road
Secondary Road
Minor Road
Track
EP187
Watercourse Area
Lake
Existing water monitoring bores
Seismic Line
EP187
Site tolerance
October 2018 weed survey
Hyptis
Parkinsonia
Lions tail
Fire Scars (2018)
January
February
March
April
May
June
July
August
September
October (up to 15th)
Premise
ENVIRONMENT
1300 017 736
mail@premise.com.au
PREMISE.COM.AU
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

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*)

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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

Appendix 14. Post 2018/19 Wet Season Weed Survey

EP187 POST-WET SEASON WEED SURVEY

Report IG-01

June 2019

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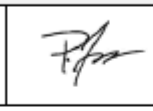
TABLE OF FIGURES

DOCUMENT AUTHORISATION					
Revision		Rev. Date		Report Details	
a		20 April 2019		Draft report	
b		10 June 2019		Final Report to include drill pads and access tracks	
Prepared By		Reviewed By		Authorised By	
P.F		A.F		P. Fox	

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 and drilling 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 and drilling 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.

1 INTRODUCTION

Fox & Co Environmental Pty Ltd 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. Eight (8) well options are also situated on the seismic lines.

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 and drilling 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.).*

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.
DENR announced the occurrence of another alert species in the Katherine region, rubber vine (*Cryptostegia grandiflora*), on 21st March 2019.
These recent finding in the region highlights the high risk of introduction of these weeds in the area.

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 Limmen Bight National Park is situated to the northeast of EP187. **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.

1.2 *Proposed Seismic and Drilling Program Locations*

The proposed seismic work program will occur in the 2019 dry season (June/July), whilst the drilling program is expected to occur following the seismic program in 2019 subject to statutory approval processes. 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 and will be in accordance with the NT Land Clearing Guidelines (LCG) (2019) and the pending Land Clearing Permits (LCP). Access to the well pads will be via existing pastoral tracks or new tracks selected to avoid sensitive areas as per the LCG (2019). The new proposed bore access track have not been surveyed at the time of reporting and will require inspection prior to drilling. Assessment of these tracks is proposed at the seismic inception when DENR weed officers will be present to undertaken onsite weed training for the seismic contractors.

Table 1, **Table 2** and **Table 3** provides the latitude and longitude coordinates of the start and end of the seismic lines, bore options and proposed bore access tracks, respectively. **Figure 2** provides a map of the proposed route of the seismic lines, proposed bore locations and access tracks.

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.

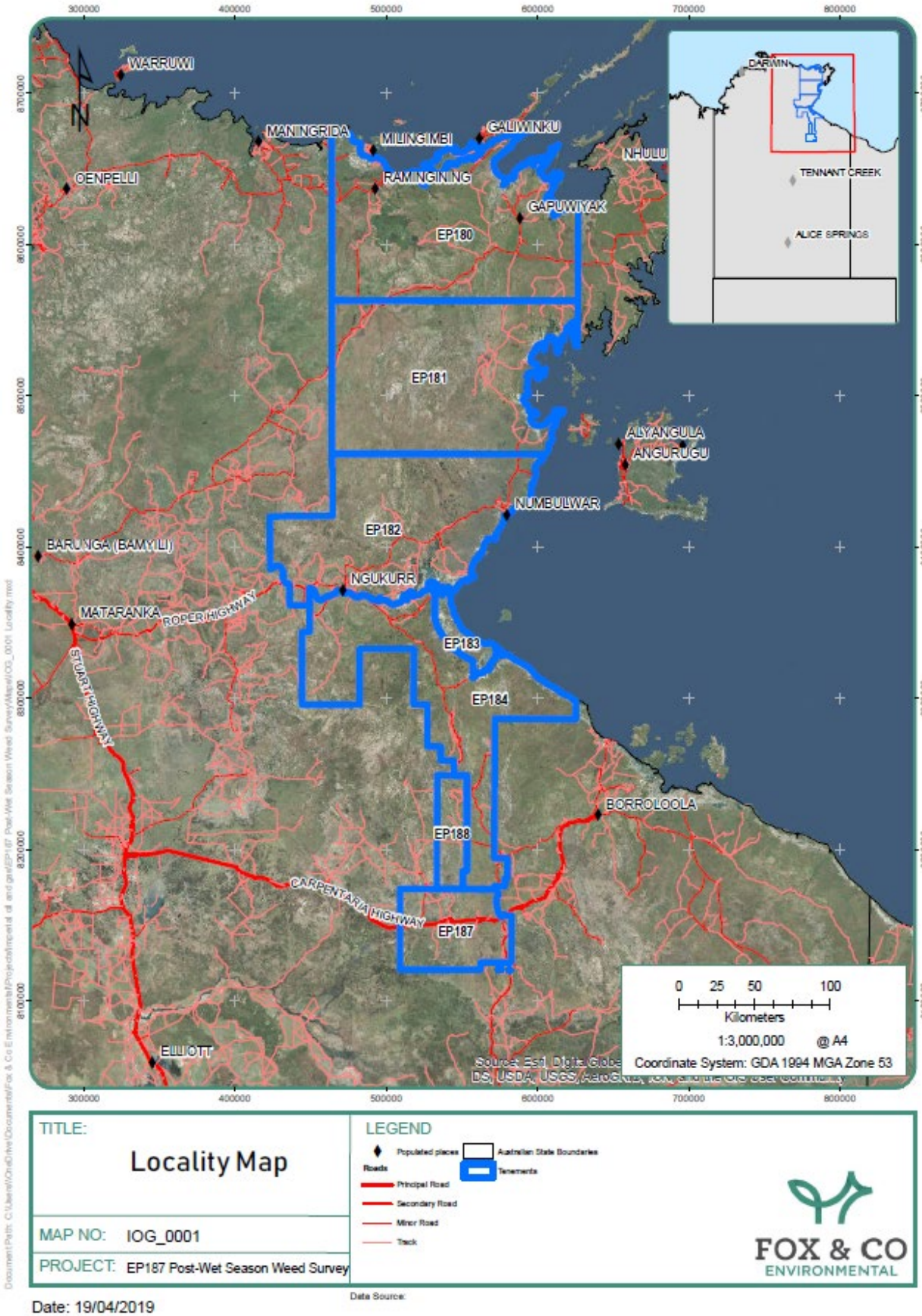
Table 2 Coordinates for proposed well pads

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		

Table 3 Access track for start and end (decimal degrees

Tracks	Start Longitude	Start Latitude	End Longitude	End Latitude	Length (km)
Western Access track joining SL-4 (Alt-3) and SL-4 (Alt-4)	135.111092	-16.742042	135.132847	-16.83641	10.7
Carpentaria Hwy to SL-3	135.244503	-16.731386	135.219816°	-16.772641°	5.3
Track from Relief Creek Pastoralist track to SL-2	135.291714	-16.764219	135.324698°	-16.761726°	3.5

NB: All coordinates are provided in decimal degrees.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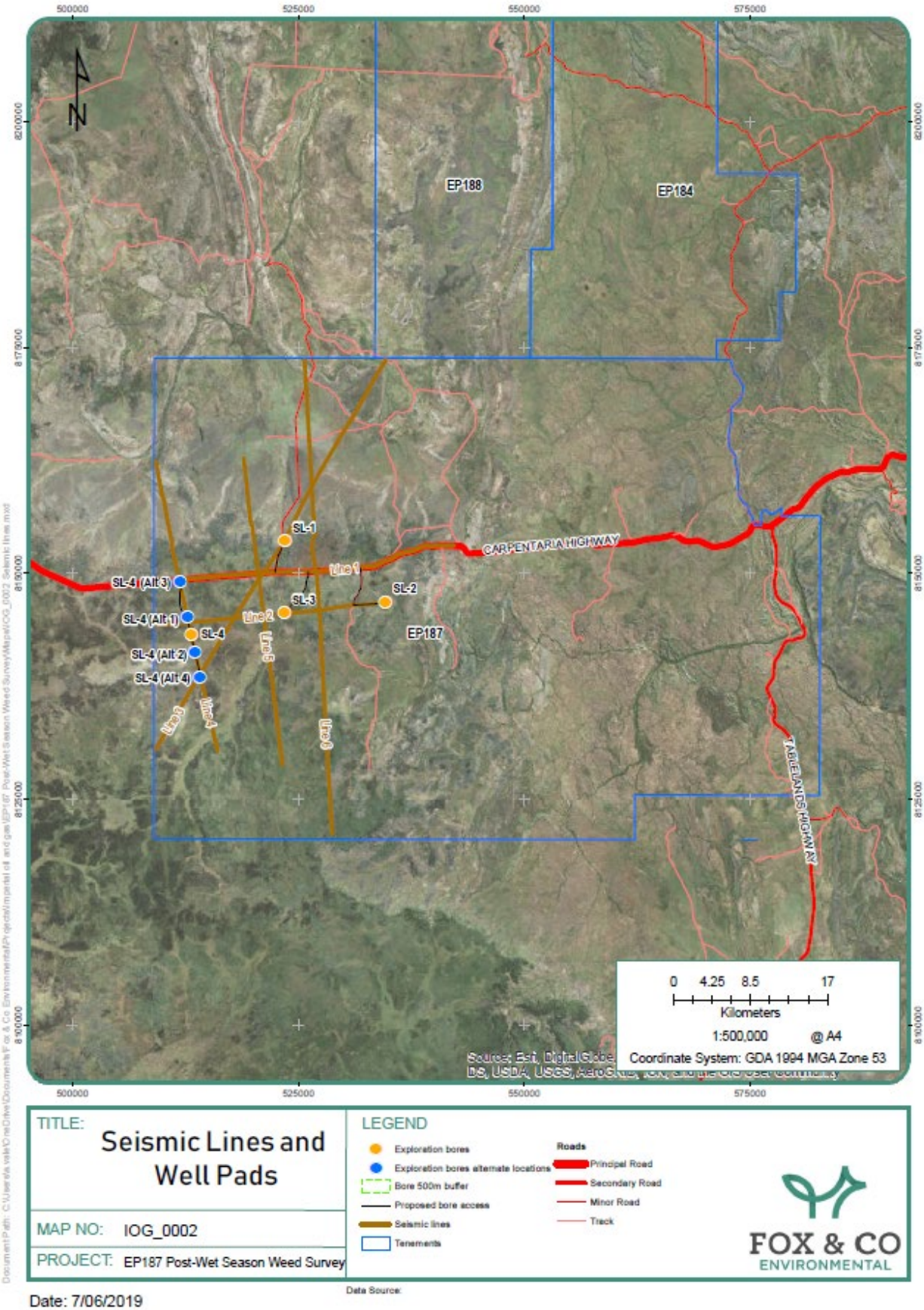
GALIWINKU
NHULU
OENPELLI
RAMINGINING
GAPUWIYAK
EP180
EP181
ALYANGULA
ANGURUGU
NUMBULWAR
EP182
BARUNGA (BAMYILI)
NGUKURR
MATARANKA
ROPER HIGHWAY
EP183
EP184
STUART HIGHWAY
BORROLOOLA
EP188
CARPENTARIA HIGHWAY
EP187
ELLIOTT
DARWIN
TENNANT CREEK
ALICE SPRINGS
0 25 50 100
Kilometers
1:3,000,000 @ A4
Coordinate System: GDA 1994 MGA Zone 53
TITLE:
Locality Map
LEGEND
Populated places
Australian State Boundaries
Roads
Tenements
Principal Road
Secondary Road
Minor Road
Track
MAP NO: IOG_0001
PROJECT: EP187 Post-Wet Season Weed Survey
FOX & CO
ENVIRONMENTAL
Date: 19/04/2019
Data Source: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8200000
8175000
8150000
8125000
8100000
N
EP188
EP184
EP187
SL-1
SL-2
SL-3
SL-4
SL-4 (Alt 1)
SL-4 (Alt 2)
SL-4 (Alt 3)
SL-4 (Alt 4)
Line 1
Line 2
Line 3
Line 4
Line 5
Line 6
CARPENTARIA HIGHWAY
TABLELANDS HIGHWAY
0 4.25 8.5 17
Kilometers
1:500,000 @ A4
Coordinate System: GDA 1994 MGA Zone 53
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
TITLE:
Seismic Lines and Well Pads
MAP NO: IOG_0002
PROJECT: EP187 Post-Wet Season Weed Survey
LEGEND
Exploration bores
Exploration bores alternate locations
Bore 500m buffer
Proposed bore access
Seismic lines
Tenements
Roads
Principal Road
Secondary Road
Minor Road
Track
FOX & CO ENVIRONMENTAL
Data Source:
Date: 7/06/2019

2 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.

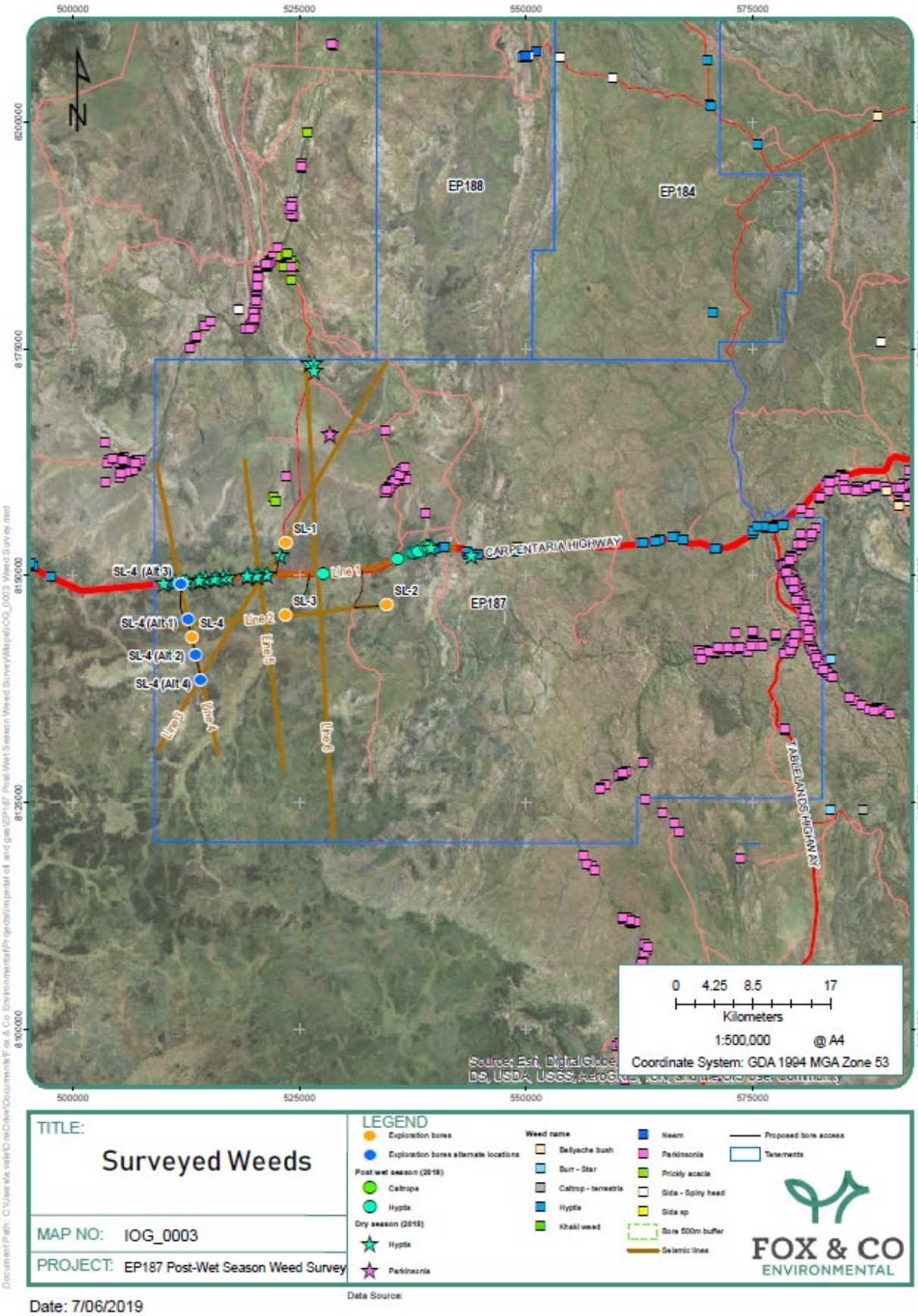
Hyptis records along the Carpentaria Highway west of Line 3/Line 1 intersection (ie. West of Broadmere Road) were comparable between seasons. Only two (2) Hyptis locations were recorded east of the Line 3/Line 1 intersection along Seismic Line 1 (Carpentaria Highway) during the 2018 weed surveys, in 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 4 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	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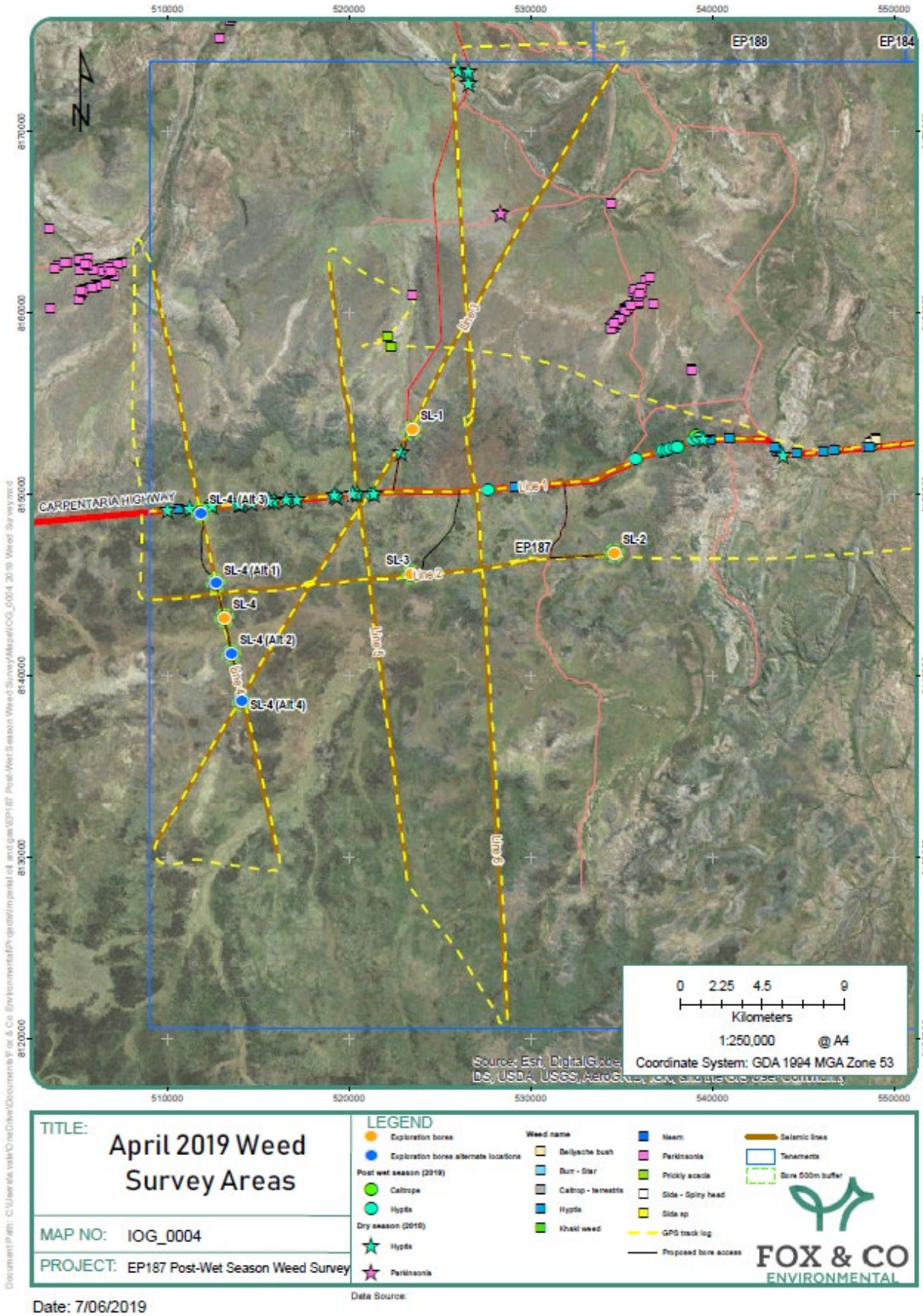
EP188
EP184
EP187
SL-1
SL-2
SL-3
SL-4
SL-4 (Alt 1)
SL-4 (Alt 2)
SL-4 (Alt 3)
SL-4 (Alt 4)
Line 1
Line 2
Line 3
Line 4
Line 5
Line 6
CARPENTARIA HIGHWAY
TABLELANDS HIGHWAY
0 4.25 8.5 17
Kilometers
1:500,000 @ A4
Coordinate System: GDA 1994 MGA Zone 53
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
TITLE:
Surveyed Weeds
MAP NO: IOG_0003
PROJECT: EP187 Post-Wet Season Weed Survey
LEGEND
Exploration bores
Exploration bores alternate locations
Post wet season (2018)
Caltrops
Hyptis
Dry season (2018)
Hyptis
Parkinsonia
Weed name
Bellyache bush
Burr - Star
Caltrop - terrestris
Hyptis
Khaki weed
Neem
Parkinsonia
Prickly acacia
Gida - Spiny head
Gida sp
Bore 500m buffer
Seismic lines
Proposed bore access
Tenements
FOX & CO
ENVIRONMENTAL
Data Source:
Date: 7/06/2019


510000
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EP188
EP184
EP187
N
SL-1
SL-2
SL-3
SL-4
SL-4 (Alt 1)
SL-4 (Alt 2)
SL-4 (Alt 3)
SL-4 (Alt 4)
CARPENTARIA HIGHWAY
Line 1
Line 2
Line 3
Line 4
Line 5
Line 6
0 2.25 4.5 9
Kilometers
1:250,000 @ A4
Coordinate System: GDA 1994 MGA Zone 53
TITLE:
April 2019 Weed Survey Areas
MAP NO: IOG_0004
PROJECT: EP187 Post-Wet Season Weed Survey
LEGEND
Exploration bores
Exploration bores alternate locations
Post wet season (2019)
Caltrope
Hyptis
Dry season (2018)
Hyptis
Parkinsonia
Weed name
Bellyache bush
Burr - Star
Caltrop - tenestris
Hyptis
Khaki weed
Neem
Parkinsonia
Prickly acacia
Sida - Spiny head
Sida sp
GPG track log
Proposed bore access
Seismic lines
Tenements
Bore 500m buffer
FOX & CO
ENVIRONMENTAL
Data Source:
Date: 7/06/2019

3 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 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 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	Glyphosate (various trade names)
	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®) for Parkinsonia. Metsulfuron methyl for Hyptis

Weed Management Area	Weed species	Management objective	Survey time/s	Treatment time/s	Control method/s	Herbicide
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	Glyphosate (various trade names)
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	Glyphosate (various trade names)
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	Glyphosate (various trade names) 2,4-D amine (various trade names) for Lion's tail
Exploration Bores SL-1 to SL-4, alternative SL-4 locations and both access track options	Hyptis *(H. suaveolens)* is present along Broadmere Road and Carpentaria Hwy proximate to the proposed side access tracks for all wells	No spread. No introduction of new weed species.	Prior to construction of access tracks and well pads. At start of seismic before well pad locations are finalised.	Immediately upon identification	Foliar spray	Glyphosate (various trade names)

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

4 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).

Access tracks for the well pads were selected following the previous weed surveys and site assessments. Tracks were selected to avoid sensitive areas as per the LCG (2019). Weed surveys are required at both access tracks as these were not surveyed during previous weed surveys and environmental investigations. The proposed timing for additional surveys is at the commencement of the seismic program as the NT DENR weed officers will also be on site undertaking onsite weed training for the contractors.

5 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

Northern Territory Government (2019) Land Clearing Guidelines

Weed Management Plan 2018 Seismic Program EP187 (15 November 2018) Premise Environment, Report # 1802587e

APPENDIX A

Weed Survey Data, April 2019

RECORDER:		Paul Fox			PROJECT:		Imperial Oil & Gas Baseline Weed Survey for Proposed Seismic					LOCALITY:	EP187 proposed seismic lines	
ORG_NAME:		Fox and Co Environmental. 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

Appendix 15. AAPA Authority Certificate (C2019/016) for Seismic Survey in EP187

Aboriginal Areas Protection Authority
protecting sacred sites across the territory

Our File: 2018/627
In reply please quote: 201808538

Imperial Oil & Gas Pty Ltd
Level 7 151 Macquarie Street
Sydney NSW 2000

ATTENTION: ALEX UNDERWOOD
RE: ISSUE OF AUTHORITY CERTIFICATE FOR SEISMIC SURVEY IN EP187

I refer to your application for Authority Certificate received on the 4th October 2018 for the above location.

Accordingly, under the powers delegated to me under Section 19 of the *Northern Territory Aboriginal Sacred Sites Act 1989* I am pleased to issue the attached Authority Certificate.

Please read carefully the conditions outlined in the Certificate. In particular, you should note that it has been issued for an indefinite period of time, providing that the works covered by the Certificate start within the period stipulated in condition 3.

You should also note that the Authority has issued you with two identical copies of digitised maps attached. One copy should be retained with your original Certificate. The second is supplied for use by contractors to avoid unnecessary photocopying of a colour coded document.

Please note that the cost of this Authority Certificate will be $12,733 inclusive of GST and an invoice will be issued to you by the Department of Corporate and Information Services. An application fee of 57 revenue units ($67) will also apply. The terms and conditions of the invoice will require you to make payment within 30 days of receipt.

If you have any further queries regarding this Authority Certificate please email enquiries.aapa@nt.gov.au or contact Virginie Branchut on (08) 89994343.

Yours faithfully

DR. BEN SCAMBARY
Chief Executive Officer

28th February 2019

Darwin
P: +61 (08) 8999 5511
F: +61 (08) 8999 4334
www.aapant.org.au
enquiries.aapa@nt.gov.au
4th Floor, R.C.G Centre,
47 Mitchell Street DARWIN NT
GPO Box 1890, Darwin NT 0801

Alice Springs
P: +61 (08) 8999 5511
F: +61 (08) 8952 2824
www.aapant.org.au
enquiries.aapa@nt.gov.au
Ground Floor, Belvedere House
Cnr Bath & Parsons Streets Alice Springs NT
All mail to Darwin GPO

ABORIGINAL AREAS PROTECTION AUTHORITY
AUTHORITY CERTIFICATE

Issued in accordance with Section 22 of the *Northern Territory Aboriginal Sacred Sites Act 1989*.

REFERENCE: **2018/627** **(Doc: 201808538)** **C2019/016**

APPLICANT: Imperial Oil & Gas Pty Ltd
Level 7 151 Macquarie Street
Sydney NSW 2000

SUBJECT LAND: Petroleum Exploration Permit 187, as shown on the map which is Annexure 'A' hereto.

PROPOSED WORK OR USE: All works associated with 2D seismic survey over 6 traverses totalling up to 235 linear kilometres within 50m either side of the centre line, use of existing public roadways, pastoral access ways and fence lines, vegetation clearance where required, removal of rocks and fallen branches/vegetation and slashing of grasses and shrubs, ground clearance by grader up to one blade width, and all works ancillary to the above mentioned works including routine and ongoing maintenance, renewal and minor upgrade of any infrastructure, facilities and services.

CONDITIONS:

1. The applicant shall ensure that the conditions of this Certificate are included in any subsequent contract or tender documents for the works or use described herein.
2. The applicant shall ensure any agent, contractor or employee is aware of the conditions of this Certificate and the obligations of all persons (who enter on, or carry out works or use land on which there is a sacred site) under Part IV of the *Northern Territory Aboriginal Sacred Sites Act 1989*.
3. This Certificate shall lapse and be null and void if the works in question or the proposed use is not commenced within 24 months of this Certificate.
4. The applicant shall ensure any agent, contractor or employee is aware of the content of section 40(1) of the *Northern Territory Aboriginal Sacred Sites Act 1989*, which provides that this Certificate does not negate the need for consent, approval or permission for the subject works or use of the land which may be required under another statute.

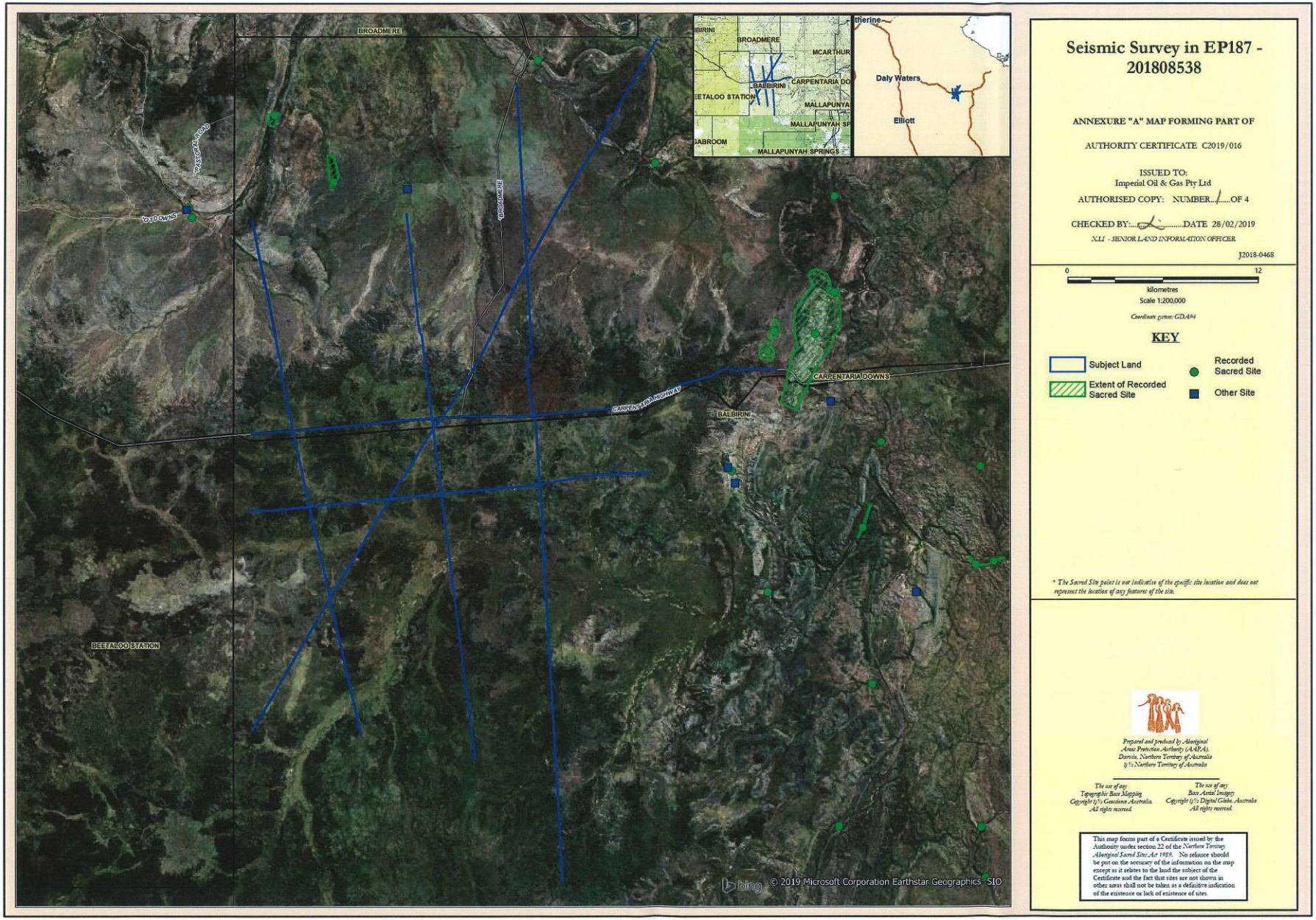
The COMMON SEAL of the
ABORIGINAL AREAS PROTECTION AUTHORITY

was hereto affixed on the 28th day

of February 2019

ABORIGINAL AREAS PROTECTION AUTHORITY
THE
COMMON SEAL
OF

DR. BEN SCAMBARY
Chief Executive Officer



Seismic Survey in EP187 - 201808538

ANNEXURE "A" MAP FORMING PART OF

AUTHORITY CERTIFICATE C2019/016

ISSUED TO:
Imperial Oil & Gas Pty Ltd

AUTHORISED COPY: NUMBER 1 OF 4

CHECKED BY: ..... DATE 28/02/2019

XLI - SENIOR LAND INFORMATION OFFICER

J2018-0468

0 12
kilometres
Scale 1:200,000

Coordinate system: GDA94

KEY

- Subject Land
- Extent of Recorded Sacred Site
- Recorded Sacred Site
- Other Site

** The Sacred Site point is not indicative of the specific site location and does not represent the location of any features of the site.*

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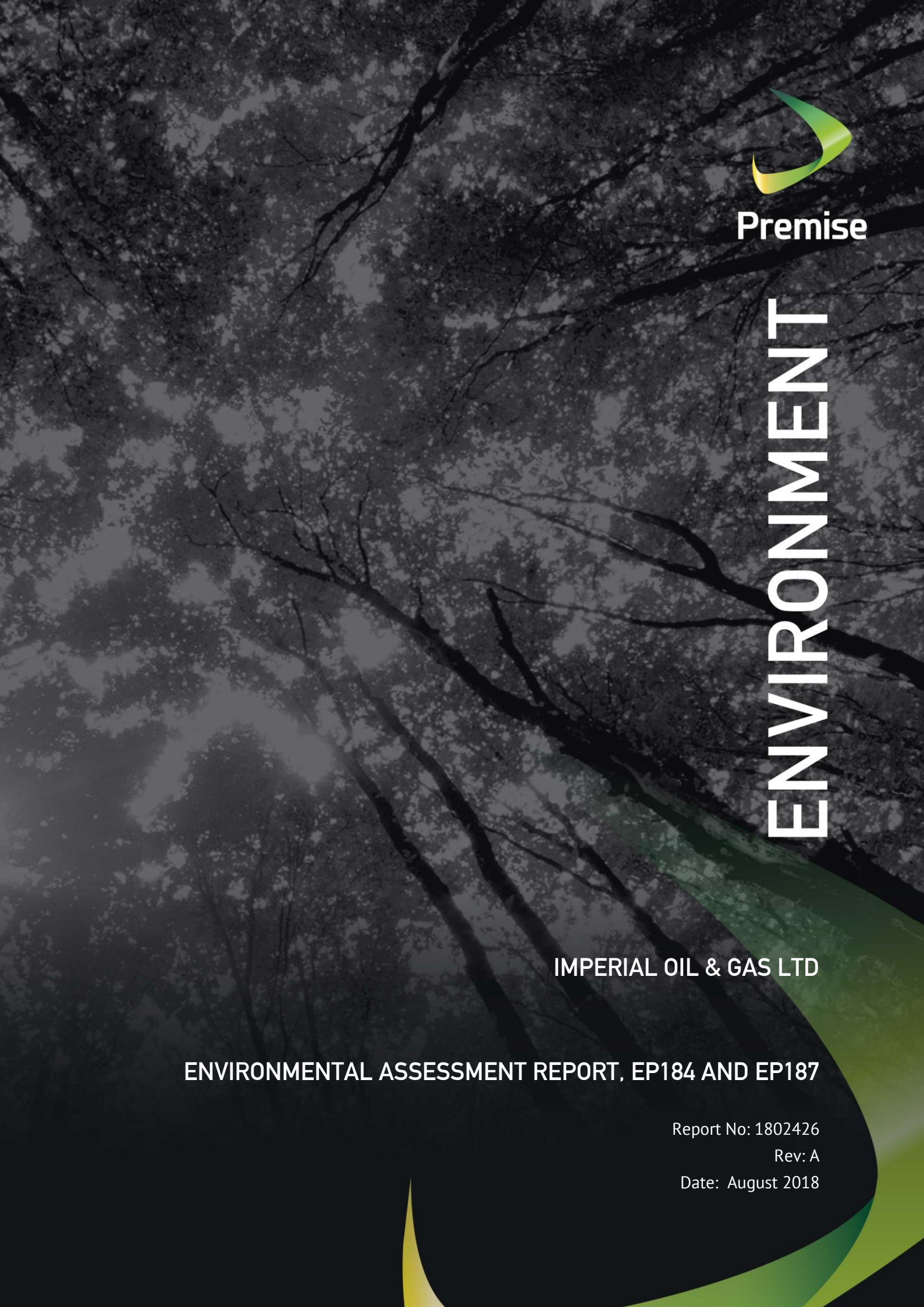
This map forms part of a Certificate issued by the Authority under section 22 of the *Northern Territory Aboriginal Sacred Sites Act 1989*. No reliance should be put on the accuracy of the information on the map except as it relates to the land the subject of the Certificate and the fact that sites are not shown in other areas shall not be taken as a definitive indication of the existence or lack of existence of sites.

Appendix 16. Preliminary Ecological Assessment Reports 2015 and 2018



Premise

ENVIRONMENT

IMPERIAL OIL & GAS LTD

ENVIRONMENTAL ASSESSMENT REPORT, EP184 AND EP187

Report No: 1802426

Rev: A

Date: August 2018

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Prepared By		**Reviewed By**		**Authorised By**	
P. Fox		M. Jewel	M.J.	P. Fox	

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EXECUTIVE SUMMARY

A dry season environmental assessment, including surface water quality sampling, was carried out as part of an ongoing baseline assessment of the existing environmental values and conditions within Exploration Permit (EP) areas EP184 and EP187 in the Northern Territory. The objectives of the baseline assessment are to provide:

- seasonal water quality assessments to further develop a baseline water quality profile;
- temporal changes in habitat and vegetation community condition; and
- opportunistic fauna (terrestrial and aquatic) species list, including introduced species and any threatened species present.

Existing Environment

EP184 is a 1,122,000 ha tenement situated in the central trough of the McArthur Basin south of the Roper River and adjacent to the Gulf of Carpentaria. The community of Ngukurr is located on the northern side of the Roper River which runs along the northern boundary of the tenement. EP187 is situated south of EP184 and the eastern boundary of EP187 is approximately 84 km south west of Borroloola. The Carpentaria Highway runs east – west through the centre of EP187.

EP184 lies within the Roper River, Towns River, Limmen Bight River, Rosie River and McArthur River catchments. EP187 lies within the Limmen Bight River and McArthur River catchments. All of these rivers discharge into the Gulf of Carpentaria, east of the tenements.

The area consists largely of national park area (Limmen National Park), agriculture (grazing of natural vegetation) and some traditional indigenous lands.

Seven Areas of Conservation Significance lie within the greater region - Limmen National Park, Limmen Bight and associated coastal floodplains, The Limmen Bight (Port Roper) Tidal Wetlands System (NT007), The Borroloola area, Borroloola Bluebush Swamps (NT006), The McArthur River coastal floodplain and Port McArthur Tidal Wetlands System (NT008). Of these, Limmen National Park and Limmen Bight and associated coastal floodplains encompass a portion of the north eastern portion of EP184. The remaining five are downstream of the tenements.

The study area falls within three IBRA Bioregions - Gulf Coastal, Gulf Falls and Uplands and Sturt Plateau.

The vegetation communities mapped over the tenements include woodland, tussock grassland, sparse samphire shrubland and forest. Eucalyptus woodland dominates the area (57%), followed by Corymbia low open woodland (11%), Eucalyptus low woodland (7%) and Chrysopogon (mixed) tussock grassland (6%). No Threatened Ecological Communities (TECs) are mapped within EP184 and EP187.

Findings

The region is generally in good ecological condition but widespread impacts from weeds, feral animals (especially pigs, buffalo, donkeys and cattle) changed fire regimes and grazing have been observed over two dry season assessment programs.

No threatened flora species were observed. Three (3) WONS (Weeds of National Significance; also Northern Territory declared Class A and C plants), *Vachellia nilotica*(prickly acacia) (EP-1, McR-1), *Chryptostegia grandiflora* (rubber vine) (LBR-1) and *Andropogon gayanus* (Gamba grass) (LC-1), and three (3) other Northern Territory declared Class B and Class C plants, *Hyptis suaveolens* (mint weed) (EP-1, WC-1), *Leonotis nepetifolia* (lion's ear) (EP-1) and *Calotropis procera* (rubber bush) (RR-1), were observed in 2015 and 2018.

No threatened fauna species were observed. Ten species listed as migratory (three species) and/or marine (10 species) under the EPBC Act were observed.

Seven introduced species were observed, all of which are feral species in the Northern Territory.

Water quality samples were collected at all sites. All sample sites are considered to be lowland streams of Tropical North Australia and most analytes were below detection levels or within guideline values. Concentrations of analytes were consistent with the results obtained during the 2015 dry season sampling event. Nitrogen concentrations were reported above adopted trigger guidelines at all sites, which is consistent with the 2015 sampling event where nitrogen was above the adopted trigger level at most sites. Phosphorous was above the adopted trigger level at two sites (LT-1 and WC-1). These results are expected to vary seasonally and may also be attributed to use of these remnant water holes by pigs, buffalo and cattle. Dissolved oxygen was low at all sites, not uncommon in remnant pools during the dry season.

Naturally occurring elevated heavy metal concentrations above trigger levels were found in water samples of Little Towns River (LT-1) (chromium, copper), Hodgson River (HR-1) (copper) and Whirlpool Creek (copper). This is consistent with regional natural elevated levels of copper which during the 2015 sampling event was also recorded above the adopted trigger levels at Towns River (TR-1), Magaranyi River (MR-1) and Little Towns River (LT-1).

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) at all locations. Further assessments are recommended during the post-wet season to provide an understanding of seasonal water quality changes.

Recommendations

The assessment program undertaken to date provides an understanding of the existing waterways and some of the associated communities. It provides a sound basis on which to conduct further baseline assessments over the tenements. The sites are spread throughout the tenements, however as the tenements encompass vast areas and a number of culturally restricted areas of access, more detailed assessments should be carried out in relevant areas once work areas are known and prior to any works.

This sampling program has identified that delivering training to local traditional owners in sample collection techniques may provide opportunity to expand the next round of sampling and facilitate more comprehensive programs in areas that are not currently available for non-indigenous personnel to enter.

LIST OF ABBREVIATIONS

Abbreviation	Definition
ALA	Atlas of Living Australia
ANZECC Guidelines	Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, 2000)
AVH	Australia's Virtual Herbarium
DLRM	Northern Territory Department of Land Resource Management
DOE	Commonwealth Department of the Environment
EP	Exploration Permit
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EVNT	Endangered, Vulnerable or Near Threatened (conservation status listing of species under the EPBC Act)
GPS	Global Positioning System
ha	Hectare
IBRA	Interim Biogeographic Regionalisation for Australia
km	Kilometre
LOR	Level of Reporting
NTEPA	Northern Territory Environment Protection Authority
NVIS	National Vegetation Information System
OZCAM	Online Zoological Collections of Australian Museums
PMST	Commonwealth EPBC Act Protected Matters search tool
TEC	Threatened Ecological Community
TPH	Total Petroleum Hydrocarbons
TPWC Act	*Territory Parks and Wildlife Conservation Act 2000*
TRH	Total Recoverable Hydrocarbons
WM Act	Northern Territory *Weeds Management Act 2001*
WONS	Weeds of National Significance

1 INTRODUCTION

Imperial Oil & Gas Pty Ltd proposes to conduct exploration within the McArthur Basin, Northern Territory and, pending identification of suitable hydrocarbon resources, commercially extract these. The exploration, development, commercial extraction and construction of associated infrastructure have the potential to impact on surface water, flora and fauna.

Premise (then O2 Ecology) was previously engaged by Imperial Oil & Gas Pty Ltd in December 2012 and December 2015 to undertake a preliminary environmental assessment within Exploration Permit area EP184 and in December 2015 in EP187 in the Northern Territory. Premise was subsequently engaged by Imperial Oil & Gas to undertake another round of assessments in June 2018 to assist in establishing baseline environmental data over these 2 tenements. This report presents the findings of the June 2018 assessment with reference to the previous environmental survey results.

1.1 Study Objectives

The dry season environmental assessment including baseline surface water quality sampling provide a continuation of an ongoing baseline assessment of the existing environmental values and conditions within the tenements. The objectives of the baseline assessment are to provide:

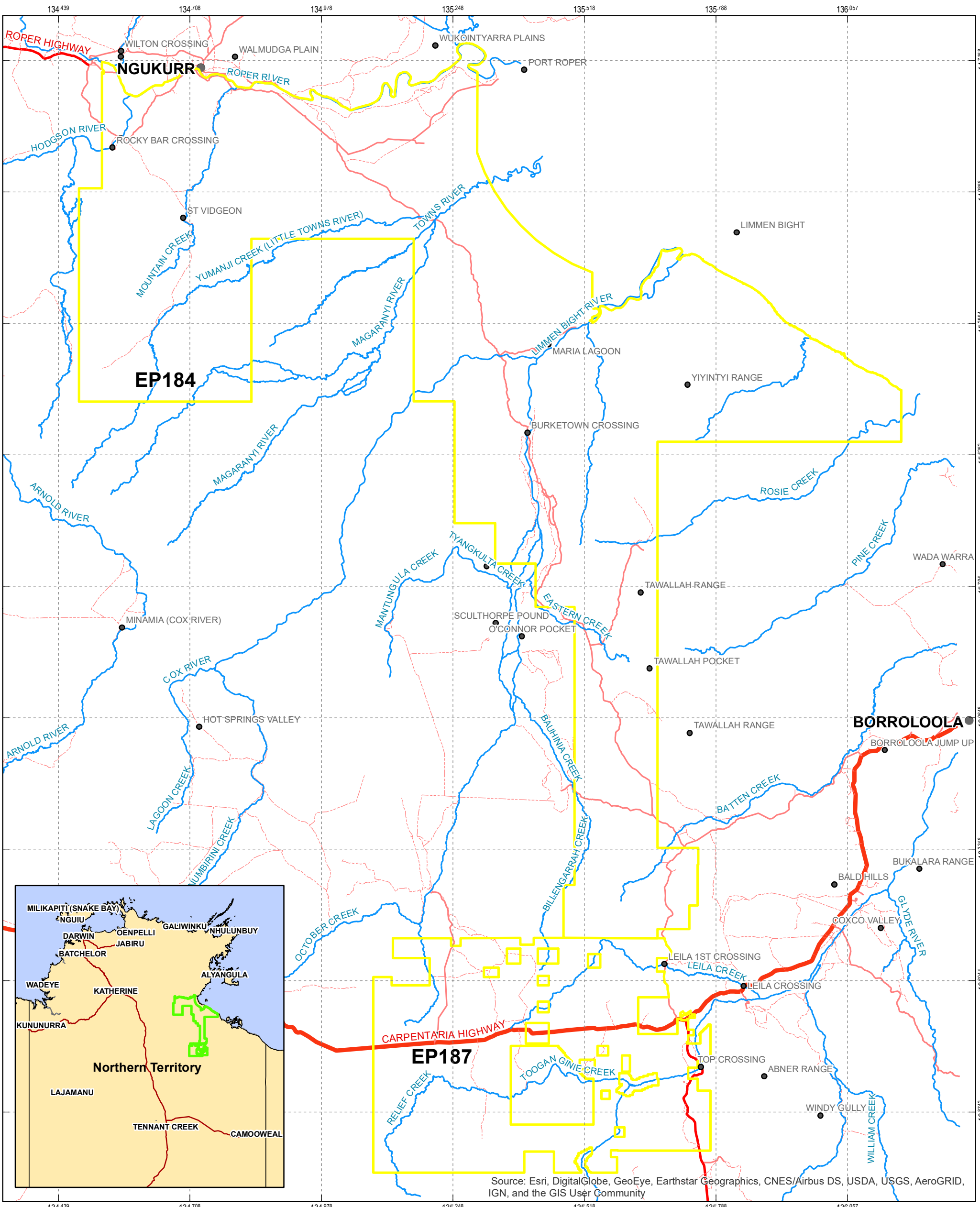
- seasonal water quality assessments to further develop a baseline water quality profile;
- temporal changes in habitat and vegetation community condition; and
- opportunistic fauna (terrestrial and aquatic) species list, including introduced species and any threatened species present.

This report contains field survey methods, survey limitations and the results of field investigations. The report is sectioned as follows:

- Section 2 - description of methods and information sources used during this investigation
- Section 3 - field assessment results
- Section 4 - conclusion

1.2 Location of the Study Area

EP184 is a 1,122,000 ha area situated in the central trough of the McArthur Basin south of the Roper River and adjacent to the Gulf of Carpentaria. The area consists largely of national park area (Limmen National Park) with some traditional indigenous lands and agriculture (grazing of natural vegetation). The eastern boundary of EP187 is situated approximately 84 km south west of Borroloola within the Carpentaria and McArthur Basin. A portion of the northern boundary is shared with the southern boundary of Limmen National Park. Agriculture (grazing of natural vegetation) is the dominant land use. Refer to **Figure 1** for the location and layout of EP184 and EP187.



Legend

- Locality
- Populated Place
- Imperial Tenements
- Major Watercourse
- NT Border

Road Network

- Principal Road
- Secondary Road
- Minor Road
- Track

[redacted]
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N W E S

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Kilometres

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Horizontal Datum: GDA 1994
Grid: GCS GDA 1994

Baseline Environmental Assessment
Report for EP184 and 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

2 METHOD

The methods replicated those used during the December 2012 survey and November / December 2015 surveys. The field survey obtained ecological information and opportunistic observations relevant to the study area in conjunction with the duplicate water quality sampling event. This section also outlines the terminology and nomenclature used in this report and describes the procedures and guidelines used for assessing the water quality.

2.1 Field Assessment

The field component of the ecological assessment was carried out in conjunction with the second round of baseline water quality sampling on EP187 and EP184. As per the previous survey, due to restrictions on site access in the area, all ecological assessments consisted of opportunistic assessments at each water quality sampling location and from the vantage of the helicopter for a broader scale perspective of the study areas. The location of the on-ground assessments is therefore in areas adjacent to water.

The ecological surveys aimed to detect any changes from the previous dry season survey undertaken in 2012 and 2015 and also opportunistic searches for threatened species. Information gathered during the field surveys included:

- confirmation of habitat and vegetation community descriptions and any noticeable changes;
- locations and photos of communities and species present;
- opportunistic fauna (terrestrial and aquatic) species list, including introduced species and any threatened species present; and
- locations of fauna breeding places and other habitat features.

The duplicate baseline surface water sampling program was undertaken in accordance with the Northern Territory Methodology for Sampling of Surface Waters (Methodology for the Sampling of Surface Waters. Advisory Note AA7-025. Northern Territory Government (Resources, 2009)).

Water quality sampling was carried out at each site for:

- 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
- Quality Assurance / Quality Control (1 duplicate sample for each EP)
- 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

Water quality sampling and assessment locations are shown in **Table 1**. Sampling locations replicated the 2015 locations, which were approved prior to field surveys being carried out. Where actual sampling sites differed from approved locations due to access, suitability as a water quality sampling location or cultural reasons, traditional owners were consulted and assisted in the re-location of the survey site. Traditional owners were present during field survey activities and approved the activities in the given location prior to any sampling at each site.

2.1.1 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

- In the absence of Australian Guidelines for hydrocarbons in water, the Dutch Intervention Guidelines are referenced (Ministry of Infrastructure and the Environment (formerly Ministry of Housing, Spatial Planning and the Environment [VROM]) (2009))

2.1.2 Quality Control

- A duplicate sample was collected from each EP and used for intralaboratory quality control at the NATA certified laboratory. 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 surface water investigation.
- Certified laboratory documentation including chain of custodies, sample receipt notifications, certificates of analysis and laboratory QA/QC reports are provided in **Appendix C**.

Table 1 Survey sites

EP	Name	Description	Zone	Zone	Easting	Northing
EP187	PP-1	Paradise Pool on Tooganginie Creek	53	K	538835	8137444
	McR-1	McArthur River	53	K	562628	8136624
	EP-1	Eleanor Pool on Christmas Creek	53	K	527222	8171987
	LC-1	Leila Creek	53	K	570928	8167018
EP184	LBR-1	Limmen Bight River	53	L	541471	8283938
	LT-1	Little Towns River	53	L	462397	8313829
	RR-1	Roper River	53	L	449786	8371639
	HR-1	Hodgson River	53	L	455672	8361327
	MC-1	Mountain Creek	53	L	474345	8354364
	WC-1	Whirlpool Creek	53	L	492111	8349991
	TR-1	Towns River	53	L	523603	8337954
	MR-1	Magaranyi River	53	L	520218	8330690

2.2 Coordinate System and Map Datum

Positional data was collected with a handheld Garmin eTrex Global Positioning System (GPS) unit, with accuracy between 4 and 8 m. Locations were recorded using the UTM coordinate system with a WGS84 datum. All locations presented in this report use MGA94 Zone 53.

2.3 Study Limitations

The preliminary ecological assessment was limited to the area immediately adjacent to water quality sampling locations along waterways due to access restrictions including culturally restricted areas of access. The tenements encompass vast areas, as such, the sites are spread throughout the tenements to provide a broad understanding of the waterways and some of the associated communities. Areas and waterways assessed are considered to represent the majority of the waterways and habitats present within the tenements. More detailed assessments should be carried out in relevant areas once work areas are known and prior to any works.

This is a duplicate dry season assessment to that undertaken in 2015. Further assessments should be carried out in the post-wet season to provide an understanding of seasonal changes.

The absence of species observations does not indicate that the species is absent from the study area.

3 FIELD ASSESSMENT RESULTS

Tables 2 and 3 provide a chronological summary of the changes, if any, between 2015 and 2018 dry season assessment sites. Only one site was assessed in 2012 in EP184 which was on the Roper River in the northern portion of the tenement. It is representative of sample location RR-1 assessed in 2015 and 2018. No obvious changes in condition, including weed abundance, was observed between surveys. Water quality results were consistent across all sites between 2015 and 2018 and from RR-1 in 2012, 2015 and 2018.

Table 2 EP 187

Site	Dry Season December 2015	Dry Season June 2018	Observations
			No changes since 2015.
LC-1 (Leila Creek) *Melaleuca leucadendra* with *Eucalyptus chlorophylla* and *Ficus racemosa* riparian corridor with sandy silty beds			Restricted to a series of pools. Disturbance by pigs and cattle observed. Wallabies observed. Abundant flowering plants attracting nectivorous bird species. Purple-crowned fairy wrens observed.
McR-1 (McArthur River upstream) *Melaleuca leucadendra* with *Pandanus aquaticus*			No changes since 2015. Series of shallow clear pools. Infestations of Noogoora burr observed on dry creek beds and banks
PP-1 (Paradise Pools (downstream))			No changes since 2015. Black bream, archerfish observed. Provides suitable habitat for *Varanus mertensi* (Mertens Water Monitor).

			Permanent long reaches of fresh water in landscape.
EP-1 (Elenor Pool)			No changes since 2015. Valuable source of freshwater in wider landscape. Dead goanna (unknown cause) and dead red kangaroo (unknown cause) in pool.

Table 3 EP 184

Site	Dry Season December 2015	Dry Season June 2018	Observations
LBR-1 (Limmen Bight River)			No changes since 2015. *Melaleuca leucadendra* with *Casuarina cunninghamiana*
TR-1 (Towns River)			No changes since 2015. *Eucalyptus tectifica* (northern box), *E. terminalis* (bloodwood) with *Sehima nervosum* (white grass), *Chrysopogon fallax* (golden beard grass) grassland understorey.
MR-1 (Magaranyi River (flows into Towns River))			No changes since 2015. *M. leucadendra* with *Flagellaria indica* on sandy instream inslands

LT-1 (Little Towns River)			No changes since 2015. Degraded by pigs, buffalo and cattle. Main water body remaining in larger landscape. Important water source for all fauna
WC-1 (Whirlpool Creek)			No changes since 2015 other than some water present in isolated small pools. Some small pools present during 2018. Large *E. camaldulenis* provides abundant small – large hollows which provides critical importance for hollow-dependent animals (e.g. parrots, dragons, bats). Freshwater crab shells observed
MC-1 (Mountain Creek)			No changes since 2015. *M. leucadendra* with *E. camaldulensis*. Large barramundi observed.
RR-1 (Roper River)			No changes since 2012 and 2015. Very low turbidity. No odour, no sheen. Provides largest permanent freshwater source. Saltwater crocodiles observed.

HR-1 (Hodgson River)			No changes since 2015. *M. leucadendra* along banks and dry vine thicket in areas.

3.1 Water Quality

Water quality samples were collected at all sites. Results of the field measurements and laboratory analysis are shown in Error! Reference source not found. with available default trigger values following the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC Guidelines) (Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, 2000). All sample sites are considered to be lowland streams of Tropical North Australia (ANZECC, 2000).

Surface water quality results are consistent with those reported in the 2015 sampling program. Most samples reported heavy metal concentrations below the laboratory level of reporting (LOR). The few samples that reported marginally higher levels above the adopted guidelines were only marginally higher as per the 2015 sampling program.

In 2015 arsenic was marginally higher than the adopted trigger value at Leila Creek (LC-1). Liela Creek (LC-1) again reported an arsenic concentration above the laboratory LOR however below the adopted guideline of 0.001mg/L. Only one other sample (LBR-1) reported an arsenic concentration above the laboratory LOR, however less than the adopted guideline of 0.013 mg/L. The low arsenic concentrations provide further baseline evidence for likely natural mineralisation.

Copper was marginally higher than the adopted trigger value at Little Towns River (LT-1), which is consistent with the 2015 sampling program where it also marginally exceeded the trigger value for copper. Two other locations (Hodgson River (HR-1) and Whirlpool Creek (WC-1)) also reported copper concentrations marginally above the adopted trigger value. In 2015, Hodgson River (HR-1) reported a copper concentration marginally less than the adopted trigger value, while Whirlpool Creek (WC-1) was not sampled as it was dry. The copper concentrations are considered consistent with the previous sampling program.

Chromium was marginally higher than the adopted trigger value at Little Towns River (LT-1), which is consistent with the 2015 sampling program where it was also marginally higher than the adopted trigger value.

All other samples reported heavy metal concentrations below the laboratory LOR, which is consistent with the 2015 sampling program.

Nitrogen and phosphorus were above the adopted trigger levels at all sites, which is consistent with the 2015 sampling program. These results suggest naturally elevated background concentrations of nitrogen and phosphorous, which will likely vary seasonally. These results are also possibly related to use of these remnant water holes by introduced pigs, buffalo and cattle.

Dissolved oxygen was low at all sites, not uncommon in remnant pools during the dry season and consistent with the 2015 sampling program.

Previous samples collected in 2015 from Magaranyi River (MR-1) and Little Towns River (LT-1) reported Total Petroleum Hydrocarbons (TPH) and Total Recoverable Hydrocarbons (TRH) fractions above detection limits. Samples collected from these locations during the current round of sampling reported TPH/TRH concentrations less than the laboratory LOR.

3.2 Quality Assurance and Quality Control

QA/QC sample QA-1 was a field duplicate sample for WC-1, collected from EP184. QA/QC sample QA-2 was a field duplicate sample for LC-1, collected from EP187. Based on the field and laboratory QA/QC program undertaken, the results indicate that the data is accurate and meets the data quality objectives for the project. Refer **Appendix C** for QA results and **Appendix D** for QA/QC compliance summary.

4 CONCLUSION AND RECOMMENDATIONS

No threatened flora or fauna species were observed during the 2018 dry season survey. Ten species listed as migratory (three species) and/or marine (10 species) under the EPBC Act were observed. Seven introduced species were observed, all of which are feral species in the Northern Territory.

Concentrations of analytes were consistent with the results obtained during the 2012 and 2015 dry season sampling event. Nitrogen concentrations were reported above adopted trigger guidelines at all sites, which is consistent with the 2012 and 2015 sampling event where nitrogen was above the adopted trigger level at most sites. Phosphorous was above the adopted trigger level at two sites (LT-1 and WC-1). These results are expected to vary seasonally and may also be attributed to use of these remnant water holes by pigs, buffalo and cattle. Dissolved oxygen was low at all sites, not uncommon in remnant pools during the dry season.

Naturally occurring elevated heavy metal concentrations above trigger levels were found in water samples of Little Towns River (LT-1) (chromium, copper), Hodgson River (HR-1) (copper) and Whirlpool Creek (copper). This is consistent with regional natural elevated levels of copper, which during the 2015 sampling event was also recorded above the adopted trigger levels at Towns River (TR-1), Magaranyi River (MR-1) and Little Towns River (LT-1).

Some Total Petroleum Hydrocarbons (TPH) and Total Recoverable Hydrocarbons (TRH) fractions were above detection limits at Magaranyi River (MR-1) and Little Towns River (LT-1) during the 2015 dry season survey. TPH and TRH fractions and benzene, toluene, ethyl-benzene and xylenes (BTEX) were less than the laboratory LOR at all locations during the 2018 dry season survey. The low level semi-volatile TRH reported in the two (2) samples (MR-1 and LT-1) in 2015 were in accordance with the applicable environmental levels. Volatile hydrocarbons originate from the sub-surface and readily breakdown in the surface environment by light and bacteria. Given that the 2015 survey was pre-exploration, the low level semi-volatile TRH reported in the two (2) surface water samples (MR-1 and LT-1) would either be from natural organic material (non-petroleum hydrocarbons, due to increased organic load due to low level of water) rather than a petroleum product such as diesel or oil; or a result of cross-contamination of the sampling equipment while stored in the helicopter tail during flights. Since the 2015 survey, the laboratory can run a silca-gel clean-up test to determine how much of the TRH is natural organic material (or some other organic compound) compared to petroleum product. Should semi-volatiles be detected in future sampling rounds, a silica-gel clean-up test will be undertaken. The 2018 samples all reported semi-volatile TRH below the laboratory LOR.

Further assessments are recommended during the post-wet season to provide an understanding of seasonal water quality changes.

5 REFERENCES

ANZECC (2000) *Australia and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC Guidelines)*.

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

APPENDIX A
FIGURES

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TURKEY LAGOON CREEK

TURKEY LAGOON CREEK

RHE LP RIVER

WILTON RIVER

ROPER HIGHWAY

WILTON CROSSING

RITTARANGU (URAPUNGA)

WALMUDGA PLAIN

WUKOINTYARRA PLAINS

RR-1

NGUKURR

ROPER RIVER

Manbilila ( )

MOUNTAIN CREEK

HR-1

Duck Spring (G9035008)

HODGSON RIVER

QUEENSLAND CROSSING

ROCKY BAR CROSSING

MC-1

WC-1

EP184

-14.9856

Nyawuddi ( )

ST VIDGEON

TR-1

TOWNS RIVER

Yinggaiyin (G9035028)

MOUNTAIN CREEK

MR-1

MAGARANYI RIVER

-15.2554

LT-1

(G9055029)

Wamarlirr ( )

Wamarlirr ( )

COX RIVER

YUMANJI CREEK (LITTLE TOWNS RIVER)

MAGARANYI RIVER

-15.5252

2a

2b

3

Legend

- Sample Location
- Spring
- Locality
- Populated Place
- Imperial Tenements
- Major Watercourse
- Minor Watercourse
- **Road Network**
- Principal Road
- Secondary Road
- Minor Road
- Track
- Watercourse Area
- Lake
- NT Border

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N W E S

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Kilometres

1:400,000 at A3

Horizontal Datum: GDA 1994
Grid: GCS GDA 1994

Baseline Environmental Assessment
Report for EP187 and EP184
Imperial Oil and Gas

Survey Locations - EP184

Figure 2a

26 Jul 2018 Z:\GIS\ECO15_0074\GIS\Maps\Working (Optional)\v3_premise\ECO15_0074_02_survey.mxd

MR-1
LBR-1
EP-1
EP184
LIMMEN BIGHT
MAGARANYI RIVER
LIMMEN BIGHT RIVER
COX RIVER
MARIA LAGOON
YIYINTYI RANGE
ROSIE CREEK
TYANGKULTA CREEK
MANTUNGULA CREEK
EASTERN CREEK
POCKET CREEK
PINE CREEK
TAWALLAH RANGE
TAWALLAH POCKET
SCULTHORPE POUND
O'CONNOR POCKET
WADA WARRA
BORROLOOLA
BORROLOOLA JUMP UP
BAUHINIA CREEK
BILLENGARRAH CREEK
BATTEN CREEK
BALD HILLS
BUKALARA RANGE
CARPENTARIA HIGHWAY
Lamahda ( )
(G9055023)
Wunuwanji ( )
Wirinangu (G9055058)
(G9055024)
(G9055029)
(G9055025)
Yarrngalarra ( )
(G9055008)
Spring No.3 E (G9055007)
Spring No.2d (G9055006)
Spring No.1 C (G9055005)
(G90550567)
Djowunda ( )
(G9055027)
(G9055056)
Four Archers Spring (G9045000)
(G9055028)
Four Archers Spring (G9045000)
Yibindjila ( )
Nathan River Hot Spring ( )
Homestead Spring (G9055000)
(G9055020)
(G9055018)
(G9065003)
(G9065004)
(G9065008)
Warrapirrmantila (G9065005)
Wununmantyala ( )
Lorella Spring (G9055014)
135.248
135.518
135.788
136.057
-15.2554
-15.5252
-15.7795
-16.0648
-16.3346
2a
2b
3

Legend

- Sample Location
- Spring
- Locality
- Populated Place
- Imperial Tenements
- Major Watercourse
- Minor Watercourse
- **Road Network**
- Principal Road
- Secondary Road
- Minor Road
- Track
- Watercourse Area
- Lake
- NT Border

1300 017 736
mail@premise.com.au
PREMISE.COM.AU

0 1.5 3 6 9 12 15
Kilometres

1:500,000 at A3

Horizontal Datum: GDA 1994
Grid: GCS GDA 1994

Baseline Environmental Assessment
Report for EP187 and EP184
Imperial Oil and Gas

Survey Locations - EP184

Figure 2b

26 Jul 2018 Z:\GIS\ECO15_0074\GIS\Maps\Working (Optional)\v3_premise\ECO15_0074_02_survey.mxd

135.248 135.518 135.788

-16.3346 -16.6044 -16.8742 -17.144

EP184

EP187

EP-1

LC-1

PP-1

McR-1

OCTOBER CREEK

LIMMEN BIGHT RIVER

THREE KNOBS CREEK

BILLENGARRAH CREEK

BATTEN CREEK

LEILA CREEK

Cockatoo Spring ( )

Paddy Spring ( )

(G9075007)

Top Spring (G9075000)

FAVENC RANGE

CARPENTARIA HIGHWAY

TOP CROSSING

DUNGANMINNIE SPRING ( )

TOOGANGINIE CREEK

RELIEF CREEK

MCARTHUR RIVER

Wee-ak (G9075081)

6 Mile Spring ( )

LITTLE SPRING ( )

SANDY CREEK

TABLELANDS HIGHWAY

LGOUR RIVER

2a

2b

3

Legend

- Sample Location
- Spring
- Locality
- Populated Place
- Imperial Tenements
- Major Watercourse
- Minor Watercourse
- **Road Network**
- Principal Road
- Secondary Road
- Minor Road
- Track
- Watercourse Area
- Lake
- NT Border

[redacted]

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N W E S

0 1 2 4 6 8 10
Kilometres

1:350,000 at A3

Horizontal Datum: GDA 1994
Grid: GCS GDA 1994

Baseline Environmental Assessment
Report for EP187 and EP184
Imperial Oil and Gas

Survey Locations - EP187

Figure 3

26 Jul 2018 Z:\GIS\ECO15_0074\GIS\Maps\Working (Optional)\v3_premise\ECO15_0074_02_survey.mxd

APPENDIX B
FIELD DATA

WATER QUALITY RESULTS

		Location	EP187				EP184							
		Sample date	24/6/18	25/6/18	25/6/18	24/6/18	21/6/18	21/6/18	21/6/18	21/6/18	22/6/18	22/6/18	22/6/18	22/6/18
Analyte grouping Analyte	**Units**	**Water Quality Trigger Value Tropical Australia**	**LC-1**	**McR-1**	**PP-1**	**EP-1**	**LBR-1**	**TR-1**	**MR-1**	**LT-1**	**MC-1**	**RR-1**	**HR-1**	**WC-1**
EA025: Total Suspended Solids dried at 104 ± 2°C														
Suspended Solids (SS)	mg/L		<5	<5	<5	<5	10	6	<5	12	<5	<5	8	6
EA065: Total Hardness as CaCO3														
Total Hardness as CaCO3	mg/L		482	256	14	22	478	442	626	8	409	292	97	11
ED093F: Dissolved Major Cations														
Calcium	mg/L		84	40	4	7	61	50	89	<1	50	56	19	1
Magnesium	mg/L		66	38	1	1	79	77	98	2	69	37	12	2
Sodium	mg/L		11	3	2	1	76	385	235	6	58	91	23	23
Potassium	mg/L		3	2	2	<1	3	14	6	3	12	10	3	4
EG020F: Dissolved Metals by ICP-MS														
Arsenic	mg/L	0.013(AsV)/0.024(AsIII)	0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	mg/L	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.002**	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.0014	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.002**	<0.001	<0.001	**0.002**	**0.002**
Lead	mg/L	0.0034	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	0.011	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
Zinc	mg/L	0.008	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
EG035F: Dissolved Mercury by FIMS														
Mercury	mg/L	0.00006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser														
Nitrite + Nitrate as N	mg/L	0.005	**0.03**	**0.03**	**0.01**	**0.03**	**0.04**	**0.04**	**0.03**	**0.01**	**0.02**	**0.02**	**0.02**	**0.02**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser														
Total Kjeldahl Nitrogen as N	mg/L		<0.1	<0.1	0.1	0.1	0.2	0.1	0.2	1.0	0.2	0.1	0.2	1.5

		Location	EP187				EP184							
		Sample date	24/6/18	25/6/18	25/6/18	24/6/18	21/6/18	21/6/18	21/6/18	21/6/18	22/6/18	22/6/18	22/6/18	22/6/18
Analyte grouping Analyte	**Units**	**Water Quality Trigger Value Tropical Australia**	**LC-1**	**McR-1**	**PP-1**	**EP-1**	**LBR-1**	**TR-1**	**MR-1**	**LT-1**	**MC-1**	**RR-1**	**HR-1**	**WC-1**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser														
Total Nitrogen as N	mg/L	0.2-0.3	<0.1	<0.1	0.1	0.1	0.2	0.1	0.2	1.0	0.2	0.1	0.2	1.5
EK067G: Total Phosphorus as P by Discrete Analyser														
Total Phosphorus as P	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.05**	<0.01	<0.01	<0.01	**0.05**
EP080/071: Total Petroleum Hydrocarbons														
C6 - C9 Fraction	µg/L		<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L		<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L		<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L		<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L		<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions														
C6 - C10 Fraction	µg/L		<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
C6 - C10 Fraction minus BTEX (F1)	µg/L		<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L		<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L		<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
>C34 - C40 Fraction	µg/L		<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L		<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L		<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
EP080: BTEXN														
Benzene	µg/L	950	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	µg/L		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Ethylbenzene	µg/L		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
meta- & para-Xylene	µg/L		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
ortho-Xylene	µg/L	350	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Xylenes	µg/L		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2

		Location	EP187				EP184							
		Sample date	**24/6/18**	**25/6/18**	**25/6/18**	**24/6/18**	**21/6/18**	**21/6/18**	**21/6/18**	**21/6/18**	**22/6/18**	**22/6/18**	**22/6/18**	**22/6/18**
Analyte grouping Analyte	**Units**	**Water Quality Trigger Value Tropical Australia**	**LC-1**	**McR-1**	**PP-1**	**EP-1**	**LBR-1**	**TR-1**	**MR-1**	**LT-1**	**MC-1**	**RR-1**	**HR-1**	**WC-1**
Sum of BTEX	µg/L		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Naphthalene	µg/L	16	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Field Measurements														
Temperature	0C		20.9	18.4	17.6	19.5	18.8	24.6	20.1	18.8	21.2	23.3	23.2	26.1
Electrical Conductivity	µS/cm	20-250	**933**	**512**	52.8	58.8	**1202**	**2878**	**2541**	69.9	**1063**	**1017**	**319.2**	172
Dissolved Oxygen	%	85-120	42.1	**72.8**	**18.3**	**63.3**	**46.5**	**79.5**	**37.1**	**49**	**54.4**	**80.7**	**67.1**	**82.1**
pH		6-8.0	8.01	8.49	7.08	7.15	8.25	8.40	8.25	7.33	8.46	8.40	8.22	7.00
Redox/ORP	mV		126.4	137.7	144.7	149	136.4	128	130.8	98.6	137.9	77.2	117.4	121.8

APPENDIX C
LABORATORY RESULTS

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1818769**	Page	: 1 of 9
Client	: **PREMISE**	Laboratory	: Environmental Division Sydney
Contact	: PAUL FOX	Contact	: Customer Services ES
Address	: SUITE 6, 8 GREBE STREET PEREGIAN BEACH QLD 4573	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: 07 5448 3288	Telephone	: +61-2-8784 8555
Project	: IMPERIAL	Date Samples Received	: 28-Jun-2018 07:30
Order number	:	Date Analysis Commenced	: 28-Jun-2018
C-O-C number	: ----	Issue Date	: 16-Jul-2018 09:27
Sampler	: PAUL FOX		
Site	: ----		
Quote number	: EN/333/17		
No. of samples received	: 14		
No. of samples analysed	: 14		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EK057G:: LOR raised for Nitrite on sample No 13 due to sample matrix.
- EK057G: LOR raised for Nitrite on sample 5 due to sample matrix.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	RR-1	HR-1	MC-1	LT-1	WC-1
				Client sampling date / time	22-Jun-2018 00:00	22-Jun-2018 00:00	22-Jun-2018 00:00	21-Jun-2018 00:00	22-Jun-2018 00:00
Compound	CAS Number	LOR	Unit		ES1818769-001	ES1818769-002	ES1818769-003	ES1818769-004	ES1818769-005
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		8.40	8.22	8.46	7.33	7.00
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		<5	8	<5	12	6
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		292	97	409	8	11
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		56	19	50	<1	1
Magnesium	7439-95-4	1	mg/L		37	12	69	2	2
Sodium	7440-23-5	1	mg/L		91	23	58	6	23
Potassium	7440-09-7	1	mg/L		10	3	12	3	4
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	0.002	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	0.002	<0.001	0.002	0.002
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		0.01	<0.01	<0.01	<0.01	<0.05
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		0.01	0.02	0.02	0.01	<0.05
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		0.02	0.02	0.02	0.01	0.02
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		0.1	0.2	0.2	1.0	1.5
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		0.1	0.2	0.2	1.0	1.5
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	<0.01	<0.01	0.05	0.05
EP080/071: Total Petroleum Hydrocarbons									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	RR-1	HR-1	MC-1	LT-1	WC-1
				Client sampling date / time	22-Jun-2018 00:00	22-Jun-2018 00:00	22-Jun-2018 00:00	21-Jun-2018 00:00	22-Jun-2018 00:00
Compound	CAS Number	LOR	Unit		ES1818769-001	ES1818769-002	ES1818769-003	ES1818769-004	ES1818769-005
					Result	Result	Result	Result	Result
EP080/071: Total Petroleum Hydrocarbons - Continued									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ Total Xylenes	----	2	µg/L		<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**105**	**104**	**104**	**101**	**98.1**
Toluene-D8	2037-26-5	2	%		**99.4**	**97.6**	**98.2**	**107**	**107**
4-Bromofluorobenzene	460-00-4	2	%		**98.4**	**98.1**	**97.6**	**99.9**	**99.1**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MR-1	TR-1	LBR-1	LC-1	MCR-1
				Client sampling date / time	21-Jun-2018 00:00	21-Jun-2018 00:00	21-Jun-2018 00:00	24-Jun-2018 00:00	25-Jun-2018 00:00
Compound	CAS Number	LOR	Unit		ES1818769-006	ES1818769-007	ES1818769-008	ES1818769-009	ES1818769-010
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		8.25	8.40	8.25	8.01	8.49
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		<5	6	10	<5	<5
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		626	442	478	482	256
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		89	50	61	84	40
Magnesium	7439-95-4	1	mg/L		98	77	79	66	38
Sodium	7440-23-5	1	mg/L		235	385	76	11	3
Potassium	7440-09-7	1	mg/L		6	14	3	3	2
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	0.002	0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		0.03	0.04	0.04	0.03	0.03
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		0.03	0.04	0.04	0.03	0.03
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		0.2	0.1	0.2	<0.1	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		0.2	0.1	0.2	<0.1	<0.1
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EP080/071: Total Petroleum Hydrocarbons									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MR-1	TR-1	LBR-1	LC-1	MCR-1
				Client sampling date / time	21-Jun-2018 00:00	21-Jun-2018 00:00	21-Jun-2018 00:00	24-Jun-2018 00:00	25-Jun-2018 00:00
Compound	CAS Number	LOR	Unit		ES1818769-006	ES1818769-007	ES1818769-008	ES1818769-009	ES1818769-010
					Result	Result	Result	Result	Result
EP080/071: Total Petroleum Hydrocarbons - Continued									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ Total Xylenes	----	2	µg/L		<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**101**	**109**	**109**	**108**	**103**
Toluene-D8	2037-26-5	2	%		**105**	**100**	**102**	**102**	**103**
4-Bromofluorobenzene	460-00-4	2	%		**100**	**100**	**102**	**101**	**99.4**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	PP-1	EP-1	QA-1	QA-2	----
				Client sampling date / time	25-Jun-2018 00:00	24-Jun-2018 00:00	22-Jun-2018 00:00	24-Jun-2018 00:00	----
Compound	CAS Number	LOR	Unit		ES1818769-011	ES1818769-012	ES1818769-013	ES1818769-014	--------
					Result	Result	Result	Result	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		7.08	7.15	6.95	8.00	----
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		<5	<5	6	<5	----
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		14	22	11	483	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		4	7	1	83	----
Magnesium	7439-95-4	1	mg/L		1	1	2	67	----
Sodium	7440-23-5	1	mg/L		2	1	23	11	----
Potassium	7440-09-7	1	mg/L		2	<1	3	4	----
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	0.001	<0.001	----
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.05	<0.01	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		0.01	0.03	<0.05	0.03	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		0.01	0.03	0.02	0.03	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		0.1	0.1	1.4	<0.1	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		0.1	0.1	1.4	<0.1	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	<0.01	0.04	<0.01	----
EP080/071: Total Petroleum Hydrocarbons									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	PP-1	EP-1	QA-1	QA-2	----
				Client sampling date / time	25-Jun-2018 00:00	24-Jun-2018 00:00	22-Jun-2018 00:00	24-Jun-2018 00:00	----
Compound	CAS Number	LOR	Unit		ES1818769-011	ES1818769-012	ES1818769-013	ES1818769-014	--------
					Result	Result	Result	Result	----
EP080/071: Total Petroleum Hydrocarbons - Continued									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	----
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	----
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	----
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	----
^ **C10 - C36 Fraction (sum)**	----	50	µg/L		<50	<50	<50	<50	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	----
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	----
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	----
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		<100	<100	<100	<100	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	<100	<100	<100	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	----
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	----
^ **Total Xylenes**	----	2	µg/L		<2	<2	<2	<2	----
^ **Sum of BTEX**	----	1	µg/L		<1	<1	<1	<1	----
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**108**	**112**	**108**	**111**	----
Toluene-D8	2037-26-5	2	%		**100**	**106**	**111**	**105**	----
4-Bromofluorobenzene	460-00-4	2	%		**102**	**107**	**104**	**104**	----

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	71	137
Toluene-D8	2037-26-5	79	131
4-Bromofluorobenzene	460-00-4	70	128

QUALITY CONTROL REPORT

Work Order	: **ES1818769**	Page	: 1 of 7
Client	: **PREMISE**	Laboratory	: Environmental Division Sydney
Contact	: PAUL FOX	Contact	: Customer Services ES
Address	: SUITE 6, 8 GREBE STREET PEREGIAN BEACH QLD 4573	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: 07 5448 3288	Telephone	: +61-2-8784 8555
Project	: IMPERIAL	Date Samples Received	: 28-Jun-2018
Order number	:	Date Analysis Commenced	: 28-Jun-2018
C-O-C number	: ----	Issue Date	: 16-Jul-2018
Sampler	: PAUL FOX		
Site	: ----		
Quote number	: EN/333/17		
No. of samples received	: 14		
No. of samples analysed	: 14		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA005P: pH by PC Titrator (QC Lot: 1766045)									
ES1818769-001	RR-1	EA005-P: pH Value	----	0.01	pH Unit	8.40	8.53	1.54	0% - 20%
ES1818935-001	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	7.85	7.89	0.508	0% - 20%
EA025: Total Suspended Solids dried at 104 ± 2°C (QC Lot: 1763369)									
ES1818769-004	LT-1	EA025H: Suspended Solids (SS)	----	5	mg/L	12	17	31.0	No Limit
EA025: Total Suspended Solids dried at 104 ± 2°C (QC Lot: 1766544)									
ES1818553-002	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	7640	7720	1.04	0% - 20%
ES1818720-007	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	10	9	15.4	No Limit
EA025: Total Suspended Solids dried at 104 ± 2°C (QC Lot: 1766545)									
ES1818769-005	WC-1	EA025H: Suspended Solids (SS)	----	5	mg/L	6	7	0.00	No Limit
ES1818888-006	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	34	38	11.0	No Limit
EA025: Total Suspended Solids dried at 104 ± 2°C (QC Lot: 1769149)									
ES1818769-010	MCR-1	EA025H: Suspended Solids (SS)	----	5	mg/L	<5	<5	0.00	No Limit
ES1818843-010	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	<5	<5	0.00	No Limit
ED093F: Dissolved Major Cations (QC Lot: 1765717)									
ES1818720-001	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	469	472	0.735	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	2	2	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	40	40	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	17	17	0.00	0% - 50%
ES1818720-011	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	456	462	1.48	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	2	2	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	38	39	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	16	17	0.00	0% - 50%
ED093F: Dissolved Major Cations (QC Lot: 1765718)									
ES1818769-009	LC-1	ED093F: Calcium	7440-70-2	1	mg/L	84	84	0.00	0% - 20%

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
ED093F: Dissolved Major Cations (QC Lot: 1765718) - continued									
ES1818769-009	LC-1	ED093F: Magnesium	7439-95-4	1	mg/L	66	67	0.00	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	11	11	0.00	0% - 50%
		ED093F: Potassium	7440-09-7	1	mg/L	3	4	0.00	No Limit
ED093F: Dissolved Major Cations (QC Lot: 1771276)									
ES1818769-010	MCR-1	ED093F: Calcium	7440-70-2	1	mg/L	40	42	3.34	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	38	40	4.82	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	3	3	0.00	No Limit
		ED093F: Potassium	7440-09-7	1	mg/L	2	2	0.00	No Limit
ES1819122-007	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	345	345	0.00	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	415	415	0.00	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	582	582	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	48	48	0.00	0% - 20%
EG020T: Total Metals by ICP-MS (QC Lot: 1770283)									
ES1818769-001	RR-1	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
ES1818769-011	PP-1	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 1765681)									
ES1818753-001	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
ES1818769-009	LC-1	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 1763160)									
ES1818769-001	RR-1	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	0.01	<0.01	0.00	No Limit
ES1818769-010	MCR-1	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 1769323)									
ES1818769-013	QA-1	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.05	<0.05	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 1767781)									
ES1818769-001	RR-1	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.02	0.02	0.00	No Limit
ES1818769-010	MCR-1	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.03	0.03	0.00	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 1767777)									

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 1767777) - continued									
ES1818769-001	RR-1	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.1	0.1	0.00	No Limit
ES1818769-011	PP-1	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.1	0.1	0.00	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 1767778)									
ES1818769-001	RR-1	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	0.00	No Limit
ES1818769-011	PP-1	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 1770632)									
ES1818769-001	RR-1	EP080: C6 - C9 Fraction	----	20	µg/L	<20	<20	0.00	No Limit
ES1818769-011	PP-1	EP080: C6 - C9 Fraction	----	20	µg/L	<20	<20	0.00	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 1770632)									
ES1818769-001	RR-1	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.00	No Limit
ES1818769-011	PP-1	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.00	No Limit
EP080: BTEXN (QC Lot: 1770632)									
ES1818769-001	RR-1	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.00	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.00	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.00	No Limit
ES1818769-011	PP-1	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.00	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.00	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA025: Total Suspended Solids dried at 104 ± 2°C (QCLot: 1763369)								
EA025H: Suspended Solids (SS)	----	5	mg/L	<5	150 mg/L	110	83	129
				<5	1000 mg/L	99.3	82	110
EA025: Total Suspended Solids dried at 104 ± 2°C (QCLot: 1766544)								
EA025H: Suspended Solids (SS)	----	5	mg/L	<5	150 mg/L	103	83	129
				<5	1000 mg/L	95.9	82	110
EA025: Total Suspended Solids dried at 104 ± 2°C (QCLot: 1766545)								
EA025H: Suspended Solids (SS)	----	5	mg/L	<5	150 mg/L	99.3	83	129
				<5	1000 mg/L	90.2	82	110
EA025: Total Suspended Solids dried at 104 ± 2°C (QCLot: 1769149)								
EA025H: Suspended Solids (SS)	----	5	mg/L	<5	150 mg/L	115	83	129
				<5	1000 mg/L	106	82	110
ED093F: Dissolved Major Cations (QCLot: 1765717)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	97.6	80	114
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	97.1	90	116
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	93.8	82	120
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	97.2	85	113
ED093F: Dissolved Major Cations (QCLot: 1765718)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	91.6	80	114
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	93.2	90	116
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	92.7	82	120
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	92.4	85	113
ED093F: Dissolved Major Cations (QCLot: 1771276)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	93.4	80	114
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	98.1	90	116
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	96.9	82	120
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	97.0	85	113
EG020T: Total Metals by ICP-MS (QCLot: 1770283)								
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	94.1	82	114
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	91.6	84	112
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	91.6	86	116
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	93.9	83	118
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	90.3	85	115
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	92.5	84	116
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	96.8	79	117

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EG035T: Total Recoverable Mercury by FIMS (QCLot: 1765681)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	90.9	77	111
EK057G: Nitrite as N by Discrete Analyser (QCLot: 1763160)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	103	82	114
EK057G: Nitrite as N by Discrete Analyser (QCLot: 1769323)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	105	82	114
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 1767781)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	98.6	91	113
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 1767777)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	83.1	69	101
				<0.1	1 mg/L	91.7	70	118
				<0.1	5 mg/L	98.3	74	118
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 1767778)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	87.5	71	101
				<0.01	0.442 mg/L	85.6	72	108
				<0.01	1 mg/L	97.1	78	118
EP080/071: Total Petroleum Hydrocarbons (QCLot: 1762699)								
EP071: C10 - C14 Fraction	----	50	µg/L	<50	2000 µg/L	92.7	76	116
EP071: C15 - C28 Fraction	----	100	µg/L	<100	3000 µg/L	91.5	83	109
EP071: C29 - C36 Fraction	----	50	µg/L	<50	2000 µg/L	81.1	75	113
EP080/071: Total Petroleum Hydrocarbons (QCLot: 1770632)								
EP080: C6 - C9 Fraction	----	20	µg/L	<20	260 µg/L	96.4	75	127
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 1762699)								
EP071: >C10 - C16 Fraction	----	100	µg/L	<100	2500 µg/L	85.7	76	114
EP071: >C16 - C34 Fraction	----	100	µg/L	<100	3500 µg/L	101	81	111
EP071: >C34 - C40 Fraction	----	100	µg/L	<100	1500 µg/L	80.6	77	119
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 1770632)								
EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	310 µg/L	97.6	75	127
EP080: BTEXN (QCLot: 1770632)								
EP080: Benzene	71-43-2	1	µg/L	<1	10 µg/L	98.7	70	122
EP080: Toluene	108-88-3	2	µg/L	<2	10 µg/L	97.1	69	123
EP080: Ethylbenzene	100-41-4	2	µg/L	<2	10 µg/L	99.2	70	120
EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	10 µg/L	100	69	121
EP080: ortho-Xylene	95-47-6	2	µg/L	<2	10 µg/L	102	72	122
EP080: Naphthalene	91-20-3	5	µg/L	<5	10 µg/L	99.9	70	120

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG020T: Total Metals by ICP-MS (QCLot: 1770283)							
ES1818769-002	HR-1	EG020A-T: Arsenic	7440-38-2	1 mg/L	99.3	70	130
		EG020A-T: Cadmium	7440-43-9	0.25 mg/L	97.7	70	130
		EG020A-T: Chromium	7440-47-3	1 mg/L	97.6	70	130
		EG020A-T: Copper	7440-50-8	1 mg/L	97.0	70	130
		EG020A-T: Lead	7439-92-1	1 mg/L	115	70	130
		EG020A-T: Nickel	7440-02-0	1 mg/L	99.5	70	130
		EG020A-T: Zinc	7440-66-6	1 mg/L	100	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 1765681)							
ES1818753-002	Anonymous	EG035T: Mercury	7439-97-6	0.01 mg/L	94.6	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 1763160)							
ES1818769-001	RR-1	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	96.6	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 1769323)							
ES1818769-013	QA-1	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	98.0	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 1767781)							
ES1818769-001	RR-1	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	106	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 1767777)							
ES1818769-002	HR-1	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	71.8	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 1767778)							
ES1818769-002	HR-1	EK067G: Total Phosphorus as P	----	1 mg/L	73.4	70	130
EP080/071: Total Petroleum Hydrocarbons (QCLot: 1770632)							
ES1818769-001	RR-1	EP080: C6 - C9 Fraction	----	325 µg/L	93.2	70	130
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 1770632)							
ES1818769-001	RR-1	EP080: C6 - C10 Fraction	C6_C10	375 µg/L	93.9	70	130
EP080: BTEXN (QCLot: 1770632)							
ES1818769-001	RR-1	EP080: Benzene	71-43-2	25 µg/L	94.9	70	130
		EP080: Toluene	108-88-3	25 µg/L	94.7	70	130
		EP080: Ethylbenzene	100-41-4	25 µg/L	99.7	70	130
		EP080: meta- & para-Xylene	108-38-3 106-42-3	25 µg/L	98.2	70	130
		EP080: ortho-Xylene	95-47-6	25 µg/L	101	70	130
		EP080: Naphthalene	91-20-3	25 µg/L	97.7	70	130

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES1818769**	Page	: 1 of 12
Client	: **PREMISE**	Laboratory	: Environmental Division Sydney
Contact	: PAUL FOX	Telephone	: +61-2-8784 8555
Project	: IMPERIAL	Date Samples Received	: 28-Jun-2018
Site	: ----	Issue Date	: 16-Jul-2018
Sampler	: PAUL FOX	No. of samples received	: 14
Order number	:	No. of samples analysed	: 14

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)		Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural							
LT-1,	MR-1,	----	----	----	29-Jun-2018	21-Jun-2018	**8**
TR-1,	LBR-1						
Clear Plastic Bottle - Natural							
RR-1,	HR-1,	----	----	----	29-Jun-2018	22-Jun-2018	**7**
MC-1,	WC-1,						
QA-1							
Clear Plastic Bottle - Natural							
LC-1,	EP-1,	----	----	----	29-Jun-2018	24-Jun-2018	**5**
QA-2							
Clear Plastic Bottle - Natural							
MCR-1,	PP-1	----	----	----	29-Jun-2018	25-Jun-2018	**4**
EA065: Total Hardness as CaCO3							
Clear Plastic Bottle - Natural							
LT-1,	MR-1,	----	----	----	29-Jun-2018	28-Jun-2018	**1**
TR-1,	LBR-1						
Clear Plastic Bottle - Natural							
MCR-1,	PP-1	----	----	----	03-Jul-2018	02-Jul-2018	**1**
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Natural							
LT-1,	MR-1,	----	----	----	29-Jun-2018	28-Jun-2018	**1**
TR-1,	LBR-1						
Clear Plastic Bottle - Natural							
MCR-1,	PP-1	----	----	----	03-Jul-2018	02-Jul-2018	**1**
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural							
LT-1,	MR-1,	----	----	----	28-Jun-2018	23-Jun-2018	**5**
TR-1,	LBR-1						
Clear Plastic Bottle - Natural							
QA-1		----	----	----	02-Jul-2018	24-Jun-2018	**8**
Clear Plastic Bottle - Natural							
RR-1,	HR-1,	----	----	----	28-Jun-2018	24-Jun-2018	**4**
MC-1,	WC-1						
Clear Plastic Bottle - Natural							
QA-2		----	----	----	02-Jul-2018	26-Jun-2018	**6**
Clear Plastic Bottle - Natural							
LC-1,	EP-1	----	----	----	28-Jun-2018	26-Jun-2018	**2**
Clear Plastic Bottle - Natural							
MCR-1,	PP-1	----	----	----	28-Jun-2018	27-Jun-2018	**1**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type / Method	Count QC	Count Regular	Rate (%) Actual	Rate (%) Expected	Quality Control Specification
Laboratory Duplicates (DUP)					
TRH - Semivolatile Fraction	0	17	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
TRH - Semivolatile Fraction	0	17	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural (EA005-P) LT-1, MR-1, TR-1, LBR-1	**21-Jun-2018**	**----**	----	----	**29-Jun-2018**	21-Jun-2018	×
Clear Plastic Bottle - Natural (EA005-P) RR-1, HR-1, MC-1, WC-1, QA-1	**22-Jun-2018**	**----**	----	----	**29-Jun-2018**	22-Jun-2018	×
Clear Plastic Bottle - Natural (EA005-P) LC-1, EP-1, QA-2	**24-Jun-2018**	**----**	----	----	**29-Jun-2018**	24-Jun-2018	×
Clear Plastic Bottle - Natural (EA005-P) MCR-1, PP-1	**25-Jun-2018**	**----**	----	----	**29-Jun-2018**	25-Jun-2018	×
EA025: Total Suspended Solids dried at 104 ± 2°C							
Clear Plastic Bottle - Natural (EA025H) LT-1, MR-1, TR-1, LBR-1	**21-Jun-2018**	**----**	----	----	**28-Jun-2018**	28-Jun-2018	✓
Clear Plastic Bottle - Natural (EA025H) RR-1, HR-1, MC-1, WC-1, QA-1	**22-Jun-2018**	**----**	----	----	**29-Jun-2018**	29-Jun-2018	✓
Clear Plastic Bottle - Natural (EA025H) LC-1, EP-1, QA-2	**24-Jun-2018**	**----**	----	----	**29-Jun-2018**	01-Jul-2018	✓
Clear Plastic Bottle - Natural (EA025H) MCR-1, PP-1	**25-Jun-2018**	**----**	----	----	**02-Jul-2018**	02-Jul-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA065: Total Hardness as CaCO3							
Clear Plastic Bottle - Natural (ED093F) LT-1, MR-1, TR-1, LBR-1	**21-Jun-2018**	**----**	----	----	**29-Jun-2018**	28-Jun-2018	×
Clear Plastic Bottle - Natural (ED093F) RR-1, HR-1, MC-1, WC-1, QA-1	**22-Jun-2018**	**----**	----	----	**29-Jun-2018**	29-Jun-2018	✓
Clear Plastic Bottle - Natural (ED093F) LC-1, EP-1, QA-2	**24-Jun-2018**	**----**	----	----	**29-Jun-2018**	01-Jul-2018	✓
Clear Plastic Bottle - Natural (ED093F) MCR-1, PP-1	**25-Jun-2018**	**----**	----	----	**03-Jul-2018**	02-Jul-2018	×
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Natural (ED093F) LT-1, MR-1, TR-1, LBR-1	**21-Jun-2018**	**----**	----	----	**29-Jun-2018**	28-Jun-2018	×
Clear Plastic Bottle - Natural (ED093F) RR-1, HR-1, MC-1, WC-1, QA-1	**22-Jun-2018**	**----**	----	----	**29-Jun-2018**	29-Jun-2018	✓
Clear Plastic Bottle - Natural (ED093F) LC-1, EP-1, QA-2	**24-Jun-2018**	**----**	----	----	**29-Jun-2018**	01-Jul-2018	✓
Clear Plastic Bottle - Natural (ED093F) MCR-1, PP-1	**25-Jun-2018**	**----**	----	----	**03-Jul-2018**	02-Jul-2018	×
EG020T: Total Metals by ICP-MS							
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG020A-T) LT-1, MR-1, TR-1, LBR-1	**21-Jun-2018**	**02-Jul-2018**	18-Dec-2018	✓	**02-Jul-2018**	18-Dec-2018	✓
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG020A-T) RR-1, HR-1, MC-1, WC-1, QA-1	**22-Jun-2018**	**02-Jul-2018**	19-Dec-2018	✓	**02-Jul-2018**	19-Dec-2018	✓
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG020A-T) LC-1, EP-1, QA-2	**24-Jun-2018**	**02-Jul-2018**	21-Dec-2018	✓	**02-Jul-2018**	21-Dec-2018	✓
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG020A-T) MCR-1, PP-1	**25-Jun-2018**	**02-Jul-2018**	22-Dec-2018	✓	**02-Jul-2018**	22-Dec-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG035T: Total Recoverable Mercury by FIMS							
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG035T)							
LT-1, MR-1, TR-1, LBR-1	**21-Jun-2018**	**----**	----	----	**29-Jun-2018**	19-Jul-2018	✓
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG035T)							
RR-1, HR-1, MC-1, WC-1, QA-1	**22-Jun-2018**	**----**	----	----	**29-Jun-2018**	20-Jul-2018	✓
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG035T)							
LC-1, EP-1, QA-2	**24-Jun-2018**	**----**	----	----	**29-Jun-2018**	22-Jul-2018	✓
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG035T)							
MCR-1, PP-1	**25-Jun-2018**	**----**	----	----	**29-Jun-2018**	23-Jul-2018	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G)							
LT-1, MR-1, TR-1, LBR-1	**21-Jun-2018**	**----**	----	----	**28-Jun-2018**	23-Jun-2018	×
Clear Plastic Bottle - Natural (EK057G)							
QA-1	**22-Jun-2018**	**----**	----	----	**02-Jul-2018**	24-Jun-2018	×
Clear Plastic Bottle - Natural (EK057G)							
RR-1, HR-1, MC-1, WC-1	**22-Jun-2018**	**----**	----	----	**28-Jun-2018**	24-Jun-2018	×
Clear Plastic Bottle - Natural (EK057G)							
QA-2	**24-Jun-2018**	**----**	----	----	**02-Jul-2018**	26-Jun-2018	×
Clear Plastic Bottle - Natural (EK057G)							
LC-1, EP-1	**24-Jun-2018**	**----**	----	----	**28-Jun-2018**	26-Jun-2018	×
Clear Plastic Bottle - Natural (EK057G)							
MCR-1, PP-1	**25-Jun-2018**	**----**	----	----	**28-Jun-2018**	27-Jun-2018	×
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
LT-1, MR-1, TR-1, LBR-1	**21-Jun-2018**	**----**	----	----	**02-Jul-2018**	19-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
RR-1, HR-1, MC-1, WC-1, QA-1	**22-Jun-2018**	**----**	----	----	**02-Jul-2018**	20-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
LC-1, EP-1, QA-2	**24-Jun-2018**	**----**	----	----	**02-Jul-2018**	22-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
MCR-1, PP-1	**25-Jun-2018**	**----**	----	----	**02-Jul-2018**	23-Jul-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G) LT-1, MR-1, TR-1, LBR-1	**21-Jun-2018**	**02-Jul-2018**	19-Jul-2018	✓	**02-Jul-2018**	19-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G) RR-1, HR-1, MC-1, WC-1, QA-1	**22-Jun-2018**	**02-Jul-2018**	20-Jul-2018	✓	**02-Jul-2018**	20-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G) LC-1, EP-1, QA-2	**24-Jun-2018**	**02-Jul-2018**	22-Jul-2018	✓	**02-Jul-2018**	22-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G) MCR-1, PP-1	**25-Jun-2018**	**02-Jul-2018**	23-Jul-2018	✓	**02-Jul-2018**	23-Jul-2018	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G) LT-1, MR-1, TR-1, LBR-1	**21-Jun-2018**	**02-Jul-2018**	19-Jul-2018	✓	**02-Jul-2018**	19-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G) RR-1, HR-1, MC-1, WC-1, QA-1	**22-Jun-2018**	**02-Jul-2018**	20-Jul-2018	✓	**02-Jul-2018**	20-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G) LC-1, EP-1, QA-2	**24-Jun-2018**	**02-Jul-2018**	22-Jul-2018	✓	**02-Jul-2018**	22-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G) MCR-1, PP-1	**25-Jun-2018**	**02-Jul-2018**	23-Jul-2018	✓	**02-Jul-2018**	23-Jul-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP080/071: Total Petroleum Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP071) LT-1, MR-1, TR-1, LBR-1	**21-Jun-2018**	**28-Jun-2018**	28-Jun-2018	✓	**03-Jul-2018**	07-Aug-2018	✓
Amber Glass Bottle - Unpreserved (EP071) RR-1, HR-1, MC-1, WC-1, QA-1	**22-Jun-2018**	**28-Jun-2018**	29-Jun-2018	✓	**03-Jul-2018**	07-Aug-2018	✓
Amber Glass Bottle - Unpreserved (EP071) LC-1, EP-1, QA-2	**24-Jun-2018**	**28-Jun-2018**	01-Jul-2018	✓	**03-Jul-2018**	07-Aug-2018	✓
Amber Glass Bottle - Unpreserved (EP071) MCR-1, PP-1	**25-Jun-2018**	**28-Jun-2018**	02-Jul-2018	✓	**03-Jul-2018**	07-Aug-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080) LT-1, MR-1, TR-1, LBR-1	**21-Jun-2018**	**04-Jul-2018**	05-Jul-2018	✓	**04-Jul-2018**	05-Jul-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080) RR-1, HR-1, MC-1, WC-1, QA-1	**22-Jun-2018**	**04-Jul-2018**	06-Jul-2018	✓	**04-Jul-2018**	06-Jul-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080) LC-1, EP-1, QA-2	**24-Jun-2018**	**04-Jul-2018**	08-Jul-2018	✓	**04-Jul-2018**	08-Jul-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080) MCR-1, PP-1	**25-Jun-2018**	**04-Jul-2018**	09-Jul-2018	✓	**04-Jul-2018**	09-Jul-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions							
Amber Glass Bottle - Unpreserved (EP071) LT-1, MR-1, TR-1, LBR-1	**21-Jun-2018**	**28-Jun-2018**	28-Jun-2018	✓	**03-Jul-2018**	07-Aug-2018	✓
Amber Glass Bottle - Unpreserved (EP071) RR-1, HR-1, MC-1, WC-1, QA-1	**22-Jun-2018**	**28-Jun-2018**	29-Jun-2018	✓	**03-Jul-2018**	07-Aug-2018	✓
Amber Glass Bottle - Unpreserved (EP071) LC-1, EP-1, QA-2	**24-Jun-2018**	**28-Jun-2018**	01-Jul-2018	✓	**03-Jul-2018**	07-Aug-2018	✓
Amber Glass Bottle - Unpreserved (EP071) MCR-1, PP-1	**25-Jun-2018**	**28-Jun-2018**	02-Jul-2018	✓	**03-Jul-2018**	07-Aug-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080) LT-1, MR-1, TR-1, LBR-1	**21-Jun-2018**	**04-Jul-2018**	05-Jul-2018	✓	**04-Jul-2018**	05-Jul-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080) RR-1, HR-1, MC-1, WC-1, QA-1	**22-Jun-2018**	**04-Jul-2018**	06-Jul-2018	✓	**04-Jul-2018**	06-Jul-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080) LC-1, EP-1, QA-2	**24-Jun-2018**	**04-Jul-2018**	08-Jul-2018	✓	**04-Jul-2018**	08-Jul-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080) MCR-1, PP-1	**25-Jun-2018**	**04-Jul-2018**	09-Jul-2018	✓	**04-Jul-2018**	09-Jul-2018	✓
EP080: BTEXN							
Amber VOC Vial - Sulfuric Acid (EP080) LT-1, MR-1, TR-1, LBR-1	**21-Jun-2018**	**04-Jul-2018**	05-Jul-2018	✓	**04-Jul-2018**	05-Jul-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080) RR-1, HR-1, MC-1, WC-1, QA-1	**22-Jun-2018**	**04-Jul-2018**	06-Jul-2018	✓	**04-Jul-2018**	06-Jul-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080) LC-1, EP-1, QA-2	**24-Jun-2018**	**04-Jul-2018**	08-Jul-2018	✓	**04-Jul-2018**	08-Jul-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080) MCR-1, PP-1	**25-Jun-2018**	**04-Jul-2018**	09-Jul-2018	✓	**04-Jul-2018**	09-Jul-2018	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Major Cations - Dissolved	ED093F	5	44	**11.36**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	3	22	**13.64**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	7	68	**10.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	0	17	**0.00**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Major Cations - Dissolved	ED093F	3	44	**6.82**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	22	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	8	68	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	3	20	**15.00**	**15.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	3	20	**15.00**	**15.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Major Cations - Dissolved	ED093F	3	44	**6.82**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	22	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	4	68	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	22	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Matrix Spikes (MS) - Continued							
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	0	17	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Suspended Solids (High Level)	EA025H	WATER	In house: Referenced to APHA 2540D. A gravimetric procedure employed to determine the amount of `non-filterable` residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. A well-mixed sample is filtered through a glass fibre filter (1.2um). The residue on the filter paper is dried at 104+/-2C . This method is compliant with NEPM (2013) Schedule B(3)
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Mercury by FIMS	EG035T	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
TRH - Semivolatile Fraction	EP071	WATER	In house: Referenced to USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
TRH Volatiles/BTEX	EP080	WATER	In house: Referenced to USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)
Digestion for Total Recoverable Metals	EN25	WATER	In house: Referenced to USEPA SW846-3005. Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (2013) Schedule B(3)
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510B 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using 60mL DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (2013) Schedule B(3) . ALS default excludes sediment which may be resident in the container.
Volatiles Water Preparation	ORG16-W	WATER	A 5 mL aliquot or 5 mL of a diluted sample is added to a 40 mL VOC vial for sparging.

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **ES1818769**

Client	: **PREMISE**	Laboratory	: Environmental Division Sydney
Contact	: PAUL FOX	Contact	: Customer Services ES
Address	: SUITE 6, 8 GREBE STREET PEREGIAN BEACH QLD 4573	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: paul.fox@premise.com.au	E-mail	: ALSEnviro.Sydney@alsglobal.com
Telephone	: 07 5448 3288	Telephone	: +61-2-8784 8555
Facsimile	: 07 5302 6680	Facsimile	: +61-2-8784 8500
Project	: IMPERIAL	Page	: 1 of 3
Order number	:	Quote number	: EB2018PREMIS0001 (EN/333/17)
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: ----		
Sampler	: PAUL FOX		

Dates

Date Samples Received	: 28-Jun-2018 07:30	Issue Date	: 28-Jun-2018
Client Requested Due Date	: 05-Jul-2018	Scheduled Reporting Date	: **05-Jul-2018**

Delivery Details

Mode of Delivery	: Client Drop Off	Security Seal	: Not Available
No. of coolers/boxes	: ----	Temperature	: 2.1 - Ice present
Receipt Detail	:	No. of samples received / analysed	: 14 / 14

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **Please refer to the Proactive Holding Time Report table below which summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory. The absence of this summary table indicates that all samples have been received within the recommended holding times for the analysis requested.**
- **Sample(s) requiring volatile organic compound analysis received in airtight containers (ZHE).**
- Please direct any queries you have regarding this work order to the above ALS laboratory contact.
- Analytical work for this work order will be conducted at ALS Sydney.
- Sample Disposal - Aqueous (3 weeks), Solid (2 months) from receipt of samples.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exists.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component

Matrix: **WATER**

Laboratory sample ID	Client sampling date / time	Client sample ID	WATER - EA005P pH (PCT)	WATER - EA025H Suspended Solids - Standard Level	WATER - NT-01D Major Cations (Ca, Mg, Na, K) + Hardness	WATER - NT-04 Nitrite and Nitrate	WATER - NT-11 Total Nitrogen and Total Phosphorus	WATER - W-05T TRH/BTEXN/8 Metals (Total)
ES1818769-001	22-Jun-2018 00:00	RR-1	✓	✓	✓	✓	✓	✓
ES1818769-002	22-Jun-2018 00:00	HR-1	✓	✓	✓	✓	✓	✓
ES1818769-003	22-Jun-2018 00:00	MC-1	✓	✓	✓	✓	✓	✓
ES1818769-004	21-Jun-2018 00:00	LT-1	✓	✓	✓	✓	✓	✓
ES1818769-005	22-Jun-2018 00:00	WC-1	✓	✓	✓	✓	✓	✓
ES1818769-006	21-Jun-2018 00:00	MR-1	✓	✓	✓	✓	✓	✓
ES1818769-007	21-Jun-2018 00:00	TR-1	✓	✓	✓	✓	✓	✓
ES1818769-008	21-Jun-2018 00:00	LBR-1	✓	✓	✓	✓	✓	✓
ES1818769-009	24-Jun-2018 00:00	LC-1	✓	✓	✓	✓	✓	✓
ES1818769-010	25-Jun-2018 00:00	MCR-1	✓	✓	✓	✓	✓	✓
ES1818769-011	25-Jun-2018 00:00	PP-1	✓	✓	✓	✓	✓	✓
ES1818769-012	24-Jun-2018 00:00	EP-1	✓	✓	✓	✓	✓	✓
ES1818769-013	22-Jun-2018 00:00	QA-1			✓		✓	✓
ES1818769-014	24-Jun-2018 00:00	QA-2			✓		✓	✓

Proactive Holding Time Report

The following table summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Client Sample ID(s)	Container	Due for extraction	Due for analysis	Samples Received Date	Samples Received Evaluation	Instructions Received Date	Instructions Received Evaluation
EA005-P: pH by PC Titrator							
EP-1	Clear Plastic Bottle - Natural	----	24-Jun-2018	28-Jun-2018	×	----	----
HR-1	Clear Plastic Bottle - Natural	----	22-Jun-2018	28-Jun-2018	×	----	----
LBR-1	Clear Plastic Bottle - Natural	----	21-Jun-2018	28-Jun-2018	×	----	----
LC-1	Clear Plastic Bottle - Natural	----	24-Jun-2018	28-Jun-2018	×	----	----
LT-1	Clear Plastic Bottle - Natural	----	21-Jun-2018	28-Jun-2018	×	----	----
MC-1	Clear Plastic Bottle - Natural	----	22-Jun-2018	28-Jun-2018	×	----	----
MCR-1	Clear Plastic Bottle - Natural	----	25-Jun-2018	28-Jun-2018	×	----	----
MR-1	Clear Plastic Bottle - Natural	----	21-Jun-2018	28-Jun-2018	×	----	----
PP-1	Clear Plastic Bottle - Natural	----	25-Jun-2018	28-Jun-2018	×	----	----
RR-1	Clear Plastic Bottle - Natural	----	22-Jun-2018	28-Jun-2018	×	----	----
TR-1	Clear Plastic Bottle - Natural	----	21-Jun-2018	28-Jun-2018	×	----	----
WC-1	Clear Plastic Bottle - Natural	----	22-Jun-2018	28-Jun-2018	×	----	----
EK057G: Nitrite as N by Discrete Analyser							
EP-1	Clear Plastic Bottle - Natural	----	26-Jun-2018	28-Jun-2018	×	----	----
HR-1	Clear Plastic Bottle - Natural	----	24-Jun-2018	28-Jun-2018	×	----	----
LBR-1	Clear Plastic Bottle - Natural	----	23-Jun-2018	28-Jun-2018	×	----	----
LC-1	Clear Plastic Bottle - Natural	----	26-Jun-2018	28-Jun-2018	×	----	----

LT-1	Clear Plastic Bottle - Natural	----	23-Jun-2018	28-Jun-2018	✘	----	----
MC-1	Clear Plastic Bottle - Natural	----	24-Jun-2018	28-Jun-2018	✘	----	----
MCR-1	Clear Plastic Bottle - Natural	----	27-Jun-2018	28-Jun-2018	✘	----	----
MR-1	Clear Plastic Bottle - Natural	----	23-Jun-2018	28-Jun-2018	✘	----	----
PP-1	Clear Plastic Bottle - Natural	----	27-Jun-2018	28-Jun-2018	✘	----	----
RR-1	Clear Plastic Bottle - Natural	----	24-Jun-2018	28-Jun-2018	✘	----	----
TR-1	Clear Plastic Bottle - Natural	----	23-Jun-2018	28-Jun-2018	✘	----	----
WC-1	Clear Plastic Bottle - Natural	----	24-Jun-2018	28-Jun-2018	✘	----	----

Requested Deliverables

PAUL FOX

- *AU Certificate of Analysis - NATA (COA) — Email — paul.fox@premise.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI) — Email — paul.fox@premise.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC) — Email — paul.fox@premise.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN) — Email — paul.fox@premise.com.au
- A4 - AU Tax Invoice (INV) — Email — paul.fox@premise.com.au
- Chain of Custody (CoC) (COC) — Email — paul.fox@premise.com.au
- EDI Format - XTab (XTAB) — Email — paul.fox@premise.com.au

CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐GLADSTONE 48 Callemondah Drive Clinton QLD 4680
Ph: 07 4978 7944 E: ALSEnviro.gladstone@alsglobal.com

CLIENT: ~~[illegible]~~ Premise
OFFICE: Suite 6, 8 Grebe St, Peregian Beach, QLD
PROJECT: Imperial — PROJECT NO: HOK-001
ORDER NUMBER: — PURCHASE ORDER NO.:
PROJECT MANAGER: PAUL FOX
SAMPLER: Fox — SAMPLER MOBILE: 0413 636 072
COC Emailed to ALS? (YES / NO) — EDD FORMAT (or default):
Email Reports to (will default to PM if no other addresses are listed): paul.fox@premise.com.au
Email Invoice to (will default to PM if no other addresses are listed):

TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)
☑ Standard TAT (List due date):
☐ Non Standard or urgent TAT (List due date):
ALS QUOTE NO.:
COUNTRY OF ORIGIN:

COC SEQUENCE NUMBER (Circle)
COC: (1) 2 3 4 5 6 7
OF: 1 (2) 3 4 5 6 7

FOR LABORATORY USE ONLY (Circle)
Custody Seal Intact? Yes No N/A
Free ice / frozen ice bricks present upon receipt? Yes No N/A
Random Sample Temperature on Receipt: °C
Other comment:

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
	Lana ALS		Kim
DATE/TIME: 27/6/18 0940	DATE/TIME: 27-06-18	DATE/TIME:	DATE/TIME: 28.06.18 8am

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	Suspended Solids	Total Hardness as $CaCO_3$	dissolved major cation Ca, Mg, Na, K	metals Zn, Ag, As, Cd, Cr, Co, Ni, Pb	Nitrogen, nitrite Nitrate as N	total Kjeldahl Nitrogen as N	Total N Total P	TPH / TRH BTEX	pH
1	RR-1	22-6-18	WATER			✓	✓	✓	✓	✓	✓	✓	✓	✓
2	HR-1	22-6-18	"			✓	✓	✓	✓	✓	✓	✓	✓	✓
3	MC-1	22-6-18	"			✓	✓	✓	✓	✓	✓	✓	✓	✓
4	LT-1	21-6-18	"			✓	✓	✓	✓	✓	✓	✓	✓	✓
5	WC-1	22-6-18	"			✓	✓	✓	✓	✓	✓	✓	✓	✓
6	MR-1	21-6-18	"			✓	✓	✓	✓	✓	✓	✓	✓	✓
7	TR-1	21-6-18	"			✓	✓	✓	✓	✓	✓	✓	✓	✓
8	LBR-1	21-6-18	"			✓	✓	✓	✓	✓	✓	✓	✓	✓
9	LC-1	24-6-18	"			✓	✓	✓	✓	✓	✓	✓	✓	✓
10	MCR-1	25-6-18	"			✓	✓	✓	✓	✓	✓	✓	✓	✓
11	PP-1	25-6-18	"			✓	✓	✓	✓	✓	✓	✓	✓	✓
12	EP-1	26-6-18	"			✓	✓	✓	✓	✓	✓	✓	✓	✓
				TOTAL										

Additional Information: Comments on likely contaminant levels dilutions or samples requiring specific QC analysis etc

LAB OF ORIGIN: DARWIN

ES1818769

Environmental Division
Sydney
Work Order Reference
ES1818769
Telephone : + 61-2-8784 8555

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

GLADSTONE 48 Callemondah Drive Clinton QLD 4680
Ph: 07 4978 7944 E: ALSEnviro.gladstone@alsglobal.com

CLIENT:	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)	☑ Standard TAT (List due date):	FOR LABORATORY USE ONLY (Circle)
OFFICE:		☐ Non Standard or urgent TAT (List due date):	Custody Seal Intact? Yes No N/A
PROJECT: PROJECT NO:	ALS QUOTE NO.:	COC SEQUENCE NUMBER (Circle)	Free ice / frozen ice bricks present upon receipt? Yes No N/A
ORDER NUMBER: PURCHASE ORDER NO.:	COUNTRY OF ORIGIN:	COC: 1 (2) 3 4 5 6 7	Random Sample Temperature on Receipt: °C
PROJECT MANAGER:		OF: 1 (2) 3 4 5 6 7	Other comment:

SAMPLER: SAMPLER MOBILE:	RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY: Kim
COC Emailed to ALS? (YES / NO) EDD FORMAT (or default):				
Email Reports to (will default to PM if no other addresses are listed):	DATE/TIME:	DATE/TIME:	DATE/TIME:	DATE/TIME: 28.06.18 8am
Email Invoice to (will default to PM if no other addresses are listed):				

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	Metals (Mg, Zn, As, Cd, Cr, Cu, Ni)	TPH / TRH	BTEX	Total N Total P	dissolved major cations	Total Hardness			Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc
13	QA-1	22-6-18	WATER			✓	✓	✓	✓	✓				LAB OF ORIGIN: DARWIN
14	QA-2	24-6-18	✓			✓	✓	✓	✓	✓				
				TOTAL										ES1818769

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

APPENDIX D
QA/QC ASSESSMENT

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 4 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 laboratory pH in addition to calibration	Yes
Chain of Custody documentation	Completed		Completed and provided in Appendix C.	Yes
Sample analysis and extraction holding times	Comply with holding times	AS4482.1-2005/NEPM(2013)	Yes. Refer Appendix C.	Yes
Sample preservation	Samples collected in appropriate preserved sample bottles		Yes. Refer Appendix C.	Yes
Analysis of intra-laboratory duplicates	At least 1 in every 20 samples collected	AS4482.1-2005	Yes. 1 in 8 samples collected for EP184 and 1 in 4 samples collected for EP187	Yes

APPENDIX E
OPPORTUNISTIC FAUNA LIST

KEY

	Australian conservation status of each taxon under the Environment Protection and Biodiversity Conservation Act 1999
CD	Conservation Dependent
CE	Critically Endangered
E	Endangered
EX	Extinct
XW	Extinct in the Wild
V	Vulnerable
M	Migratory
Ma	Marine

	Territory Parks and Wildlife Conservation Act 2000 and IUCN Red List
	Under TPWC Act, Threatened wildlife = EW, CE, E or V
CR	Critically Endangered
DD	Data Deficient
EN	Endangered
EX	Extinct
EW	Extinct in the Wild
LC	Least Concern
NT	Near Threatened
NE	Not Evaluated
VU	Vulnerable
LR/lc	Lower Risk/least concern (IUCN Red List Only)

* Introduced species

	Family	Scientific Name	Common Name	Method of Capture	EPBC Act	TPWC Act	IUCN
	Amphibians						
*	Bufonidae	*Rhinella marina*	Cane toad	Opportunistic	-	-	LC
	Mammals						
*	Bovidae	*Bos taurus*	Cow	Opportunistic	-	-	-
*	Bovidae	*Bubalus bubalis*	Water buffalo	Opportunistic	-	-	-
*	Canidae	*Canis lupus familiaris*	Wild dog	Opportunistic	-	-	-
*	Equidae	*Equus asinus*	Donkey	Opportunistic	-	-	-
*	Equidae	*Equus caballus*	Horse	Opportunistic	-	-	-
	Macropodidae	*Macropus agilis*	Agile wallaby	Opportunistic	-	LC	LC
	Macropodidae	*Macropus robustus*	Common wallaroo	Opportunistic	-	LC	LC
*	Suidae	*Sus scrofa*	Wild boar	Opportunistic	-	-	LC
	Reptiles						
	Agamidae	*Lophognathus gilberti*	Gilberts dragon	Opportunistic	-	LC	LC
	Agamidae	*Diporiphora bilineata*	Two-lined dragon	Opportunistic	-	LC	-
	Crocodylidae	*Crocodylus johnstoni*	Freshwater crocodile	Opportunistic	-	LC	LR/lc

Family	Scientific Name	Common Name	Method of Capture	EPBC Act	TPWC Act	IUCN
Crocodylidae	*Crocodylus porosus*	Salt water crocodile	Opportunistic	M, Ma	LC	LR/lc
Scincidae	*Carlia amax*	Two-spined rainbow skink	Opportunistic	LC	LC	-
Scincidae	*Ctenotus inornatus*	Plain Ctenotus	Opportunistic	-	LC	-
Scincidae	*Ctenotus spaldingi*	Spalding's Ctenotus	Opportunistic	LC	LC	-
Varanidae	*Varanus tristis*	Black-headed monitor	Opportunistic	LC	LC	-
Birds						
Acanthizidae	*Gerygone olivacea*	White-throated gerygone	Opportunistic	-	LC	LC
Acanthizidae	*Smicrornis brevirostris*	Weebill	Opportunistic	-	LC	LC
Accipitridae	*Aquila audax*	Wedge-tailed eagle	Opportunistic	-	LC	LC
Accipitridae	*Haliastur sphenurus*	Whistling kite	Opportunistic	Ma	LC	LC
Accipitridae	*Milvus migrans*	Black kite	Opportunistic	-	LC	LC
Anhingidae	*Anhinga novaehollandiae*	Australasian darter	Opportunistic	-	LC	LC
Ardeidae	*Ardea alba*	Intermediate egret	Opportunistic	-	LC	LC
Ardeidae	*Nycticorax caledonicus*	Nankeen night-heron	Opportunistic	Ma	LC	LC
Artamidae	*Cracticus nigrogularis*	Pied butcherbird	Opportunistic	-	LC	LC
Cacatuidae	*Cacatua galerita*	Sulphur-crested cockatoo	Opportunistic	-	LC	LC
Cacatuidae	*Calyptorhynchus banksii*	Red-tailed black-cockatoo	Opportunistic	-	LC	LC
Cacatuidae	*Cacatua sanguinea*	Little corella	Opportunistic	-	LC	LC
Campephagidae	*Coracina novaehollandiae*	Black-faced cuckoo-shrike	Opportunistic	Ma	LC	LC
Ciconiidae	*Ephippiorhynchus asiaticus*	Black-necked stork	Opportunistic	-	LC	NT
Columbidae	*Geopelia cuneata*	Diamond dove	Opportunistic	-	LC	LC
Columbidae	*Geopelia humeralis*	Bar-shouldered dove	Opportunistic	-	LC	LC
Columbidae	*Geopelia striata*	Peaceful dove	Opportunistic	-	LC	LC
Columbidae	*Phaps chalcoptera*	Common bronzewing	Opportunistic	-	LC	LC
Corcoracidae	*Struthidea cinerea*	Apostlebird	Opportunistic	-	LC	LC
Corvidae	*Corvus orru*	Torresian crow	Opportunistic	-	LC	LC
Estrildidae	*Neochmia phaeton*	Crimson finch	Opportunistic	-	LC	LC
Estrildidae	*Taeniopygia bichenovii*	Double-barred finch	Opportunistic	-	LC	LC
Halcyonidae	*Dacelo leachii*	Blue-winged kookaburra	Opportunistic	-	LC	LC
Halcyonidae	*Todiramphus sanctus*	Sacred kingfisher	Opportunistic	Ma	LC	LC
Maluridae	*Malurus coronatus* (not the western subspecies)	Purple-crowned fairy wren	Opportunistic		LC	LC
Maluridae	*Malurus lamberti*	Variegated fairy-wren	Opportunistic	-	LC	LC
Maluridae	*Malurus melanocephalus*	Red-backed fairy-wren	Opportunistic	-	LC	LC
Meliphagidae	*Cissomela pectoralis*	Banded honeyeater	Opportunistic	-	LC	LC
Meliphagidae	*Entomyzon cyanotis*	Blue-faced honeyeater	Opportunistic	-	LC	LC
Meliphagidae	*Lichenostomus flavescens*	Yellow-tinted honeyeater	Opportunistic	-	LC	LC
Meliphagidae	*Lichenostomus keartlandi*	Grey-headed honeyeater	Opportunistic	-	LC	LC
Meliphagidae	*Lichenostomus plumulus*	Grey-fronted honeyeater	Opportunistic	-	LC	LC
Meliphagidae	*Lichenostomus unicolor*	White-gaped honeyeater	Opportunistic	-	LC	LC

Family	Scientific Name	Common Name	Method of Capture	EPBC Act	TPWC Act	IUCN
Meliphagidae	*Lichenostomus virescens*	Singing honeyeater	Opportunistic	-	LC	LC
Meliphagidae	*Lichmera indistincta*	Brown honeyeater	Opportunistic	-	LC	LC
Meliphagidae	*Melithreptus albogularis*	White-throated honeyeater	Opportunistic	-	LC	LC
Meliphagidae	*Philemon argenticeps*	Silver-crowned friarbird	Opportunistic	-	LC	LC
Meliphagidae	*Philemon citreogularis*	Little friarbird	Opportunistic	-	LC	LC
Meliphagidae	*Ramsayornis fasciatus*	Bar-breasted honeyeater	Opportunistic	-	LC	LC
Meropidae	*Merops ornatus*	Rainbow bee-eater	Opportunistic	M, Ma	LC	LC
Monarchidae	*Grallina cyanoleuca*	Magpie-lark	Opportunistic	Ma	LC	LC
Monarchidae	*Myiagra inquieta*	Restless flycatcher	Opportunistic	-	LC	LC
Monarchidae	*Myiagra rubecula*	Leaden flycatcher	Opportunistic	-	LC	LC
Nectariniidae	*Dicaeum hirundinaceum*	Mistletoebird	Opportunistic	-	LC	LC
Oriolidae	*Oriolus sagittatus*	Olive-backed oriole	Opportunistic	-	LC	LC
Otididae	*Ardeotis australis*	Australian bustard	Opportunistic	-	NT	LC
Pachycephalidae	*Colluricincla megarhyncha*	Little shrike-thrush	Opportunistic	-	LC	LC
Pachycephalidae	*Colluricincla harmonica*	Grey shrike-thrush	Opportunistic	-	LC	LC
Pachycephalidae	*Pachycephala rufiventris*	Rufous whistler	Opportunistic	-	LC	LC
Pardalotidae	*Pardalotidae striatus*	Striated pardalote	Opportunistic	-	LC	LC
Pelecanidae	*Pelecanus conspicillatus*	Australian pelican	Opportunistic	Ma	LC	LC
Petroicidae	*Microeca fascinans*	Jacky winter	Opportunistic	-	LC	LC
Phalacrocoracidae	*Microcarbo melanoleucos*	Little pied cormorant	Opportunistic	-	LC	LC
Pomatostomidae	*Pomatostomus temporalis*	Grey-crowned babbler	Opportunistic	-	LC	LC
Psittacidae	*Aprosmictus erythropterus*	Red-winged parrot	Opportunistic	-	LC	LC
Psittacidae	*Melopsittacus undulatus*	Budgerigar	Opportunistic	-	LC	LC
Psittacidae	*Platycercus venustus*	Northern rosella	Opportunistic	-	LC	LC
Psittacidae	*Psitteuteles versicolor*	Varied lorikeet	Opportunistic	-	LC	LC
Psittacidae	*Trichoglossus haematodus*	Rainbow lorikeet	Opportunistic	-	LC	LC
Ptilonorhynchidae	*Ptilonorhynchus nuchalis*	Great bowerbird	Opportunistic	-	LC	LC
Rhipiduridae	*Rhipidura leucophrys*	Willie wagtail	Opportunistic	-	LC	LC
Rhipiduridae	*Rhipidura rufiventris*	Northern fantail	Opportunistic	-	LC	LC
Threskiornithidae	*Plegadis falcinellus*	Glossy ibis	Opportunistic	M, Ma	LC	LC
Threskiornithidae	*Threskiornis moluccus*	Australian white ibis	Opportunistic	-	LC	LC
Threskiornithidae	*Threskiornis spinicollis*	Straw-necked ibis	Opportunistic	Ma	LC	LC
Fish						
Latidae	*Lates calcarifer*	Barramundi	Opportunistic	-	LC	-
Sparidae	*Acanthopagrus palmaris*	Northwest black bream	Opportunistic	-	LC	LC
Toxotidae	*Toxotes chatareus*	Sevenspot archerfish	Opportunistic	-	LC	-

Premise

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ENGINEERING ENVIRONMENT AGRIBUSINESS WATER

Preliminary Ecological Assessment Report
EP184 and EP187 – End of Dry Season 2015

CLIENT:

Imperial Oil & Gas Pty Ltd

STATUS:

Final

REPORT NUMBER:

R002499b

ISSUE DATE:

February 2016

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Version Register

Version	Status	Author	Reviewer	Change from Previous Version	Authorised for Release	
					Signature	Date
	Draft	M. Ng/P. Fox	P. Fox	-		
a	Final	M. Ng/P. Fox	P. Fox	Address client comments		15.02.2016
b	Final	M. Ng/P. Fox	P. Fox	Address client comments		16.02.2016

Transmission Register

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Name	Email Address
Geoff Hokin	ghokin@empiregp.net

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Figures

Plates

Tables

Appendices

Executive Summary

A desktop investigation and preliminary ecological assessment was carried out to identify key ecological characteristics and potential constraints to exploration and development within Exploration Permit areas EP184 and EP187 in the Northern Territory. Water quality sampling was carried out to provide an end of dry season sample. The field assessment was carried out at 12 sites, eight within EP184 and four within EP187. The preliminary ecological assessment was limited to the area immediately adjacent to water quality sampling locations along waterways.

The scope of the study was to provide:

- end of dry season water quality assessment;
- habitat and vegetation community descriptions;
- locations and photos of communities and species present;
- opportunistic fauna (terrestrial and aquatic) species list, including introduced species and any threatened species present;
- locations of fauna breeding places and other habitat features; and
- likelihood of targeted threatened species to occur generally over the tenements.

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

Existing Environment

EP184 is a 1,122,000 ha area situated in the central trough of the McArthur Basin south of the Roper River and adjacent to the Gulf of Carpentaria. EP187 is situated approximately 84 km south west of Borroloola within the Carpentaria and McArthur Basin. The area consists largely of national park area (Limmen National Park), agriculture (grazing of natural vegetation) and some traditional indigenous lands.

EP184 lies within the Roper River, Towns River, Limmen Bight River, Rosie River and McArthur River catchments. EP187 lies within the Limmen Bight River and McArthur River catchments. All of these rivers discharge into the Gulf of Carpentaria, east of the tenements.

The area consists largely of national park area (Limmen National Park), agriculture (grazing of natural vegetation) and some traditional indigenous lands.

Seven Areas of Conservation Significance lie within the greater region - Limmen National Park, Limmen Bight and associated coastal floodplains, The Limmen Bight (Port Roper) Tidal Wetlands System (NT007), The Borroloola area, Borroloola Bluebush Swamps (NT006), The McArthur River coastal floodplain and Port McArthur Tidal Wetlands System (NT008). Of these, Limmen National Park and Limmen Bight and associated coastal floodplains encompass a portion of the north eastern portion of EP184. The remaining five are downstream of the tenements.

The study area falls within three IBRA Bioregions - Gulf Coastal, Gulf Falls and Uplands and Sturt Plateau.

The vegetation communities mapped over the tenements include woodland, tussock grassland, sparse samphire shrubland and forest. Eucalyptus woodland dominates the area (57%), followed by Corymbia low open woodland (11%), Eucalyptus low woodland (7%) and Chrysopogon (mixed) tussock grassland (6%). No Threatened Ecological Communities (TECs) are mapped within EP184 and EP187.

Findings

The region is generally in good ecological condition but widespread impacts from weeds, feral animals (especially pigs, buffalo, donkeys and cattle) changed fire regimes and grazing was observed.

Many of the sites had experienced hot fires in the recent past, causing plant death and removal. No threatened flora species were observed. Three (3) WONS (also Northern Territory declared Class A and C

plants), *Vachellia nilotica*(prickly acacia) (EP-1, McR-1), *Chryptostegia grandiflora* (rubber vine) (LBR-1) and *Andropogon gayanus* (Gamba grass) (LC-1), and three (3) other Northern Territory declared Class B and Class C plants, *Hyptis suaveolens* (mint weed) (EP-1, WC-1), *Leonotis nepetifolia* (lion's ear) (EP-1) and *Calotropis procera* (rubber bush) (RR-1), were observed.

One threatened fauna species, Mertens' Water Monitor (*Varanus mertensi*), listed as Vulnerable under the TPWC Act, was observed at LT-1 (Zone 53 E462397, N8313829). Fourteen species listed as migratory (three species) and/or marine (14 species) under the EPBC Act were observed. A further 39 conservation significant species (18 threatened and 21 migratory/marine) are at least moderately likely to occur within the tenements based on the likelihood of occurrence assessment. Note that many of the migratory species are specialists of tidal areas and are likely to be concentrated in the estuarine area in the east of EP184.

Seven introduced species were observed, all of which are feral species in the Northern Territory.

Water quality samples were collected at all sites except Whirlpool Creek (WC-1), which was dry at the time of the assessment. All sample sites are considered to be lowland streams of Tropical North Australia and most analytes were below detection levels or within guideline values. Nitrogen and phosphorus concentrations were reported above adopted trigger guidelines at most sites and turbidity was elevated at Little Towns River (LT-1). These results are expected to vary seasonally and may also be attributed to use of these remnant water holes by pigs, buffalo and cattle. Dissolved oxygen was low at all sites, not uncommon in remnant pools at the end of the dry season.

Naturally occurring elevated heavy metal concentrations above trigger levels were found in water samples of Leila Creek (LC-1) (arsenic) and Towns River (TR-1), Magaranyi River (MR-1) and Little Towns River (LT-1) (copper). These high levels may be a consequence of natural mineralisation, as demonstrated previously in the region in the McArthur River Mine Public Environmental Report of the McArthur River. These elements are known to be a primary target of mineral exploration in the greater area.

Some Total Petroleum Hydrocarbons (TPH) and Total Recoverable Hydrocarbons (TRH) fractions were above detection limits at Magaranyi River (MR-1) and Little Towns River (LT-1). It is unlikely that the detected hydrocarbons are due to surrounding land use and the hydrocarbons may have been a cross-contamination of the sampling equipment while stored in the helicopter tail during flights or from sunscreen worn by personnel. No other samples contained detectable levels of hydrocarbons.

This is the preliminary assessment for the end of dry season. Further assessments will be carried out in the coming months to provide an understanding of seasonal changes.

Recommendations

The tenements encompass vast areas and although the sites are spread throughout the tenements and provide a broad understanding of the waterways and some of the associated communities, the majority of the area could not be visited and assessed. More detailed assessments should be carried out in relevant areas once work areas are known and prior to any works.

This sampling program has identified that delivering training to local traditional owners in sample collection techniques may provide opportunity to expand the next round of sampling and facilitate more comprehensive programs in areas that are not currently available for non-indigenous personnel to enter.

List of Abbreviations

Abbreviation	Definition
ALA	Atlas of Living Australia
ANZECC Guidelines	Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand 2000)
AVH	Australia's Virtual Herbarium
DLRM	Northern Territory Department of Land Resource Management
DOE	Commonwealth Department of the Environment
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EVNT	Endangered, Vulnerable or Near Threatened (conservation status listing of species under the EPBC Act)
GPS	Global Positioning System
ha	Hectare
IBRA	Interim Biogeographic Regionalisation for Australia
km	Kilometre
NTEPA	Northern Territory Environment Protection Authority
NVIS	National Vegetation Information System
OZCAM	Online Zoological Collections of Australian Museums
PMST	Commonwealth EPBC Act Protected Matters search tool
TEC	Threatened Ecological Community
TPH	Total Petroleum Hydrocarbons
TPWC Act	*Territory Parks and Wildlife Conservation Act 2000*
TRH	Total Recoverable Hydrocarbons
WM Act	Northern Territory *Weeds Management Act 2001*
WONS	Weeds of National Significance

1. Introduction

Imperial Oil & Gas Pty Ltd proposes to conduct shale gas exploration within the McArthur Basin, Northern Territory and, pending identification of suitable resources, commercially extract the gas. The exploration, development, commercial extraction and construction of associated infrastructure have the potential to impact on surface water, flora and fauna.

O2 Ecology was engaged by Imperial Oil & Gas Pty Ltd to undertake a preliminary ecological assessment within Exploration Permit areas EP184 and EP187 in the Northern Territory.

1.1. Project Overview

This project involves a desktop investigation and preliminary ecological assessment to identifying key ecological characteristics and potential constraints to exploration and development within the tenements. The information will be used by Imperial Oil & Gas Pty Ltd to assist with assessing the financial and technical viability of resource development within the areas studied on these tenements and developing a preliminary Environmental Assessment Report.

1.2. Study Objectives

The desktop investigation and end of dry season preliminary ecological assessment and water quality sampling provide an assessment and summary of the existing environmental values and conditions within the tenements. The objectives of the ecological surveys are to provide:

- end of dry season water quality assessment;
- habitat and vegetation community descriptions;
- locations and photos of communities and species present;
- opportunistic fauna (terrestrial and aquatic) species list, including introduced species and any threatened species present;
- locations of fauna breeding places and other habitat features; and
- likelihood of targeted threatened species to occur generally over the tenements.

This report contains field survey methods, survey limitations, the results of desktop investigations and findings and is sectioned as follows:

- Method – describes the methods and information sources used during this investigation
- Existing Environment – describes the existing environment on the tenements, including the physical and biological aspects of the environment
- Conclusion

1.3. Location of the Study Area

EP184 is a 1,122,000 ha area situated in the central trough of the McArthur Basin south of the Roper River and adjacent to the Gulf of Carpentaria. The area consists largely of national park area (Limmen National Park) with some traditional indigenous lands and agriculture (grazing of natural vegetation).

EP187 is situated approximately 84 km south west of Borroloola within the Carpentaria and McArthur Basin. A portion of the northern boundary is shared with the southern boundary of Limmen National Park. Agriculture (grazing of natural vegetation) is the dominant land use.

Refer to **Figure 1** for the location and layout of EP184 and EP187.

Figure 1 Regional location

2. Method

This section outlines the methods undertaken to describe the existing environmental values of the study area. A combination of desktop assessment and end of dry season field survey was conducted as part of this study. The desktop assessments included a review of relevant literature, mapping and database searches. The field survey obtained preliminary ecological information and opportunistic observations relevant to the study area in conjunction with the preliminary water quality sampling event. This section also outlines the terminology and nomenclature used in this report and describes the procedures and guidelines used for assessing the vegetation and flora values of the study area.

2.1. Background Assessment

Desktop assessments of available State 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. The desktop assessment used the following databases and documents described briefly below:

- Commonwealth Department of Environment protected matters search tool
- The Atlas of Living Australia (ALA) database
    - Australia's Virtual Herbarium (AVH)
    - Online Zoological Collections of Australian Museums (OZCAM)
- BirdLife Australia's Birdata
- National Vegetation Information System (NVIS)
- Department of Land Resource Management (DLRM) species atlas
- Biodiversity Northern Territory Portal
    - FrogWatch
    - ReptileWatch
    - MammalWatch
    - BirdWatch
- National Vegetation Information System (NVIS) mapping data
- Australian Wetland Database
- Topographic and hydrological mapping
- Available geology and soils mapping
- Atlas of Australian Soils and Explanatory Data Sheet for area
- Any other previous environmental surveys, studies or EIS in the vicinity of the project area
- Available remotely sensed imagery such as Google Earth or orthorectified aerial photography

The Commonwealth Department of the Environment (DOE) 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 -14.677, 136.168; -16.998, 136.168; -16.998, 134.48; -14.677, 134.48; and -14.677, 136.168 with a 10 km buffer.

The Atlas of Living Australia (ALA) database contains records of Australia's Virtual Herbarium (AVH) (Council of Heads of Australasian Herbaria 2014) and the Online Zoological Collections of Australian Museums (OZCAM) (Council of Heads of Australian Faunal Collections 2014) and provides information on all the known species in Australia aggregated from a wide range of data providers: museums, herbaria, community groups, government departments, individuals and universities. Database records for the area surrounding the site

were used to provide locations of any threatened species records within the area. Records for the Roper Gulf Shire Council area were downloaded and clipped to records relevant to the tenement areas.

BirdLife Australia's Birdata was used to provide a list of all bird species observed within a one degree squares containing postcode 0854 (Borroloola) and latitude/longitude coordinates -14.72716, 134.73408 and -16.69114, 135.74868.

Records of species in the Northern Territory Department of Land Resource Management (DLRM) spatial species atlas dataset was clipped to 1km of the tenement boundaries.

The Biodiversity Northern Territory Portal (including FrogWatch, ReptileWatch, MammalWatch and BirdWatch) provides information about species found across northern Australia.

The National Vegetation Information System (NVIS) provides information on the extent and distribution of vegetation types in Australian landscapes. The NVIS framework enables the compilation of data collected by States and Territories into a nationally consistent vegetation dataset. It provides descriptions of structural and floristic patterns of groups of plants in the landscape. NVIS version 4.1 products were used.

2.2. Likelihood of Occurrence Assessment

An assessment was undertaken of the likelihood of occurrence for threatened 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 Environment Protection Authority (NTEPA) 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 Assessment

The field component of this preliminary ecological assessment was carried out in conjunction with the first round of baseline water quality sampling on EP187 (16-17 December 2015) and EP184 (27-28 December 2015). Due to restrictions on site access in the area, all ecological assessments consisted of opportunistic assessments at each water quality sampling location and from the vantage of the helicopter for a broader scale perspective of the study areas. The location of the on-ground assessments is therefore in areas adjacent to water.

The 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.

The ecological surveys aimed to document for end of dry season conditions:

- habitat and vegetation community descriptions;
- locations and photos of communities and species present;
- opportunistic fauna (terrestrial and aquatic) species list, including introduced species and any threatened species present;
- locations of fauna breeding places and other habitat features; and
- likelihood of targeted threatened species to occur generally over the site.

Water quality sampling was carried out at each site for:

- 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
- 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

Water quality sampling and ecological assessment locations are shown in **Table 1**. Sampling locations were chosen through a desktop process and approved prior to field surveys being carried out. Where actual sampling sites differed from approved locations due to access, suitability as a water quality sampling location or cultural reasons, traditional owners were consulted and assisted in the re-location of the survey site. Traditional owners were present during field survey activities and approved the activities in the given location prior to any sampling at each site.

Table 1 Survey sites

Name	Description	Zone	Zone	Easting	Northing
PP-1	Paradise Pool on Tooganginie Creek	53	K	538835	8137444
McR-1	McArthur River (approved location)	53	K	566932	8140603
EP-1	Eleanor Pool on Christmas Creek	53	K	527222	8171987
LC-1	Leila Creek	53	K	570928	8167018
LBR-1	Limmen Bight River	53	L	541471	8283938
LT-1	Little Towns River	53	L	462397	8313829
RR-1	Roper River	53	L	449786	8371639
HR-1	Hodgson River	53	L	455672	8361327
MC-1	Mountain Creek	53	L	474345	8354364
WC-1	Whirlpool Creek	53	L	492111	8349991
TR-1	Towns River	53	L	523603	8337954
MR-1	Magaranyi River	53	L	520218	8330690

2.4. Coordinate System and Map Datum

Some raw search results (see **Appendix A**) are provided in Latitude/Longitude format.

Positional data was collected with a handheld Garmin eTrex Global Positioning System (GPS) unit, with accuracy between 4 and 8 m. Locations were recorded using the UTM coordinate system with a WGS84 datum. All locations presented in this report use MGA94 Zone 53.

2.5. Study Limitations

The preliminary ecological assessment was limited to the area immediately adjacent to water quality sampling locations along waterways due to access restrictions. The tenements encompass vast areas and although the sites are spread throughout the tenements and provide a broad understanding of the waterways and some of the associated communities, the majority of the area could not be visited and assessed. More detailed assessments should be carried out in relevant areas once work areas are known and prior to any works.

Many of the sites had experienced hot fires in the recent past, causing plant death and removal.

This is the preliminary assessment for the end of dry season. Further assessments will be carried out in the coming months to provide an understanding of seasonal changes.

The absence of species observations does not indicate that the species is absent from the study area.

3. Existing Environment

3.1. Physical Environment

3.1.1. Climate

The majority of EP184 experiences a grassland (Koeppen Classification) climate with hot, humid, wet (650-1200 mm rainfall) summers and winter droughts (Bureau of Meteorology 2012). Two exceptions to this are the eastern portion of the tenement that lies along the coast experiences a savanna (Koeppen Classification) climate and the southern 'leg' of the tenement experiencing slightly less rainfall (Bureau of Meteorology 2012).

EP187 also experiences a grassland (Koeppen Classification) climate with hot, humid, wet summers and winter droughts (Bureau of Meteorology 2012) but receives less rainfall (350-650 mm rainfall) than EP184.

Figure 2 shows the mean monthly rainfall and the mean monthly temperature at the nearest Bureau of Meteorology (BOM) long term weather station to EP184 (Ngukurr 14609). This station was closed on 1 May 2013. The mean maximum temperatures range from 29.6°C in July to 38.8°C in November, with the mean minimum temperatures ranging from 15.2°C in July to 25.5°C in December. The mean annual rainfall is 815.5 mm with January, the wettest month, averaging 182.8 mm of rainfall and August, the driest month, averaging 0.7 mm of rainfall. Over 60% of the rainfall occurs between December and February (inclusive). (Bureau of Meteorology 2015)

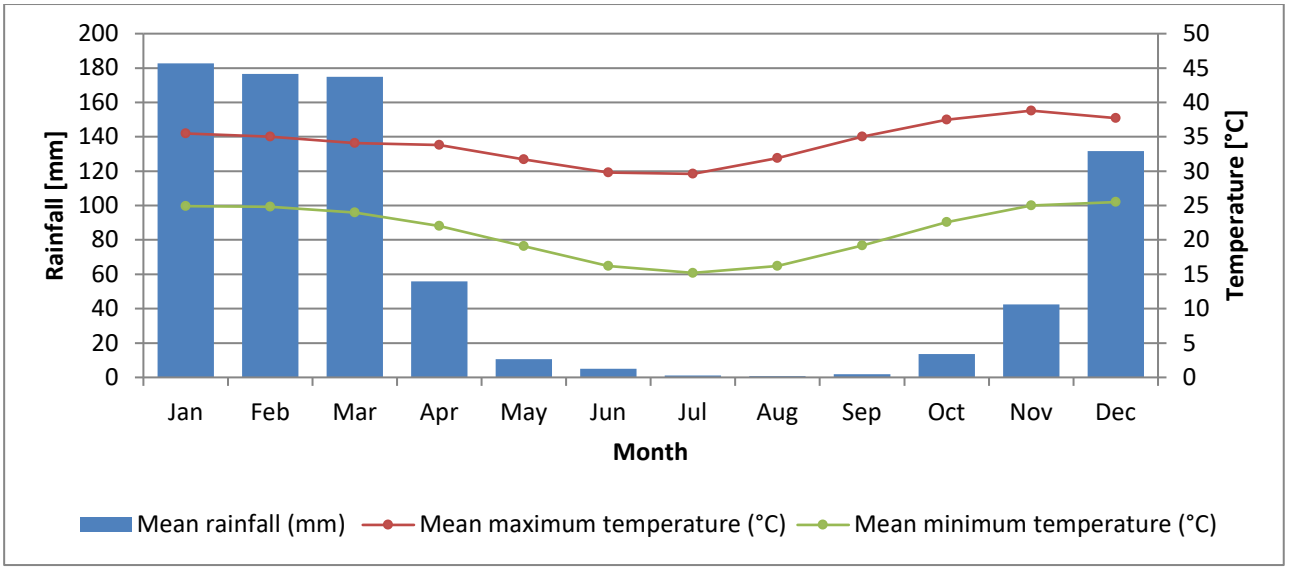

Figure 2 Mean monthly rainfall and temperature (Ngukurr 14609)

Figure 3 shows the mean monthly rainfall and the mean monthly temperature at the nearest Bureau of Meteorology (BOM) long term weather station to EP187 (McArthur River Mine Airport 14704). The mean maximum temperatures range from 29.8°C in June to 38.6°C in November, with the mean minimum temperatures ranging from 12.2°C in July to 25°C in December. The mean annual rainfall is 794.5 mm with January, the wettest month, averaging 214.2 mm of rainfall and August, the driest month, averaging 0.3 mm of rainfall. Over 65% of the rainfall occurs between December and February (inclusive). (Bureau of Meteorology 2015)

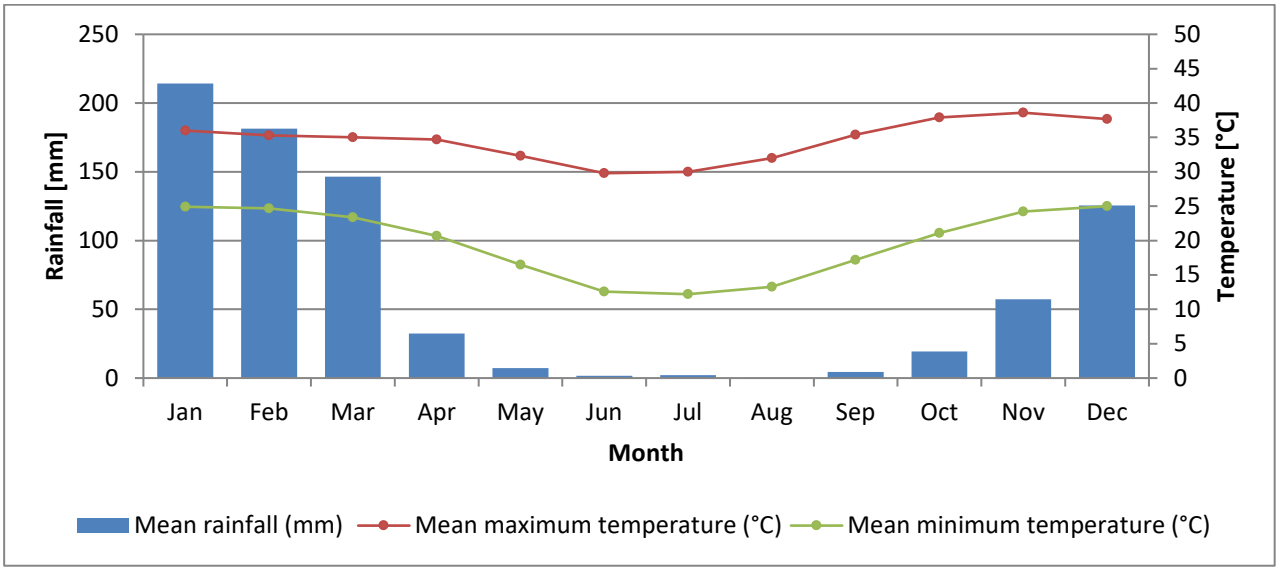

Figure 3 Mean monthly rainfall and temperature (McArthur River Mine Airport 14704)

The Bureau of Meteorology's Ngukurr station is along the northern boundary and on the western side of EP184. The McArthur River Mine Airport station is to the west of EP187. The differences between the climate statistics at the two long term weather station indicate that the tenements experience different rainfall and temperature due to the vast areas as well as differences in topographical features.

3.1.2. Surface Water Hydrology

EP184 lies within the Roper River, Towns River, Limmen Bight River, Rosie River and McArthur River catchments. EP187 lies within the Limmen Bight River and McArthur River catchments. All of these rivers discharge into the Gulf of Carpentaria, east of the tenements.

Three nationally significant wetlands are located within or downstream of the tenements:

- Limmen Bight (Port Roper) Tidal Wetlands System (NT007)
- Borroloola Bluebush Swamps (NT006)
- Port McArthur Tidal Wetlands System (NT008)

These wetlands are discussed further in **Section 3.2.2**.

Numerous springs have been recorded within the tenements as shown by the Northern Territory Government's Springs of the Northern Territory dataset. The waterways, wetlands and springs are shown in **Figure 4**.

Figure 4 Waterways, Wetlands and Springs

3.2. Biological Environment

3.2.1. IBRA7 Bioregion and Subregion

The Interim Biogeographic Regionalisation for Australia (IBRA) is endorsed by all levels of government and provides the national and regional planning framework for the systematic development of a comprehensive, adequate and representative National Reserve System. IBRA7 (the current version) classifies Australia's landscapes into 89 large geographically distinct bioregions based on common climate, geology, landform, native vegetation and species information. These are broken into 419 subregions based on more localised and homogenous geomorphological units in each bioregion.

The study area falls within three IBRA Bioregions (**Figure 5**).

Gulf Coastal Bioregion

The north eastern portion of EP184 falls within the Limmen subregion (GUC01) of the Gulf Coastal (GUC) Bioregion.

The Gulf Coastal bioregion comprises 2,711,718 ha of gently undulating coastal plains with scattered rugged areas of Proterozoic sandstones and Tertiary sediments. The soils are predominantly sandy red earths and shallow gravelly sands. (Department of Land Resource Management 2016a)

Much of the bioregion is in good condition but widespread impacts from weeds, feral animals, changed fire regimes and grazing and localised impacts from mining and exploration are increasing (Department of Land Resource Management 2016a).

Gulf Fall and Uplands Bioregion

The western and southern EP184 and the majority of EP187 fall within the McArthur subregion (GFU01) of the Gulf Fall and Uplands (GFU) Bioregion.

The Gulf Falls and Uplands bioregions comprises 11,847,909 ha of undulating terrain with scattered low, steep hills on Proterozoic and Palaeozoic sedimentary rocks, often overlain by lateritised Tertiary material. The soils are mostly skeletal or shallow sands. (Department of Land Resource Management 2016b)

The bioregion is generally in good condition but impacts from increasing numbers of feral animals (especially pigs, buffalo, donkeys and cattle) and weeds, and broad-scale changes in fire regime are intensifying (Department of Land Resource Management 2016b).

Sturt Plateau Bioregion

The south eastern portion of EP187 falls within the Newcastle subregion (STU02) of the Sturt Plateau (STU) Bioregion.

The Sturt Plateau bioregion mostly comprises 9,857,531 ha of gently undulating plain on lateritised Cretaceous sandstones. Soils are predominantly neutral sandy red and yellow earths. (Department of Land Resource Management 2016c)

Most of the bioregion is in moderate to good condition with minor impacts from weeds, feral animals, pastoralism and changed fire regimes (Department of Land Resource Management 2016c).

3.2.2. Conservation Significant Areas

Areas of conservation significance coinciding with and downstream of the tenements include national park, conservation reserve, nationally and internationally significant wetland areas (**Figure 5**).

The majority of the EP184 coincides with Limmen National Park, a vast 960,846 ha area that was declared as a national park on 17 July 2012. The park protects permanent tidal rivers, extensive wetlands, sandstone 'lost

city' formations, Indigenous and European historic sites and an abundance of wildlife, including a large number of threatened fauna and flora species.

Limmen Bight and associated coastal floodplains are located in the Gulf of Carpentaria and cover a marginal portion of the north eastern portion of EP184 (**Figure 5**). The area is associated with the coastal regions surrounding the Roper River, Towns River and Limmen Bight River mouths. The area is dominated by some of the most extensive coastal mudflats in the Northern Territory; and mangrove forests of the Roper River mouth and the Limmen Bight River coastal delta system. The coastal area is considered of international significance by providing breeding grounds and habitat for marine turtles, seabirds, waterbirds and shorebirds, and majority of this site is listed as a wetland of national significance in the Directory of Important Wetlands (see NT007 below). The extensive intertidal mudflats of Limmen Bight are among the most important areas for migratory shorebirds in the Northern Territory, supporting large aggregations of waders (Department of Natural Resources Environment the Arts and Sport 2013b). The area also supports large colonies of waterbirds and nesting seabirds and provides important nesting sites for Green and Flatback turtles (Department of Natural Resources Environment the Arts and Sport 2013b).

The Limmen Bight (Port Roper) Tidal Wetlands System (NT007) is a wetland of national importance that includes tidal wetland in the far south-west of the Gulf of Carpentaria that extends from near Warrakunta Point, southwest to Port Roper and southeast to the mouth of Rosie Creek (Department of the Environment 2016c). Most of this mapped wetland system is northeast of EP184 and outside of the tenement (refer **Figure 5**). The wetlands are the second-largest area of saline coastal flats in the Northern Territory and are a good example of a system of tidal wetlands typical of the Gulf of Carpentaria coast (Department of the Environment 2016c).

The Borroloola area is located in the transition zone between tropical and arid zones, immediately southwest of Borroloola. The Borroloola area is located outside of both EP184 and EP187, approximately 25 km east of the southern portion of EP184 and approximately 50 km downstream of EP187 (whilst the township of Borroloola is approximately 84km away from EP187) (**Figure 5**). The centre of the area is dominated by rugged rocky sandstone hills of the north Bukalara Range and there is near-permanent water at Caranbirini Waterhole (Department of Natural Resources Environment the Arts and Sport 2013a). The area includes a diverse range of habitats for fauna, including black soil plains and swamps, woodland, and sandstone ranges that provide habitat for some endemic, range restricted species and geographically disjunct populations (Department of Natural Resources Environment the Arts and Sport 2013a). The operational Glencore Xstrata McArthur River Mine (one of the world's largest zinc, lead and silver mines) is located within the Borroloola Area.

Caranbirini Conservation Reserve (**Figure 5**) is encompassed within the Borroloola area described above and is located approximately 18km north and downstream of the existing and operational Glencore Xstrata McArthur River Mine. The reserve is located within the ecological transition zone between the tropical north and drier centre and protects the region's unique flora and fauna and a variety of habitats including a sandstone escarpment, a semi-permanent waterhole with surrounding riverine vegetation and open woodland (Parks and Wildlife Commission NT 2016).

Borroloola Bluebush Swamps (NT006) is a wetland of national importance located 3.5 km south-south-west of Borroloola (**Figure 5**). The wetland is notable for its combination of vegetation types and is a regionally significant breeding area for waterbirds (Department of the Environment 2016c). The Borroloola Bluebush Swamps

The McArthur River coastal floodplain is located approximately 30 km northeast of Borroloola in the Gulf of Carpentaria, downstream of EP184 and EP187 (**Figure 5**). The area is of national significance. The McArthur River has a large delta system and the floodplain encompasses open saline flats that are amongst the most extensive around the coast of the Northern Territory and support low chenopod shrublands (Department of Natural Resources Environment the Arts and Sport 2013c). The mud flats are dry for much of the year and

extend beyond extensive mangrove systems for up to five kilometres in places (Department of Natural Resources Environment the Arts and Sport 2013c). The area is important to migratory shorebirds, breeding waterbirds and colonially-breeding seabirds (Department of Natural Resources Environment the Arts and Sport 2013c). This area is significantly downstream of EP184 and EP187. There is currently a loading port facility in this area for bulk concentrate material from the Glencore Xstrata McArthur River Mine.

3.2.3. Vegetation communities

The National Vegetation Information System (NVIS) provides information on the extent and distribution of vegetation types in Australian landscapes. The NVIS framework enables the compilation of data collected by States and Territories into a nationally consistent vegetation dataset. It provides descriptions of structural and floristic patterns of groups of plants in the landscape. There are 41 NVIS Level 4 community descriptions mapped over the tenements (**Table 2** and **Figure 6**).

The vegetation communities mapped over the tenements include woodland, tussock grassland, sparse samphire shrubland and forest. Eucalyptus woodland dominates the area (57%), followed by Corymbia low open woodland (11%), Eucalyptus low woodland (7%) and Chrysopogon (mixed) tussock grassland (6%).

3.2.4. Conservation Significant Ecosystems

Ecological communities are naturally occurring biological assemblages that occur in a particular type of habitat. Threatened ecological communities (TECs) are ecological communities that have been assessed and assigned to a particular category related to the status of the threat to the community at a national scale, i.e. extinct, critically endangered, endangered, vulnerable, and conservation dependant. TECs are protected under the EPBC Act.

No listed TECs were identified by the EPBC PMST (**Appendix A**) within the search area.

Figure 5 IBRA7 and Conservation Significant Areas

Table 2 Vegetation communities mapped over the tenements (NVIS4.1)

Vegetation ID	NVIS L2	NVIS L3	NVIS L4	Area (ha)
1053	Closed forest	*Avicennia* low closed forest	*Avicennia* low closed forest*Aegialitis* low open woodland*Avicennia* low open shrubland	53
1049	Closed forest	*Ceriops* low closed forest	*Ceriops* low closed forest*Ceriops* unknown tree*Ceriops* low sparse shrubland	296
1062	Mid closed forest	*Aglaia* (mixed) mid closed forest	*Aglaia* (mixed) mid closed forest	29
1061	Mid closed forest	*Canarium* (mixed) mid closed forest	*Canarium* (mixed) mid closed forest	775
1050	Mid closed forest	*Rhizophora* (mixed) mid closed forest	*Rhizophora* (mixed) mid closed forest*Bruguiera* low open forest*Aegialitis* (mixed) low open sparse	1,632
1051	Mid closed forest	*Rhizophora* mid closed forest	*Rhizophora* mid closed forest*Rhizophora* tall sparse shrubland*Rhizophora* (mixed) mid sparse	290
390	Open forest	*Acacia* low open forest	*Acacia* low open forest*Eriachne* low open tussock grassland	5,367
364	Open forest	*Acacia* open forest	*Acacia* mid open forest*Acacia* tall open shrubland*Chrysopogon* low open tussock grassland	10,208
1048	Open forest	*Avicennia* (mixed) low open forest	*Ceriops* (mixed) low open forest*Aegialitis* mid sparse shrubland*Halosarcia* low sparse chenopod	395
1047	Open forest	*Avicennia* low open forest	*Avicennia* low open forest*Ceriops* low open forest*Avicennia* low open shrubland	1,872
330	Open forest	*Melaleuca* open forest	*Melaleuca* mid open forest*Melaleuca* low open woodland*Eleocharis* low open sedgeland	1,546
315	Open forest	*Melaleuca* open forest	*Melaleuca* mid open forest*Melaleuca* low open woodland*Pseudoraphis* low open tussock grassland	91
360	Open forest	*Melaleuca* open forest	*Melaleuca* mid open forest*Pandanus* low sparse palmland*Germainia* mid open tussock grassland	1,143
343	Open woodland	*Corymbia* low open woodland	*Corymbia* low open woodland*Acacia* mid open shrubland*Triodia* mid open hummock grassland	39,662
342	Open woodland	*Corymbia* low open woodland	*Corymbia* low open woodland*Acacia* tall open shrubland*Triodia* mid open hummock grassland	146,215
1041	Open woodland	*Eucalyptus* low open woodland	*Eucalyptus* low open woodland*Acacia* mid sparse shrubland*Astrebla* low tussock grassland	18,017
346	Open woodland	*Eucalyptus* low open woodland	*Eucalyptus* low open woodland*Acacia* mid sparse shrubland*Triodia* low open hummock grassland	6,748
345	Open woodland	*Eucalyptus* low open woodland	*Eucalyptus* low open woodland*Carissa* mid sparse shrubland*Triodia* low open hummock grassland	59,175
355	Open woodland	*Lysiphyllum* low open woodland	*Lysiphyllum* low open woodland*Atalaya* mid sparse shrubland*Eulalia* low tussock grassland	12,210
413	Sparse samphire shrubland	*Halosarcia* low sparse samphire shrubland	*Halosarcia* low sparse samphire shrubland	27,314
336	Tussock grassland	*Chrysopogon* (mixed) low tussock grassland	*Eucalyptus* low open woodland*Carissa* mid sparse shrubland*Chrysopogon* low tussock grassland	2,076
1020	Tussock grassland	*Chrysopogon* (mixed) tussock grassland	*Eucalyptus* low woodland*Carissa* mid sparse shrubland*Chrysopogon* mid tussock grassland	97,901

Vegetation ID	NVIS L2	NVIS L3	NVIS L4	Area (ha)
317	Tussock grassland	*Xerochloa* tussock grassland	*Xerochloa* mid tussock grassland	130
395	Woodland	*Acacia* low woodland	*Acacia* low woodland*Eragrostis* low open tussock grassland	602
391	Woodland	*Acacia* low woodland	*Acacia* low woodland*Eriachne* low open tussock grassland	10,047
392	Woodland	*Acacia* woodland	*Acacia* mid woodland*Eriachne* mid open tussock grassland	7277
331	Woodland	*Corymbia* low woodland	*Corymbia* low woodland*Terminalia* mid sparse shrubland*Chrysopogon* low tussock grassland	59,762
365	Woodland	*Eucalyptus* low woodland	*Eucalyptus* low woodland*Acacia* mid sparse shrubland*Eriachne* low open tussock grassland	10,363
1020	Woodland	*Eucalyptus* low woodland	*Eucalyptus* low woodland*Carissa* mid sparse shrubland*Chrysopogon* mid tussock grassland	97,901
338	Woodland	*Eucalyptus* low woodland	*Eucalyptus* low woodland*Erythrophleum* mid sparse shrubland*Triodia* mid hummock grassland	3110
570	Woodland	*Eucalyptus* woodland	*Eucalyptus* mid woodland*Bossiaea* tall sparse shrubland*Eriachne* low sparse tussock grassland	380,533
382	Woodland	*Eucalyptus* woodland	*Eucalyptus* mid woodland*Eucalyptus* tall sparse shrubland*Heteropogon* mid open tussock grassland	5793
324	Woodland	*Eucalyptus* woodland	*Eucalyptus* mid woodland*Flueggea* mid sparse shrubland*Sehima* mid tussock grassland	520,884
394	Woodland	*Macropteranthes* (mixed) low woodland	*Macropteranthes* low woodland*Chrysopogon* mid open tussock grassland	233
323	Woodland	*Melaleuca* low woodland	*Melaleuca* low woodland*Calytrix* mid sparse shrubland*Chrysopogon* low open tussock grassland	6,853
358	Woodland	*Melaleuca* low woodland	*Melaleuca* low woodland*Flueggea* mid sparse shrubland*Chrysopogon* low open tussock grassland	26,606
325	Woodland	*Melaleuca* low woodland	*Melaleuca* low woodland*Melaleuca* mid sparse shrubland*Eulalia* low open tussock grassland	253
320	Woodland	*Melaleuca* low woodland	*Melaleuca* low woodland*Pandanus* low sparse palmland*Eleocharis* mid sedgeland	980
321	Woodland	*Melaleuca* woodland	*Melaleuca* mid woodland*Asteromyrtus* low open woodland*Triodia* low open hummock grassland	6,884
316	Woodland	*Melaleuca* woodland	*Melaleuca* mid woodland*Melaleuca* low open woodland*Chrysopogon* mid open tussock grassland	4,673
383	Woodland	*Melaleuca* woodland	*Melaleuca* mid woodland*Melaleuca* low open woodland*Fimbristylis* low open sedgeland	471
982	Unknown	Unknown	unknown	252

Note: Vegetation ID can be used to identify dominant vegetation type in polygons shown in **Figure 6**

Figure 6 Vegetation (NVIS 4.1 Dominant Structural Formation)

3.2.5. 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 has been previously recorded within the search area.

Of the 169 conservation significant fauna species known or predicted to occur, 80 species have been previously recorded within the search area.

Table 3 lists the threatened fauna and flora species that are at least moderately likely to occur within the study area based on the likelihood of occurrence assessment.

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. Note that many species are specialists of tidal areas and are likely to be concentrated in the estuarine area in the east of EP184.

The following sections summarise findings from each of the databases.

EPBC Protected Matters

The EPBC PMST identified the search area as having potential habitat for no nationally threatened flora and 112 conservation significant fauna (30 threatened and 82 migratory or marine) species listed under the EPBC Act (**Appendix A**).

It should be noted that the EPBC Act online search gives details of species that are predicted to be present with the defined area based on bioclimatic modelling. The search area also includes some coastal and marine areas. As such, these species have not necessarily been observed within the study area and suitable habitat may not occur within the study area. For example, bioclimatic generated PMST results of potentially occurring species within the marine environment adjacent to EP184 report sea turtle, whale and seahorse species; these species are excluded from our likelihood of occurrence assessments as they are unlikely to occur within the tenements.

Birdata

BirdLife Australia's Birdata (**Appendix A**) shows records of 191 bird species observed within the search area. Of those, 40 species are conservation significant, including 2 threatened species listed under the EPBC Act and TPWC Act and 38 migratory or marine species protected under the EPBC Act. Please refer to the Likelihood of Occurrence table (**Appendix B**) for further details on conservation status, habitat preferences and likelihood of occurrence in the region.

Atlas of Living Australia

The ALA database returned records for 32 fauna species listed under the EPBC Act and/or TPWC Act within the search area. The records for one endangered flora species, *Cryptocarya hypospodia*, do not appear to be from a trusted source, are not referred to by other accounts of the species and have therefore been ignored.

Department of Land Resource Management Species Atlas

A query of the DLRM Species Atlas returned 1078 plant species that have been historically recorded within the study area. These included 1034 native species and 44 species that have been introduced to the Northern Territory. There are no historical records for threatened flora species within the search area.

The DLRM Species Atlas database returned 411 vertebrate species that have been historically recorded within 1 km of the tenement boundaries. These included 402 native species and nine exotic species. There were historical records for 79 conservation significant fauna species within the search area.

Table 3 Threatened species likely to occur within the study area

Class	Species Name	Common Name	EPBC Act Status	TPWC Act Status	IUCN Status
Birds	*Calidris canutus*	Red knot, knot	M, Ma	V	LC
Birds	*Calidris ferruginea*	Curlew sandpiper	CE, M, Ma	V	LC
Birds	*Calidris tenuirostris*	Great knot	M, Ma	V	VU
Birds	*Charadrius leschenaultii*	Greater sand plover	M, Ma	V	LC
Birds	*Charadrius mongolus*	Lesser sand plover	M, Ma	V	LC
Birds	*Erythrotriorchis radiatus*	Red goshawk	V	V	NT
Birds	*Erythrura gouldiae*	Gouldian finch	E	V	NT
Birds	*Falcunculus frontatus whitei*	Northern shrike-tit	V	-	-
Birds	*Grantiella picta*	Painted honeyeater	V	V	VU
Birds	*Limosa lapponica*	Bar-tailed godwit	Ma, M	V	LC
Birds	*Numenius madagascariensis*	Eastern curlew	CE, M, Ma	V	VU
Birds	*Rostratula australis* (Syn. *Rostratula benghalensis*)	Australian painted snipe	E, Ma	V	EN
Birds	*Tyto novaehollandiae kimberli*	Masked owl (northern)	V	V	
Mammals	*Dasyurus hallucatus*	Northern quoll	E	CE	EN
Mammals	*Rattus tunneyi*	Pale field-rat	-	V	LC
Mammals	*Xeromys myoides*	Water mouse	V	-	VU
Reptiles	*Varanus mertensi*	Mertens' water monitor	-	V	-
Reptiles	*Varanus mitchelli*	Mitchell's water monitor	-	V	-
Reptiles	*Varanus panoptes*	Yellow-spotted monitor	-	V	-

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

Table 4 Migratory species likely to occur within the study area

Class	Species Name	Common Name	EPBC Act Status	TPWC Act Status	IUCN Status
Birds	*Actitis hypoleucos*	Common sandpiper	Ma, M	-	LC
Birds	*Apus pacificus*	Fork-tailed swift	Ma, M	-	LC
Birds	*Ardea alba* (Syn. *A. modesta*)	Great egret, white egret	Ma, M	-	LC
Birds	*Ardea ibis* (Syn. *Bubulcus ibis*)	Cattle egret	Ma, M	-	LC
Birds	*Arenaria interpres*	Ruddy turnstone	M, Ma	NT	LC
Birds	*Calidris acuminata*	Sharp-tailed sandpiper	M, Ma	-	LC
Birds	*Calidris ruficollis*	Red-necked stint	M, Ma	-	LC
Birds	*Charadrius veredus*	Oriental plover, oriental dotterel	M, Ma	-	LC
Birds	*Gelochelidon nilotica* (Syn. *Sterna nilotica*)	Gull-billed tern	M, Ma	-	LC
Birds	*Glareola maldivarum*	Oriental pratincole	M, Ma	-	LC
Birds	*Hirundo rustica*	Barn swallow	M, Ma	-	LC
Birds	*Hydroprogne caspia*	Caspian tern	M	-	LC
Birds	*Limicola falcinellus*	Broad-billed sandpiper	M, Ma	-	-
Birds	*Limosa limosa*	Black-tailed godwit	M, Ma	NT	NT
Birds	*Merops ornatus*	Rainbow bee-eater	Ma, M	-	LC
Birds	*Numenius phaeopus*	Whimbrel	M, Ma	NT	LC
Birds	*Pandion haliaetus* (Syn. *P. cristatus*)	Eastern osprey	M	-	LC
Birds	*Plegadis falcinellus*	Glossy ibis	M, Ma	-	LC
Birds	*Pluvialis fulva*	Pacific golden plover	M, Ma	-	LC
Birds	*Pluvialis squatarola*	Grey plover	M, Ma	NT	LC
Birds	*Tringa glareola*	Wood sandpiper	M, Ma	-	LC
Birds	*Tringa nebularia*	Common greenshank	M, Ma	-	LC
Birds	*Tringa stagnatilis*	Marsh sandpiper	M, Ma	-	LC
Birds	*Xenus cinereus*	Terek sandpiper	M, Ma	-	LC
Reptiles	*Crocodylus porosus*	Salt-water crocodile, estuarine crocodile	M, Ma	-	LC/LR

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
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

3.2.6. Weeds and Pests

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 2007). 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 & Lynch 2000). 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 Territory level, a declared weed is a plant or species of plant which has been identified for control, eradication, or prevention of entry in all or part of the Territory under the Northern Territory *Weeds Management Act 2001* (WM Act). A weed may be declared as:

- **Class A** – necessary to eradicate
- **Class B** – necessary to prevent the growing and spreading
- **Class C** – necessary to prevent the introduction to the Territory

All Class A and Class B weeds are also considered to be Class C weeds.

One of the 44 introduced plant species, *Parthenium hysterophorus*, is listed as a WONS and nine are declared weeds in the Northern Territory (**Table 5**).

A feral animal species declared under section 47(1) of the *Territory Parks and Wildlife Conservation Act 2006* is one that is not indigenous to Australia or, if it is indigenous to Australia, its natural habitat is not in the Territory; has spread from the site of its introduction and established itself within Australia or the Territory since its introduction into Australia or the Territory; and whose population or presence in a particular area in the Territory is not able to be easily controlled.

The DLRM Species Atlas database returned nine exotic species, eight of which are feral in the Northern Territory (**Table 6**).

Table 5 Weeds with historical records within the search area

Species	Common Name	WONS	NT Class
Acanthospermum hispidum	Star burr, goat's head		B
Cenchrus echinatus	Mossman river grass		B

Dalbergia sissoo	Dalbergia		A
Hyptis suaveolens	Hyptis		B
Parthenium hysterophorus	Parthenium weed	Y	A
Senna alata	Candle bush		B
Senna occidentalis	Coffee senna		B
Sida acuta	Spinyhead sida		B
Sida cordifolia	Flannel weed		B

Table 6 Feral animals with historical records within the search area

Species	Common Name
Bos taurus	Cattle
Bubalus bubalis	Swamp Buffalo
Canis lupus	Wild dog
Columba livia	Rock Dove
Equus caballus	Horse
Felis catus	Cat
Rhinella marina	Cane Toad
Sus scrofa	Pig

4. Field Assessment Results

4.1. Flora

The dominant flora species observed are listed in **Appendix D**.

4.1.1. Threatened Species

No threatened flora species were observed.

4.1.2. Weeds

Three (3) WONS (also Northern Territory declared Class A and C plants), *Vachellia nilotica*(prickly acacia) (EP-1, McR-1), *Chryptostegia grandiflora* (rubber vine) (LBR-1) and *Andropogon gayanus* (Gamba grass) (LC-1), and three (3) other Northern Territory declared Class B and Class C plants, *Hyptis suaveolens* (mint weed)(EP-1, WC-1), *Leonotis nepetifolia* (lion's ear) (EP-1) and *Calotropis procera* (rubber bush)(RR-1), were observed.

	Family	Species	Common Name	EP-1	LBR-1	LC-1	McR-1	RR-1	WC-1	Weed Class
*	Apocynaceae	*Cryptostegia grandiflora*	rubber vine		Y					WONS, A
*	Asclepiadaceae	*Calotropis procera*	rubber bush					Y		B
*	Lamiaceae	*Hyptis suaveolens*	hyptis	Y					Y	B
*	Lamiaceae	*Leonotis nepetifolia*	lion's ear	Y						B
*	Mimosaceae	*Vachellia nilotica*	prickly acacia	Y			Y			WONS, A
*	Poaceae	*Andropogon gayanus*	gamba grass			Y				WONS, A

4.2. Fauna

Opportunistic observations resulted in 100 fauna species including three amphibian, 11 mammal, 10 reptile, 72 bird and four fish species (**Appendix D**). Seven of the observed species were introduced and/or feral species.

4.2.1. Habitat Descriptions

Landscape features of benefit to wildlife (Queensland Government 2014) include:

- Large vegetation patches can support larger populations; fauna that require large territories and/or occur in low population densities; and may support a larger diversity of wildlife
- Patches that are rounded in shape have a smaller edge-to-area ratio and suffer fewer edge effects than patches of a similar size that are long and thin. Edge effects that can impact on wildlife include increased weed invasion, predation, wind, high temperature and solar radiation
- Patches of vegetation that are in close proximity to other patches provide opportunities for wildlife to move between patches as there is a lower risk of predation during movement
- The proportion of the landscape that is cleared of suitable habitat affects wildlife, with birds and mammals negatively affected if more than 70% of the suitable habitat is removed from the landscape. Remaining patches of vegetation are important to wildlife conservation and restoration projects.

Microhabitat features within the larger landscape are also important to native fauna (Queensland Government 2014):

- Large trees with or without hollows, fallen logs, leaf litter, and understorey vegetation provide food, shelter and breeding sites for native mammals.
- Many native birds are specialised in their habitat requirements and rely on natural bushland for shelter, food and nesting.
- Native vegetation, tree hollows, hollow logs, peeling bark, rocky outcrops, surface rock and leaf litter provide food, shelter and breeding sites for reptiles.
- Creeks, dams and temporary puddles provide breeding, food and shelter to frog species reliant on water. Riparian vegetation including grasses, sedges and shrubs provides shelter and insect prey while logs and rocks near water offer shelter. Some frog species inhabit areas away from water.

The following sections describe the habitats that occur within the study area. The areas of intact vegetation provide a range of habitats that may support a diversity of fauna species. Areas that are heavily grazed, burned or degraded are of lowest habitat value within the study area. **Table 9** and **Table 10** summarise observed habitat values.

Ephemeral Waterways and Riparian Vegetation

Plate 1 Ephemeral waterway and riparian vegetation

Riparian areas often have significantly higher fauna diversity than surrounding areas, particularly if habitat diversity is correspondingly high. Habitat values include:

- Provides water 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
- Pools support aquatic, riparian-associated and other fauna species (bats, birds and introduced species) may rely on the water during drier periods
- Riparian woodlands are of critical importance for hollow-dependent animals (e.g. parrots, bats)
- The 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 red goshawk (*Erythrotriorchis radiatus*) where trees tall enough for nesting are restricted to the banks of major rivers
- Potential habitat for painted honeyeater (*Grantiella picta*) where riparian woodlands have an abundance of mistletoes.
- Potential water source for orange leaf-nosed bat (*Rhinonicteris aurantia*) where water occurs near suitable roost sites

Woodland or Shrubland

Plate 2 Low open 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
- Potential habitat for Carpentarian Antechinus (*Pseudantechinus mimulus*), which inhabits rocky areas and shelters among pebbles, boulders and stony hillsides or outcrops with shrubby open woodland and hummock grass understorey
- Potential foraging areas for orange leaf-nosed bat (*Rhinonicteris aurantia*) where eucalypt woodland occurs near cave roosts with appropriate microclimate conditions

Rocky Slopes, Stony Hills and Rock 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 Carpentarian Antechinus (*Pseudantechinus mimulus*), which inhabits rocky areas and shelters among pebbles, boulders and stony hillsides or outcrops with shrubby open woodland and hummock grass understorey
- Potential roost habitat for orange leaf-nosed bat (*Rhinonicteris aurantia*) where there are caves, boulder piles, shallow escarpments, deep natural caves or disused mines that provide the appropriate specific microclimate

Table 7 EP 187 Stream and Habitat Descriptions

Vegetation Community	Site/s	General Observations	Photo
RIPARIAN CORRIDOR			
Melaleuca leucadendra with *Eucalyptus chlorophylla* and *Ficus racemosa* riparian corridor with sandy silty beds.	LC-1 (Leila Creek) Surface water sample LC-1	Restricted to a series of pools. Disturbance by pigs and cattle observed. Evidence of macropods (scats). Freshwater crocodiles present in pools. Abundant flowering plants attracting nectivorous bird species.	

Vegetation Community	Site/s	General Observations	Photo
Melaleuca leucadendra with *Pandanus aquaticus*	McR-1 (McArthur River upstream) Surface water sample TC-1	Series of shallow clear pools. Abundant cane toad tadpoles and newly morphed cane toads. Some Noogoora burr observed on dry creek beds and banks	
Eucalyptus camaldulensis with *Melaleuca viridiflora, Pandanus aquaticus*	PP-1 (Paradise Pools (downstream)) Surface water sample PP-1	Freshwater crocodiles, black bream, archerfish observed. Provides suitable habitat for *Varanus mertensi* (Mertens Water Monitor). Permanent long reaches of fresh water in landscape.	
Eucalyptus camaldulensis, Acacia lamprocarpa, Alphitonia excels, Owenia vernicosa	EP-1 (Elenor Pool) Surface water sample EP-1	Valuable source of freshwater in wider landscape.	
LOW OPEN FOREST TO WOODLAND			
16. *Eucalyptus tectifica* (northern box), *E. terminalis* (bloodwood) woodland with *Sehima nervosum* (white grass), *Chrysopogon fallax* (golden beard grass) grassland understory. 35. *E. leucophloia* (snappy gum) low open woodland with *Plectrachne pungens* (curly spinifex) hummock grassland understorey.	LC-1	Evidence of grazing by cattle Wallabies present	
35. *E. leucophloia* (snappy gum) low open woodland with *Plectrachne pungens* (curly spinifex) hummock grassland understorey.	McR-1	*Acacia nilotica* Prickly acacia (Weed of National Significance (WONS))	

Vegetation Community	Site/s	General Observations	Photo
E. dichromophloia (variable-barked bloodwood) low woodland with *Chrysopogon fallax* (golden beard grass) and *Plectrachne pungens* (curley spinifex) grassland understory	PP-1 (foreground of photo)	Hot fire has burnt and killed much of the vegetation at this site.	
Corymbia low open woodland\Acacia tall open shrubland\Triodia mid open hummock grassland	EP-1	This site is adjacent to a cleared grazing property with horses Tawny frogmouth observed on a nest Termite mounds present	
ROCKY HABITATS			
E. dichromophloia (variable-barked bloodwood) low woodland with *Chrysopogon fallax* (golden beard grass) and *Plectrachne pungens* (curley spinifex) grassland understory	PP-1 (background of photo – rocky hill)	Rocky hills provide overhangs and habitat for reptiles and other rock-dwelling species. Spinifex	
35. *E. leucophloia* (snappy gum) low open woodland with *Plectrachne pungens* (curly spinifex) hummock grassland understorey	McR-1	Rocky hills provide overhangs and habitat for reptiles and other rock-dwelling species	

Table 8 EP 184 Stream and Habitat Descriptions

Vegetation Community	Site/s	General Observations	Photo
RIPARIAN CORRIDOR			
Melaleuca leucadendra with *Casuarina cunninghamiana*	LBR-1 (Limmen Bight River) Surface water sample NR-1	Predominantly dry. Restricted to a couple of pools. Cane toad tadpoles present. Some disturbance by cattle, buffalo and horses observed.	

Vegetation Community	Site/s	General Observations	Photo
Eucalyptus tectifica (northern box), *E. terminalis* (bloodwood) with *Sehima nervosum* (white grass), *Chrysopogon fallax* (golden beard grass) grassland understorey.	TR-1 (Towns River) Surface water sample TR-1	Black bream, archerfish and long-tom / garr observed.	
Melaleuca leucadendra with *Flagellaria indica* on sandy instream inslands	MR-1 (Magaranyi River (flows into Towns River)) Surface water sample TRU-1	Very low turbidity. Restricted to a series of clear freshwater pools. Freshwater crocodiles observed.	
Melaleuca symphyocarpa with *Brachychiton diversifolius*	LT-1 (Little Towns River) Surface water sample LT-1	*Varanus mertensi* Water monitor (Vulnerable – TPWC Act 2000) was observed from distance and swam into hollow in water body. Degraded by pigs, buffalo and cattle. Main water body remaining in larger landscape. Important water source for all fauna.	
E. camaldulensis with *Brachychiton diversifolius and B. paradoxum*	WC-1 (Whirlpool Creek) Surface water sample SW-1	Dry. Large *E. camaldulenis* provides abundant small – large hollows which provides critical importance for hollow-dependent animals (e.g. parrots, dragons, bats)	
Melaleuca leucadendra with *Eucalyptus camaldulensis*	MC-1 (Mountain Creek) Surface water sample MC-1	Very low turbidity. No odour, no sheen. Archerfish, barramundi and black bream observed.	
Melaleuca leucadendra along banks	RR-1 (Roper River) Surface water sample RR-1	Very low turbidity. No odour, no sheen Provides largest permanent freshwater source. Saltwater crocodiles observed.	

Vegetation Community	Site/s	General Observations	Photo
Melaleuca leucadendra along banks and dry vine thicket in areas.	HR-1 (Hodgson River) Surface water sample HR-1	Very low turbidity. No odour, no sheen. Saltwater crocodiles observed. Small colony of *Pteropus alecto* (black flying fox). Permanent freshwater source.	
LOW OPEN FOREST TO WOODLAND			
Melaleuca citrolens (paperbark) low woodland with *Chrysopogon fallax* (golden beard grass) open-grassland understorey.	LBR-1	Recently burnt landscape leaving little grass and shrub cover.	
Eucalyptus tectifica (northern box), *E. terminalis* (bloodwood) with *Sehima nervosum* (white grass), *Chrysopogon fallax* (golden beard grass) grassland understorey.	TR-1, MR-1, MC-1, LT-1, WC-1, HR-1	Donkeys and wild cattle observed. Recently burnt landscape leaving little grass and shrub cover.	
E. pruinosa (silver box) low woodland with *Eulalia aurea* (silky browntop), *Sehima nersosum* (white grass) grassland understorey.	RR-1	Wild horse and cattle observed	

4.2.2. Threatened Species

One threatened species, Mertens' Water Monitor (*Varanus mertensi*), listed as Vulnerable under the TPWC Act, was observed at LT-1 (Zone 53 E462397, N8313829).

4.2.3. Migratory and Marine Species

Fourteen species listed as migratory (three species) and/or marine (14 species) under the EPBC Act were observed (**Table 9**).

Table 9 Observed migratory and marine species

Species	Common Name	EPBC Act	Location
Crocodylus porosus	Salt water crocodile	M, Ma	RR-1
Merops ornatus	Rainbow bee-eater	M, Ma	EP-1, HR-1, LBR-1, LC-1, McR-1, PP-1, RR-1, TR-1
Plegadis falcinellus	Glossy ibis	M, Ma	MC-1, MR-1

Species	Common Name	EPBC Act	Location
Accipiter fasciatus	Brown goshawk	Ma	EP-1, MC-1, McR-1
Haliastur sphenurus	Whistling kite	Ma	EP-1, LBR-1, LC-1, LT-1, MC-1, McR-1, PP-1
Ardea alba	Great egret	Ma	EP-1
Nycticorax caledonicus	Nankeen night-heron	Ma	EP-1, HR-1, RR-1, TR-1
Coracina novaehollandiae	Black-faced cuckoo-shrike	Ma	LT-1, LBR-1
Coracina papuensis	White-bellied cuckoo-shrike	Ma	PP-1, WC-1
Eurystomus orientalis	Dollarbird	Ma	EP-1, LBR-1, LC-1, LT-1, MC-1, PP-1, RR-1
Todiramphus sanctus	Sacred kingfisher	Ma	LBR-1, McR-1, PP-1, WC-1
Grallina cyanoleuca	Magpie-lark	Ma	EP-1, PP-1
Pelecanus conspicillatus	Australian pelican	Ma	LT-1, PP-1
Threskiornis spinicollis	Straw-necked ibis	Ma	MR-1

4.2.4. Introduced and Feral Species

Seven introduced species were observed, all of which are feral species in the Northern Territory (**Table 10**).

Table 10 Observed feral species

	Species	Common Name	Location
*	*Rhinella marina*	Cane Toad	LBR-1, MC-1, McR-1
*	*Bos taurus*	Cow	HR-1, LC-1, LT-1, MC-1, PP-1, RR-1, WC-1
*	*Bubalus bubalis*	Water Buffalo	LBR-1, MC-1
*	*Canis lupus familiaris*	Wild Dog	McR-1
*	*Equus asinus*	Donkey	LBR-1, LT-1, MC-1, MR-1, PP-1, WC-1
*	*Equus caballus*	horse	EP-1, HR-1, LBR-1, MC-1, MR-1, RR-1
*	*Sus scrofa*	Wild Boar	EP-1, LT-1, McR-1, MR-1, PP-1

4.3. Water Quality

Water quality samples were collected at all sites except Whirlpool Creek (WC-1), which was dry at the time of the assessment. Results of the field measurements and laboratory analysis are shown in **Appendix E** with available default trigger values following the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC Guidelines) (Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand 2000). All sample sites are considered to be lowland streams of Tropical North Australia.

Most analytes were below detection levels or within adopted guideline values.

Arsenic was marginally higher than the adopted trigger value at Leila Creek (LC-1) (by 0.001 mg/L) and Copper was marginally higher than the adopted trigger value at Towns River (TR-1), Magaranyi River (MR-1) and Little Towns River (LT-1). These high levels may be a consequence of natural mineralisation. Such natural mineralisation has been demonstrated previously in the McArthur River Mine Public Environmental Report of the McArthur River. These elements are known to be a primary target of mineral exploration in the greater area.

Nitrogen and phosphorus were above the adopted trigger levels at most sites and turbidity was above the adopted trigger level at Little Towns River (LT-1). These results suggest naturally elevated background concentrations of nitrogen, phosphorous and turbidity which will likely vary seasonally. These results are also possibly related to use of these remnant water holes by introduced pigs, buffalo and cattle.

Dissolved oxygen was low at all sites, not uncommon in remnant pools at the end of the dry season.

Of note were some Total Petroleum Hydrocarbons (TPH) and Total Recoverable Hydrocarbons (TRH) fractions above detection limits at Magaranyi River (MR-1) and Little Towns River (LT-1). TPH and TRH are equivalent but reporting fractions have been altered in TRH to allow correlation with health screening levels for various fuel types (National Measurement Institute 2016). Detected hydrocarbons were in the TPH C15-C36 (sum) fraction and TRH >C16-C40 (sum) fraction, only LT-1 samples contained readings for TRH >C10-C16 fraction. The major petroleum groups in these ranges include jet fuel (C4-C16), fuel oil #1 (C9-C16), fuel oil #2 (C10-C19) and mineral oils (C15-C50) (Agency for Toxic Substances and Disease Registry 1999). MR-1 is approximately 6.5km upstream of the nearest road and LT-1 is isolated from roads. Given the location of the sampling points away from vehicle traffic, it is unlikely that the detected hydrocarbons are due to surrounding land use. Without knowing the exact chemical components of the samples, the most likely source of these readings is the fuel and lubricants associated with the helicopter or mineral oils in sunscreen. Subsequent seasonal sampling following a review of sampling and transportation procedures will provide further information and clarification as to the presence of these hydrocarbons at these sites.

5. Conclusion

A desktop investigation and preliminary ecological assessment was carried out to identify key ecological characteristics and potential constraints to exploration and development within Exploration Permit areas EP184 and EP187 in the Northern Territory. Water quality sampling was carried out to provide an end of dry season sample. The field assessment was carried out at 12 sites, eight within EP184 and four within EP187. The preliminary ecological assessment was limited to the area immediately adjacent to water quality sampling locations along waterways.

EP184 is a 1,122,000 ha area situated in the central trough of the McArthur Basin south of the Roper River and adjacent to the Gulf of Carpentaria. EP187 is situated approximately 84 km south west of Borroloola within the Carpentaria and McArthur Basin. The area consists largely of national park area (Limmen National Park), agriculture (grazing of natural vegetation) and some traditional indigenous lands.

EP184 lies within the Roper River, Towns River, Limmen Bight River, Rosie River and McArthur River catchments. EP187 lies within the Limmen Bight River and McArthur River catchments. All of these rivers discharge into the Gulf of Carpentaria, east of the tenements.

The area consists largely of national park area (Limmen National Park), agriculture (grazing of natural vegetation) and some traditional indigenous lands.

Seven Areas of Conservation Significance lie within the greater region. Of these, Limmen National Park and Limmen Bight and associated coastal floodplains encompass a portion of the north eastern portion of EP184. The remaining five are downstream of the tenements.

The study area falls within three IBRA Bioregions - Gulf Coastal, Gulf Falls and Uplands and Sturt Plateau.

The vegetation communities mapped over the tenements include woodland, tussock grassland, sparse samphire shrubland and forest. Eucalyptus woodland dominates the area (57%), followed by Corymbia low open woodland (11%), Eucalyptus low woodland (7%) and Chrysopogon (mixed) tussock grassland (6%). No Threatened Ecological Communities (TECs) are mapped within EP184 and EP187.

The region is generally in good ecological condition but widespread impacts from weeds, feral animals (especially pigs, buffalo, donkeys and cattle) changed fire regimes and grazing was observed.

Many of the sites had experienced hot fires in the recent past, causing plant death and removal. No threatened flora species were observed. Three (3) WONS (also Northern Territory declared Class A and C plants), *Vachellia nilotica*(prickly acacia) (EP-1, McR-1), *Chryptostegia grandiflora* (rubber vine) (LBR-1) and *Andropogon gayanus* (Gamba grass) (LC-1), and three (3) other Northern Territory declared Class B and Class C plants, *Hyptis suaveolens* (mint weed) (EP-1, WC-1), *Leonotis nepetifolia* (lion's ear) (EP-1) and *Calotropis procera* (rubber bush) (RR-1), were observed.

One threatened fauna species, Mertens' Water Monitor (*Varanus mertensi*), listed as Vulnerable under the TPWC Act, was observed at LT-1 (Zone 53 E462397, N8313829). Fourteen species listed as migratory (three species) and/or marine (14 species) under the EPBC Act were observed. A further 39 conservation significant species (18 threatened and 21 migratory/marine) are at least moderately likely to occur within the tenements based on the likelihood of occurrence assessment. Note that many of the migratory species are specialists of tidal areas and are likely to be concentrated in the estuarine area in the east of EP184.

Seven introduced species were observed, all of which are feral species in the Northern Territory.

Water quality samples were collected at all sites except Whirlpool Creek (WC-1), which was dry at the time of the assessment. All sample sites are considered to be lowland streams of Tropical North Australia and most analytes were below detection levels or within guideline values. Nitrogen and phosphorus concentrations were reported above adopted trigger guidelines at most sites and turbidity was elevated at

Little Towns River (LT-1). These results are expected to vary seasonally and may also be attributed to use of these remnant water holes by pigs, buffalo and cattle. Dissolved oxygen was low at all sites, not uncommon in remnant pools at the end of the dry season.

Naturally occurring elevated heavy metal concentrations above trigger levels were found in water samples of Leila Creek (LC-1) (arsenic) and Towns River (TR-1), Magaranyi River (MR-1) and Little Towns River (LT-1) (copper). These high levels may be a consequence of natural mineralisation, as demonstrated previously in the region in the McArthur River Mine Public Environmental Report of the McArthur River. These elements are known to be a primary target of mineral exploration in the greater area.

Some Total Petroleum Hydrocarbons (TPH) and Total Recoverable Hydrocarbons (TRH) fractions were above detection limits at Magaranyi River (MR-1) and Little Towns River (LT-1). It is unlikely that the detected hydrocarbons are due to surrounding land use and the hydrocarbons may have been a cross-contamination of the sampling equipment while stored in the helicopter tail during flights or from sunscreen worn by personnel. No other samples contained detectable levels of hydrocarbons.

This is the preliminary assessment for the end of dry season. Further assessments will be carried out in the coming months to provide an understanding of seasonal changes.

6. Recommendations

The tenements encompass vast areas and although the sites are spread throughout the tenements and provide a broad understanding of the waterways and some of the associated communities, the majority of the area could not be visited and assessed. More detailed assessments should be carried out in relevant areas once work areas are known and prior to any works.

This sampling program has identified that delivering training to local traditional owners in sample collection techniques may provide opportunity to expand the next round of sampling and facilitate more comprehensive programs in areas that are not currently available for non-indigenous personnel to enter.

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Appendix A Search Results

Appendix B Likelihood of Occurrence

Species Name	EPBC Act Status	TPWC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
AVES					
Calidris canutus Red Knot, Knot	M, Ma	V	LC	Found in flocks on large, sheltered intertidal sand and mudflats during the austral summer. Feed on bivalves, crustaceans and other invertebrates at the receding tide. Rarely encountered inland. Northern Arnhem Land coast is important land during the non-breeding season (Garnett, S.T., Szabo, J.K., and Dutson 2011)	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
Calidris ferruginea Curlew Sandpiper	CE, M, Ma	V	LC	Inhabits intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. Can be found inland, though less often, including around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand. They occur in both fresh and brackish waters and occasionally around floodwaters(Department of the Environment 2015e; Morcombe 2003).	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
Calidris tenuirostris Great Knot	M, Ma	V	VU	Inhabit the same habitat as, and are often found in flocks with, the Red Knot (see above)(Garnett, S.T., Szabo, J.K., and Dutson 2011)	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
Charadrius leschenaultii Greater Sand Plover	M, Ma	V	LC	Only seen in Australia from July-December, with an influx of individuals into the Top End of the NT during October. Inhabit littoral and estuarine habitats, mainly on sheltered beaches with large sand or mudflats, though observations have been made in estuary lagoons, inshore reefs, small rocky islands and sand cays on coral reefs. Occasionally sighted on near-coastal salt lakes and brackish swamps. Roosting generally takes place on sand-spits and banks on beaches or in tidal lagoons, higher up the beach than other waders (can be well above the high tide mark) (Department of the Environment 2016a)	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present

Species Name	EPBC Act Status	TPWC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
Charadrius mongolus Lesser Sand Plover	M, Ma	V	LC	Recorded along most of the coastline of the NT, in particular the North Arnhem coast, Mud Blue Bay, coast between Anson Bay and Murgenella creek and the Port McArthur area (Chatto 2003). Inhabits mud and sandflats in sheltered bays, estuaries, harbours, and occasionally rocky outcrops, sandy beaches and coral reefs. Roosting occurs near foraging areas (Department of the Environment 2016b)	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
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). This species has retracted over much of its previous range.	**Moderate potential to occur** species has not been recorded in the region (no records from desktop searches) however potentially suitable habitat occurs
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
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)	**Moderate potential to occur** species has not been recorded in the region (no records from desktop searches) however potentially suitable habitat occurs

Species Name	EPBC Act Status	TPWC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
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)	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
Limosa lapponica Bar-tailed Godwit	Ma, M	V	LC	Inhabits mainly in coastal areas such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays, around beds of seagrass, saltmarsh, coastal sewage farms and saltworks, saltlakes and brackish wetlands near coasts, sandy ocean beaches, rock platforms, and coral reef-flats. Rarely found on inland wetlands or in areas of short grass, such as farmland, paddocks and airstrips (Department of the Environment 2015k; Morcombe 2003).	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
Numenius madagascariensis Eastern Curlew	CE, M, Ma	V	VU	Never far from the coast, usually in mangrove areas, intertidal flats and salt marshes. Seen in small flocks or solitary during Australian summer. Breeds in central-eastern Asia (Garnett, S.T., Szabo, J.K., and Dutson 2011)	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
Rostratula australis Australian painted snipe (Syn. *Rostratula benghalensis*)	E, Ma	V	EN	Variety of habitats but generally requires presence of water. Inhabits shallow terrestrial freshwater wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains (Department of the Environment 2014c).	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
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)	**Moderate potential to occur** species has not been recorded in the region (no records from desktop searches) however potentially suitable habitat occurs
MAMMALIA					

Species Name	EPBC Act Status	TPWC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
Conilurus penicillatus Brush-tailed Rabbit-rat, Brush-tailed Tree-rat, Pakooma	V	E	NT	Found in QLD, WA and NT. In the NT *C.penicillatus* has been recorded in east and south-east Arnhem Land, on Inglis Island, in Kakadu NP, on the Tiwi Islands, on the Cobourg Peninsula and between Central Island and the mouth of the Victoria River. Habitat is very specific - *C.penicillatus* occupies mixed Eucalypt woodland and open forest, or on dunes where *Casuarina* is present. Habitat with a sparse to moderate middle storey and an understorey predominantly consisting of perennial grasses that isn't burnt annually is preferred. Small home ranges of approximately 1 ha. Usually active around dusk (Department of Environment, 2016e). Currently known to persist in the NT only on Coburg Peninsula, Bathurst, Melville and Inglis Islands and Groote Eylandt (Department of Land and Resource Management 2012a)	**Low potential to occur** current known distribution does not encompass study area
Dasyurus hallucatus Northern Quoll	E	CE	EN	The Northern Quoll occupies a diversity of habitats across its range which includes rocky areas, eucalypt forest and woodlands, rainforests, sandy lowlands and beaches, shrubland, grasslands and desert. Northern Quolls are also known to occupy non rocky lowland habitats such as beach scrub communities in central Queensland. Northern Quoll habitat generally encompasses some form of rocky area for denning purposes with surrounding vegetated habitats used for foraging and dispersal. Rocky habitats are usually of high relief, often rugged and dissected but can also include tor fields or caves in low lying areas such as in Western Australia. Eucalypt forest or woodland habitats usually have a high structural diversity containing large diameter trees, termite mounds or hollow logs for denning purposes. Dens are made in rock crevices, tree holes or occasionally termite mounds (Department of the Environment 2014a).	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
Isoodon auratus Golden Bandicoot	V	E	VU	The Golden Bandicoot was only found on Marchinbar Island in the NT before populations were translocated to the mainland and other islands. Due to this habitat descriptions are sparse and incomplete. On Marchinbar Island the Golden Bandicoot occurs mainly in heathland or shrubland on sandstone and avoids vegetation with greater tree cover (Southgate *et al.* 1996). Mainland Bandicoots	**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
				inhabit rainforest margins and viney thickets, Eucalypt woodland and Euc. Woodland over hummock grassland(Department of the Environment 2016e)	
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 favoured by foxes, which are one of their main threats. (Department of the Environment 2015m)	**Low potential to occur** current known distribution does not encompass study area
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
Notomys aquilo NorthernHopping-mouse, Woorrentinta	V	V	EN	Restricted to monsoonal tropics of the NT. Occurs in central and north-eastern Arnhem Land and on Groote Eylandt in areas with sandy substrates. Usually seen on sand dunes and sand sheets with tussock grass or heath, but also inhabits shrubland, open Eucalypt	**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
				forest and the margins of rainforest thickets (Department of the Environment 2016h)	
Pseudantechinus mimulus Carpentarian Antechinus	V	NT	EN	Inhabits rocky areas or woodlands close to rocky areas It is known from the Mt Isa area where it is found in woodland of *Eucalyptus leucophloia*, *Corymbia terminalis*, *Eucalyptus normantonensis*, *Atalaya hemiglauca* and *Acacia* spp. with *Trioda* spp. ground cover (Department of the Environment 2015r; Curtis & Dennis 2012).	**Low potential to occur** current known distribution does not encompass study area
Rattus tunneyi Pale Field-rat	-	V	LC	Nocturnal animal that shelters in shallow burrows during the day. Pale Field-rats form loose colonies and breeding occurs during the dry season. Generally found in cane fields, tall grassland and other modified habitats (Department of Land and Resource Management 2012b)	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
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
Xeromys myoides Water mouse	V	-	VU	Found in habitats including mangroves and the associated saltmarsh, sedgelands, clay pans, heathlands and freshwater wetlands (Department of the Environment 2015w).	**Moderate potential to occur** species has not been recorded in the region (no records from desktop searches) however potentially suitable habitat occurs
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** current known distribution does not encompass study area
Varanus mertensi Mertens' Water Monitor	-	V	-	Aquatic lizard found on rocks and logs, or tree trunks and branches overhanging rivers, lagoons and swamps. Submerges itself when disturbed (Cogger 2014)	**Known to occur** the species was recorded during field assessments

Species Name	EPBC Act Status	TPWC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
Varanus mitchelli Mitchell's Water Monitor	-	V	-	Aquatic lizard seen on rocks or in trees in or surrounding rivers and lagoons. Dark body with numerous yellow flecks, neck bright yellow (Cogger 2014)	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
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** species has not been recorded in the region (no records from desktop searches) however potentially suitable habitat occurs

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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

Species Name	EPBC Act Status	TPWC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
Actitis hypoleucos Common Sandpiper	Ma, M	-	LC	Seen in the NT from approx. July-November. Found in coastal and inland wetlands, streams, lakes, billabongs, dams, estuaries, claypans and occasionally jetties (Department of the Environment 2015a)	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
Apus pacificus Fork-tailed swift	Ma, M	-	LC	Summer migrant (October – April). Occurs in low to very high airspace over variety of habitats including rainforest and semi-arid areas. Known to be most active in front of summer storm fronts (Morcombe 2003).	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
Ardea alba *(Syn. A. modesta)* Great Egret, White Egret	Ma, M	-	LC	Widespread in Australia. Recorded in a wide range of wetland habitats including flooded pastures, dams, estuarine mudflats, mangroves and reefs and usually frequents shallow water. (Morcombe 2003; Department of the Environment 2015b)	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present

Species Name	EPBC Act Status	TPWC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
Ardea ibis Cattle egret (Syn. *Bubulcus ibis)*	Ma, M	-	LC	Occurs in moist pastures with tall grass, shallow open wetlands and margins and also mudflats (Morcombe 2003).	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
Arenaria interpres Ruddy Turnstone	M, Ma	NT	LC	Found on rocky shores or beaches where seaweed is present. In Australia from August to mid-March, migrating north for the breeding season (Department of the Environment 2015c).	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
Calidris acuminata Sharp-tailed Sandpiper	M, Ma	-	LC	In Australia from mid-August to April. Foraging takes place in shallow water of wetlands and mudflats or on bare wet sand or mud. Roosting occurs in sparse vegetation such as saltmarsh or grass, on wet open mud and sand and occasionally in mangroves, sandy beaches and stony shores (Department of the Environment 2015d)	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
Calidris ruficollis Red-necked Stint	M, Ma	-	LC	Inhabits a diverse range of environments including in sheltered inlets, bays, lagoons and estuaries with intertidal mudflats, often near spits, islets and banks and protected sandy or coralline shores. Have, occasionally, been recorded on exposed or ocean beaches, and sometimes on stony or rocky shores, reefs or shoals. Red-necked stinks also can occur in saltworks and sewage farms; saltmarsh; ephemeral or permanent shallow wetlands near the coast or inland and have occasionally been recorded on dry gibber plains, with little or no perennial vegetation(Department of the Environment 2015f; Morcombe 2003).	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
Calonectris leucomelas Streaked Shearwater	M, Ma	-	LC	Unusual to see inshore, usually in pelagic seas, shelf waters and further out to sea. Summer-autumn visitor to Australian coasts (PDA Solutions 2012)	**Low potential to occur** suitable habitat is generally lacking from the study area
Cecropis daurica/Hirundo daurica Red-rumped Swallow	M, Ma	-	LC	Generally only migrates south to Borneo and New Guinea, but is occasionally seen in Northern Australia in open country and grasslands (PDA Solutions 2012)	**Low potential to occur** current known distribution does not encompass study area
Charadrius veredus	M, Ma	-	LC	Arrives in Australia Sep-Nov and usually inhabits inland semi-arid regions on open grasslands Can be found in coastal habitats such as	**Moderate potential to occur**

Species Name	EPBC Act Status	TPWC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
Oriental Plover, Oriental Dotterel				estuarine mudflats and sandbanks, on sandy or rocky ocean beaches or nearby reefs, or in near-coastal grasslands, before dispersing further inland where they usually inhabit flat, open, semi-arid or arid grasslands, or open areas that have been recently burnt(Department of the Environment 2015g; Morcombe 2003)	species has not been recorded in the region (no records from desktop searches) however potentially suitable habitat occurs
Gelochelidon nilotica or *Sterna nilotica* Gull-billed Tern	M, Ma	-	LC	Uses inland fresh and salt water for nesting, and can be seen around mudflats, clay pans, salt marsh and open floodplains where extensive shallow flooding occurs. Often seen on salt marshes and lagoons near the coast during the non-breeding season (PDA Solutions 2012)	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
Glareola maldivarum Oriental Pratincole	M, Ma	-	LC	Open plains, grasslands, floodplains, near terrestrial wetlands such as billabongs, creeks, lakes, reservoirs and sewage farms. Also seen occasionally around coastlines on beaches, mudflats and coastal lagoons. Present in Australia from late October to March (Department of the Environment 2015i)	**Moderate potential to occur** species has not been recorded in the region (no records from desktop searches) however potentially suitable habitat occurs
Hirundo rustica Barn Swallow	M, Ma	-	LC	Often sighted on overhead wires with other swallows. Found both in open county and in towns, often near water. (Morcombe 2003)	**Moderate potential to occur** species has not been recorded in the region (no records from desktop searches) however potentially suitable habitat occurs
Hydroprogne caspia Caspian tern	M	-	LC	Within Australia, the Caspian Tern has a widespread occurrence and is found in both coastal and inland habitat. Occurs mostly in sheltered coastal harbours, lagoons, inlets, bays, estuaries and river deltas. Areas with sandy or muddy margins are preferred. They can also be found on near-coastal or inland terrestrial wetlands that are either fresh or saline, especially lakes, waterholes, reservoirs, rivers and creeks. They also use artificial wetlands, including reservoirs, sewage ponds and salt works (Department of the Environment 2015j).	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
Limicola falcinellus Broad-billed Sandpiper	M, Ma	-	-	In Australia August-May in sheltered coastlines, particularly estuarine mudflats. Also seen on shallow freshwater lagoons, saltmarshes, sewerage farms, creeks, lakes and swamps. Rarely recorded inland. (Department of the Environment 2016f)	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present

Species Name	EPBC Act Status	TPWC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
Limosa limosa Black-tailed Godwit	M, Ma	NT	NT	Usually inhabits coastal environment including sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats, spits and banks of mud, sand or shell-grit. Can also be found in shallow and sparsely vegetated, near-coastal, wetlands; such as saltmarsh, saltflats, river pools, swamps, lagoons and floodplains. Infrequently they are found inland around shallow, freshwater and saline lakes, swamps, dams and bore-overflows, sewage farms and saltworks(Department of the Environment 2015l; Morcombe 2003).	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
Merops ornatus Rainbow bee-eater	Ma, M	-	LC	Summer migrant (September – April) although in northern Australia they remain and breed. Occurs in open woodlands, semi-arid scrub, grasslands, clearing in heavier forests, farmlands and coastal areas. Avoids heavy forests due to hindrance to feeding (i.e. Catching insects) (Morcombe 2003).	**Known to occur** the species was recorded during field assessments
Motacilla cinerea Grey Wagtail	M, Ma	-	-	Near fresh rocky or sandy streams, mown grass, ploughed land and sewage ponds (PDA Solutions 2012)	**Low potential to occur** current known distribution does not encompass study area
Motacilla flava Yellow Wagtail	M, Ma	-	LC	Summer migrant to Australia, preferring open habitats, often near water, including swamp margins, salt marshes, sewage ponds, lawns, pastures, playing fields and surrounds (Morcombe 2003).	**Low potential to occur** current known distribution does not encompass study area
Numenius phaeopus Whimbrel	M, Ma	NT	LC	Australia-wide distribution from August to February – In the NT N. phaeopus is generally seen along coastlines, but can follow rivers inland. Prefers mudflats on sheltered coasts, but has been recorded in harbours, estuaries, lagoons and river deltas. Less frequently observed on sandy and rocky beaches, intertidal reefs, and brackish or saline lakes near coastlines. Generally roost in mangrove branches, but have been noted to roost on the ground under mangroves or in tall trees (Department of the Environment 2015n)	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
Pandion haliaetus *(*Syn. *P. cristatus)* Eastern osprey	M	-	LC	Eastern ospreys occur in littoral and coastal habitats and terrestrial wetlands, and occasionally travel inland along major rivers. They require extensive areas of open fresh, brackish or saline water for foraging. (Department of the Environment 2015o)	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present

Species Name	EPBC Act Status	TPWC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
Plegadis falcinellus Glossy Ibis	M, Ma	-	LC	Found in the shallows of swamps and rivers, lagoons, flood-plains, wet meadows, reservoirs, sewage ponds, rice-fields and cultivated areas under irrigation. Occasionally found in estuaries, deltas, saltmarshes lagoons of coastal regions (Department of the Environment 2015p; Morcombe 2003).	**Known to occur** the species was recorded during field assessments
Pluvialis fulva Pacific Golden Plover	M, Ma	-	LC	Inhabits mainly coastal areas including beaches, mudflats and sandflats , harbours, estuaries and lagoons, and evaporation ponds in saltworks. Sometimes recorded on islands, sand and coral cays and exposed reefs and rock, less often recorded in terrestrial habitats, usually wetlands such as fresh, brackish or saline lakes, billabongs, pools, swamps and wet claypans, only very rarely far inland(Department of the Environment 2015q; Morcombe 2003).	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
Pluvialis squatarola Grey Plover	M, Ma	NT	LC	In Australia from August-March in almost entirely coastal environments. Estuaries and lagoons with mud and sandflats, reef flats, as well as near-coastal lakes, swamps and salt flats (Department of the Environment 2016j)	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
Sterna hirundo Common Tern	M, Ma	-	LC	Typically seen offshore in open ocean but have been sightings in coastal waters, estuaries, sheltered bays and ocean beaches (PDA Solutions 2012)	**Low potential to occur** current known distribution does not encompass study area
Sternula albifrons Little Tern	M	-	LC	Found in lagoons, estuaries, river mouths, lakes, bays, deltas, inlets and harbours (particularly with exposed sand banks). Common on islands off the NT (Department of the Environment 2016n)	**Low potential to occur** current known distribution does not encompass study area
Sterna anaethetus Bridled Tern	M, Ma	-	-	Tropical and subtropical seas. Breeding/nesting takes place on islands, rock stacks and vegetated coral cays, and roosting takes place at sea (Department of the Environment 2016i)	**Low potential to occur** current known distribution does not encompass study area
Sterna dougallii Roseate Tern	M, Ma	-	LC	Coastal and marine habitats such as rocky and sandy beaches, offshore islands, coral reefs and sand cays. Very rarely seen on the mainland (Department of the Environment 2016l)	**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
Sterna sumatrana Black-naped Tern	M, Ma	-	LC	Small offshore sand and coral cays, lagoons, coral reefs, sandy and rocky islands and surrounding seas. Have been recorded in harbours and bays in Australia (Department of the Environment 2016m)	**Low potential to occur** current known distribution does not encompass study area
Sula leucogaster Brown Booby	M, Ma	-	LC	Tropical waters, harbours, estuaries, and near offshore islands. Nests on beaches, rocky cliffs, coral rubble and sand bars (Department of the Environment 2016o)	**Low potential to occur** current known distribution does not encompass study area
Tringa glareola Wood Sandpiper	M, Ma	-	LC	Inhabits freshwater wetlands, such as swamps, billabongs, lakes, pools and waterholes, inundated grasslands, floodplains and irrigated crops. They can also be found in artificial wetlands, including open sewage ponds, reservoirs, large farm dams, and bore drains. Rarely found using brackish wetlands, or dry stunted saltmarsh(Department of the Environment 2015s; Morcombe 2003).	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
Tringa nebularia Common Greenshank	M, Ma	-	LC	Widespread common migrant between Sept and April. Found in a variety of habitats including inland wetlands, sheltered coastal habitats, embayments, harbours, river estuaries, deltas and lagoons, tidal pools, rock-flats and rock platforms. Away from the coast they are found in both permanent and ephemeral terrestrial wetlands, including swamps, lakes, dams, rivers, creeks, billabongs, waterholes and inundated floodplains, claypans and saltflats as well as artificial wetlands, including sewage farms and saltworks dams, inundated rice crops and bores(Department of the Environment 2015t; Morcombe 2003).	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
Tringa stagnatilis Marsh Sandpiper	M, Ma	-	LC	Inhabits permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, saltpans, saltmarshes, estuaries, pools on inundated floodplains, intertidal mudflats, sewage farms and saltworks(Department of the Environment 2015u; Morcombe 2003).	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present
Xenus cinereus Terek Sandpiper	M, Ma	-	LC	Inhabits coastal mudflats in sheltered estuaries, embayments, harbours or lagoons. Occasionally, on sandy beaches, on rock or coral reefs or platforms, and occasionally sighted around drying sewage ponds and saltpans if surrounded by mudflats (Department of the Environment 2015v; Morcombe 2003).	**High potential to occur** the species has been recorded in the region (desktop searches) and suitable habitat is present

Species Name	EPBC Act Status	TPWC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
REPTILIA					
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile	M, Ma	-	LC/LR	Inhabits coastal rivers and swamps, though often seen at sea and inland (via rivers, billabongs and floodplains) (Cogger 2014)	**Known to occur** the species was recorded during field assessments

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Appendix C Flora Species List

	Family	Species	common name	Weed Class
	Mimosaceae	*Acacia holosericea*	candelabra wattle	
	Mimosaceae	*Acacia lamprocarpa*	western salwood	
*	Mimosaceae	*Acacia nilotica*	prickly acacia	A
	Fabaceae	*Acacia* sp.		
	Mimosaceae	*Acacia torulosa*	torulosa wattle	
	Fabaceae	*Albizia lebbeck*	albizzia	
	Rhamnaceae	*Alphitonia excelsa*	red ash	
	Loranthaceae	*Amyema* sp.	mistletoe	
*	Poaceae	*Andropogon gayanus*?	gamba grass	WONS, A
	Phyllanthaceae	*Antidesma parvifolium*?	currant-tree	
	Myrtaceae	*Asteromyrtus symphyocarpa*	liniment tree	
	Caesalpiniaceae	*Bauhinia cunninghamii*	native bauhinia	
	Fabaceae	*Bossiaea bossiaeoides*	bossiaea	
	Malvaceae	*Brachychiton diversifolius*	kurrajong	
	Malvaceae	*Brachychiton paradoxus*	red flowered kurrajong	
	Anacardiaceae	*Buchanania obovata*	green plum	
*	Asclepiadaceae	*Calotropis procera*	rubber bush	B
	Apocynaceae	*Carissa spinarum*	conkerberry	
	Casuarinaceae	*Casuarina cunninghamiana*	river she-oak	
	Mimosaceae	*Cathormion umbellatum*	cathormion	
	Bixaceae	*Cochlospermum fraseri*	kapok bush	
	Myrtaceae	*Corymbia bella*	ghost gum	
	Myrtaceae	*Corymbia confertiflora*	cabbage gum	
	Myrtaceae	*Corymbia grandifolia* subsp. *grandifolia*	cabbage gum	
	Myrtaceae	*Corymbia polycarpa*	long-fruited bloodwood	
	Myrtaceae	*Corymbia* sp.		
	Amaryllidaceae	*Crinum angustifolium*	bush lily	
*	Apocynaceae	*Cryptostegia grandiflora*	rubber vine	WONS, A
	Poaceae	*Cymbopogon bombycinus*	citronella grass	
	Cyperaceae	*Cyperus holoschoenus*		
	Fabaceae	*Erythrophleum chlorostachys*	camel poison	
	Myrtaceae	*Eucalyptus camaldulensis*	river red gum	
	Myrtaceae	*Eucalyptus chlorophylla*	greenleaf box	
	Myrtaceae	*Eucalyptus leucophloia*	snappy gum	
	Myrtaceae	*Eucalyptus microtheca*	black box	

	Family	Species	common name	Weed Class
	Myrtaceae	*Eucalyptus pruinosa*	kullingal	
	Euphorbiaceae	*Excoecaria parvifolia*	gutta percha	
	Moraceae	*Ficus coronulata*	crown fig	
	Moraceae	*Ficus virens* or *racemosa*	fig	
	Flagellariaceae	*Flagellaria indica*	bush cane	
	Proteaceae	*Grevillea striata*	beef oak	
	Malvaceae	*Grewia retusifolia*	dogs nuts	
	Hernandiaceae	*Gyrocarpus americanus*	corkwood	
	Proteaceae	*Hakea arborescens*	arrarruwurra	
	Proteaceae	*Hakea* sp.		
*	Lamiaceae	*Hyptis suaveolens*	hyptis	B
	Convolulaceae	*Ipomoea aquatica*	swamp convolvulus	
*	Lamiaceae	*Leonotis nepetifolia*	lion's ear	B
	Onagracea	*Ludwigia octovalvis*	willow primrose	
	Malvaceae	*Malvaceae* sp. (probably *Sida*)		
	Malvaceae	*Malvastrum americanum*	malvastrum	
	Myrtaceae	*Melaleuca alsophila*	saltwater paperbark	
	Myrtaceae	*Melaleuca argentea*	silver cadjeput	
	Myrtaceae	*Melaleuca leucadendra*	weeping tea tree	
	Myrtaceae	*Melaleuca nervosa*	paperbark	
	Myrtaceae	*Melaleuca* sp.		
	Myrtaceae	*Melaleuca* sp.		
	Myrtaceae	*Melaleuca viridiflora*	broad leaved tea tree	
	Myrtaceae	*Myrtaceae* sp.		
	Rubiaceae	*Nauclea orientalis*	canary cheesewood	
	Nymphaeaceae	*Nymphaea* sp.		
	Orchidaceae	*Orchidaceae* sp.		
	Meliaceae	*Owenia vernicosa*	emu apple	
	Picrodendraceae	*Petalostigma pubescens*	bitter bark	
	Picrodendraceae	*Petalostigma quadriloculare*	bitter crab	
	Rubiaceae	*Rubiaceae* sp.		
	Santalaceae	*Santalum lanceolatum*	blue bush	
	Aizoaceae	*Sesuvium portulacastrum*	sea purslane	
	Loganiaceae	*Strychnos lucida*	strychnine bush	
	Combretaceae	*Terminalia bursarina*	bendee	
	Combretaceae	*Terminalia canescens*	pindan walnut	
	Combretaceae	*Terminalia erythrocarpa*		

Family	Species	common name	Weed Class
Combretaceae	*Terminalia platyphylla*	durin	
Combretaceae	*Terminalia* sp.		
Menispermaceae	*Tinospora smilacina*	snake vine	
Fabaceae	*Vachellia farnesiana*	mimosa weed	
Vitaceae	*Vitaceae* sp.		

Notes on Weed Class:

A declared weed is a plant or species of plant which has been identified for control, eradication, or prevention of entry in all or part of the Territory under the Northern Territory Weeds Management Act 2001. A weed may be declared as:

- Class A – To be eradicated
- Class B – Growth and spread to be controlled
- Class C – Not to be introduced to the Territory

Thirty two Weeds of National Significance (WoNS) have been agreed by Australian governments based on an assessment process that prioritised these weeds based on their invasiveness, potential for spread and environmental, social and economic impacts. Landowners and land managers at all levels are responsible for managing WoNS. State and territory governments are responsible for legislation, regulation and administration of weeds.

Appendix D Fauna Species List

KEY

	Australian conservation status of each taxon under the Environment Protection and Biodiversity Conservation Act 1999
CD	Conservation Dependent
CE	Critically Endangered
E	Endangered
EX	Extinct
XW	Extinct in the Wild
V	Vulnerable
M	Migratory
Ma	Marine
	Territory Parks and Wildlife Conservation Act 2000 and IUCN Red List
	Under TPWC Act, Threatened wildlife = EW, CE, E or V
CR	Critically Endangered
DD	Data Deficient
EN	Endangered
EX	Extinct
EW	Extinct in the Wild
LC	Least Concern
NT	Near Threatened
NE	Not Evaluated
VU	Vulnerable
LR/lc	Lower Risk/least concern (IUCN Red List Only)
*	Introduced species

	Family	Scientific Name	Common Name	Method of Capture	EPBC Act	TPWC Act	IUCN
	Amphibians						
*	Bufonidae	*Rhinella marina*	Cane toad	Opportunistic	-	-	LC
	Hylidae	*Litoria caerulea*	Green tree frog	Opportunistic	-	-	LC
	Hylidae	*Litoria rothii*	Roth's tree frog	Opportunistic	-	-	LC
	Mammals						
*	Bovidae	*Bos taurus*	Cow	Opportunistic	-	-	-
*	Bovidae	*Bubalus bubalis*	Water buffalo	Opportunistic	-	-	-
*	Canidae	*Canis lupus familiaris*	Wild dog	Opportunistic	-	-	-
*	Equidae	*Equus asinus*	Donkey	Opportunistic	-	-	-
*	Equidae	*Equus caballus*	Horse	Opportunistic	-	-	-
	Macropodidae	*Macropus agilis*	Agile wallaby	Opportunistic	-	LC	LC

Family	Scientific Name	Common Name	Method of Capture	EPBC Act	TPWC Act	IUCN
Macropodidae	*Macropus robustus*	Common wallaroo	Opportunistic	-	LC	LC
Macropodidae	*Onychogalea unguifera*	Northern nailtail wallaby	Opportunistic	-	NT	LC
Pteropodidae	*Pteropus alecto*	Black flying fox	Opportunistic	-	LC	LC
Pteropodidae	*Pteropus scapulatus*	Little red flying-fox	Opportunistic	-	LC	LC
* Suidae	*Sus scrofa*	Wild boar	Opportunistic	-	-	LC
Reptiles						
Agamidae	*Amphibolurus gilberti*	Gilberts dragon	Opportunistic	-	LC	LC
Agamidae	*Diporiphora bilineata*	Two-lined dragon	Opportunistic	-	LC	-
Agamidae	*Diporiphora magna*	Yellow-sided two-line dragon	Opportunistic	-	LC	-
Chelidae	*Chelodina rugosa*	Northern long-necked turtle	Opportunistic	-	LC	-
Chelidae	*Emydura subglosa*	Diamond head turtle	Opportunistic	-	LC	-
Crocodylidae	*Crocodylus johnstoni*	Freshwater crocodile	Opportunistic	-	LC	LR/lc
Crocodylidae	*Crocodylus porosus*	Salt water crocodile	Opportunistic	M, Ma	LC	LR/lc
Scincidae	*Carlia amax*	Two-spined rainbow skink	Opportunistic	-	LC	-
Scincidae	*Cryptoblepharus metallicus*	Metallic snake-eyed skink	Opportunistic	-	LC	-
Varanidae	*Varanus mertensi*	Mertens' water monitor	Opportunistic	-	V	-
Birds						
Acanthizidae	*Gerygone olivacea*	White-throated gerygone	Opportunistic	-	LC	LC
Acanthizidae	*Smicrornis brevirostris*	Weebill	Opportunistic	-	LC	LC
Accipitridae	*Accipiter cirrocephalus*	Collared sparrowhawk	Opportunistic	-	LC	LC
Accipitridae	*Accipiter fasciatus*	Brown goshawk	Opportunistic	Ma	LC	LC
Accipitridae	*Aquila audax*	Wedge-tailed eagle	Opportunistic	-	LC	LC
Accipitridae	*Haliastur sphenurus*	Whistling kite	Opportunistic	Ma	LC	LC
Accipitridae	*Milvus migrans*	Black kite	Opportunistic	-	LC	LC
Anatidae	*Dendrocygna eytoni*	Plumed whistling-duck	Opportunistic	-	LC	LC
Anhingidae	*Anhinga novaehollandiae*	Australasian darter	Opportunistic	-	LC	LC
Ardeidae	*Ardea alba*	Great egret	Opportunistic	Ma	LC	LC
Ardeidae	*Nycticorax caledonicus*	Nankeen night-heron	Opportunistic	Ma	LC	LC
Artamidae	*Cracticus nigrogularis*	Pied butcherbird	Opportunistic	-	LC	LC
Cacatuidae	*Cacatua galerita*	Sulphur-crested cockatoo	Opportunistic	-	LC	LC
Cacatuidae	*Calyptorhynchus banksii*	Red-tailed black-cockatoo	Opportunistic	-	LC	LC
Campephagidae	*Coracina novaehollandiae*	Black-faced cuckoo-shrike	Opportunistic	Ma	LC	LC
Campephagidae	*Coracina papuensis*	White-bellied cuckoo-shrike	Opportunistic	Ma	LC	LC
Campephagidae	*Lalage tricolor*	White-winged triller	Opportunistic	-	LC	LC
Casuariidae	*Dromaius novaehollandiae*	Emu	Opportunistic	-	NT	LC

Family	Scientific Name	Common Name	Method of Capture	EPBC Act	TPWC Act	IUCN
Ciconiidae	*Ephippiorhynchus asiaticus*	Black-necked stork	Opportunistic	-	LC	NT
Columbidae	*Geopelia cuneata*	Diamond dove	Opportunistic	-	LC	LC
Columbidae	*Geopelia humeralis*	Bar-shouldered dove	Opportunistic	-	LC	LC
Columbidae	*Geopelia striata*	Peaceful dove	Opportunistic	-	LC	LC
Columbidae	*Phaps chalcoptera*	Common bronzewing	Opportunistic	-	LC	LC
Coraciidae	*Eurystomus orientalis*	Dollarbird	Opportunistic	Ma	LC	LC
Corcoracidae	*Struthidea cinerea*	Apostlebird	Opportunistic	-	LC	LC
Corvidae	*Corvus orru*	Torresian crow	Opportunistic	-	LC	LC
Cuculidae	*Eudynamys orientalis*	Common koel	Opportunistic	-	LC	LC
Estrildidae	*Neochmia phaeton*	Crimson finch	Opportunistic	-	LC	LC
Estrildidae	*Poephila acuticauda*	Long-tailed finch	Opportunistic	-	LC	LC
Estrildidae	*Taeniopygia bichenovii*	Double-barred finch	Opportunistic	-	LC	LC
Falconidae	*Falco berigora*	Brown falcon	Opportunistic	-	LC	LC
Gruidae	*Grus rubicunda*	Brolga	Opportunistic	-	LC	LC
Halcyonidae	*Dacelo leachii*	Blue-winged kookaburra	Opportunistic	-	LC	LC
Halcyonidae	*Todiramphus sanctus*	Sacred kingfisher	Opportunistic	Ma	LC	LC
Maluridae	*Malurus melanocephalus*	Red-backed fairy-wren	Opportunistic	-	LC	LC
Meliphagidae	*Cissomela pectoralis*	Banded honeyeater	Opportunistic	-	LC	LC
Meliphagidae	*Conopophila rufogularis*	Rufous-throated honeyeater	Opportunistic	-	LC	LC
Meliphagidae	*Entomyzon cyanotis*	Blue-faced honeyeater	Opportunistic	-	LC	LC
Meliphagidae	*Lichenostomus flavescens*	Yellow-tinted honeyeater	Opportunistic	-	LC	LC
Meliphagidae	*Lichenostomus keartlandi*	Grey-headed honeyeater	Opportunistic	-	LC	LC
Meliphagidae	*Lichenostomus plumulus*	Grey-fronted honeyeater	Opportunistic	-	LC	LC
Meliphagidae	*Lichenostomus unicolor*	White-gaped honeyeater	Opportunistic	-	LC	LC
Meliphagidae	*Lichenostomus virescens*	Singing honeyeater	Opportunistic	-	LC	LC
Meliphagidae	*Lichmera indistincta*	Brown honeyeater	Opportunistic	-	LC	LC
Meliphagidae	*Melithreptus albogularis*	White-throated honeyeater	Opportunistic	-	LC	LC
Meliphagidae	*Philemon argenticeps*	Silver-crowned friarbird	Opportunistic	-	LC	LC
Meliphagidae	*Philemon citreogularis*	Little friarbird	Opportunistic	-	LC	LC
Meliphagidae	*Ramsayornis fasciatus*	Bar-breasted honeyeater	Opportunistic	-	LC	LC
Meropidae	*Merops ornatus*	Rainbow bee-eater	Opportunistic	M, Ma	LC	LC
Monarchidae	*Grallina cyanoleuca*	Magpie-lark	Opportunistic	Ma	LC	LC
Monarchidae	*Myiagra inquieta*	Restless flycatcher	Opportunistic	-	LC	LC
Monarchidae	*Myiagra rubecula*	Leaden flycatcher	Opportunistic	-	LC	LC
Nectariniidae	*Dicaeum hirundinaceum*	Mistletoebird	Opportunistic	-	LC	LC
Oriolidae	*Oriolus sagittatus*	Olive-backed oriole	Opportunistic	-	LC	LC

Family	Scientific Name	Common Name	Method of Capture	EPBC Act	TPWC Act	IUCN
Otididae	*Ardeotis australis*	Australian bustard	Opportunistic	-	NT	LC
Pachycephalidae	*Colluricincla harmonica*	Grey shrike-thrush	Opportunistic	-	LC	LC
Pachycephalidae	*Pachycephala rufiventris*	Rufous whistler	Opportunistic	-	LC	LC
Pelecanidae	*Pelecanus conspicillatus*	Australian pelican	Opportunistic	Ma	LC	LC
Petroicidae	*Poecilodryas cerviniventris*	Buff-sided robin	Opportunistic	-	NT	LC
Phalacrocoracidae	*Microcarbo melanoleucos*	Little pied cormorant	Opportunistic	-	LC	LC
Podargidae	*Podargus strigoides*	Tawny frogmouth	Opportunistic	-	LC	LC
Pomatostomidae	*Pomatostomus temporalis*	Grey-crowned babbler	Opportunistic	-	LC	LC
Psittacidae	*Aprosmictus erythropterus*	Red-winged parrot	Opportunistic	-	LC	LC
Psittacidae	*Platycercus venustus*	Northern rosella	Opportunistic	-	LC	LC
Psittacidae	*Trichoglossus haematodus*	Rainbow lorikeet	Opportunistic	-	LC	LC
Ptilonorhynchidae	*Ptilonorhynchus nuchalis*	Great bowerbird	Opportunistic	-	LC	LC
Rhipiduridae	*Rhipidura leucophrys*	Willie wagtail	Opportunistic	-	LC	LC
Rhipiduridae	*Rhipidura rufiventris*	Northern fantail	Opportunistic	-	LC	LC
Threskiornithidae	*Platalea regia*	Royal spoonbill	Opportunistic	-	LC	LC
Threskiornithidae	*Plegadis falcinellus*	Glossy ibis	Opportunistic	M, Ma	LC	LC
Threskiornithidae	*Threskiornis moluccus*	Australian white ibis	Opportunistic	-	LC	LC
Threskiornithidae	*Threskiornis spinicollis*	Straw-necked ibis	Opportunistic	Ma	LC	LC
Fish						
Eleotridae	*Oxyeleotris selheimi*	Giant gudgeon	Opportunistic	-	LC	-
Latidae	*Lates calcarifer*	Barramundi	Opportunistic	-	LC	-
Sparidae	*Acanthopagrus palmaris*	Northwest black bream	Opportunistic	-	LC	LC
Toxotidae	*Toxotes chatareus*	Sevenspot archerfish	Opportunistic	-	LC	-

Appendix E Field Data

WATER QUALITY RESULTS

Analyte grouping / Analyte	Units	Water Quality Trigger Value Tropical Australia	Sample date	16/11/2015	17/11/2015		27/11/2015			28/11/2015			
				LC-1	McR-1	PP-1	EP-1	LBR-1	TR-1	MR-1	LT-1	MC-1	RR-1	HR-1
EA025: Total Suspended Solids dried at 104 ± 2°C														
Suspended Solids (SS)	mg/L			152	<5	<5	<5	14	<5	<5	2030	<5	<5	<5
EA065: Total Hardness as CaCO3														
Total Hardness as CaCO3	mg/L			448	254	18	12	540	3690	2380	51	522	377	313
ED093F: Dissolved Major Cations														
Calcium	mg/L			82	31	4	3	53	258	163	9	31	47	48
Magnesium	mg/L			59	43	2	1	99	740	478	7	108	63	47
Sodium	mg/L			17	5	3	2	95	5620	1250	32	98	160	101
Potassium	mg/L			4	4	2	1	12	182	12	13	24	21	13
EG020F: Dissolved Metals by ICP-MS														
Arsenic	mg/L	0.013(AsV)/0.024(AsIII)		0.014	<0.001	<0.001	<0.001	0.008	0.001	0.001	0.004	0.002	<0.001	<0.001
Cadmium	mg/L	0.0002		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.013	<0.001	<0.001	<0.001
Copper	mg/L	0.0014		0.001	<0.001	<0.001	<0.001	0.001	0.002	0.002	0.029	<0.001	<0.001	0.001
Lead	mg/L	0.0034		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.025	<0.001	<0.001	<0.001
Nickel	mg/L	0.011		<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.005	<0.001	<0.001	<0.001
Zinc	mg/L	0.008		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	1.14	<0.005	<0.005	<0.005
EG035F: Dissolved Mercury by FIMS														
Mercury	mg/L	0.00006		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser														

		Sample date	16/11/2015	17/11/2015			27/11/2015			28/11/2015			
Analyte grouping Analyte	**Units**	**Water Quality Trigger Value Tropical Australia**	**LC-1**	**McR-1**	**PP-1**	**EP-1**	**LBR-1**	**TR-1**	**MR-1**	**LT-1**	**MC-1**	**RR-1**	**HR-1**
Nitrite + Nitrate as N	mg/L	0.005	0.03	0.04	0.05	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser													
Total Kjeldahl Nitrogen as N	mg/L		1.1	0.3	0.4	0.5	1.4	0.2	1.2	17.3	0.6	0.2	0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser													
Total Nitrogen as N	mg/L	0.2-0.3	1.1	0.3	0.4	0.5	1.4	0.2	1.2	17.3	0.6	0.2	0.1
EK067G: Total Phosphorus as P by Discrete Analyser													
Total Phosphorus as P	mg/L	0.01	0.18	<0.01	0.18	0.08	0.01	0.02	<0.01	2.24	<0.01	<0.01	<0.01
EP080/071: Total Petroleum Hydrocarbons													
C6 - C9 Fraction	µg/L		<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L		<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L		<100	<100	<100	<100	<100	<100	130	760	<100	<100	<100
C29 - C36 Fraction	µg/L		<50	<50	<50	<50	<50	<50	140	310	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L		<50	<50	<50	<50	<50	<50	270	1070	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions													
C6 - C10 Fraction	µg/L		<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
C6 - C10 Fraction minus BTEX (F1)	µg/L		<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L		<100	<100	<100	<100	<100	<100	<100	130	<100	<100	<100
>C16 - C34 Fraction	µg/L		<100	<100	<100	<100	<100	<100	230	870	<100	<100	<100
>C34 - C40 Fraction	µg/L		<100	<100	<100	<100	<100	<100	110	140	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L		<100	<100	<100	<100	<100	<100	340	1140	<100	<100	<100

		Sample date	16/11/2015	17/11/2015			27/11/2015			28/11/2015			
Analyte grouping Analyte	**Units**	**Water Quality Trigger Value Tropical Australia**	**LC-1**	**McR-1**	**PP-1**	**EP-1**	**LBR-1**	**TR-1**	**MR-1**	**LT-1**	**MC-1**	**RR-1**	**HR-1**
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L		<100	<100	<100	<100	<100	<100	<100	130	<100	<100	<100
EP080: BTEXN													
Benzene	µg/L	950	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	µg/L		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Ethylbenzene	µg/L		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
meta- & para-Xylene	µg/L		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
ortho-Xylene	µg/L	350	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Xylenes	µg/L		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Sum of BTEX	µg/L		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Naphthalene	µg/L	16	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates													
1.2-Dichloroethane-D4	%		86.2	112	107	109	98.5	95.5	106	103	101	108	100
Toluene-D8	%		84.8	109	110	108	108	103	107	108	108	109	106
4-Bromofluorobenzene	%		84.2	102	101	96.6	98.5	92	95.8	96.9	99	102	96.7
Field Measurements													
Temperature	0C		30.3	29.2	32.7	32.7	29.3	33.9	34.2	27.0	31.0	32.6	32.9
Electrical Conductivity	µS/cm	20-250	696	407	51	35	1176	28	9	210	1194	13	907
Turbidity	NTU	2-15.0	33.1	2.5	5.7	10.2	17.7	2.2	7.2	1595.7	2.1	2.4	6.2
Dissolved Oxygen	%	85-120	6.44	4.36	3.08	4.58	1.28	3.31	4.09	0.41	2.84	4.90	3.08
pH		6-8.0	7.99	7.95	7.38	6.96	7.75	8.12	8.13	6.18	8.14	8.42	7.67

		Sample date	16/11/2015	17/11/2015			27/11/2015			28/11/2015			
Analyte grouping Analyte	**Units**	**Water Quality Trigger Value Tropical Australia**	**LC-1**	**McR-1**	**PP-1**	**EP-1**	**LBR-1**	**TR-1**	**MR-1**	**LT-1**	**MC-1**	**RR-1**	**HR-1**
Total Dissolved Solids	mg/L		425	241	27	19	727	20	6	121	738	796	557

Appendix 17. EP187 Environmental Summary Report 2019

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		K. A.		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 work program is proposed to occur in the 2019 dry season. 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.

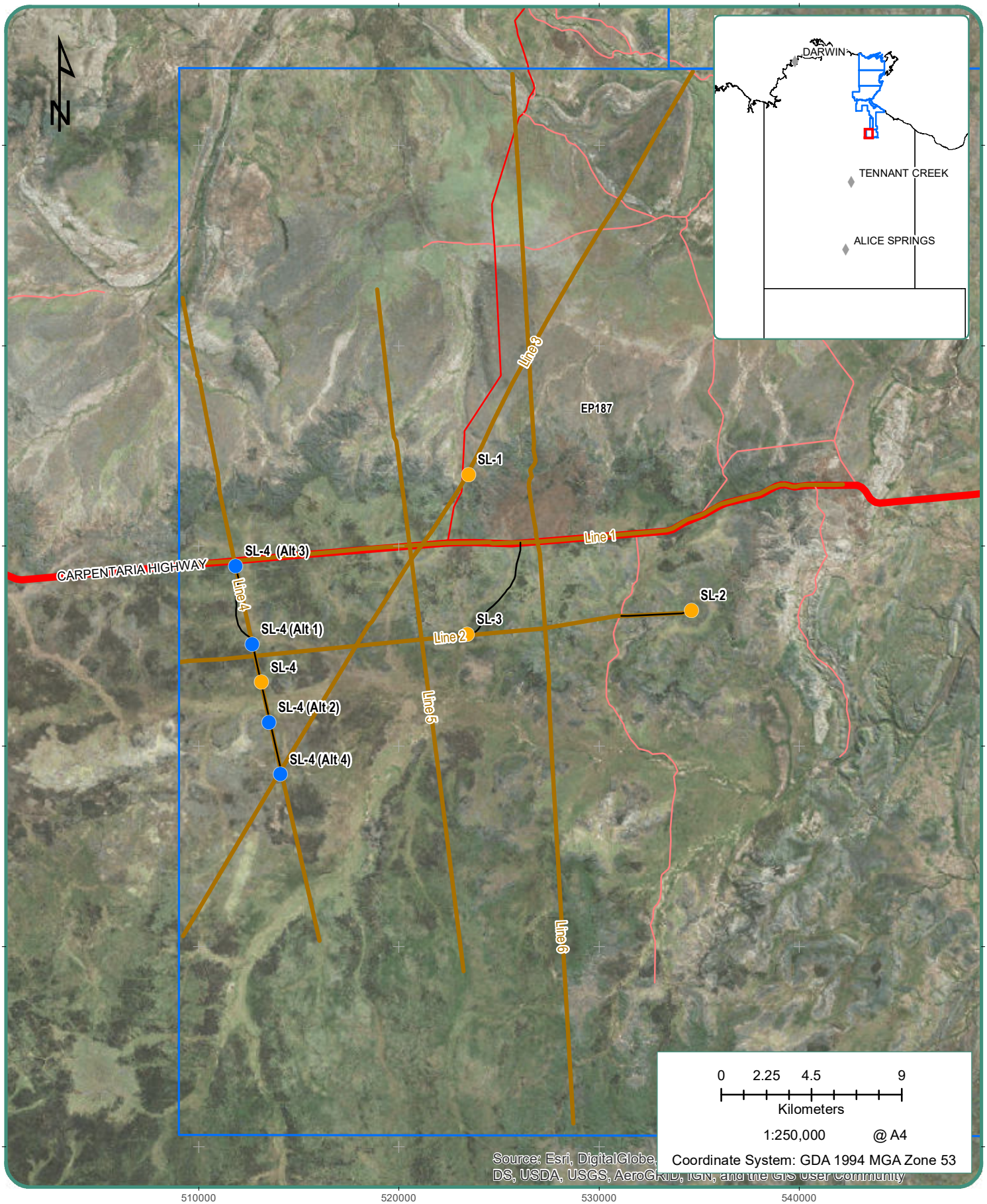
Table 1: Seismic line coordinates for start and end (decimal degrees)

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

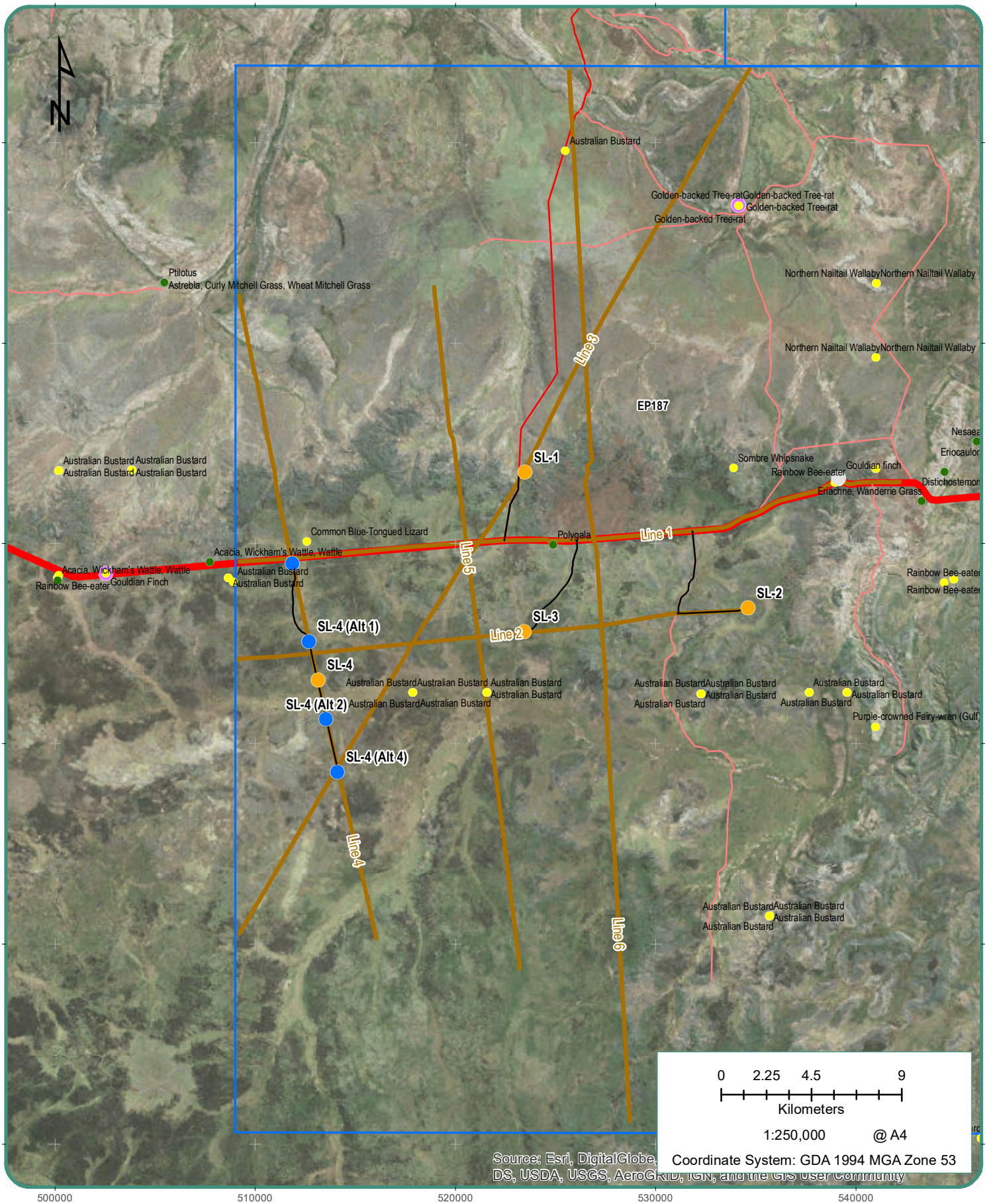
Details of the weeds occurring in relation to the proposed seismic are included in the Weed Management Plan (WMP) prepared by Premise (*Weed Management Plan, 2018 Seismic Program, EP187, Premise Environment, 15 November 2018, Report # 1802587e*). A revised WMP will be prepared to include the proposed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



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

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

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:

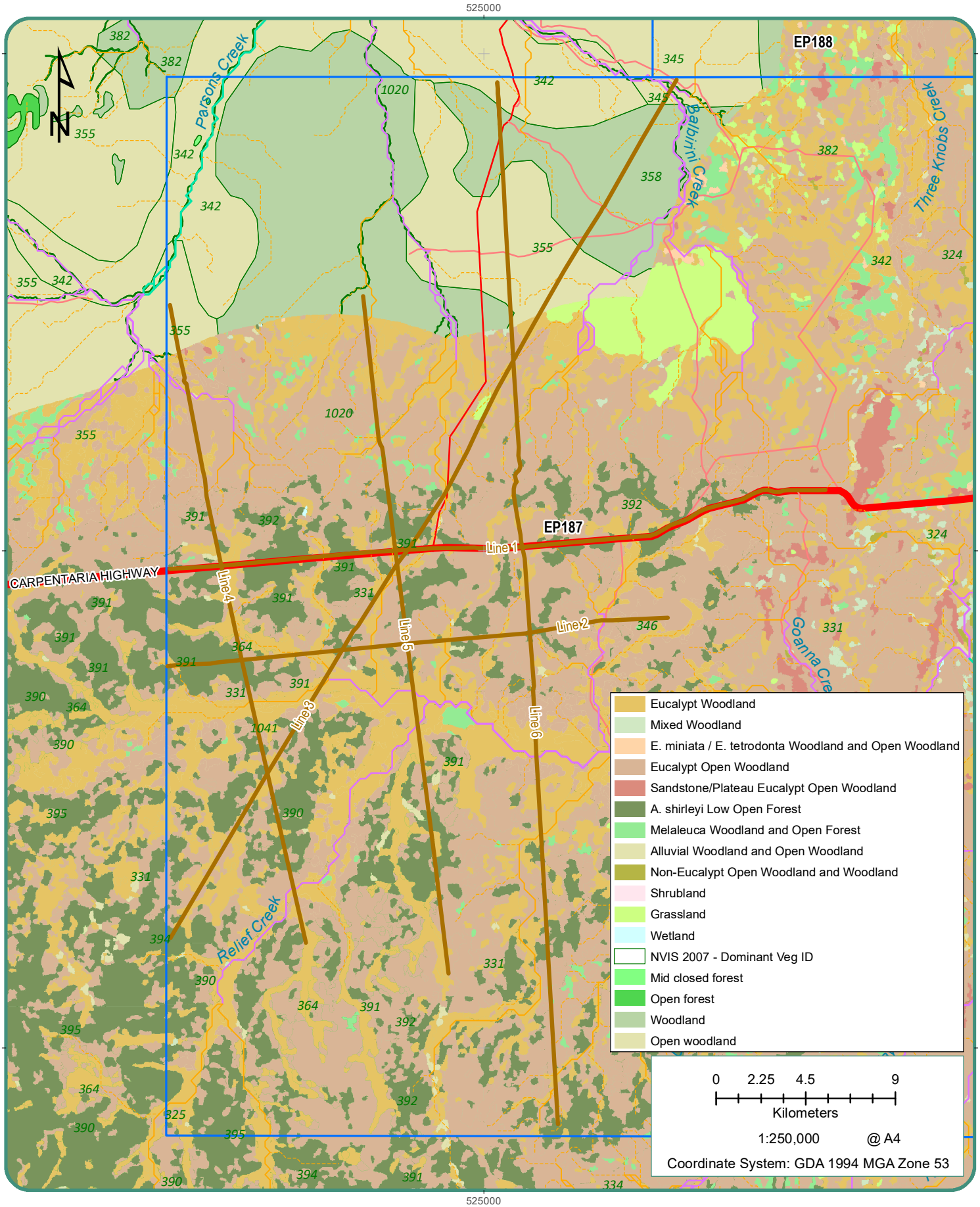
- deep cracks in dry alluvials which provides refuge for reptiles, amphibians and small mammals
- Large areas open for cattle grazing
- Open areas for raptor foraging

***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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APPENDIX A

Search Results

Australian Government
Department of the Environment and Energy

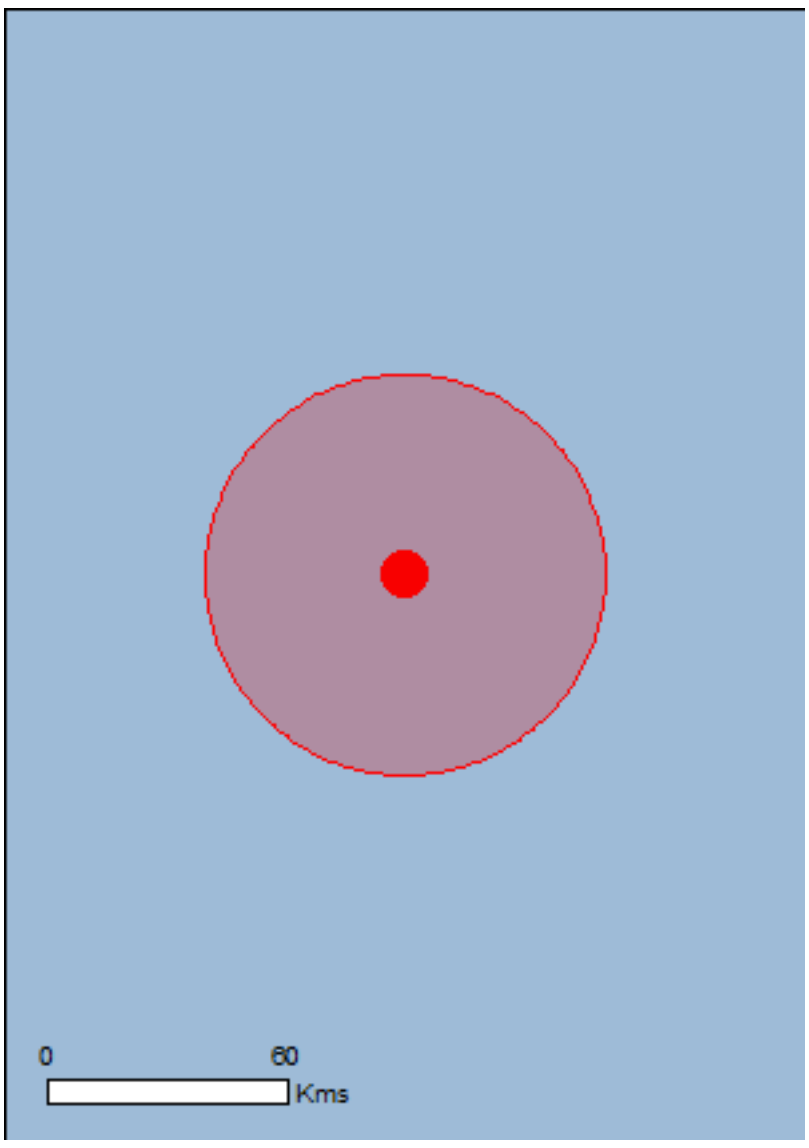
EPBC Act Protected Matters Report

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



Coordinates

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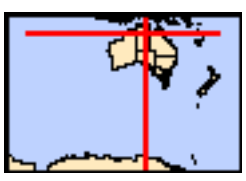

Summary

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.
Falco hyploleucos Grey Falcon	-	V	LC	Grey Falcons live in areas of lightly-timbered lowland plains, typically on inland drainage systems, where the average annual rainfall is less than 500 mm. They use nests built by other species and prefer nests in the tallest trees along watercourses. The majority of records from the Northern Territory (NT) are from the southern half, but there are records all the way up to Darwin and also a record from Groote Eylandt (NT Gov (2012) Threatened Species of the Northern Territory).	**Moderate potential to occur** Suitable habitat exists. Given the narrow linear nature of clearing, the likelihood 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 – moderate potential to occur** species has not been recorded in the seismic project area (no records from desktop searches). Minimal clearing of suitable habitat and therefore considered low risk of impact
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

Species Name	EPBC Act Status	TPWC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
					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-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 17^0 latitude (north of the study area which is 16^0 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	**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
				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 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 mertensi Mertens' Water Monitor	-	V	-	Aquatic lizard found on rocks and logs, or tree trunks and branches overhanging rivers, lagoons and swamps. Submerges itself when disturbed (Cogger 2014)	**Low potential to occur** Lack of suitable habitat in the seismic and well pad project areas. This species may potentially occur in the broader landscape of EP187 along permanent waterways and lagoons. This species was recorded in EP184 during previous surveys.
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 range of

Species Name	EPBC Act Status	TPWC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
					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

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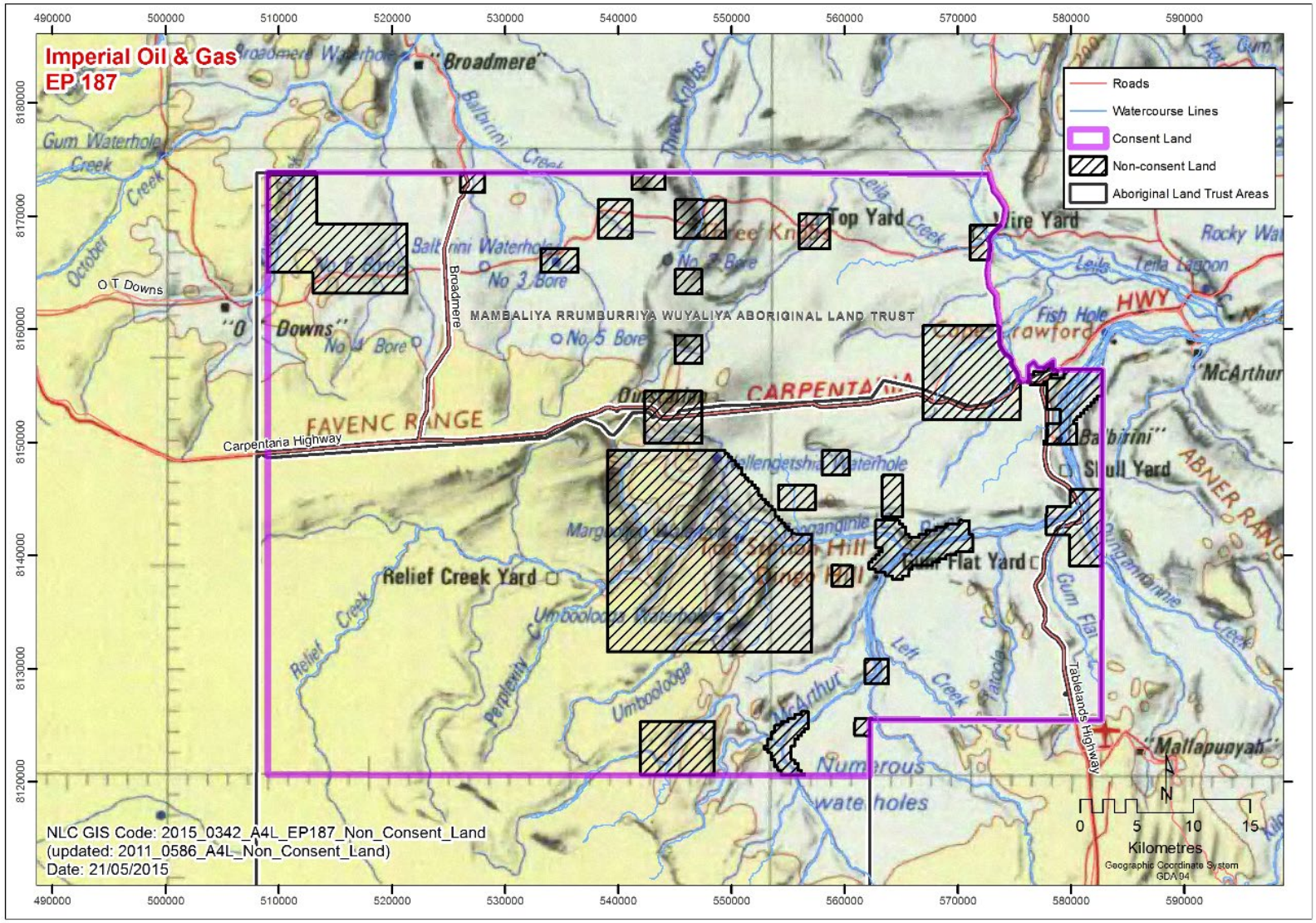
ENVIRONMENTAL

Appendix 18. Anthropological Survey



Appendix 19. Bushfire management

Bushfire management plan

Introduction

The area of planned exploration activity for the acquisition of the 2D seismic program within EP187 is generally an open grassland savannah area lightly timbered. The area is regularly burnt using aerial fire bombing and traditional owner cultural fire management practices.

More recently the area has been increasingly utilized for cattle grazing and as a consequence many new fence lines and fire breaks have been constructed through the exploration area. As a part of grazing management practices towards the end of the dry season the area is regularly burnt to reduce fuel load and to promote new pasture growth through the following wet season. The practice of regular burns reduces the risk of significant hot fires and allows for a cooler less intense burn, however the risk of bush fires and wildfires remains in some areas.

Commitment and policy

Purpose

This document has been developed to provide the staff and contractors operating on exploration sites owned and managed by Imperial Oil & Gas Pty Ltd (Imperial) with information and understanding of fire policies and procedures. The objectives of this Bushfire Management Plan (BMP) is to ensure fire control practices are implemented on site to minimise the incidence risk of fire from site activities and bush fires, and is designed to provide information on how to manage fire risk and how all staff on site will be informed about fire safety measures as part of Imperials overarching Health Safety and Environmental Management Plan (HSEMP).

The objectives of this BMP are to:

- Ensure a comprehensive risk management process is applied across all work areas to ensure a high level of safety for persons, property and environment
- Reduce the likelihood of fires starting as a consequence of Imperial exploration activity and thereby reduce the threat to life, property and the environment.
- Ensure that fire safety problems that arise are quickly and effectively contained and resolved
- Ensure that appropriate training and information is provided on fire safety and fire control to all personnel on site.
- Ensure Imperial complies with its legal obligations to fire safety

Scope

This BMP has been prepared to provide additional information to the Environmental Management Plan in relation to the planned 2D seismic acquisition within EP187. This BMP applies existing management commitments as outlined within the 'Imperial Oil & Gas Pty Ltd Emergency Response Plan', specifically sections 1.9, 2.7 and 3.1, with regards to fire management and safety.

Safety

This BMP is devoted to the pre-suppression of fires and the maintenance of natural resources and considers the Traditional Owners landscape-scale burning activities and regional fuel load reduction practices carried out by pastoralists and other land users.

All works are to be undertaken in a safe manner incorporating the use of Personal Protective Equipment (PPE), safe work practices (SWP) and Job Safety and Environment Analysis (JSEA) prior to the commencement of each task.

General requirements

Legislation and codes

The following fire safety legislation is applicable in the Northern Territory

- Bushfire Management Act (NT) 2016
- Bushfire Management (General) Guidelines (NT) 2018
- Environmental Assessment Act (NT) 2013
- Fire and emergency Regulations (NT) 2017
- Work Health and Safety (National Uniform Legislation) (NT) 2016

Standards and guidance material

- Imperial Oil & Gas Pty Ltd Emergency Response Plan
- Imperial Oil & Gas Pty Ltd Environmental Management Policy
- Imperial Oil & Gas Pty Ltd Environmental Management Plan
- Imperial Oil & Gas Pty Ltd Risk Management Procedure

Roles and responsibilities

Responsibility for ensuring the site environmental requirements are met, including this BMP lie with the Chief Executive Officer (CEO), Environmental Manager, Site Manager (designated Person In Charge (PIC)) and the Health and Safety Manager and their delegates. An individual may hold more than one of these roles and the associated responsibilities.

The responsibilities include:

- Ensuring all company personnel and contractors comply with the BMP
- Allocation of appropriate funding for fire safety
- Ensuring the appropriate infrastructure and operational design is consistent with the requirements of the BMP
- Ensuring that all company personnel and contractors on site are appropriately trained and responsible for carrying out their assigned duties to minimise fire safety risk and to provide fire safety response in the event of an incident

The person in charge (PIC) of field operations is responsible for the implementation of this BMP on site. Resources shall be obtained and maintained to provide the level of protection required by this plan.

As a minimum:

- All field personnel shall understand the requirements of this BMP;
- All field personnel shall be trained in first aid and firefighting techniques;
- All Supervisory personnel shall understand the detail of all emergency response procedures; and

- The PIC of any works shall be competent in all of the above requirements as they apply to the works.
- The PIC shall ensure that drills of the emergency response procedures are performed.

Management Strategies

In regard to bushfire risk, the management objective is to reduce the threat of bushfires to personnel, third parties, property and the environment.

- The induction program shall inform personnel of the required bushfire management procedures.
- Imperial shall maintain regular liaison with local emergency services organisations.
- Regular liaison with landholders shall be conducted regarding the nature and schedule of operations activities.
- All work activities shall be restricted to the operational site area, site office, lay down hard stand, workshop, and designated access routes.
- All vehicles shall carry fire extinguishers.
- A mobile safety trailer with water tank, fire extinguishers and general safety gear is to be maintained in readiness.
- All machinery shall be maintained and operated to comply with relevant fire safety standards.
- Defective machinery shall be shut down until the defect is rectified and the machine made safe for operations.
- The event of a fire shall be limited through the employment of fire prevention mechanisms.

All Imperial personnel, each contractor and the PIC is responsible for the safety of their unit and personnel, and must have procedures in place to ensure that each person under their authority is fully acquainted with their duties in the event of fire.

If there is a fire, all precautions will be taken to eliminate any danger to personnel. Operations will be curtailed where necessary. Where a fire cannot be controlled with the resources available on site, other equipment will be called in to assist.

Bushfire/wildfire threat

The EP187 exploration tenement is not in a fire control area, however controlled burn management is practiced by the traditional owners of the region and by the land users of the area. Vegetation is generally sparse during the latter half of the dry season and the area is dominantly covered by open savannah grassland and scattered small trees. Fire risk is greatest after the wet season when the fuel load is highest.

Within the region bush fires and wild fires are thought to be generated from lightning strikes. Fuel load reduction burning is conducted by Traditional Owner practices and pastoralist/land users also undertake control burns to promote new grass growth for grazing.

Exploration activities conducted by Imperial will operate under the general principle of fire avoidance. The main sources of fire are outlined below:

- Lightning generated natural wildfire
- Uncontrolled burn outs –not Imperial
- Traditional owner controlled burns
- Land user initiated fires
- Accidental fires – land user activities
- Accidental fires – Imperial activities

As this is a short term exploration activity expected to be completed within 28 days of commencement there will be no central reticulated fire system or fire hoses available on the exploration site. Fire protection will occur through the use of hand held fire extinguishers mounted within site vehicles. All vehicles on site will be fitted with two way radios and appropriate fire extinguishers.

Mitigation strategies/hazard management

Housekeeping will play a major role in fire prevention. The housekeeping will include:

- slashing of grasses and shrub vegetation in operational areas to eliminate prolonged contact with hot machinery that could have the potential to start fires
- It is imperative that weather conditions are regularly monitored with particular notice of Fire Danger Periods where there can be imposed a Total Fire Ban

Primary mitigation strategies include:

- All personnel are strictly banned from lighting fires on the exploration site
- All personnel will comply with fire bans declared by Bushfires NT
- All personnel will be trained in the use of fire extinguishers
- All operational seismic line areas will be cleared of loose dead vegetation; grasses and low shrubs will be slashed to avoid contact with hot machinery
- When machinery is parked consideration will be given to the location of the machinery and the potential of contact of hot engines or exhaust with dry vegetation
- All vehicles/plant to enter the site must undergo daily inspection for accumulated vegetation; any accumulations will be removed prior to the vehicle/plant entering site
- Any repairs to machinery or plant that involves welding, cutting or grinding activities will require a Hot Work Permit to be issued prior to commencing. Any such work will be at a site well removed from any combustible material. All such activities will include the use of spark and flash barriers
- Half-filled clear plastic water bottles when left in sunlight can act as a magnifier concentrating sunlight. Such concentration can create localised hotspots leading to fires when in contact with combustible material. No clear plastic water bottles shall be left in sunlight on a vehicle seat in contact with upholstery.
- To prevent damage to the equipment in the first instance make sure all flammable material is removed
- Understand your work site and in doing so prepare a Fire Safety Risk Assessment.

Appropriate safety clothing must be worn at all times including a minimum of hard hat, safety glasses, high visibility long sleeve shirts (tucked in), long cotton trousers and steel or Kevlar toe safety foot wear. All clothing shall be secured with no loose flapping sections.

Observe all safety signs such as **"No Smoking"** and **"No Unauthorised Entry".** These are placed for the safety of all personnel.

Vehicle inspections

All machinery must be inspected daily for fit for purpose. Any machinery, vehicle plant or equipment found to have a fault will be moved to the site mechanic for immediate repairs.

All equipment, radiators and undercarriage will be inspected daily for the build-up of grass and other vegetation and where found it will be removed from the vehicle to prevent contact with hot metal and the potential to start a fire. Obtain a hot work permit before welding, cutting or grinding activities.

Training

All employees, contractors and visitors will be required to attend a site induction with attendance documents on the induction/training record form and induction training register. All personnel on site will undergo safety training in the use of fire extinguishers and bush fire awareness.

The site induction which covers environmental and safety aspects will inform all personnel about fire awareness and the requirement to obtain a hot work permit before welding, cutting or grinding activities, emergency contact numbers, and procedures in case of fire.

Regular drills will be carried out to refresh knowledge of emergency equipment and procedures. Drills will be noted on the morning reports and monthly Environment, Health and Safety meetings minutes.

Emergency response

Any fire is a serious situation that requires immediate corrective action. With appropriate wind conditions, a bush fire can spread rapidly and present a threat to life and property not only at its location, but also in the nearby areas.

If wildfire is encountered personnel should avoid the area and evacuate to a downwind positon. For safety reasons Imperial personnel and contractors are not permitted to fight such fires as they can be highly unpredictable.

Should a fire threaten personnel and plant equipment and evacuation is not an option and it appears probable/highly likely that the fire will approach; fire break clearing is the first activity to be conducted using either a grader, shovel or other means or back burning to reduce the amount of vegetation (fuel) in the immediate vicinity.

Fire break clearing is permitted if the following actions are taken:

8. Contact the company site PIC and advise them of your location and the situation
9. Move portable equipment to a safe location
10. Preferably select small patches of vegetation to burn individually, one at a time. After each patch is burnt, extinguish any remaining embers to avoid ember attack on nearby vegetation.
11. Always burn upwind. i.e. only burn vegetation where a fire break exists in the down wind direction. The intention is to eliminate the fuel in the zone between the site and the wild fire.
12. Ensure a line of retreat away from the fire to safe ground
13. Never attempt to fight a fire alone
14. **Remain Calm**

The key to containing a fire is to isolate the problem area in the form of long grass and scrub and then shut in the affected area at risk so as to minimise damage from the fire. Minor fires may be dealt with by using on-site fire-fighting equipment.

Any fire that threatens property must be notified to the nearest Police / Fire / Emergency Service **and the Emergency Services Officer.**
In the event of a fire that cannot be controlled by site personnel, support and specialised firefighting trucks can be mobilised from the McArthur River Mine that provides this service to the broader region.

Safe Work Procedures

What to do in event of a Fire

If a fire starts:

13. Do not panic, remain calm, and think
14. Ensure someone has raised the alarm. Notify PIC.
15. Should a bush fire become active in or near work locations evacuation is necessary.

In an emergency use the Imperial UHF Channel or satellite telephone to notify the **Person In Charge (PIC).** Inform the PIC of your location, number of personnel at the location and the type and extent of fire

DO NOT CALL

- a Rural Fire Service district office
- a Fire Control Centre
- a rural fire brigade
- volunteer member

The PIC will make the necessary contact

16. Do not attempt to fight the fire if you do not feel safe to do so. Raise the alarm and leave the area in accordance with the evacuation procedure
17. Select the right type of extinguisher to fight the fire and be sure you know how to use it or any other equipment provided. Be trained and assessed competent in correct use
18. If in doubt, **READ THE INSTRUCTIONS** provided with equipment
19. Have another person back you up with another extinguisher or fire control appliance
20. If possible do not let the fire get between you and your pre planned escape route
21. Do not get too close to the fire. Radiated heat will burn you
22. Quick test the extinguisher or other fire control appliance with a test squirt to ensure they work before approaching the fire
23. Direct the extinguisher nozzle stream at the flame source and not the flames or the smoke
24. If a bush fire occurs then work crews should attempt to drive out of the fire area if safe to do so, if it's not safe to drive away from the area then work crews should make their way to the nearest road, open area or established cleared hard stand area. This will provide best protection while the fire passes over

All Personnel

4. If time permits clear away any long grass or scrub that may act as a fire source.

5. Determine type, location and extent of fire. Do not close off any pipes or vessels that are subject to heat as they may become over pressured and fail.
6. Direct visitors, contractors and service personnel to an appropriate safe area.

Person-in-Charge:-

8. If safe to do so, de-pressure any gas containing equipment located close to the fire by venting/flaring to minimise collateral damage.
9. While natural gas will normally disperse quickly and in an upward direction, gas vented from high pressures can be very cold and hence heavier than air, until it warms up, and can contain heavier hydrocarbon that will not disperse so easily.
10. If safe to do so, relocate a fire trailer to the area in preparation for firefighting activities.
11. Advise and liaise with Site Coordinator or most Senior person present at the site of the fire
12. Use fire trailer and/or knapsack if safe to do so. Note it may be appropriate to allow fire to diminish prior to using the correct type of extinguisher.
13. Determine need for additional services or evacuation.
14. Advise other appropriate Government contacts including as appropriate Police / Fire / Emergency Service or other bodies, e.g. relevant Councils.

Head of Field Operations:-

5. Advise Imperial Chief Executive Officer.
6. Ensure emergency contacts have been notified and necessary steps taken.
7. Liaise with Government Departments as appropriate.
8. Notify other Imperial personnel as appropriate.

Imperial Chief Executive Officer
Notify Imperial legal counsel and Insurers, as appropriate.

1.1 Ancillary Equipment

Fire extinguishers are located in all vehicles on site along with first aid kits and all personnel should familiarize themselves with their location and proper use.

A fire should only be fought with available fire extinguishers and pumped water if necessary. However, firefighting should only occur where individuals are able to do so in complete safety.

The first priority in the event of a fire is to notify others. This allows them to plan their escape, and ensures that assistance will be available if the fire is not controlled.

In addition, before fighting a fire a person must ensure that there is a certain escape route if the fire is not put out.

1.2 Accommodation Areas

When using commercially provided accommodation, the Senior Site Officer should check the accommodation provided to operational crew to confirm that it is of an adequate standard.

In the event of a fire and/or evacuation of an accommodation premises, employees shall follow the emergency procedures of the accommodation providers. However, the senior person present at the emergency should also independently confirm that all employees are safe, and should immediately notify the HSE Coordinator of the emergency.

CALL IN OUTSIDE HELP IF THERE IS ANY DOUBT THAT THE FIRE CANNOT BE HANDLED BY SITE EMPLOYEES.

DISTRICT CONTACT DETAILS

Hospitals		
Royal Darwin Hospital	Darwin	**08 8922 8888**
Katherine Hospital	Katherine	**08 8973 9211**
Tennant Creek Hospital	Tennant Creek	**08 8962 4399**
Care flight NT	Darwin	**Tel: 08 89442007**
		Fax: 08 89270645
Police Emergency 000		
Police	Borroloola	**08 8975 8770**
	Katherine	**08 8973 8000**
Emergency Service	Borroloola	**000**
	Katherine	**08 8972 3602**
Bushfire	Borroloola	
	Katherine	**08 8973 8871** **0401 115 744**
Fire Station	Borroloola	**000**
Community Health	Borroloola	**08 8975 8711**
	Katherine	**08 8973 8871**
Aerial Medical services	Borroloola	**08 8973 8570**
	Katherine	**08 8999 4988**
Remote Rural Health	Borroloola	**08 8975 8711**
	Katherine	**08 8973 8570**
Northern Land Council	Borroloola	**08 8975 8848**
	Darwin	**08 8920 5100**
	Katherine	**08 8971 9899**
Borroloola Doctor	Work Hours	**08 8975 8711**
	After Hours	**08 8975 9859**
Land holders	On file in field office	
Dep't Primary Industry &	Darwin	**Tel: 08 8999 6567**

Resources		**Tel: 08 8999 6350** **Fax: 08 8999 5191**
	After Hours	**Tel: 0439 744 119** **Tel: 0430 739 507**
Next of Kin	On file at field Office	
	Managing Director and Chief Executive Officer Level 7 151 Macquarie Street Sydney NSW 2000	

Appendix 20. Dial Before You Dig (DBYD) Works Approval

OSD Asset Services

Power Water

DBYD Works Approval Form

Purpose	Detail the approval and associated controls that are to be followed when conducting the proposed third party works in the vicinity of a pipeline asset. Note, the conditions outlined in this form are compulsory. All approvals granted shall be revoked if any condition is not met.

Section 1 - Request Details

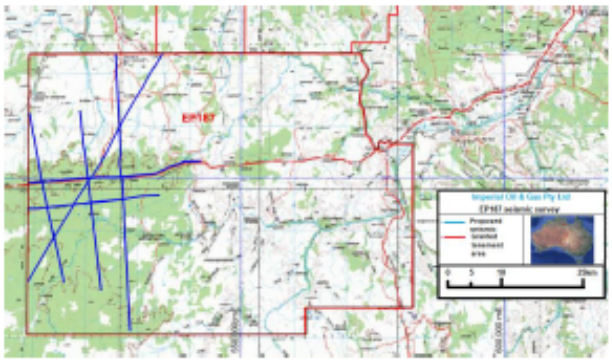
Requestors Details	
DBYD Enquiry Number: N/A Email enquiry	Date of DBYD Enquiry: N/A Email Enquiry 3/8/18
Name: Geoffrey Hokin	Company: Imperial Oil & Gas Ltd
Contact Number: +61 437 440 417	Email Address: ghokin@empiregp.net
Postal Address: Level 7, 151 Macquarie Street, Sydney, NSW, 2000	
Principal Contractors Details (N/A if not applicable)	
Name: N/A	Company: N/A
Contact Number: N/A	Email Address: N/A
Postal Address: N/A	

Section 2 - Location and Timing of Works

Request Details	
Location of Works (Address): Various locations along McArthur River Mine Pipeline, refer to map in section 3	
Start Date & Time of Works: TBC by Imperial Oil and Gas	Finish Date & Time of Works: TBC by Imperial Oil and Gas

Section 3 - Approval and Conditions

Scope of Proposed Activities – Summary
Imperial Oil & Gas plan to undertake a 2D Seismic Acquisition Survey in land adjacent to the McArthur River Mine (MRM) pipeline as described in a letter received from Imperial Oil and Gas dated 3/8/2018. Imperial Oil and Gas has requested approval to cross the MRM pipeline with the Seismic trucks.



Page 1 of 3

Conditions to be observed when conducting the works

An assessment has been completed based on the supplied vehicle data to determine if the weight of the vehicle poses a risk to the pipeline. Please refer to calculation 1797-02-EL-CAL-003 for details. Subsequently, Imperial Oil and Gas changed the Seismic Contractor that changed the dimensions and weight of the Seismic Trucks. At this time AS2885.3-2018 was released with a new method for calculating the crossing stresses.

The new combination of vehicle and calculation as caused the crossing calculations to fail.

As a result, the following conditions apply

- A 25mm steel plate (3mx5m) must be installed over the pipeline at locations where the trucks wish to cross.
- Do not place the steel plates at locations were erosion is visible
- The vibration unit cannot be operated within 20m of the pipeline.
- Only the vehicle specified by Imperial Oil and Gas has permission to cross the MRM pipeline.
- Report any issues found in the field to OSD Asset Services
- Imperial Oil and Gas to notify OSD Asset Services one week prior to mobilisation

Reference Documents

1. Imperial Oil and Gas letter
2. Email containing vehicle type
3. Email of OSD confirmation

Section 4 - Asset Caretaker Approval

Please note, the approval provided by this form applies only to scope of work described in Section 3 of this form, subject to the application of the conditions outlined also in Section 3 of this form.

Minor Works – Approved by OSD

	Name	Position	Signature	Date
Reviewed by:	Soheil Taherian	Supervising Pipeline Engineer		07/05/2019
Approved by:	Jarrod Woolnough	Asset Services Manager		07/05/2019

Major Works – Approved by Power Water Corporation

	Name	Position	Signature	Date
Approved by:	Graham Piggott	Asset Manager		07/05/2019

Section 5 - Affirmation

To be signed by party conducting the works.

a) This DBYD Works Approval Form applies only to the scope of work detailed in Section 3 of this form.
b) The approval granted by this form is subject to the application of all conditions detailed in Section 3 of this form unless written dispensation is provided by Power Water Corporation
c) Works may only progress following the receipt (by Power Water Corporation or its nominated representative) of the signed affirmation (Part 5 of this form)
d) Power Water Corporation will arrange for a Supervisor to be on site as necessary during the work. Power Water Corporation will advise the requirement for an inspector.
e) The applicant is responsible for any damage resulting from the work and all consequential damages and losses arising from such damage and therefore must insure against every liability of the contractor in respect of or arising out of any loss of life, loss of or damage to property of person (both real and personal), arising out of or in any way connected to this work.
f) Power Water Corporation DBYD requests are valid for one month only. Enquiries may need to be renewed and a new application may be required.
g) Under the Work Health and Safety Act 2011, each work place has an obligation to comply with Workplace Health and Safety Regulations and Codes of Practice. Failure to comply with Work Health and Safety Regulations 2011, Chapter 4:

Hazardous Work may result in Power Water Corporation reporting the non-compliance to Workplace Health and Safety. **Under no circumstances does Power Water Corporation's approval of or supervision of works transfer the responsibilities under the Work Health and Safety Regulations from the third party to Power Water Corporation or Power Water Corporation's contractors.**

Conditions a) to g), listed above have been fully understood and accepted?
I, as the person requesting authorisation to conduct work confirm that only those works detailed in Section 3 of this form will be conducted
I, as the person requesting authorisation to conduct work confirm that all conditions listed under Part 3 of this form will be met prior to and during the execution of the works

Signature: Underwood Date: 07/05/2019.

Name: ALEXANDER UNDERWOOD. Position: CHIEF EXECUTIVE OFFICER.

Company: IMPERIAL OIL & GAS PTY LTD.

OFFICE USE ONLY

Section 6 - Review and Follow up

Form Received (Power Water Corporation Representative to populate)	
Date Received	/ /

Further Action (Power Water Corporation Representative to populate)	Y	N
All Sections above have been reviewed	☐	☐

Signature: _____ Date: _____

Name: _____ Position: _____

Appendix 21. Works in Carpentaria Highway Approval

NORTHERN TERRITORY GOVERNMENT

DEPARTMENT OF INFRASTRUCTURE, PLANNING AND LOGISTICS

Government Centre
First Street, Katherine
Postal PO Box 1171, Katherine
NT 0851
Tel (08) 89738705
Fax (08) 89738666
Email: Roadskatherine.ntg@nt.gov.au

Reference: 21720582

To: Imperial Oil and Gas
Date: 21/11/2018
Total pages: 55 (including cover sheet & attachments)

Tracking number: 21720582 (for Road Operations records)

Location of Works: Carpentaria Highway (CH200 – CH239.2)

The submitted Traffic Management Plan (TMP) has been appraised by Road Operations Officers and appears suitable for the proposed works. Please also refer to the authorised temporary speed limit authorisations & permit (if applicable).
Any changes to the scope of works or traffic management arrangements are to be forwarded to the Departments Project Officer prior to implementation of these changes.

Please ensure the attached documents can be referenced on site for compliance.

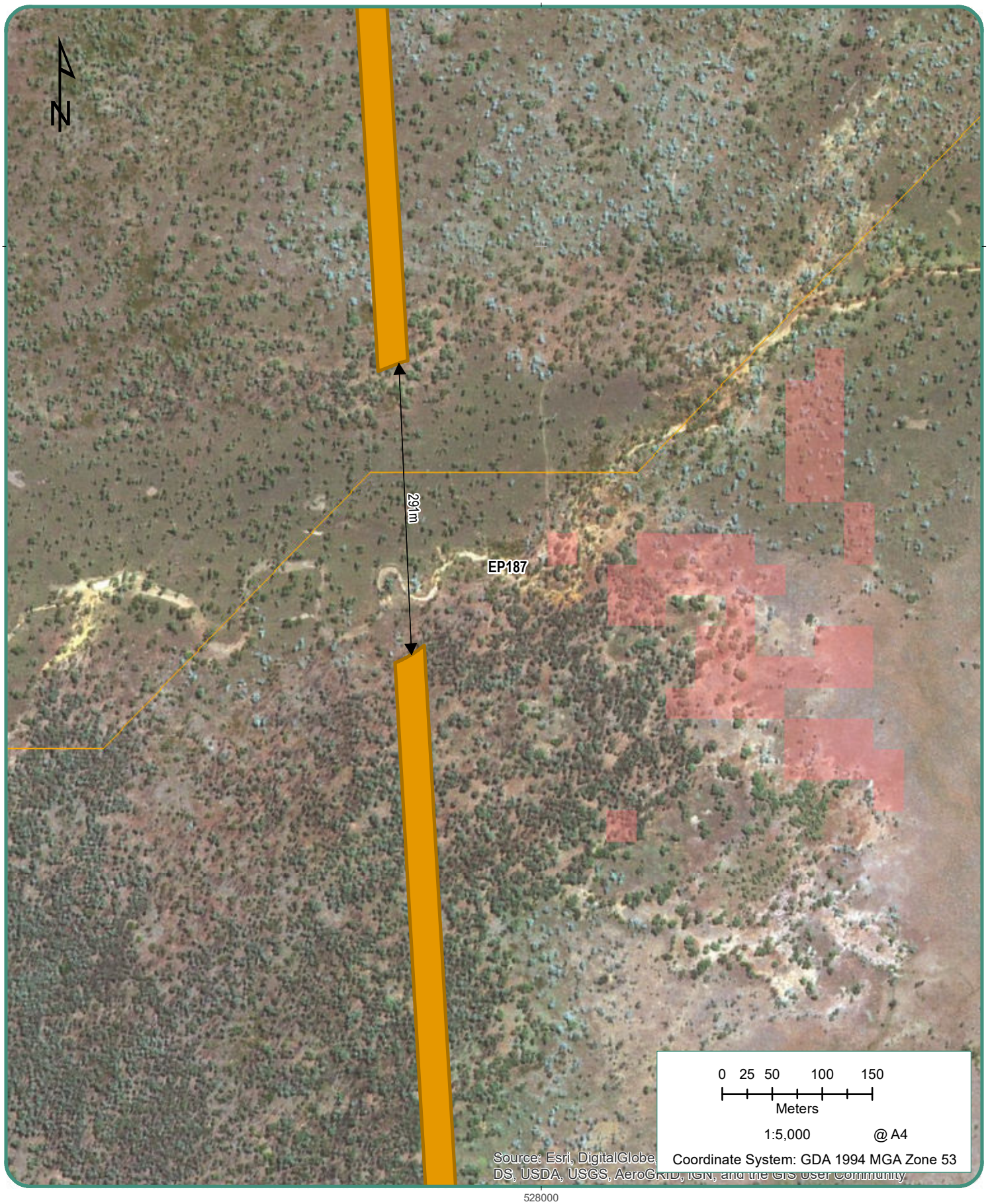
Don't hesitate to contact DIPL if you require further information.

Yours faithfully

PHIL HARRIS
Senior Director Northern Region

21st November 2018

Appendix 22. Example buffer distances from Waterways



TITLE:

Clearing areas watercourse buffers

MAP NO: IOG_0004

PROJECT: EP187 Clearing plan

LEGEND

- Distance
- Seismic lines (30m corridor)
- Tenements
- Slope greater than 2% (red)

Stream Order

Intermittant Streams

- 1
- 2

Creeks

- 3
- 4

Rivers

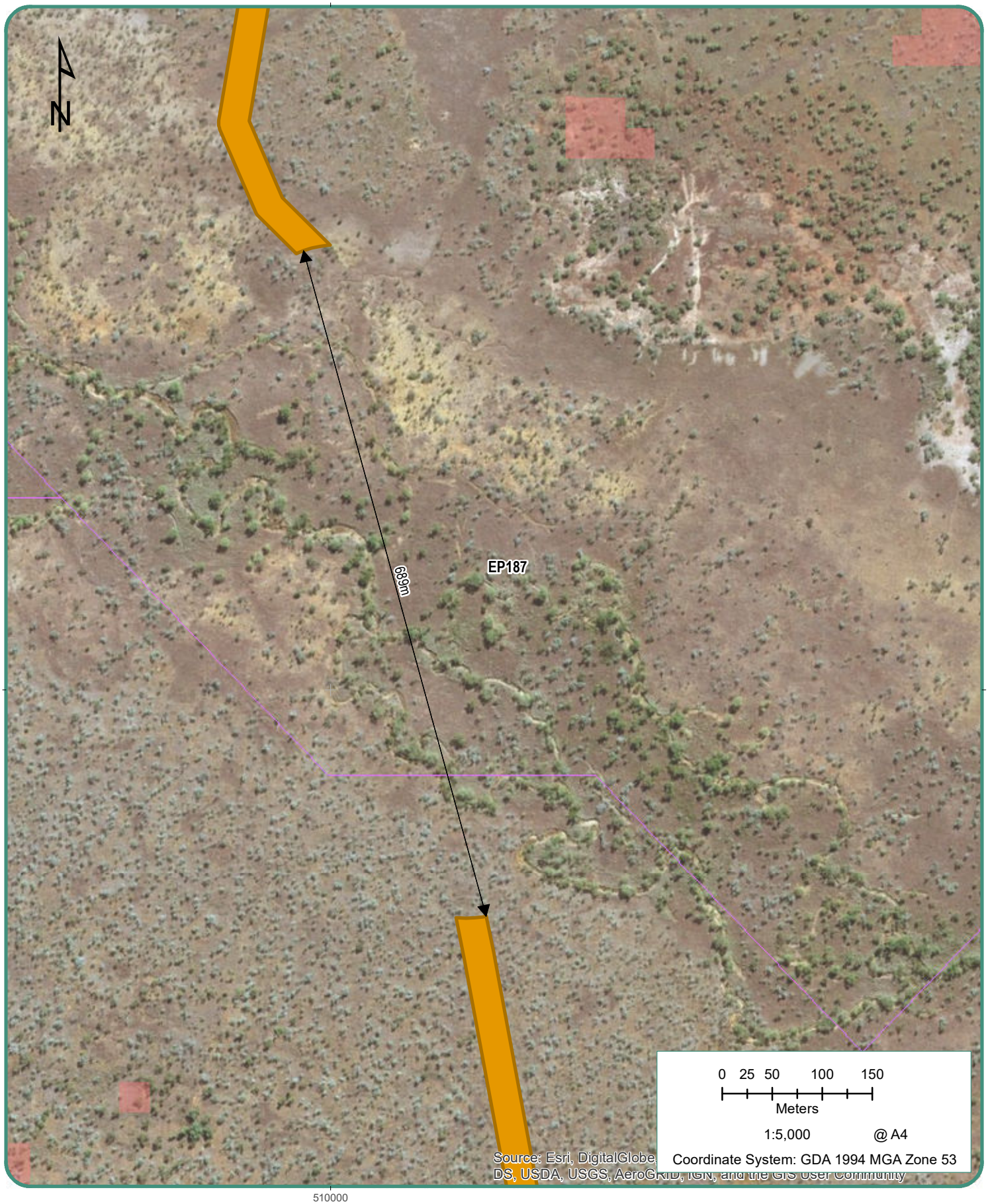
- 5
- 6
- 7

FOX & CO ENVIRONMENTAL

Date: 29/07/2019

Data Source:
Northern Territory Stream Order (2018-08-09), NT Per Cent Slope as 2 Classes (derived from 1 sec SRTM DEM-S) (2018-12-04)
Supplied by the 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_0004 Watercourse buffer example 1.mxd



TITLE:

Clearing areas watercourse buffers

MAP NO: IOG_0005

PROJECT: EP187 Clearing plan

LEGEND

- Distance
- Seismic lines (30m corridor)
- Tenements
- Slope greater than 2% (red)

Stream Order

Intermittant Streams
- 1
- 2

Creeks
- 3
- 4

Rivers
- 5
- 6
- 7

FOX & CO ENVIRONMENTAL

Date: 29/07/2019

Data Source:
Northern Territory Stream Order (2018-08-09), NT Per Cent Slope as 2 Classes (derived from 1 sec SRTM DEM-S) (2018-12-04)
Supplied by the Department of Environment and Natural Resources

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Appendix 23. Heritage and Archaeological Survey Report

IMPERIAL ENERGY SEISMIC LINE AND DRILL PAD ARCHAEOLOGICAL SURVEY – FAVENC RANGE, NORTHERN TERRITORY

A report for Imperial Oil and Gas Pty Ltd (Imperial Energy)

Principal
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Cover photo: RTF(QZ) bifacially retouched point and VH-RQJ at LZ10.

August 2019

EXECUTIVE SUMMARY

Imperial Oil and Gas (Imperial Energy) are proposing to construct six seismic lines totalling 231.8km on the eastern edge of the Favenc Range, halfway between Daly Waters and Borroloola in the Northern Territory. An aerial survey was the most efficient method to cover a large area in the short time available. Two drill pads and four alternative drive pad sites are also planned including access tracks to those sites. These works required an archaeological assessment to mitigate their impact on cultural material.

Four low-density background scatters and one significant archaeological site were found. All of the sites occur in the vicinity of Balbirini Creek, an important water way in the north of the survey area. The proposed works will have little to no impact on three of the sites. The high-density artefact scatter, Imperial Energy Archaeological Site 1 (IEAS01) will, however, is directly impacted. A Restricted Work Area (RWA) is suggested for the site. A site boundary polygon has been recorded. All works should avoid the site.

Summary of recommendations:

- **Mitigation schedule of sites:**

No.	Site ID	Site Type	Individual site type	GPS Grid Reference (Centroid) Datum: WGS 84, Zone: 53L		Description	Significance	Recommendation
			Artefacts (n.)	Easting	Northing			
1	IEBS01	Artefact scatter	2			Low density, 50m radius	Low	Option 1. Avoid. Site is 100m to the west of Line 3
2	IEBS02	Artefact scatter	4			Low density, 145m radius	Low	Option 1. Avoid. Option 2. Destroy
3	IEBS03	Artefact scatter	4			Low density, 30m radius	Low	Option 1. Avoid. Site is 30m to the east of Line 6
4	IEBS04	Artefact scatter	3			Low density, 6m radius	Low	Option 1. Avoid. Site is 10m to the east of Line 4. Wpt No. 801 moved 10m to the east
5	IEAS01	Artefact scatter	>5 per m^2			High density artefact scatter with a range of tool types	High	Option 1. Avoid. Line 6 runs through the site. Refer to RWA (Fig. 11 and Appendix 2)

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1.0 INTRODUCTION

1.1 Background and consultancy brief

Imperial Oil and Gas Ltd Pty (Imperial Energy) are proposing to build 231.80kms of seismic survey lines and two drill pads on the eastern edge of the Favenc Range, off the Carpentaria Highway, half way between Daly Waters and Borroloola in the Northern Territory (Figs 1 and 2). An archaeological survey was required to assess the impact of the proposed works, if any, on archaeological sites, or objects.

A four-day aerial survey was conducted from 5 to 8 August 2019 by archaeologists and with Traditional Owner from the Lightning Ridge outstation off Broadmere Road. Our pilot was , who flew a Robinson R44 (VH-RQJ). The consultancy brief was specifically to:

- Identify any prescribed archaeological objects or places as defined under the Northern Territory *Heritage Act (2012)*, and any archaeological sites located within the entire survey area.

- Assess the nature, distribution and significance of these objects or places and discuss possible constraints to the works posed by the presence of archaeological and historic sites and an indication of what sites are likely to be the most sensitive in this respect.

- Present a final report including a summary of survey results, determination of significance of sites and the likely impact of the proposed development, and recommendations regarding management strategies or mitigation procedures as appropriate under the Northern Territory *Heritage Act (2012)*.

The 231.8kms of survey lines are divided into six lines. The lines will be approximately 10m wide i.e., five metres either side of the survey centre line. Line One, which runs parallel to the Carpentaria Highway, from east to west, is 33.6km long. Line Two, which runs parallel and to the south of Line One, is 25.3kms long. Line Three runs perpendicular to the previous two lines, and is 50.4kms long. This line runs from the north of the highway on the Balbirini Creek and crosses the highway in a south by southeasterly direction. Lines Four, Five and Six run in a similar direction and are 33kms, 34.4kms and 55.1kms long respectively.

Two drill pads are also proposed, one (SL-4) on Line Four, with four alternative sites (SL-4 ALT 1 - 4). The other proposed drill site is on Line Two (SL-3) with no alternative sites. The drill pad sites are 120m^2. Two access tracks to these drill pads from the highway were also part of the survey. The track to SL-4 is 6.3kms long and the track to SL-3 is 5.5kms long.

Several previously recorded archaeological sites north of the highway were relocated, but these were well outside of the construction corridor for the seismic lines. The corridor is ten metres wide. Four background scatter sites and one archaeological site were found during the survey. All sites were characteristically stone artefact scatters. The following describes the methods and outcomes of the survey, together with recommendations for the proposed works.

1.2 Environmental description

The survey area north of the Carpentaria Highway is characterised by open woodland and savannah, with a major waterway to the north of the highway, Balbirini Creek. This section of the survey area is heavily dissected across the Favenc Range, levelling out across black soil plain. North of the highway, quartzite outcrops occur.

In the southern section of the survey area, it is virtually all floodplain with only one major waterway, Relief Creek, which was dry at the time of the survey. The only permanent water sources are Cockatoo (near the eastern end of line 1) and at Eleanor Pool Yard1, off Broadmere Road.

Some ten kilometres southeast of the survey area is Paradise Pool, not far from the McArthur River, which would have been a significant refugia for Aboriginal People. It's triple waterfalls fill a permanent pool with abundant resources.

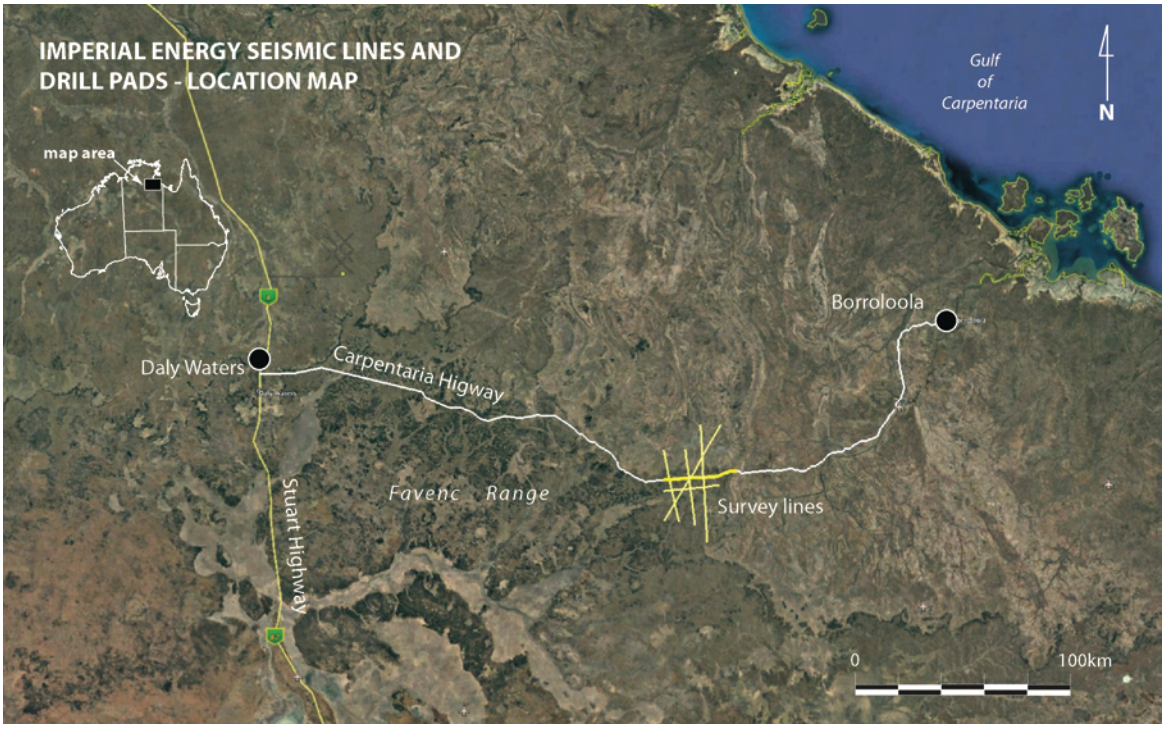

Figure 1. Location map of the study area, between Daly Waters and Borroloola on the Carpentaria Highway, on the eastern edge of the Favenc Range (After Google Earth).

The geology is recorded as predominately black soil plains north of the Carpentaria Highway and bounded at the northern end of the survey lines, associated with alluvial and lateritic deposits south of the highway. The following geological units occur in the survey area:

- KI Sandstone, lithic sandstone, clayey sandstone, conglomerate, sandy claystone and siltstone, commonly ferruginised and silicified; claystone may contain bivalve and brachiopod shell impressions and possible belemnite casts; sandstone commonly contains plant debris casts and leaf imprints.

- Czl – Pisolitic and mottled laterite: in situ and reworked remnants of standard laterite profiles (Fig. 2)

- Cz – Undifferentiated alluvial, colluvial and eluvial deposits: unconsolidated gravel, sand, silt, clay, ferruginous cemented detritus, minor calcrete, silcrete and ferricrete.

- Czb – Grey-black, earthy, clay-rich soil; black soil plain

- Pre – Ridge-forming: pseudo-karstically weathered, strongly jointed quartzarenite; feldspathic and ferruginous in places; predominantly planar cross-beds, ripple marks (Fig. 3).

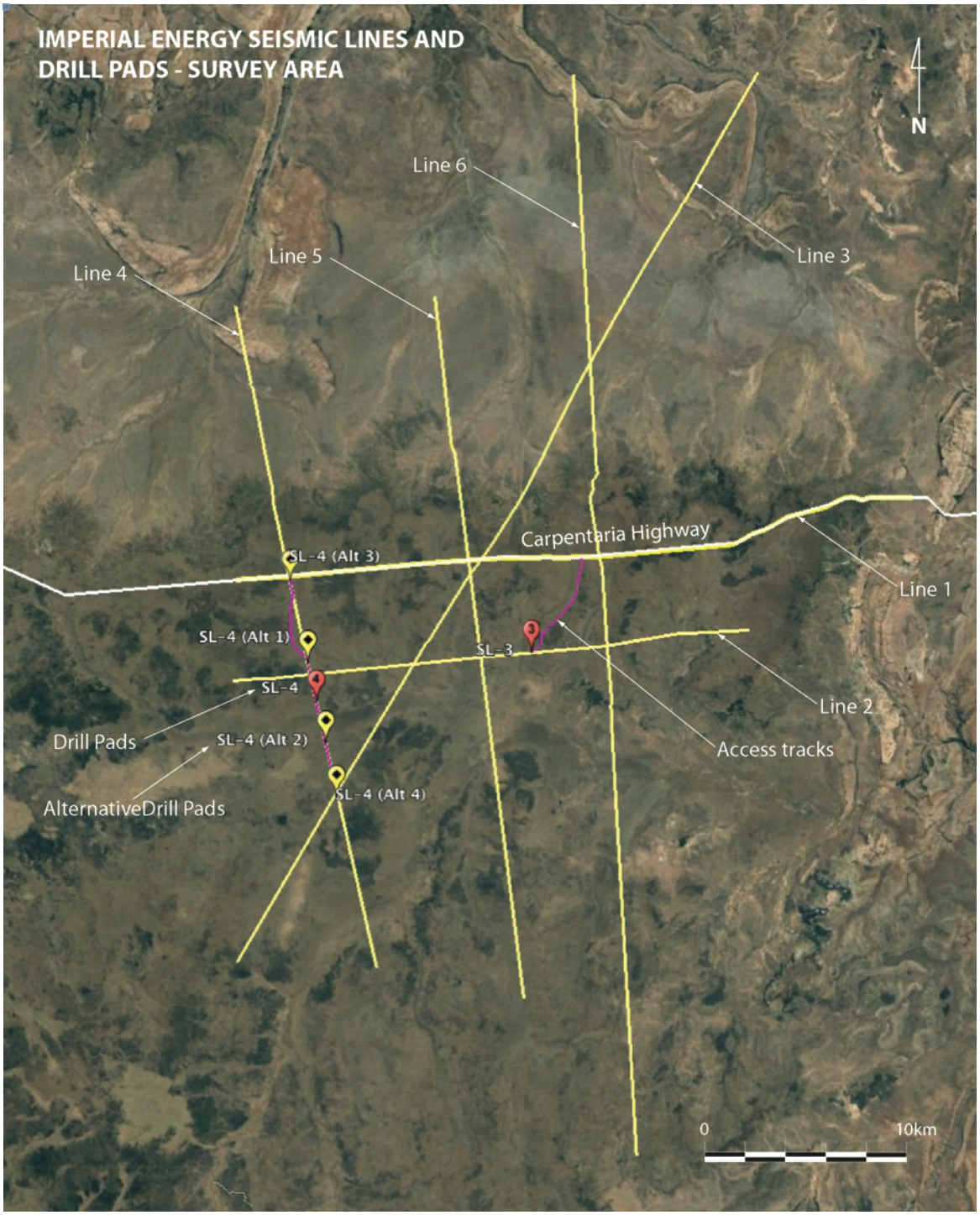

Figure 2. Location of the study area on the Carpentaria Highway, showing seismic lines, drill pads and access tracks (After Google Earth).

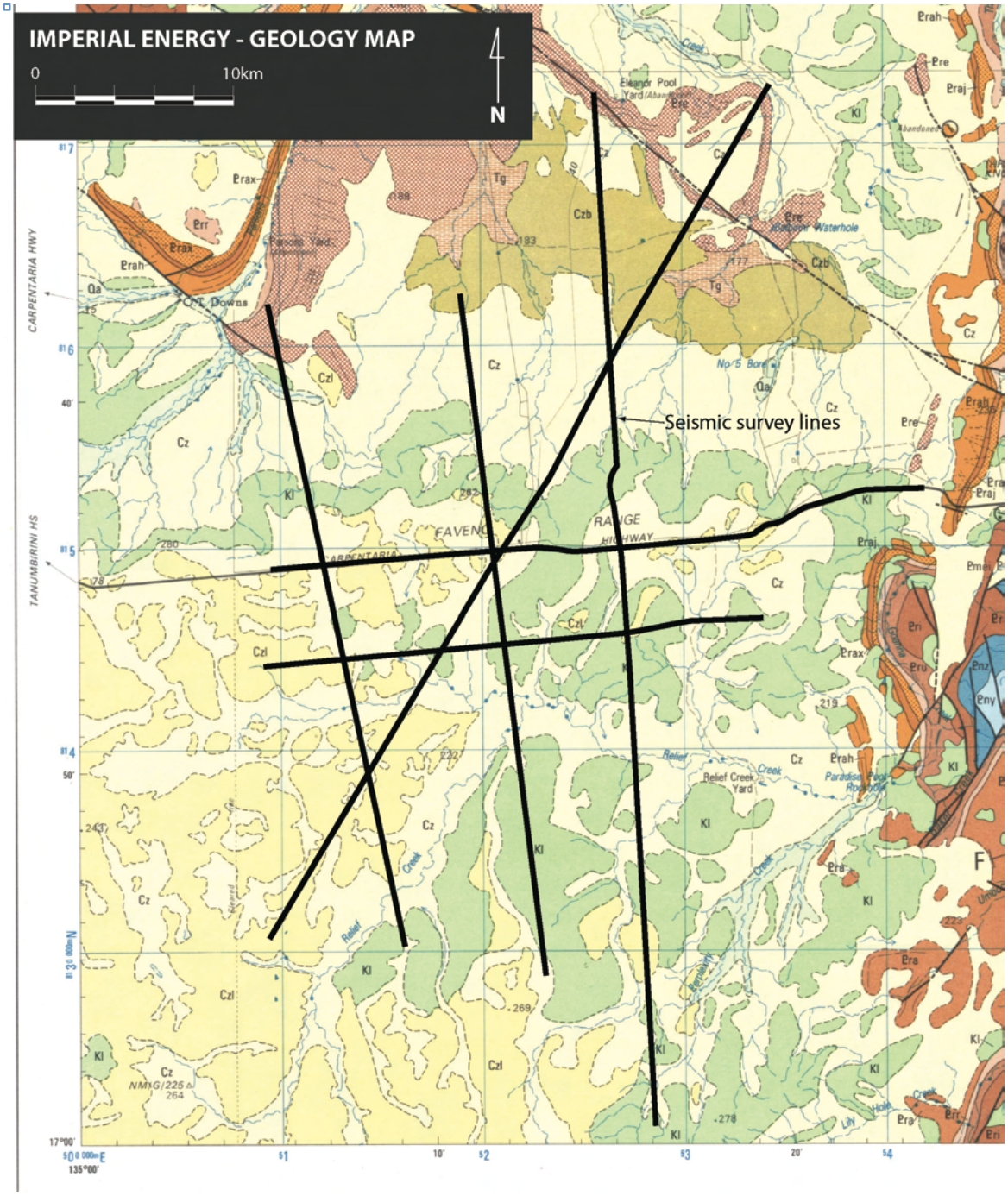

Figure 3. Geology map of the survey area with overlaid seismic survey lines (After BAUHINIA DOWNS se5303. Geoscience Australia. 1: 250 000 Geological Map, 1st edition 1991. http://scanned-maps.geoscience.gov.au/250dpi/se5303.jpg. Accessed 11 August 2019).

The vegetation communities are open woodland dry sclerophyll forests *of E. miniata* (Darwin Wooly Butt), *E. tetrodonta* (Stringybark) and *E. bleeseri* (Smooth-stemmed Bloodwood), extensively covered by an understorey of Mitchell and spinifex grasses. *E. pruinosa* (Silverleaf Box) occurs extensively in the survey area, south of the Carpentaria Highway on the Barkly Tablelands.

2.0 HERITAGE LEGISLATIVE FRAMEWORK

2.1. Northern Territory legislation

There are two kinds of heritage sites protected under the Northern Territory *Heritage Act* (2012), hereafter referred to as the Act, declared and prescribed places and objects. The Act places legal constraints on owners of private property, local government and the Crown:

- Places or objects listed on the Northern Territory Heritage Register are declared heritage places and objects that are protected under section 33 of the Act, and

- Prescribed archaeological places and objects, which may or may not be declared, are protected under sections 29 and 39 of the Act.

It is an offence under the Act to damage, destroy, alter or carry out work of any sort on declared or prescribed sites without the written consent of the Minister or Minister's delegate. If considered appropriate, the Heritage Branch may on occasion utilise the discretion available in the Act to give permission for small-scale disturbance (such as the relocation of isolated stone artefacts) without the need for a formal application. The discretion is allowed under s148 of the Act, which in effect says that a heritage officer (such as an archaeologist) may undertake actions (or authorize actions), not construed as an offence.

2.1.1 Declared heritage places and objects

Categories, which describe the status of each site on the Northern Territory Heritage Register database, are listed in Table 1.

Table 1. Site status on the Northern Territory Heritage Register database

Status	Description
D	Declared heritage place.
NR	Not recommended. HC* determined that the place did not meet heritage assessment criteria and did not hold sufficient value to warrant declaration under the *Act*.
RF	Refused by the Minister. HC* recommended for declaration and Minister refused to do so.
P	Proposed. HC* has determined that the place warrants declaration under the *Act* but has not yet made its recommendations to the minister.
RV	Revoked. Declaration as a heritage place pursuant to Section 26(1) of the *Act* is revoked.
N	Nominated. HC* has yet to complete its assessment of the heritage value of the place.

*Heritage Council

The Northern Territory Heritage Register contains places that possess special significance for the Northern Territory and have been recognized for a wide range of natural and cultural values. As a result it includes places that have been deemed significant because of their environmental and/or cultural characteristics. For the purposes of the current report, only places of historic or archaeological significance have been included. A search of the register indicates that the proposed Imperial Energy works will not impact on any sites listed in the Heritage Register.

2.1.2 Prescribed archaeological places and objects

Most archaeological places and objects are listed in the *Heritage Conservation Regulations* (1999) as prescribed places and objects. The Heritage Branch, Department of Tourism and Culture, formerly the Department Lands, Planning and Environment (DLPE), formerly the Department of Natural Resources Environment and the Arts (NRETAS) hold the Archaeological Sites Register. Included in this register are the protected prescribed sites that consist of all archaeological sites and objects pertaining to the past occupation by Aboriginal People. Any historic sites listed on this register do not indicate that these sites are protected or hold legal significance under the Northern Territory *Heritage Act* (2012).

2.2. Constraints

2.2.1 Ground Integrity (GI)

Assessing ground surface integrity provides an indicator of whether or not the landscape under study has been modified, and if so the degree of disturbance encountered. It then becomes possible to gauge the degree to which modification has influenced the environmental context within which artefacts and/or places of cultural and/or scientific interest are located. Ground surface integrity must also be assessed from the perspective of the current legislation.

The *Aboriginal Cultural Heritage Act 2003* (in Queensland, but equally applicable to the Northern Territory) provides a definition for GI that includes the removal of native vegetation as inferring the ground has been subjected to 'significant ground disturbance'. Under these criteria of modification, therefore, the *Act* assumes that archaeological integrity and significance is greatly reduced, is negligible, or even extinguished completely.

Contrary to this however, archaeologists are continually finding evidence that important cultural heritage material and/or places regularly survive not only land clearing activities but also invasive farming techniques such as ploughing.

Combined with this is the fact that, regardless of levels of GI, significant Aboriginal objects and/or significant Aboriginal areas can be defined on entirely cultural grounds, by Traditional Owners, not requiring any assessment of ground surface integrity.

Levels of GI are determined using a percentage range between 0-100% where 0% indicates all GI is gone, and 100% represents excellent preservation of the original context. Zero – 0%; Poor – 1-25%; Moderate- 26-50 %; Fair – 51-75 %; Good – 76-85%; Excellent 86-100%.

2.2.2 Ground Surface Visibility (GSV)

Assessments of ground surface visibility provide an indication of how much of the ground surface can actually be seen.

Ground surface visibility (GSV) is most commonly inhibited by vegetation but other inhibitors may include concrete, gravel and bitumen. Levels are determined using a percentage scale similar to that used for the calculation of Ground Integrity (GI), in that 0% represents zero visibility and 100% represents maximum visibility (bare ground). Zero – 0%; Poor – 1-25%; Moderate – 26-50 %; Fair – 51-75 %; Good – 76-85%; Excellent – 86-100%. The better the visibility, the more potential there is for locating cultural/archaeological material.

3.0 PREVIOUS RESEARCH

3.1 Literature review

The geologist Ernest Favenc mapped the Favenc Range in 1883 (Gibbney, 1972). The main concentrations of Aboriginal People that he saw were at Anthony Lagoon, Corella Lagoon and Brunette Creek, just to the south of the survey area and to the east of the former overland telegraph line (Sydney Mail, 1883). A map of expedition shows that he departed from Cresswell Creek in a north, northeasterly direction to Borroloola (National Archives of Australia. Series Number: A6128, Control Symbol: NTR119B and Series Number: A6128, Control Symbol: NTR119C).

The first archaeological survey conducted was in 1998 for the Nabre seismic line (Guse and Collis, 1998). The results of that survey discovered six archaeological sites, which occur in this year's survey area, most of which were stone artefact scatters (Table 2). Imperial Energy's proposed works, however, will directly impact none of those sites. The route of the 1998 survey is shown if Figure 4. The 1998 survey only covered one transect north of the Carpentaria Highway. No previous work has been conducted south of the highway.

Table 2. Previously recorded archaeological sites in the study area (Courtesy: Heritage Branch, NTG)

Site_Name	Easting	Northing	Zone	No#_Map _Sheet	Map_ Sheet	Site_Type	Contents	Comments
Balbirini Creek1			53	5964	O.T. Downs	Stone artefact scatter	Artefact scatter	
Balbirini Creek2			53	5964	O.T. Downs	Stone artefact scatter	Artefact scatter	
Eleanor Pool Yard1			53	5964	O.T. Downs	stone artefact scatter, historic site, stone arrangement, grindstone portable	Artefact scatter, stone arrangement, faunal remains	Contact site, knapped glass
OT Downs1			53	5964	O.T. Downs	Quarry	Quarry	
OT Down2			53	5964	O.T. Downs	Stone artefact scatter	Artefact scatter	
OT Down3			53	5964	O.T. Downs	Stone artefact scatter, grindstone portable	Artefact scatter	

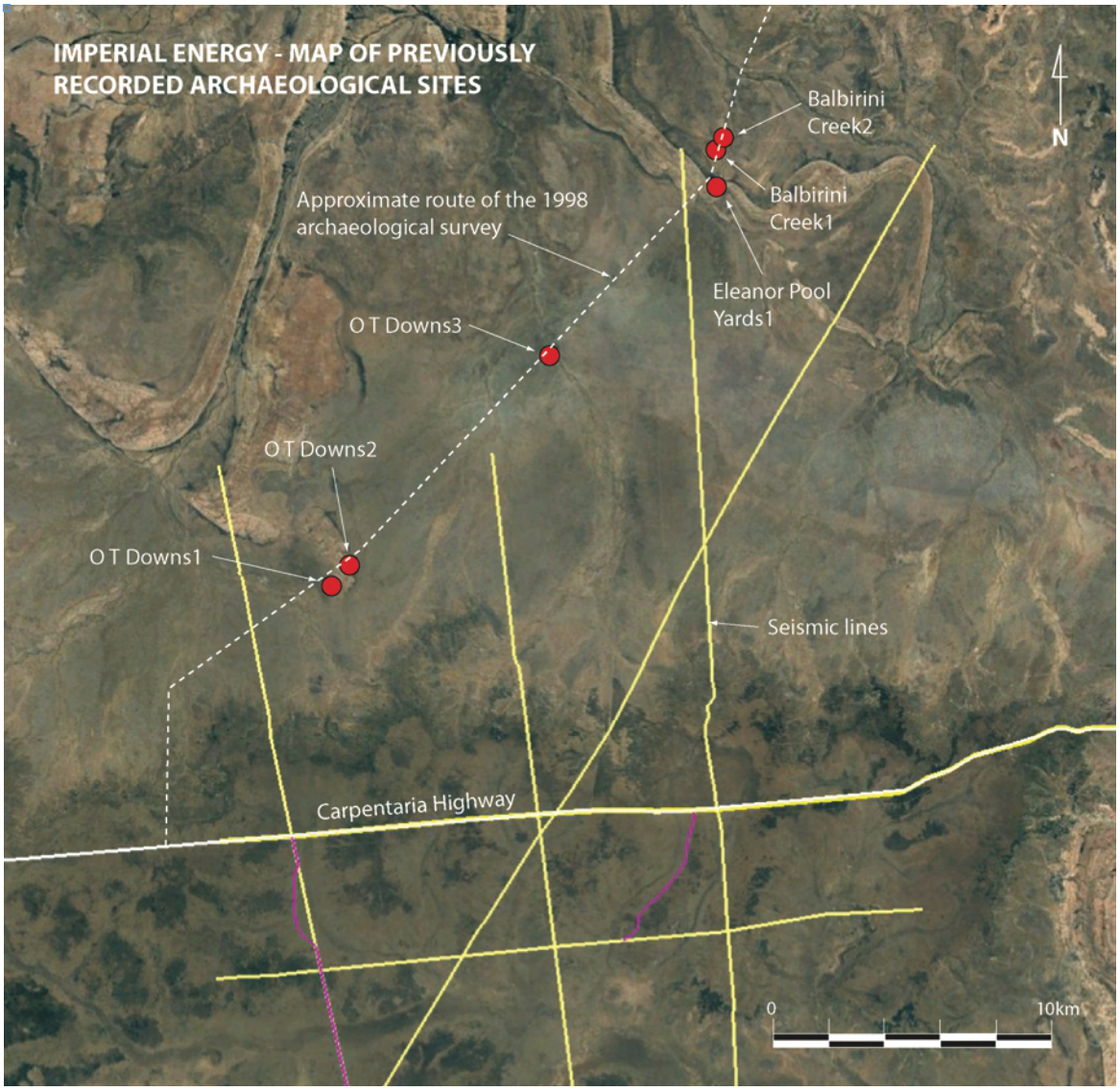

Figure 4. Map of previously recorded archaeological sites in the survey area (After Guse and Collis, 1998: between pages 5 and 6).

4.0 METHODS

4.1 Survey method

The survey method was to use a helicopter to assay likely habitation areas. Water is a key determinate as to where people were in the environment. Waterways were targeted in the aerial survey, as well as low stoney laterite ridges on the edges of swamps and drainage channels. Rock outcrops were also investigated, as well as rocky ridges for possible stone arrangements and or quarries. A pedestrian survey was conducted along each of the survey lines from the helicopter land zones (LZs). Artefacts were photographed and a GPS grid reference was recorded. Previously recorded sites were relocated to confirm their locations with current GPS accuracy, as the GPS coordinates for sites recorded in 1998 were still being dithered.

4.1.1 Identification of archaeological material

Stone artefacts, including tools and debitage, the by-product of manufacture, are identified on the following criteria after McCarthy (1976), Holdaway and Stern (2004):

- Bulb of percussion
- Erailure scar (on the ventral surface)
- Point of force application (PFA) and associated ring crack
- Termination types (e.g. feathered, stepped, hinged, plunge)
- Flake scars (dorsal scars and ridges)
- Cores (identified by the presence of negative flake scars)
- Hammer stones (identified by the presence of end-crushing on pebble stones)
- Retouch (reworking of flake margins)
- Raw material type
- Grinding stones (very smooth wear on upper surface)

List of artefact type abbreviations:

- Ad – Adze
- An – Anvil
- Bl – Blade
- Co – core
- Cf – Core fragment
- Ct – Core tool
- F – flake
- Fp – flake piece
- Gs – Grindstone/Grinding plate
- Hs – Hammer stone
- M – Manuport
- Mp – Multi platform core
- Rtf – retouched flake
- S – Scraper
- Sp – Single platform core
- Ts – Top stone
- X – Axe/wasted cobble
- Z – Other e.g., ceremonial

List of artefact raw material abbreviations:

- Ch – Chert
- G – Greywacke
- Hs – Hornsfel

- Im – Indurated mudstone
- J – Japser
- SS – Sandstone
- S – Silcrete
- Q – Quartz
- Qz – Quartzite
- V – Volcanic

4.1.2 Definition of archaeological sites

4.1.2.1 Historical Sites

Historical sites in north Australia are those that have physical evidence of European and non-European activities. These range from Macassan sites to military sites of WWII. These sites may overlap with Aboriginal heritage sites.

4.1.2.2 Aboriginal Heritage Sites

Aboriginal archaeological sites can be classified by six main types: 1) stone knapping sites, including quarries, 2) background scatters, including isoliths, 3) stone arrangements, such as mounds, walls, fish traps or stone motifs, 4) shell middens, 5) burials, 6) scarred trees and 7) rock art sites.

Burke and Smith (2004:63) define an archaeological site as ‘any place that contains the physical evidence of past human activity. Australia, however, has what has been referred to as a background scatter of stone artefacts, which refers to low-density artefact scatters that either represent singular knapping events (‘dinner-time’ camps or ‘hunting camps’), or larger sites that have been buried or disturbed. To differentiate this site type from larger sites that may contain thousands of artefacts, the term Archaeological Site (AS) is used to describe home-camps or quarries i.e., places where people have been returning to for millennia, as opposed to sites that have very low artefact densities that represent sporadic visits i.e., background scatters (BS).

5.0 RESULTS

5.1 Archaeology

Thirty-four landings were made along the six survey lines and at the drill pads (Table 3 and Fig. 5). GSV was generally 80 – 90% across the survey area. GI was assessed as 90%. Cattle and pig damage accounted for lowering GI. Four low-density background scatters and a high-density archaeological site were located, all in proximity to Balbirini Creek. The location data and find descriptions are presented in Table 4 and mapped in Figure 6. Artefact photographs are listed in Appendix 1.

All previously recorded sites were relocated with the exception of OT Downs2, whereby only a chert core was found. No grindstone was found at OT Downs3. The stone arrangement at Eleanor Pool Yards1 was not found and was most likely destroyed during the construction of water tanks on top of the ridge. The drill pads SL-3 and SL-4 (and it's four alternative sites) were inspected, but no archaeological material was found. Figure 7 shows the drill site for SL-4, with typical vegetation and terrain for the area.

The two access tracks leading to the drill pad sites were assayed from the air, but no suitable habitation areas were seen along their routes.

Table 3. Location of LZs and descriptions

Format: UTM M/D/Y H:M:S 9.50 hrs Datum[121]: WGS 84					
Name	**Description**	**Zone**	**Zone**	**Easting**	**Northing**
LZ01	OT Downs1	53	K		
LZ02	SL-4 (ALT3) drill pad, flat, open woodland	53	K		
LZ03	Line 1, eastern edge of range. Heavily dissected, narrow valley floors. Rocky ridges	53	K		
LZ04	Line 1, eastern edge of range. Heavily dissected, narrow valley floors. Rocky ridges	53	K		
LZ05	Line 1, eastern edge of range. Heavily dissected, narrow valley floors. Rocky ridges	53	K		
LZ06	Line 2, flat, open woodland with understory of Mitchell grass, laterised light brown soils	53	K		
LZ07	Line 2, ephemeral creek	53	K		
LZ08	SL-3 drill pad, flat, open woodland	53	K		
LZ09	Line 3, Balbirini Creek, northern bank. IEBS01	53	K		
LZ10	Line 3, Balbirini Creek, southern bank. IEBS02	53	K		
LZ11	Eleanor Pool Yard1	53	K		
LZ12	Balbirini Creek1	53	K		
LZ13	Line 3, small ephemeral creek, open woodland, flat	53	K		
LZ14	Line 3, Small creek line on edge of Broadmere Road	53	K		
LZ15	SL-4 (ALT4) drill pad, flat, open woodland	53	K		
LZ16	Line 4, Relief Creek, ephemeral, open	53	K		

	woodland, flat, bloodwoods, and stringy barks.				
LZ17	SL-4 (ALT2) drill pad, flat, open woodland	53	K		
LZ18	O T Down2	53	K		
LZ19	Line 4. On top of stoney ridge, quartzite outcrop. Adjacent to ephemeral creek, flat, yellow sandy, laterised soils – IEBS04	53	K		
LZ20	Line 4, ephemeral creek, flat, open woodland, underground of spinifex, stoney, laterised soils	53	K		
LZ21	Line 4, northern edge of Favenc Range, gentle slopping ridges from creek like to the base of the range	53	K		
LZ22	SL-4 (ALT-1), open woodland, flat, understory of Mitchell grass	53	K		
LZ23	SL-4 drill pad. Open woodland, flat, understory of Mitchell grass	53	K		
LZ24	Line 5, open woodland, flat, understory of Mitchell grass	53	K		
LZ25	Line 5, near Relief Creek, large creek with steep banks, adjacent to large black soil billabong (dry)	53	K		
LZ26	Line 5, gentle undulating rises, edge of Favenc Range	53	K		
LZ27	Line 5, rocky quartzite outcrop	53	K		
LZ28	OT Downs3	53	K		
LZ29	Line 6, Balbirini Creek	53	K		
LZ30	Line 6, Balbirini Creek IEBS03, IEAS01	53	K		
LZ31	Line 6, stoney quartzite outcrops	53	K		
LZ32	Line 6, edge of Favenc Range	53	K		
LZ33	Line 6, heavily dissected valleys, sandy floors with drainage lines	53	K		
LZ34	Line 6, flat open woodland, dry ephemeral creek bed, yellow soils	53	K		

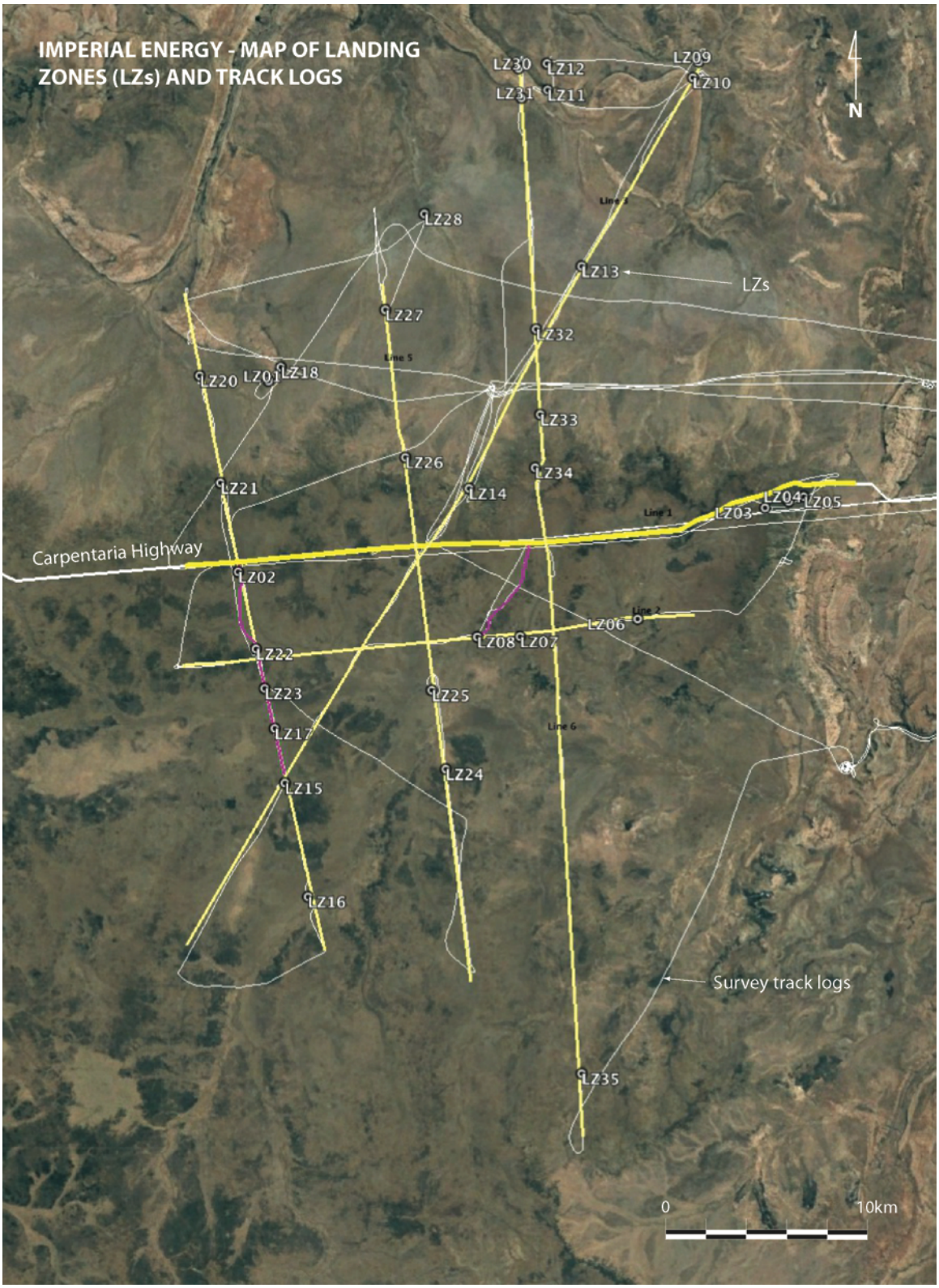

Figure 5. Map of Landing Zones (LZs) and survey track logs (After Google Earth).

Table 4. Background Scatters (BS) and Archaeological Sites (AS)

Format: UTM M/D/Y H:M:S 9.50 hrs Datum[121]: WGS 84						
WPT Name	**Comment**	**Zone**	**Zone**	**Easting**	**Northing**	**Photo No.**
IEBS01						
796	F(S)	53	K			DSCN9203 DSCN9204 Site photo
IEBS02						
797	F(QZ)X1. FP(QZ) X2	53	K			DSCN9208
798	F(QZ)	53	K			
BALBIRINI CREEK1						
799	BALBIRINI SITE 01	53	K			
BALBIRINI CREEK2						
800	C(C)	53	K			DSC_7354
IEBS03						
804	FP(QZ)	53	K			DSCN9236
805	F(QZ)	53	K			DSCN9237
806	FP(QZ)	53	K			DSCN9238
807	F(C)	53	K			DSCN9239 DSCN9240 Site photo
IEBS04						
801	RTF(QZ) BIFACIAL, BROKEN TIP	53	K			DSCN9218 Obverse DSCN9219 Reverse
801-R (Relocated)		53	K			
803-1	FP(S)	53	K			DSCN9232
803-2	FP(S)	53	K			DSCN9233
OT Downs3						
802	C(C)	53	K			DSCN9228
OT Downs 2						
						DSCN9213
IEAS01						
808	F(S) DISTAL	53	K			DSCN9241
809	FP(QZ)	53	K			DSCN9242
810	F(QZ)	53	K			DSCN9243
811	F(QZ)	53	K			DSCN9244
812	S(QZ)	53	K			DSCN9245

						DSCN9246 Site photo
813	S(QZ)	53	K			DSCN9247
814	S(QZ)	53	K			DSCN9248
815	S(C)	53	K			DSCN9249
824	C(S)	53	K			DSCN9250
Paradise Pool						
835	Permanent water source	53	K			
Cockatoo						
	Near by permanent water source adjacent to the highway, just north of Line 1	53	K			

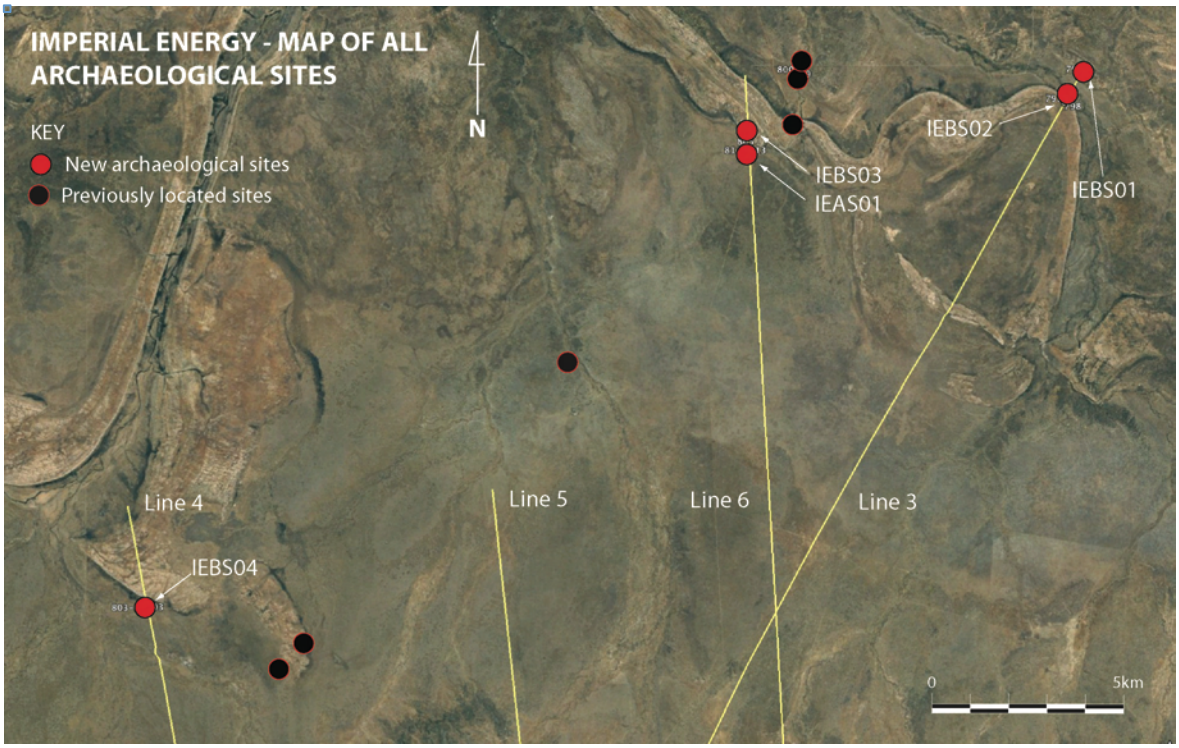

Figure 6. Map of all archaeological sites – red dots (After Google Earth).

Figure 7. Drill pad SL-4 environment with VH-RQJ virtually on the GPS mark.

5.2 Background scatters (BS) and archaeological sites (AS)

5.2.1 IEBS01

Low-density artefact scatter at the northern end of Line 3 at Balbirini Creek. On low laterite rise to the north of the creek. It is in an open woodland with Mitchell grass cover and is relatively flat (Fig. 8).

Figure 8. IEBS01 site photo.

5.2.2 IEBS02

Low-density artefact scatter on stoney rise at the northern end of Line 3. At base of stoney rise. Generally flat with low outcrops of silcrete and quartzite.

5.2.3 IEBS03

Low-density artefact scatter on top of stoney rise about 12m above ground flood plain. Outcrops of sandstone, quartzite and silcrete (Fig. 9). Site leads down to IEAS01.

Figure 9. IEBS03 site photo. Scale in 2m.

5.2.4 IEBS04

Low-density artefact scatter in reddish/brown laterite soils at the base of a quartzite and silcrete rise. Significantly, the only retouched point found in the survey was found here. It is bifacially retouched, which is rare. Retouched points are generally unifacially retouched in this region (Fig. 10). The point is virtually intact, except for the tip, which is broken.

Figure 10. Traditional Owner, Peter Ellis holding the bifacially retouched point at IEBS04.

5.2.5 IEAS01

Just south of IEBS03 at the base of a rocky ridge near Balbirini Creek, lies a high-density artefact scatter with a range of tool types including scrapers, flakes and flake pieces. The site is at the edge of a waterway that runs at the base of the ridge and lies exposed on yellow/brownish laterite soils. It was dry at the time of the survey. The site is close to Broadmere Road. A Restricted Work Area (RWA) polygon was established around the site. Line 6 goes through the site. Figure 11 maps the site and shows it's proximity to Broadmere Road and it's relation to IEBS03 on top of the nearby ridge. Figures 12 and 13 show ground and aerial perspectives of the site. The light brown, yellowish laterite soils provide a clear view of artefacts with increased GSV.

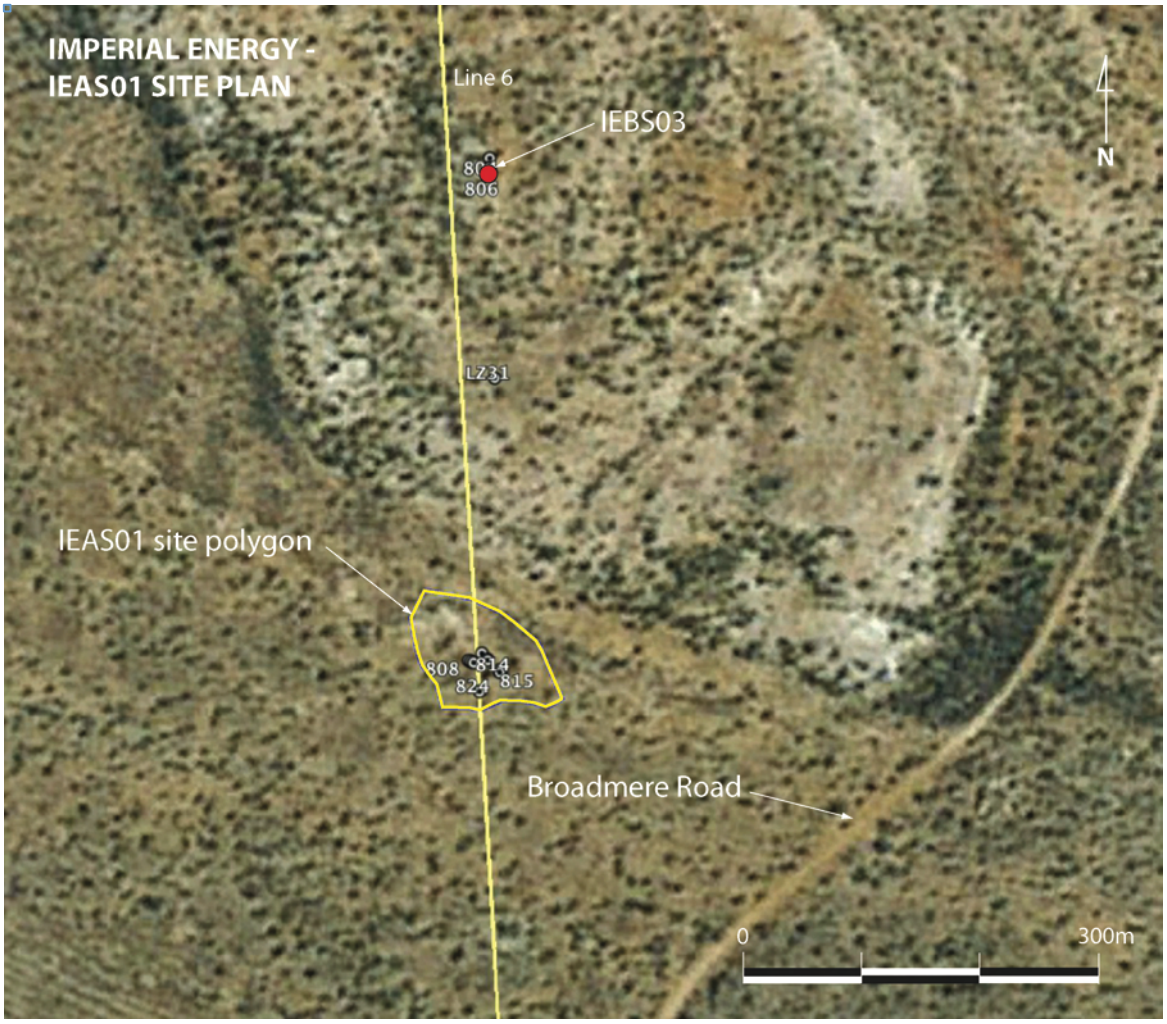

Figure 11. IEAS01 site plan (After Google Earth).

Figure 12. IEAS01 site photo. Scale in 2m.

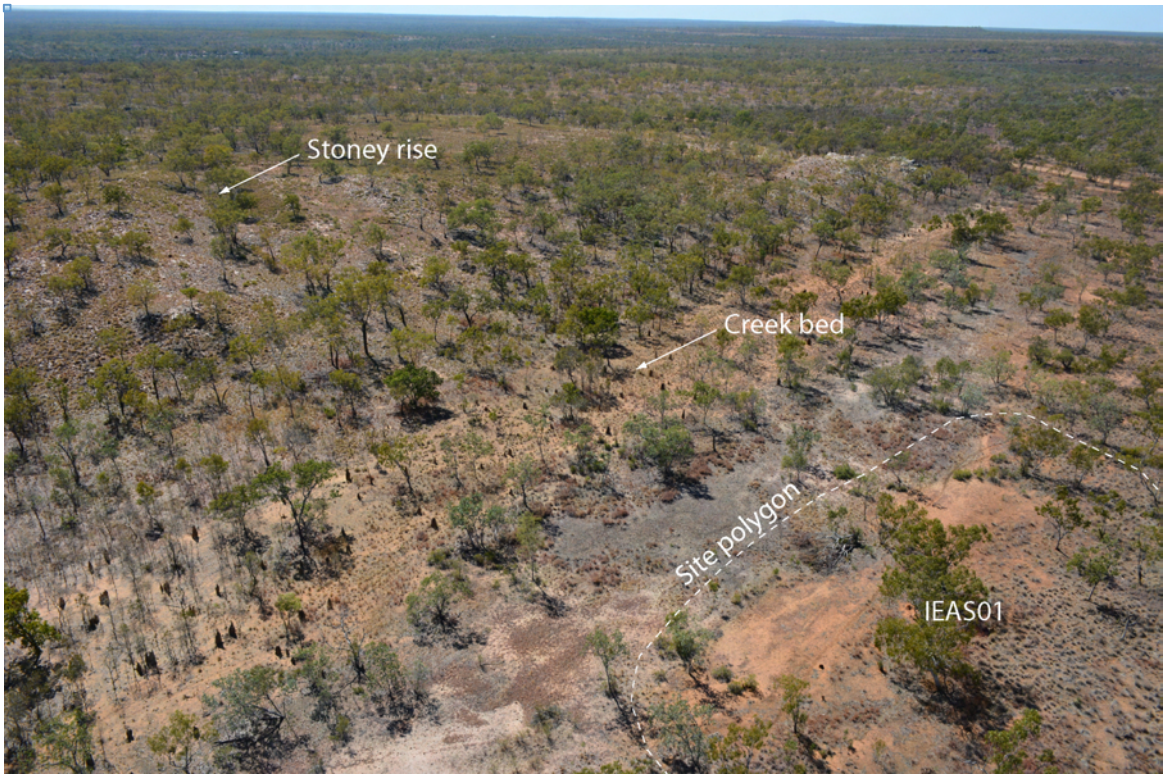

Figure 13. Aerial view of IEAS01 at the base of a stoney rise, adjacent to ephemeral creek.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The archaeological survey of Imperial Energy's proposed seismic line and drilling programme on the Favenc Range in the Northern Territory recorded five sites. Four of these were low-density artefact scatters, or Backgound Scatters and one is a high-density archaeological site near Broadmere Road. All of the finds occur in the northern section of the survey area in close proximity to Balbirini Creek.

No cultural material was found south of the Carpentaria Highway. There were no suitable rock outcrops found there and there is only one significant waterway, Relief Creek, which was dry at the time of the survey. No cultural material was found at the six proposed drill pad sites and access tracks.

The following recommendations arise from this report:

6.2 Recommendations

6.2.1 Recommendation 1: Site Avoidance

- The proposed works will have no impact on IEBS01 and IEBS03 (Line 3 and Line 6 respectively) as these sites were greater than ten metres from the centre line of the proposed seismic lines. No further action is required.
- IEBS04 is >10m to the east of Line 4. No further action is required.
- Line 6 will impact IEAS. A RWA has been established for the site and the site should be avoided. Appendix 2 lists the grid references for the RWA site polygon.

6.2.2 Recommendation 1: Site destruction

- IEBS02 covers a considerable area. It was impractical to move the finds. Site recommendations should be to avoid the last 1km northern section of Line 3 at Balbirini Creek. If not, the artefacts may be destroyed as they are of low archaeological significance.

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Books:
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Holdaway, S. and Stern, N. 2004. *A record in stone: the study of Australia's flaked stone artefacts*. Museum Victoria and AIATSIS, Melbourne.

Gibbney, H. 1972. 'Favenc, Ernest (1845–1908)'. Australian Dictionary of Biography, Volume 4. URL: http://adb.anu.edu.au/biography/favenc-ernest-3506. Accessed 12 August 2019.

Guse, D. and Collis, A. 1998. Archaeological survey of the proposed Nabre seismic lines, McArthur River Region, Northern Territory. Unpublished report for the North Australian Basins Resource Evaluation Australian Geological Survey Organization. Quaternary Archaeological Surveys, P.O. Box 43119, Casuarina NT 0811.

McCarthy, F. 1976. *Australian Aboriginal stone implements*. Australian Museum Trust, Sydney.

National Archives:
National Archives of Australia. Series Number: A6128, Control Symbol: NTR119B, Title: Track in Red shows the new road explored and opened up by W. R. Creswell, from Anthony's Lagoon to Borroloola April 1885. Base is sketch map showing explorations made by Ernest Favenc 1878 to 1883. National Archives of Australia, Canberra.

National Archives of Australia. Series Number: A6128, Control Symbol: NTR119C, Title: [shows track from Anthony's Lagoon to Borroloola]. Reduced 5/8 from E. Favenc's Exploration. National Archives of Australia, Canberra.

Newspapers:
Sydney Mail. 1883. 'Mr Ernest Favenc's expeditions in the Northern Territory'. Sydney Mail and New South Wales Advertiser (NSW: 1871 - 1912), Saturday 10 November 1883, page 905.

APPENDIX 1: Artefact photographs

Figure 14. Wpt No. 796 F(S). Scale in 1cm.

Figure 15. Wpt No. 797 FP(QZ) x 2, F(QZ). Scale in 1cm.

Figure 16. Wpt No. 801 RTF(QZ) Bifacially retouched point. Obverse. Scale in 1cm.

Figure 17. Wpt No. 801 RTF(QZ) Bifacially retouched point. Reverse. Scale in 1cm.

Figure 18. Wpt No. 804 FP(QZ). Scale in 1cm.

Figure 19. Wpt No. 805 F(QZ). Scale in 1cm.

Figure 20. Wpt No. 806 FP(QZ). Scale in 1 cm.

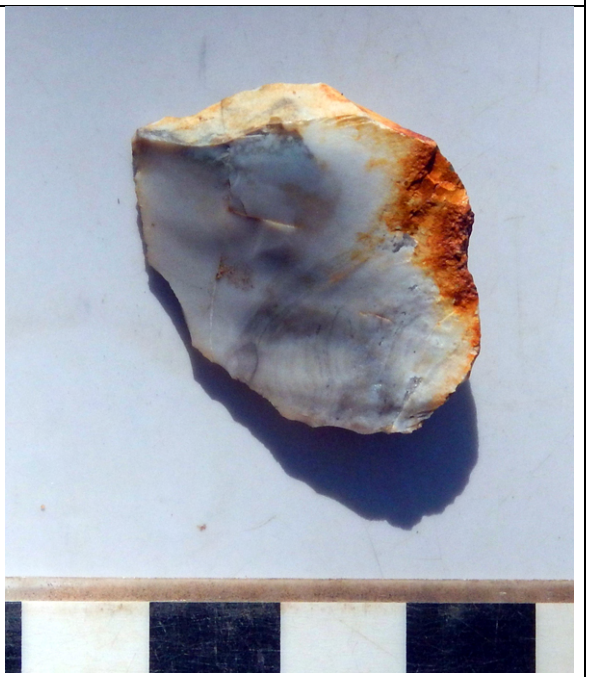

Figure 21. Wpt No. 807 F(C). Scale in 1 cm.

Figure 22. Wpt No. 808 F(S) distal. Scale in 1cm.

Figure 23. Wpt No 809 FP(QZ). Scale in 1cm.

Figure 24. Wpt No. 810 F(QZ). Scale in 1cm.

Figure 25. Wpt No. 811 F(QZ). Scale in 1cm.

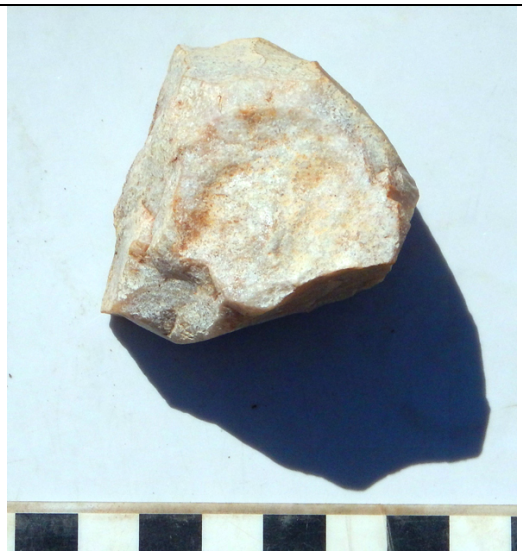

Figure 26. Wpt No. 812 C(QZ). Scale in 1cm.

Figure 27. Wpt No. 813 S(QZ). Scale in 1cm.

Figure 28. Wpt No. 814 S(QZ). Scale in 1cm.

Figure 29. Wpt No. 815 S(C). Scale in 1cm.

Figure 30. Wpt No. 824 C(S). Scale in 1cm.

Figure 31. Stone artefacts at OT Downs2. Scale in 1cm.

Figure 32. Silcrete core at OT Downs2. Scale in 1cm.

APPENDIX 2: IEAS01 Restricted Work Area (RWA) polygon coordinates

Format: UTM M/D/Y H:M:S 9.50 hrs Datum[121]: WGS 84				
ID	Zone	Zone	Easting	Northing
T	53	K		
T	53	K		
T	53	K		
T	53	K		
T	53	K		
T	53	K		
T	53	K		
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T	53	K		

Appendix 24. Erosion and Sediment Control Plan

EROSION AND SEDIMENT CONTROL PLAN

IMPERIAL SEISMIC 2019

CLIENT: IMPERIAL OIL AND GAS PTY LTD

DOCUMENT NUMBER: 19-0109/R0940

VERSION: DRAFT

DATE: 13/08/19

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 Seismic Lines (2019) located near Borroloola, Northern Territory. It is understood that the project will commence in August 2019.

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
- Imperial Environment Management Plan for EP187 2D Seismic Work Program (EP187-EMP-XPN-REP-007 Rev 3)
- 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 2019 seismic 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 seismic 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

1.3. CERTIFICATION

I Tom Bailey certify that this Erosion and Sediment Control Plan (ref: R0940) 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
DRAFT	13/08/19	R. Kleijn	T. Bailey	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), 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 the seismic lines, as well as a proposed drill pad pending geological results generated by the seismic lines.

The site location and outline of the proposed seismic lines is presented in Figure 1.

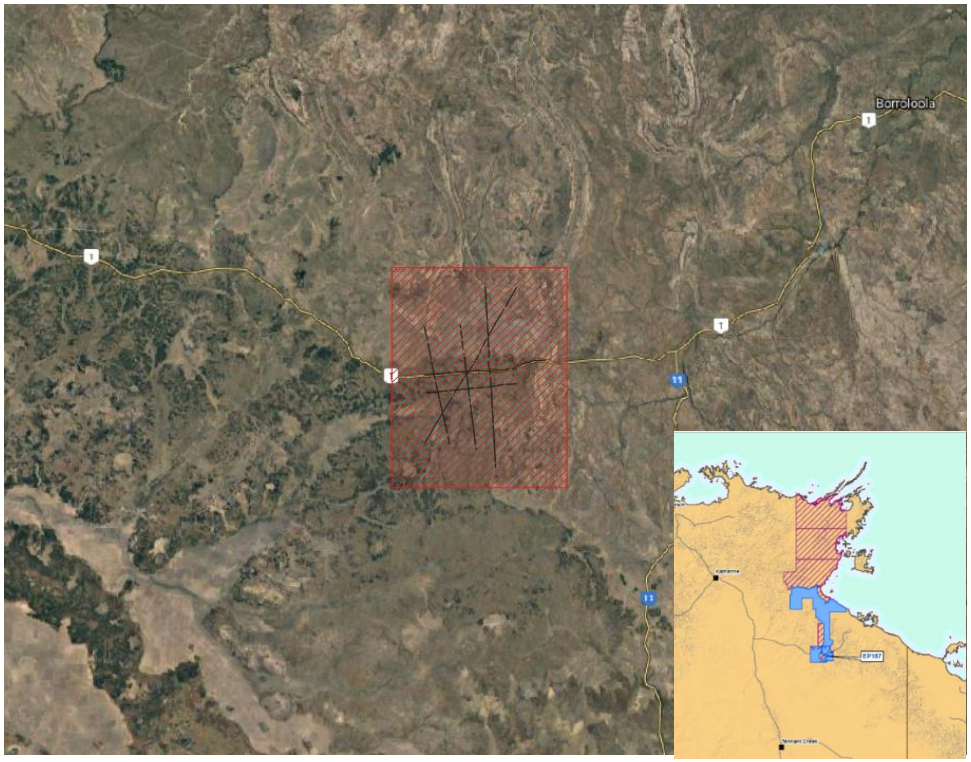


Figure 1 – Site Location (Source: Google Maps)

2.2. PROJECT WORKS

Projects works will involve the following major activities:

- Line clearing and preparation using a H140 Grader with 4m blade, within 30m corridor;
- Clearing of patches of Lancewood with D6 Dozer within 4m blade, within 30m corridor;
- Conducting seismic testing with Vibroseis buggies;
- Spreading of cleared mulch/timber over disturbed areas upon completion of works;
- Upgrading and/or creation of new access tracks;
- Clearing of vegetation and drilling of well, pending acquisition of seismic survey data. Instalment of a drill pad and associated structures and infrastructure (location to be confirmed).

The seismic lines length and areas have been shown in Table 1 below. It is noted that no clearing is envisaged for Line 1 which runs alongside the Carpentaria Highway, adjacent to the bitumen.

Table 1 – Seismic Lines and area (source: Land Clearing Permit Supporting Information June 2019)

Line	Length (km)	Area (ha)
1	33.6	13.0
2	25.3	10
3	50.2	20
4	32.8	13
5	34.3	14
6	54.8	21

The areas presented in Table 1 include approximately 20ha of land not subject to clearing during this scope of works, comprising previously cleared areas and non-clearing zones such as drainage lines, waterways and creeks and their associated buffer widths.

2.3. CLIMATE

The historic monthly rainfall for the region is presented below in Figure 2. Works are expected to commence in August 2019. Based on historic rainfall data August and September have a low monthly mean rainfall. The seasonal outlook, included as Figure 3, predicts a 25% chance of rainfall over 10mm from August to October, which implies it is unlikely for rainfall to be above the historic median of 15mm. The climate is described as a tropical savannah climate which can experience rainfall of between 600-800mm per year during the summer wet. The wet season is also characterised by high intensity rainfall and cyclonic winds,

With the weather in this region dominated by a stark contrast in wet and dry seasons, erosion, sediment and drainage controls considered in this plan are heavily based on seasonal variability.

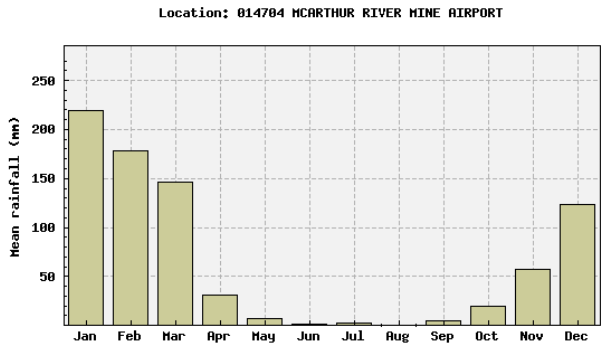


Figure 2 – Historic rainfall (Source: BoM)

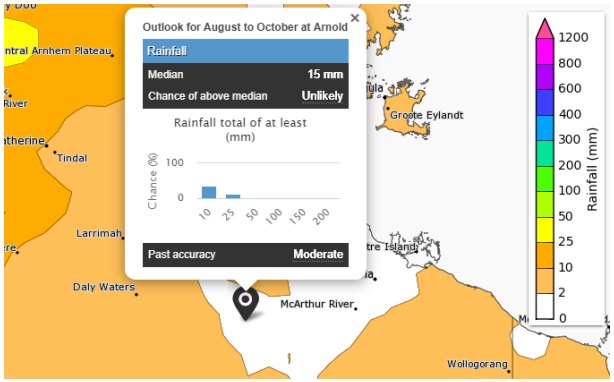


Figure 3 – Seasonal outlook – August to October (Source: BoM)

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.

Generally, seismic lines in the east-west orientation move between 258m ASL to 213m ASL with average slope of 1% over 30km. Line 1 follows the Carpentaria Highway. Lines in the north-south orientation vary from south 260m ASL to north 162m ASL over a 50km length with an average of 1% (max 3.7%).

A key consideration in plan development was the orientation of lines with respect to local fall, whether it be perpendicular or parallel to slope, or passing diagonally up the slope. The impact that these orientations have on drainage, erosion and sediment control is presented in Appendix A.

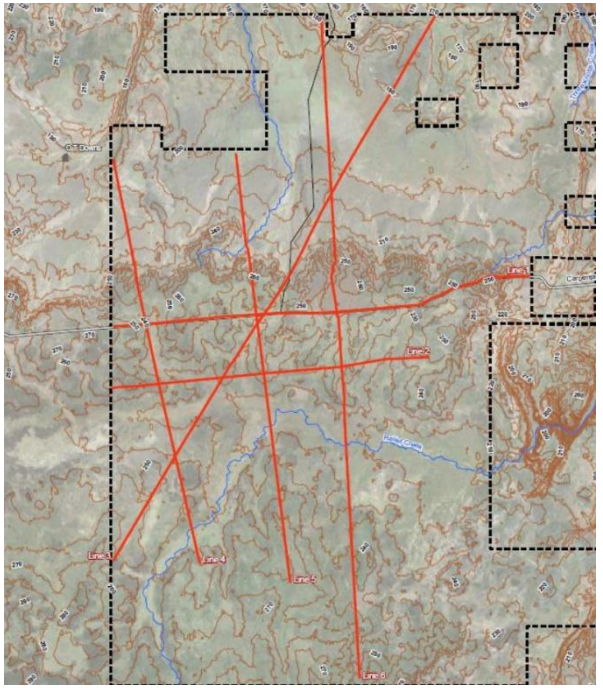


Figure 4 – Regional topography and major drainage paths

Land types have been described in Table 2.

Table 2 – Area of Land Types (source: Land Clearing Permit Supporting Information June 2019)

Land Type	Description	Total Area (ha)
A	Lancewood	13.0
B	Grassy Woodland	48.1
C	Open Grassland	4.2
D	Sandstone jump-ups and plans	4.7

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. It is noted that contour mulch bunds must be placed at a maximum spacing of 200m on site during clearing works.

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.

In accordance with the Imperial EMP (EP187-EMP-XPN-REP-007 Rev 3) and Land Clearing Permit (LCP) Supporting Information, ground disturbance is to be limited to the removal of rocks and fallen branches and the slashing of grasses and shrubs to allow effective ground contact of the seismic vibro-source and the geophones, minimise the risk of fire, and provide for safe vehicle access. Topsoil will not be stripped or windrowed.

Based on the description above and Table E10 of IECA 2008 it would be reasonable to assume a C factor of 0.45 for the dozer cleared areas, and 0.1 for grader cleared areas, representing 0% to 40% cover in areas of long-established grass cover.

However, to conservatively allow for additional areas of disturbance, closer to that resembling a half-stripped seismic line a C-factor for both areas of clearing has been set at 0.5.

Given that topsoil will not be stripped, with grass and roots retained a P factor of 0.9 has been adopted, similar to that used for track-walked or straw punched surfaces.

Table 3 – Cover and Practice Factor Consideration

Type	Description	C Factor	P Factor
Typical line	H140 grader with blade set at 1" above the ground used to sweep the ground surface of large rocks and fallen timber	0.5	0.9
Lancewood areas	D6 bulldozer used for clearing (blade 1in above ground level). Grass and brush root stocks to be retained	0.5	0.9

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 (<30t/ha/yr) for the entire site according to Table 4.4.7 of IECA, 2008. Figure 5 and Table 4 below indicate the determined erosion risk for the site and surrounding areas.

Table 4 – Erosion Risk

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

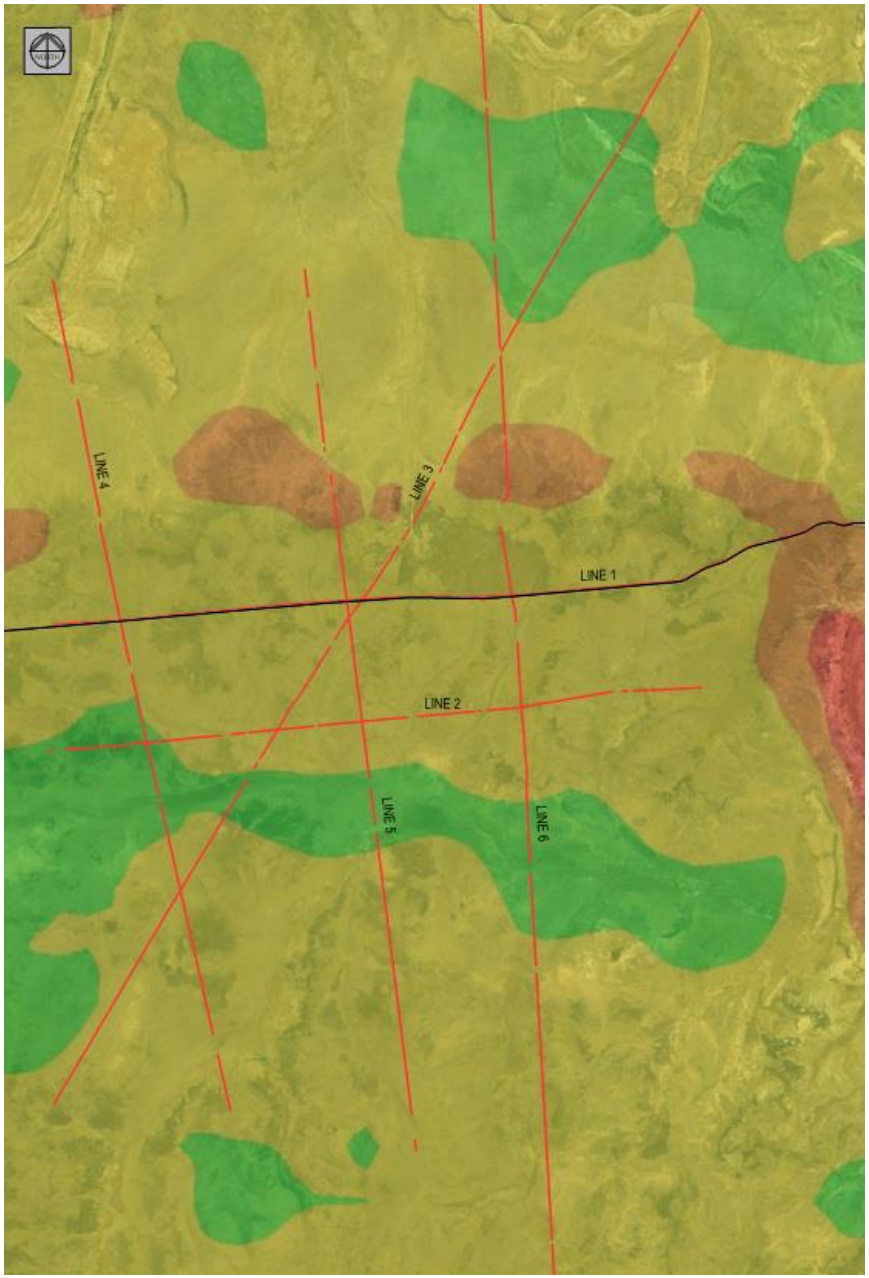


Figure 5 – Erosion Risk

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 5. 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 5 – 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 5 (IECA, 2018), the calculated soil losses (which are very low) permit the use of Type 3 sediment control measures throughout site.

The rock filter dam proposed for integration with perimeter bunding surrounding future drill pads is classified as a Type 2 control. This exceeds the minimum requirement but is better suited the anticipated concentrated flow and can be practically installed in these locations.

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 this 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 the calculated soil loss.

5 EROSION CONTROL

Erosion management techniques for various erosion risk ratings, with minimum requirements in accordance with IECA (2008) guidelines are presented in Table 6.

Table 6 - Erosion Risk Rating Based on Soil Loss and Required Management (adapted from Table 4.4.7 of IECA, 2008)

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 seismic operations adopt an erosion control management standard that far exceeds the minimum given in Table 6.

Proposed measures are presented in Table 7.

Table 7 – 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 seismic easement or within nominated buffer areas
- Stabilisation of any high traffic areas within drill pads using gravel
- Establishing stabilised entry/exit points where construction tracks intersect public roadways
- Utilising existing tracks wherever possible
- Adapting the alignment of the seismic line within the 30m easement to a path of least disturbace

It is noted that the proposed exploration methodology has been adopted to minimise disturbance of existing ground cover wherever possible, including restricting the maximum possible 30m width of clearing to 4m and using machinery to limit ground disturbance to the removal of rocks and fallen branches and the slashing of grasses and shrubs. Topsoil will not be stripped or windrowed and the cleared and windrowed ground cover/vegetation is to be re-spread over the site upon completion of the seismic survey.

Given that a high level of ground cover is expected to be retained on site, the following methodology and approach to erosion control is proposed.

Step 1: Assess site and select path of least disturbance for 4m width of clearing

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

Step 3: Commence clearing, ensuring timeframes between clearing and scheduled seismic work do not exceed those indicated in Table 7.

Step 4: Complete clearing and assess residual groundcover (%) using the tools presented in Appendix A.

Step 5: Carry out seismic works, ensuring that if rainfall is forecast that exceeds the probability AND depth presented in Table 7 immediately re-establish the level of groundcover required in Table 7 (if current % assessed in Step 4 does not comply).

Step 6: Complete survey and re-establish minimum ground cover % within minimum timeframes indicated in Table 7.

Options for re-establishing ground cover include:

- Respreading windrowed grass, branches, rocks and other vegetation over exposed areas
- Application of soil binder at manufacturers specification
    - eg. Vital Stonewall applied at minimum 1L/m^2

It is suggested that a supply of soil binder be readily available to seismic teams to achieve the timeframes and groundcover requirements proposed (note, binder can be applied via the same water trucks used on standby for fire suppression).

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.

Flow diversion 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 seismic 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).

Seismic line drainage has been considered to specifically address runoff over a variety of topography (discussed in Section 2.4) whether the line 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 buffer to suit. Retain buffer width in accordance with Land Clearing Permit (width varies) Maintain all existing ground cover within buffer zone. If access results in disturbance of more than a single set of wheel tracks, restrict access and re-establish ground cover using soil binder (min. Stonewall 2L/m2 or equiv.) or ground cover mattress Install cleared vegetation windrows on either side of flow path.

Unmapped flow path	Retain a 3m 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 on either side of flow path. Create break to allow access but re-form afterwards

Where buffer zones require the establishment of a detour route all efforts should be made to cross the mapped waterway at an existing ford, bridge or culvert, or at an alternative stable, dry and trafficable area. Maintain all existing ground cover along the detour route. If disturbance results in more than a single set of wheel tracks restrict access and re-establish ground cover using soil binder.

Specific measures have been described to address drainage control within and around the proposed drill pad. These include an earth perimeter bund to direct external flows around the outside of the perimeter and internal flows to a rock filter dam in the lowest corner.

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

7 ROLES AND RESPONSIBILITIES

Table 8 outlines the responsibilities of project personnel in respect to ESC.

Table 8 - 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.

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.

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.

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

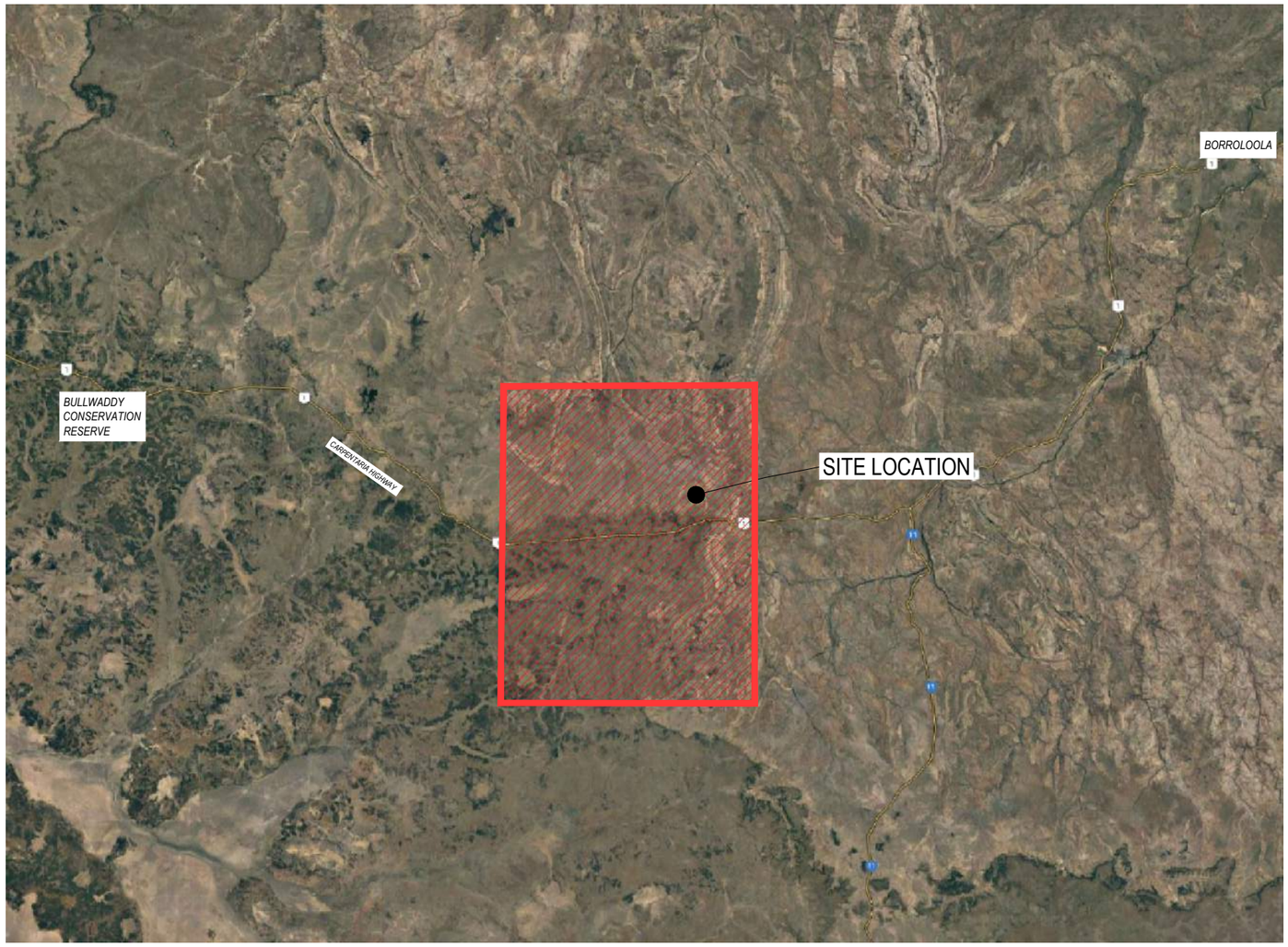
Following runoff producing rainfall (within 18 hours of rainfall event)

- 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



DRAWING LIST:

REFER TO REPORT **R0940** 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
A	ORIGINAL ISSUE	TB	13/08/19

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CLIENT: IMPERIAL OIL AND GAS PTY LTD

DRAWN	DESIGNED	DATE
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RPEQ / SIGNATURE (IF REQUIRED): CPESC No. 6374

PROJECT: IMPERIAL SEISMIC 2019

DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN COVER SHEET

PROJECT No	DRAWING No	REVISION
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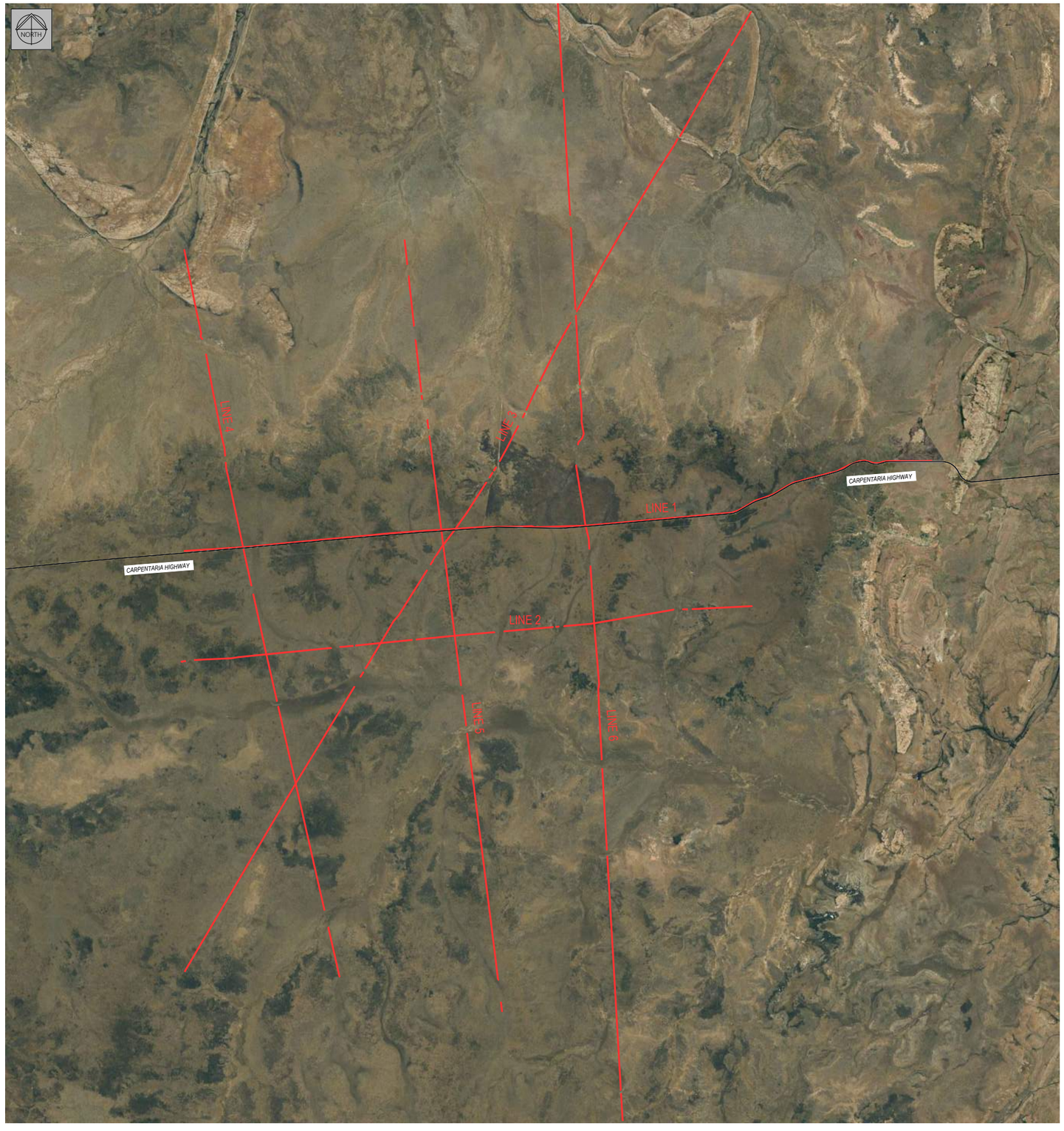

EXTENT OF WORKS

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RPEQ / SIGNATURE (IF REQUIRED)
CPESC No. 6374

PROJECT: IMPERIAL SEISMIC 2019
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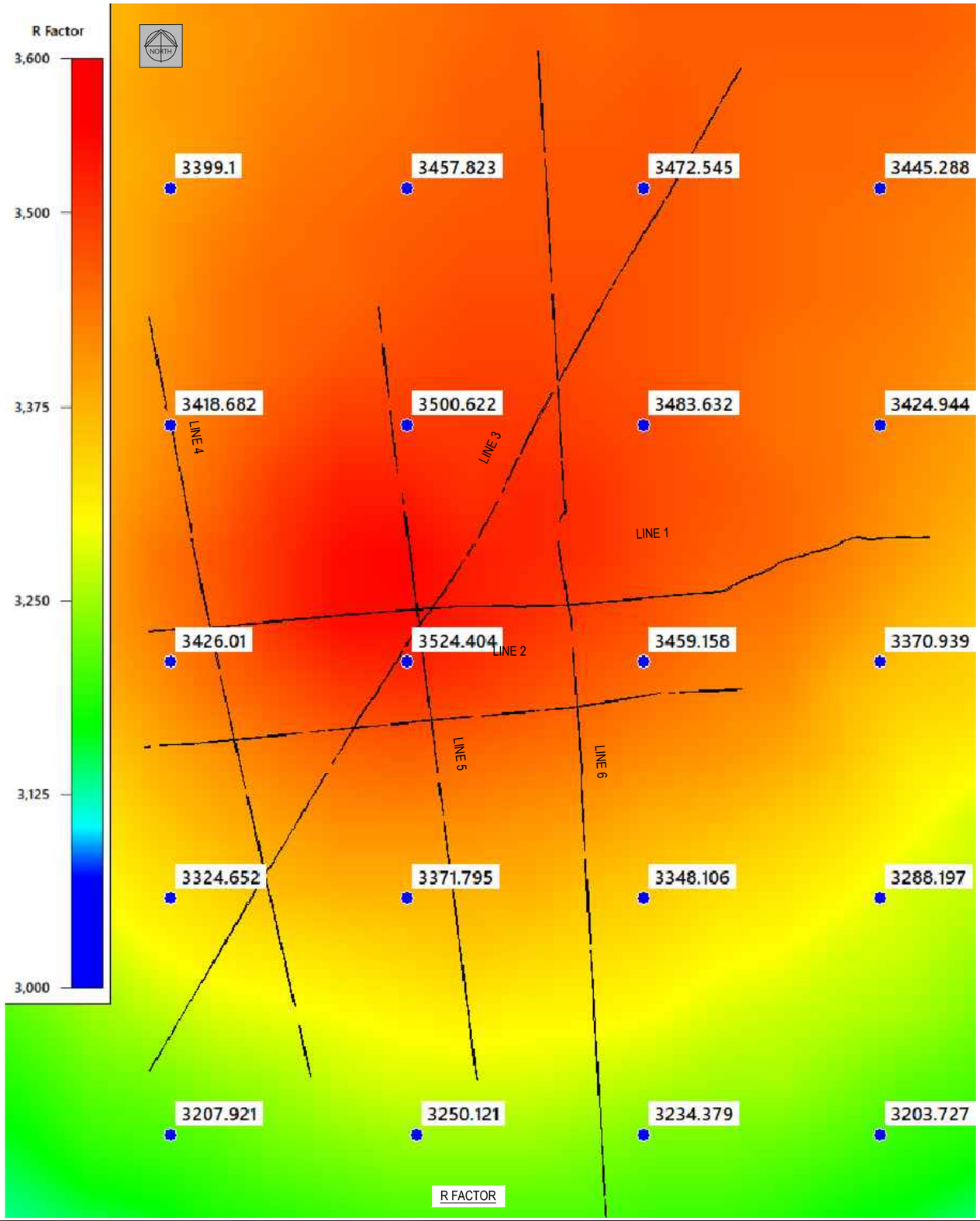

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DRAWN	DESIGNED	DATE
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RPEQ / SIGNATURE (IF REQUIRED): CPESC No. 6374

PROJECT: IMPERIAL SEISMIC 2019

DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN
R FACTOR

PROJECT No	DRAWING No	REVISION
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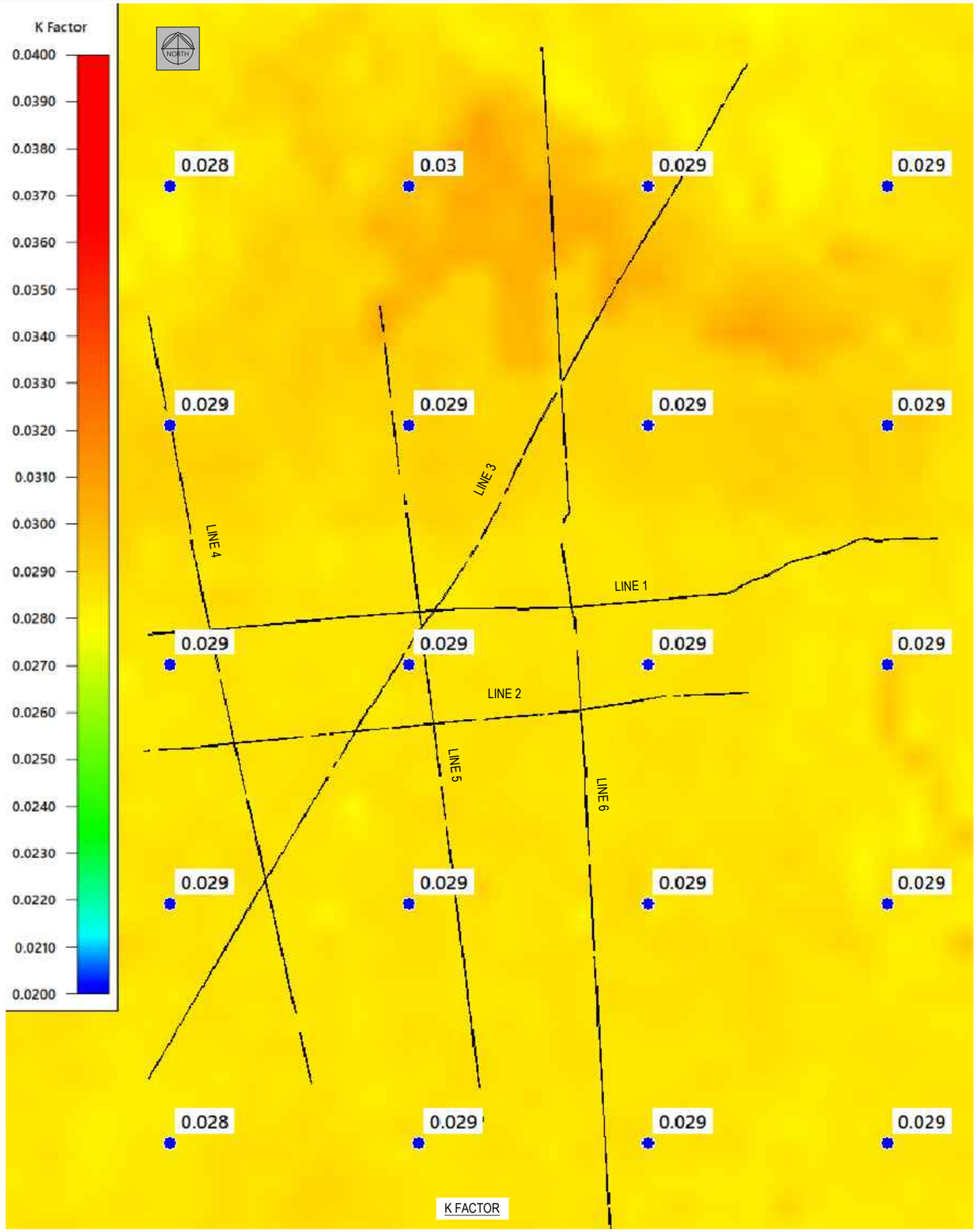

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ISSUED FOR USE

CLIENT: IMPERIAL OIL AND GAS PTY LTD

DRAWN	DESIGNED	DATE
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RPEQ / SIGNATURE (IF REQUIRED): CPESC No. 6374

PROJECT: IMPERIAL SEISMIC 2019

DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN
K FACTOR

PROJECT No	DRAWING No	REVISION
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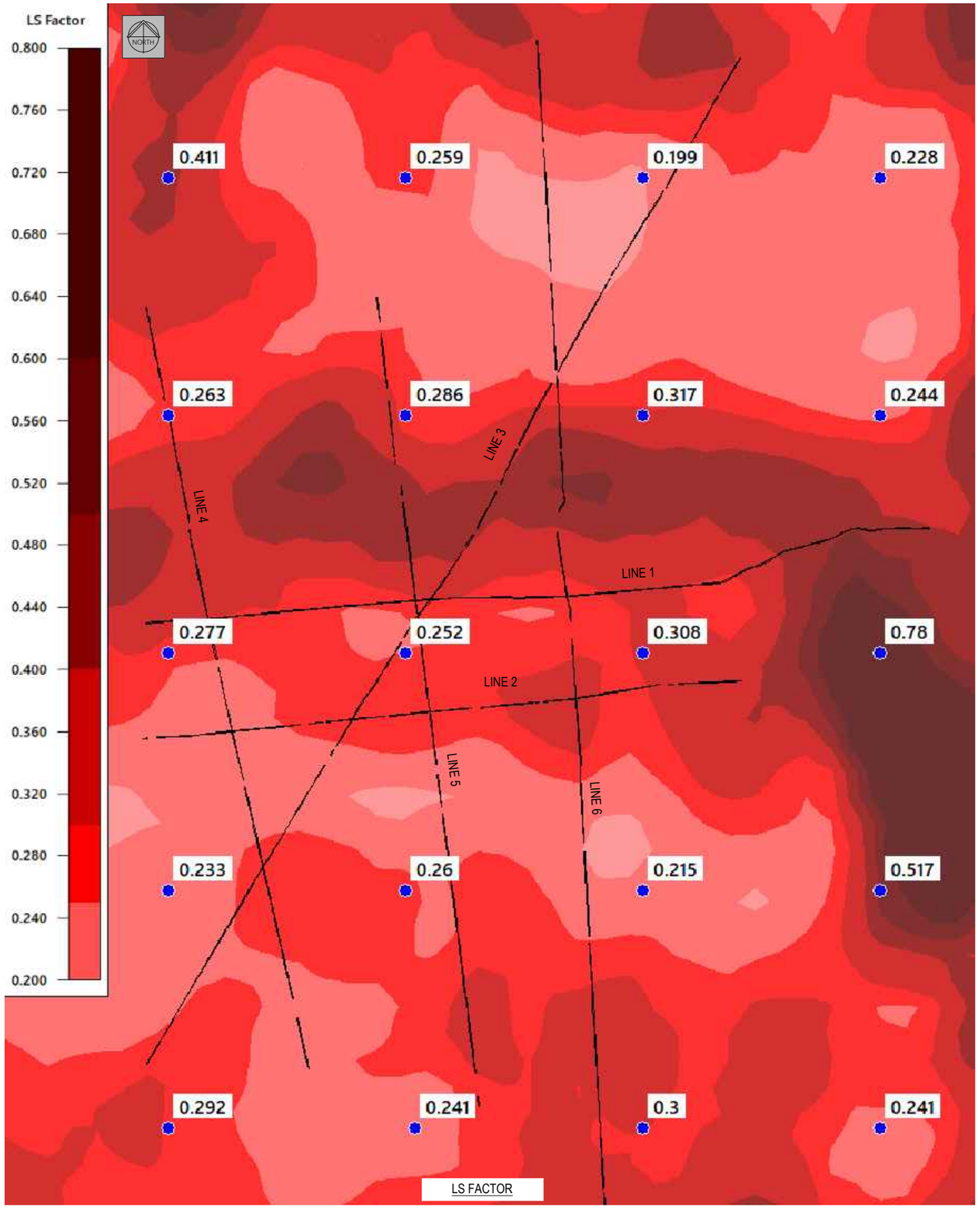

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ISSUED FOR USE

CLIENT: IMPERIAL OIL AND GAS PTY LTD

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RK	TB	13/08/19

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CPESC No. 6374

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PROJECT No	DRAWING No	REVISION
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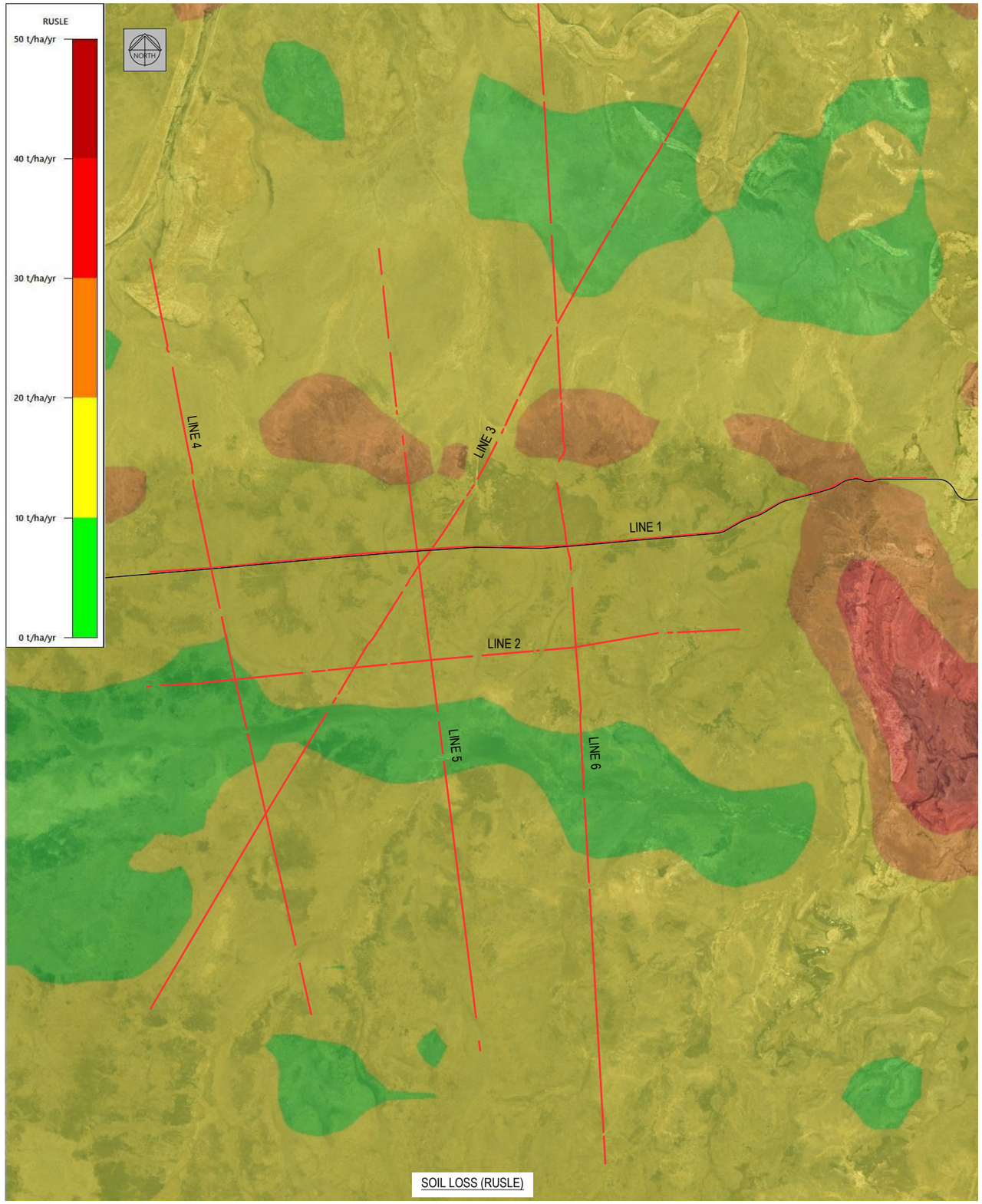

SOIL LOSS (RUSLE)

NOTES:

C FACTOR - 0.5
GROUND DISTURBANCE LIMITED TO REMOVAL OF ROCKS AND FALLEN BRANCHES. GRASS AND SHRUBS SLASHED WITH GROUND COVER, TOPSOIL AND ROOTS TO REMAIN IN PLACE.

P FACTOR - 0.9
GRASS AND ROOTS RETAINED

TOPO.

REVISION	DESCRIPTION	APPROVED BY	DATE
A	ORIGINAL ISSUE	TB	13/08/19

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CLIENT: IMPERIAL OIL AND GAS PTY LTD
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RPEQ / SIGNATURE (IF REQUIRED): CPESC No. 6374

PROJECT: IMPERIAL SEISMIC 2019
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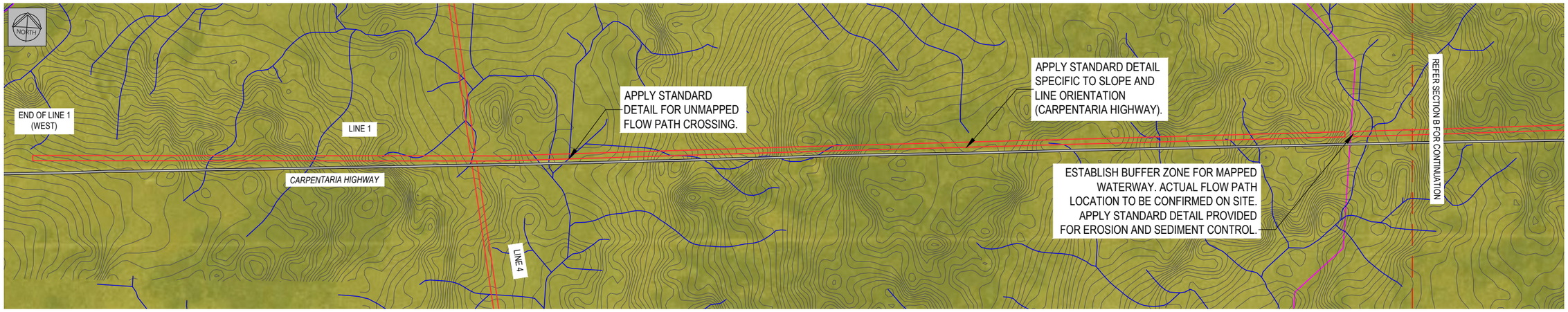
PROJECT No: 19-0109 | DRAWING No: D05 | REVISION: A



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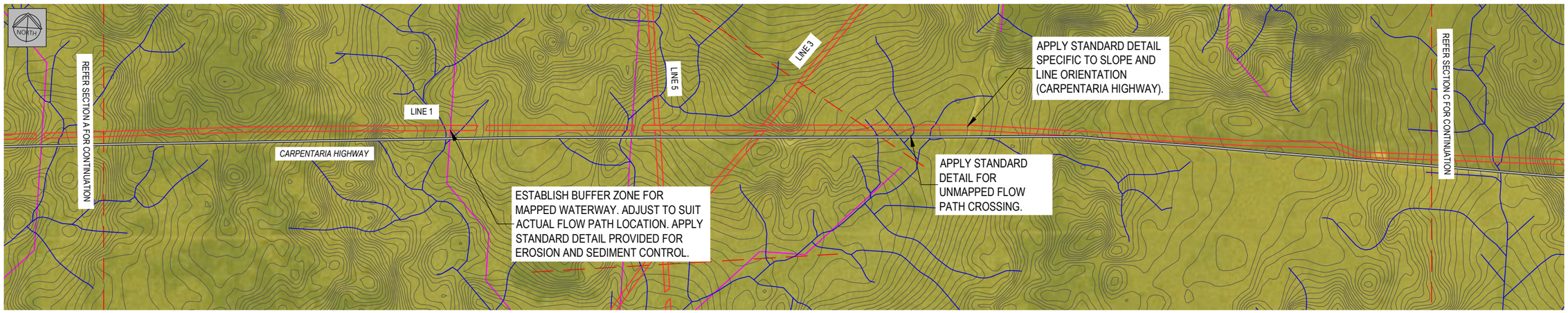

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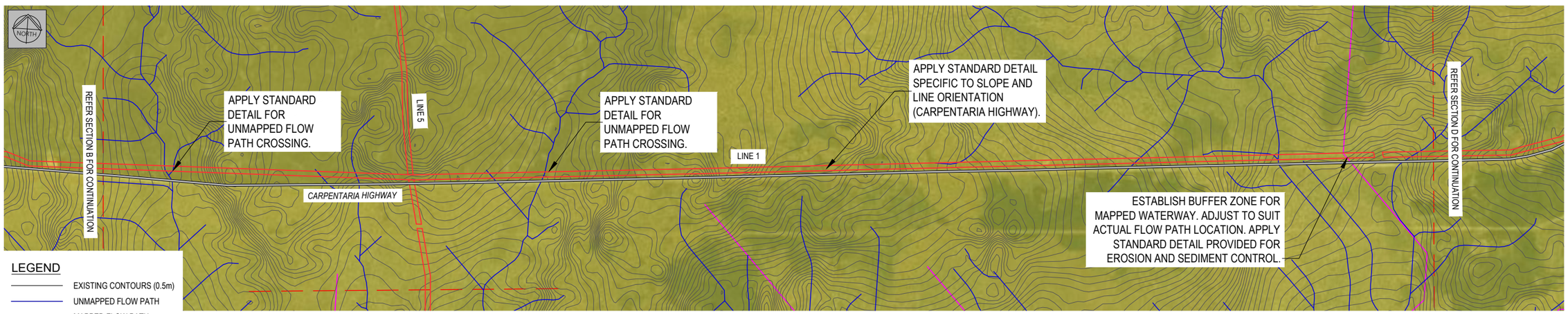

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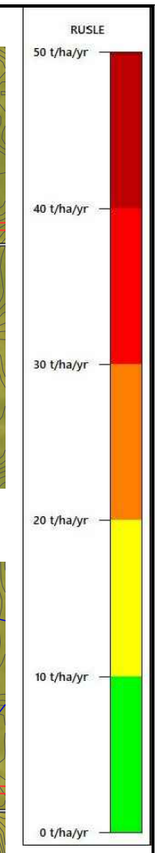

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RPEQ / SIGNATURE (IF REQUIRED): CPESC No. 6374

PROJECT: IMPERIAL SEISMIC 2019
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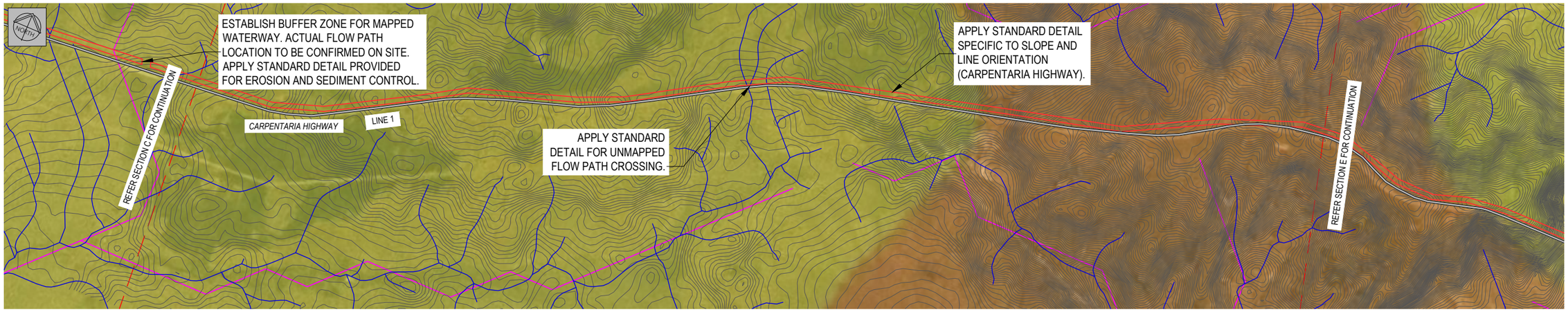
PROJECT No: 19-0109 | DRAWING No: D06 | REVISION: A



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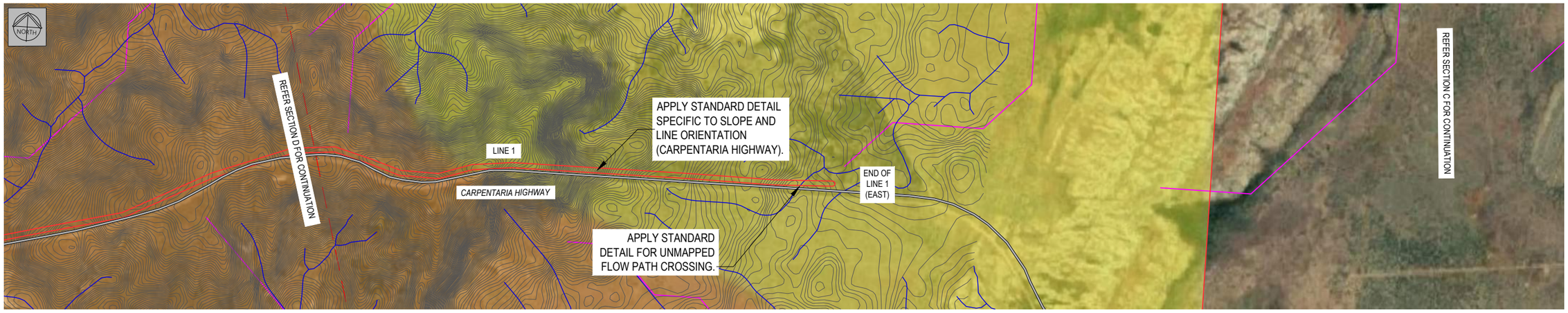

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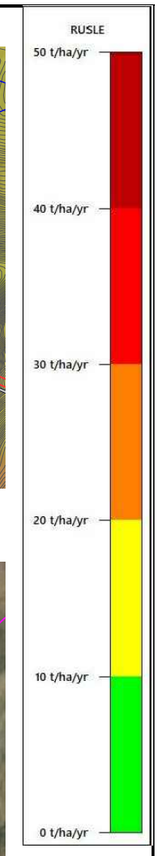

LEGEND

- EXISTING CONTOURS (0.5m)
- UNMAPPED FLOW PATH
- MAPPED FLOW PATH
- SEISMIC LINE (30m)

TOPO.

REVISION	DESCRIPTION	APPROVED BY	DATE
A	ORIGINAL ISSUE	TB	13/08/19

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ISSUED FOR USE

CLIENT: IMPERIAL OIL AND GAS PTY LTD
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PROJECT: IMPERIAL SEISMIC 2019
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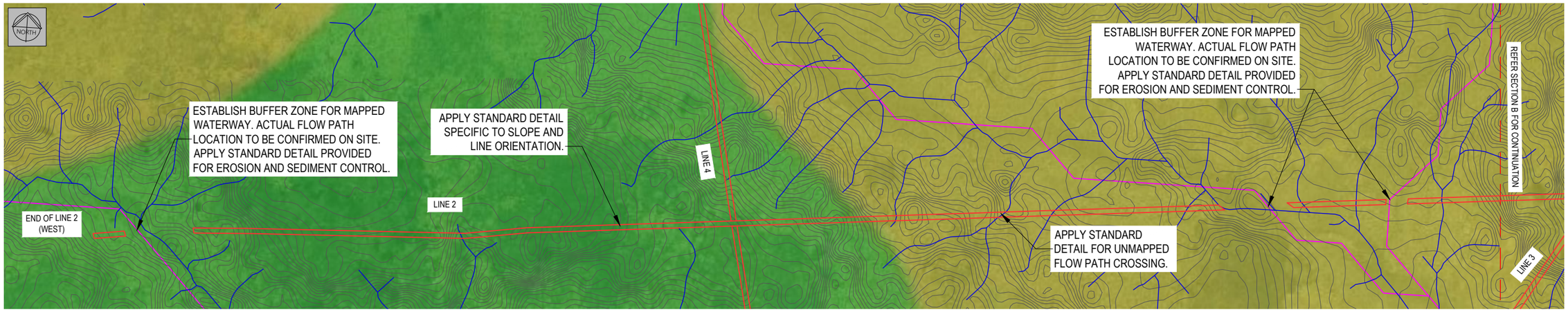
PROJECT No: 19-0109 | DRAWING No: D07 | REVISION: A



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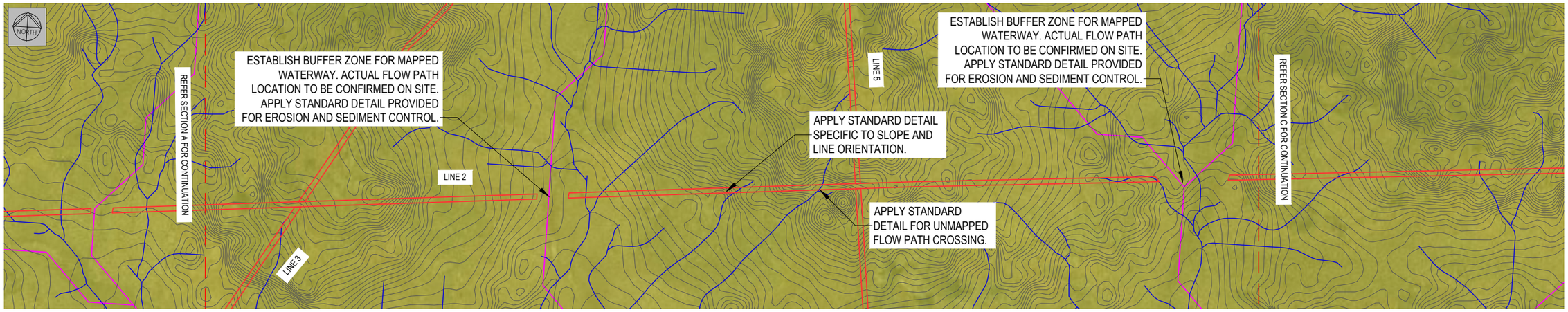

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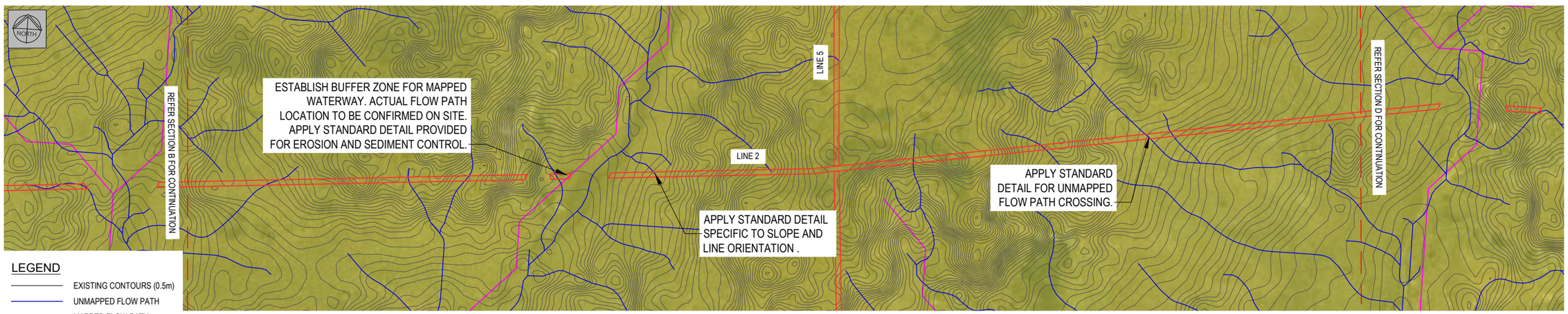

LINE 2 SECTION C
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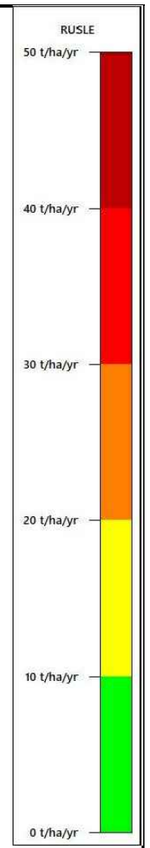
LEGEND

- EXISTING CONTOURS (0.5m)
- UNMAPPED FLOW PATH
- MAPPED FLOW PATH
- SEISMIC LINE (30m)



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PROJECT: IMPERIAL SEISMIC 2019

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PROJECT No	DRAWING No	REVISION
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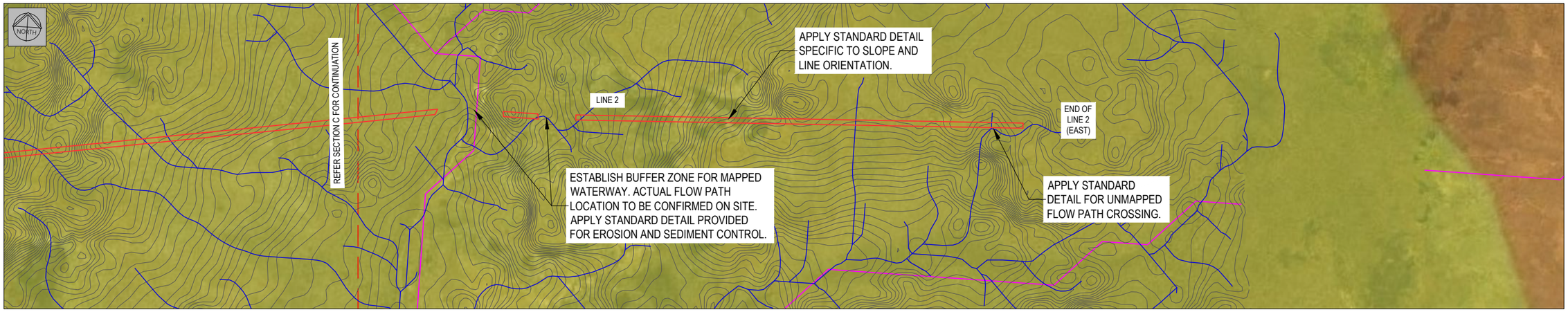

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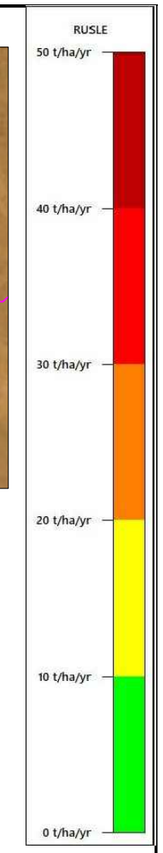

LEGEND

- EXISTING CONTOURS (0.5m)
- UNMAPPED FLOW PATH
- MAPPED FLOW PATH
- SEISMIC LINE (30m)

TOPO.

REVISION	DESCRIPTION	APPROVED BY	DATE
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PROJECT: IMPERIAL SEISMIC 2019

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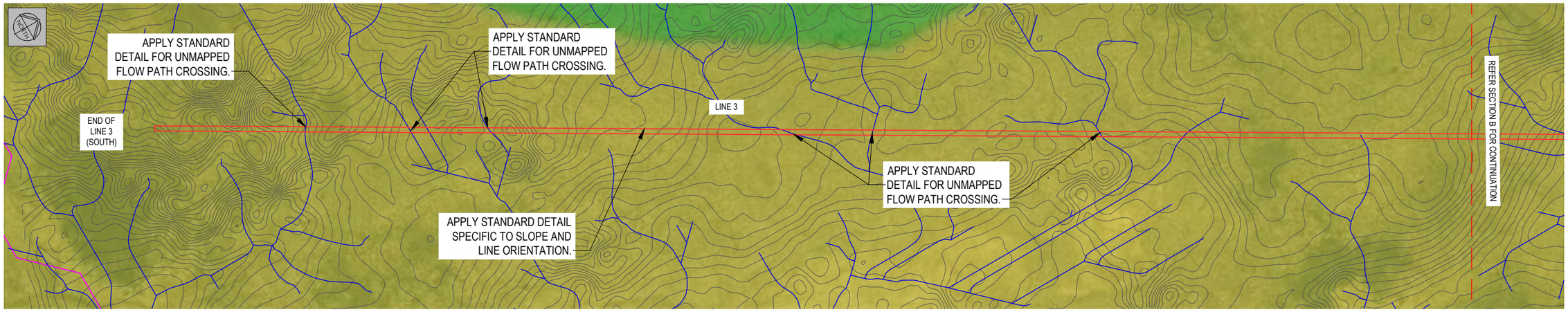

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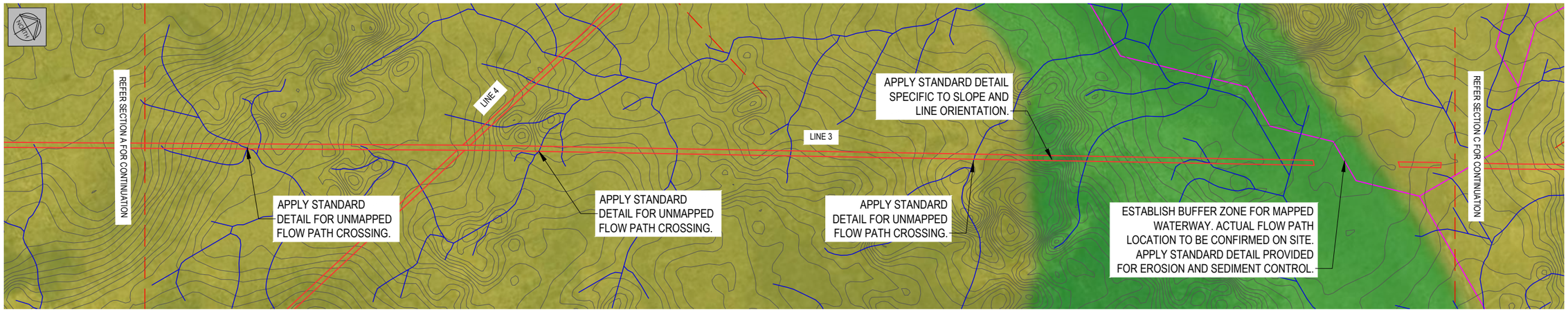

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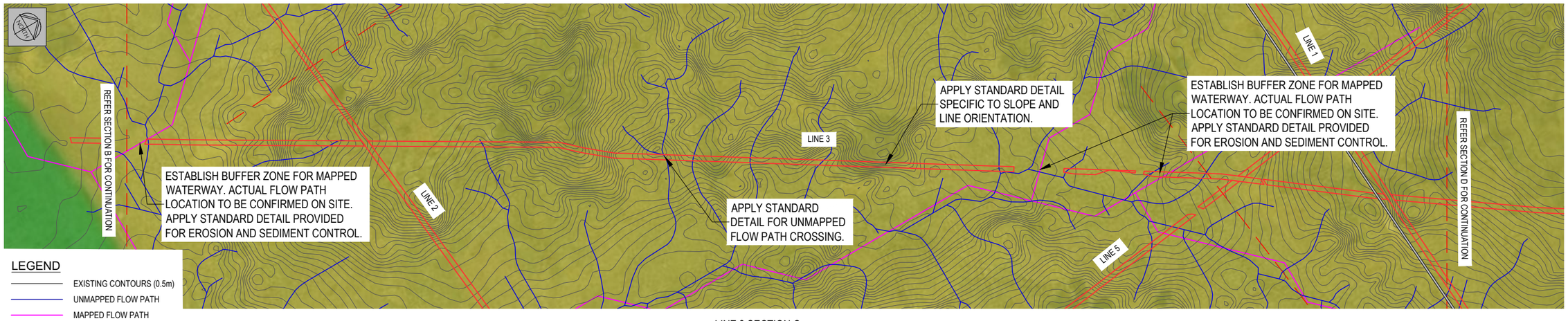

LINE 3 SECTION C
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LEGEND

- EXISTING CONTOURS (0.5m)
- UNMAPPED FLOW PATH
- MAPPED FLOW PATH
- SEISMIC LINE (30m)

RUSLE

- 50 t/ha/yr
- 40 t/ha/yr
- 30 t/ha/yr
- 20 t/ha/yr
- 10 t/ha/yr
- 0 t/ha/yr

TOPO.

REVISION	DESCRIPTION	APPROVED BY	DATE
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A3

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CPESC No. 6374

PROJECT: IMPERIAL SEISMIC 2019

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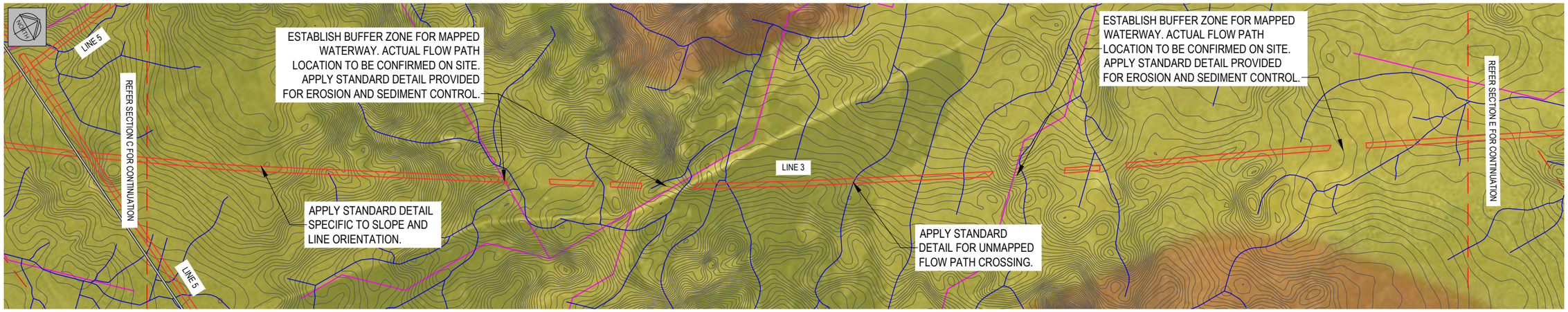

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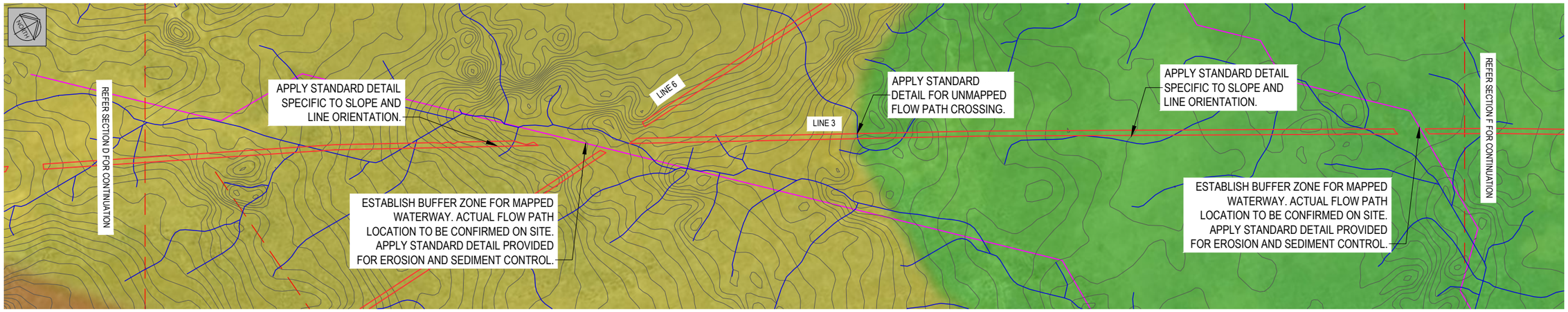

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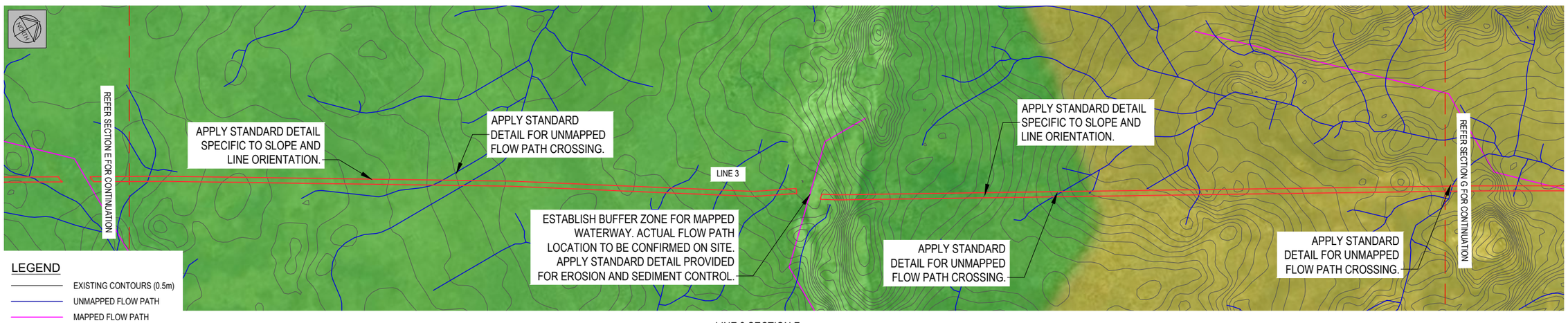

LINE 3 SECTION F
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LEGEND

- EXISTING CONTOURS (0.5m)
- UNMAPPED FLOW PATH
- MAPPED FLOW PATH
- SEISMIC LINE (30m)

RUSLE

- 50 t/ha/yr
- 40 t/ha/yr
- 30 t/ha/yr
- 20 t/ha/yr
- 10 t/ha/yr
- 0 t/ha/yr

TOPO.

REVISION	DESCRIPTION	APPROVED BY	DATE
A	ORIGINAL ISSUE	TB	13/08/19

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SCALE 1:25000
A3

ISSUED FOR USE

CLIENT: IMPERIAL OIL AND GAS PTY LTD
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RPEQ / SIGNATURE (IF REQUIRED): CPESC No. 6374

PROJECT: IMPERIAL SEISMIC 2019
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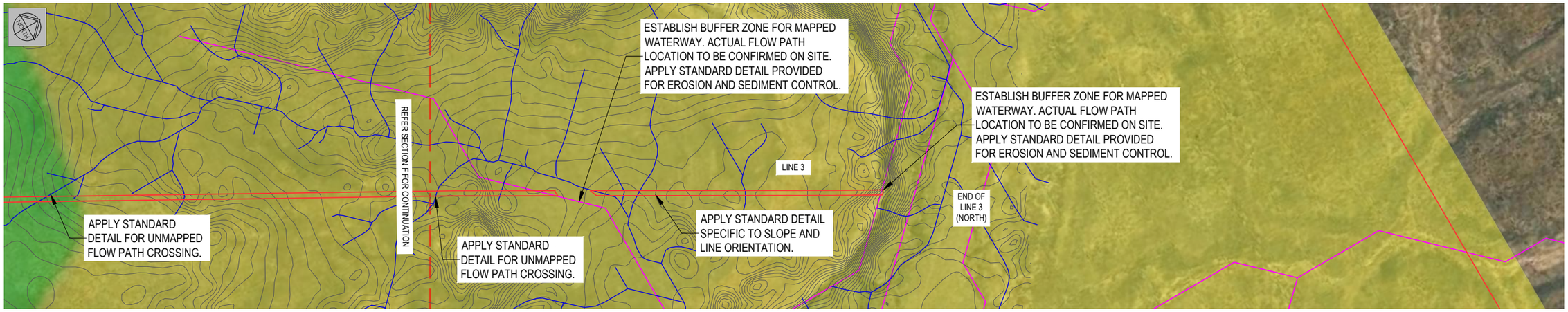
PROJECT No: 19-0109 | DRAWING No: D11 | REVISION: A



LINE 3 SECTION G
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LEGEND

- EXISTING CONTOURS (0.5m)
- UNMAPPED FLOW PATH
- MAPPED FLOW PATH
- SEISMIC LINE (30m)

TOPO.

REVISION	DESCRIPTION	APPROVED BY	DATE
A	ORIGINAL ISSUE	TB	13/08/19

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SCALE 1:25000
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CLIENT: IMPERIAL OIL AND GAS PTY LTD

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PROJECT: IMPERIAL SEISMIC 2019

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PROJECT No	DRAWING No	REVISION
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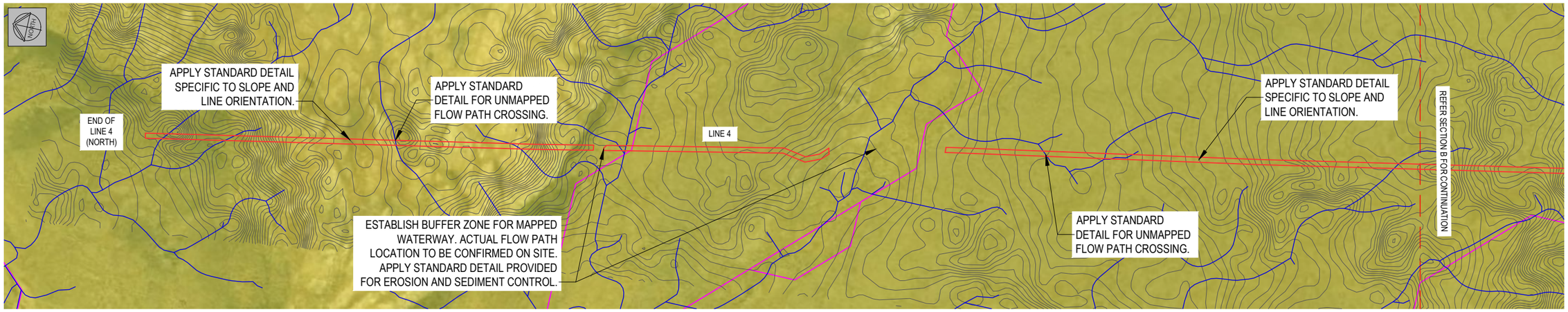

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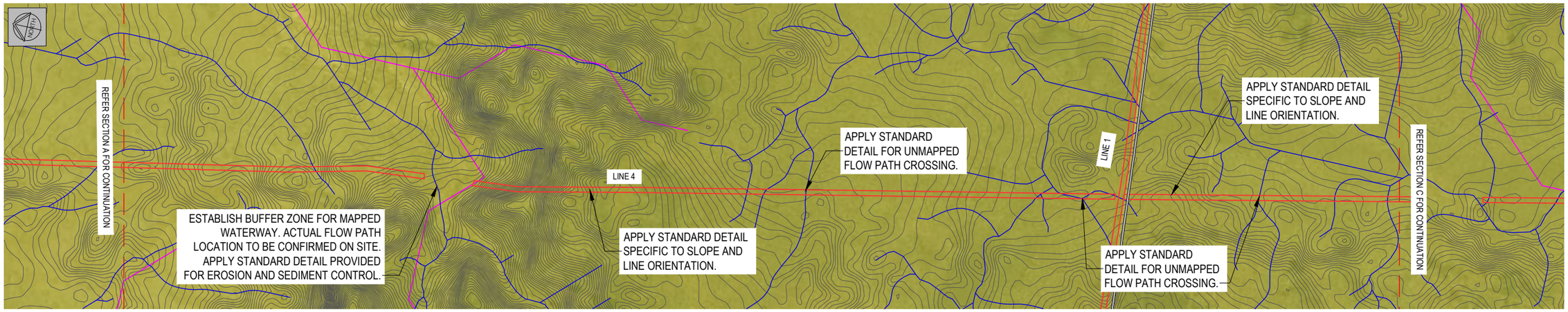

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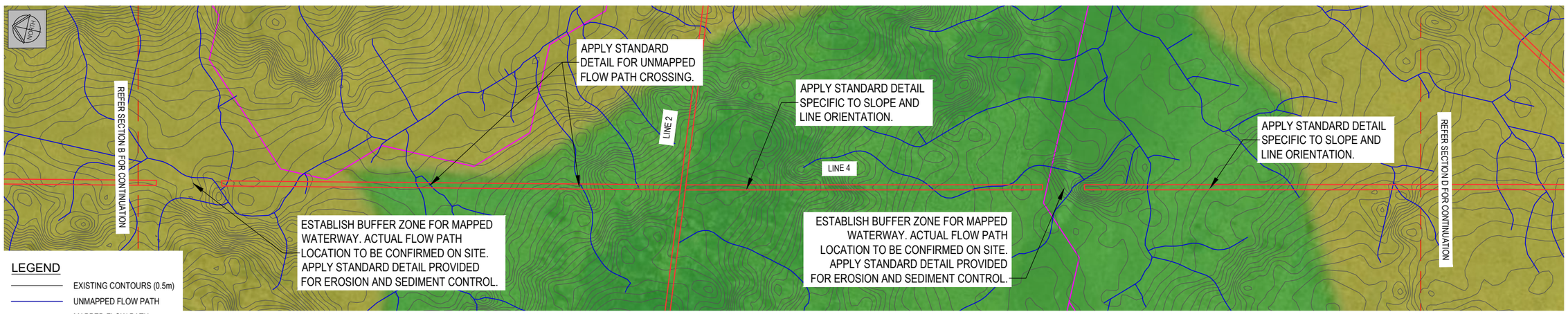


LEGEND

- EXISTING CONTOURS (0.5m)
- UNMAPPED FLOW PATH
- MAPPED FLOW PATH
- SEISMIC LINE (30m)

LINE 4 SECTION C
1:25000

TOPO

REVISION	DESCRIPTION	APPROVED BY	DATE
A	ORIGINAL ISSUE	TB	13/08/19

0 500
SCALE 1:25000
A3

ISSUED FOR USE

CLIENT: IMPERIAL OIL AND GAS PTY LTD

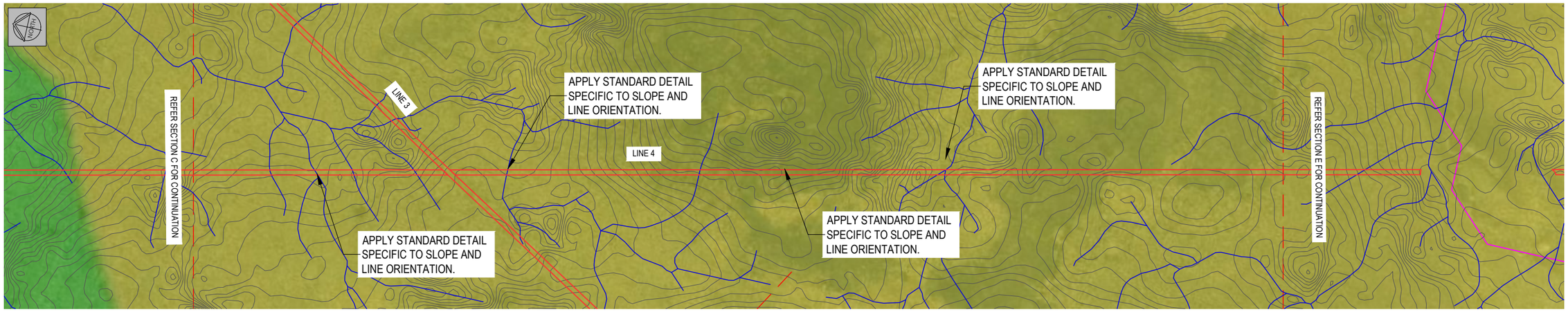
DRAWN	DESIGNED	DATE
RK	TB	13/08/19

RPEQ / SIGNATURE (IF REQUIRED): CPESC No. 6374

PROJECT: IMPERIAL SEISMIC 2019

DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN CONTROLS - LINE 4 SHEET 1/2

PROJECT No	DRAWING No	REVISION
19-0109	D13	A



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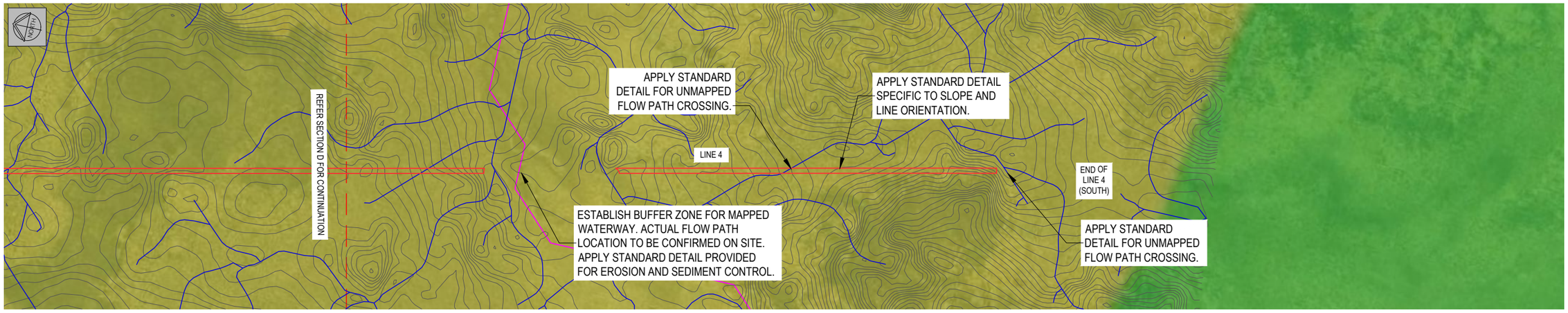

LINE 4 SECTION E
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LEGEND

- EXISTING CONTOURS (0.5m)
- UNMAPPED FLOW PATH
- MAPPED FLOW PATH
- SEISMIC LINE (30m)

TOPO.

REVISION	DESCRIPTION	APPROVED BY	DATE
A	ORIGINAL ISSUE	TB	13/08/19

0 500
SCALE 1:25000
A3

ISSUED FOR USE

CLIENT: IMPERIAL OIL AND GAS PTY LTD
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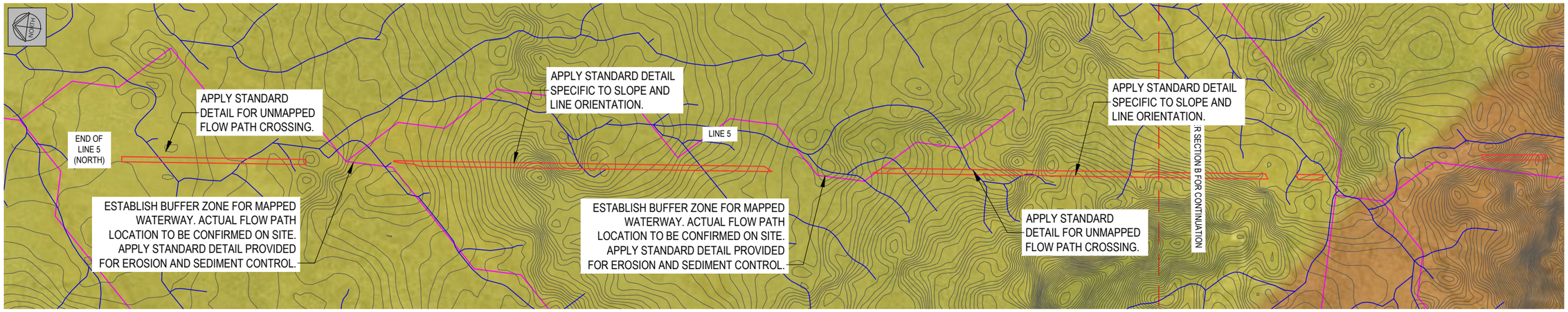
RPEQ / SIGNATURE (IF REQUIRED): CPESC No. 6374

PROJECT: IMPERIAL SEISMIC 2019
DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN CONTROLS - LINE 4 SHEET 2/2
PROJECT No: 19-0109 | DRAWING No: D14 | REVISION: A



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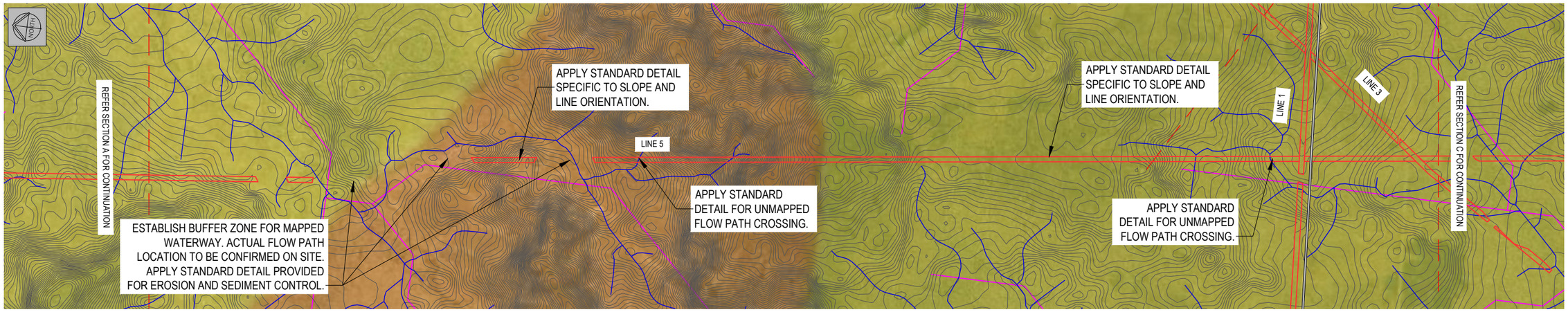

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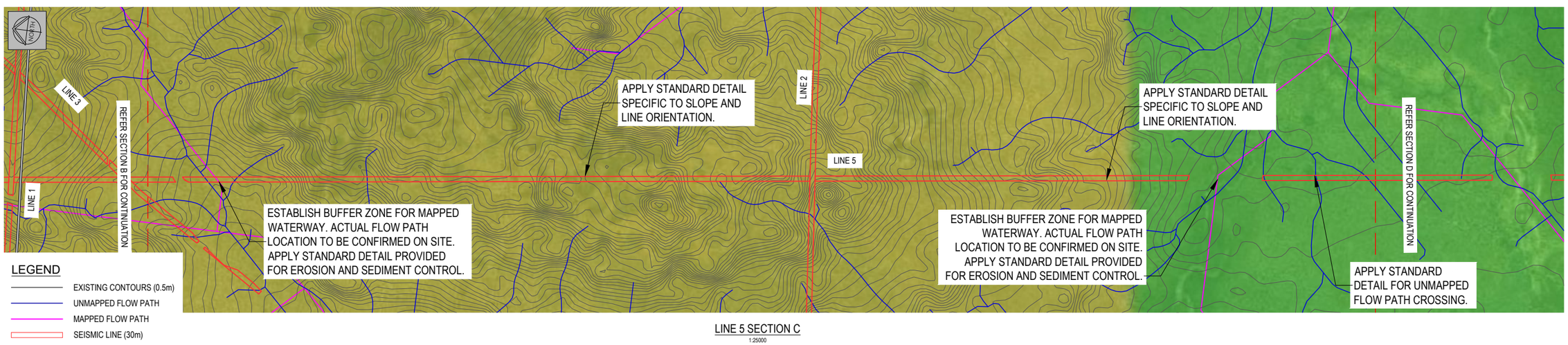

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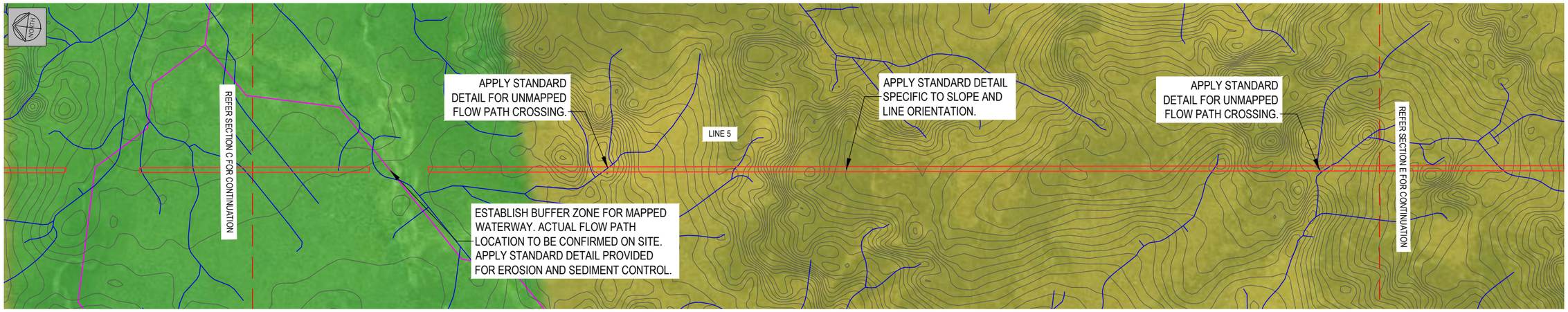
REVISION	DESCRIPTION	APPROVED BY	DATE
A	ORIGINAL ISSUE	TB	13/08/19

0 500
SCALE 1:25000
A3

ISSUED FOR USE

CLIENT: IMPERIAL OIL AND GAS PTY LTD
DRAWN: RK | DESIGNED: TB | DATE: 13/08/19
RPEQ / SIGNATURE (IF REQUIRED): CPESC No. 6374

PROJECT: IMPERIAL SEISMIC 2019
DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN CONTROLS - LINE 5 SHEET 1/2
PROJECT No: 19-0109 | DRAWING No: D15 | REVISION: A



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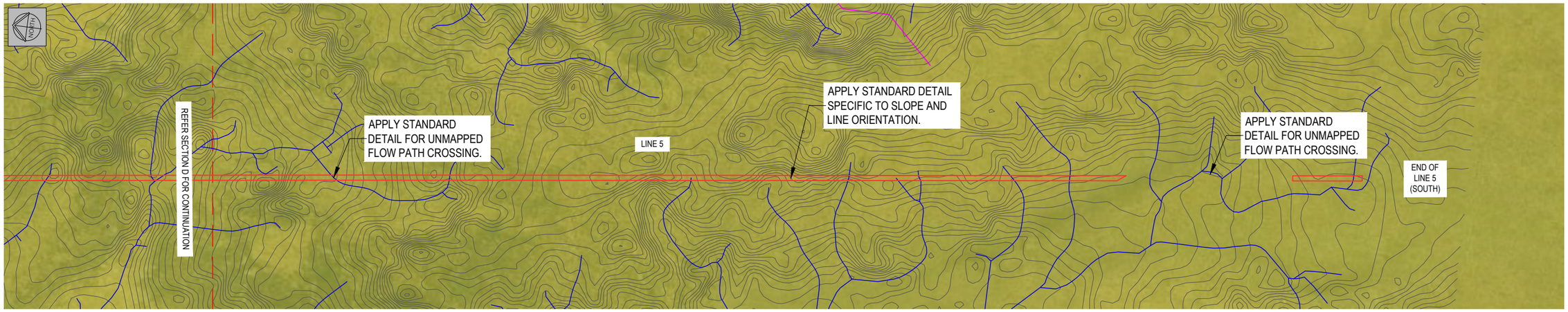

LINE 5 SECTION E
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LEGEND

- EXISTING CONTOURS (0.5m)
- UNMAPPED FLOW PATH
- MAPPED FLOW PATH
- SEISMIC LINE (30m)

TOPO.

REVISION	DESCRIPTION	APPROVED BY	DATE
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0 500
SCALE 1:25000
A3

ISSUED FOR USE

CLIENT: IMPERIAL OIL AND GAS PTY LTD

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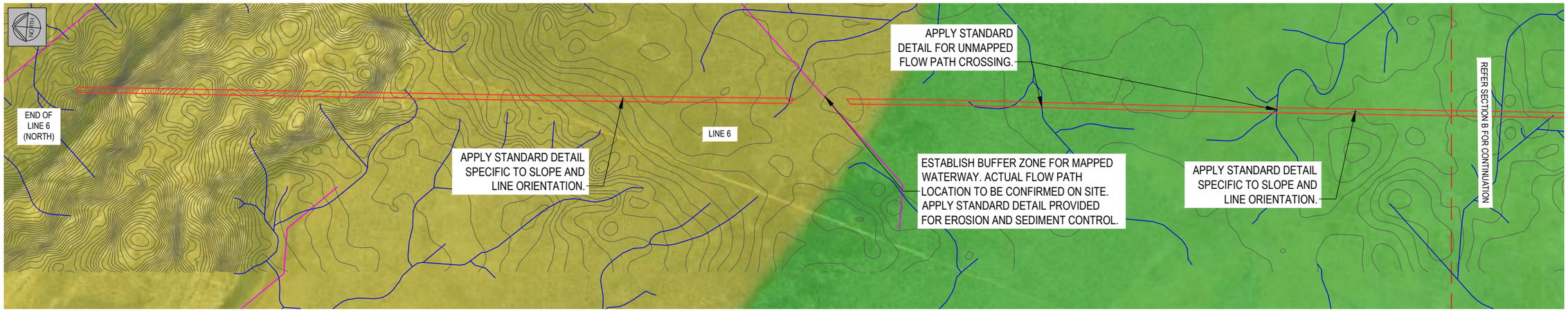
RPEQ / SIGNATURE (IF REQUIRED): CPESC No. 6374

PROJECT: IMPERIAL SEISMIC 2019

DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN CONTROLS - LINE 5 SHEET 2/2

PROJECT No	DRAWING No	REVISION
19-0109	D16	A



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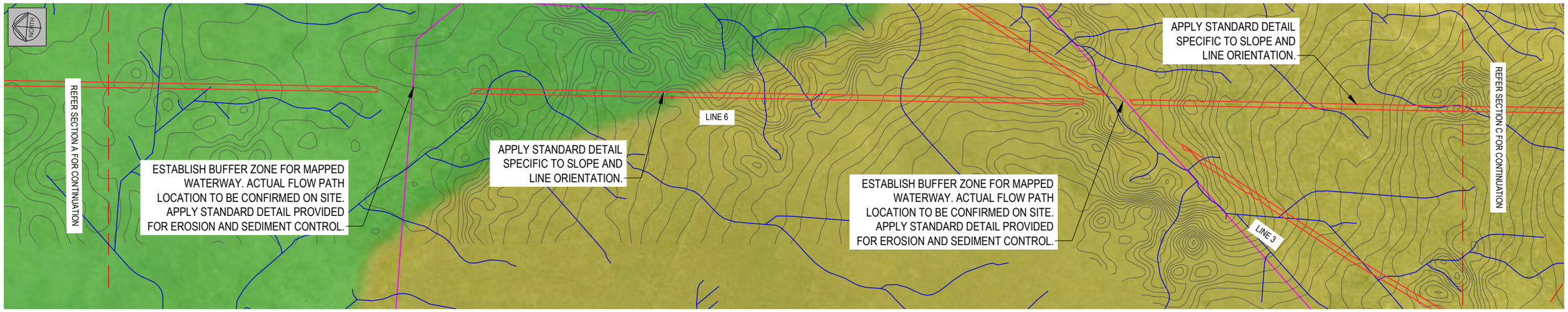

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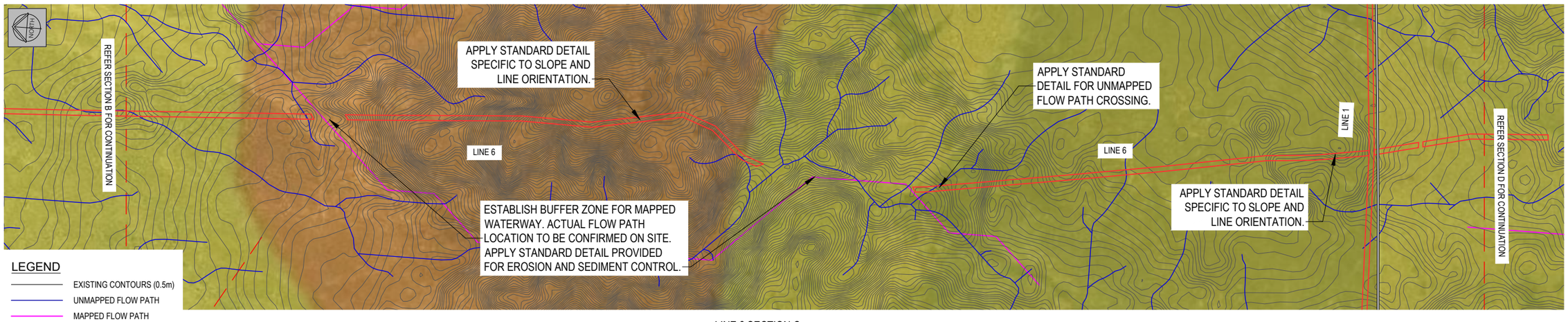

LINE 6 SECTION C
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LEGEND

- EXISTING CONTOURS (0.5m)
- UNMAPPED FLOW PATH
- MAPPED FLOW PATH
- SEISMIC LINE (30m)

TOPO.

REVISION	DESCRIPTION	APPROVED BY	DATE
A	ORIGINAL ISSUE	TB	13/08/19

0 500
SCALE 1:25000
A3

ISSUED FOR USE

CLIENT: IMPERIAL OIL AND GAS PTY LTD

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PROJECT: IMPERIAL SEISMIC 2019

DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN CONTROLS - LINE 6 SHEET 1/3

PROJECT No	DRAWING No	REVISION
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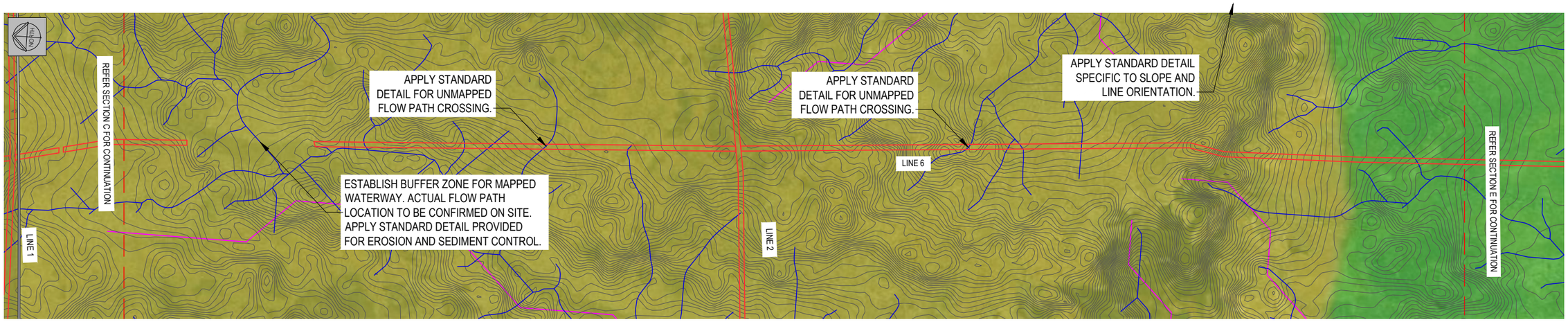

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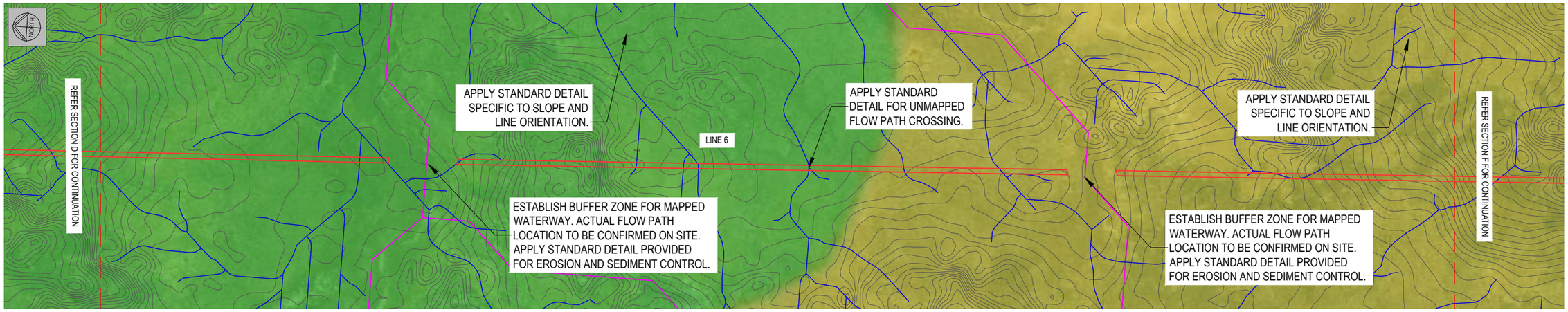

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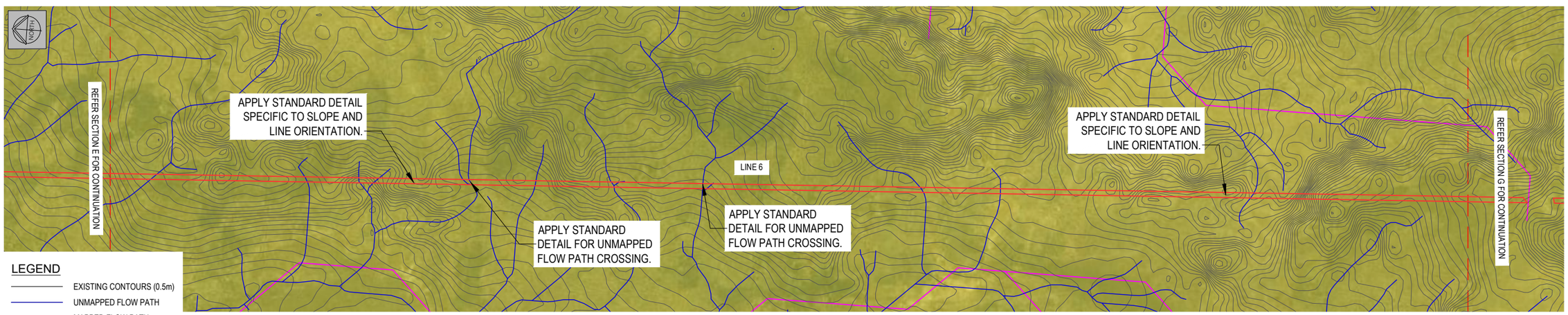

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TOPO.

REVISION	DESCRIPTION	APPROVED BY	DATE
A	ORIGINAL ISSUE	TB	13/08/19

0 500
SCALE 1:25000
A3

ISSUED FOR USE

CLIENT: IMPERIAL OIL AND GAS PTY LTD

DRAWN	DESIGNED	DATE
RK	TB	13/08/19

RPEQ / SIGNATURE (IF REQUIRED)
CPESC No. 6374

PROJECT: IMPERIAL SEISMIC 2019

DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN CONTROLS - LINE 6 SHEET 2/3

PROJECT No	DRAWING No	REVISION
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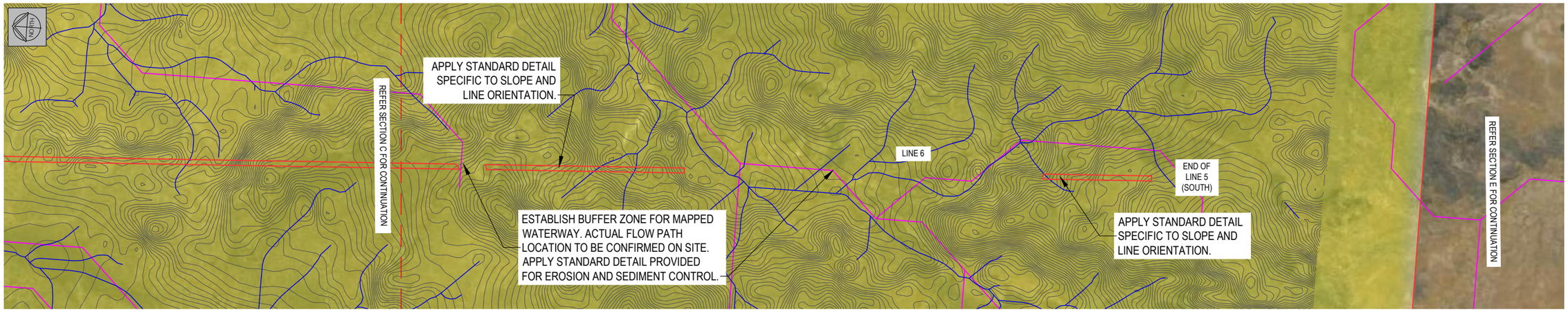

LINE 6 SECTION G

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LEGEND

- EXISTING CONTOURS (0.5m)
- UNMAPPED FLOW PATH
- MAPPED FLOW PATH
- SEISMIC LINE (30m)

TOPO.

REVISION	DESCRIPTION	APPROVED BY	DATE
A	ORIGINAL ISSUE	TB	13/08/19

0 500

SCALE 1:25000

A3

ISSUED FOR USE

CLIENT: IMPERIAL OIL AND GAS PTY LTD

DRAWN	DESIGNED	DATE
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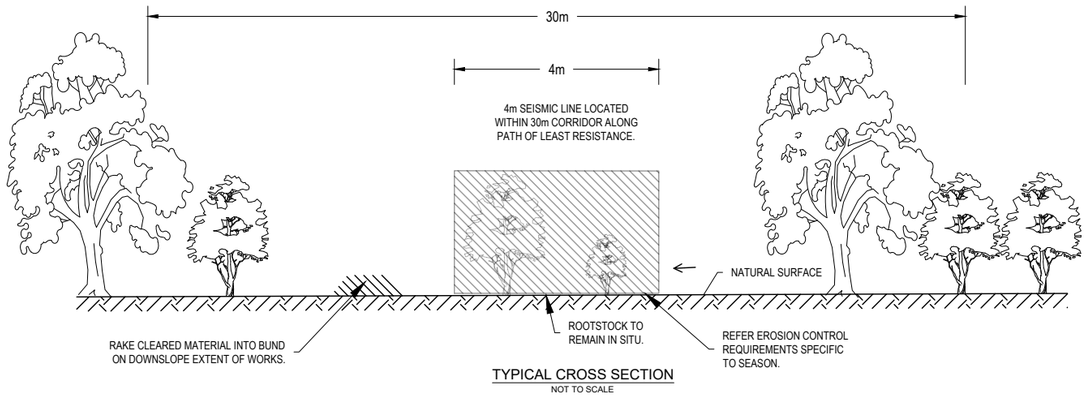
RPEQ / SIGNATURE (IF REQUIRED)

CPESC No. 6374

PROJECT: IMPERIAL SEISMIC 2019

DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN CONTROLS - LINE 6 SHEET 3/3

PROJECT No	DRAWING No	REVISION
19-0109	D19	A



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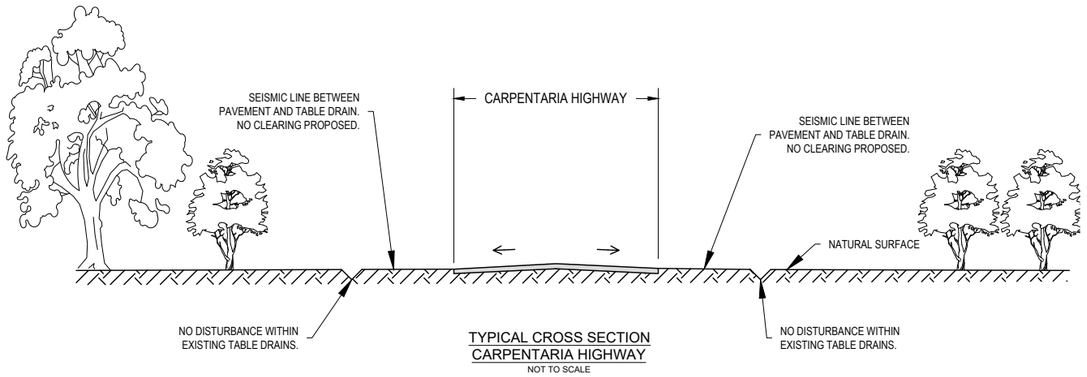
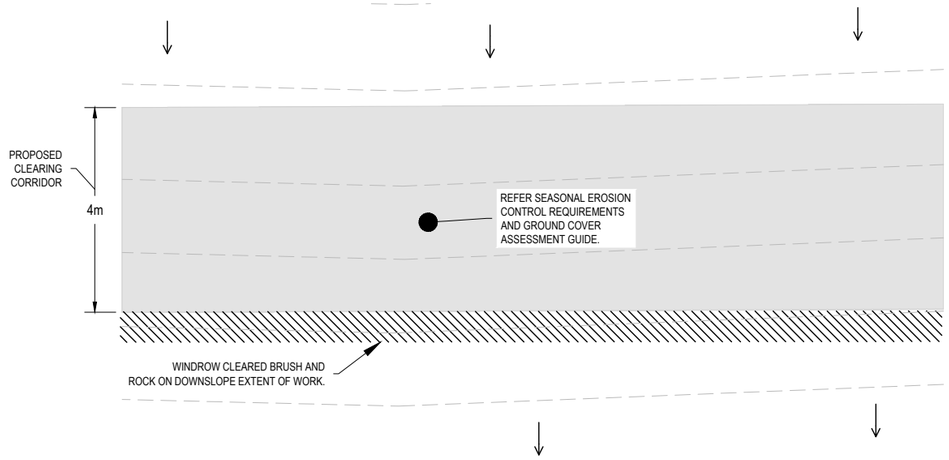


TYPICAL CROSS SECTION
CARPENTARIA HIGHWAY
NOT TO SCALE



SEISMIC LINE PERPENDICULAR TO FALL
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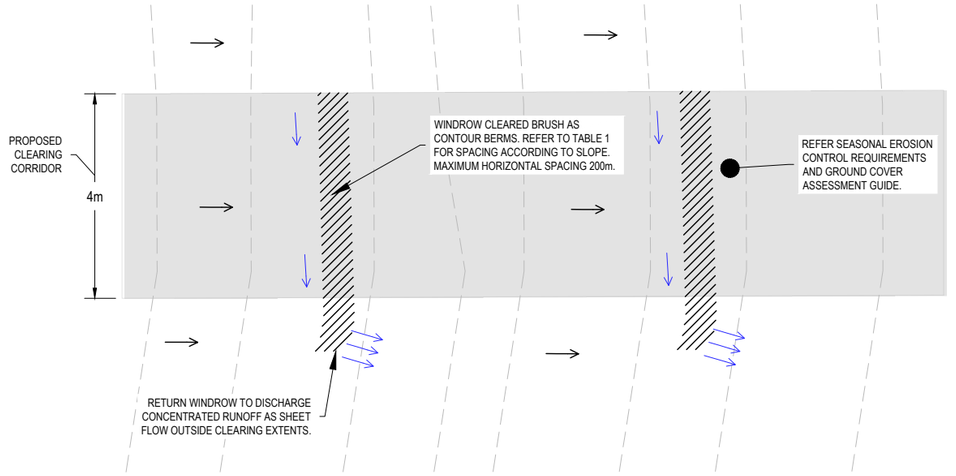

SEISMIC LINE PARALLEL TO FALL
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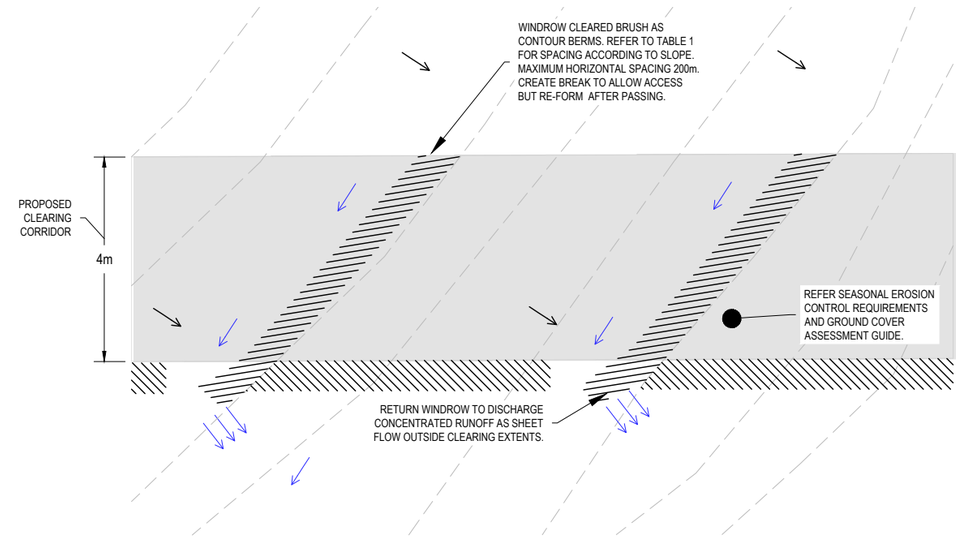


SEISMIC LINE DIAGONAL TO FALL
NOT TO SCALE

Open Earth Slopes						Vegetated Slopes		
Slope	Horiz.	Vert.	Slope	Horiz.	Vert.	Horiz.	Vert.	Slope
1%	80m	0.9m	15%	19m	2.9m	<10%	No maximum	
2%	60m	1.2m	20%	16m	3.2m	12%	100m	12m
4%	40m	1.6m	25%	14m	3.5m	15%	80m	12m
6%	32m	1.9m	30%	12m	3.5m	20%	55m	11m
8%	28m	2.2m	35%	10m	3.5m	25%	40m	10m
10%	25m	2.5m	40%	9m	3.5m	30%	30m	9m
12%	22m	2.6m	50%	6m	3.0m	>36%	Case Specific	

TABLE 1 - MAXIMUM BERM SPACING ON OPEN EARTH AND VEGETATED SLOPES

TOPO.

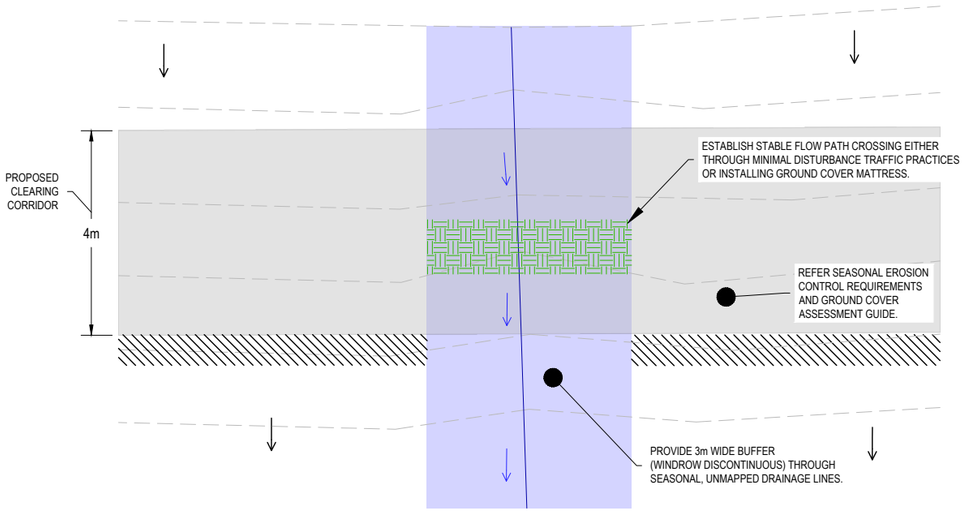
REVISION	DESCRIPTION	APPROVED BY	DATE
A	ORIGINAL ISSUE	TB	13/08/19

0 500
SCALE 1:25000
A3

ISSUED FOR USE

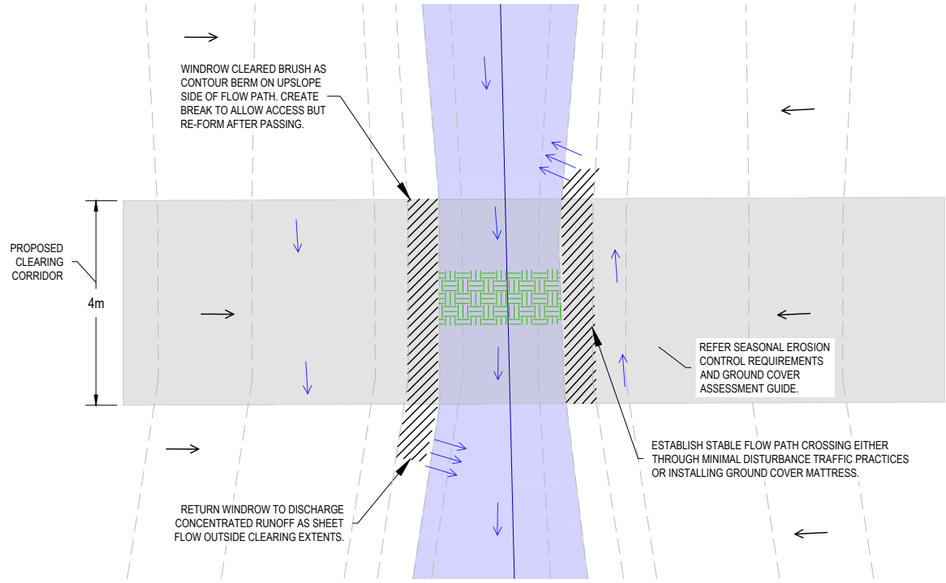
CLIENT: IMPERIAL OIL AND GAS PTY LTD
DRAWN: RK | DESIGNED: TB | DATE: 13/08/19
RPEQ / SIGNATURE (IF REQUIRED): CPESC No. 6374

PROJECT: IMPERIAL SEISMIC 2019
DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN SEISMIC LINE CONTROLS
PROJECT No: 19-0109 | DRAWING No: D20 | REVISION: A



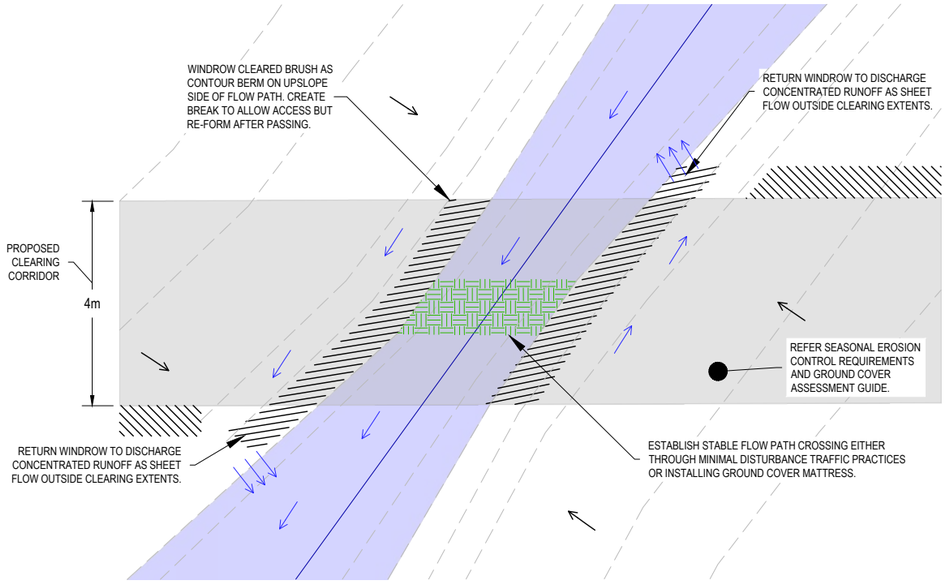
SEISMIC LINE PERPENDICULAR TO FALL - UNMAPPED FLOW PATH CROSSING

NOT TO SCALE



SEISMIC LINE PARALLEL TO FALL - UNMAPPED FLOW PATH CROSSING

NOT TO SCALE



SEISMIC LINE DIAGONAL TO FALL - UNMAPPED FLOW PATH CROSSING

NOT TO SCALE

TOPO.

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ISSUED FOR USE

CLIENT: IMPERIAL OIL AND GAS PTY LTD

DRAWN	DESIGNED	DATE
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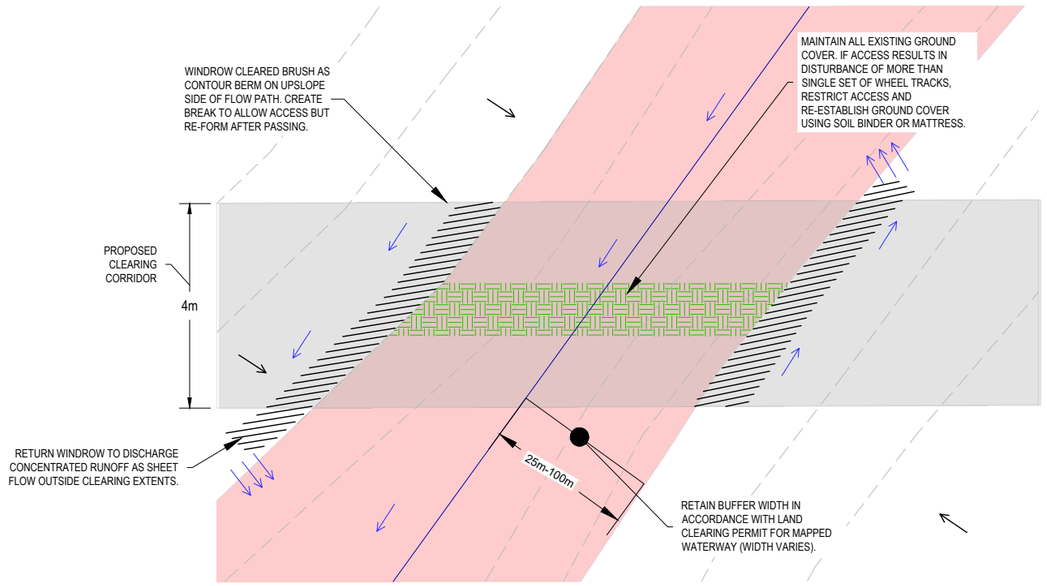
RPEQ / SIGNATURE (IF REQUIRED): CPESC No. 6374

PROJECT: IMPERIAL SEISMIC 2019

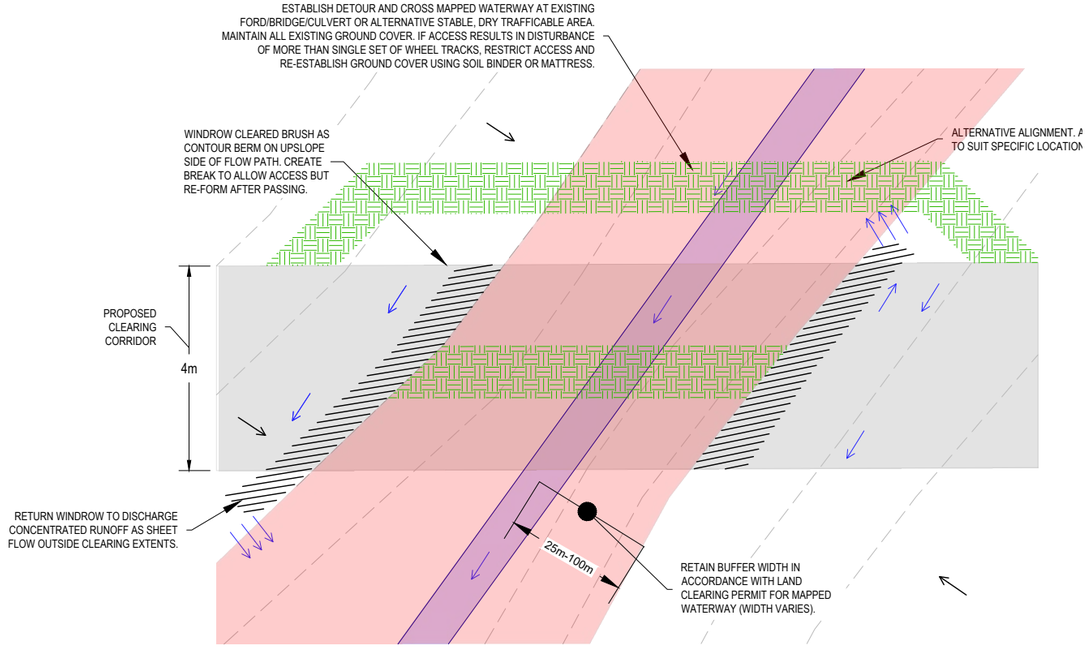
DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN UNMAPPED FLOW PATH CONTROLS

PROJECT No	DRAWING No	REVISION
19-0109	D21	A



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

NOT TO SCALE



MAPPED WATERWAY BUFFER - NOT TRAFFICABLE: FORMED BANKS AND SURFACE WATER EVIDENT

NOT TO SCALE

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%	80%
Reinstatement/revegetation timeframes	30 days	5 days

TABLE 2 - EROSION CONTROL REQUIREMENTS

CLEARING METHODOLOGY

Step 1: Assess site and select path of least disturbance for 4m width of clearing

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

Step 3: Commence clearing, ensuring timeframes between clearing and scheduled seismic work do not exceed those indicated in Table 7.

Step 4: Complete clearing and assess residual groundcover (%) using the tools presented in Appendix A.

Step 5: Carry out seismic works, ensuring that if rainfall is forecast that exceeds the probability AND depth presented in Table 7 immediately re-establish the level of groundcover required in Table 7 (if current % assessed in Step 4 does not comply).

Step 6: Complete survey and re-establish minimum ground cover % within minimum timeframes indicated in Table 7.

Options for re-establishing ground cover include:

- Respreading windrowed grass, branches, rocks and other vegetation over exposed areas
- Application of soil binder at manufacturers specification
  - eg. Vital Stonewall applied at minimum 1L/m^2

It is suggested that a supply of soil binder be readily available to seismic teams to achieve the timeframes and groundcover requirements proposed (note, binder can be applied via the same water trucks used on standby for fire suppression).

TOPO.

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0 500

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A3

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CPESC No. 6374

PROJECT: IMPERIAL SEISMIC 2019

DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN MAPPED FLOW PATH CONTROLS

PROJECT No: 19-0109 | DRAWING No: D22 | REVISION: A

GROUND COVER ASSESSMENT

STEP POINT METHOD

1. PREPARE A FIELD SHEET ON WHICH TO RECORD OBSERVATIONS.
2. IDENTIFY AN AREA WITHIN THE SITE WHICH IS TYPICAL IN TERMS OF THE AMOUNT OF COVER AND PROPORTION OF NATIVE GROUNDCOVER.
3. WALK 100 STEPS IN A STRAIGHT LINE ACROSS THE SELECTED AREA.
4. AT EACH STEP, RECORD THE GROUNDCOVER AT THE TIP OF YOUR BOOT
5. REPEAT THIS IN AT LEAST FOUR OTHER AREAS ACROSS THE CLEARED SITE, COVERING VARIATIONS IN GROUNDCOVER WHERE POSSIBLE.
6. TO CALCULATE THE PERCENTAGE OF THE GROUNDCOVER DIVIDE THE AVERAGE BY THE OVERALL GROUNDCOVER PERCENTAGE FROM THE PREVIOUS STEP AND THEN MULTIPLY BY 100.
7. LOG PHOTOGRAPHS OF THE ASSESSMENT FOR PERFORMANCE TRACKING

QUADRAT METHOD

THIS METHOD USES A SQUARE FRAME (QUADRAT) OF AT LEAST 70cm x 70cm. SUCH A QUADRAT IS EASILY ASSEMBLED USING FOUR THIN PIECES OF PVC PIPE OR WIRE CUT TO EQUAL LENGTHS AND JOINED WITH TIGHT-FITTING ELBOW JOINTS.

1. PREPARE A FIELD SHEET ON WHICH TO RECORD OBSERVATIONS.
2. WITHIN THE SPECIFIC AREA SELECT AT LEAST FIVE AREAS OF GROUNDCOVER THAT ARE TYPICAL OF THE GROUNDCOVER ACROSS THAT AREA
3. FOR EACH REPRESENTATIVE AREA (SAMPLE AREA), PLACE THE QUADRAT RANDOMLY 10 TIMES.
4. FOR EACH QUADRAT PLACEMENT ESTIMATE THE PERCENTAGE OF THE QUADRAT THAT HAS VEGETATIVE GROUNDCOVER (NON-NATIVE AND NATIVE GROUNDCOVER), AND RECORD THIS IN THE FIELD SHEET
5. FOR THE WHOLE SITE ADD THE AVERAGES FROM ALL SAMPLE AREAS AND DIVIDE THESE TOTALS BY THE NUMBER OF SAMPLE AREAS TO YIELD THE AVERAGE PERCENTAGE OF GROUNDCOVER (NATIVE AND NON-NATIVE) ACROSS THE ENTIRE SITE
6. LOG PHOTOGRAPHS OF THE ASSESSMENT FOR PERFORMANCE TRACKING

GROUND COVER - 20%

GROUND COVER - 40%

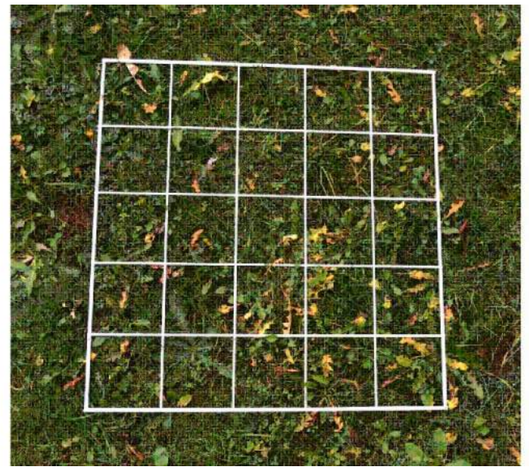
GROUND COVER - 70%

GROUND COVER - 90%

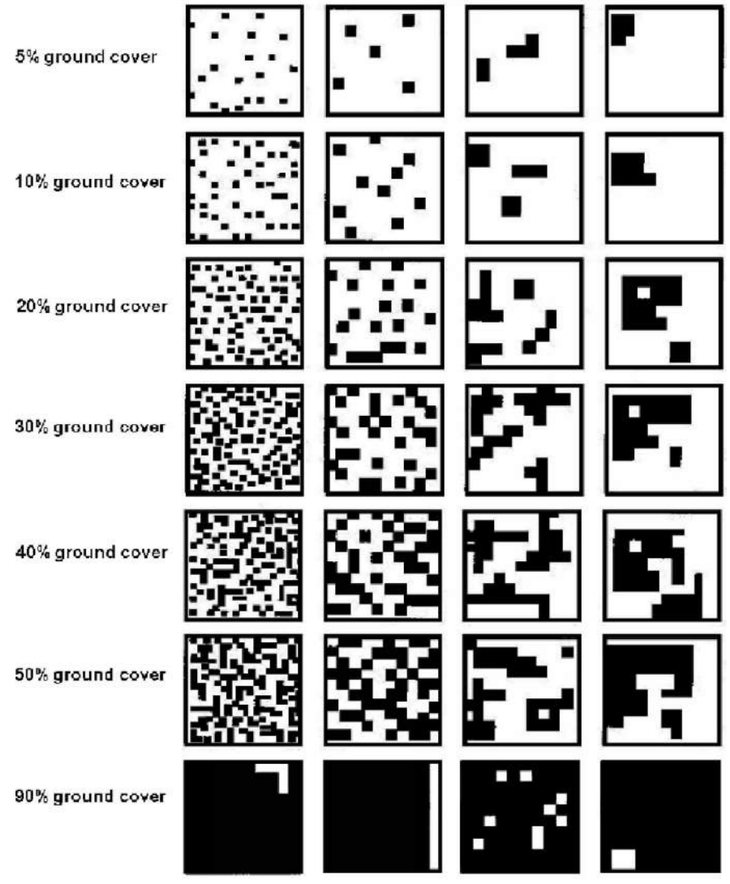
GROUND COVER ASSESSMENT OF VEGETATION

'GROUND COVER' APP

A USEFUL APPLICATION TO ASSESS GROUND COVER IS AVAILABLE FOR IOS DEVICES ON THE APP STORE. 'GROUND COVER' USES GEO-LOCATION TECHNOLOGY ALONG WITH A STANDARD STEP POINT MONITORING PROCESS AND IS SUPPORTED WITH PHOTOGRAPHIC BENCHMARK CAPABILITY. 'GROUND COVER' TAKES THE USER THROUGH THE STEP POINT METHOD IN A STRAIGHT FORWARD WAY TO GET YOU STARTED.



QUADRAT METHOD



GROUND COVER ASSESSMENT FOR VEGETATION, ROCK, GRAVEL, SOIL BINDER, LEAF MATTER, MULCH OR SIMILAR

TOPO.

REVISION	DESCRIPTION	APPROVED BY	DATE
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A3

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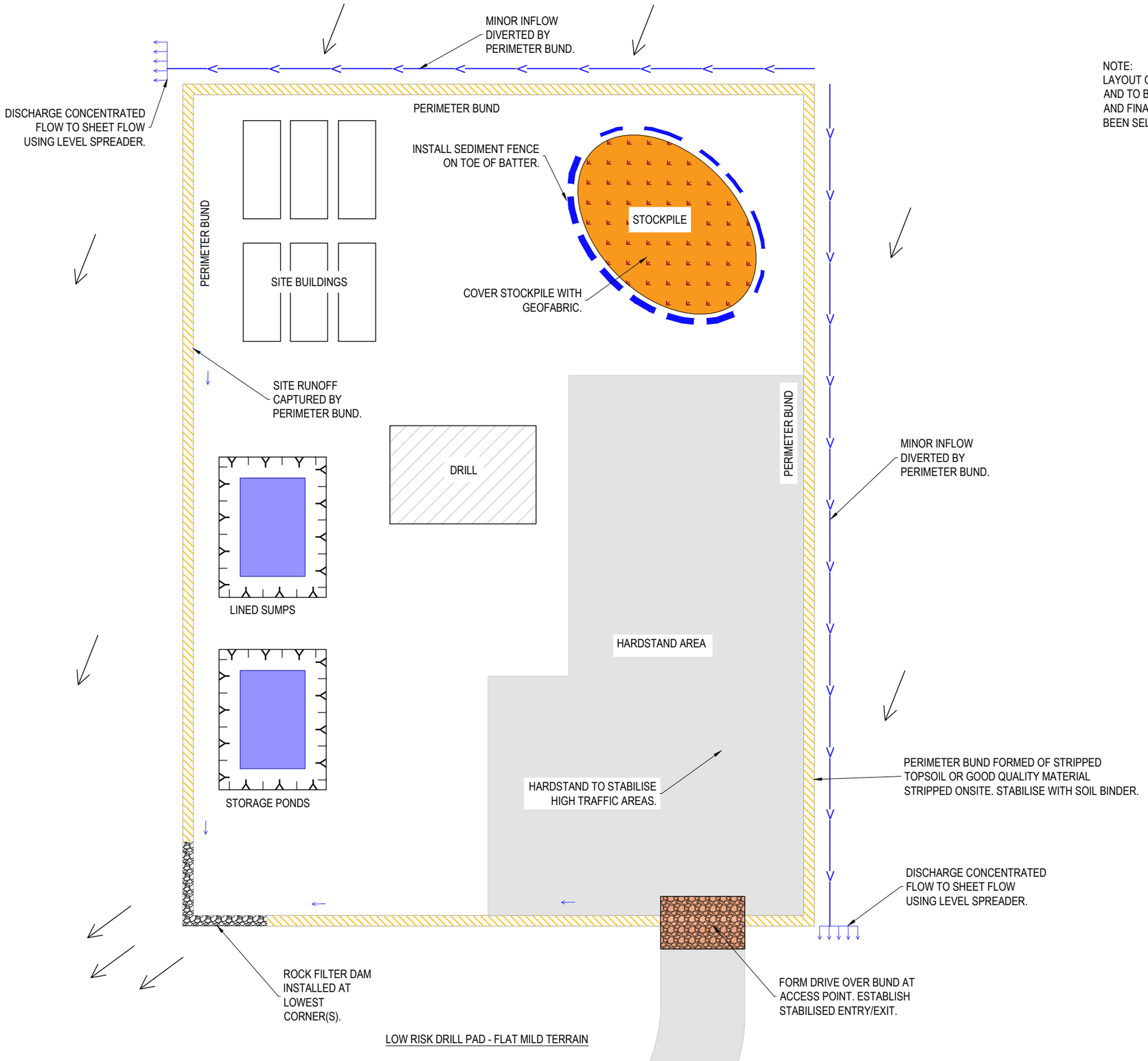
CPESC No. 6374

PROJECT: IMPERIAL SEISMIC 2019

DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN
GROUND COVER ASSESSMENT

PROJECT No	DRAWING No	REVISION
19-0109	D23	A



NOTE:
LAYOUT OF DRILL PAD IS INDICATIVE ONLY AND TO BE CONFIRMED AFTER LOCATION AND FINAL PLANT REQUIREMENTS HAVE BEEN SELECTED.

LOW RISK DRILL PAD - FLAT MILD TERRAIN

TOPO

REVISION	DESCRIPTION	APPROVED BY	DATE
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ISSUED FOR USE

CLIENT: IMPERIAL OIL AND GAS PTY LTD

DRAWN	DESIGNED	DATE
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PROJECT: IMPERIAL SEISMIC 2019

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

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Appendix 25. Seismic Line Clearing Methodology

Imperial Oil and Gas 2019 Seismic Line Clearing Methodology.

Contents

Overview

The seismic line clearing for the Imperial Oil and Gas 2019 program will be carried out with a minimal disturbance methodology. Wherever practical, ground disturbance will be restricted to the removal of rocks and fallen branches and the brushing off of grasses and shrubs to provide effective ground contact of the seismic vibro-source and the geophones and minimise the risk of fire. Where ground clearance is unavoidable such disturbance will be undertaken with a grader and the access width shall be no more than 1 blade width wide (4m) with minimal ground disturbance sufficient to provide for safe vehicle access.

Some patches of lancewood (*Acacia shirleyi*) are present along the proposed seismic lines. These areas represent the thickest vegetation and will require clearing with a dozer or loader. Of the 70 ha of impacted area (excluding already cleared areas such as the Carpentaria Highway and no-go areas such as drainage lines, creeks, waterways and their buffers), 13.0 ha of lancewood is proposed to be cleared (approximately 19%).

No windrows will remain after rehabilitation. Where new access section of seismic is required to be developed it will be developed as a temporary access and grasses will be left on the tracks to stabilize the earth and permit rapid regeneration. Root stocks are to be left in place in such a manner as to minimise risk of puncture to tyred vehicles while providing for rapid regrowth of original plant species.

Overall Methodology

Minimal Disturbance Work Practices

Root stock will be left in place where present to help hold the soil together and to allow quick revegetation when it rains.

Where practicable mature trees will be avoided by deviating around them whilst staying inside the approved corridor.

Seismic lines will be deviated along their alignment rather than straight to reduce their visual impact.

Equipment

Clearing will be carried out with a minimal disturbance mindset, utilising a grader to sweep the seismic line free from large rocks and sticks whilst leaving the rootstock intact.

Where individual mature trees cannot be practicably avoided, they will be selectively pushed with a bulldozer or loader.

All clearing equipment will be fitted with GPS equipment showing where the equipment is with-in the approved corridor.

Operator Training & Induction

Prior to the commencement of seismic line clearing operations Imperial Oil and Gas will hold an on site Icebreaker / Induction session covering the overall works, safety and compliance.

In addition to this the topics specific to the clearing of seismic lines will be covered;

- Works to be carried out
- Approval conditions and constraints
- No Go / buffer zones
    - Cultural Heritage
    - Watercourses and associated buffers
    - 3rd party infrastructure
- Different Land types, and associated work methodologies.
- Different Leaseholders and requirements.

Supervision and Monitoring

Imperial Oil and Gas will have an on site supervisor for the duration of all works, as well as managing the job their duties will include compliance of the following;

- Ensure all works are carried out in the correct location.
- Ensure all no go zones and buffers are complied with.
- Ensure all works are carried out in line with approval conditions.
- Ensure all works are carried out in line with the appropriate Land types work methodologies

Land Type Methodologies

Acacia shirleyi area methodology

1. Assess site and ensure that there are no exclusion zones within the patch of Acacia shirleyi.
    a. If there are any exclusion zones within the patch of Acacia shirleyi ensure that these are flagged prior to starting works in that area.
2. Assess site and select path of least disturbance for 4m width of clearing within 30m corridor.
3. Clear a 4m seismic line with the dozer or loader, ensuring that the blade is carried at least 25mm above the ground at all times.
    a. Where practicable push timber into non timbered areas rather than disturbing more Acacia shirleyi
4. Clean up the a 4m seismic line with a Grader, ensuring that the blade is carried at least 25mm above the ground at all times and that any windrows of vegetation are on the downslope side of the seismic line if there is crossfall.

Grassy woodland methodology

1. Assess site and ensure that there are no exclusion zones in the work area.
    a. If there are any exclusion zones ensure that these are flagged prior to starting works in that area.
2. Assess site and select path of least disturbance for 4m width of clearing within 30m corridor.
3. Clear a 4m seismic line with a Grader, ensuring that the blade is carried at least 25mm above the ground at all times and that any windrows of vegetation are on the downslope side of the seismic line if there is crossfall.
4. Where mature trees cannot be practicably avoided push them selectively with a bulldozer or loader.

Open grassland methodology

1. Assess site and ensure that there are no exclusion zones in the work area.
    a. If there are any exclusion zones ensure that these are flagged prior to starting works in that area.
2. Assess site and select path of least disturbance for 4m width of clearing within 30m corridor.
3. Clear a 4m seismic line with a Grader, ensuring that the blade is carried at least 25mm above the ground at all times and that any windrows of vegetation are on the downslope side of the seismic line if there is crossfall.

Sandstone jump-ups and plains methodology

1. Assess site and ensure that there are no exclusion zones in the work area.
    a. If there are any exclusion zones ensure that these are flagged prior to starting works in that area.
2. Assess site and select path of least disturbance for 4m width of clearing within 30m corridor.
3. Clear a 4m seismic line with a Grader, ensuring that the blade is carried at least 25mm above the ground at all times and that any windrows of vegetation are on the downslope side of the seismic line if there is crossfall.
4. Where mature trees cannot be practicably avoided push them selectively with a bulldozer or loader.

Watercourse buffer methodology

1. When approaching a watercourse buffer flag the start of the buffer to back up the GPS technology being utilised
2. Alert the equipment operators to the upcoming buffer zone via radio.
3. Assess site and select a path of least disturbance to traverse the equipment through the watercourse buffer.
4. Lead the clearing equipment through the water course buffer following the selected route.

Cultural Heritage buffer methodology

1. When approaching a cultural Heritage buffer flag the buffer to back up the GPS technology being utilised
2. Alert the equipment operators to the upcoming buffer zone via radio.
3. Assess site and select a path of least disturbance to traverse the equipment around the Cultural Heritage buffer.
4. Lead the clearing equipment around the Cultural Heritage buffer following the selected route.

Third Party Infrastructure buffer methodology

1. When approaching a Third Party Infrastructure flag the start of the buffer to back up the GPS technology being utilised
2. Alert the equipment operators to the upcoming buffer zone via radio.
3. Assess site and select a path of least disturbance to traverse the equipment through the watercourse buffer.
4. Lead the clearing equipment through the water course buffer following the selected route.

Carpentaria Highway verge methodology

Imperial Oil and Gas is updating its traffic management plan for seismic acquisition along the Carpentaria Highway, this section will be updated when the permit conditions are finalised.