

Imperial O&G EMP IMP4-3 Appendices

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1 - Description of the existing environment for the Location of the Regulated Activity

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1.1 Climate

The Location of the Regulated Activity experiences a tropical savannah climate within the humid zone with a distinct Wet and Dry season which can experience an average rainfall between 600 – 800mm per year over the summer wet season. This seasonal variation has significant implications for water resources. The summer monsoon season brings rain and cyclones, and during this period, the Location of the Regulated Activity experiences considerable rainfall events. These rainfall events can cause flooding, determined by the rainfall's volume, duration, and spatial distribution. It is these flooding events that provide the recharge to the aquifers. In contrast, the Dry season between April and December experiences little rain, resulting in many rivers ceasing to flow.

The mean daily minimum temperatures at the Daly Waters mine range from 11.3 to 23.4°C, and a maximum mean daily temperature range from 28.9 – 37.6 °C. The average annual evaporation is approximately 2,418mm for the region, which exceeds the annual rainfall even in the wettest of years.

Table 1 (BoM.a, 2020) displays the mean monthly rainfall and temperature data for the Daly Waters region with the data drawn from this weather station.

Table 1: Daly Waters long term averages

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean Max (°C)	35.7	34.7	34.3	33.6	31.5	29.0	28.9	32.0	34.5	36.9	37.5	37.6	33.8
Mean Min (°C)	23.4	23.0	21.8	19.0	15.3	12.1	11.3	13.4	16.3	20.3	22.9	23.5	18.4
Mean Rain (mm)	162.4	161.6	112.8	23.1	4.9	4.4	1.2	1.7	4.5	22.5	61.0	110.7	655.4
Media Rain (mm)	150.3	135.6	74.9	6.9	0.0	0.0	0.0	0.0	0.0	10.4	51.2	92.7	615.9
Mean Rain Days	12.0	11.8	8.2	2.4	0.6	0.5	0.2	0.2	0.7	2.8	6.0	9.7	48.8

The mean daily minimum temperatures at the McArthur River mine range from 12.1 to 25.1°C, and a maximum mean daily temperature range from 29.9 – 38.6 °C. The average annual evaporation is approximately 2,400mm for the region, which, even in the wettest of years, exceeds the annual rainfall (BoM b., 2020).

Table 2 displays the mean monthly rainfall and temperature data for the McArthur River region with the data drawn from its weather station.

Table 2: McArthur River Mine long term averages

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean Max (°C)	35.9	35.2	35.0	34.7	32.4	29.8	29.9	32.1	35.3	37.8	38.6	37.8	34.5
Mean Min (°C)	24.9	24.7	23.4	20.5	16.7	12.7	12.1	13.4	17.2	21.0	24.1	25.1	19.6
Mean Rain (mm)	210.3	184.4	153.8	33.5	7.7	1.7	2.4	0.3	5.1	20.3	62.2	129.9	819.2
Media Rain (mm)	170.0	162.1	109.2	14.4	0.4	0.0	0.0	0.0	0.0	1.6	37.2	88.6	669.5
Mean Rain Days	13.6	13.3	10.8	3.5	1.2	0.5	0.4	0.3	0.7	2.0	5.7	9.7	59.2

1.2 Rainfall

The Location of the Regulated Activity is between Daly Waters and McArthur River Mine, being 196km from Daly Waters and 110km from McArthur River Mine. Imperial has utilised Bureau of Meteorology (BOM) data from weather stations 14618 (Daly Waters) and 14704 (McArthur River Mine Airport) in its analysis of rainfall patterns and intensity. Daly Waters BOM station has 147 years of daily rainfall data (1873 to current), and McArthur River Mine Airport BOM station has 52 years of data (1968 to present). Imperial has evaluated average daily rainfall, historically Significant Rainfall Events (SREs), and 1 in 1000-year events when assessing rainfall risks for this EMP.

1.2.1 Average Daily Rainfall

The average daily rainfall records for Daly Waters and McArthur River Mine Airport show that the amount of rainfall expected and the uncertainty range is highest in December through March, inclusive. The average rainfall and uncertainty range for both locations in April through November is relatively low, with averages below 2mm per day. In October and November, the rainfall is low, and it is falling on dry ground, so little runoff is expected.

The daily recorded rainfall for Daly Waters and McArthur River Mine Airport showing the Minimum, lower quartile, median, upper quartile, Maximum and Outliers (1.5 times the Maximum) are shown in Figure 1 and Figure 2, respectively.

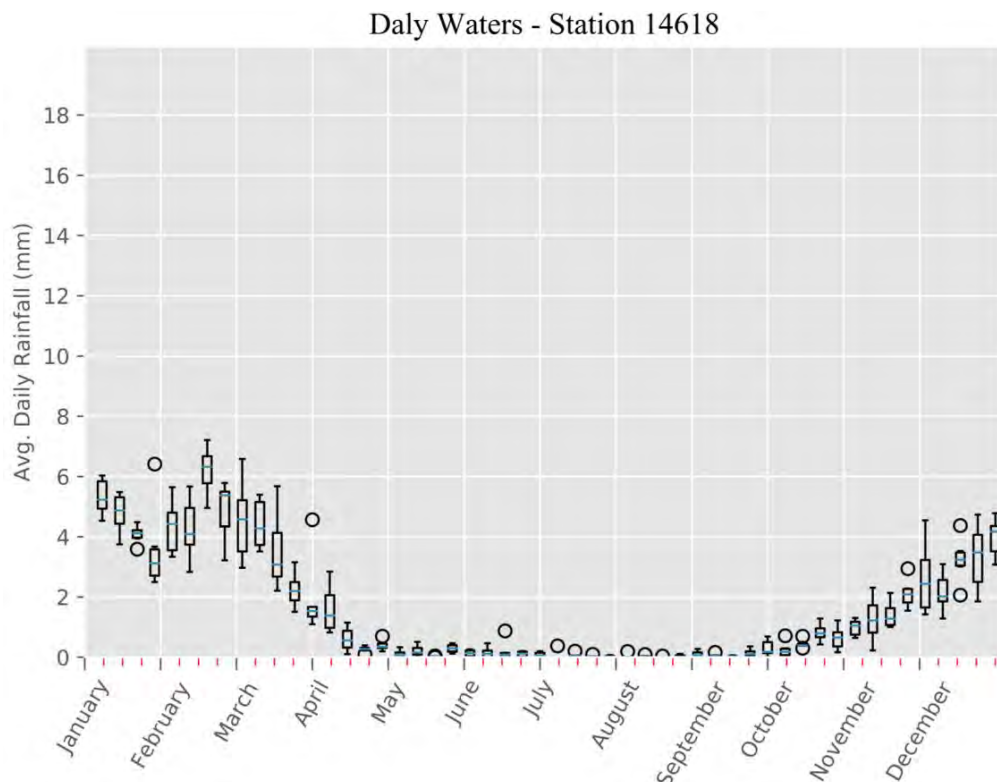


Figure 1: Daly Waters Avg. Monthly Rainfall

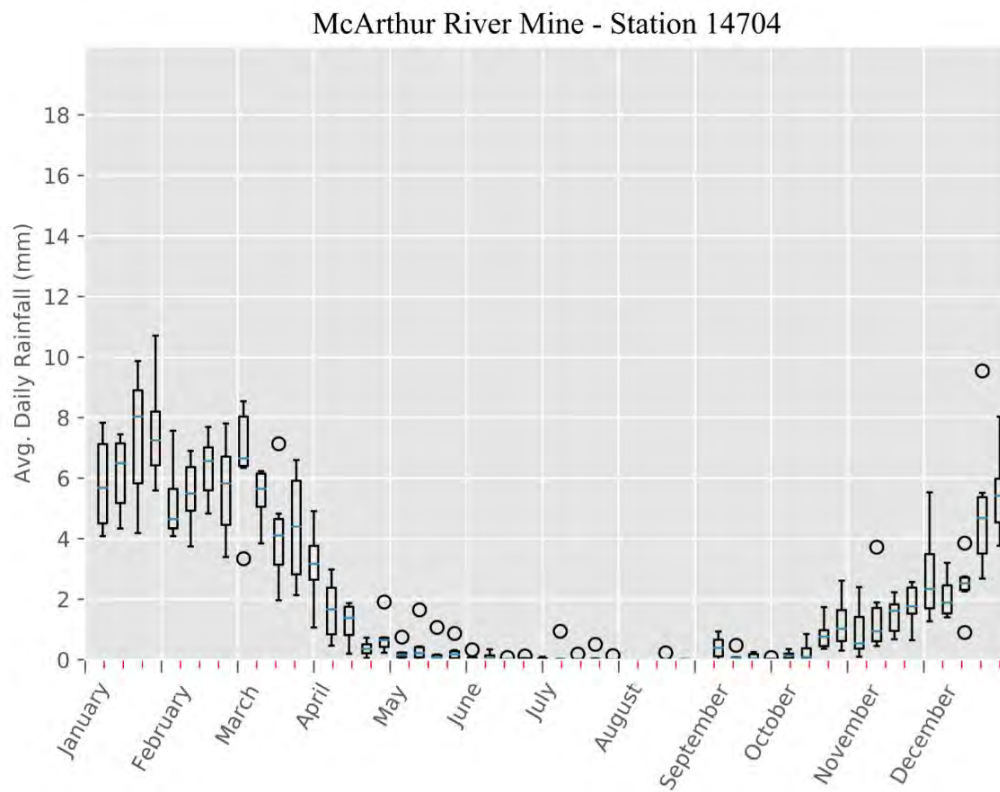


Figure 2: McArthur River Mine Avg. Monthly Rainfall

1.2.2 Significant Rainfall Events

Imperial has defined a Significant Rainfall Event (SRE) in this EMP as an event where greater than 300mm total rainfall occurs over four days. This type of rain is consistent with rainfall from monsoonal troughs, tropical lows or cyclones. The three historical SREs for McArthur River Mine Airport are shown in Figure 3 and Darwin Airport for comparison; Daly Waters is not shown in this figure as there are no recorded SREs.

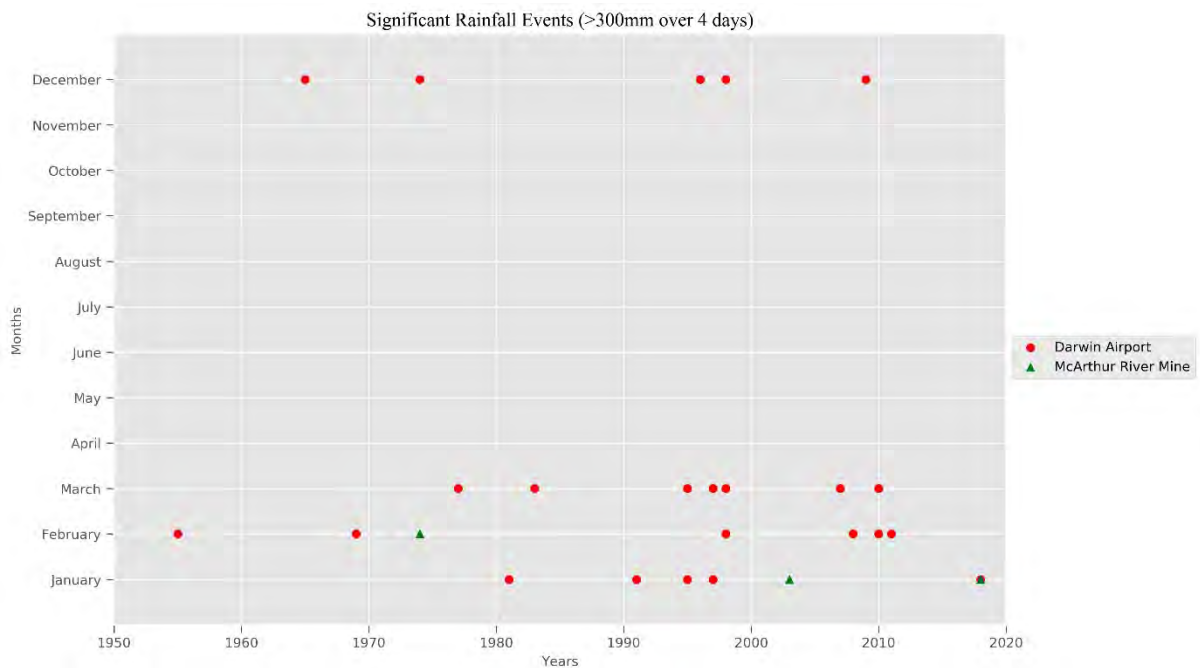


Figure 3: SREs for Darwin Airport and McArthur River Mine

1.2.3 Evaporation

Imperial has utilised SILO Data Drill lake evaporation data (SILO, 2021) for the calculation of evaporation in the Location of the Regulated Activity. Monthly evaporation depth totals have been listed in Table 3 for the 10th, 50th and 90th percentiles (P10, P50 and P90). Percentiles are based on 130 years of SILO Data Drill lake evaporation data.

Table 3: Monthly evaporation depths (mm) – SILO lake evaporation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
P10	178	147	158	148	125	106	116	146	172	202	203	189	1890
P50	197	170	180	158	132	112	123	152	180	213	213	212	2043
P90	219	192	200	169	140	118	129	156	187	223	223	227	2183

Given that the highest rainfall months for the Location of the Regulated Activity are December, January and February, Imperial has used the sum of the P10 lake evaporation for December, January and February, being 514mm based on the same 130 years SILO Data. As such, Imperial will use 90-day evaporation of 500mm when calculating freeboard requirements to cater for 1 in 1000-year rainfall events.

1.3 Geology

Organically rich source rocks with the potential to generate and host oil and gas are present in several intervals within thick Meso and Palaeo-Proterozoic age formations of the McArthur Basin Velkerri and Barney Creek Formations.

The Velkerri Formation and the Barney Creek Formation are the major organic-rich source rocks and the primary unconventional hydrocarbon generation targets. These formations have been proven to be gas-bearing in exploration wells drilled during 2012 and 2013 by Armour Energy, Santos/Tamboran in 2014 in the Tanumbirini 1 well in EP161, which is immediately adjacent to Imperial's EP187 Tenement, and by Origin Energy in the Amungee NW-1 well within the Beetaloo Sub-Basin.

The Velkerri Formation is overlain by other formations of the Roper Group (Maiwok Sub-group), including the Moroak Sandstone, Kyalla Formation, Bukalorkmi Sandstone and Chambers River Formation. These comprise a thick sequence of fine-grained siltstones and mudstones interbedded with sandstones, which provide excellent isolation between the target zones in the underlying Velkerri Formation and the overlying aquifer. (Top Springs Formation). A chronostratigraphic column indicates these formations' sequences shown in Figure 4 (Ahmed et al., 2001).

Recognised conventional reservoirs are developed at various levels within the carbonates of the McArthur Group. Shales potentially seal them in Barney Creek and Lynott Formations or by thick evaporites at the Balbirini Dolomite base.

The uppermost unit, the Roper Group, varies between 1,500 and 4,000m in thickness. The Roper Group thickens to the northwest from EP187 as it develops across the Beetaloo Sub-Basin of the McArthur Basin. It consists of alternating quartz arenites, siltstones and shales. The Roper Group unconformably overlies the McArthur and the Nathan Groups. An illustrative section through the Beetaloo Sub-Basin is presented in Figure 5 (DITT, 2018).

The sedimentary sequences within the Roper Group have significant lateral extent, with more uniform facies when compared to the underlying successions of the Nathan, McArthur and Tawallah Groups. The estimated age of the Roper Group is at least 1,430 Ma. An un-named sequence of sandstones and shales of probable Neo-Proterozoic age overlies the Roper Group. These formations have a maximum thickness of over 600 m. The Tawallah Group is the lowermost of the four major sequences present in the McArthur Basin and is up to 4,500 m thick and represents the economic or practical basement. However, it also contains shales with hydrocarbon generating potential in the Wologorang and McDermott Formations.

The Bukalara Sandstone is unconformably overlain by the Cambrian age Top Springs Limestone (also known as the Gum Ridge Formation and informally as the Cambrian Limestone Aquifer). This unit is recognised as a regional aquifer and is considered the deepest aquifer present at the Location of the Regulated Activity.

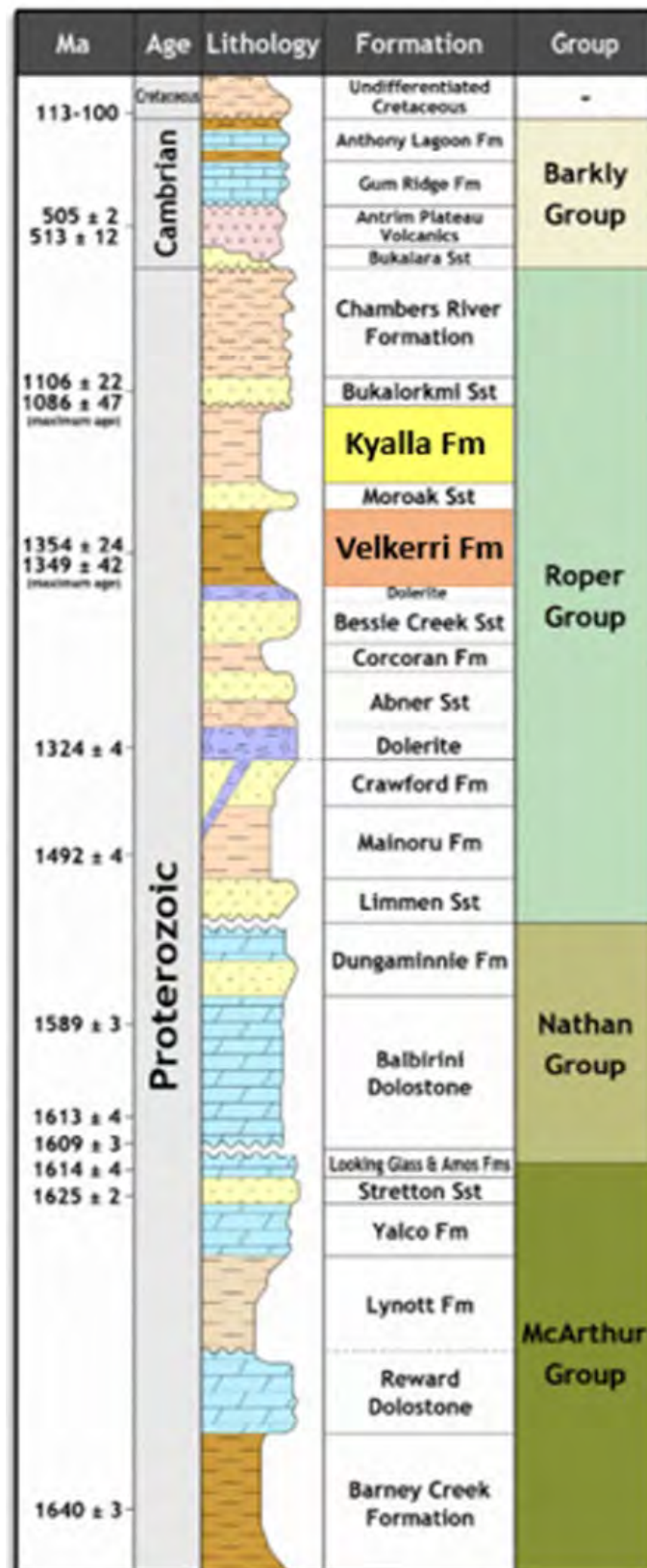


Figure 4: Chronostratigraphic framework of formations within the McArthur Basin

Based on Ahmed et al. (in prep). Ages from Lindsay (2001) and Ahmed et al. Oil & Gas potential from Powell et al. (1987) and Pegum (1979)

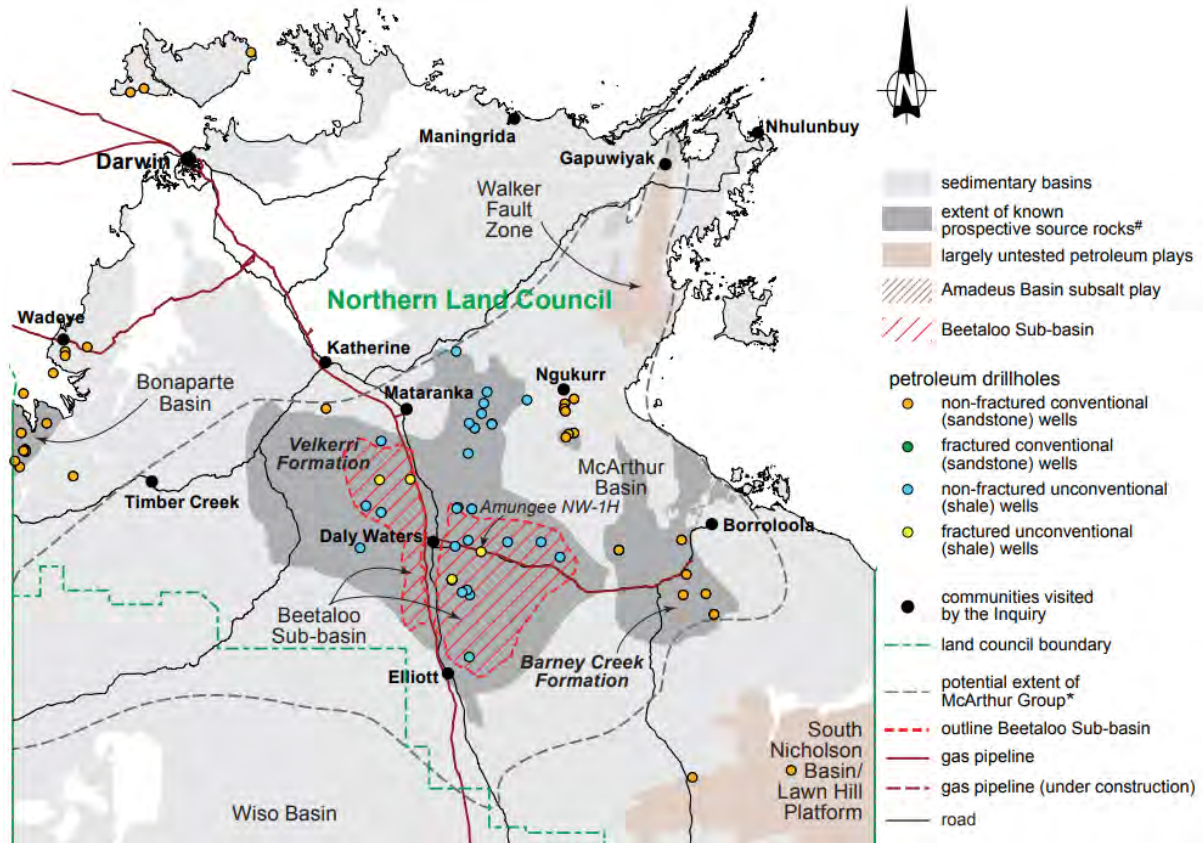


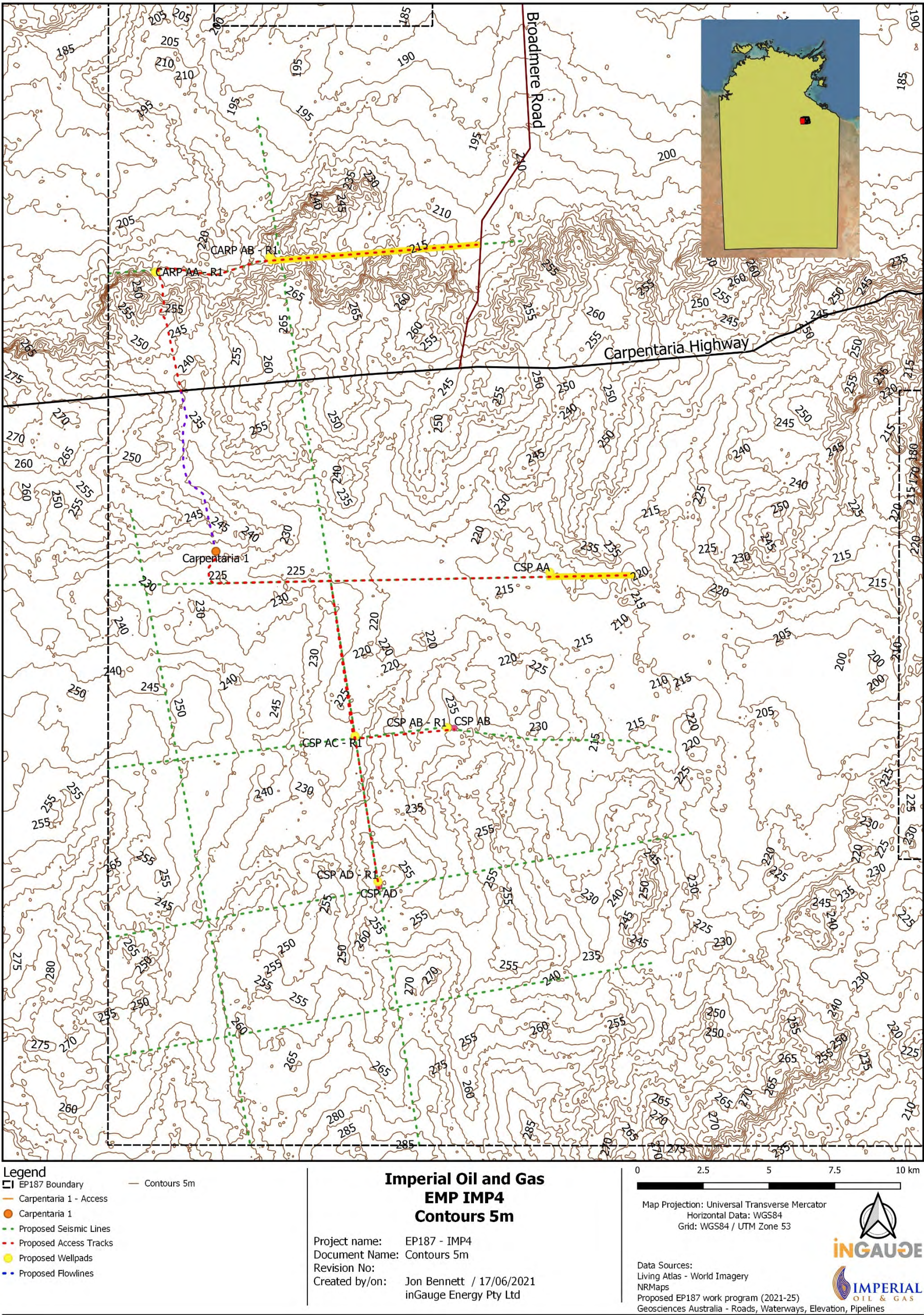
Figure 5: Geological Setting of the Beetaloo Sub-basin / McArthur Basin

1.4 Topography

The region comprises predominantly gently sloping terrain with scattered low hills and breakaways. The bioregion's northern edge includes Proterozoic age quartz sandstones, shale and chert of the lower McArthur and Tawallah Group. (Figure 5)

The Location of the Regulated Activity is located at the Sturt Plateau, described as an ancient, uplifted erosion surface of some 250m. It is flat to gently undulating plain that is deeply weathered, covered by thick laterite and associated soils and supports savannah vegetation (Day et al., 1985) predominantly.

The map of the topography of EP187 is presented in Figure 6.



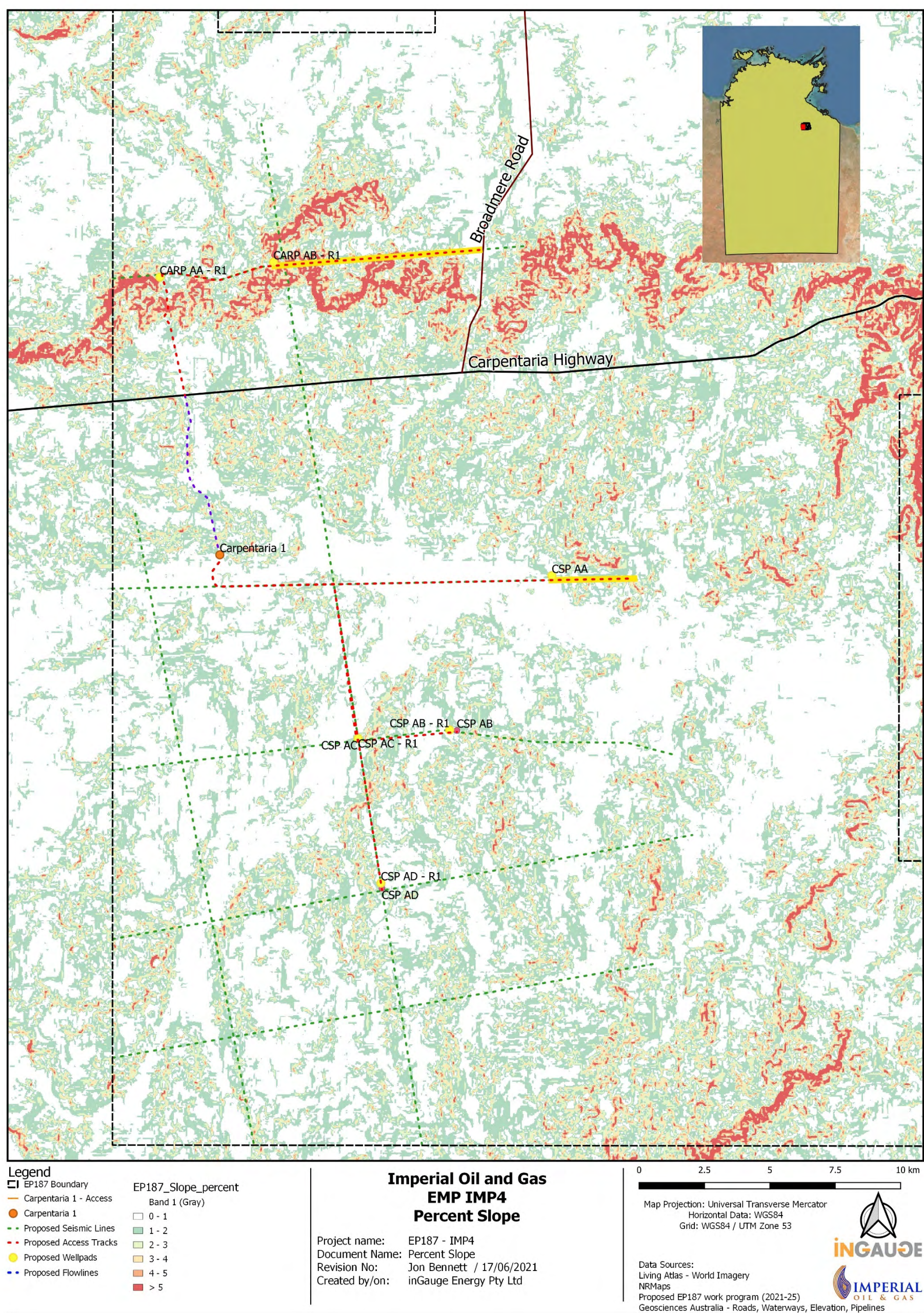


Figure 7: Percent Slope

1.5 Soils

The proposed activities are located in an area generally described as plains and rises associated with deeply weathered profiles (laterite), including sand sheets and other depositional products, sandy and earth soils (NR Maps, 2020). Figure 8 shows soil types throughout the Location of the Regulated Activity.

Kandosols and rudosols dominate the Location of the Regulated Activity with no occurrence of acid sulphate soils. (Appendix 3). Kandosols are massive and gravelly soils (formed red, yellow and brown earths) widespread across the Sturt Plateau bioregion. Rudosols are very shallow soils or those with minimal soil development and include very shallow, rocky and gravelly across rugged terrain.

Understanding the implications for erosion and sedimentation due to the regulated activities is based on the knowledge acquired through desktop research and soil mapping available in the public domain. Soil verification has not been conducted.

1.6 Land Systems

Land systems are based on the ecosystem concept, in which several local land features sequences are repetitive and integrated, e.g., climate, geological material, landform, soil and native vegetation.

Table 4 presents the description of the land systems of the proposed area (Aldrick J. M et al., 1992).

Land systems of EP187 are shown in Figure 9.

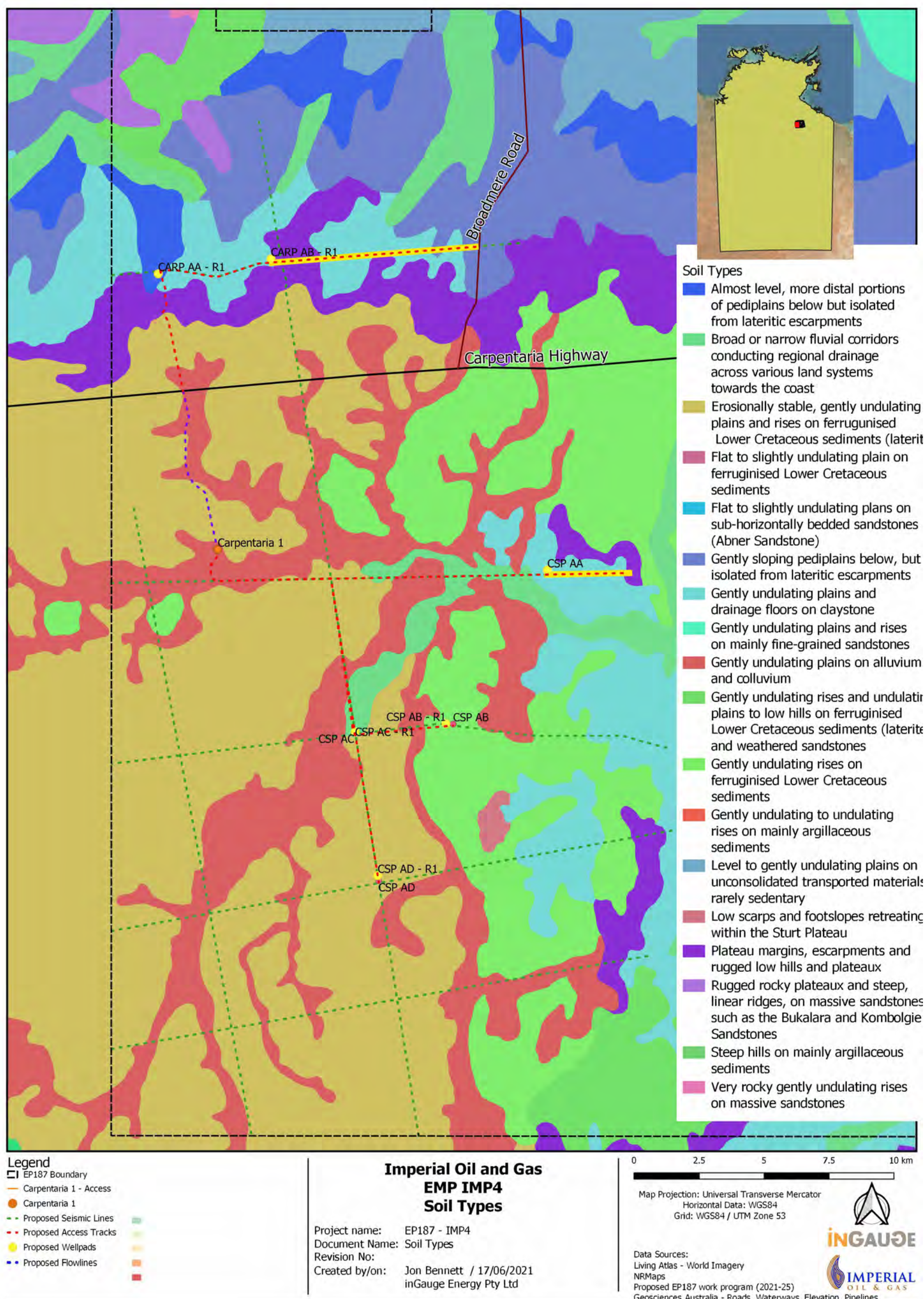


Figure 8: Soil Types

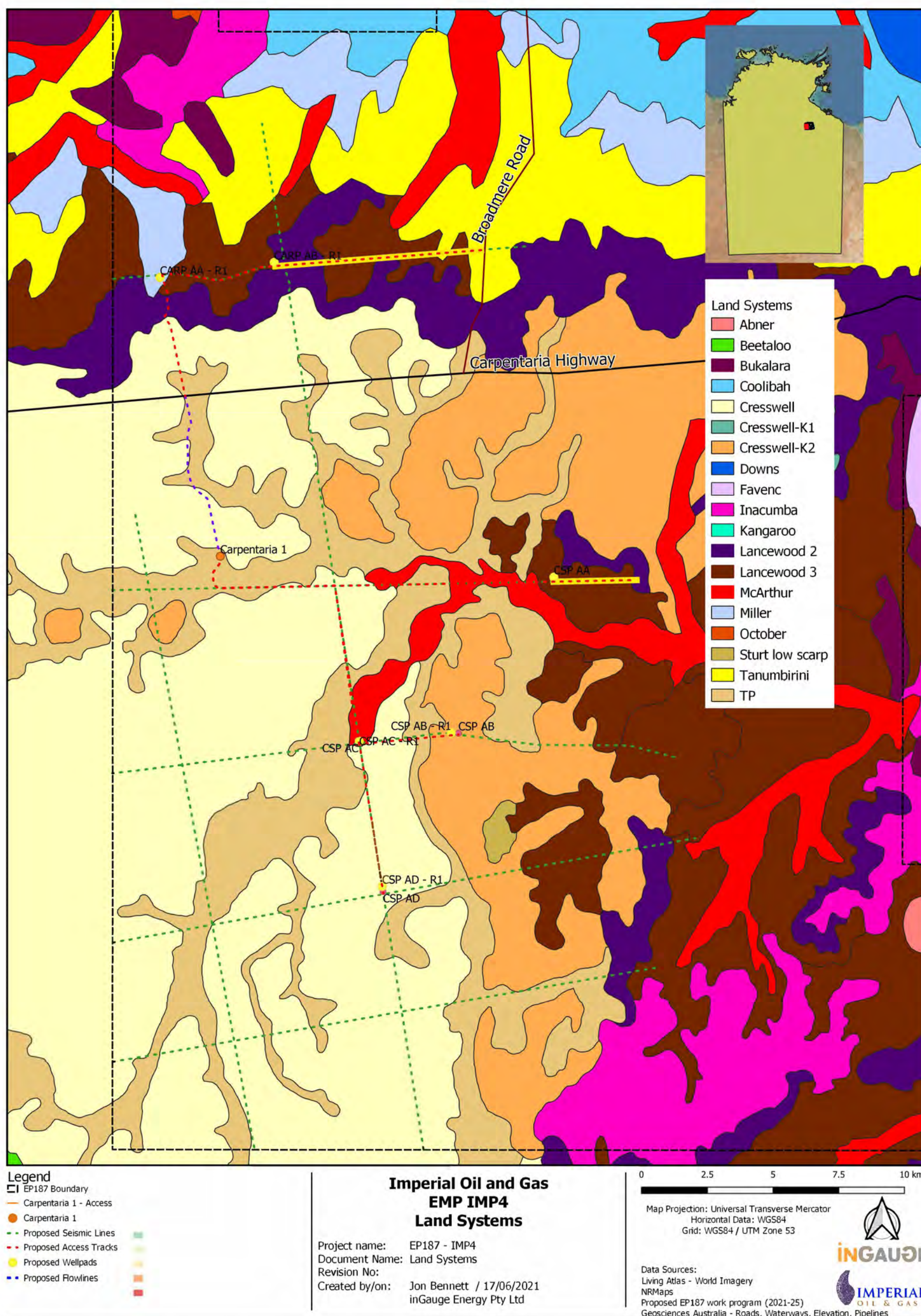


Figure 9. Land systems

Table 4: Description of Land Systems

Land System	Landscape class	Class Description	Landform	Soil description	Vegetation Description	% approx. of area
Cresswell	Lateritic plains and rises	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils	Erosionally stable, gently undulating plains and rises on ferruginised Lower Cretaceous sediments (laterite)	Ferruginous lithosols, lateritic podsolics, red and yellow earths, earthy sands and brown clays	Mid-high open woodland of <i>C. dichromophloia</i> , <i>C. bleeseri</i> , <i>E. tetradonta</i> , <i>Erythrophleum chlorostachys</i> with isolated stands of <i>A. shirleyi</i> on crests over <i>Chrysopogon fallax</i> , <i>Plectrachne pungens</i> , <i>Sorghum plumosum</i>	80
TP	Lateritic plains and rises	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils	Gently undulating plains on alluvium and colluvium	Shallow to moderately deep gravelly yellow earths	Woodland of <i>E. tectifera</i> over <i>Chrysopogon fallax</i> and <i>Dicanthium fecundum</i> and low open woodland of <i>E. pruinosa</i> over <i>Dicanthium fecundum</i> and <i>Sehima nervosa</i>	15
Cresswell-K2	Lateritic plains and rises	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils	Gently undulating rises on ferruginised Lower Cretaceous sediments	Lithosols and shallow siliceous sands	Open forest of <i>Acacia shirleyi</i> and woodland of <i>C. dichromophloia</i> , <i>E. luecophloia</i> over <i>Chrysopogon fallax</i> , <i>Plectrachne pungens</i>	4
McArthur	Alluvial floodplains	Alluvial floodplains, swamps, drainage depressions and alluvial fans; sandy, silty and clay soils on Quaternary alluvium	Broad or narrow fluvial corridors conducting regional drainage across various land systems towards the coast	Aq Vertosols, Red and Yello Kandosols and Orthic Tenosols	Mid-high open woodland of <i>C. terminalis</i> , <i>E. microtheca</i> , <i>Excoecaria parvifolia</i> , <i>Lysiphyllum cunninghami</i> , <i>C. papuana</i> over <i>Chrysopogon</i> spp, <i>Eulalia fulva</i> , <i>Iseilema vaginiflorum</i>	1

1.7 Groundwater

Table 5 below summarises the regional hydrostratigraphy of the Beetaloo Basin (Fulton S, & Knapton A., 2015).

Table 5: Summary of Beetaloo Basin Hydrostratigraphy

PROVINCE	PERIOD / AGE	FORMATION		AQUIFER STATUS	THICKNESS (m)	YIELD (l/s)	AVE. EC (µs/cm)
CARPENTARIA BASIN	CRETACEOUS 145 – 66 Ma	Undifferentiated		Local Aquifer	0 – 130	0.3 – 4	1800
GEORGINA BASIN	CAMBRIAN 497-630 Ma	Cambrian Limestone Aquifer (CLA)	Anthony Lagoon Beds	REGIONAL AQUIFER	0 – 200	1 – 10	1600
			Gum Ridge Formation	REGIONAL AQUIFER	0 – 300	0.3 – >20	1400
		Antrim Plateau Volcanics		REGIONAL AQUITARD Local Aquifer	0 – 440	0.3 – 5	900
		Bukalara Sandstone		Local Aquifer	0 – 75	0.3 – 5	1000
BEETALOO BASIN (ROPER GROUP)	NOT KNOWN	Hayfield Mudstone		REGIONAL AQUITARD Local Aquifer	0 – 450	-	32000
		Jamison Sandstone		Local Aquifer	0 – 150	-	138000
	MESO-PROTEROZOIC 1430-1500 Ma	Kyalla Formation		REGIONAL AQUITARD	0 – 800	-	-
		Moroak Sandstone		Local Aquifer	0 – 500	0.5 – 5	131000
		Velkerri Formation		REGIONAL AQUITARD	700 – 900	-	-
		Bessie Ck Sandstone		Local Aquifer	450	0.5 – 5	-

EP187 is not within a water allocation plan area. It lies immediately to the east of the Daly Roper Beetaloo Water Control District, straddling the northeast boundary of the Georgina Basin. It partially overlies the aquifer known as the Gum Ridge Formation, part of the extensive regional Cambrian Limestone Aquifer, including the Tindall Limestone Aquifer to the North in the Daly Basin.

Any guidelines published by the Northern Territory Government relating to groundwater monitoring parameters, methodologies, frequencies, reporting and data submission for petroleum operations will be followed, including the Preliminary Guideline: Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-basin and the requirements for a water extraction license.

1.7.1 Regional Groundwater within the Cambrian Limestone Aquifer (CLA)

The Beetaloo Basin straddles the basement divide that separates regional groundwater flow systems in the Georgina and Wiso Basins. Groundwater flow in the Georgina Basin emanates approximately 300km southeast of the Beetaloo Basin, where a significant flow divide occurs in the CLA. Groundwater southeast of this divide flow toward discharge points in the Lawn Hill Creek and the Gregory River in Queensland. Groundwater northwest of the divide flows through the Beetaloo Basin and discharges in the Roper River region, supporting aquatic, riparian, and floodplain ecosystem function. Recharge to the CLA forms a local flow component where the aquifer outcrops along the Ashburton Ranges' flanks. Nonetheless, groundwater recharge mechanisms to the CLA are poorly characterised but are likely to be dominated by infiltration through sinkholes and preferential recharge through soil cavities.

The regional flow direction within the Beetaloo Basin is to the northwest. Gradients in the CLA are flat-lying, averaging around 10m per 100km (gradient of 0.0001), and flow rates are in the order of metres/year (Tickell, 2003). Along the northern edge of the basin, groundwater flow in the CLA is channelled between outcropping Proterozoic rocks to the east and a zone of lower permeability Antrim Plateau Colcanis to the west. Groundwater flow emerges from the CLA in the Roper River 100km northwest of the Beetaloo Basin. It provides a significant flow component of spring discharge in the Roper River between Matarkanka and Elsey National Park. High sulphate concentrations in the Bukalara Sandstone aquifer immediately north of the Beetaloo Basin suggest a component of flow north into local Proterozoic aquifers.

Relatively minor groundwater extraction occurs in the McArthur River basin for small community supplies. A review of the available historical bore data has indicated the water drawn from bores for this region is from aquifers shallower than 100m deep.

An initial baseline assessment was conducted in 2019, with groundwater samples were collected from five (5) existing bores; HWY-1 (RNo27848), 4B-1 (RNo07696), 5B-1 (RNo07699), HB-1 (RNo39575), and RCB-1 (RNo27945) Bores were selected based on their location within the extent of the proposed exploration activities. Samples were analysed for a range of characterisation parameters relevant for exploration purposes.

Control and Impact monitoring bores were drilled into the Gum Ridge aquifer on Carpentaria 1 during the 2020 drilling program, RNo4168 and RNo41800, respectively.

Monitoring samples have been undertaken from the nearby water supply bores (RNo27848 and RNo39574) and the Gum Ridge Monitoring bores to demonstrate a baseline of water quality data for the area and to comply with recommendations from the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, March 2018 (NT Government, 2018). Figure 10 presents the water bores in relation to the location of the regulated activities.

The Stratigraphy in the Location of the Regulated Activity, as confirmed in the 2020 drilling program, is shown in the EMP.

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

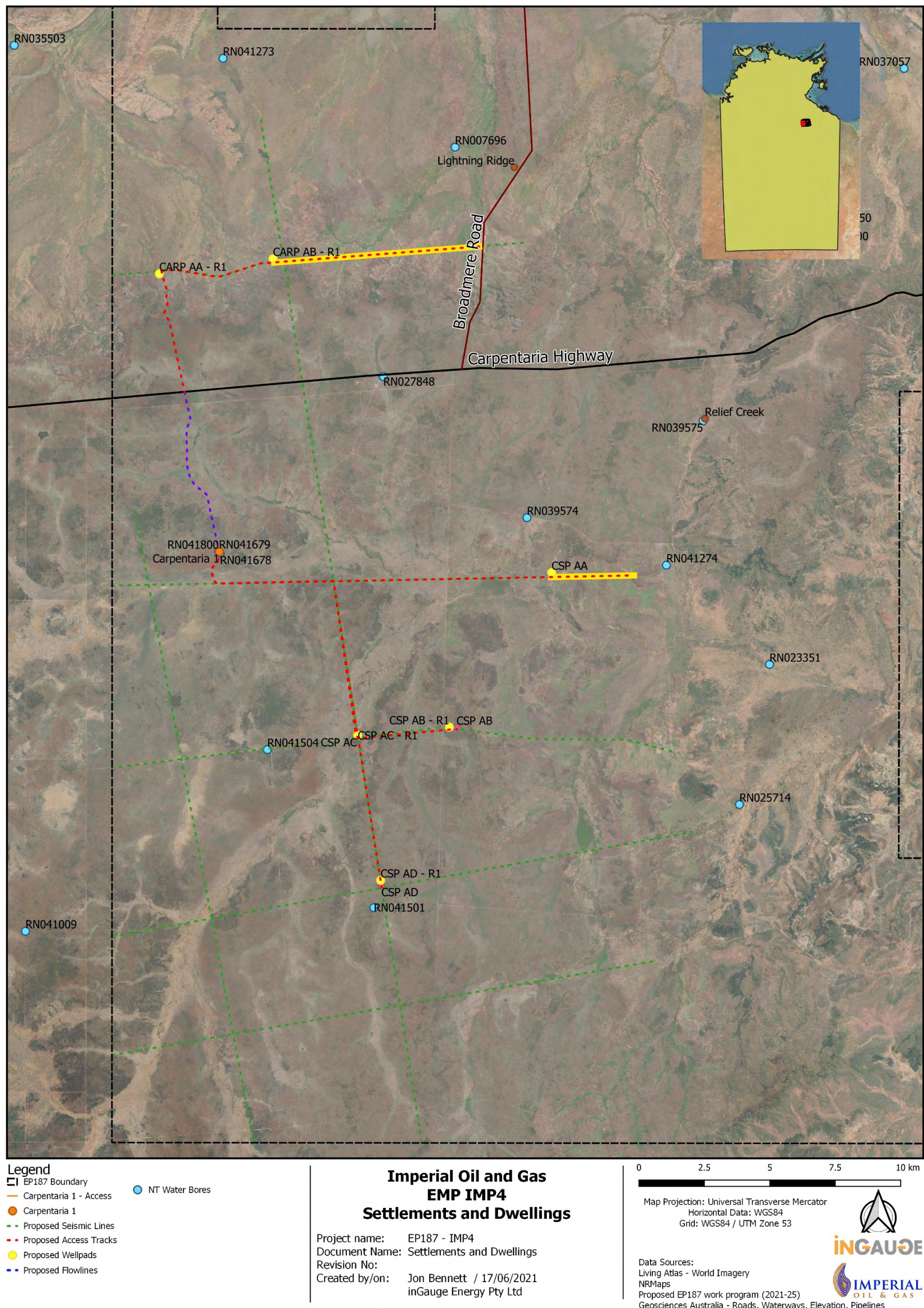


Figure 10. Water bores

1.8 Surface Water

The Location of the Regulated Activity is part of the Gulf Fall and Uplands region and part of the McArthur River's catchment and its tributaries. The McArthur River generally flows in a northerly direction from the Barkly Tableland's upland to the Southern Gulf in the Sir Edward Pellew Islands region. The geology of this region influences the drainage system and the extensive cap of the Bukalara Sandstone outcrop in the south of the area. It provides an extensive network of ephemeral creeks and streams that follow significant faults and joints within the rock formation.

The McArthur River is the prominent surface water feature in the region. This watercourse drains the whole area into the Gulf of Carpentaria. The Glyde is the main tributary to the McArthur River and lies to the Regulated Activity's east location. The Glyde is not affected by any proposed exploration operations within EP187.

The EP187 tenement includes the floodplains associated with the Upper McArthur River catchment, the Leila Creek Catchment, Tooganginie Creek, Christmas Tree Creek, and the upper reaches of the Balbirini Creek (Figure 11). Only limited freshwater flood plain habitat is associated with the Upper McArthur River. As reported in the Biodiversity Assessment - Gulf Coastal report (2009), no wetlands of significance occur in this bioregion.

Since there is little or no rain over the dry season, the waters that flow in permanent streams connect with the local water table. In some parts of the McArthur River's upper reaches, Balbirini Creek and Tooganginie Creek, permanent surface water pools persist throughout the year as waterholes, springs, and minor swamps. The other broad group of surface waters are ephemeral. This group is also made up of streams, waterholes, lagoons and swamps, but they receive insufficient groundwater recharge to sustain them for the whole year. The region also includes minor floodplains associated with the upper reaches of the McArthur River.

Stream Orders of EP187 are shown in Figure 11.

1.8.1 Springs

Research of the springs spatial layer of the Natural Resource Maps (NR Maps, 2020) shows that the closest spring to a wellpad is 22km. Therefore, there is not a figure specific to springs within the Location of the Regulated Activities.

Figure 12. Springs shows springs in relation to EP187.

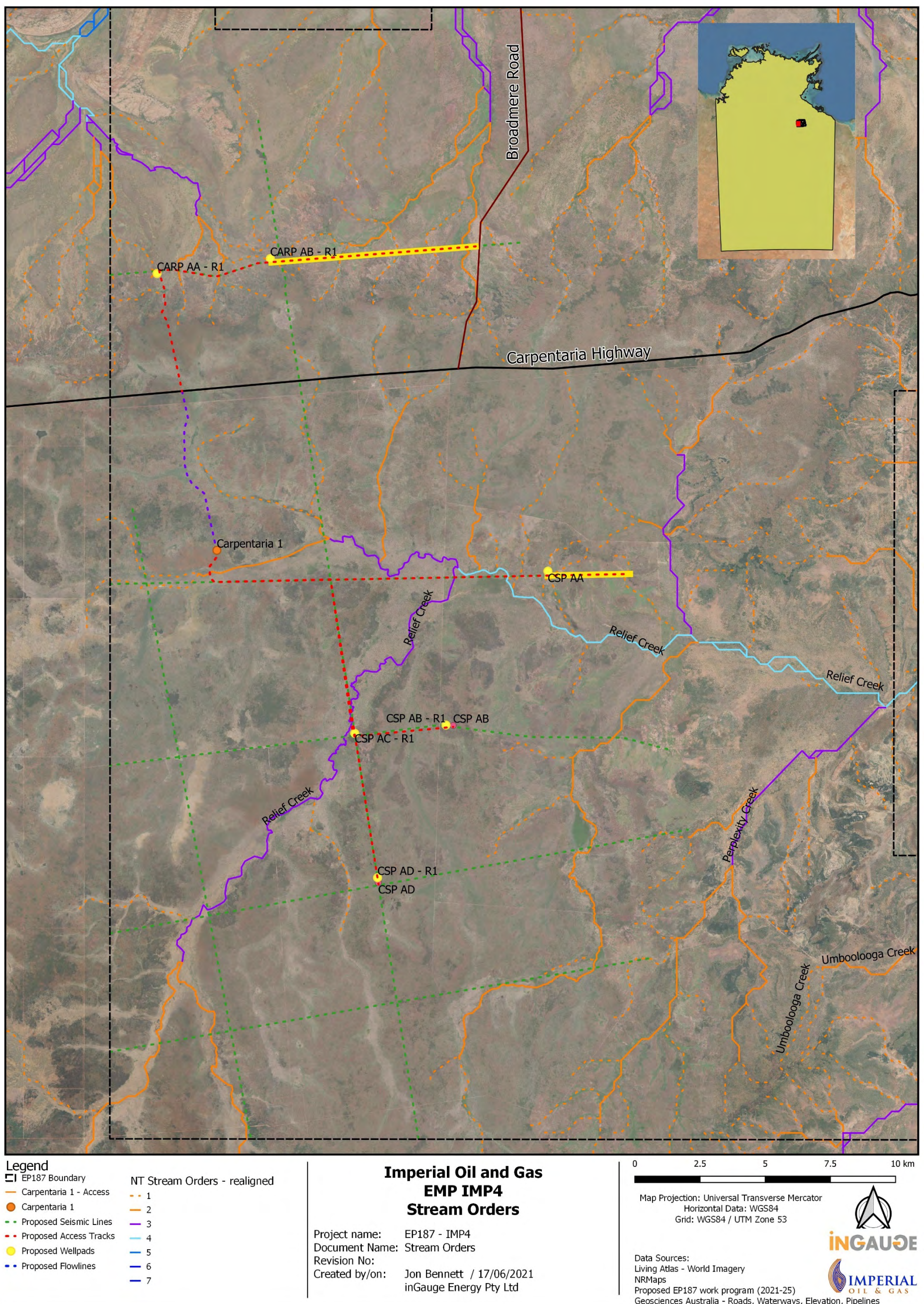


Figure 11. Stream Orders

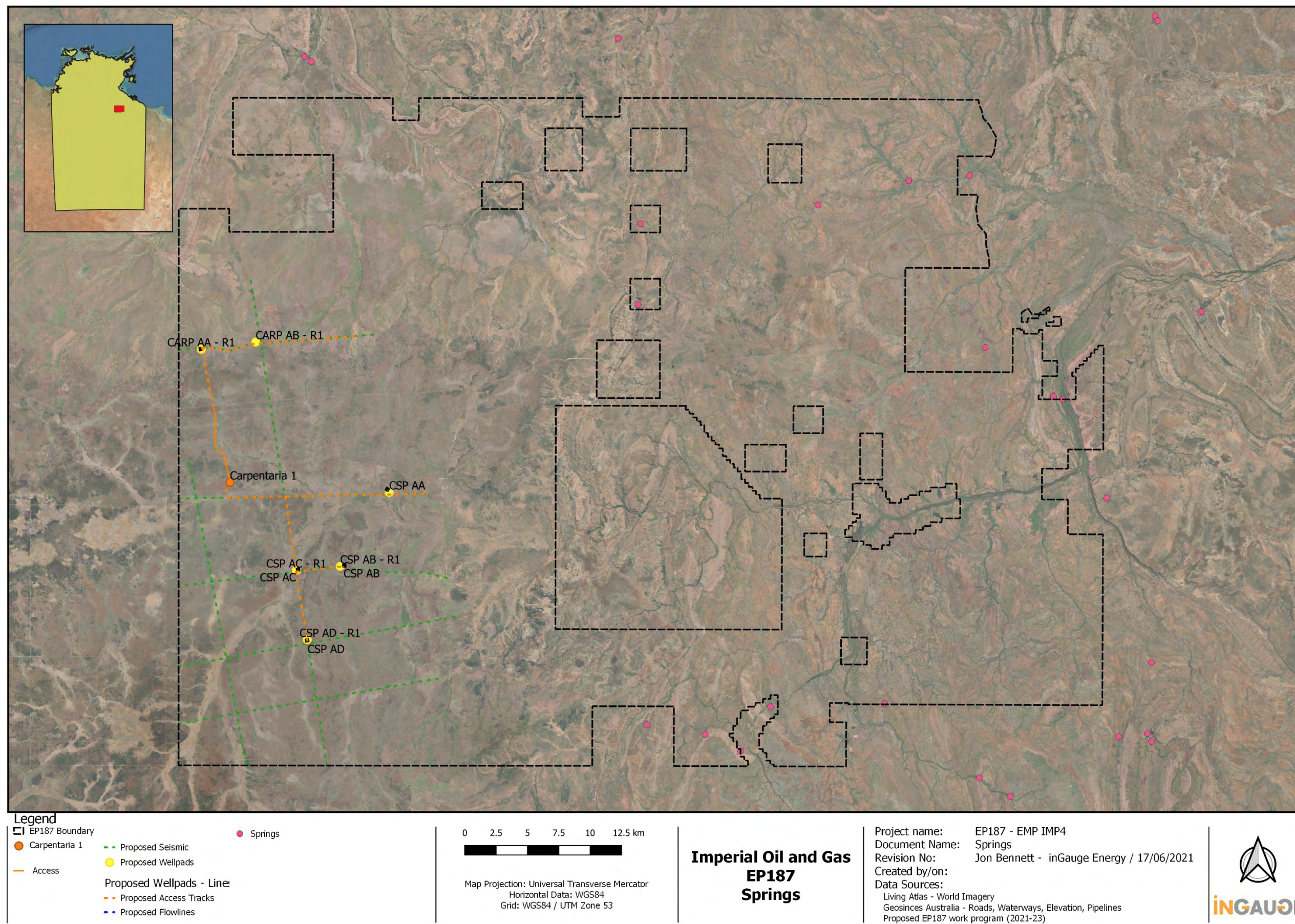


Figure 12. Springs

1.9 Flooding

1.9.1 Location Characteristics

EP187 comprises two catchment zones: Limmen Bight River and the McArthur River, which drain North, and North East, respectively. The area of interest in the western third of the allotment is located at both catchments' headwaters. The primary watercourse is Relief Creek, which leads into Tooganginie Creek before joining the McArthur River in the eastern third of EP187. These smaller streams are ephemeral and only experience flow during the wet season, mainly from cyclones and monsoonal rainfall.

The hydrologically enforced SRTM (Shuttle Radar Topography Mission) digital elevation model, and the report 'Northern Territory Hydrology - The Alice Springs to Darwin Railway (Weeks, 2006)', indicate that the land containing the proposed well pad locations can mostly be characterised as arid and flat with poorly defined catchment boundaries.

1.9.2 Flood Modelling

An Annual Exceedance Probability (AEP) is the probability of a flood event occurring in any year. It is denoted as either a percentage, such as a 1% or a 1 in 100-year event.

Typically, a regional flood frequency estimation (RFFE) would be used in conjunction with the SRTM model to calculate peak stream discharge rates for a known flow path. However, it was determined that for flood modelling in EP187, this method is not adequately accurate due to the following points:

- The ephemeral nature of the nearby streams
- The area of interest is located at the headwaters of two rivers.
- The nearest gauged watercourse (McArthur River - Baileys Grave) is approximately 60km downstream from the target location.

Therefore, a Log Pearson III distribution was used to calculate a 1 in 100-year rainfall event. A steady-state rainfall simulation was then developed over the catchment area using TUFLOW and the SRTM data to calculate peak flood depths and flow rates using the rainfall values from this event. The results are displayed in Figure 13 below.

As seen in Figure 13, none of the proposed wellpad locations will be affected by a flood, even during a 1 in 100-year rainfall event. CSP AA could be exposed to between 1 and 1.5m during a 1 in 100-year AEP flood event as it lies close to Relief Creek between two incoming streamlines. A decision was made to move the wellpad location approximately 5km East to the new location outlined below.

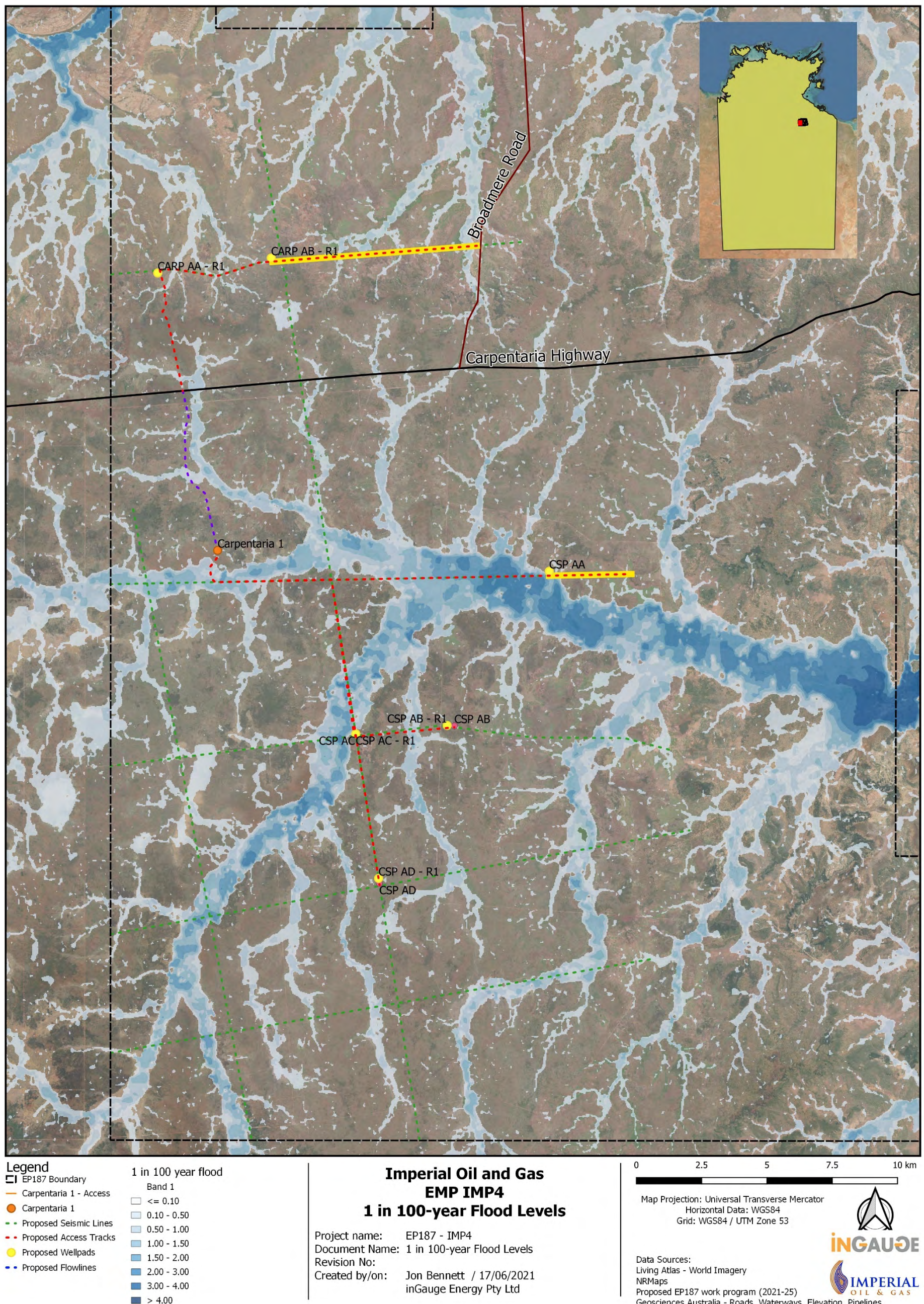


Figure 13: 1 in 100-year flood event

1.10 Air Quality

Imperial has studied the available CSIRO report (Ong C., Myers M., Mainson M., Maney B., & day S. 2018) on baseline methane values across the Beetaloo Sub-basin in consideration of compliance with the requirements of the NT Scientific Inquiry into Hydraulic Fracturing (the " Inquiry"). Imperial consider The Beetaloo Basin methane baseline monitoring program conducted by the CSIRO in 2018 applicable across the operational area of EP187. Data collected from this monitoring are available online (CSIRO, 2019).

A Methane Emissions Monitoring Plan is available in Appendix 10. Imperial is committed to undertaking a 6-monthly leak detection at the well pad as per Part D (5) of the Code.

1.11 Bioregions

Bioregions provide a consistent and robust framework for biodiversity assessment and planning. The classification is based on typical climate, geology, landform, native vegetation and species information. As shown in Figure 14, the Location of the Regulated Activity is situated over the Sturt Plateau and Gulf Fall and Uplands bioregions.

The Sturt Plateau bioregion mostly comprises a gently undulating plain on lateritised Cretaceous sandstones. Soils are predominantly neutral sandy red and yellow earths. The most extensive vegetation is eucalypt woodland (dominated by variable-barked bloodwood *Eucalyptus dichromophloia*) with spinifex understory. Still, there are also large areas of lancewood (*Acacia shirleyi*) thickets, bullwaddy (*Macropteranthes keckwickii*) woodlands, *Acacia* shrublands on deep sands, and open eucalypt forest (dominated by a range of species including Darwin stringybark *Eucalyptus tretodonta*) over tussock grass understory. The Sturt Plateau bioregion includes the most extensive areas of the distinctive lancewood-bullwaddy vegetation associations, with associated fauna including spectacled hare-wallaby.

The Gulf Fall and Uplands bioregion includes water holes, gorges and dissected sandstone plateaus. Vegetation is predominantly eucalypt woodlands over spinifex grasslands. Cattle grazing and mining are the main industries. Other land uses include Aboriginal land and conservation reserves. Major population centres are Borroloola and Ngukurr. The bioregion has a monsoonal climate with much higher rainfall in the North (DoEE, 2008).

There are several weeds (e.g. *Barleria prionitis*, *Bellyache bush*, *Chinee apple*, *Creeping lantana* et al) and invasive animals (e.g. feral pig, wild dog, cane toad, feral cat, water buffalo, donkey and horses) known to occur in the Gulf Fall and Uplands bioregion. In the past ten years, major infrastructure developments have occurred, resulting in increased stock numbers and reduced wildfires and feral animals in the bioregion, slightly improving the land condition.

Landscape function and land condition generally have improved due to better fire management, destocking of some properties and overall infrastructure development, leading to better herd control. Despite these improvements, the bioregion remains relatively undeveloped.

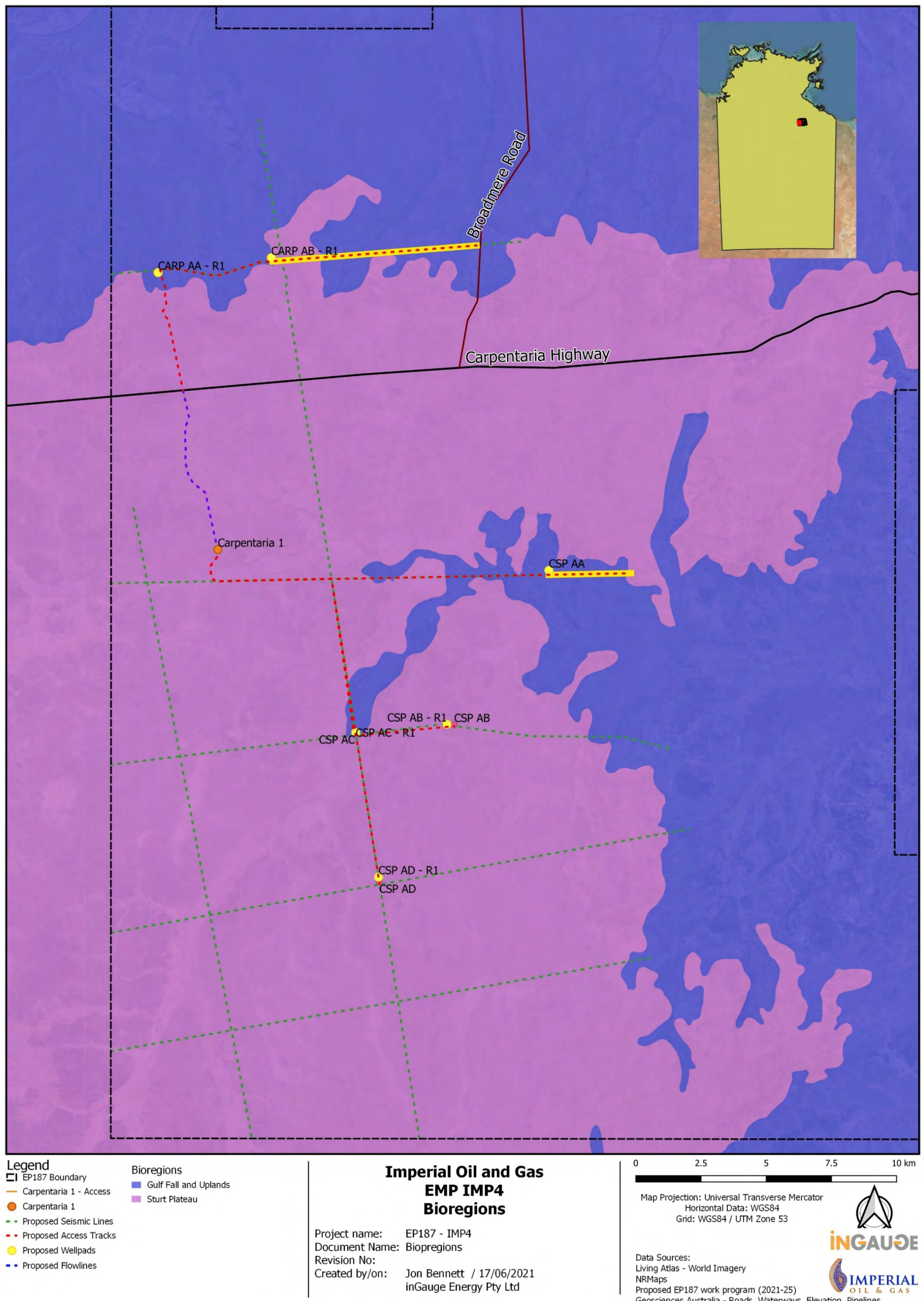


Figure 14. Bioregions

1.12 Vegetation

The National Vegetation Information System (NVIS) provides information on the extent and distribution of vegetation types in Australian landscapes. Figure 15 presents the vegetation communities over the Location of the Regulated Activity. At a 20km radius of the proposed area, Eucalyptus low open woodland/Acacia mild sparse shrubland/Astrebla low tussock grassland dominates the area (approx. 50%), followed by Acacia low woodland/Eriachne low open tussock grassland (approx. 35%), Corymbia low woodland/Terminalia mid sparse shrubland/Chrysopogon low tussock grassland (approx. 10%) and Acacia mid open forest/Acacia tall open shrubland/Chrysopogon low open tussock grassland (approx. 5%).

The woodland communities vary according to topography. The most common community on the undulating plains is a Darwin Stringybark (*E. tetradonta*) / Darwin woolly butt (*E. miniata*) open forest with a sparse to open shrub layer and a dense ground layer dominated by sorghum species. Other woodland species may include ironwood (*Erythrophloeum chlorostachys*), cypress pine (*Callitris intratropica*), northern box (*E. tectifica*) and round-leaved bloodwood (*Corymbia latifolia*). Mid storey species include fan palm (*Livistona humilis*) and zamia palm (*Cycas armstrongii*).

There is low open woodland of variable-barked bloodwood (*Corymbia dichromophloia*) and Darwin woolly butt on the rugged sandstone plateaus and rocky outcrops with a variable mid-layer and ground layer dominated by curly spinifex (*Plectrachne pungens*). Stringybark and rusty bloodwood (*Corymbia ferruginea*) may also occur.

In the poorly drained soils and riverine areas, communities of paperbark (*Melaleuca viridiflora*), screw palm (*Pandanus spirilis*) and river pandanus (*Pandanus aquaticus*) occur.

The majority of this region is covered by open forest and light density woodland dominated by Darwin Stringybark (*E. tetradonta*). There are also patches of monsoon forest scattered throughout the woodlands to the east in proximity to the Abner Range, mainly where there are permanent springs.

Significant vegetation on site is only associated with the riparian areas. See Figure 15 for a visual representation of the spread of significant vegetation types through the region. Riparian vegetation is primarily centered around Relief Creek and is the closest major watercourse to the Location of the Regulated Activity.

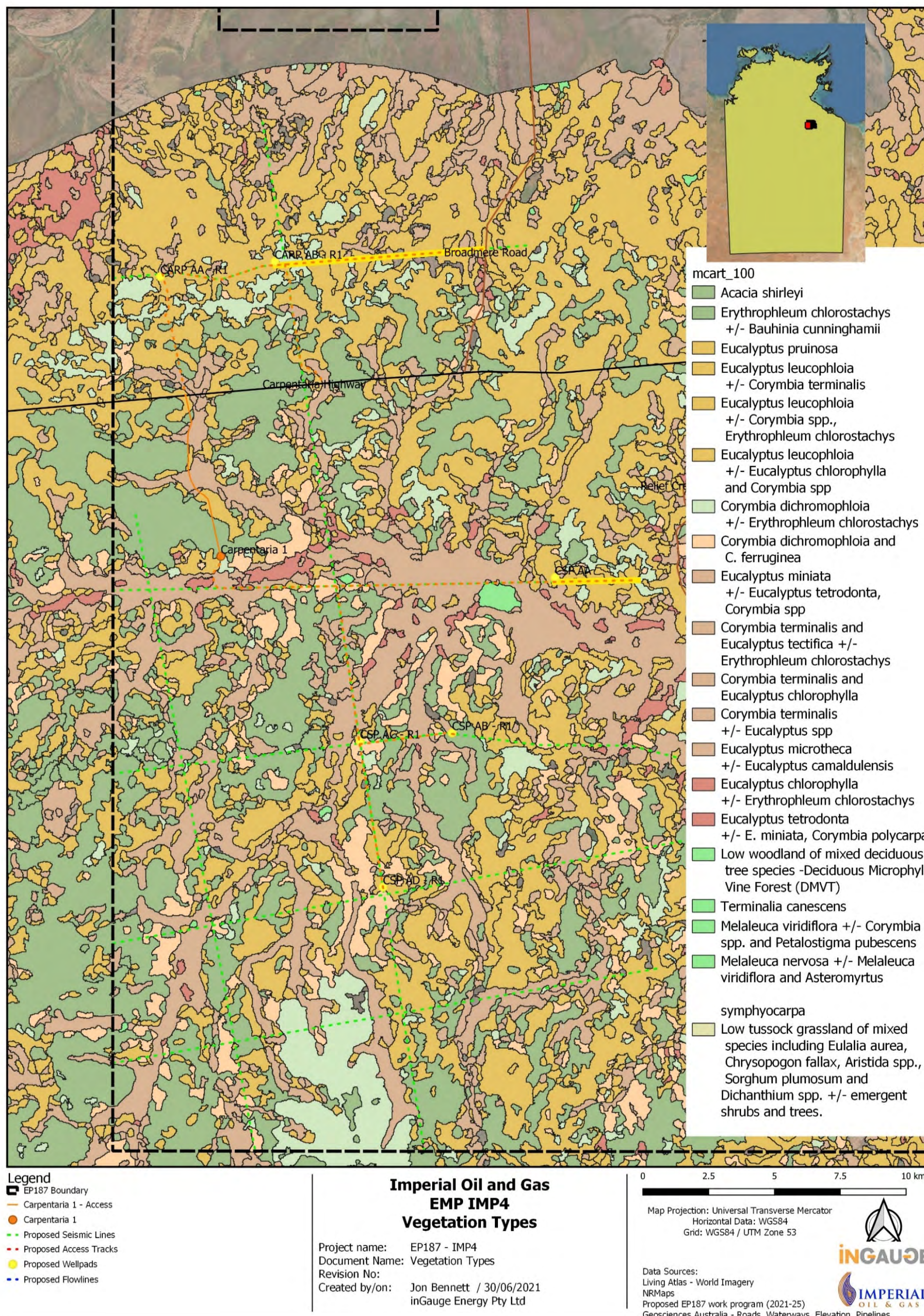


Figure 15. Vegetation types of EP187

1.13 Listed Threatened Species

A search of the NT Flora and Fauna Atlas (NR Maps, 2020) completed on December 16 2020, recorded one threatened species (*Erythrura gouldiae* (Gouldian Finch)) within a 15km radius from the Location of the Regulated Activity. The Protected Matters Search Tool (PMST), on the other hand, identified thirteen (13) threatened species and fourteen (14) migratory species that may occur within the area. Eight (8) of the 14 migratory species are specialist marine species and have therefore been excluded from the assessment. One (1) species classified as Critically Endangered (*Calidris ferruginea* (Curlew Sandpiper)) that is not expected to occur within the area due to the absence of suitable habitat (e.g. Wetland). The second threatened fauna species (*Erythrura gouldiae* (Gouldian Finch)) was not identified through NT or Commonwealth database searches but rather included based on observations during field assessment conducted in March 2021. In general, not all of the threatened species indicated through desktop information are expected to occur within the study area due to the absence of suitable habitats for some species.

Table 6 below lists the threatened fauna and flora species present within a 15km radius of the proposed activities as per the EPBC, and the Baseline Ecological Assessment conducted in March 2021. Appendix 01.03 includes an assessment of the level of impact/risk to threatened species.

Table 6: Threatened Fauna and Flora

Species Name	Common Name	EPBC Act Status	TPWC Act Status	Likelihood of occurrence	Records and Habitat
Birds					
<i>Erythrotriorchis radiatus</i>	Red Goshawk	V	V	Low	No previous records and no suitable habitat
<i>Erythrura gouldiae</i>	Gouldian finch	E	V	Occurs	The species has been recorded in the region (desktop searches), and suitable habitat is present along Relief Creek (around 10km southeast of Carpentaria 1). Species identified during March 2021 ecological surveys.
<i>Falco hypoleucos</i>	Grey Falcon	V	V	Medium	The majority of the records are from the southern half of the NT and typically on inland drainage systems. (Ward S. , 2012). This species may occasionally occur within the study area.
<i>Falcunculus frontatus whitei</i>	Crested Shrike-tit (northern)	V	-	Low - Med	Species has not been recorded in the Location of the Regulated Activity (no records from desktop searches).
<i>Grantiella picta</i>	Painted Honeyeater	V	V	Low - Med	The species has been recorded in the region (desktop searches); however, not within the study area. Suitable habitat is present anywhere mistletoe is present.
<i>Tyto novaehollandiae kimberli</i>	Masked Owl (northern)	V	V	Low - Med	Species has not been recorded in the region (no records from desktop searches), and marginal potentially suitable habitat occurs.

Species Name	Common Name	EPBC Act Status	TPWC Act Status	Likelihood of occurrence	Records and Habitat
					No large hollows in the Location of the Regulated Activity are proposed to be cleared.
Mammals					
<i>Macroderma gigas</i>	Ghost Bat	V	-	Low	Current known distribution does not encompass the Location of the Regulated Activity and no suitable habitat in the Location of the Regulated Activity.
<i>Macrotis lagotis</i>	Greater Bilby	V	V	Low	Current known distribution does not encompass the Location of the Regulated Activity.
<i>Mesembriomys macrurus</i>	Golden-backed Tree-rat	V	CE	Low	Previous records over 100 years old, now considered likely extinct from local area. Current known distribution does not encompass study area.
Reptiles					
<i>Acanthophis hawkei</i>	Plains Death Adder	V	V	Low	No previous records. No potential habitat on proposed exploration areas. Risk considered low due to lack of suitable habitat.
<i>Varanus panoptes</i>	Yellow-spotted Monitor	-	V	Med	Has potential to occur due to wide range of occurrence and wide range of habitats. Highly mobile species. Low risk of Impact.
<i>Varanus mertensi</i>	Mertens water monitor	-	V	Low	Has potential to occur due to wide range of occurrence. 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, DD = Data Deficient.

1.14 Listed Migratory Species

Table 7 list the migratory fauna species that are at least moderately likely to occur within a 15km radius of the proposed project site based on the likelihood of occurrence assessment. Species that are specialists in tidal areas are not included.

Table 7: Migratory species likely to occur within the proposed area

Species Name	Common Name	EPBC Act Status	TPWC Act Status	Likelihood of occurrence	Records and Habitat
Migratory Marine Birds					
Apus pacificus	Fork-tailed swift	Ma, M	-	Medium	In Australia, they mostly occur over inland plains but sometimes above foothills or in coastal areas. They often occur over cliffs and beaches and also over islands and sometimes well out to sea. They also occur over settled areas, including towns, urban areas and cities. They mostly occur over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh (Atlas, 2020)
Migratory Terrestrial Species					
Cecropis daurica	Red-rumped swallow	Ma, M	-	Low	Predominately forages over wetlands and open well-watered grasslands (EPBC, 2015)
Cuculus optatus	Oriental cuckoo	Ma	-	Low	Monsoonal rainforest, vine thickets, wet sclerophyll forest or open Casuarina, Acacia or Eucalyptus woodlands. Frequently at edges or ecotones between habitat types. Riparian forest is a favoured habitat in the Kimberley region. (EPBC, 2015)
Hirundo rustica	Barn swallow	M, Ma	-	Low	Occurs in the air above open vegetated areas, including native and agricultural grasslands as well as over open water areas (EPBC, 2015)
Motacilla cinerea	Grey wagtail	M, Ma	-	Low	Has a strong association with water, particularly rocky substrates along watercourses but also lakes and marshes (EPBC, 2015)
Motacilla flava	Yellow wagtail	M, Ma	-	Low	Mostly well-watered open grasslands and the fringes of wetlands. Roosts in mangroves and other dense vegetation. (EPBC, 2015)
Merops ornatus	Rainbow Bee-eater	M, Ma	LC	Low	Occurs mainly in open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation (DAWE, 2021)

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 2019 (TPWC Act), NT): NT=Near Threatened, LC: Least concern

1.15 Pest Species and Weeds

The NT classification for declared weeds are grouped into the following classes:

- class A - eradicate
- class B - control
- class C - prevent entry.

All class A and class B weeds are also class C weeds.

The EPBC PMST Report (2020) identified twelve invasive species, including plants and animals, potentially occurring within 15km of the Location of the Regulated Activity. Weed species identified during the surveys undertaken between 2018 and 2021 within the proposed exploration area are presented in Table 8. No pest species were identified during the field surveys.

The DEPWS Natural Resource (NR) maps database was also used to identify all introduced flora species that have previously been recorded within the tenement area associated with the proposed seismic program. Weeds along the Carpentaria Highway between Cape Crawford (Heartbreak Hotel) were also identified as the road upon which contractors will travel each day. Full details of observed weed locations are presented in Appendix 9.

Table 8: Pest Species within 15km radius of the Location of the Regulated Activity

Scientific Name	Common Name	NT Class (NT Gov, 2020)	WoNS (WoNS, 2020)	Plant Type
<i>Themeda quadrivalvis</i>	Grader Grass	B	Yes	Grass
<i>Mesosphaerum suaveolens</i>	Hyptis, Mint Weed	B	No	Herb
<i>Parkinsonia aculeata</i>	Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean	B	No	Tree
<i>Tribulus sp.</i>	Caltrop	B	No	Herb

Identified pests in the bioregion with a significant impact on the natural environment are cane toads, buffalos, domestic cattle, domestic dogs, horses, cats, feral pigs. Pigs and buffalos may be considered a resource by local Aboriginal people.

Table 9 below provides the list of weeds observed in and around the Location of the Regulated Activity and priority weed species as per the Katherine Regional Weed Management Plan 2015-2020. A weed survey was conducted in March 2021 in conjunction with a Senior Weeds Officer of the Department of Environment, Parks and Water Security Resources (DEPWS). Appendix 09 (Weed Management Plan) presents the new March 2021 post-rehabilitation weed survey for the 2019-2020 program and the pre-exploration survey undertaken in March 2021 for the 2021-2025 exploration program as an addendum.

Table 9: Weeds recorded in the EP187 surveyed area

Scientific Name	Common Name	NT Class	WoNS	Recorded in surveys
Mesquite*	Prosopis spp.*	A & C	Yes	No Priority Weed
Prickly acacia	Vachellia nilotica (previously Acacia nilotica)*	A & C	Yes	Yes pre-exploration weed survey (2018/2019)
Parkinsonia aculeata	Parkinsonia	B	Yes	Yes pre-exploration weed survey (2018/2019)
Ziziphus mauritiana*	Chinese apple	A & C	No	No Priority Weed
Mimosa pigra*	Mimosa	A & C	Yes	No Priority Weed
Jatropha gossypifolia*	Bellyache bush	A & C	Yes	Yes, along Carpentaria Highway pre-exploration weed survey (2018/2019)
Andropogon gayanus*	Gamba grass	A & C	Yes	No Priority Weed
Azadirachta indica	Neem	B	No	No Priority Weed
Themeda quadrivalvis	Grader grass	B	Yes	Yes June 2020 & March 2021
Stachytarpheta spp	Snake weed	B	No	No Priority Weed
Martynia annua	Devils claw	A	No	No Priority Weed
Hyptis suaveolens	Hyptis	B	No	Yes Oct 2018, April & Sept 2019 & March 2021
Alternanthera pungens	Khaki weed	B	No	Yes pre-exploration weed survey (2018/2019)
Sida acuta, Sida cordifolia, Sida rhombifolia	Sida	B	No	Yes pre-exploration weed survey (2018/2019)
Leonotis nepetifolia	Lion's tail		No	Yes pre-exploration weed survey (2018/2019)
Tribulus sp.	Caltrop	B	No	Yes pre-exploration weed survey (2019/2020)

Further information around Imperials management of weeds can be found in the WMP under appendix 9.

1.16 Protected Areas

There are no Parks, World Heritage Properties, National Heritage Places, Wetlands of International Importance or conservation areas or Sites of Conservation significance within the Location of the Regulated Activity (Figure 16). The only area identified as a site of significance adjacent to the proposed Location of the Regulated Activity is situated in a different catchment called The Limmen National Park, situated approximately 50km North-East of the Location of the Regulated Activity. The National Park covers an area of approximately 12,300 square kilometres.

The Limmen Bight Marine Park and the adjoining Federal Limmen Marine Park are located within the Gulf of Carpentaria and are adjacent to the Limmen National Park. Imperial doesn't foresee any impact on the park or visitors travelling through to and passing along the exploration permit. All traffic, transport and possible community and people impact will be managed following Appendix 03 (Environmental Risk Assessment).

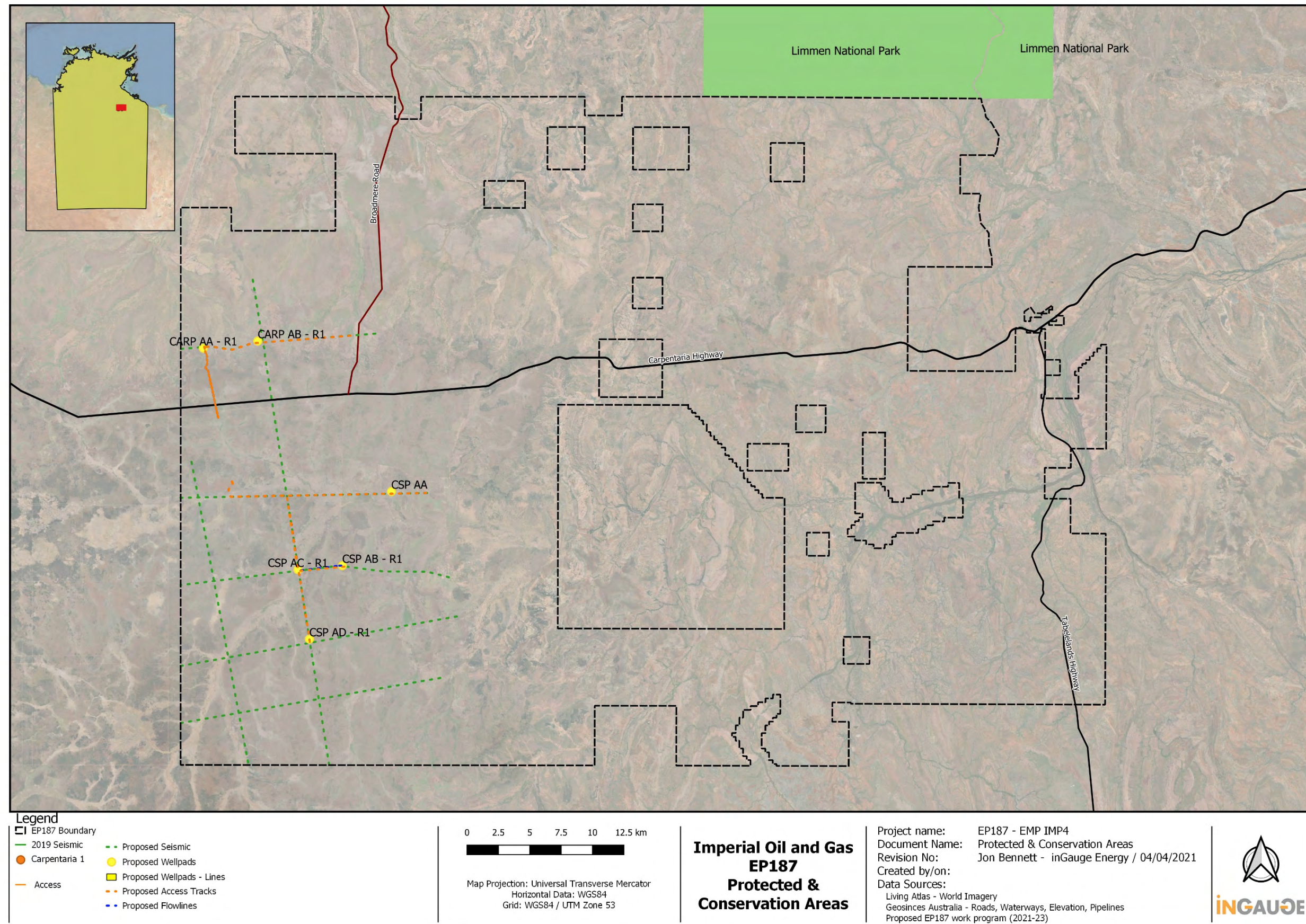


Figure 16: Protected and Conservation areas in relation to the proposed well locations

1.17 Groundwater Dependent Ecosystems (GDEs)

GDEs are complex dynamic natural ecosystems that require groundwater access to meet all or some of their water requirements on a permanent or intermittent basis to maintain their communities of plants and animals, ecosystem processes and ecosystem 'services' (Richardson et al., 2011). These diverse ecosystems are primarily driven by temporal groundwater flow variability contingent on climate, geology and land use (Alfaro and Wallace, 1994, Bertrand et al., 2012, Kløve et al., 2014) (Elsevier, 2017).

A search of the National Groundwater Dependent Ecosystems (GDEs) Atlas (BoM, 2020) conducted in March 2021 identified low to moderate potential of terrestrial or aquatic GDEs occurring within the Location of the Regulated Activity. The Baseline Ecological Assessment conducted in March 2021 identified a suitable habitat (Riparian eucalypt vegetation along Relief Creek) for GDEs. However, these will not be impacted as the exploration will adhere to the NT Land Clearing Guidelines 2020 (LCG) buffer areas associated with water and drainage lines.

The riparian vegetation communities present along the watercourse, particularly those dominated by *Eucalyptus camaldulensis* along Relief Creek, may rely on rainfall stored in alluvial sediments and, therefore, may be groundwater-dependent, a high potential of GDE occurring at 15km southwest from site related to *Melaleuca citrolens*, *M. viridiflora* low woodland ecosystem. Nonetheless, with the controls established for aquifer protection, including no surface water extraction, no disturbance of sensitive vegetation, continuous water extraction monitoring, and the lack of permanent surface waters in the Location of the Regulated Activity, Imperial believes that the likelihood of impacting these communities is very unlikely.

Water depth at the Impact and the Observation monitoring bores and regionally has found that the depth of the water under the lease is over 20 meters in depth. Generally, where groundwater is within 20m of the land surface, some native plants may access and use groundwater (DEPWS, 2020). This depth of water indicates that there is unlikely to be any groundwater dependent ecosystems that will be impacted due to the site's operations.

Stygofauna are a form of GDE that inhabit the interstitial spaces of the cavities of alluvial, sedimentary and karstic aquifers. Limited information is available on the presence of Stygofauna within the Beetaloo Sub-basin, with a Gas Industry Social and Environment Research Alliance (GISERA) program currently underway to identify and characterise stygofauna assemblages in the CLA units of the Beetaloo Sub-basin (GISERA, 2020). Data is available that can provide an indication of the likelihood of stygofauna presence (Hose, 2015), outlining the following factors affecting the distribution of stygofauna:

- Formation type: Stygofauna are predominantly found in aquifers with large pore spaces, which is more common for alluvial, karstic and some fractured rock aquifers.
- Depth below ground level: The abundance and diversity of stygofauna typically decrease with depth below ground, with fauna rarely found more than 100 m below ground level (Hose, 2015).
- The proximity of exchange and recharge: Stygofauna is more abundant in areas of surface water-groundwater exchange compared to deeper areas or those further along the groundwater flow path remote from areas of exchange or recharge.

Based upon the above, Stygofauna are anticipated to be present in upper CLA intervals in the Location of the Regulated Activity within the Gum Ridge formation. This formation is currently used for water extraction by Imperial and is present at the upper depth range of stygofauna presence, being approximately 75Mbgl. The depth and limited extraction draw down predicted and observed conclude that impacts to stygofauna from extraction are considered unlikely.

Changes in groundwater quality may also result in impacts to stygofauna. Impacts to aquifers are mitigated through the following controls:

- Well design and construction to isolate aquifers
- Low toxicity drilling fluid systems utilised
- Groundwater monitoring bores are located within 20m of wells to detect changes in groundwater quality

Based upon the above information, the presence of significant assemblages of stygofauna in the area is considered limited, and impacts are considered unlikely

Other materials, such as previous groundwater tests conducted in the nearby water bores, did not identify terrestrial or aquatic GDEs within the Location of the Regulated Activity.

Figure 17 shows the Groundwater Dependent Ecosystems present within the Location of the Regulated Activity.

In order to protect any potential GDEs available in the location of the regulated activities (Figure 17) all clearing will be subject to the recommended buffers available in Section 4.4.8.2 of the NT Land Clearing Guidelines. The minimum acceptable width of the buffers depends on the value of the wetland (if available) or GDEs and the risk posed by the clearing. After a discussion with the Flora and Fauna division (DEPWS), the ecological assessment of the location of the regulated activities and an extensive mapping of the area developed to better understand the landscape, the vegetation communities and the fauna available; the value of the GDEs in the location of the regulated activities was determined to be medium to low.

This value was supported by:

- no threatened, endangered or vulnerable vegetation communities available that could be impacted by the regulated activities
- the regulated activities are not conducted in an area described as wetland or in close proximity to a recognized wetland under the Ramsar convention
- there are not isolated pockets of vegetation but a continuous line of common and dense vegetation that goes along the Relief Creek. Vegetation connectivity will not be interrupted by the program's sinkholes available in close proximity to the regulated activities that could provide significant habitats for GDEs. During the ecological assessment, one potential area for GDEs was identified located out of the area of the program
- hydrology of the area won't be affected by the regulated activities. Surface water will not be taken for the program, water will not be diverted from natural waterways and aquifers will be well protected by well design and construction, low toxicity for fluids and groundwater monitoring. All water extraction will comply with the approved water licence
- all regulated activities will be conducted by retaining and exceeding buffers (100m for medium value) for riparian vegetation and stream orders as per the land clearing guidelines
- access tracks will be along the seismic lines to avoid further clearing
- an ecologist will be on site prior to clearing to determine sensitive/significant vegetation type areas and mark them for protection
- mitigations in place to avoid spread of invasive species

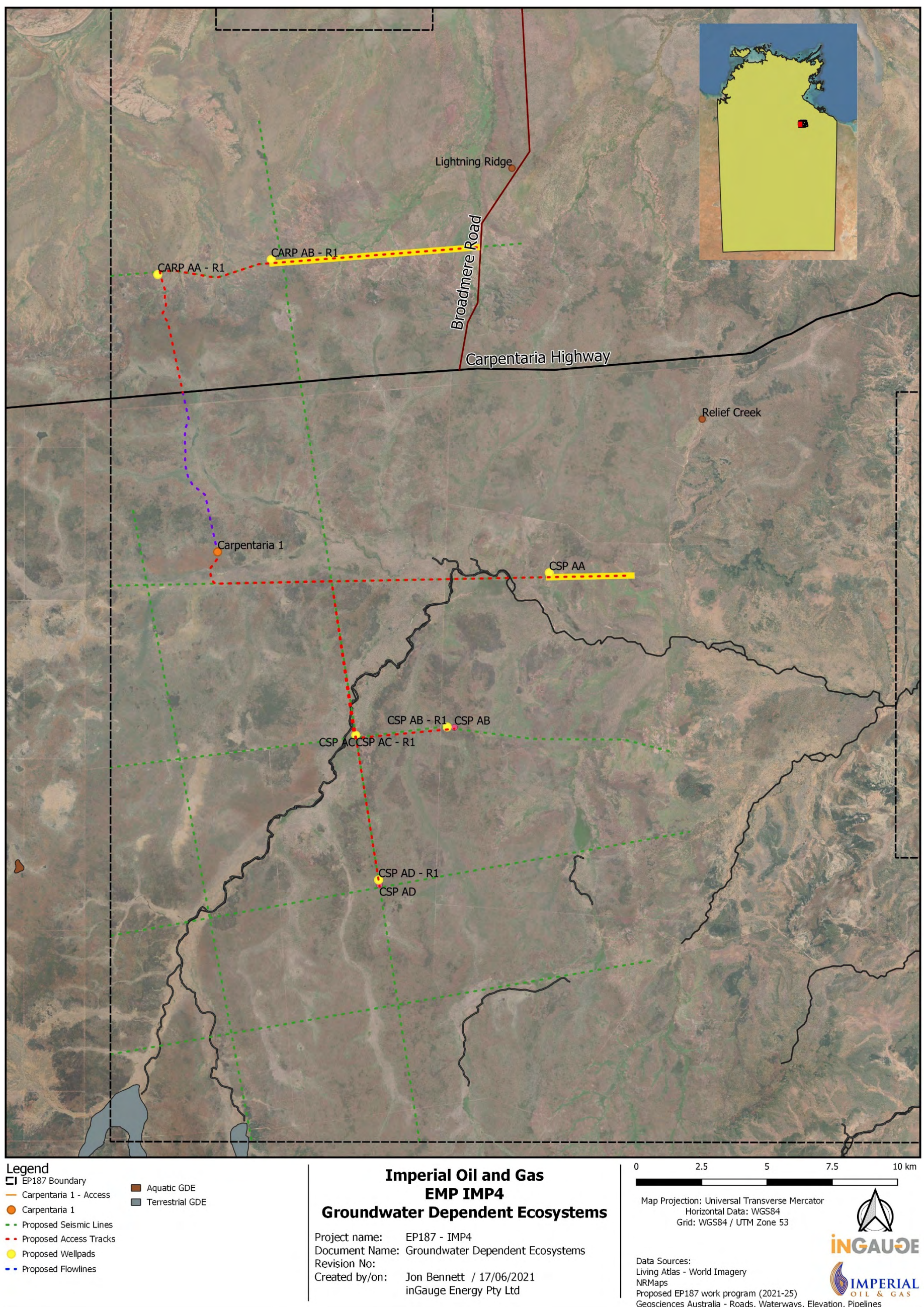


Figure 17. Groundwater Dependent Ecosystems

1.18 Fire

The Location of the Regulated Activity within EP187 is generally an open grassland savannah lightly timbered. The area is regularly burnt using aerial firebombing and traditional owner cultural fire management practices.

More recently, the area has been increasingly utilised for cattle grazing, and therefore 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.

Mapping obtained from the North Australia Fire Information website (NAFI, 2020) indicates that the Location of the Regulated Activity was last burnt in 2017.

Imperials Bushfire Management Plan was developed as part of the Exploration Program and is provided in Appendix o8.

1.19 Historical and Natural Heritage

A search of the NT Heritage Register (DTC, 2020) for EP187 was conducted, and no recorded NT heritage items or places are present in the Location of the Regulated Activity. A search of the EPBC PMST database (EPBC, 2020) showed no World Heritage Properties or National Heritage Places registered within 5 km of the Location of the Regulated Activity.

An anthropological survey was conducted in May 2015 by NLC across the tenement area to ensure the project would impact no sites of significance. The anthropological survey report from this survey was submitted to the DITT and DEWPS as part of the Drilling EMP.

An archaeological survey was conducted in December 2020 by Ellengowan Enterprises, an approved NT archaeological consultant. The archeological report from this survey is attached to this EMP as appendix o1.01.

Traditional Owner Representatives will be present at all land clearing activities for the project. The disturbance footprint for these activities is not within the vicinity of any known Aboriginal cultural or heritage sites. Therefore, Imperial consider that the risk of contamination or damage to these sites is extremely low to negligible.

1.19.1 Northern Land Council

Imperial will acquire the necessary NLC approvals for this project.

1.19.2 AAPA

An Authority Certificate application for the planned activities and the work area has been submitted to the AAPA. The certificate will be forwarded to the relevant government departments when Imperial receives certificate approval.

The AAPA Authority Certificate aims to prevent damage to and interference with sacred sites by identifying and setting out the conditions for entering and working on the land. Proponents must obtain an AAPA certificate to ensure areas of significance for sacred sites are identified and protected from proposed activities.

1.20 Socioeconomic Environment

EP187 is on Aboriginal freehold land and held by the Mambaliya Rumburriya Wuyaliya Aboriginal Land Trust. The deed of agreement for access to the land is held with the Northern Land Council.

Borrooloola is the nearest township community to the Location of the Regulated Activity and is the main service centre for the McArthur River and Robinson River Southern gulf region.

EP187 mainly supports Indigenous use with pastoral grazing rights awarded, divided into several blocks to pastoralists under Section 19 agreements. Other than mining at McArthur River and pastoral activities, there are no significant industries within the region. There is some limited tourism at the site of Paradise Pools done by helicopter tours.

The McArthur River Mine is located approximately 100km east of EP187; the local area remains generally undeveloped in infrastructure and roads. Major infrastructure within EP187 includes the Carpentaria Highway and the Daly Waters to McArthur River gas pipeline, which runs approximately parallel with one another east-west through the middle of the tenement.

1.21 Petroleum Reserved Block

EP187 does not lie within a Reserved block or contain any Proposed Reserved Block as identified in NT Governments "Petroleum Reserved Block Policy, July 2019" (Northern Territory Government, 2019).

1.22 Settlements

EP187 is sparsely populated, with several S19 leaseholders having permanent camps scattered throughout; none are within a 10km radius of the Location of the Regulated Activity. The closest settlement is Heartbreak Hotel, which is 60km east of the Location of the Regulated Activity along the Carpentaria Highway.

The nearest Aboriginal community is the township of Borrooloola and the associated outstations at Campbell Springs, Devil Springs and Cow Lagoon. Each of these residential locations lies approximately 100km to the northeast of EP187. The Aboriginal community of Minyerri (Hodgson Downs) lies about 180 km to the northwest of EP187.

Figure 18 shows the dwellings and settlements in the vicinity of the Location of the Regulated Activity.

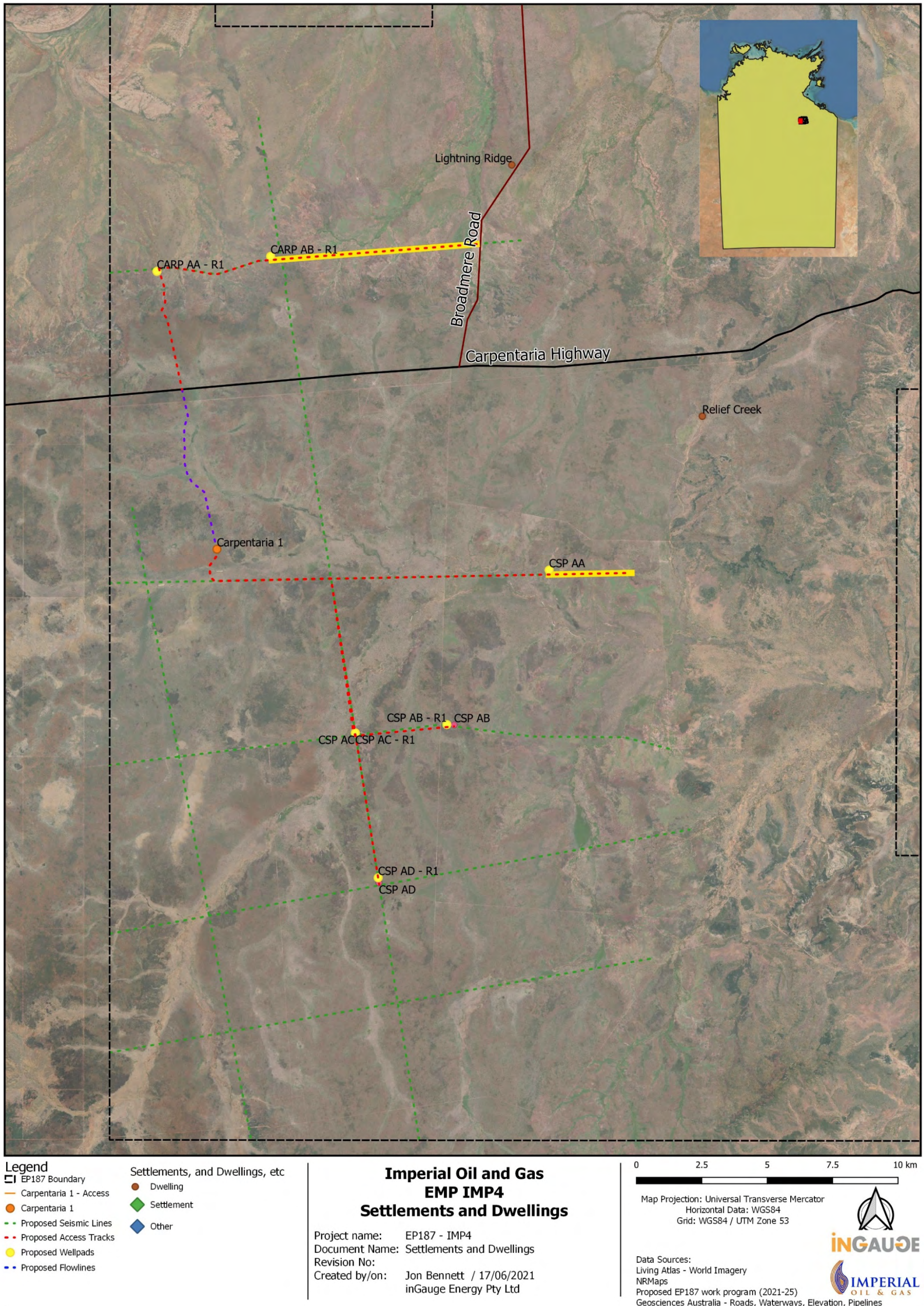


Figure 18: Settlements and Dwellings

1.23 Environmental Values as defined under the Environment Protection Act

The Environment Protection Act 2019 and Environment Protection Regulations 2020 require that any operator conducting an activity with a potential environmental impact assess all the matters fully and evaluate the effectiveness of the proposed safeguards to mitigate these impacts. It also recommends actions to ensure the project's development and operational phases are managed in an environmentally sound manner.

A combination of desktop assessment and field surveys was conducted to describe the area's existing environmental values. The assessment determines the likelihood of occurrence for threatened fauna and flora species identified. Appendix 01.02 shows the environmental values and likelihood of occurrence, potential effect on the environmental factors due to activities, and applicable codes of practice to ensure risk and/or impacts are reduced to ALARP.

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Appendix 01.01 - Archeological Report

The "wellpad" coordinates referred to in this report are not the wellpad locations to be constructed under this EMP, they are the intersection points of seismic lines.

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



A report for Imperial Oil & Gas Pty Ltd, Sydney NSW

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January 2021

Cover image: VH-ZWC at an ephemeral creek in EP187

EXECUTIVE SUMMARY

Imperial Oil & Gas (Imperial Energy) proposes to expand their seismic line, access tracks and gas well programme from their initial 2019 proposal at EP187 on the Favenc Range in the Northern Territory's Barkly Tablelands. A supplementary archaeological survey was required to assess the impacts the works proposal may have on Aboriginal cultural heritage. In addition to six new gas well sites, 171km of seismic lines were surveyed in December 2020. Two background scatters were found on Relief Creek, the main waterway in the works area. The proposed works, however, will not impact on these sites. The following points summarise Imperial Energy's 2021 seismic line and drilling programme.

- No further action is required by Imperial Energy on EP187 in respect to the additional 171km of seismic lines, access tracks and well sites. The proposed works are cleared and comply with the requirements of the Northern Territory *Heritage Act* (2011), as no significant archaeological material was found.
- The well sites south of the Carpentaria Highway should, however, avoid Relief Creek.
- Well sites CARP AA and CARP AB north of the highway will require a systematic archaeological survey should their placement area, or placement zone, increase from 300m to 1.5km radii. Small creeks and drainage channels, that may contain archaeological material, intersect these sites.
- Two rockshelters, Balbirini 1 and 2 were located during mobilisation. Both are in EP187, but these are outside of the proposed 2021 work area programme. These sites have a high archaeological significance as they may be used to date the initial Aboriginal occupation in the Carpentaria region. Imperial Energy requires no further action at this time in respect to these sites.

Summary of mitigation schedule:

No.	Site ID	Site Type	Individual site type	GPS Grid Reference (Centroid) Datum: WGS 84, Zone: 53L		Description	Significance	Recommendation
			Artefact (n.)	Easting	Northing			
1	IEBS05	Isolith	1			F(S)	Low	Option 1. Avoid. Inside the 750m zone for well CSP AC
2	IEBS06	Isolith	1			GS(SS)	Low	Option 1. No action. Relocated 60m away
3	Balbirini 1	Rock art?	N/a			Large singular gallery	High	Option 1. No action. Outside of survey area
4	Balbirini 2	Stone artefact scatter	N/a			Stone artefact cache in rockshelter – no art	High	Option 1. No action. Outside of survey area

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1.0 INTRODUCTION

1.1 Background and consultancy brief

This is a supplementary survey report to Imperial Oil and Gas Ltd Pty (Imperial Energy) initial Cultural Heritage Assessment, of Exploration Permit (EP) 187 approximately 85km southwest of Borroloola in the Northern Territory (Jung, 2019). Imperial Energy required a further archaeological survey to complete the works (InGauge Energy Australia, 2019). An additional seismic lines survey, 171.84km in total (including new access tracks) and an additional six well sites assessment was required (Fig. 1). The seismic line survey widths were 100 metres, with a clearing area of 750m radii for the gas well sites. Furthermore, the wells were to avoid all watercourses. There were seven transect lines to cover. Five lines ranged from 15 to 22km long from east to west. The two longest transect lines from north to south were 24 and 40km long and transected the Carpentaria Highway. The consultancy brief was specifically to:

- Identify any prescribed archaeological objects or places as defined under the Northern Territory *Heritage Act* (2011), and any archaeological sites located within the seismic line corridors and the well sites.
- 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 supplementary 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* (2011).

The survey was conducted for two days from 15 to 16 December 2020, with Traditional Owners (TOs) Peter Ellis, Johnny Wilson, Asman Rory, Steven Wilson-Dashwood and Caine O'Keefe. Our helicopter pilot was Finn Blackhall from Airborne Solutions. Our aircraft was a Robinson R44, Registration: VH-ZWC.

The survey method again was to target watercourses and any rocky outcrops as these environment features were found to be key determinates as to where people were in the landscape. Thirteen landing zones were completed, resulting in the discovery of two background scatters consisting of isolated stone artefacts. The finds were all made on Relief Creek, the only significant waterway in the survey area. One of the isolated stone artefacts was relocated outside of the survey corridor and the other was left in situ. These sites were named following the nomenclature of the 2019 survey report i.e., Imperial Energy Background Scatter 5 (IEBS05) and IEBS06 (Fig. 2).

In addition to the background scatters found in the survey area, this report details two rockshelter sites found while mobilising. These have been named after the station they occur on, Balbirini. Neither of these rockshelters will be impacted by Imperial Energy's 2021 work programme, as they are outside of the survey area. The following describes the outcomes of the survey, together with recommendations for the proposed works.

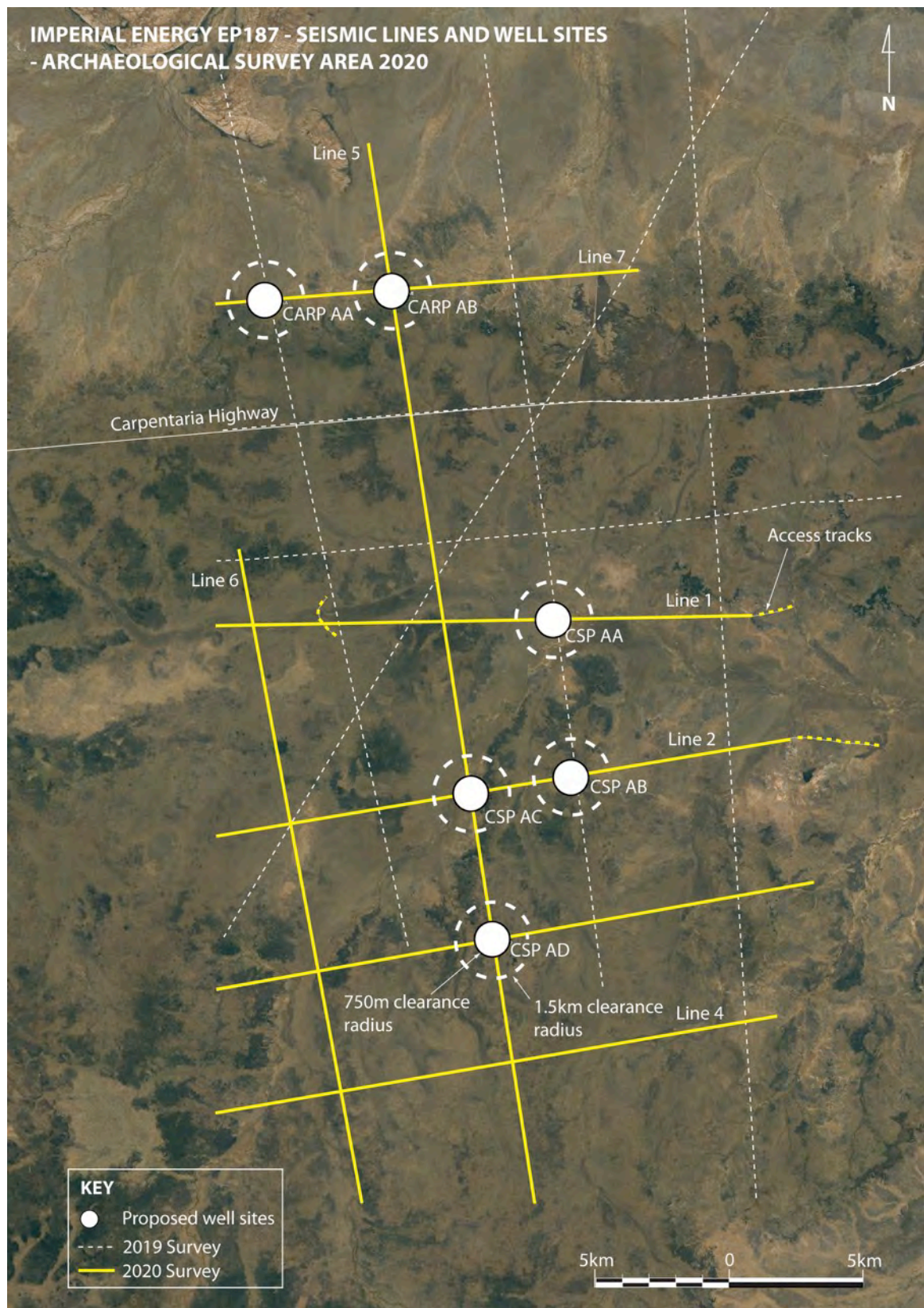


Figure 1. Survey seismic lines and proposed well sites with 750m radius clearance zones (After Google Earth).

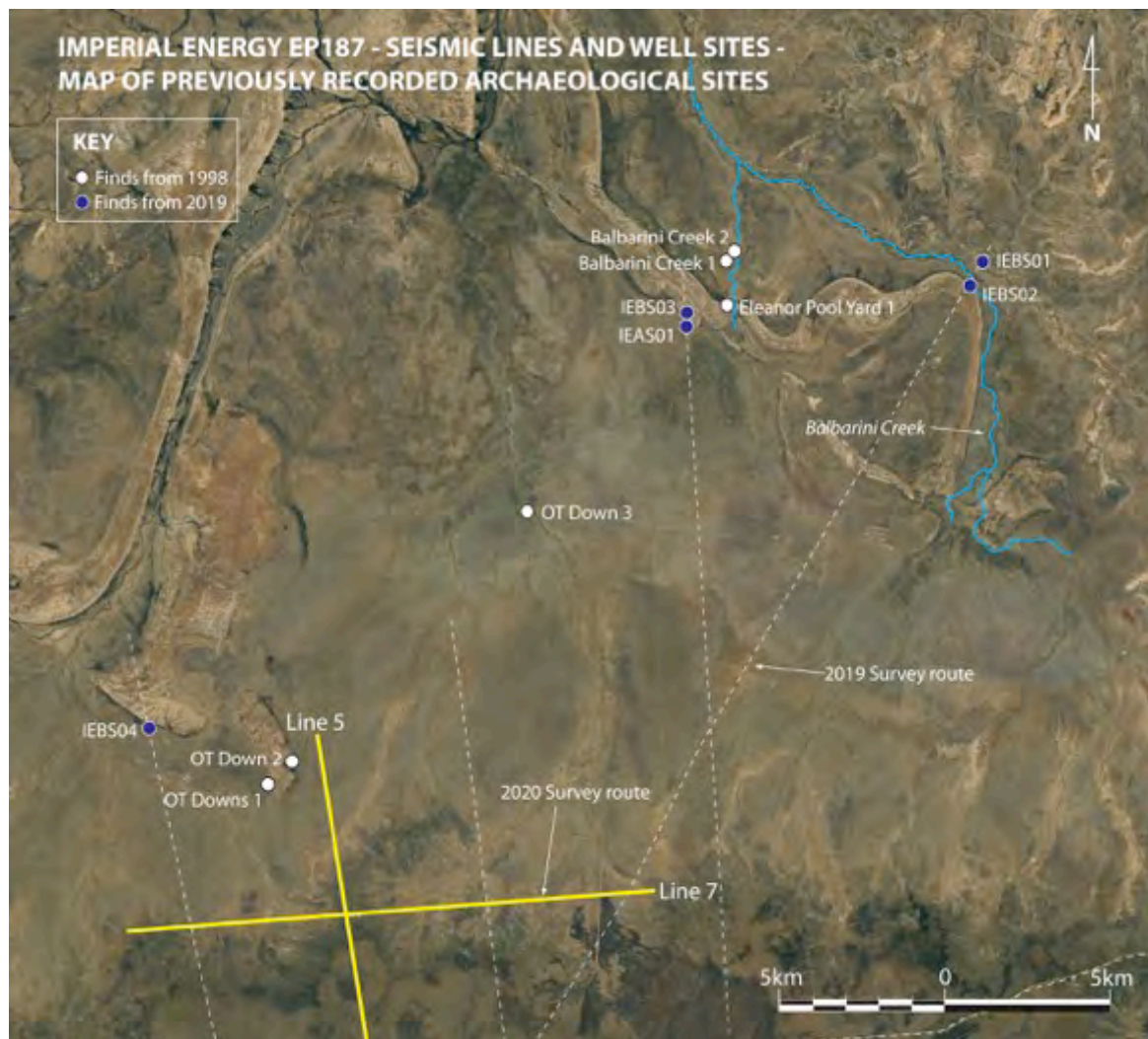


Figure 2. Map of previously recorded archaeological sites in the survey area (After Google Earth).

2.0 RESULTS

2.1 Archaeology

The environment traversed by the new seismic lines was similar to the previous year's survey, except that rains prior to and during the survey accentuated a creek drainage system in the eastern section of the survey area, south of the highway. These drainage lines were filled with water and were assessed, together with landings at Relief Creek. No archaeological material was found along the drainage lines, suggesting that they may be recent, as they quite likely change their course every wet season. Line 7, which runs east west north of the highway, however, traverses undulating country with numerous creeks. One of the proposed wells sites, CARP AB, was found to be in unsuitable terrain and will need to be moved within its 750m-clearance area. The 13 landing zones accomplished in this survey are recorded in Table 1 and are mapped in Figure 3.

One well had been constructed since last year's survey, on Line 4 (2019), SL-4, now called 'Carpentaria 1'. Access tracks to the well site were surveyed, including the access tracks to Lines 1 and 2, but no archaeological material was found.

The main waterway south of the highway is Relief Creek. The results of this survey found the first artefacts to be recorded on the creek, proving that it was utilised by Aboriginal People. The finds, however, were only isolated artefacts and no significant archaeological sites have yet been found. The sites have been named Imperial Energy Background Scatter 5 and 6 (IEBS05 and IEBS06) (Fig. 3). The background scatters are recorded in Table 2 and photographs of the finds are shown in Figures 4 and 5 respectively. IEBS05 occurred approximately 45m south of Line 2, but within the 750m radius of well CSP AC. IEBS06 was right on Line 6 and was relocated 52m to the west of the line. The artefact, a grind stone fragment occurs on an adjacent drainage line feeding into Relief Creek.

InGauge put a proposal to the survey team on the last day of the survey, to increase the well location zones to 1.5km radii, in affect doubling the well site survey area. A start was made to assess one of the wells north of the highway, CARP AA, by a radial search out from the well centroid. A rock hole was found and investigated (LZ13), but no finds were made. The extended 1.5 radius survey area for the well sites were not feasible in the time allocated to the work and represented a variation to the initial scope of works. The onset of rain precluded any further landing operations on the afternoon of the 16th December as the pilot deemed that it was not safe to do so. All landing zone photographs and aerial views of the proposed well sites are shown in Appendix 1.

Table 1. Location of LZs and descriptions

Format: UTM M/D/Y H:M:S 9.50 hrs Datum[121]: WGS 84					
Name	Description	Zone	Easting	Northing	Photo no.
15/12/2020					
LZ01	Line 1 – drainage channel	53 K	528837	8142264	2379
LZ02	Line 1 – drainage channel	53 K	525826	8142146	2380
LZ03	Line 1 – edge of swamp	53 K	508579	8141269	2382
LZ04	Line 2 – Relief Creek, IEBS05. CSP AC in lancewood forest, move to LZ? CSP AB on fence line (no landing)	53 K	518008	8135622	2383/84/ 85/86/87/ 88
LZ05	Line 3 – Headwater of drainage channel	53 K	527116	8131681	2389

LZ06	Line 3 – CSP AD in cleared, burnt out area (no landing). Landing on Relief Creek	53 K	511978	8129063	2390/91/92
LZ07	Line 4 – Relief Creek.	53 K	510839	8124401	2393
16/12/2020					
LZ08	Line 7 – drainage channel	53 K	524377	8155006	2428
LZ09	Line 7 – drainage channel	53 K	521197	8154620	2429
LZ10	Line 7 – @ foot of low hills near CARP AB, small creek line. Move well to LZ? CARP AA – flat cleared near small hill	53 K	515498	8154139	2430 (well) 2431 (LZ) 2432(CA RP AA
LZ11	Line 6 – Relief Creek. IEBS06	53 K	512548	8129606	2470
LZ12	Line 6 – Relief Creek. Small drainage channel	53 K	510426	8141920	2471
LZ13	Rock hole north of highway	53 K	509305	8150767	2472

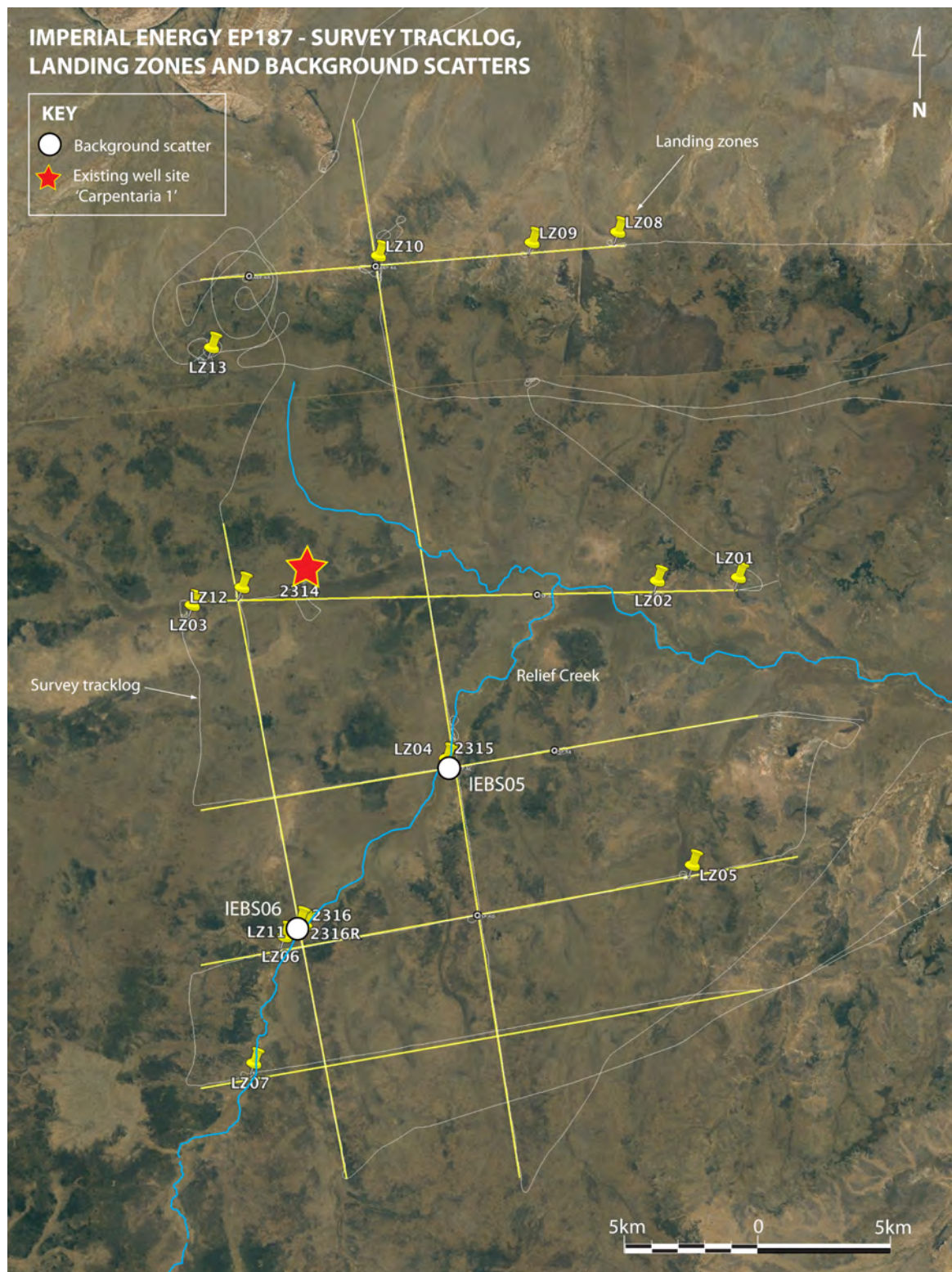


Figure 3. Map of survey tracklog, landing zones and background scatters (After Google Earth).

Table 2. Archaeological finds

Format: UTM M/D/Y H:M:S 9.50 hrs Datum[121]: WGS 84					
WPT Name	Comment	Zone	Zone	Easting	Northing
IEBS05					
2315	F(S) on Line 2	53	K		
IEBS06					
2316	GS(SS) on Line 6	53	K		
2316R	Relocation	53	K		



Figure 4. LZ04, IEBS05 – F(S). Scale in cms.



Figure 5. LZ11, IEBS06 – GS(SS). Scale in 1cm.

2.1.1 Regional study

The development of exploration projects in the Beetaloo Basin has seen an archaeological picture emerging for the region, which shows a proliferation of stone artefact scatters, mainly focused around water courses (Aecom, 2020; Jung, 2020). Three rockshelter sites were discovered during while flying over Imperial Energy’s EPs 187 and 188. One site was found while mobilising from Darwin and the other two while transiting between EP187 and the Heartbreak Hotel. These sites add to our understanding of the Carpentaria regional archaeological context. The location data for the three sites is listed in Table 3 and are mapped in Appendix 2. The flight route deviated to avoid heavy rain clouds and by chance flew over the rockshelter sites.

The second site encountered during the survey was found on the last day of the survey while heading back to the Heart Break Hotel from EP187. A rockshelter with a ceiling height of approximately 7m was seen from the air. The site, however, was not inspected as the weather was closing in. The site photograph is shown in Appendix 4. The site is only 8km north of Paradise Pool, a highly significant and sacred site to Aboriginal People. It quite likely will have art and perhaps an extensive occupation floor suitable for archaeological excavations.

TOs Rory and Wilson, who showed us the site from the air en route to EP187, reported the third rockshelter recorded in this survey. It occurs just south of the Heartbreak Hotel on a steep hill, just west and adjacent to the Tablelands Highway. Rain again precluded a site visit, but the site is said to contain an extensive cache of formal tool types. No art, however, was seen at the site (Rory, A. pers. comm., 16 December 2020).

A third rockshelter site was discovered while mobilising enroute to Heartbreak Hotel. This site, named Tanumbirini 1, however, was found on EP161 operated by Santos. This site and another rock art site found on Bauhinia Downs on EP188 is reported on in Jung (2021).

Table 3. Location details for rockshelter sites

Format: UTM M/D/Y H:M:S 9.50 hrs Datum[121]: WGS 84					
WPT Name	Comment	Zone	Zone	Easting	Northing
Balbirini 1					
	Rockshelter with art gallery (not verified)?	53	K		
Balbirini 2					
	Rockshelter with stone tool cache (approx. location only)	53	K		

2.2 Significance assessment of finds

- **High significance**

Two sites of high significance were found, these are Balbirini 1 and Balbirini 2. Balbirini 1 may be a rock art site, given that others occur nearby, but in different EPs. Both of these sites, however, are on EP 187, but outside of the proposed works area. They were only assessed from the air and were not inspected.

- **Moderate significance**

No moderate sites of significance were found

- **Low significance**

Two archaeological background scatters were assessed as having low significance, IEBS05 and IEBS06. They were both isolated stone artefacts. These were found on Line 6 and Line 2 at crossing points along Relief Creek.

3.0 RECOMMENDATIONS AND CONCLUSIONS

3.1 Recommendations

3.1.1 *Cleared for works:*

All seven seismic lines assessed in this report are cleared for works, as little to no archaeological material was found. Only two background scatters were found, consisting of isolated stone artefacts: IEBS05 and IEBS06. One was relocated off the seismic line and the other was just outside of the disturbance corridor. Imperial Energy requires no further action.

The six proposed well sites are cleared for works, as no archaeological material was found at their locations. The clearance is given only for a 750m radius from the well centroids. The following radii are allowed for the well sites, with a reduction in area for some to avoid Relief Creek (CSP AA and CSP AC) and other waterways north of the highway (CARP AA and CARP AB):

- CSP AA - 500m radius (Restricted by Relief Creek, north and south)
- CSP AB - 750m radius
- CSP AC - 300m radius (Restricted by Relief Creek to the west)
- CSP AD - 750m radius
- CARP AA - 100m radius (Note: restricted by creeks)
- CARP AB - 100m radius (Note: suggest moving to LZ10, as the site is in the middle of a lancewood forest)

3.1.2 *Not cleared for works*

- A 1.5km radius per well site was not cleared. This went beyond the initial scope of works.

3.1.3 *Future works:*

- A systematic survey would be required to increase the location area for the CARP well sites, as they occur in an extensive creek system area north of the highway. If a 1.5km radius area is required for the CARP sites, a survey team could be dropped off by helicopter and conduct a series of 100m transects across the complex terrain unit north of the highway. The helicopter would pick the team up and the end of the day.
- Detailed recordings and site mapping should be carried out at the rockshelter sites. An excavation programme should also be instigated to determine an age/depth sequence for the Carpentaria region.

3.2 Conclusions

Imperial Energy's proposal to clear an additional 171km of seismic lines and access tracks in EP187 on the Favenc Range required a supplementary archaeological survey. This was to assess the impacts the new lines and well sites may have on any Aboriginal cultural heritage. The survey was conducted over two days utilising an aerial survey method that targeted waterways and stone outcrops. The main waterway in the survey area is Relief Creek and only two background scatters were found along its banks, intersecting Lines 2 and 6. These finds represent the first archaeological material found on Relief Creek and the first material found south of the highway on EP187. There are no stone outcrops south of the highway in the work area.

The proposed works will not impact the two background scatters, IEBS05 and IEBS06 found in the survey area. IEBS05 was just outside of the seismic Line 2 corridor and IEBS06 was relocated

52m west from the centre of Line 6. The results of this survey indicate that Imperial Energy's 2021 seismic line and well drilling programme will have little to no impact on Aboriginal cultural heritage as only low significance background scatters were found and meets the requirements to comply with the Northern Territory *Heritage Act* (2011). Proposals to expand the possible location zones for the well sites from a radius of 750m to a radius of 1.5km will, however, require a systematic survey, particularly for the CARP well sites north of the highway. It was beyond the initial scope of works for this survey to do so.

Two rockshelter sites were found in the region of the proposed works on Imperial Energy's EP187, but these were well away from the new seismic lines and well sites. One of the rockshelter sites is most likely to contain rock art as it was observed to have a very high ceiling and possibly an extensive occupation floor. The results of this survey may have inadvertently discovered some of the most significant archaeological sites in the region, found by chance during mobilisation while avoiding rain clouds.

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APPENDIX 1: Photographs of Landing Zones (LZs)



Figure 6. LZ01 ephemeral creek.



Figure 7. LZ02 ephemeral creek.



Figure 8. LZ03 ephemeral creek after rain.



Figure 9. LZ04 on edge of swamp.



Figure 10. LZ04 site of CSP AC in lancewood forest.



Figure 11. LZ04 Relief Creek.



Figure 12. CS AB aerial view on fenceline.



Figure 13. LZ05 on ephemeral creek.



Figure 14. CSP AD aerial.



Figure 15. LZ06 Relief Creek.



Figure 16. LZ07 Relief Creek.



Figure 17. LZ08 drainage channel.



Figure 18. LZ09 drainage channel.



Figure 19. LZ 10 CARP AB site near small creek.



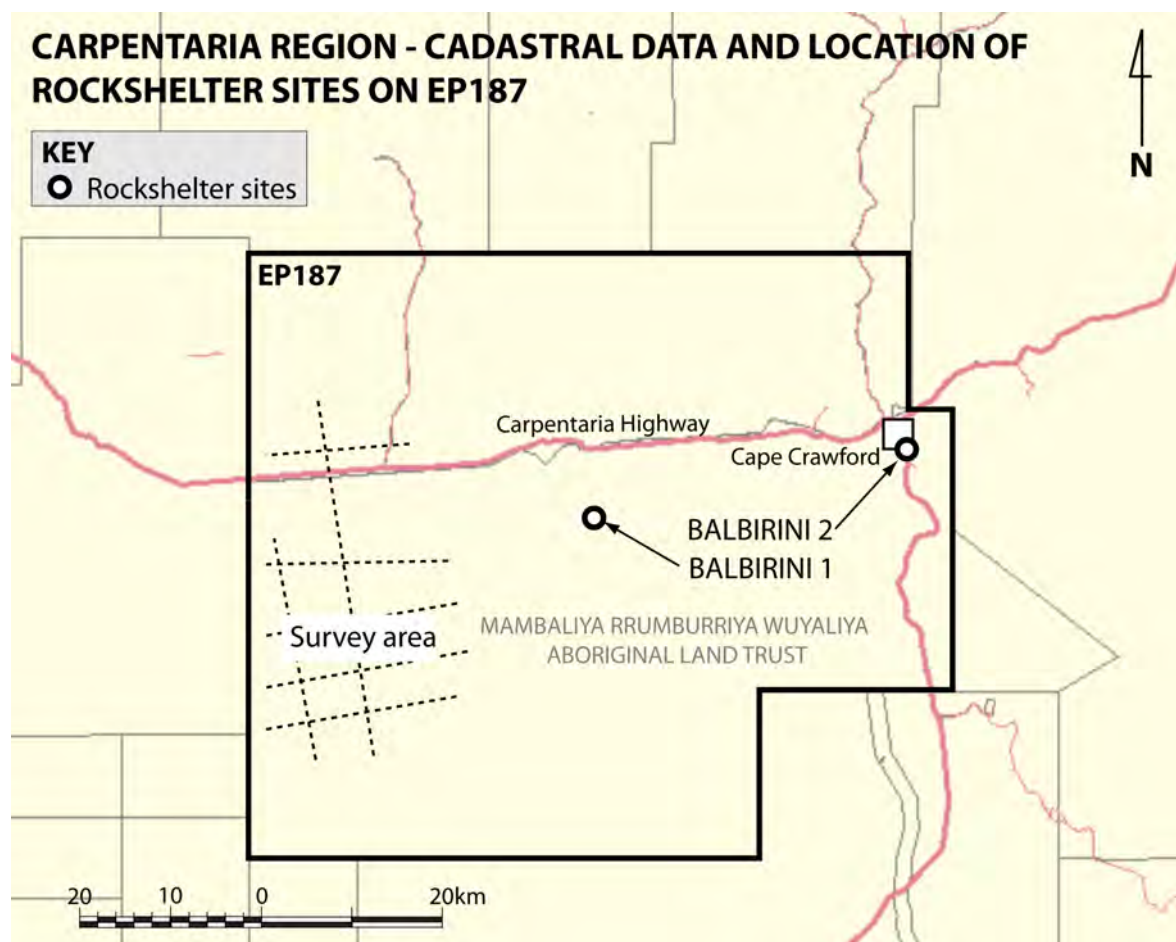
Figure 20. LZ10. Move CARP AB to this location?



Figure 21. LZ12 ephemeral creek.



Figure 22. LZ13 at Rockhole, north of the highway.

APPENDIX 2: Carpentaria Region – Cadastral data and location of rockshelter sites

Site Name	Exploration Permit (EP) Number	Operator
Balbirini 1	EP187	Imperial Energy
Balbirini 2	EP187	Imperial Energy

APPENDIX 3: Balbirini 1 Rockshelter (not verified)



Figure 23. Balbirini 1 rockshelter, aerial view. 8km north, northeast of Paradise Pool.

Appendix 01.02 - Baseline Environmental Assessment Report

EP187
ENVIRONMENTAL
ASSESSMENT REPORT
2021-2025
SEISMIC AND DRILLING PROGRAM

Client: Imperial Oil and Gas

STATUS: Final

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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 March 2021 with specific focus on Imperial's proposed seismic lines and well pads for their 2021-2025 exploration program. 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.

One (1) threatened fauna species (Gouldian Finch (*Erythrura gouldiae*)) was observed within EP187 during the March 2021 survey. The Gouldian finches were observed approximately 22km east of the proposed exploration area. No other 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.

Acronyms and Abbreviations

Acronyms/Abbreviation	Description
DAWE	Department of Agriculture, Water and the Environment (Formerly DoE) – Australian Government
DEPWS	Department of Environment, Parks and Water Security (Formerly DENR) – Northern Territory Government
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
IOG	Imperial Oil & Gas
LCG	Land Clearing Guidelines
TPWC Act	<i>Territory Parks and Wildlife Conservation Act 1976</i>

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 all the previous field surveys on EP187.

1 INTRODUCTION

Imperial Oil & Gas Pty Ltd (IOG) 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 seismic lines and well pads for the 2019-2020 exploration program. Other investigations have involved developing baseline surface water quality data, targeted waterway assessments and landscape scale environmental assessments. During weed surveys undertaken in 2018, 2019 and 2020, concurrent biodiversity assessments were undertaken including the likelihood of occurrence of Northern Territory and Commonwealth listed threatened flora and fauna species within EP187. A pre-exploration ecological assessment was undertaken in March 2021 over the proposed 2021-2025 exploration areas. This report provides site specific assessment with particular focus on the proposed 2021-2025 seismic and well pad exploration programs in relation to biodiversity and environmental values.

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

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

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

1.1 Location

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

1.2 Proposed Seismic and Exploration Program Location

The proposed 2021-2025 exploration activities include:

- Acquisition of 165km of 2 D Seismic data
 - o Clear up to 82.5 hectares for seismic acquisition lines
 - o Conduct 2D seismic acquisition operations
 - o Rehabilitate cleared seismic acquisition lines
- Construction of up to six well pads
 - o Clear up to 75 hectares for six well pads
 - o Construct wellpads as per Figure 2
 - o Establish lined ponds, as per Figure 2
 - o Drill water production and monitoring bores on well pads
 - o Establish Erosion and Sediment Control devices on well pads
- Construction of access tracks to six well pads
 - o Clear up to 25 hectares for access tracks
 - o Construct an intersection onto the Carpentaria highway
 - o Establish Erosion and Sediment Control devices on access tracks

- Drilling gas exploration wells from the seven well pads (six to be constructed, plus Carpentaria 1 (existing well))
 - o Drill 1 Lateral gas exploration wells from the existing Carpentaria 1 wellbore
 - o Drill a total of 6 Vertical gas exploration wells from the six well pads, (up to six well from any well pad)
 - o Drill a total of 6 Lateral gas exploration wells from the six well pads, (up to six well from any well pad)
- Establish banded tanks pads and tanks fitted with leak detection at the above well site.

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.

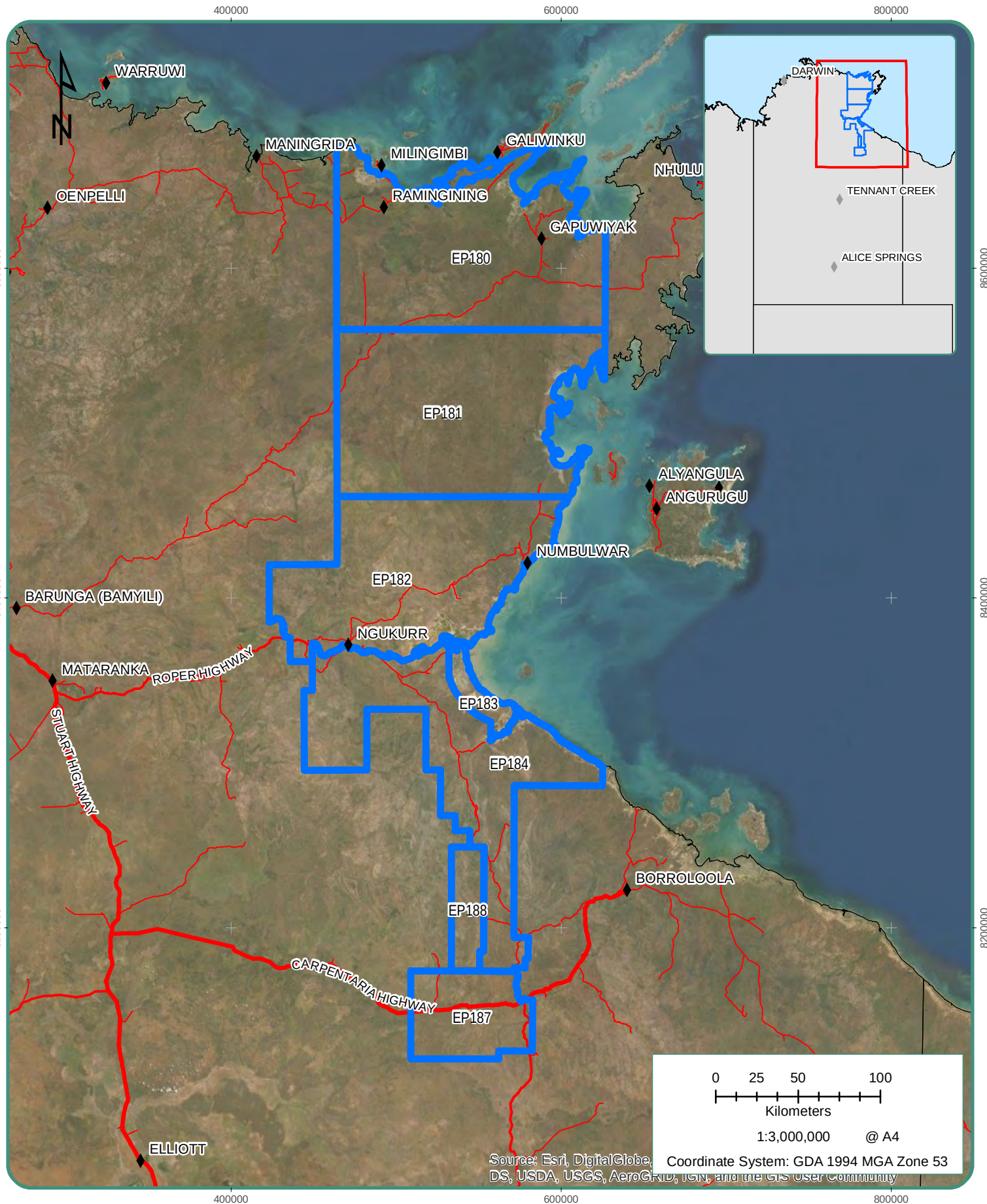
Table 1 2021-2025 Seismic Line and Access Track Coordinates for Start and End (decimal degrees)

Line	Start Longitude	Start Latitude	End Longitude	End Latitude	Length (km)
1	135.0838	-16.8062	135.2720	-16.8025	20.1
2	135.0838	-16.8692	135.2861	-16.8633	21.7
3	135.0838	-16.9275	135.2937	-16.8909	22.5
4	135.0838	-16.9685	135.2811	-16.9353	21.2
5	135.0925	-16.7793	135.1356	-16.9994	24.7
6	135.1376	-16.6447	135.1959	-16.9992	39.6
7	135.0838	-16.6991	135.2330	-16.6874	16.0
Access track	135.1015	-16.6972	135.1209	-16.8042	12.5

Table 2 Coordinates for Exploration Wells (2021-2025)

SITE	Latitude (decimal degrees)	Longitude (decimal degrees)
Exploration bore(s)		
CARP AA-R1	-16.6972	135.1015
CARP AB-R1	-16.6919	135.1420
CSP AA	-16.8026	135.2019
CSP AB-R1	-16.8547	135.2081
CSP AC-R1	-16.8577	135.2019
CSP AD-R1	-16.9071	135.1809
Grid: GDA94 Zone 53K		

- NB: All coordinates are provided in decimal degrees.



TITLE:

Locality Map

MAP NO: Figure 1

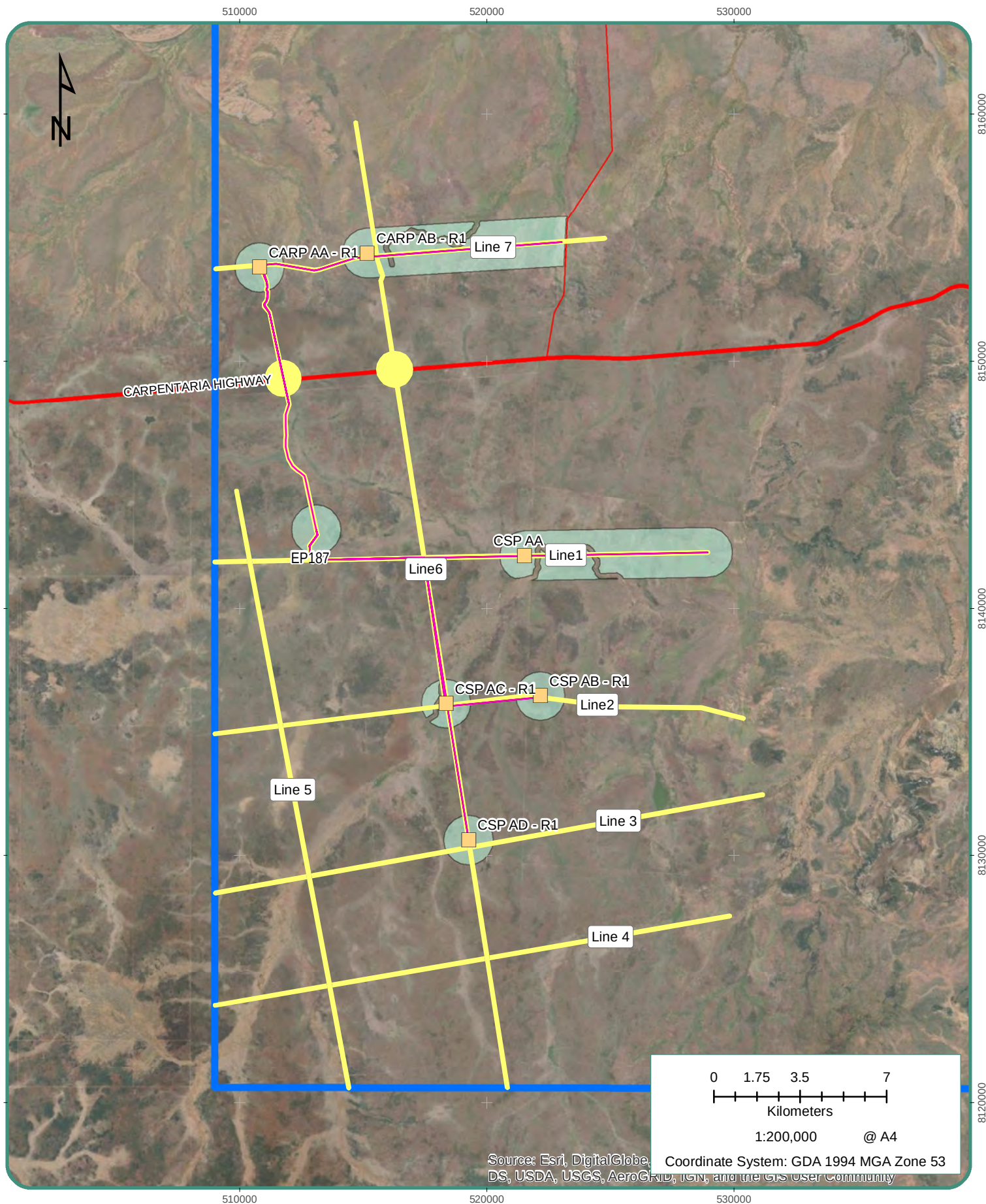
PROJECT: EP187 March 2021
Environmental Assessment Report

LEGEND

- ◆ Populated places
- Australian State Boundaries
- Tenements
- Principal Road
- Secondary Road
- Minor Road



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TITLE:

2021-2025 EP187 Exploration Program

MAP NO: Figure 2

PROJECT: EP187 March 2021
Environmental Assessment Report

LEGEND

- | | |
|------------------------|----------------|
| Wellpads | Roads |
| Proposed pipelines | Principal Road |
| Proposed access | Secondary Road |
| AAPA 2021 Works Type A | Minor Road |
| AAPA 2021 Works Type B | |
| Tenements | |



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Data Source:

Date: 25/03/2021

2 METHOD

This section outlines the methods undertaken to describe the existing environmental values of the seismic lines and access tracks (Type A) and well pad areas and buffers (Type B). 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 Agriculture, Water and the Environment (DAWE) protected matters search tool (-16.804167, 135.174167)
- The Atlas of Living Australia (ALA) database
 - o Australia's Virtual Herbarium (AVH)
 - o Online Zoological Collections of Australian Museums (OZCAM)
- BirdLife Australia's Birdata
- Northern Territory Government Department of Environment, Parks and Water Security (DEPWS) 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 DAWE and the Northern Territory DEPWS 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*

Targeted surveys were undertaken in relation to the proposed seismic and drilling activities on EP187 in March 2021 during optimal wet-season conditions.

Surveys were undertaken with DEPWS weed officers and were undertaken on foot, vehicle and helicopter.

3 EXISTING ENVIRONMENT

The following provides a 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 1976* (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 identified in a rest-stop adjacent to the Carpentaria Highway within EP187 during the recent March 2021 survey.

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 Agriculture, Water and the Environment (DAWE) 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, 12 threatened terrestrial species and 14 migratory species listed under the EPBC Act (**Appendix A**). Eight (8) of the 14 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 Birddata

BirdLife Australia's Birddata (**Appendix A**) shows records of 62 bird species observed within the search area. Of those, 1 species *Ardeotis australis* (Australian bustard) is listed as Near Threatened

(NT) 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 2 significant and/or threatened fauna species *Ardeotis australis* (Australian bustard) and *Mesembriomys macrurus* (golden-backed tree rat) listed under the EPBC Act and/or TPWC Act within the search area.

3.1.4 DEPWS 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 DEPWS NR Maps database returned 1 Data Deficient (DD) plant species and 5 fauna species 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 project area

Class	Species Name	Common Name	EPBC Act Status	TPWC Act Status
Birds	<i>Ardeotis australis</i>	Australian bustard	-	NT
Birds	<i>Merops ornatus</i>	Rainbow bee-eater	migratory	LC
Mammals	<i>Mesembriomys macrurus</i>	Golden-backed Tree-rat ¹		CE
Reptiles	<i>Demansia quaesitor</i>	Sombre whipsnake	-	DD
Reptiles	<i>Tiliqua scincoides</i>	Common blue-tongued lizard	-	DD
Plant	<i>Polygala petrophila</i>	Polygala		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 1976* (TPWC Act), NT): CE = Critically Endangered, E = Endangered, V = Vulnerable, NT=Near Threatened, DD = Data Deficient

¹ – records from 1901 and presumed locally extinct.

Table 4 Migratory species likely to occur within the project area

Class	Species Name	Common Name	EPBC Act Status	TPWC Act Status
Birds	<i>Apus pacificus</i>	Fork-tailed swift	Ma, M	-
Birds	<i>Cecropis daurica</i>	Red-rumped swallow	M, Ma	-
Birds	<i>Cuculus optatus</i>	Oriental cuckoo	Ma	-
Birds	<i>Hirundo rustica</i>	Barn swallow	M, Ma	-

Class	Species Name	Common Name	EPBC Act Status	TPWC Act Status
Birds	<i>Motacilla cinerea</i>	Grey wagtail	M, Ma	-
Birds	<i>Motacilla flava</i>	Yellow wagtail	M, Ma	-
Birds	<i>Merops ornatus</i>	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 1976* (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

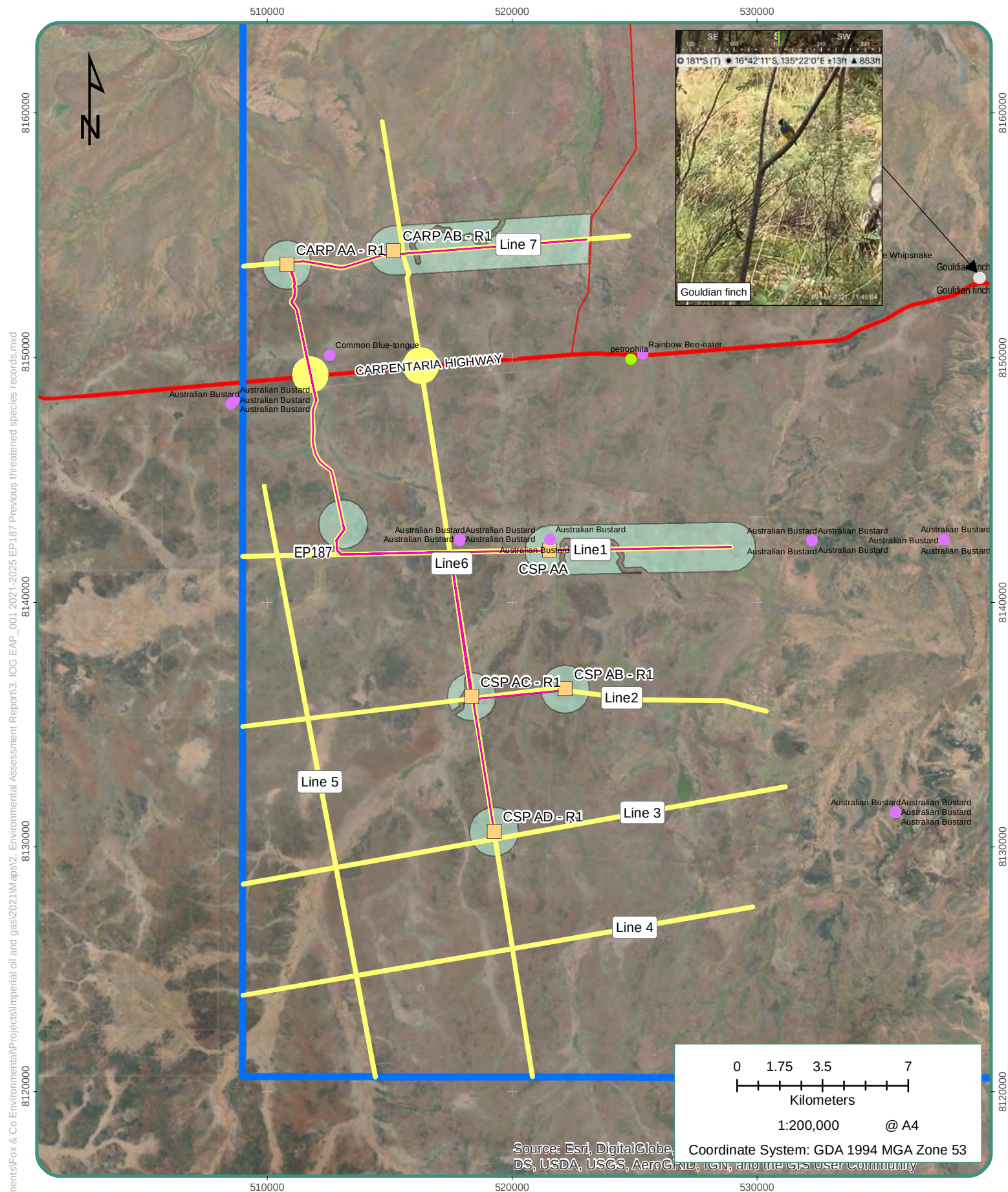
Details of the weeds occurring in relation to the proposed seismic are included in the Weed Management Plan (WMP) prepared by Fox & Co Environmental (*Weed Management Plan EP187, Fox & Co Environmental, March 2021, Report # IG-04*).

Table 5 provides the weeds reported on EP187 during weed surveys undertaken between 2018 and 2021. No weeds have been identified within the proposed 2021-2025 exploration areas. The Carpentaria Highway represents the greatest threat for weed migration into the 2021-2025 exploration areas.

Table 5 Weeds known to occur in EP187

Species	Common Name	WONS	NT Class
<i>Hyptis suaveolens</i>	Hyptis	-	B
<i>Parkinsonia aculeata</i>	Parkinsonia	-	B
<i>Tribulus sp.</i>	Caltrop	-	B
<i>Themeda quadrivalvis</i>	Grader Grass	Yes	B

No pest species were identified during the field surveys.



TITLE: 2021-2025 EP187 Previous threatened and significant species records

MAP NO: Figure 3

PROJECT: EP187 March 2021 Environmental Assessment Report

LEGEND

- Gouldian finch sighting
- Species Atlas Native Flora
- Species Atlas Significant Fauna
- Species Atlas Threatened Fauna
- Wellpads
- Proposed pipelines
- Proposed access
- AAPA 2021 Works Type A
- AAPA 2021 Works Type B
- Tenements

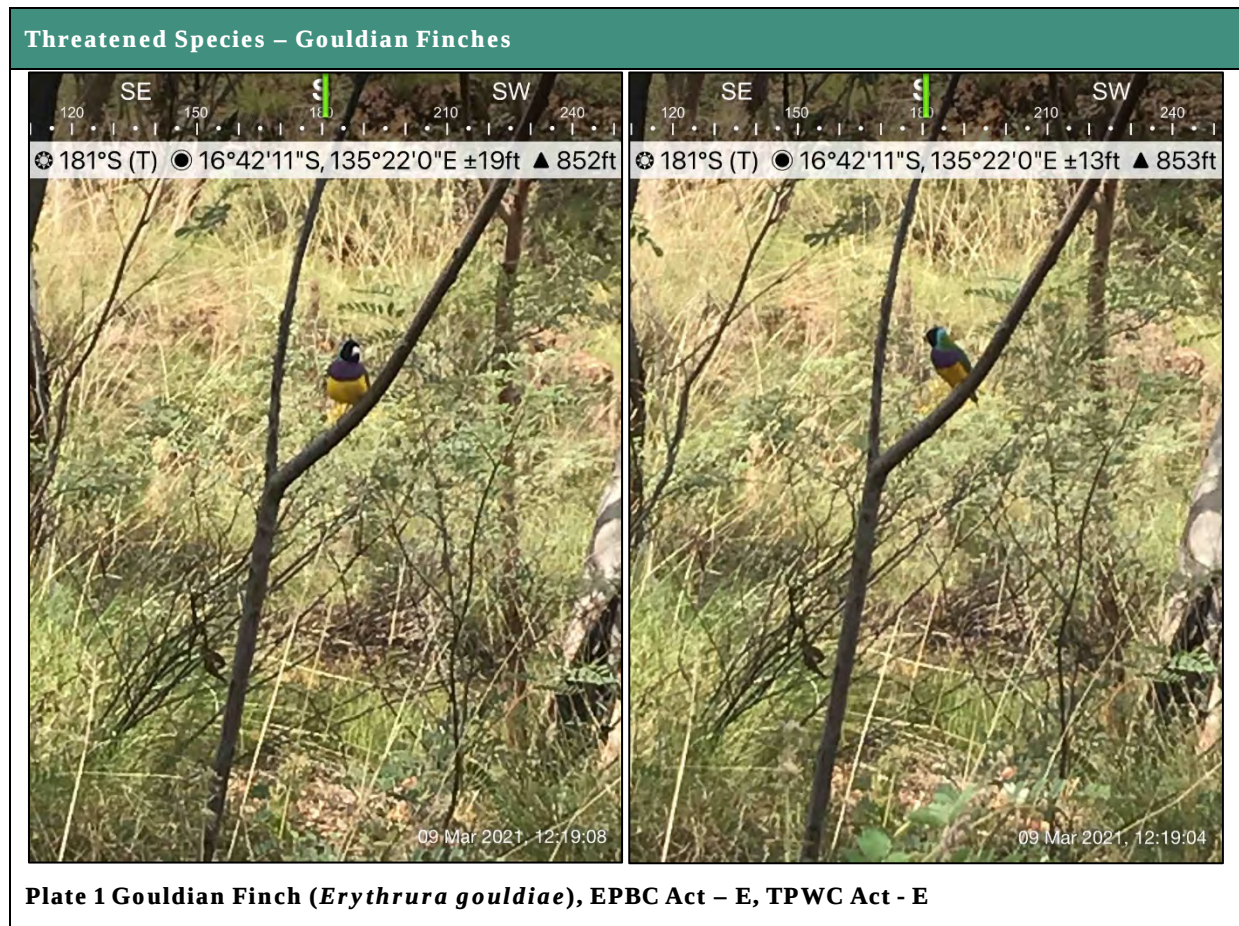


4 FIELD ASSESSMENT RESULTS

4.1 Threatened Species

One (1) threatened fauna species (Gouldian Finch (*Erythrura gouldiae*)) which is listed as endangered € under the EPBC Act and TPWC Act, was observed within EP187 during the March 2021 survey. Eight (8) Gouldian finches were observed in a rest area approximately 22km east of the proposed exploration area (refer **Figure 3**). No other threatened fauna or flora species were observed during on-ground surveys.

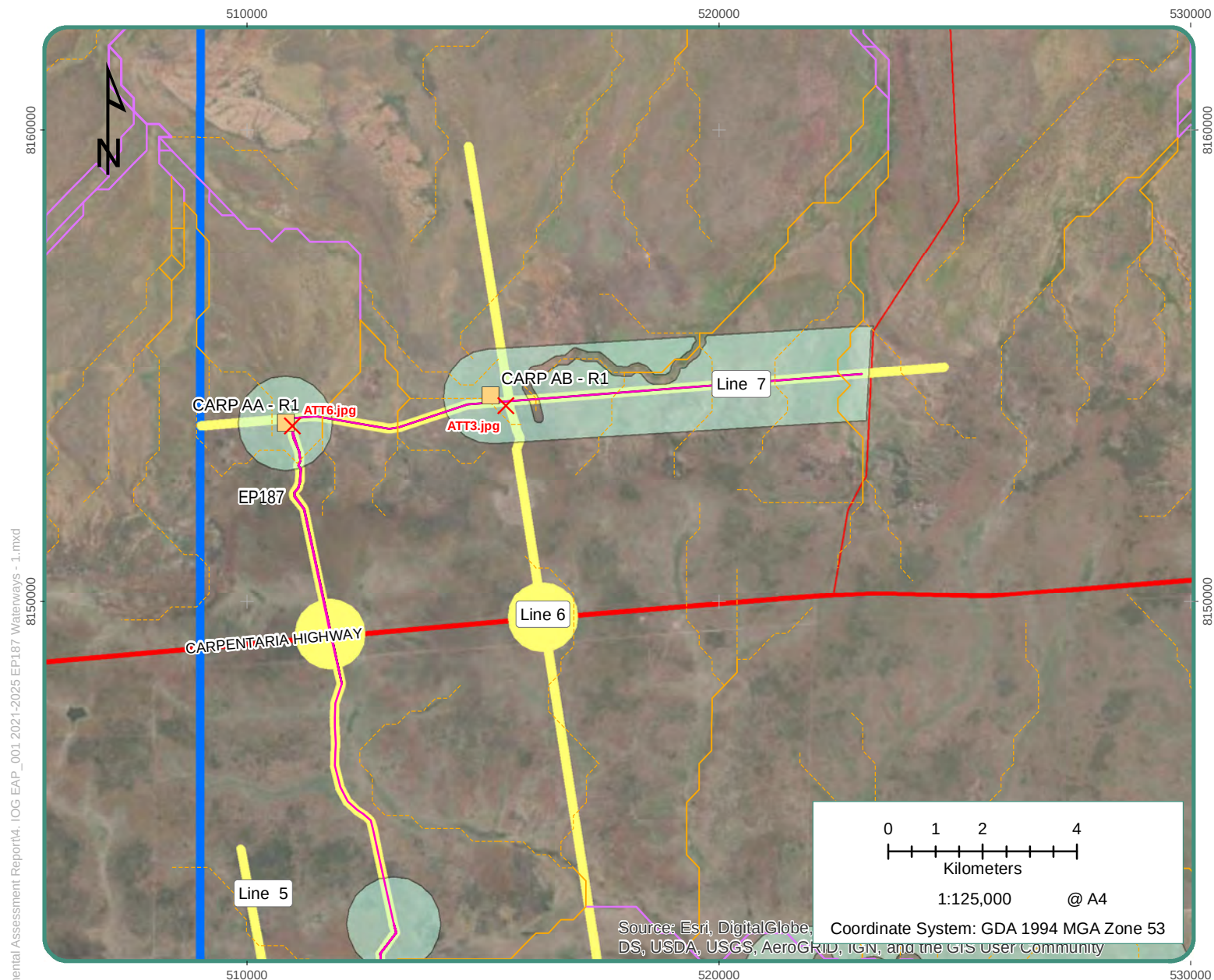
Table 6 Gouldian Finches observed on EP187



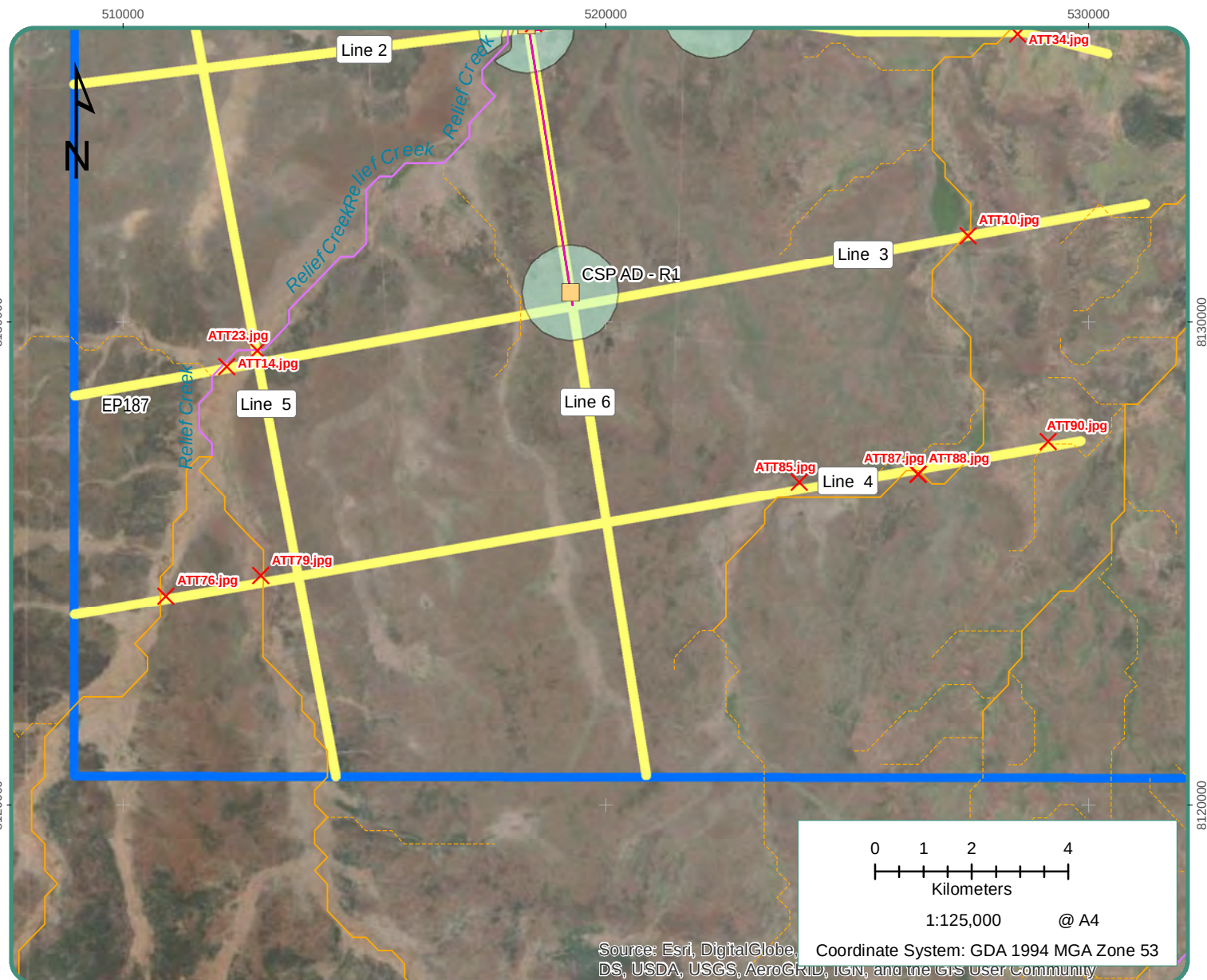
4.2 *Waterways*

There are several Stream Order 1 and 2 ephemeral waterways and one (1) Stream Order 3 (Relief Creek) within the proposed exploration areas (refer **Figure 4** (1-3)). Disturbance from cattle was observed on most waterways and drainage lines across the exploration areas. Relief Creek contains riparian vegetation, including eucalypt vegetation with hollows which will be avoided by maintaining buffer distances in accordance with Table 19 (Recommended Widths for Riparian Buffers) of the Land Clearing Guidelines (LCG) (2019). These buffers distances are:

- Drainage lines and 1st order streams = 25m buffer from outer edge of drainage depression or riparian vegetation / levee
- 2nd order streams = 50 m buffer
- 3rd order creeks = 100 m buffer



TITLE: 2021-2025 EP187 Waterways (Map 1 of 3)		LEGEND		
MAP NO: Figure 4-1 PROJECT: EP187 March 2021 Environmental Assessment Report	X GeoTagged photos Wellpads Proposed pipelines Proposed access AAPA 2021 Works Type A AAPA 2021 Works Type B	Stream Order Intermittant Streams 1 2 Creeks 3 4	Rivers 5 6 7 Tenements	



TITLE: 2021-2025 EP187 Waterways (Map 3 of 3) MAP NO: Figure 4-3 PROJECT: EP187 March 2021 Environmental Assessment Report	LEGEND - GeoTagged photos - Wellpads - Proposed pipelines - Proposed access - AAPA 2021 Works Type A - AAPA 2021 Works Type B Stream Order - Intermittent Streams 1 2 3 4 Rivers 5 6 7 - Tenements FOX & CO ENVIRONMENTAL
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4.3 *Habitat Descriptions*

The following table describes the habitats that occur within the exploration areas, including adjacent areas. The areas of intact vegetation provide a range of habitats that may support a diversity of fauna species.

Table 7 Habitat Descriptions

Ephemeral Waterways and Riparian Vegetation

Plate 2 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 • Riparian woodlands associated with Relief Creek have some hollows which are important for hollow-dependent animals (e.g. parrots, bats, finches (eg. Gouldian Finch)) • Drainage lines and waterways were impacted by cattle, pigs and buffalo • Potential habitat for Gouldian finch (<i>Erythrura gouldiae</i>) where eucalypt and paperbark woodlands, usually with a grassy understorey, occur in the vicinity • Potential habitat for painted honeyeater (<i>Grantiella picta</i>) where riparian woodlands have an abundance of mistletoes. • Riparian eucalypt vegetation along Relief Creek is likely a Groundwater Dependent Ecosystem (GDE), which is typical in highly monsoonal environments with prolonged dry seasons. These will not be impacted as the exploration will adhere to the LCG buffer areas associated with waterways and drainage lines.

Woodland or Shrubland



Plate 3 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*) and yellow-spotted monitor (*Varanus panoptes*). Dry *Eucalyptus* and *Acacia* in open forests, open woodland, tall shrublands, tussock grasslands and hummock grasslands.

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

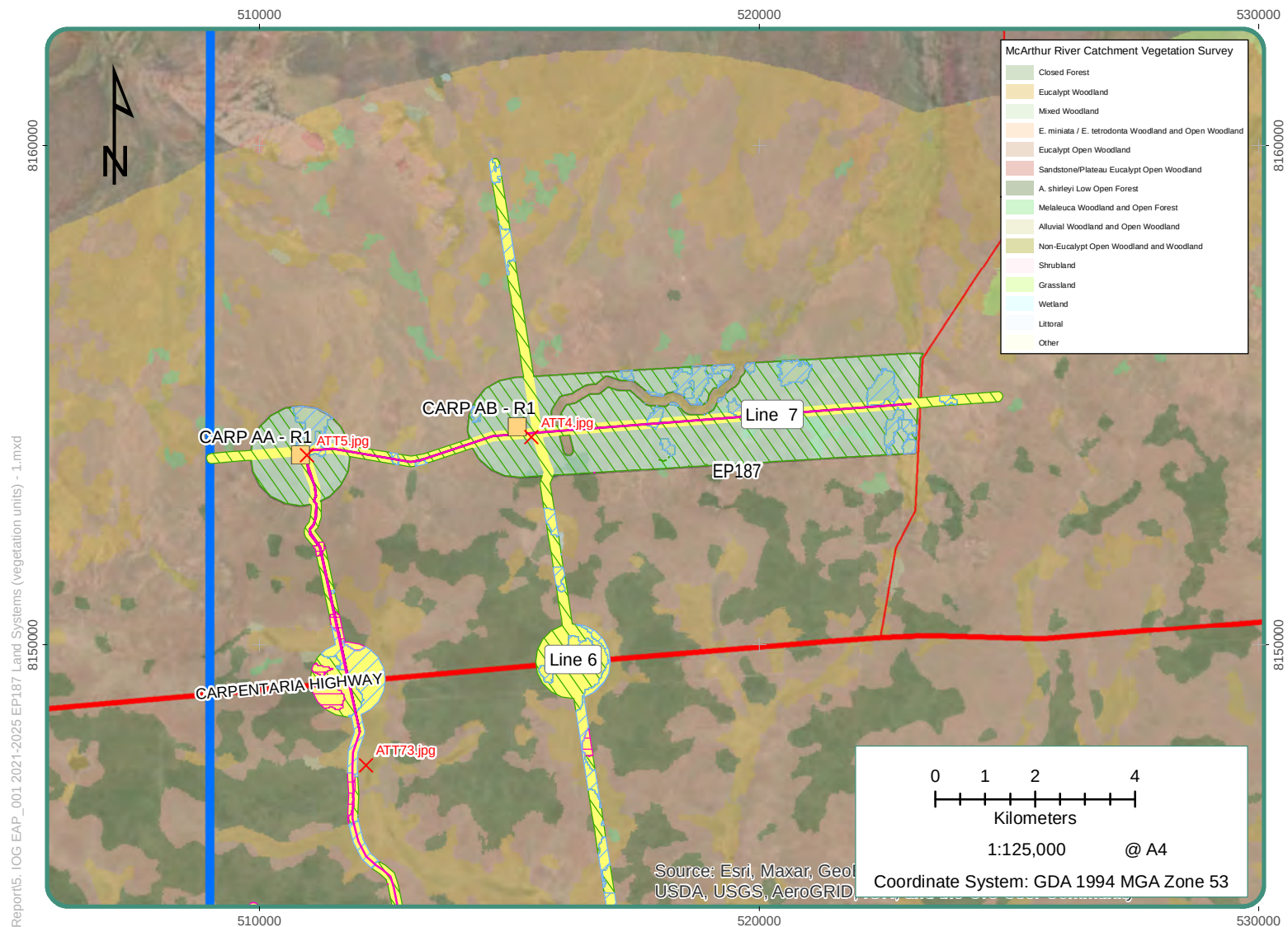
Acacia shirleyi (lancewood)



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: 2021-2025 EP187
Land Systems (vegetation units)
(1 of 3)

MAP NO: Figure 5-1

PROJECT: EP187 March 2021
Environmental Assessment Report

LEGEND

- GeoTagged photos
- Wellpads
- Proposed pipelines
- Proposed access
- AAPA 2021 Works Type A
- AAPA 2021 Works Type B
- Tenements

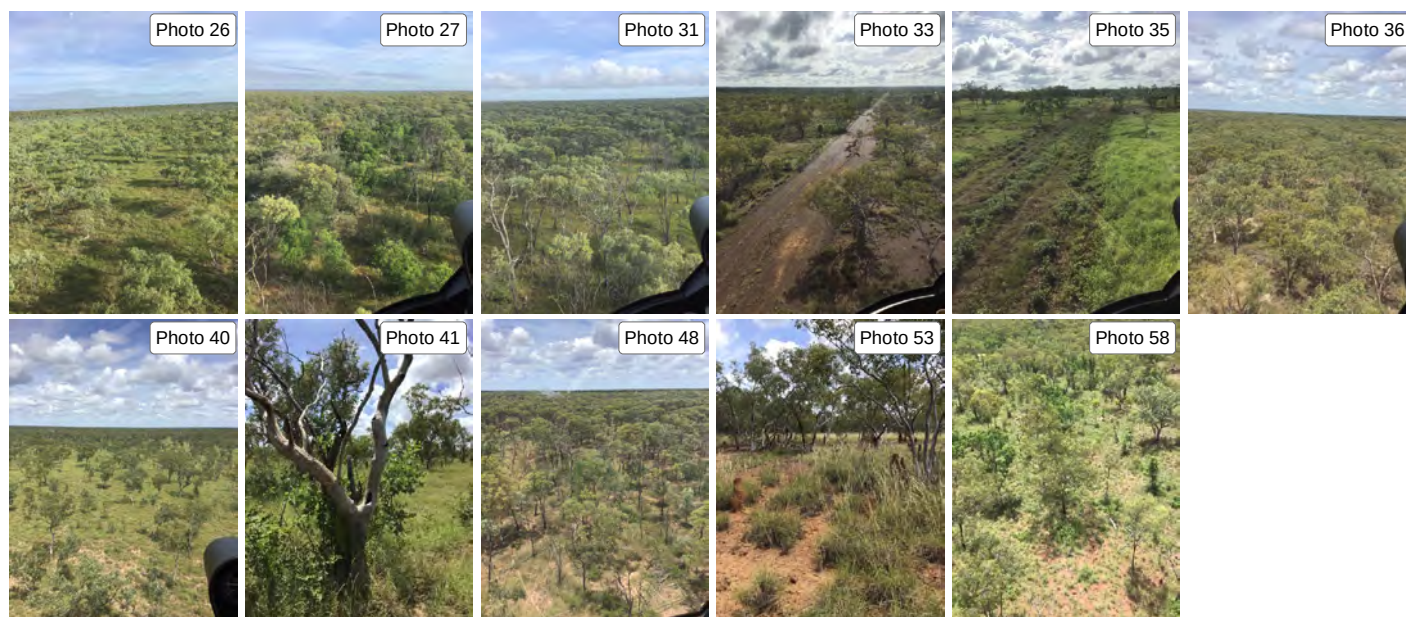
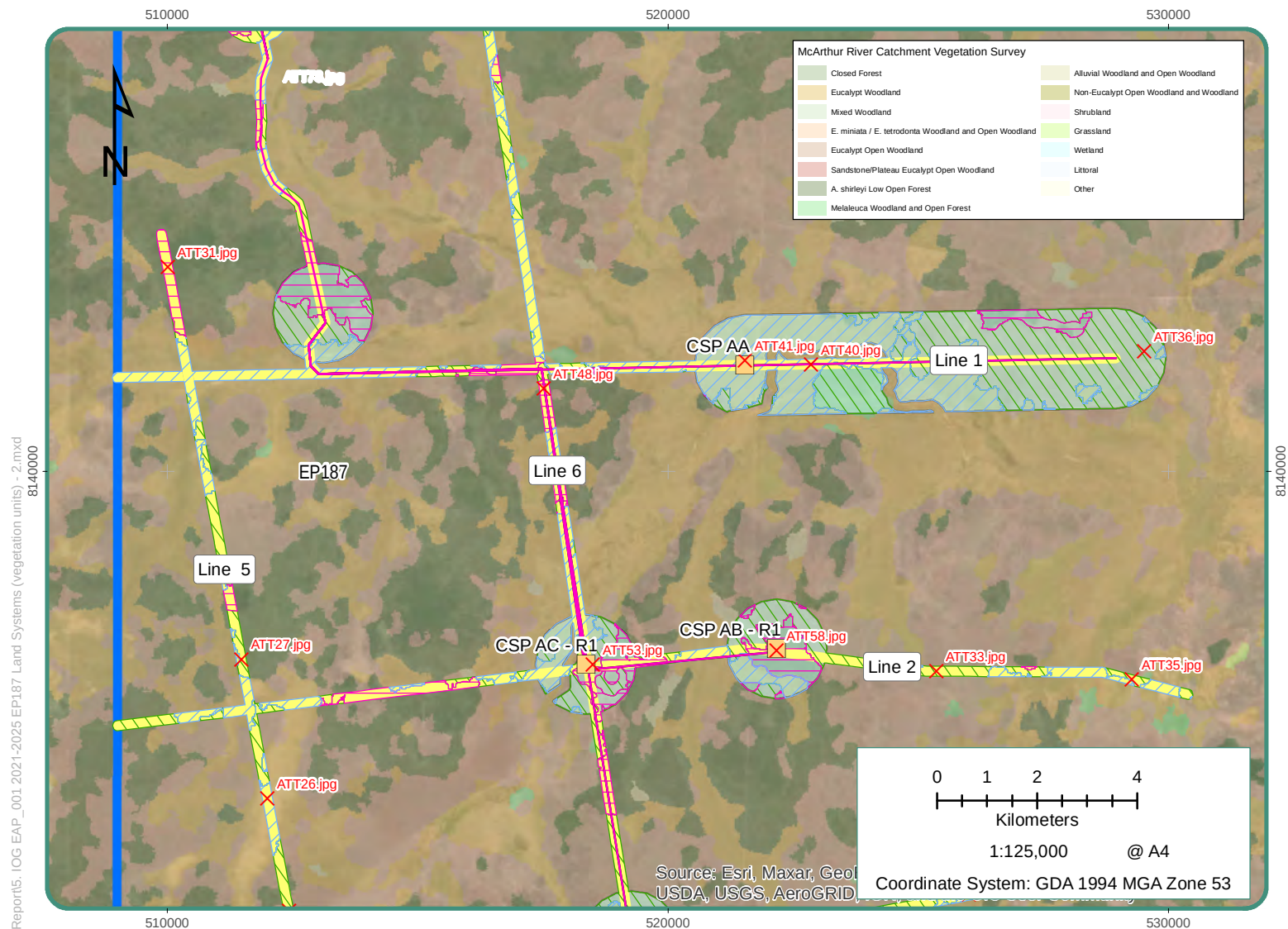
Roads

- Principal Road
- Secondary Road
- Minor Road

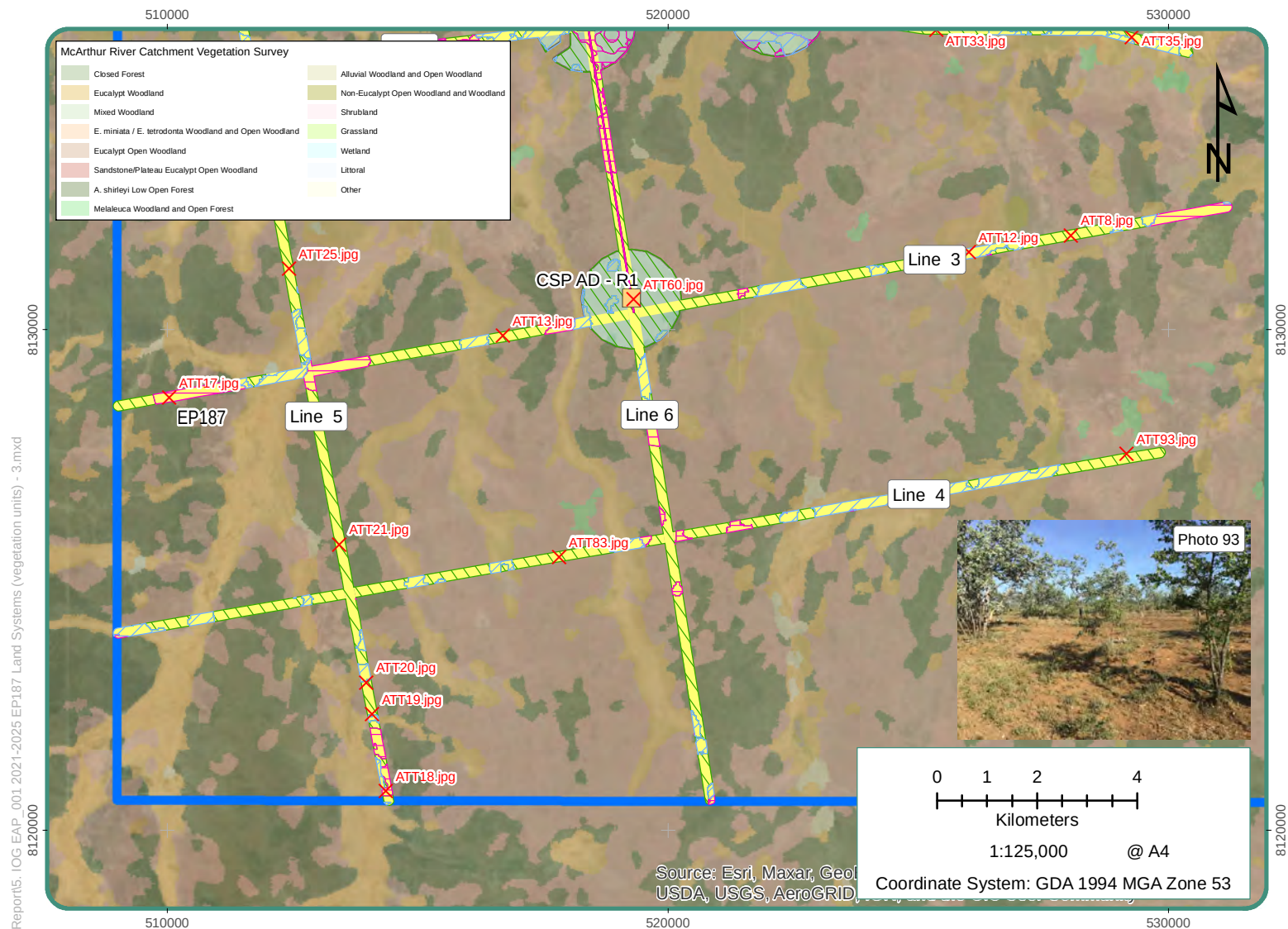
Vegetation communities

- Eucalypt woodland
- Open woodland / grassland
- Shirleyi





TITLE: 2021-2025 EP187 Land Systems (vegetation units) (2 of 3)		LEGEND X GeoTagged photos Wellpads Proposed pipelines Proposed access AAPA 2021 Works Type A AAPA 2021 Works Type B Tenements		Roads Principal Road Secondary Road Minor Road Vegetation communities Eucalypt woodland Open woodland / grassland Shirleyi		
MAP NO: Figure 5-2						
PROJECT: EP187 March 2021 Environmental Assessment Report						



TITLE: 2021-2025 EP187
Land Systems (vegetation units)
(3 of 3)

MAP NO: Figure 5-1

PROJECT: EP187 March 2021
Environmental Assessment Report

LEGEND

- GeoTagged photos
- Wellpads
- Proposed pipelines
- Proposed access
- AAPA 2021 Works Type A
- AAPA 2021 Works Type B
- Tenements

Roads

- Principal Road
- Secondary Road
- Minor Road

Vegetation communities

- Eucalypt woodland
- Open woodland / grassland
- Shirleyi

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5 CONCLUSION

A number of previous environmental investigations have been undertaken on EP187 to gain an understanding of 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 access tracks (Area A) and well pads and buffer areas (Area B). The ecological assessment was carried out to identify weeds, key ecological characteristics such as waterways, and potential constraints to the proposed seismic and drilling activities on EP187 in the Northern Territory.

One (1) threatened fauna species (Gouldian Finch (*Erythrura gouldiae*)) was observed within EP187 during the March 2021 survey. A flock of eight (8) Gouldian finches were observed approximately 22km east of the proposed exploration area. No other 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, well pad and access track construction are considered low.

6 RECOMMENDATIONS

The following is recommended to ensure compliance with regulatory provisions:

- Undertake post-exploration rehabilitation surveys.
- Maintain buffer distances from waterways in accordance with the LCG (2019)
- Undertake works in accordance with approved clearing permits and environmental management plans.

7 WORKS CITED AND RELEVANT REFERENCE DOCUMENTS

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- Department of the Environment . (2021, March 26). *Macrotis lagotis* in *Species Profile and Threats Database*. Retrieved from Department of the Environment SPRAT: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=282
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- Department of the Environment. (2021, March 26). *Erythrotriorchis radiatus* in *Species Profile and Threats Database*. Retrieved from Department of the Environment SPRAT: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=942
- Department of the Environment. (2021, March 26). *Erythrura gouldiae* in *Species Profile and Threats Database*. Retrieved from Department of Environment SPRAT: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=413

- Department of the Environment. (2021, March 26). *Macroderma gigas* in *Species Profile and Threats Database*,. Retrieved from Department of the Environment SPRAT: <http://www.environment.gov.au/cgi-bin/sprat/public/spratlookupspecies.pl?name=Macroderma+gigas&searchtype=Wildcard>
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- Department of the Environment. (2021, March 26). *Tyto novaehollandiae kimberli* in *Species Profile and Threats Database*. Retrieved from Department of the Environment SPRAT: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=26048
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- Higgins, P. J. (1999). *Handbook of Australian, New Zealand and Antarctic Birds Volume 4: Parrots to Dollarbird*. Melbourne: Oxford University Press.
- Morcombe, M. (2004). *Steve Parish Field Guide: Australian Birds*. Steve Parish.
- Northern Territory Government. (2012). *Grey falcon*. Retrieved from Threatened Species of the Northern Territory: https://nt.gov.au/__data/assets/pdf_file/0020/206354/grey-falcon.pdf

APPENDIX A

Search Results



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.

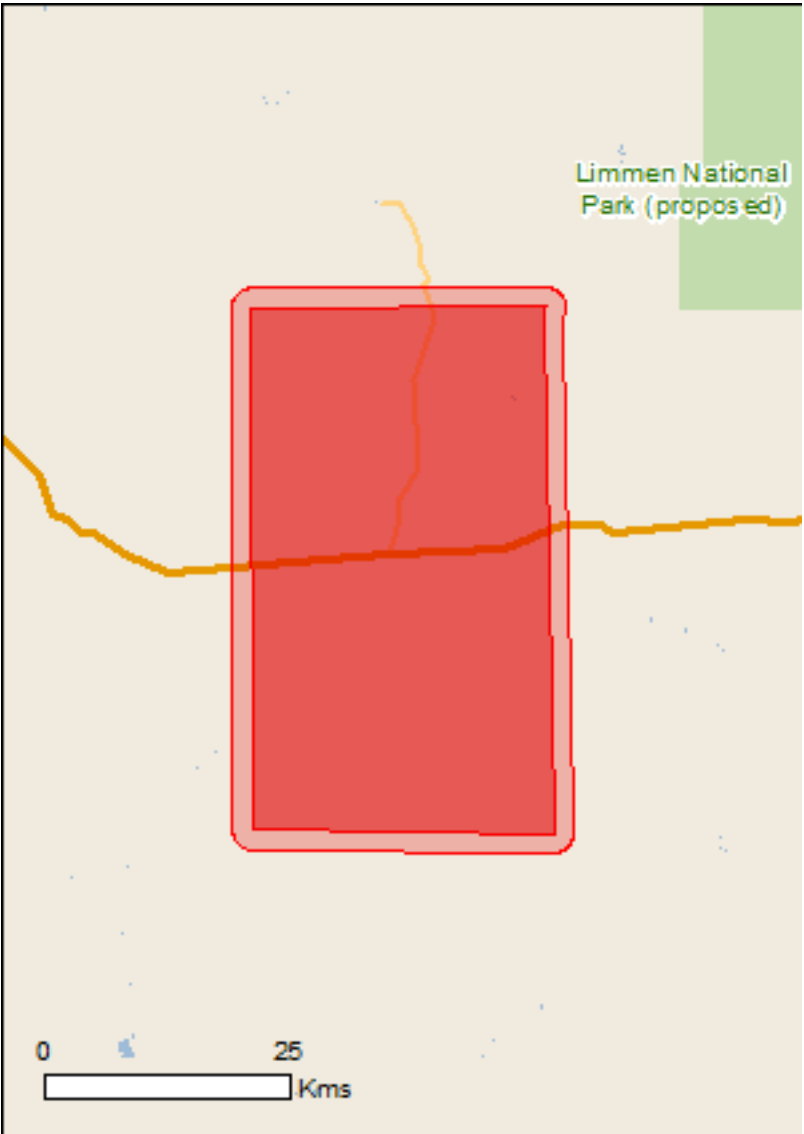
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

Report created: 16/03/21 15:32:24

- [Summary](#)
- [Details](#)

[Matters of NES](#)[Other Matters Protected by the EPBC Act](#)[Extra Information](#)
- [Caveat](#)
- [Acknowledgements](#)



This map may contain data which are
©Commonwealth of Australia
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[Coordinates](#)

Buffer: 2.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	12
Listed Migratory Species:	14

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:	None
Regional Forest Agreements:	None
Invasive Species:	12
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

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

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

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat may occur within area
Hirundo daurica Red-rumped Swallow [59480]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within

Name	Threatened	Type of Presence
Motacilla flava Yellow Wagtail [644]		area Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Reptiles		
Crocodylus johnstoni Freshwater Crocodile, Johnston's Crocodile, Johnstone's 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

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		
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Bubalus bubalis Water Buffalo, Swamp Buffalo [1]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Plants		
Acacia nilotica subsp. indica Prickly Acacia [6196]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur 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

-16.514986 135.352312,-16.516604 135.349877,-16.974242 135.35949,-16.971615 135.084832,-16.515644 135.083834,-16.514986 135.352312

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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Common Name	Scientific Name
Crested Pigeon	<i>Ocyphaps lophotes</i>
Diamond Dove	<i>Geopelia cuneata</i>
Peaceful Dove	<i>Geopelia placida</i>
Pallid Cuckoo	<i>Heteroscenes pallidus</i>
Australian Bustard	<i>Ardeotis australis</i>
White-necked Heron	<i>Ardea pacifica</i>
Black-breasted Buzzard	<i>Hamirostra melanosternon</i>
Wedge-tailed Eagle	<i>Aquila audax</i>
Spotted Harrier	<i>Circus assimilis</i>
Brown Goshawk	<i>Accipiter fasciatus</i>
Whistling Kite	<i>Haliastur sphenurus</i>
Black Kite	<i>Milvus migrans</i>
Rainbow Bee-eater	<i>Merops ornatus</i>
Sacred Kingfisher	<i>Todiramphus sanctus</i>
Blue-winged Kookaburra	<i>Dacelo leachii</i>
Nankeen Kestrel	<i>Falco cenchroides</i>
Brown Falcon	<i>Falco berigora</i>
Cockatiel	<i>Nymphicus hollandicus</i>
Red-tailed Black-Cockatoo	<i>Calyptorhynchus banksii</i>
Galah	<i>Eolophus roseicapilla</i>
Red-winged Parrot	<i>Aprosmictus erythropterus</i>
Northern Rosella	<i>Platycercus venustus</i>
Red-collared Lorikeet	<i>Trichoglossus rubritorquis</i>
Budgerigar	<i>Melopsittacus undulatus</i>
Great Bowerbird	<i>Ptilonorhynchus nuchalis</i>
Black-tailed Treecreeper	<i>Climacteris melanurus</i>
Variegated Fairy-wren	<i>Malurus lamberti</i>
Red-backed Fairy-wren	<i>Malurus melanocephalus</i>
Silver-crowned Friarbird	<i>Philemon argenticeps</i>
Little Friarbird	<i>Philemon citreogularis</i>
Banded Honeyeater	<i>Cissomela pectoralis</i>
Brown Honeyeater	<i>Lichmera indistincta</i>
Rufous-throated Honeyeater	<i>Conopophila rufogularis</i>
Singing Honeyeater	<i>Gavicalis virescens</i>
Grey-fronted Honeyeater	<i>Ptilotula plumula</i>
Yellow-tinted Honeyeater	<i>Ptilotula flavescens</i>
Red-browed Pardalote	<i>Pardalotus rubricatus</i>
Striated Pardalote	<i>Pardalotus striatus</i>
White-throated Gerygone	<i>Gerygone olivacea</i>
Weebill	<i>Smicrornis brevirostris</i>
Grey-crowned Babbler	<i>Pomatostomus temporalis</i>
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>
White-bellied Cuckoo-shrike	<i>Coracina papuensis</i>
White-winged Triller	<i>Lalage tricolor</i>

Common Name	Scientific Name
Rufous Whistler	<i>Pachycephala rufiventris</i>
Grey Shrike-thrush	<i>Colluricincla harmonica</i>
Crested Bellbird	<i>Oreoica gutturalis</i>
Australian Magpie	<i>Gymnorhina tibicen</i>
Pied Butcherbird	<i>Cracticus nigrogularis</i>
Black-faced Woodswallow	<i>Artamus cinereus</i>
Little Woodswallow	<i>Artamus minor</i>
Willie Wagtail	<i>Rhipidura leucophrys</i>
Torresian Crow	<i>Corvus orru</i>
Restless Flycatcher	<i>Myiagra inquieta</i>
Magpie-lark	<i>Grallina cyanoleuca</i>
Apostlebird	<i>Struthidea cinerea</i>
Jacky Winter	<i>Microeca fascinans</i>
Hooded Robin	<i>Melanodryas cucullata</i>
Mistletoebird	<i>Dicaeum hirundinaceum</i>
Long-tailed Finch	<i>Poephila acuticauda</i>
Double-barred Finch	<i>Taeniopygia bichenovii</i>

APPENDIX B

Likelihood of Occurrence

Table 8 Likelihood of Occurrence

Species Name	EPBC Act Status	TPWC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
AVES					
<i>Erythrura gouldiae</i> 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 <i>E. tintinnans</i> , <i>E. brevifolia</i> and <i>E. leucophloia</i>) Its breeding habitat is usually confined to ridges and rocky foothills, probably due to the presence of Sorghumgrasses (Department of the Environment, 2021) (Morcombe, 2004)	Occurs The species was identified in EP187 during March 2021 surveys. No clearing is proposed in this area as the seismic activity is 22km away to the west.
<i>Falco hypoleucos</i> 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 (Northern Territory Government, 2012).	Moderate potential to occur Suitable habitat exists. Given the narrow linear nature of clearing, the likelihood of impact is considered low.
<i>Falcunculus frontatus whitei</i> 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 , 2021).	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
<i>Grantiella picta</i> 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	Low to Moderate potential to occur

Species Name	EPBC Act Status	TPWC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
				shrublands, often with abundant mistletoe (Birdlife Australia, 2021) (Morcombe, 2004)	The species has been recorded in the region (desktop searches) however not within the study area. Suitable habitat is present anywhere mistletoe is present. Is likely a rare visitor from Qld. Dependent on mistletoe. Avoid clearing Acacia and Eucalypt with mistletoe. Risk of impact is considered low.
<i>Tyto novaehollandiae kimberli</i> Masked Owl (northern)	V	V		Inhabits tall, open Eucalypt forests (particularly those dominated by Eucalyptus miniata and E. tetradonta). 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 (<i>Tyto alba</i>), though the Masked Owl is larger, darker and has more feathering on the feet (Department of the Environment, 2021) (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 in the proposed exploration area are proposed to be cleared. No clearing of hollow-bearing trees (HBT) will occur. Risk of impact is considered low.
<i>Erythrotriorchis radiatus</i> 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, 2021).	Low potential to occur No previous records and no suitable habitat

Species Name	EPBC Act Status	TPWC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
MAMMALIA					
<i>Macroderma gigas</i> 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° latitude (north of the study area which is 16° latitude) as well as Elcho Island, Groote Eylandt and other nearby islands (Department of the Environment, 2021).	Low potential to occur Current known distribution does not encompass study area and no suitable habitat in study area.
<i>Macrotis lagotis</i> Greater Bilby	V	V	V	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 <i>Acacia kempeana</i> , <i>A. hillebrandii</i> and <i>A. rhodophylla</i> , 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 , 2021).	Low potential to occur Current known distribution does not encompass study area
<i>Mesembriomys macrurus</i> 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, 2021).	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
REPTILIA					

Species Name	EPBC Act Status	TPWC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
<i>Acanthophis hawkei</i> 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 proposed exploration areas. Risk considered low due to lack of suitable habitat.
<i>Varanus panoptes</i> 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 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 1976* (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

Appendix 02 - Project Activities

2. - Project Activities

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Foreword

This appendix gives an overview of regulated activities to be carried out under EMP IMP 4 and its revisions, referred to in this document as the EMP.

2.1 2D Seismic Survey

2.1.1 Overview

The 2D seismic survey aims to produce detailed images of the various formations and their location beneath the earth's surface.

The proposed seismic survey method uses vibrator trucks to produce sound waves. These sound waves are reflected off underground rock formations, and the waves that reflect back to the surface are captured by recording sensors (geophones).

The returning reflections are recorded in a digital format and sent to a seismic data processing centre to produce a 'cross-section' of the earth's crust layers. Analysing the waves' time to return provides valuable information about rock types and possible gases or fluids in rock formations.

The 2D seismic lines are laid out in a grid pattern to help construct a better understanding of the operating area's geology.

Seismic acquisition operations are carried out over a relatively short time, with generally less than two months between line clearing and line rehabilitation; the traffic volumes over that time are very low, with less than 40 total vehicle movements. The majority of movements are carried out using light four-wheel drives, plus one traverse of the Vibroseis buggies.

2.1.2 Methodology

Imperial will have an ecologist on-site before or during clearing operations to undertake ground-truthing for ground-disturbing activities in advance of any ground disturbance.

Wherever practical, ground disturbance will be restricted to removing rocks and fallen branches and clearing taller grasses and shrubs to provide sufficient ground contact of the seismic vibro-source and the geophones and minimise fire risk.

Where ground clearance is unavoidable, such disturbance will be undertaken with a grader and blade up bulldozer; the access width will be 4m wide, with minimal ground disturbance sufficient to provide safe vehicle access.

Figure 2.1 Shows two seismic vibrator trucks working on a cleared line.



Figure 2.1: Two Seismic vibrator trucks working

The impact to trees of significance or environmentally sensitive flora or fauna will be minimised as practicable during the proposed program; a decision tree for the tree clearing for seismic acquisition operations is shown in Figure 2.10 : Tree Clearing Decision Tree for Seismic Acquisition.

Figure 2.2 shows a bulldozer, grader and fire response vehicle carrying out seismic line clearing activities, deviating the line to avoid clearing trees.



Figure 2.2: Seismic line clearing activities

Figure 2.3 shows a cleared seismic line, with the majority of grasses and rootstock left in place to minimise erosion and facilitate quick revegetation.



Figure 2.3: Cleared seismic acquisition line

Where patches of *Acacia shirleyi* are present along the seismic lines, they will require clearing as they are too dense to allow the machinery to work through. Imperial will deviate seismic lines and linear infrastructure within the approved corridor to minimise the amount of *Acacia shirleyi* cleared, as shown in Figure 2.4. A large proportion of the vegetation mapped as *Acacia shirleyi* is not; this is visible in Figure 2.4; this will be ground-truthed during seismic acquisition operations.

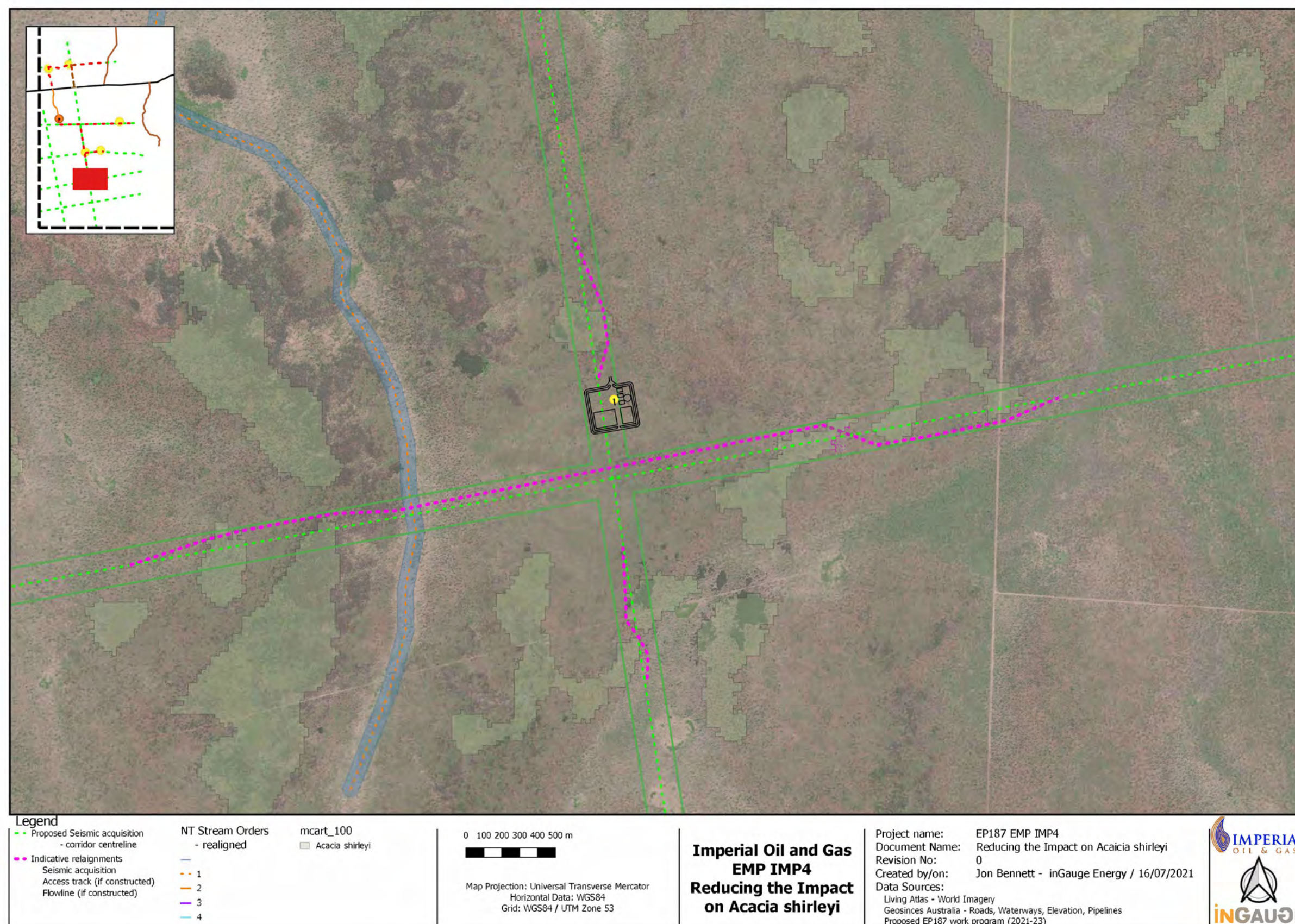


Figure 2.4: Reducing the Impact on Acacia shirleyi

Timber and vegetation will be cleared from the seismic acquisition alignment and stockpiled for future rehabilitation activities.

There will be an overlap of the line clearing, survey, data acquisition, and rehabilitation phases of the seismic program to reduce the survey's overall time and associated rehabilitation as much as practicable.

Vegetation will be returned to the seismic lines, and windrows will be removed during rehabilitation. Rootstocks are to be left in place in such a manner to promote rapid regrowth of original plant species, as shown in Figure 2.5



Figure 2.5: Seismic acquisition line rehabilitation

Figure 2.6 shows cleared *Acacia shirleyi* placed onto a cleared area during rehabilitation to protect the soil and promote revegetation.

Figure 2.7 shows a seismic line 18 months after the acquisition program, with full ground cover.



Figure 2.6: Respreading *Acacia shirleyi* over a seismic line during rehabilitation



Figure 2.7: Seismic line 18 months after the acquisition

Several historical pastoral access ways exist through the area, and newer access ways developed by pastoralists holding S19 permits. Where available, access to seismic lines will utilise the existing roadways and pastoral tracks.

The Seismic acquisition process requires only a small traffic volume, predominately of light 4-wheel drives and the Vibroseis buggies; all of these vehicles are quite low ground impact and reasonably agile. As such, vegetation clearing within watercourses and their associated buffers can be avoided, as shown in Figure 2.8 and Figure 2.9. because of this, even alignments through watercourses and riparian vegetation that are planned as access tracks and flowline routes will not be cleared during seismic acquisition activities.



Figure 2.8: Vibroseis buggy traversing uncleared watercourse (a)



Figure 2.9: Vibroseis buggy traversing uncared watercourse (b)

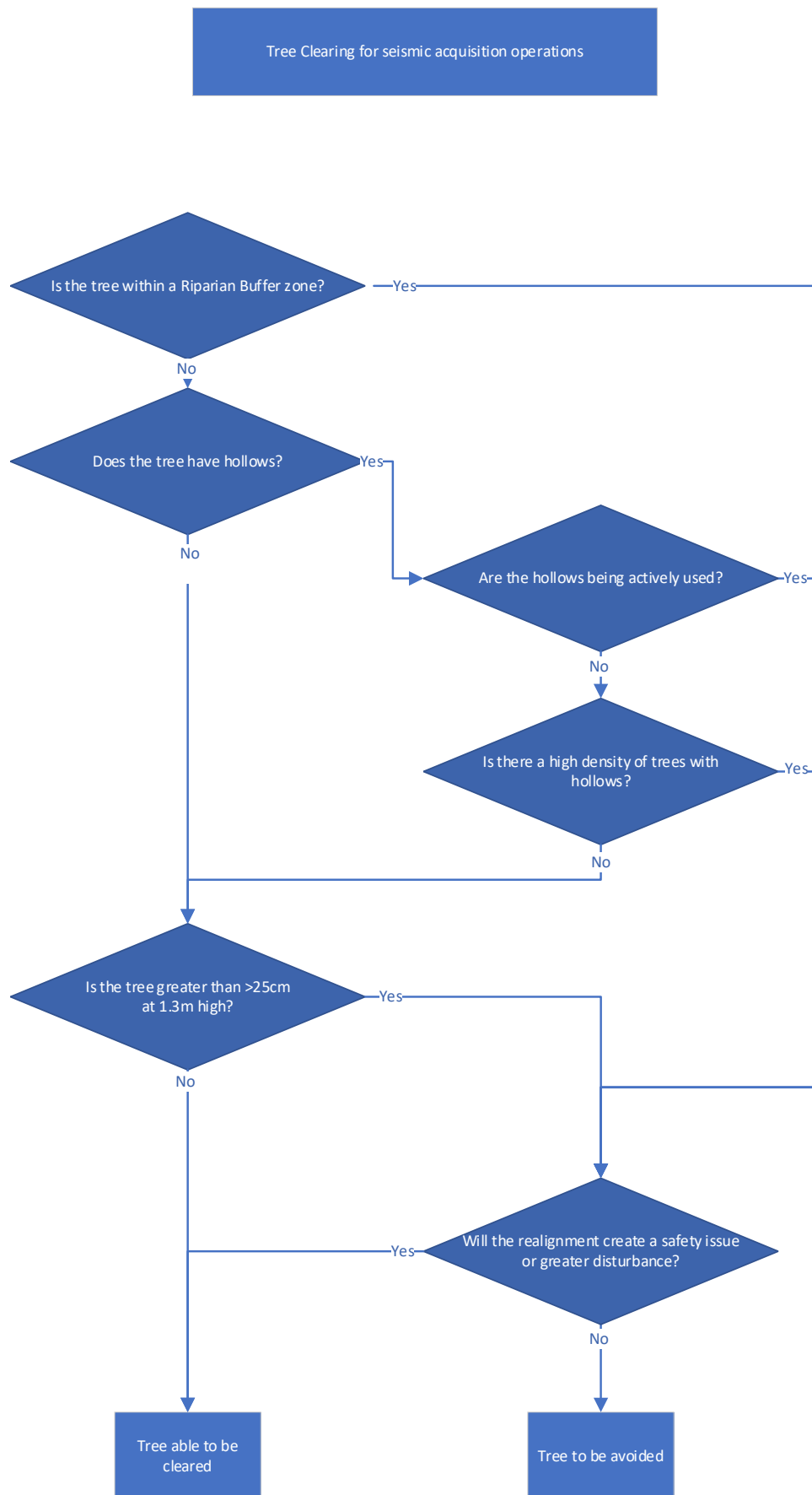


Figure 2.10 : Tree Clearing Decision Tree for Seismic Acquisition

2.2 Access Track Construction

2.2.1 Overview

Imperial will have an ecologist on-site before or during clearing operations to undertake ground-truthing for ground-disturbing activities in advance of any ground disturbance.

Six-metre wide access tracks will be constructed as required to provide access to wellpads and other facilities, where practicable access tracks will follow the disturbance footprint of the seismic survey or existing disturbed areas.

The construction of access tracks will require vegetation clearing and rootstock removal, including within riparian zones; however, the path of least impact will be selected within the working corridor.

As indicated in Appendix 01.02, the majority of the riparian zones are degraded from uncontrolled cattle access and the resultant unmanaged erosion. Figures 3.13 through 3.32 (inclusive) of the EMP show desk-topped proposed stream crossings for seismic lines, access tracks and flowlines. These stream crossings will further ground-truthed for the lowest impact alignment within the working corridor before construction.

Access tracks will increase to a maximum of 15m wide at intersections to allow for a safe turning radius and visibility. Turn out drains will be constructed as required, avoiding mature trees. The clearing area for intersections and drains is included in the access track land clearing area calculations.

Where required local material will be utilised from quarries to provide a wear surface for road sections.

The impact to trees of significance or environmentally sensitive flora or fauna will be minimised as practicable during the proposed program; a decision tree for the tree clearing to construct linear infrastructure, i.e. access tracks and flowlines is shown in Figure 2.11: Tree Clearing Decision Tree for Linear Infrastructure Construction.

2.2.2 Methodology

Timber and vegetation will be cleared from the access track alignment and stockpiled for future rehabilitation activities. These stockpiles will be situated in naturally clear areas to avoid further vegetation clearing if a naturally clear area is available with the immediate vicinity. The access track will be formed and compacted utilising on-site materials; materials will be imported as required where the local material is not suitable, e.g. watercourse crossings. Erosion and sediment controls will be constructed as per Appendix 05 (Erosion and Sediment Control Plan).

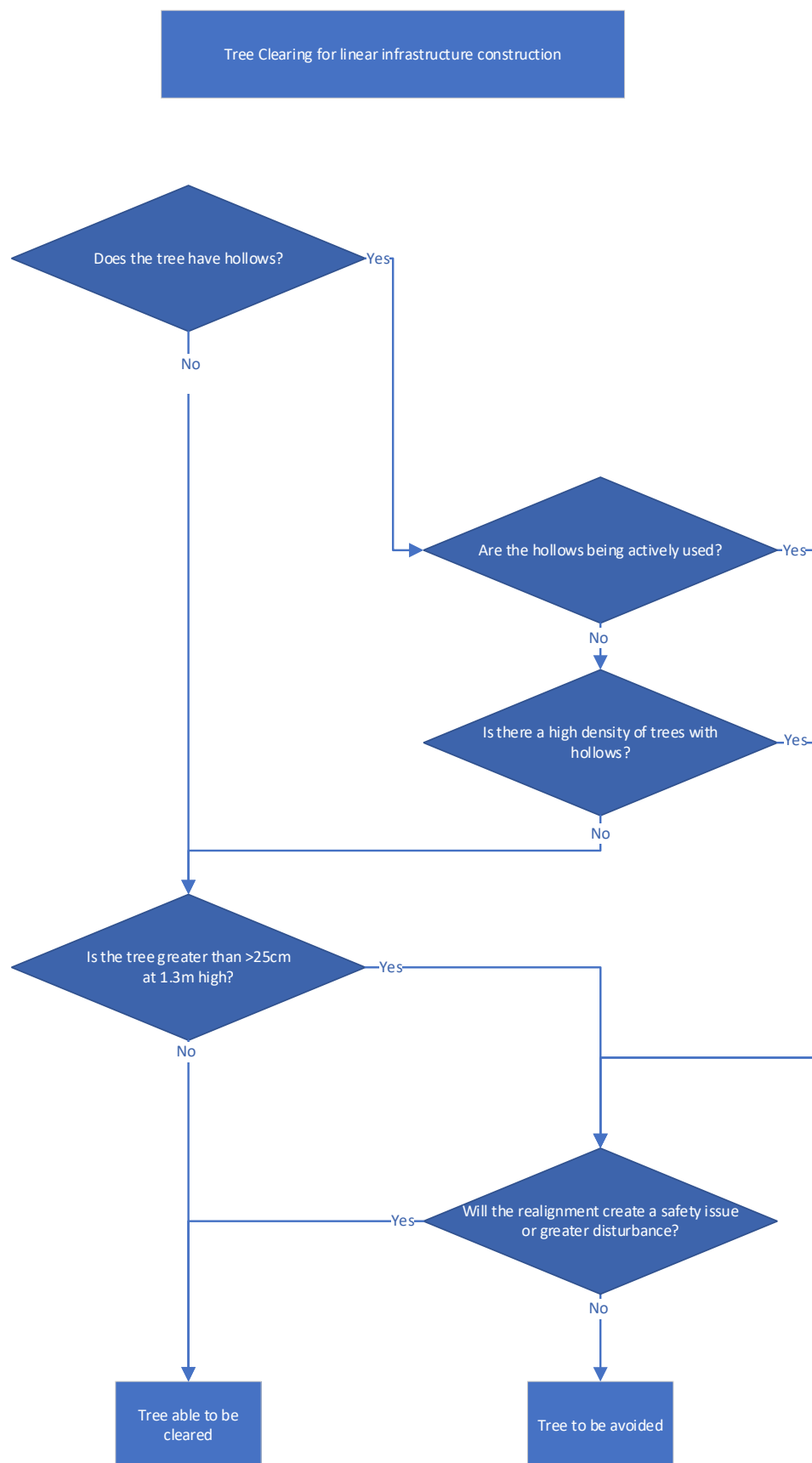


Figure 2.11: Tree Clearing Decision Tree for Linear Infrastructure Construction

2.3 Flowline Construction, Operation and Decommissioning

2.3.1 Overview

Imperial will have an ecologist on-site before or during, clearing operations to undertake ground-truthing for ground-disturbing activities in advance of any ground disturbance, to ensure the actual riparian zones and the buffers for drainage depressions, and stream orders 1 to 4, and the location and density of hollow-bearing trees and their buffers, are identified, and regulated activities are avoided in sensitive areas.

Imperial may install a Wastewater Gathering Network, utilising low-pressure (less than 1,500kPag) Polyethelene (PE) flowlines. If used, these will be constructed as required to provide the ability to safely and efficiently transfer high volumes of fluids between wellpads and other facilities.

Fluids transferred in the Gathering Network may include :

- Groundwater
- Drilling fluids
- Flowback Fluids
- Wastewater
- But will not include liquid or gaseous hydrocarbons or concentrated chemicals

Flowlines will be constructed, operated, maintained and abandoned in line with the "Code of Practice for Upstream PE Gathering Lines in the CSG Industry and Companion Papers" published 10 November 2018 (hereafter referred to as the PEGN Code).

The motivation for Imperial to install and operate the Wastewater Gathering Network is to:

- Reduce the land clearing requirements for storage tanks at each well site
- Provide the capability for recycling and reuse of fluids between well sites
- Optimise in-field Flowback Fluid and Wastewater treatment to a centralised location
- Reduce trucking requirements
- Reducing the amount of groundwater water take
- Reduce the amount of wastewater for final disposal
- Operate the well site to minimise the potential for contaminant releases to the environment and any potential impacts of such releases.

Depending on the order and timing of the appraisal program, it may not be beneficial to install the gathering network, e.g. if two wellpads are drilled relatively close together in a relatively short time, Imperial will likely construct flowlines between them. However, if wellpads are built in a more dispersed pattern across the project, it may not be the lowest impact approach, and flowlines may not be constructed. The current wellpad design in the EMP allows room for wastewater storage and treatment on each wellpad; where wastewater flowlines are built, the wellpad footprint will be reduced accordingly.

Imperial will bury any flowlines outside of wellpad fences to protect them from fire, flood, and damage from livestock and human activity; this is in line with industry best practice.

Flowlines will follow the disturbance footprint of access tracks or other disturbed areas to reduce the amount of land clearing required and allow efficient construction, operation and maintenance.

2.3.2 Methodology

Flowline installation will be carried out utilising the following steps:

- Right-Of-Way clearing & grubbing
- Pipe stringing
- Pipe Jointing
- Trenching and bedding
- Placing of pipe into the trench
- Backfilling and Compaction
- Pressure/leak testing
- Pipe location and marker-signposting
- Commissioning
- ROW reinstatement

Further detail is provided in the following sections.

2.3.3 Right of way clearing & grubbing

By following access tracks with Right-Of-Ways (ROWs), clearing requirements will be reduced to widening the access tracks by up to 6m, rather than clearing a dedicated 10m wide flowline route. The flowlines will be constructed utilising the access track as a work area; they will be buried off to the access track's side and marked to avoid trafficking directly above the buried flowline. Having the access tracks and ROWs on a joint alignment will also allow easy visual inspection of the ROW without a dedicated access track.

Timber, vegetation and debris such as rocks etc., will be cleared and grubbed next to access track alignment for ROWs and will be stockpiled on the edge of the ROW for future rehabilitation activities.

Before any ROW clearing is carried out in watercourses, Imperial will check the 7-day weather forecast to ensure an adequate window for the trenching, installation, backfill, and stabilisation works to be carried out.

2.3.4 Pipe stringing

The pipe will be either stick (~12m lengths) or coils of up to 100m. The pipe will be strung out on the ROW when clearing and grubbing for that section is complete. The pipe will not be strung across non-Imperial access tracks or watercourse crossings until it is ready for installation on the same day. When the pipe is strung from end to end, adequate topographic and geomorphic provision shall allow for unimpeded overland flow/drainage, access by property owners, fauna and construction traffic.

2.3.5 Pipe Jointing

PE pipe or fittings can be joined only by heat fusion (welding) or mechanical fittings. In the oil and gas industry, adhesives, cement or elastomeric joints cannot join PE pipes and fittings for water applications.

There are three types of heat fusion joints currently used - butt fusion welding, electrofusion welding and saddle fusion welding. Saddle fusion welding is typically not used in the oil and gas industry.

Pipe jointing is a skilled operation; several very specific procedures need to be carried out to achieve a successful joint. Imperial will approve jointing procedures of the service provider before construction begins.

Data loggers will be used to verify conformance to the nominated welding parameters. A unique weld numbering system will be established to identify each production weld and tie-in for traceability records.

2.3.5.1 Butt Welding

The most widely used method for joining individual lengths of PE pipe is by heat fusion of the pipe butt ends, as illustrated in Figure 2.12.



Figure 2.12. Standard Butt Fusion Join

This technique, which precludes the need for specially modified pipe ends or couplings, produces a permanent, economical and flow-efficient connection. Welding parameters used will follow PIPA Guideline POP 003, which provides guidelines for butt fusion welding parameters. The welding temperatures for PE pipe used in constructing flowlines are not high enough to be considered a potential cause for ignition.

The following procedures will be adopted to ensure the integrity of the fusion welds:

- a) The welding contractor shall have:
 - Demonstrated experience in fusion welding of PE pipe
 - Suitably sized equipment which has been maintained in good condition with calibration status documentation available
 - Qualified operators who have an up to date log detailing project and welding experience

b) Assessment of the proposed welding procedures:

- Pre-qualified welding procedures for pipe class and diameters being proposed for the project and the welding machines or control box which will be used and destructive weld testing data may be considered
- Carry out trial welds on the actual pipe to be used for the contract and have these destructively tested to meet the specified performance requirements (testing and minimum performance requirements are detailed in Section 7 – Inspection and Testing)
- Determine and document the agreed welding parameters, procedures, and welding equipment (this may also include the use of welding tents, pipe end covers etc.); and
- The agreed welding parameters, procedures and welding equipment become the contract requirements and should not be varied without additional evaluation and testing

c) Determine quality control and assurance requirements, including but not limited to:

- Inspection for wall thickness and welding zone preparation
- Internal inspection of pipe for obstruction and cleanliness. Including the removal of swarf after machining welding face for butt welding
- Maintaining a detailed welding log for each weld (including unique weld ID and GPS location record keeping)
- Destructive testing of a percentage of welds
- Visual and non-destructive assessment of each weld

d) Continuously review process and results.

- Butt fusion welding is a skilled operation; several very specific procedures need to be carried out to achieve a successful joint. All operators carrying out butt fusion welding will be trained by appropriately registered training organisations (RTOs), meeting the prerequisite training requirements of PMBWELD 301

2.3.5.2 Electrofusion welding

The main difference between butt welding and electrofusion is the method by which the heat is applied. The electrofusion joint is heated internally by a conductor at the joint interface. Heat is created as an electric current that is applied to the conductive material in the fitting. PE pipe to pipe connections made using the electrofusion process requires electrofusion couplings, as shown in Figure 2.13.

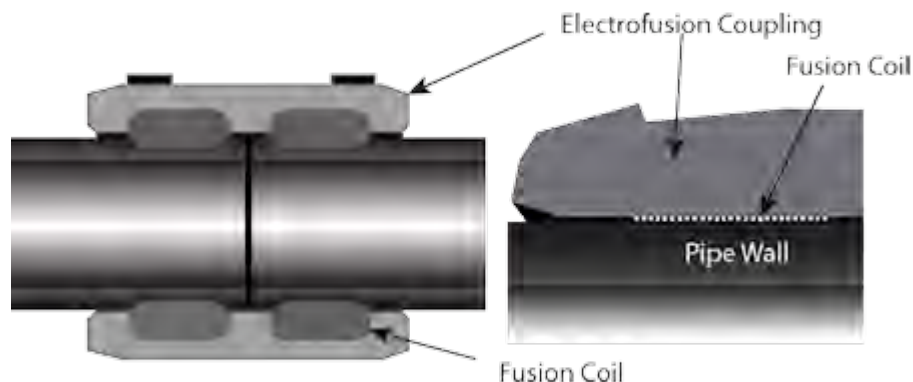


Figure 2.13. Typical Electrofusion Joint

Electrofusion (EF) fittings shall conform to AS/NZS 4129 and shall be third-party certified by a JAS-ANZ accredited certifier under the StandardsMark, GasMark, WaterMark schemes, or equivalent.

To consistently make satisfactory electrofusion joints, it is essential to follow the jointing procedure, emphasising pipe surface preparation, cleanliness, joint restraint during the fusion and cooling cycles, and temperature control.

Electrofusion is a skilled operation; several very specific procedures need to be carried out to achieve a successful joint. Imperial will approve welding procedures before construction begins. All operators carrying out electrofusion welding will be trained by appropriate RTOs, meeting the prerequisite training requirements of PMBWELD 302.

2.3.5.3 Mechanical joints

Where fusion joints are not appropriate, mechanical fittings can be used, particularly for the 50mm and smaller PE pipe's. Three basic fittings can be used:

- Flanges
- Mechanical compression joints
- Mechanical couplings

When jointing of PE pipe is required to other materials, a flanged joint is generally the most practical for field jointing. Otherwise, a material transition fitting can be considered and welded in.

Imperial will preferentially use flanges for jointing to other materials.

2.3.5.4 Flanges

When jointing is required to other materials, a flanged joint is generally the most practical.

Jointing to other pipe materials may also be achieved using mechanical flange adaptors similar to mechanical couplers, except one end is replaced by a flange.

A typical flange connection is shown in Figure 2.14.

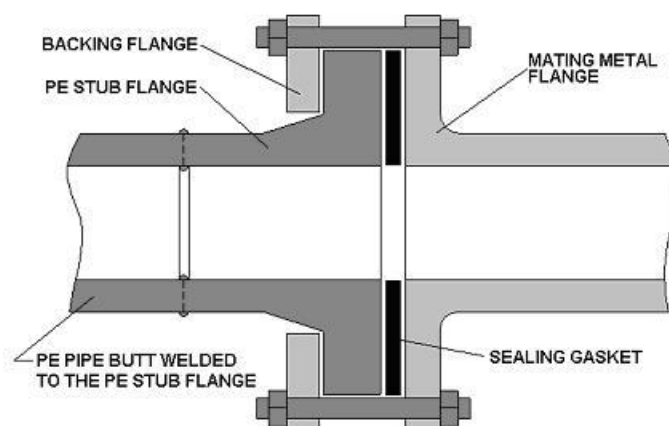


Figure 2.14. Typical flanged connection

2.3.5.5 Mechanical compression joints

Mechanical compression joints will be installed following the manufacturer's requirements.

2.3.5.6 Mechanical couplings

Mechanical couplings will be installed following the manufacturer's requirements.

2.3.6 Trenching and bedding

A trench will be excavated to a depth that will give 750mm Depth Of Cover (DOC) to flowlines installed, except where the flowline crosses an access track or watercourse, where it will have a DOC of no less than 1200mm.

Trench excavation will be carried out using a trenching machine, excavator with an attachment or similar. In both instances, the objective is to achieve a trench bottom free of rocks, stones or other material with an angular profile that may cause damage to the pipe and a trench profile in continuous contact with the pipe. When such conditions are achieved, the pipe will be laid directly on the trench bed; if this is not achievable from the direct trenching operations, bedding will be applied into the trench to achieve the same.

Any trenches that are left open overnight will be:

- Fenced with electric fencing to exclude livestock
- Fitted with fauna ladders to allow fauna egress
- Checked by a Fauna Spotter before starting works the next day, and any fauna removed

Trenches will not be left open overnight across watercourses or access tracks.

Before any trenching is carried out in watercourses, Imperial will check the 7-day weather forecast to ensure there is an adequate weather window for the trenching, installation, backfill, and stabilisation works to be carried out.

2.3.7 Placing of pipe into the trench

The pipe will be lowered into the trench without excessive strain and laid with sufficient slack to allow for contraction caused by temperature changes.

PE pipe up to approximately 160mm diameter can usually be placed in the trench manually. Heavier, larger diameter pipe will require handling equipment to lift, move, and carefully lower the pipe into the trench.

2.3.8 Backfilling and Compaction

After the pipe is laid into the trench, backfilling will commence using excavated material.

- The initial material will be screened to ensure it is free of rocks, stones or other material with an angular profile that may cause damage to the pipe.
- The balance of the trench will be backfilled and compacted using excavated material.
- Compaction shall be performed to ensure the required compaction level is achieved while ensuring that any stress placed upon the pipe is acceptable.

- The standard of backfill and compaction shall minimise subsequent soil movement and prevent subsidence of the trenched area.
- The permeability of the backfilled and compacted trench shall be similar to that of the unexcavated material to minimise damage along the trench invert and potential "tunnel" erosion.
- Where scouring could occur in a trench, barriers shall be installed to prevent scouring. Barriers shall be built of non-degradable foam, sandbags or other approved material.

2.3.9 Pressure/leak testing

All new components of the flowline network and any part of an existing network that is diverted or altered in any way shall be subject to a pressure test to validate mechanical strength and detect leakage of the network before commissioning.

The PE Gathering Networks' pressure testing will be broken into separate tests; a strength test and a leak test. The strength test proves the pipe's integrity and identifies any large leaks or defects in the network being tested. The leak test determines if there are any small leaks in the network. The leak test shall be undertaken after the successful completion of a strength test. Further details on strength and leak testing are covered in sections 2.3.9.8 and 2.3.9.9, respectively.

Due to the visco-elastic nature of PE, it is not practical to conduct such tests in a manner that ensures no pressure change. Variations of atmospheric pressure, the temperature of the test fluid in the pipe, and material creep significantly affect the test pressure. Therefore, it is necessary to permit some drop in measured pressure over the test period.

2.3.9.1 Pressure Test safety

Pressure testing is considered one of the significant hazards in the development of a PE Network.

Pressure testing equipment will be fitted with regulators and Pressure Safety Valves to ensure the gathering network is not overpressured during testing. The primary safety control for pressure testing is QA/QC conformance, primarily in material selection and welding. The secondary safety control measure is the introduction and use of calculated exclusion zones.

2.3.9.2 Pressure testing exclusion zones

The test section will have a defined primary exclusion zone, determined by the amount of stored energy released upon test section failure.

A secondary exclusion zone boundary shall be established around the control point.

Figure 2.15 shows the configuration of exclusion zones for pressure testing.

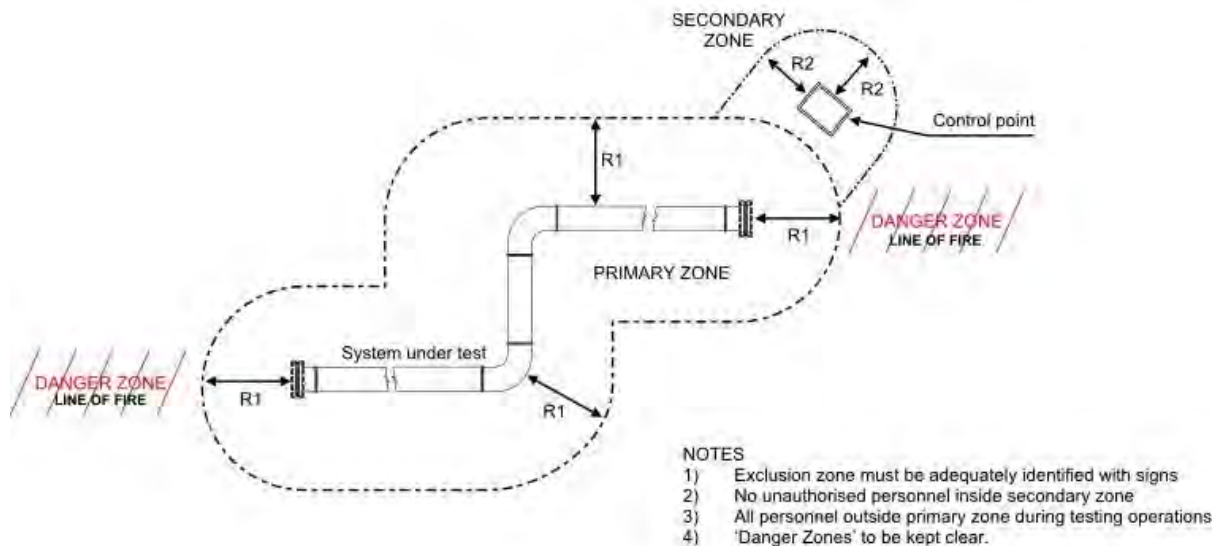


Figure 2.15. Defined Exclusion Zones

2.3.9.3 Exclusion zones during pressure tests

The primary exclusion zone is designed to achieve a specified distance from the test to the safe area for any unauthorised person to be located during the test.

While the test pressure is being introduced, and for the actual strength test period, strict precautions will be implemented to ensure that unauthorised persons are prevented from entering the exclusion zone (primary and secondary) test areas. Barriers, signs or other markers shall be displayed to indicate the entry points to the restricted area. Consideration will be given to manning road crossings and other higher-risk locations while the test section is under test to ensure that no persons enter the test area.

After successfully completing the strength test and after the pressure has been reduced to Maximum Allowable Operating Pressure (MAOP) or lower, authorised personnel may be allowed inside the primary exclusion zone.

The test equipment will be located outside the primary exclusion zone and be surrounded by a secondary exclusion zone. During testing operations, no unauthorised person will be permitted to enter this zone.

2.3.9.4 Pressure testing primary exclusion zone (R1)

The primary exclusion zone boundary shall be calculated using the approach defined in ASME PCC-2 or following Section 8.2.9 of the PEGN Code requirements. This approach calculates the amount of stored energy and then calculates a distance based on the blast wave impact on personnel and structures. The minimum primary exclusion zone is:

- 30 m if the calculated energy is less than 135.5 MJ
- 60 m if the calculated energy is between 135.5 and 271 MJ
- For energy levels greater than 271MJ, the distance $R_{scaled}(2TNT)^{1/3}$ in metres, calculated following Appendix B2, based on a R_{scaled} number of 20, where TNT is the energy measured in kilograms of TNT (Trinitrotoluene).

These distances are subject to an increase in the specific direction of failure to allow for potential projected missiles.

2.3.9.5 Pressure testing secondary exclusion zone (R2)

The secondary exclusion zone boundary shall be established around the control point. The minimum recommended approach is to use the distance based on a scaled number of 20. In this calculation, the stored energy is the energy in the test equipment – hoses and headers. An alternative is to use an exclusion distance of 10 m.

2.3.9.6 Preliminary testing

Sections of the network in key areas may need to be preliminary tested or pre-tested separate from the main network section. Examples are roads, creek crossings, and sections near plants and houses where the impact of a pressure test failure is critical. The fabricated pipe sections to be installed will be preliminary tested where possible. These sections can later be tied into a long test section. The preliminary section's exclusion zone can be reduced in these cases as it has previously passed a strength test.

2.3.9.7 Test plan

A test plan will be developed for all pressure tests. This plan can be a general document to cover most cases. However, in all cases, the particular test's risks and hazards shall be understood and managed.

The testing plan shall be able to:

- Ensure the implementation of all risk controls
- Ensure that a JSA is completed and all items identified are adhered to
- Ensure that all relevant equipment has a current calibration certificate from a recognised and certified testing agency
- Ensure that all measuring equipment is located at a suitable distance from the test section to conform with exclusion zone requirements
- Ensure that the EMP is followed for the disposal of the test fluids and other wastes.

The person or persons responsible for the preparation of the test plan shall have appropriate qualifications and experience.

2.3.9.8 Strength test

The strength test intends to prove the pipe's integrity and identify any large leaks or defects in the network being tested. The pipe shall be considered to have passed the strength test if, at the end of the test period, the test section's pressure is above MAOP, and there is no evidence of a sudden pressure drop. After completing the strength test, the pipe shall then be subject to a leak test process.

The criteria for pneumatic strength testing is shown in Table 1.

Table 1. Strength test criteria

Pneumatic Strength Test	Acceptance Criteria
Starting pressure $f_p \times \text{MAOP}$ Test pressure to remain between $f_p \times \text{MAOP}$ & MAOP during the test.	Structural integrity maintained for 6 hours while pressure held between $f_p \times \text{MAOP}$ & MAOP.

2.3.9.9 Leak Test

The leak test intends to determine if there are any small leaks in the network. The 24 hour leak test shall be undertaken after successful completion of a strength test.

Exclusion zones are generally not required for leak tests as the network has been proven to have adequate structural integrity with no significant leaks. However, it is recommended that exclusion zones be maintained around above-ground pipe sections and testing equipment to keep unauthorised people out of the area during leak testing activities.

The minimum starting test pressure at which the leak test is performed shall be the nominated MAOP of the test network.

The criteria for pneumatic strength testing is shown in Table 2.

Table 2. Leak test criteria

Pneumatic Leak Test Method	Acceptance Criteria
Allowable Pressure Loss (Pneumatic pressure decay test) Details of this test method and calculations are described in CP-8-003 Leak Test Methods and Appendix B1 of the PEGN Code, respectively.	The acceptable volume loss is 1 litre/hr/actual m ³ volume of test fluid. NOTE: The word "fluid" in this context means air or another gaseous medium.

Tracer gas will not be used for leak testing of the constructed flowlines.

2.3.10 Pipe survey, location and marker-signposting

2.3.10.1 Pipe survey

A survey will be made to locate the Gathering Network (and all related infrastructure) relative to permanent marks and benchmarks conforming to Mapping Grid of Australia (MGA 94) or other approved datum.

The survey will develop sufficient information on the constructed Gathering Network to satisfy the materials traceability requirements of the PE.

Specific survey locations that will be captured occur at crossings (such as road, rail, creeks, rivers, third-party infrastructure) at changes of direction, fence lines, and boundaries.

The existence of services, structures, and other obstructions in or on the route shall be checked, identified and recorded before construction begins. The location of these shall be recorded in the as-constructed survey record.

2.3.10.2 Survey accuracy

The uncertainty of the x-y coordinates shall not exceed 500 mm, the uncertainty of the as-built top of pipe level shall not exceed 50 mm.

2.3.10.3 Pipe location

All buried flowlines will have a detectable tracer wire installed, including bored sections. This detectable tracer wire enables the pipe location to be traced with a pipe locator, reducing the likelihood of damage during future excavations. Tracer wire will be metallic, electrically insulated and have a minimum diameter of 14 gauge. Tracer wire shall be resistant to corrosion damage either by using coated copper wire or by other means.

2.3.10.4 Marker signposting

Marker signs will be installed to alert people of the Wastewater Gathering Network's presence and, if they plan to carry out work nearby, of the possible consequences of inflicting unintended damage. Markers also instruct those intending to work near the Gathering Network to contact the nominated network operator and provide relevant contact details. Pipe marker signs shall conform to the requirements for safety signs per AS 1319 'Safety Signs for the Occupational Environment.'

Marker signs shall:

- a) Indicate the approximate position of the pipe
- b) Indicate that excavating near the pipe is hazardous
- c) include a direction to contact the Gathering Network operator before commencing excavation near the network

Signs shall be placed at the following locations and be inter-visible:

- a) Both sides of public roads
- b) Both sides of railways
- c) At each property boundary (and at internal fence lines as appropriate)
- d) Both sides of creeks and rivers
- e) Both sides of vehicle tracks
- f) Each change of direction
- g) Utility crossings (buried or above ground)
- h) At all network facilities

At all other places where signs marking the network location are considered to contribute to network safety by properly identifying its location.

2.3.11 Commissioning

Commissioning is broadly defined as the range of activities required between mechanical completion of the plant or network and its handover for operation; it involves introducing process fluids and the functional and performance testing of all related equipment and systems before handover.

Commissioning will always be preceded by acceptance pressure testing of the relevant network section. As this Gathering Network is very simple in design and operation, the commissioning plan will be equally simplistic.

Commissioning will ensure that both the PE pipes and all associated facilities are checked and verified by a competent and qualified inspector to ensure that they are fit for the nominated operating envelopes for all Gathering Networks. Such facilities shall include valves, flanges, protective devices (pressure safety valves), electrical and instrumentation equipment where applicable.

The network shall not be considered ready to commence or recommence operation until, as a minimum, the following checklist has been completed:

- a) The network safety management study has been reviewed, and the network determined as ready for operation
- b) The strength and leak test requirements have been achieved and documented
- c) The MAOP has been established
- d) If tie-in welds to existing facilities have not been subjected to b) above, then such welds have been subjected to the requirements of Section 7.5.1, 7.7.1, 7.8 and 7.9 of the PEGN Code
- e) All components have been tested for satisfactory operation

Sufficient operating, maintenance and emergency personnel have been trained and qualified as competent.

2.3.12 ROW reinstatement

After backfilling has been completed, construction tools, equipment, and debris will be removed. Areas disturbed by the installation will be reinstated as soon as practicable, including pulling stockpiled timber back over the ROW.

Appropriate measures shall be taken to prevent erosion and minimise long-term degradation of the environment (e.g. the construction of contour banks or diversion banks).

Fences that have been removed to provide temporary access to the route will be re-erected.

2.3.13 Material Selection

Polyethylene is a thermoplastic and behaves differently from metals.; however, these properties are well-known and are embraced in Australian and other international standards.

PE100 resins used in today's pipes have high toughness, excellent resistance to slow crack growth and rapid crack propagation. They also have an inherent resistance to water and many chemicals. Polyethylene is now the material of choice for many water, wastewater, gas and other applications.

Materials used for the construction of the gathering network will comply with section 3 of the PEGN Code.

2.3.14 Watercourse crossing

Where a buried service alignment crosses a waterway with defined banks or a defined drainage channel; a study to show that waterway crossing can be constructed using open trenching methods while having no adverse impact on water flow patterns or waterhole water retention timing will be carried out, before open trenching construction methods are utilised. If this cannot be achieved, directional drilling will be used.

Before any flowline construction work is carried out in watercourses, Imperial will check the 7-day forecast to ensure an adequate window for the trenching, installation, backfill, and stabilisation works to be carried out.

A decision tree for the Flowline waterway crossing methodology is presented in Figure 2.16.

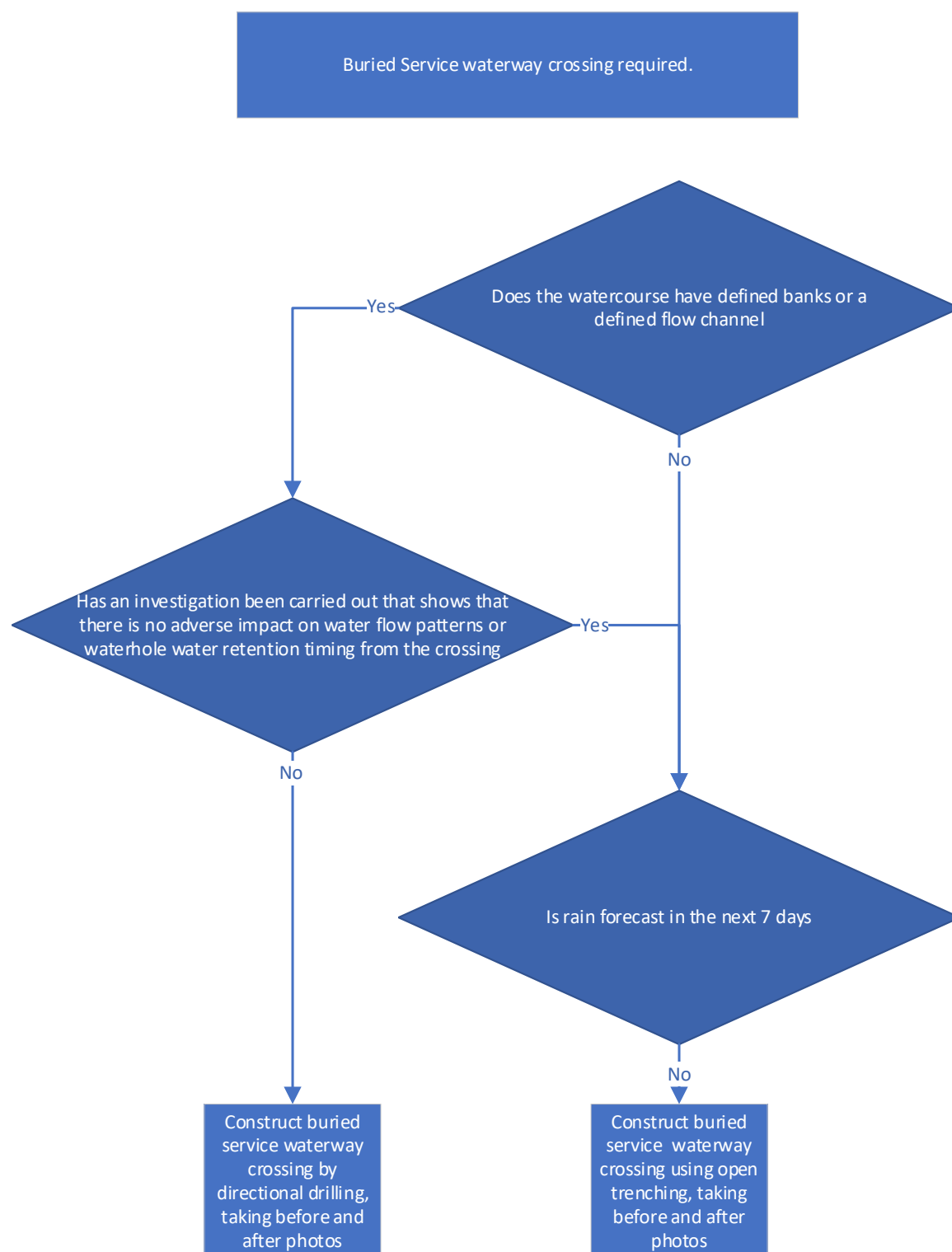


Figure 2.16: Buried Service Waterway crossing methodology Decision Tree

2.3.15 High Point vents and in field valves

Water flowlines in undulating areas are prone to air locking; High Point Vents (HPVs) will be installed in undulating areas to release entrapped air, thereby preventing this air locking. As the high point vents are between the entry and discharge flow monitoring points, any wastewater discharge from them will be captured by the flow balance monitoring.

High Point vents will be visually checked weekly when flowlines are in use, i.e. whenever flowlines contain wastewater.

Infield valves will be installed as required to allow efficient use of the network.

Any above-ground infrastructure outside of wellpad fencelines will be barricaded to prevent livestock access. Erosion and sediment controls will be constructed as per the access track requirements of Appendix 05 (Erosion and Sediment Control Plan).

2.3.16 Operation and leak detection

The flowline network will be fitted with manifolds and valves to isolate it into sections. These valves will be locked at all times unless attended by authorised personnel to prevent unintentional operation.

Each inlet/outlet point will be fitted with a flowmeter fitted with live telemetry to measure the amount of water/wastewater passing that point. The flow readings from the flow meters will continually be compared to detect an imbalance in inflow and outflow volumes. If there is an imbalance of 100 litres, the system will alarm and transfer operations stopped until the imbalance in flow is investigated and rectified. Suppose the reason for the imbalance is a spill from the flowline network. In that case, the system will not be restarted until the leak is repaired and an investigation is carried out as to how the leak occurred and how it will be prevented from re-occurring.

The 100-litre imbalance for a "Wastewater Flowline Leak" is based on system vendor advice on the accuracy of the inlet and outlet flow meters and measurement synchronisation across the system. One hundred litres gives a quick response to a leak without causing false trigger/alarm events due to flow meter accuracy. Although a lower threshold could theoretically be set, it would come with a higher risk of false trigger/alarm events without a significant increase in response time to an actual leak event. As shown in many incident investigations, false trigger events erode the usefulness of a monitoring system which has been shown to be a contributing factor in event escalation. Therefore Imperial considers the 100-litre imbalance for a "Wastewater Flowline Leak" event ALARP and acceptable.

Imperial will ensure that any "Wastewater Flowline Leak" events report directly to the Site Operators, as well as to Imperial Operations Management. Site Operators will have the ability to stop pumping operations remotely to ensure that the system pumps can be turned off immediately in response to "Wastewater Flowline Leak".

The reporting of any "Wastewater Flowline Leak" events from the flowline network will be recorded and reported in line with the Spill Management Plan.

When water/wastewater is being transferred between two points, only the valves will be operated to direct the flow between those points and isolate the balance of the flowline network; an example of transferring water/wastewater between Carpentaria 1 and CARP AB is shown in Figure 2.17.

When a flowline section is not planned on being used for a week, it will be flushed with 125% of its volume with fresh water to purge it of wastewater.

The volume of each flowline section is shown in Table 3.

Table 3: Flowline section volumes (m³)

Wellpad	CARP AA	CARP AB	CSP AA	CSP AB	CSP AC	CSP AD
CARP AA		303	547	508	414	556
CARP AB	303		850	811	717	859
CSP AA	547	850		526	431	519
CSP AB	508	811	526		94	236
CSP AC	414	717	431	94		142
CSP AD	556	859	519	236	142	

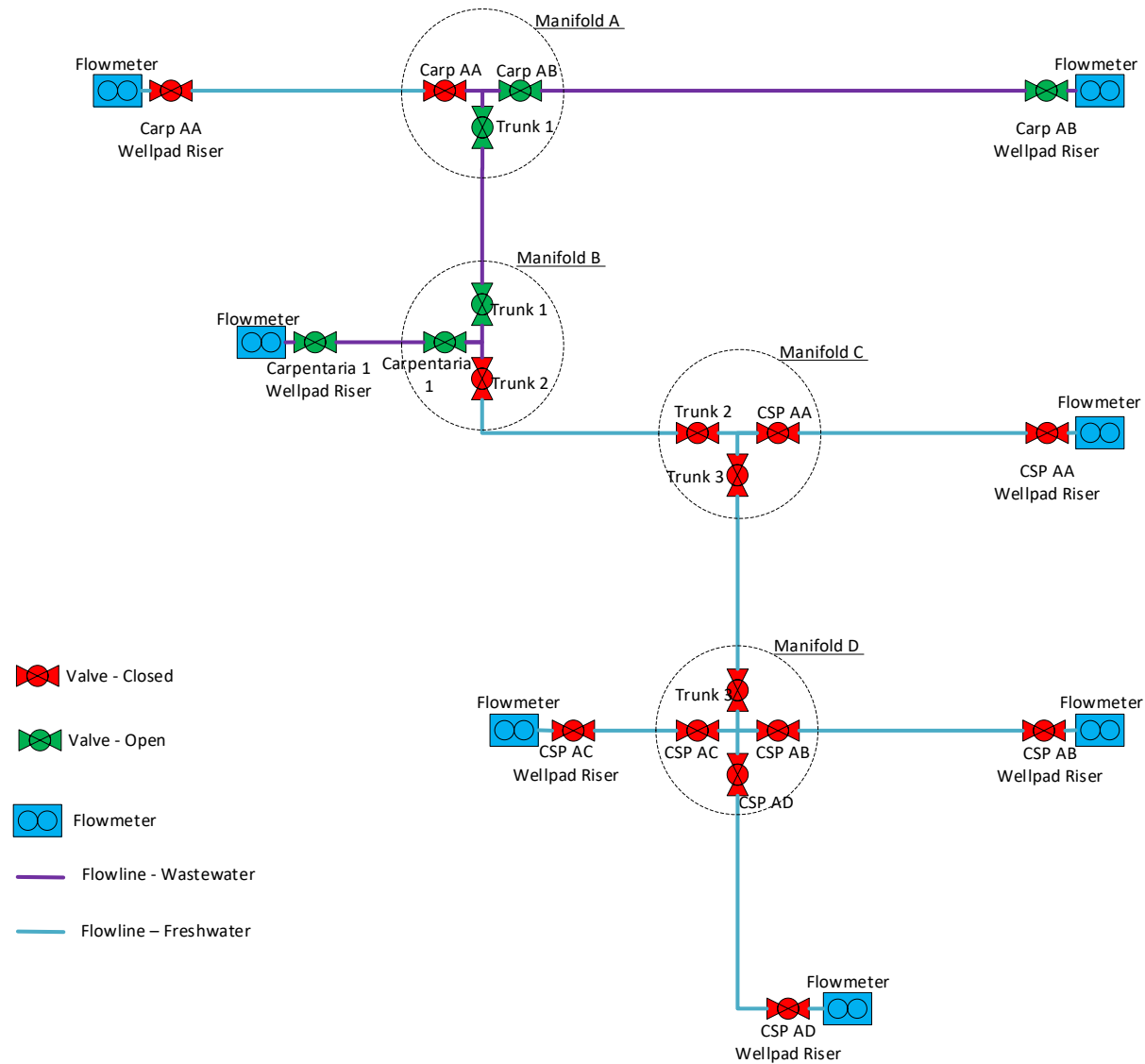


Figure 2.17: Flowline Network example; flowing between Carpentaria 1 and Carp AB

2.3.16.1 Abandonment

When a network is abandoned, it shall be disconnected from all wastewater sources present in other pipes and flushed clear of wastewater. Disposal of the wastewater shall meet all relevant environmental and safety requirements. As the Gathering Network will be constructed from PE, the risk of subsidence caused by flowline collapse is minimal.

When a network is abandoned, the following additional requirements shall be completed:

- a) The cutting and removal of all sections of buried pipes that come to the surface:
 - a. at a minimum of 750 mm below the natural surface, or
 - b. at the pipe depth, whichever is the lesser
- b) The removal of all surface equipment
- c) The removal of all signage associated with the network on completion of the post abandonment maintenance period
- d) Obtaining landowner releases for the completed abandonment

Upon completing the network section's abandonment in place, the records identifying and locating sections of the abandoned network shall be prepared as part of the relinquishment procedure.

These records shall be publicly available to prevent possible mistakes in identifying an abandoned network as an operational network.

2.4 Wellpad Construction

2.4.1 Overview

Imperial will have an ecologist on-site before clearing operations to undertake ground-truthing for ground-disturbing activities in advance of any ground disturbance, to ensure the actual riparian zones and the buffers for drainage depressions, and stream orders 1 to 4, and the location and density of hollow-bearing trees and their buffers, are identified, and regulated activities are avoided in sensitive areas.

Wellpads will be constructed as required to provide a safe and efficient workplace for drilling and other wellpad regulated activities.

The construction of wellpads will include:

- Clearing and levelling of the wellpad work area
- Construction of lined pits for the storage of freshwater, drilling fluids and drilling cuttings
- Construction of water production and monitoring bores
- Installation of drilling cellar and conductor
- Installation of above ground tanks for the storage and disposal of Frac Flowback fluid and produced water
- Fencing of the wellpad to prevent livestock and personnel entry
- Clearing of firebreaks
- Installation of erosion and sediment control devices

2.4.2 Methodology

Timber and vegetation will be cleared from the site and stockpiled for future rehabilitation activities.

The site will be levelled and compacted utilising on-site materials as far as practicable.

Pits will be constructed utilising bulldozers and excavators, with berms consolidated with watering and compaction.

The footprint for any above-ground tanks will be consolidated and tested to the tank supplier's requirements.

Water monitoring production and monitoring bores will be drilled by licenced drillers, in line with permit conditions.

Fire breaks will be constructed and maintained in line with Appendix 8 (Fire Management Plan).

Erosion and sediment controls will be constructed as per Appendix 05 (Erosion and Sediment Control Plan). The site will be fenced to exclude livestock, barbed wire will be used, in line with local pastoral practices. Site diagrams and schematics can be seen in the EMP.

2.4.3 Cut and fill wellpad methodology

Where the slope is too great for a drilling rig to operate safely on the natural slope, the wellpad will be cut and filled to flat, using the following methodology;

2.4.3.1 Vegetation stockpiling and dirty water filtration

Vegetation will be stripped from the site and windrowed along the downslope section of the wellpad and fire access track to filter any runoff from the work site during construction and from the wellpad fill batters post-construction. As shown in Figure 2.19.

2.4.3.2 Topsoil and clean water diversion

Topsoil from the site shall be stripped and windrowed above the cut batter and fire access track, on the upslope extent of the site as shown in the image below and attached plan. Care should be taken to ensure that water intercepted by the topsoil bund does not drain back onto the pad or to dirty water catch drains.



Figure 2.18: Topsoil windrow above the cut batter used to divert clean water away from the wellpad

2.4.3.3 Levelling the wellpad

The wellpad are will be cut and filled to flat, balancing the on-site material volumes to avoid the need to bring material onto the site or remove material from the site. The wellpad will be compacted to provide a good working surface and crowned along the Plant North/South Centreline to achieve a 1% fall back to the wellpad edge draining to the plant East and West.batters

Both cut and fill batters will be at a 1:1 slope

The cut batters will be protected from erosion by the topsoil stockpile/clean water diversion bund preventing significant water volumes from washing over them.

The fill batters will be protected by constructing a bund at the top to prevent water from the wellpad from running down the batter face.

2.4.3.4 Wellpad drainage

Significant volumes of water are expected to runoff from the compacted pad. This water will drain plant East and West on the wellpad to shallow spoon drains constructed inside the bunds at the top of the fill batters and the toes of the cut batters. These drains will be contoured to take the runoff to the cut/fill point of the wellpad.

2.4.4 Sediment control

Drains shall be installed from the cut/fill point on the pad to type 2 sediment controls, as shown in Figure 2.19.

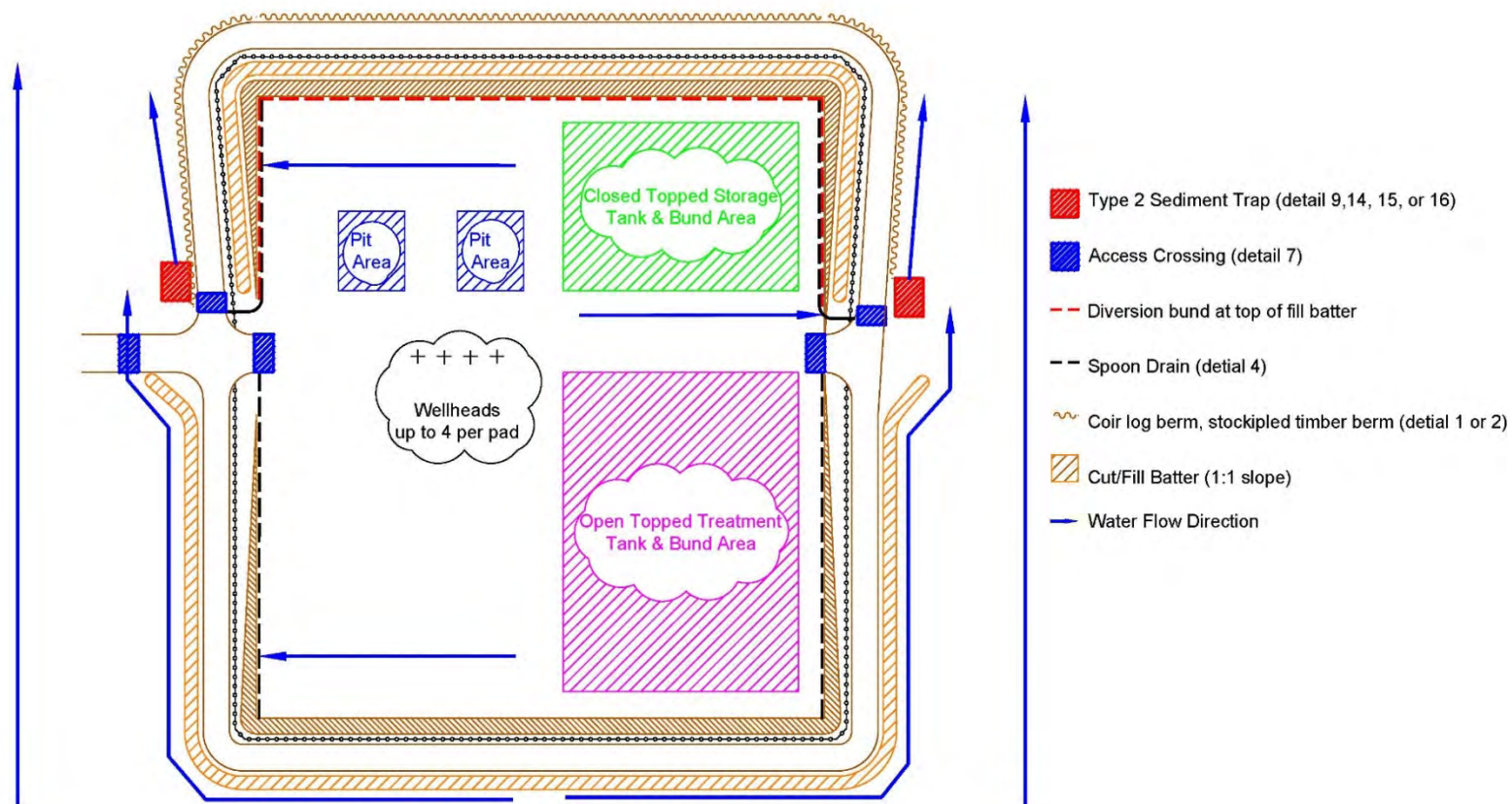


Figure 2.19: Cut and Fill Wellpad Layout

2.5 Gravel Pits

2.5.1 Overview

Imperial will use on-site material for the majority of civil construction works. Gravel will be required to give a better running surface on some road sections and may be required to cap some wellpads, depending on the on-site material.

Imperial will have an ecologist on-site before clearing operations to undertake ground-truthing for ground-disturbing activities in advance of any ground disturbance, to ensure the actual riparian zones and the buffers for drainage depressions, and stream orders 1 to 4, and the location and density of hollow-bearing trees and their buffers, are identified, and regulated activities are avoided in sensitive areas. Where gravel is required, Imperial will establish local gravel pits; the establishment of these pits will include the following;

- Gravel pits will use the same site selection criteria as wellpads.
- Clearing of vegetation, to be stockpiled around the perimeter of the cleared area for rehabilitation
- Stripping of topsoil (if required)
 - Topsoil will be stockpiled around the upslope side of the gravel pit to divert overland flow from entering the gravel pit
 - If there is no topsoil on-site (e.g. Pea Gravel site), a diversion bund will be constructed upslope to divert any overland flow
- A whoa boy will be constructed on the access track so that water does not flow down the access track into the gravel pit
- Batters will not be steeper than 1:1, to allow safe passage for animals, and people
- Gravel pits will not be fenced
- Gravel pits will intentionally be kept wide and shallow to facilitate rehabilitation

An indicative layout for a gravel pit is shown in

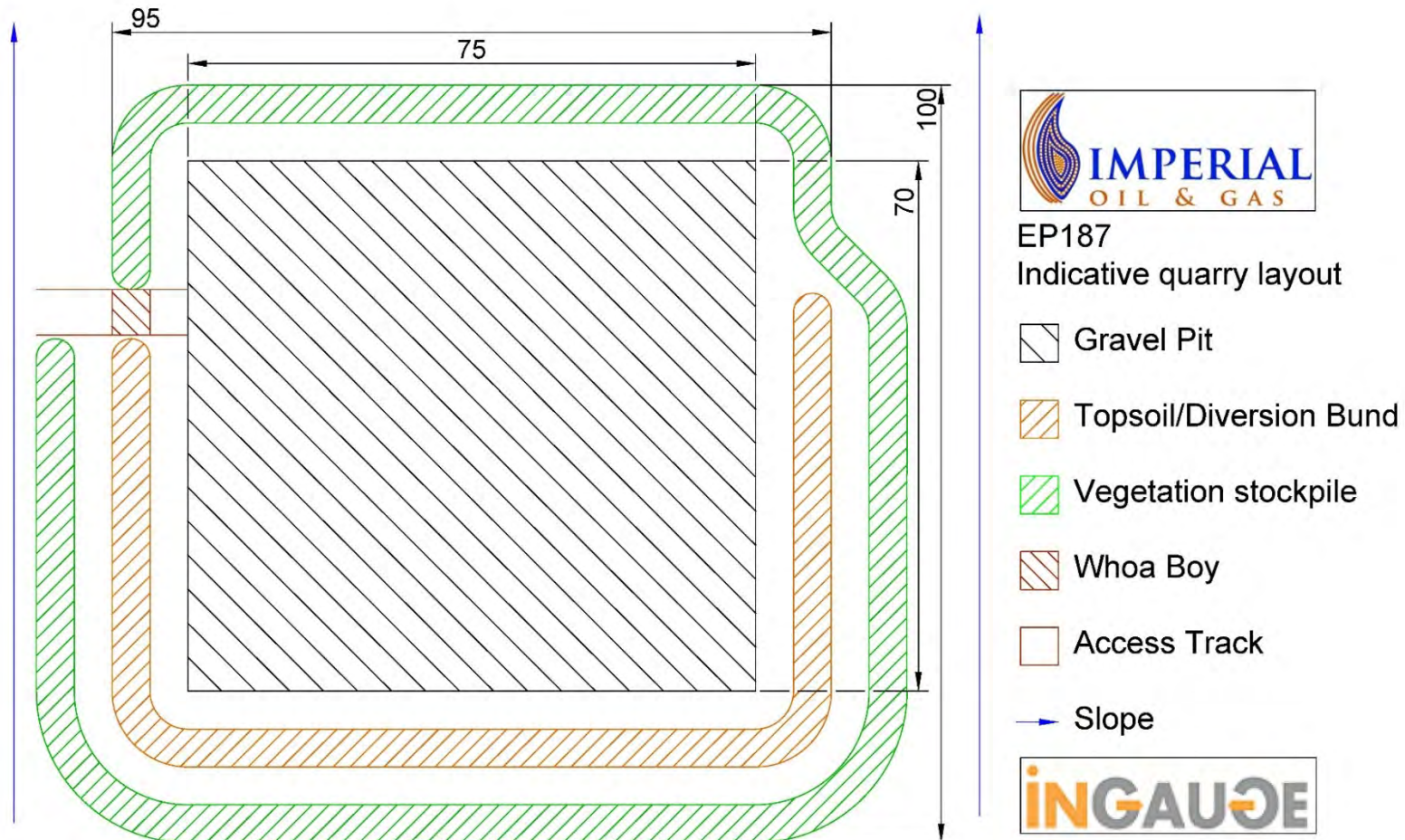


Figure 2.20: Indicate Gravel Pit Layout

2.6 Drilling

2.6.1 Overview

There are four potential well designs to be carried out under this EMP:

- a. A cased vertical well
- b. A cased horizontal production well with a plugged back open hole vertical pilot
 - The open hole vertical pilot in this design is drilled and logged to confirm the prognosed formations depths before being plugged back to the horizontal kick-off point and horizontal section drilled and cased
- c. A cased horizontal production well from a plugged back cased hole vertical well
 - The bottom section of the vertical cased hole in this design is plugged back to the horizontal kick-off point, a whipstock is set, and an exit is milled into the casing to allow a horizontal section to be drilled and cased
- d. A cased horizontal production well without a vertical pilot

The surface and intermediate hole sections are the same under all four well designs so that they will be covered once; the production section for each design will be covered in dedicated sections below.

This EMP scope also includes multiwell pads, where more than one wellbore is drilled from a wellpad; the details of the extra complexity of collision avoidance for multiwell pads are covered in Section 2.6.6.

2.6.2 Surface Hole section

The surface hole section will be drilled from the pre-installed cellar and conductor to a depth that isolates any shallow aquifer/s, the Gum Ridge Formation in this region.

During drilling of the Carpentaria 1 well, total drilling fluid losses were observed in the Gum Ridge Formation. This scenario was anticipated during the well design and in current well designs, with high permeability conduits, fractures and cavernous zones expected in karstic formations. Loss of circulation material (LCM) is generally not successful for responding to fluid losses in these formations. When total losses occur, the drilling fluid systems are reduced back to water to maintain dynamic well control while minimising drilling additive losses to the formation.

The 'surface casing' will be installed into the surface hole and cemented (specifically engineered cement) to seal the aquifer off from the rest of the wellbore to prevent fluid crossflow between formations. During cement operations, cement may also be lost to the formation resulting in cement slumping or "patchy" cement sections. If cementing of the surface casing for a well is unsuccessful (i.e. the cement does not return to the surface or slumping is observed), top-up cement job/s will be undertaken. This process involves spotting cement from the surface in the annulus of the surface casing and formation.

2.6.3 Intermediate Hole section

The surface casing shoe will be drilled out; drilling will then progress down to the target intermediate hole depth for a vertical well, or the 'kick off' point for a horizontal well. When the intermediate hole

section reaches its target depth, the intermediate casing is installed and cemented to isolate potential hydrocarbon-bearing zones and the surface.

A Formation Integrity Test (FIT) or Leak-off Test (LOT) will be carried out at the intermediate casing shoe to prove integrity before drilling ahead.

2.6.4 Vertical Production Hole sections

A vertical production hole section may be cased or left open hole; the drilling of either design is the same up until the process of running casing.

Once the intermediate casing is cemented in place, a Blow Out Preventer (BOP) or Annular Diverter will be installed, function tested, and pressure tested to confirm its integrity. The intermediate casing shoe will be drilled out, and a short section of the production hole will be drilled. A FIT or LOT will be carried out at the intermediate casing shoe to prove integrity before drilling ahead. The production hole section will then be drilled to the target production hole depth.

If the production hole section is to be cased, the production casing is installed and cemented to isolate potential hydrocarbon-bearing zones and the surface. A Cement Bond Log (CBL) will be carried out to verify the production casing cement's integrity.

If a horizontal section is then planned to be drilled, the vertical production section will be plugged back to the kick-off point.

If the vertical production section is abandoned and a horizontal production hole section drilled later, the following will apply. The vertical production section will be plugged back a minimum of 200m inside the intermediate casing shoe to suspend the well until future activities occur.

2.6.5 Horizontal Production Hole sections

A horizontal wellbore can be drilled from a dedicated intermediate section or plugged back from a vertical wellbore.

Where a horizontal wellbore is being drilled from a dedicated intermediate section, the following will apply. The intermediate casing shoe will be drilled out, and a short section of the production hole will be drilled. A FIT or LOT will be carried out at the intermediate casing shoe to prove integrity before directionally drilling ahead.

Where a horizontal wellbore is being drilled from the intermediate section of a vertical open hole pilot, the following will apply. The vertical open-hole section will be abandoned and plugged back to above the kick-off point before directionally drilling ahead.

Where a horizontal wellbore is being drilled from the intermediate section of a vertical cased hole pilot, the following will apply:

The vertical cased-hole section will be abandoned back to the kick-off point, a whipstock set into the intermediate casing, and an exit point milled into the intermediate casing.

Once the kick-off operation has occurred, the production section will be directionally drilled horizontally within the selected shale target/s, the horizontal section length within the selected shale target will be up to 2,800m.

When drilling horizontal wellbores or, for that matter, any directional well, standard directional drilling techniques and equipment are employed to enable accurate wellbore direction to be recorded and maintained.

2.6.6 Collision avoidance on multiwell pads

An added complexity of multiwell pads is collision avoidance of wellbores; unplanned wellbore collisions can have serious safety and environmental consequences. To minimise the risk of wellbore collision, the position of any existing wellbores and the well being drilled need to be clearly understood and a Separation Factor maintained.

While directionally drilling, standard directional drilling techniques and equipment are employed to enable accurate wellbore direction to be recorded and maintained. A "Separation Factor" for the well is also continually calculated and monitored. The use of separation factors is a standard industry control that has been effectively used for multiwell pad drilling within Australia and internationally.

Industry practice generally maintains a Separation Factor greater than two between well paths unless an internal risk assessment is carried out to avoid wellbore collision. Separation factors are covered in more detail in section 2.6.6.1.

Imperial will follow this industry practice whilst drilling multiple wells on a pad under this EMP.

2.6.6.1 Separation factors

A visual representation of separation factors is provided in Figure 2.22 and Figure 2.23. The level of uncertainty of a wellbore's position increases along its path, as shown in Figure 2.21, due to several factors:

- Relative Depth Error
 - Error in measuring along the hole depth, e.g. stretch in a wireline
- Misalignment Error
 - o Error due to instrument misalignment in the wellbore
- True Inclination Error
 - o Error in inclination reading
- Compass reference error
 - o A constant error in direction due to misalignment, e.g. gyro error or error in magnetic declination
- Drill string Magnetisation
 - o Magnetic interference caused by "hot spots"
- Gyrocompass
 - o Error due to gyron Gimbal drift

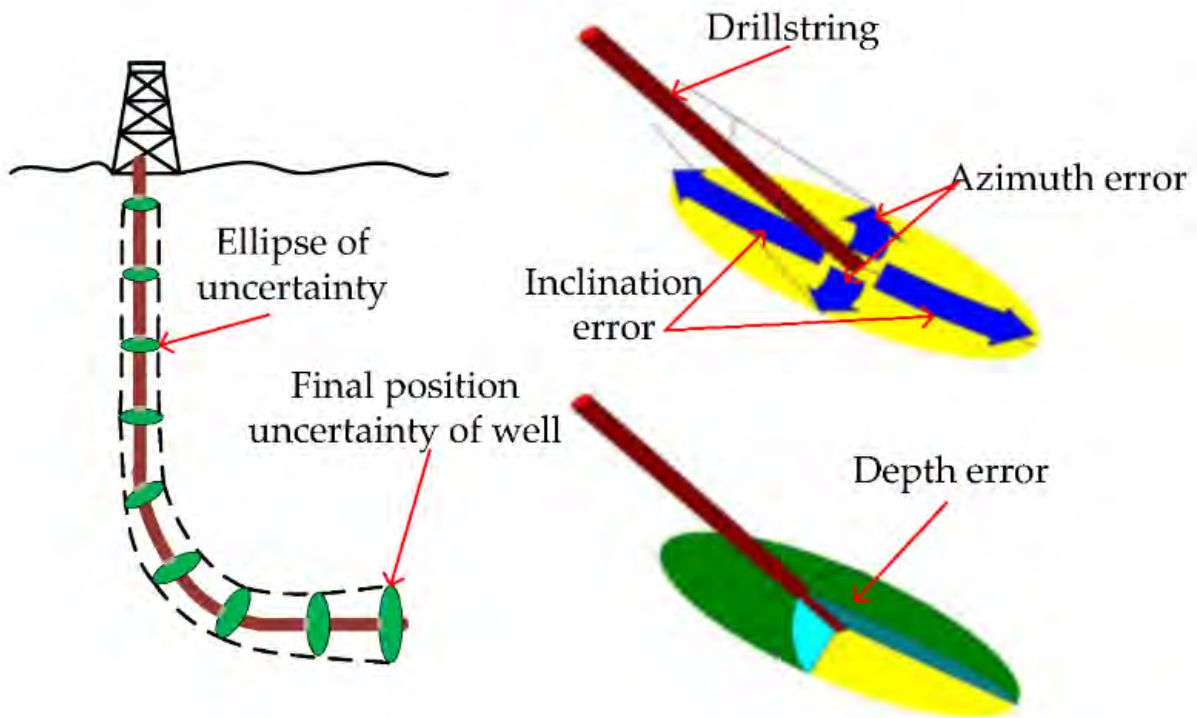


Figure 2.21: Wellbore Uncertainty

Because of this increase in uncertainty along the Wellpath, a Separation Factor is used, rather than standard separation distance. The Separation factor is a ratio of the centre to centre distance of the wellbores over the sum of the uncertainty of both wellbores, as shown in Figure 2.22.

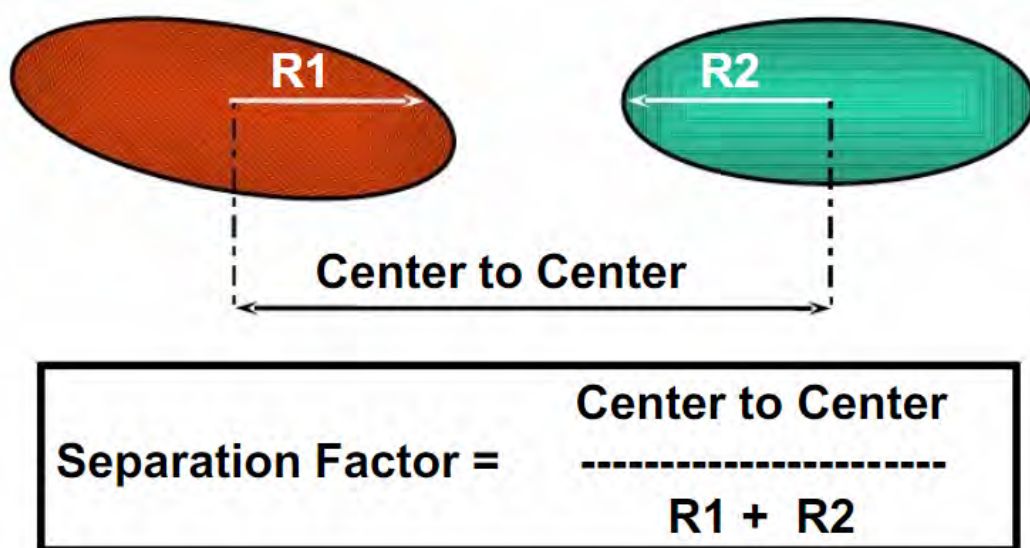


Figure 2.22: Separation Factor

As shown in Figure 2.23 separation factor of:

- Greater than 1, the two ellipses of uncertainty do not overlap
- 1, the two ellipses of uncertainty just touch
- Less than 1, the two ellipses of uncertainty overlap

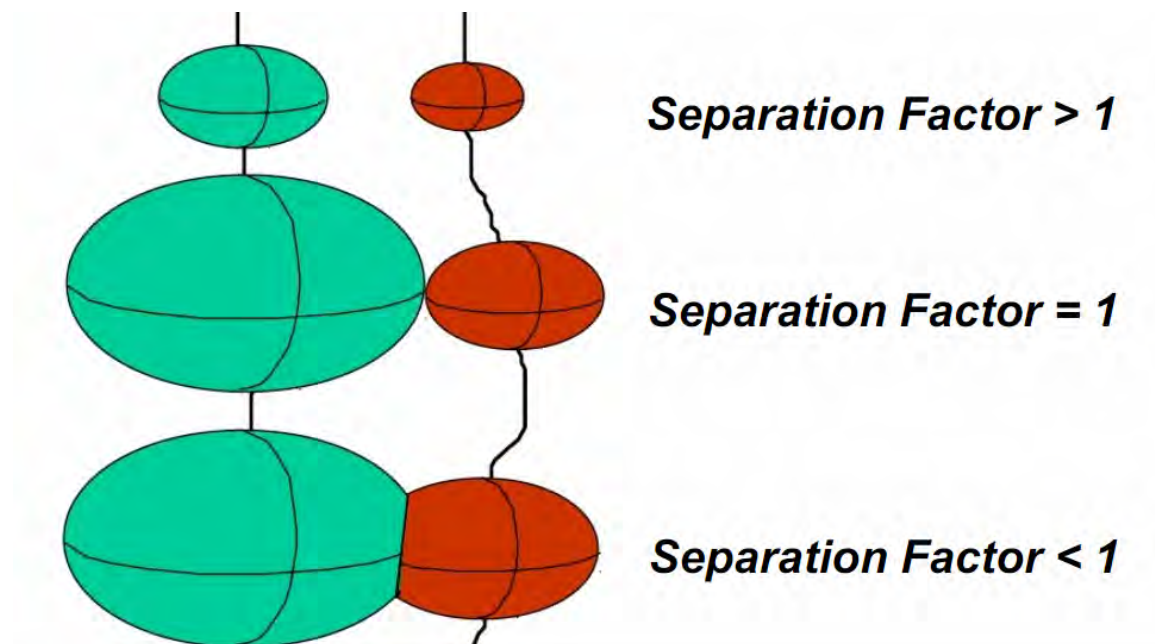


Figure 2.23: Separation Factor comparison

2.7 Diagnostic Fracture Injection Test (DFIT)

2.7.1 Overview

During a diagnostic fracture injection test (DFIT), a relatively small volume of freshwater (without proppant) is injected into the target formation, creating a hydraulic fracture. After the end of injection, the wellbore pressure is monitored for a short period (up to an hour). The pressure measurements are used to infer properties of the formation, including the leak-off coefficient, permeability, fracture closure pressure (related to the magnitude of the minimum principal stress and the net pressure), and formation pressure. These are key parameters for hydraulic fracture design and reservoir engineering in shale.

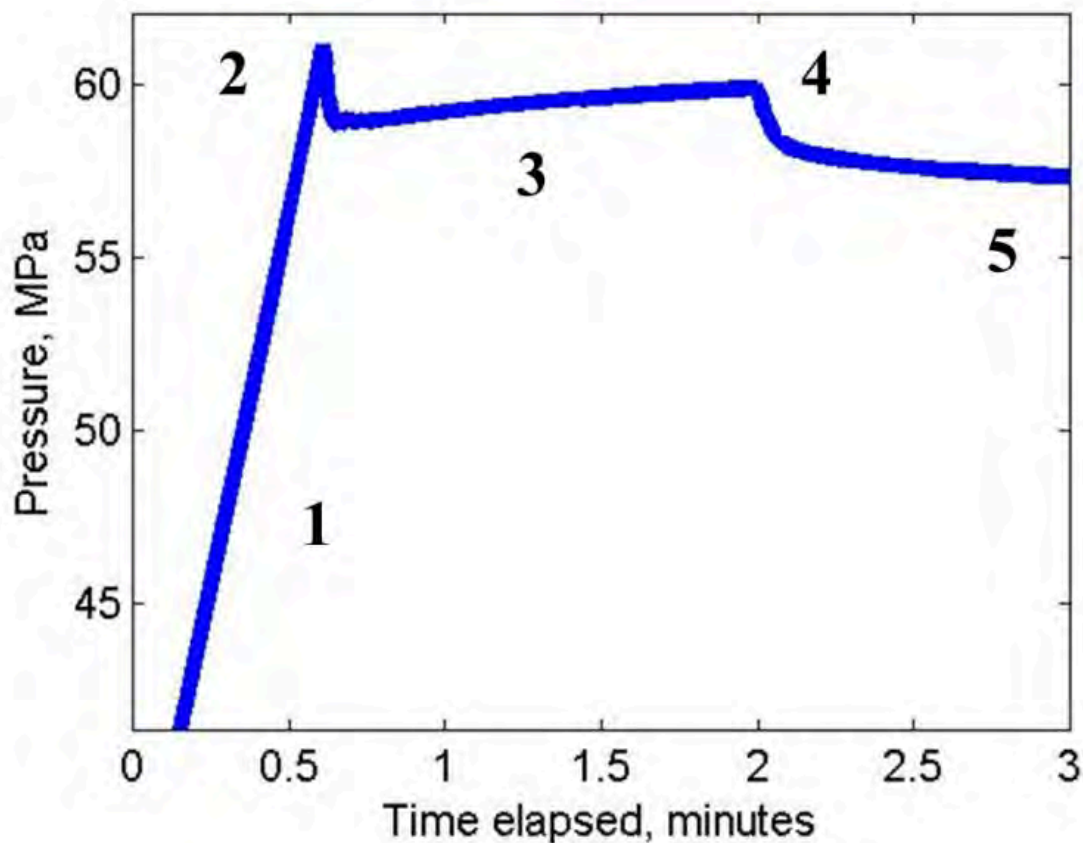


Figure 2.24: A typical pressure response during injection in a DFIT.

During period #1, a fracture has not formed, and wellbore storage controls the pressure behaviour. The leak-off point occurs at #2, the fracture propagation pressure is reached at #3, and the ISIP (initial shut-in pressure) is reached at #4. DFIT analysis is primarily interested in analysing the trends in pressure in the hours and days after shut-in.

2.8 Completion

2.8.1 Overview

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

A completion will be run into the well for well testing after cased hole fracture stimulation if the initial flowback rates cannot sustain free flow up the casing. The completion will be run using a workover rig; this will involve the following activities:

- Ensure the well is dead using appropriately weighted fluid

-
- Cleanout the wellbore by running tubing into the well and circulating out any debris from the wellbore, including proppant and plugs
 - Run tubing into the well
 - Land the tubing in a hanger in the wellhead
 - Set a packer to isolate the tubing annulus
 - Install surface master valves and pressure test wellhead seals
 - Install Flowback and EPT surface equipment for well testing

2.9 Perforation

2.9.1 Overview

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

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

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

2.10 Hydraulic Fracturing

2.10.1 Overview

Hydraulic fracturing (HF) is a commonly used oil and gas well completion process first used in Oklahoma, USA, in 1947. It typically involves injecting a slurry of water, sand, and a small amount of chemicals under high pressure into a bedrock formation via the well. This process is intended to create new fractures in the rock and increase the size, extent, and connectivity of existing natural fractures. HF is a well-stimulation technique used commonly in low-permeability rocks like tight sandstone, shale, and some coal beds to increase oil and/or gas flow to a well from petroleum-bearing rock formations

During Hydraulic Fracturing activities, HF fluid is pressurised by high-pressure pumping units and directed downhole via a manifold to discrete target intervals along the vertical or horizontal wellbore (referred to as "stages"). Each Stage is isolated and perforated using a plug and perforation gun assembly deployed via wireline. As the pressure is sustained, the fractures propagate radially from the well through the target formation. Once optimal fracture propagation has been initiated, the

proppant (sand) is pumped down the well and into the open fractures to prevent them from closing. This process is repeated for each Stage. The final number of Stages pumped is dependent on the useable length of the wellbore, the design fluid rates, the number of perforations per Stage and in-situ geological conditions. Once all stages are complete, the well is suspended, awaiting completion and well-testing activities.

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

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

All fluid additives (water and chemicals) and sand are mixed on the surface immediately before being pumped through HF equipment. The mixture and pumping schedules (rates, volumes and proppant) are based on an HF model, determining the desired fracture attributes. The HF model will be completed before the commencement of HF activities and underpinned by a Mechanical Earth Model (MEM). The MEM will be generated from data collected during drilling, wireline logging, core analysis and DFIT tests. The HF fluid mixture and pumping schedule are continuously updated during and after each Stage to ensure optimal outcomes. An example of the process and a modelled side view fracture is illustrated in Figure 2.25 and Figure 2.26.

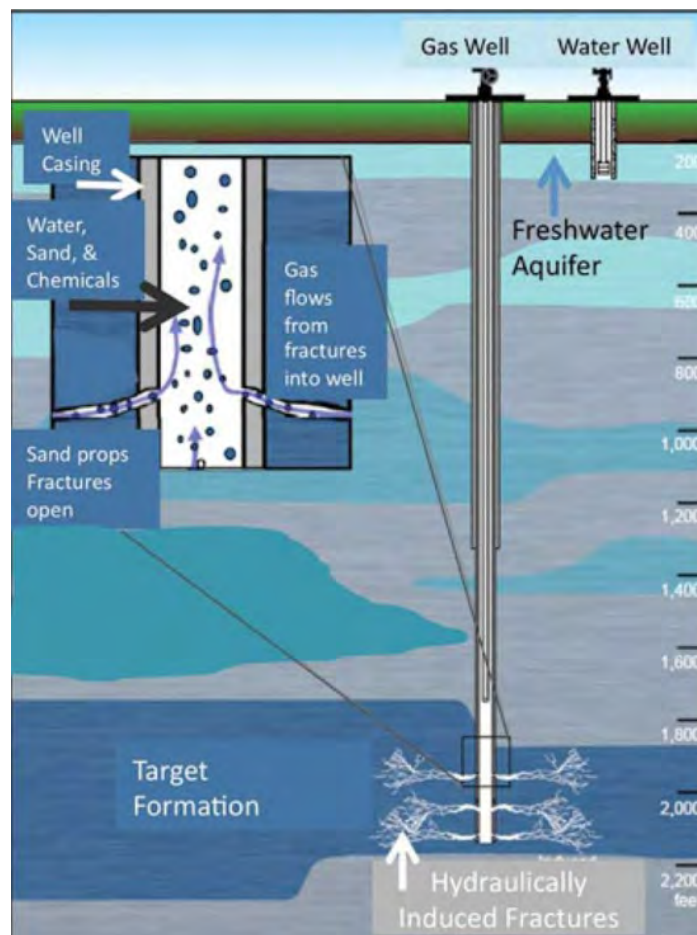


Figure 2.25: Indicative hydraulic fracture schematic

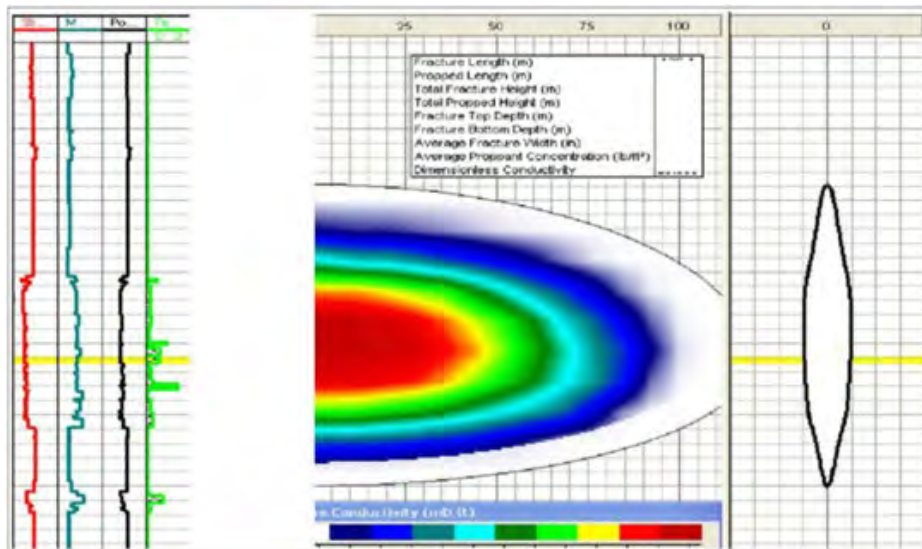


Figure 2.26: Example HF Model

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

2.10.2 Hydraulic Fracture Stages

The Hydraulic Fracture in a horizontal well can be placed several ways, but the most common way is to use a plug and perforate method in multiple stages. This method involves using perforating tools to place perforations, or holes, in the steel casing and cement around the wellbore. The perforations are placed in sections along the wellbore length, within the target shale.

The fracture stimulation is then pumped, and the fracture is placed through these perforations. The wellbore is broken down into sections called "Stages" to control the HF operation and allow each Stage to be successfully placed.

The following images demonstrate the process followed. The First Stage of the wellbore is perforated, as shown in Figure 2.27

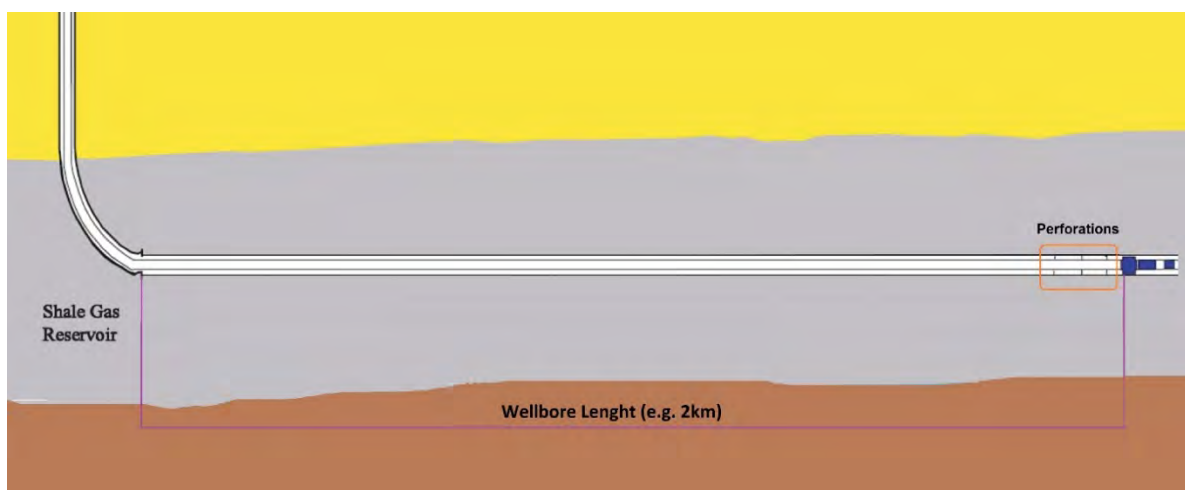


Figure 2.27: Perforation of 1st Stage

The first Stage of Hydraulic Fracture is then pumped, as shown in Figure 2.28

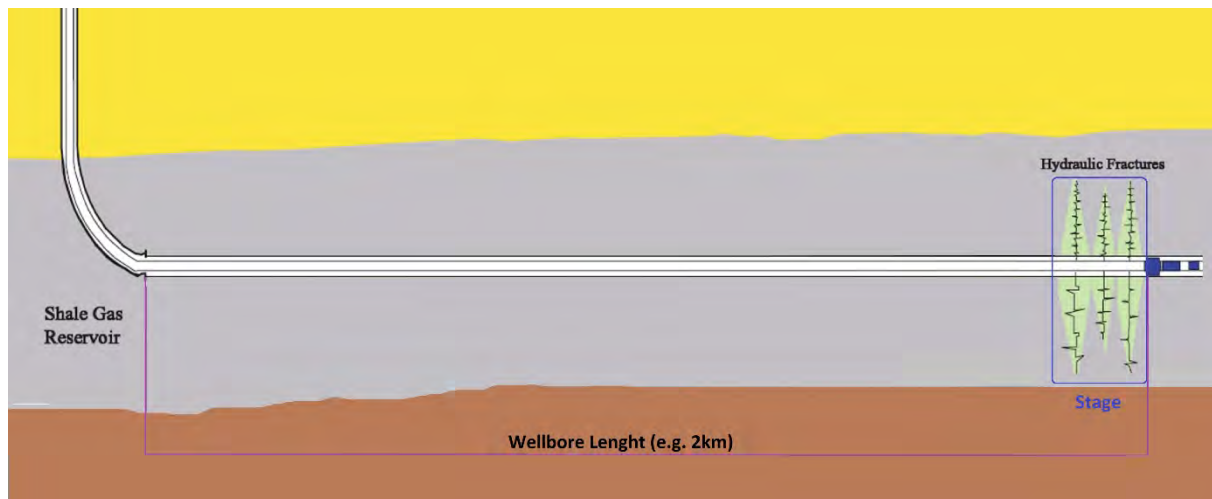


Figure 2.28: 1st stage Hydraulic Fracture

After the first Stage of Hydraulic Fracture is pumped, a plug is set to isolate that Stage from the balance of the wellbore, the second Stage is then perforated, as shown in Figure 2.29

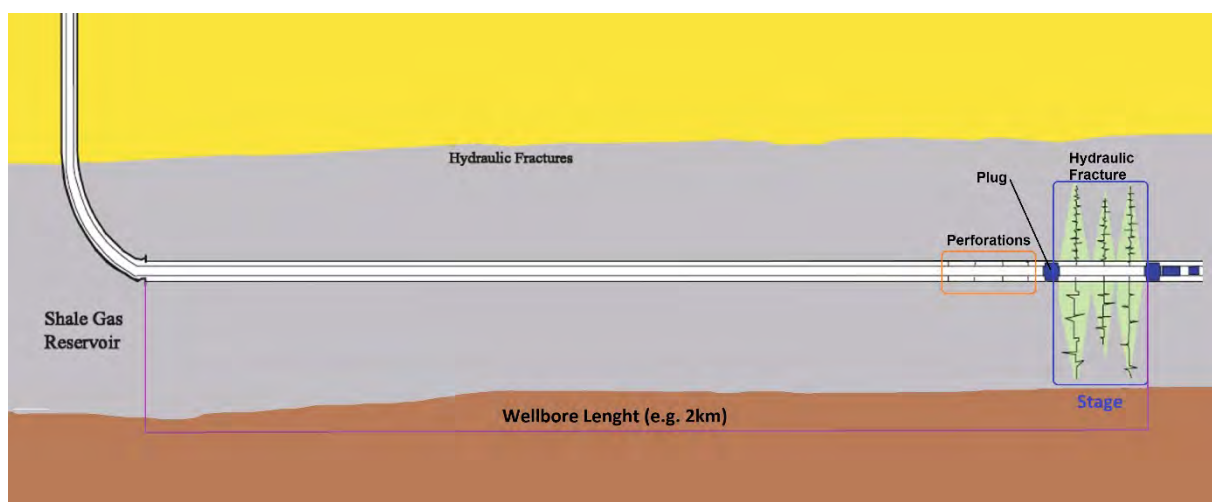


Figure 2.29: 1st stage plug, 2nd stage perforation

This process is repeated along the wellbore until the entire length of the target zone of the wellbore is Hydraulically Fractured. Each of the Stages of the wellbore is separately treated with a Hydraulic Fracture job. There will be several smaller fractures within each Stage that each come from the various perforations put in the casing.

Each Stage is designed to optimise the available fluid and the pumping capacity of equipment on-site, balancing the tradeoff between the size of a Stage for efficiency and placement control. If more stages are placed in a certain length, the size of each Stage will reduce.

In addition, as the well gets longer and more perforations and more frac stages are added, the additional length the fluid travels adds friction pressure such that the volume pumped per Stage has to be reduced; therefore, the stages tend to get smaller as the well gets longer and the number of stages increases.

So the volume pumped per fracture stimulation stage is not standard and is not a fixed volume, and the length of a Stage is not a fixed length. The volume of fluid pumped is therefore not proportional to the number of Stages placed.

The number of stages Hydraulically Fractured in a length of the wellbore can be varied to optimise this control; Figure 2.30 and Figure 2.31 show the same length wellbore, with the same amount of Hydraulically Fractured length and the same total fluid volume broken into five and ten stages, respectively

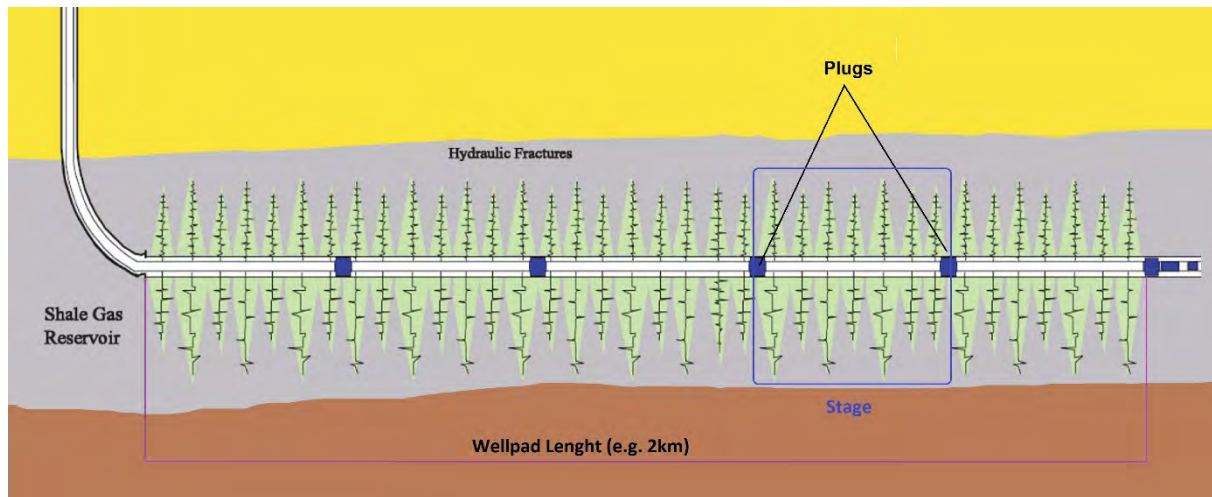


Figure 2.30: Wellbore split into 5 HF Stages

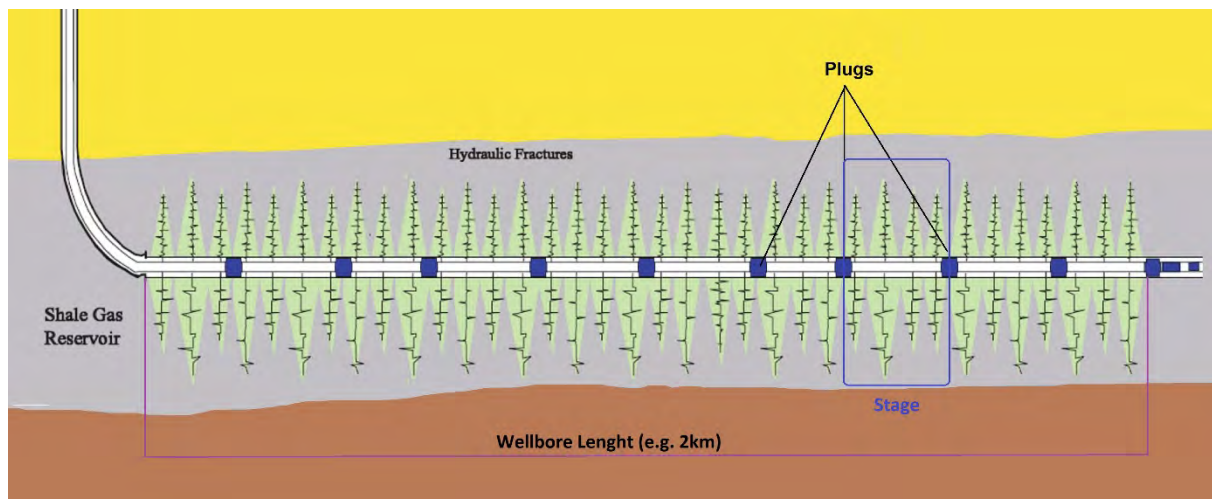


Figure 2.31: Wellbore split into 10 HF Stage

As each Stage has an incremental cost, a wellbore that is Hydraulically Fractured with a higher number of smaller Stages will have a higher cost than the same wellbore fractured with fewer larger Stages, even though a similar amount of fluid and proppant is pumped; however, the resultant design flow control may justify this cost.

The amount of Hydraulic Fracture fluid chemical and proppant use is primarily based on the type of fluid used in the design, the wellbore length, the perforation spacing and the design volume of each fracture node, not the number of stages.

Once all the stages are complete, and regardless of the number of stages, the isolation plugs are removed, and access to the full length of the wellbore is regained as part of the cleanout Hydraulic Fracture operations, as shown in Figure 2.32.

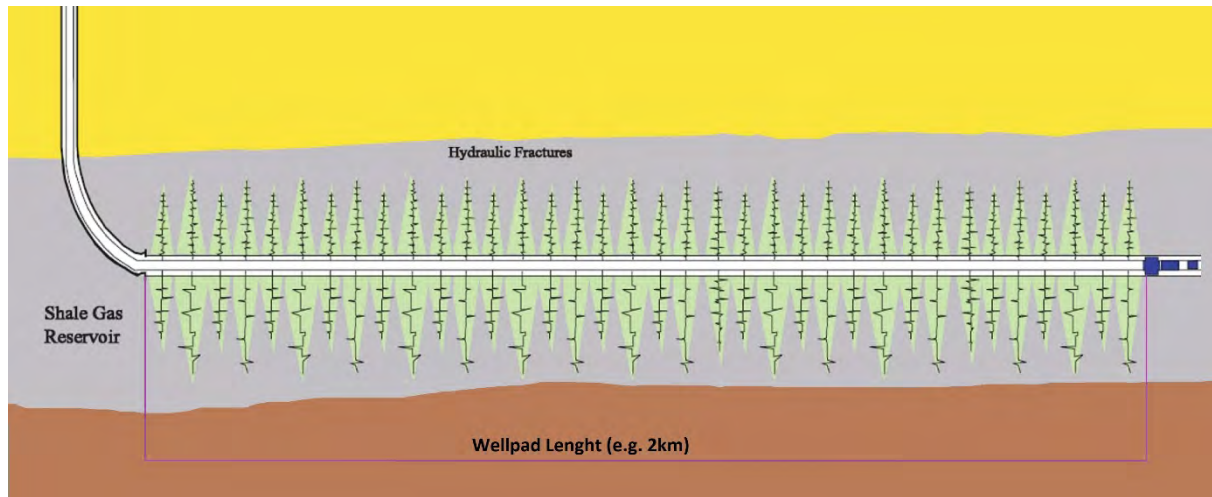


Figure 2.32: Wellbore with plugs removed

The design for Carpentaria 1 horizontal and Carpentaria 2 through 6 calls for up to 50 stages; however, these stages will be smaller and more closely spaced than if fewer stages were to be pumped in the same well. The total volume of fluid pumped is based on a range of design inputs and will not necessarily increase simply because of the number of stages.

2.10.3 Proppant and Chemical Additives

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

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

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

-
- **Viscosity regulators:** increases or decreases the thickness of a fluid

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

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

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

2.10.4 Tracers

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

Tracers are harmless chemicals designed to be unique in composition every well. They can be absorbed into both the water or gas phases, allowing them to be delineated from source due to each stage's unique tracer.

2.10.5 HF Equipment

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

2.10.6 Wellhead

The wellhead is the portion of the well's anatomy that shows above ground. It is made up of housings and valves that cap the wellbore and serve as a point used to inject into and control the well. The wellhead provides the primary surface barriers for well control; an example is shown in Figure 2.33.

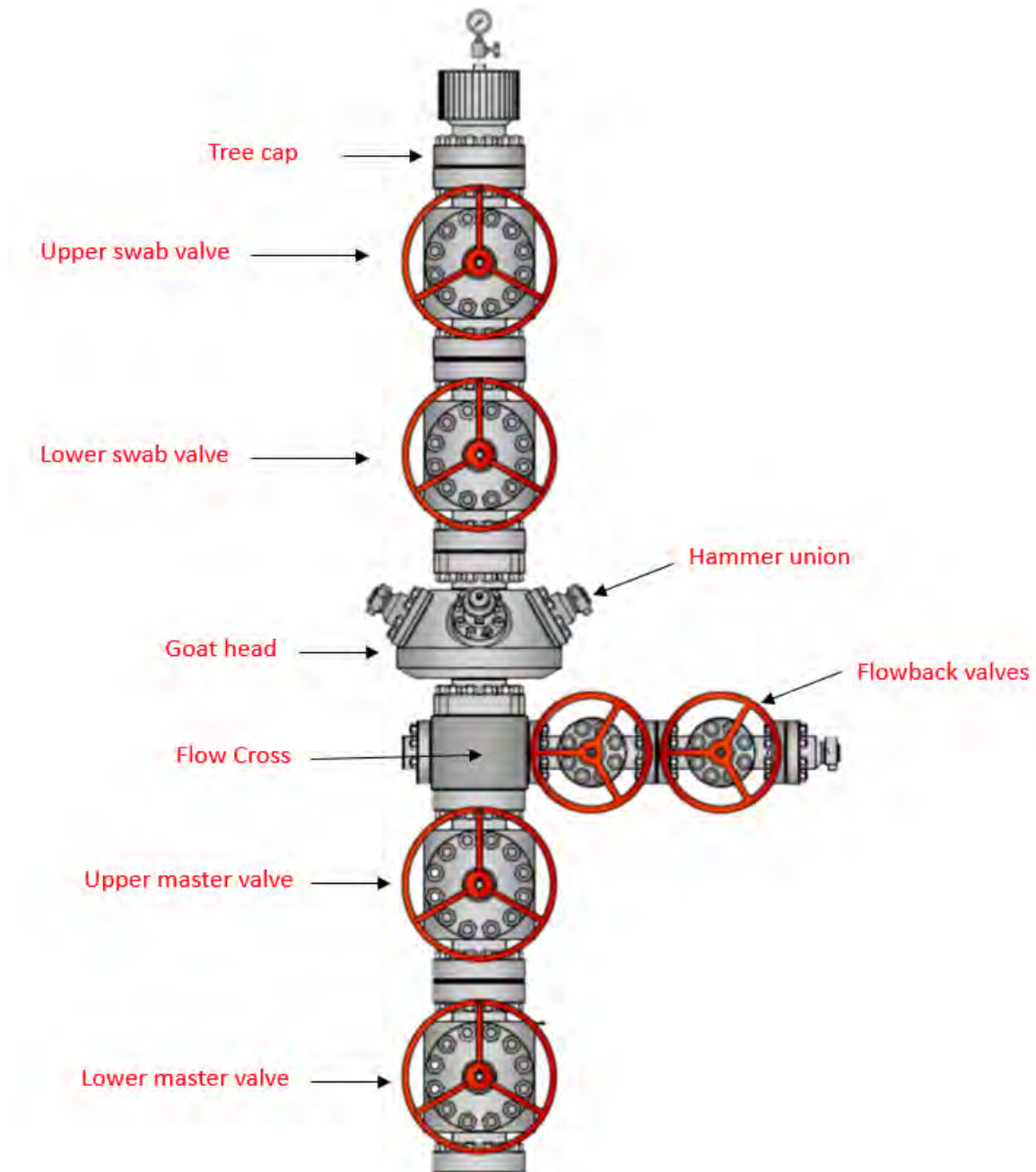


Figure 2.33: Typical HF Wellhead

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

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

2.10.7 Sand Trailer Units

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

2.10.8 Blender Units

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

2.10.9 High-Pressure Pumps

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

2.10.10 Control and Data Acquisition Unit

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

2.11 Flow-back and Extended Production Testing Activities.

2.11.1 Overview

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

The gas is directed to flare, water to flowback tanks, and condensate to storage tanks or flare, depending on the composition. All gas, water and condensate flow volumes are measured and recorded. A generic layout of a flowback and EPT package is shown in Figure 2.34 below.

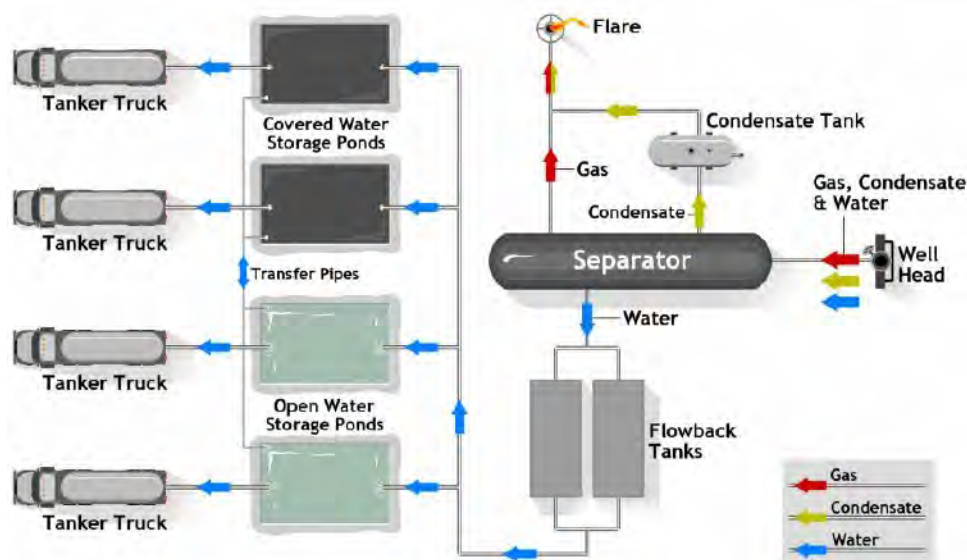


Figure 2.34: Example of Well Test Equipment Schematic

2.11.2 Flowback and EPT Equipment

2.11.2.1 Separator

The separator package splits the comingled flow from the wellbore into gas, water and condensate. All gas, water and condensate flow volumes are measured and recorded.

2.11.2.2 Above ground storage tanks

Temporary water storage and treatment tanks will be utilised on-site during the hydraulic flowback and EPT process. See appendix o6 Wastewater Management Plan for more details.

2.11.2.3 Flare

Produced gas, and pending results, potentially condensate, during EPT will be sent to a flare system to allow a controlled release and gas burning. It is equipped with an autoignition system that provides electrical impulses to generates a spark every 1.3 seconds to ensure that the flare is always operational. Any flares used under this EMP will have a tip efficiency of greater than 96%.

Appendix 03 - Environmental Risk Assessment Framework

3. Environmental Risk Assessment Framework

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3.1 Definition

As defined by the Petroleum (Environment) Regulations 2016; Environmental risk means "the chance of something happening that will have an environmental impact, measured in terms of the environmental consequences and the likelihood of those consequences occurring". This assessment is measured in terms of environmental consequences and likelihood of occurrence. Furthermore, an Environmental Impact can be described as any adverse change, or potential adverse change, to the environment resulting wholly or partly from a regulated activity.

3.2 Overview of the Environmental Risk Assessment Process

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

A risk can be considered to have been reduced to ALARP when all reasonably practicable control measures are in place to control a potential risk or impact considering the level of consequence and cost, time and resources involved to mitigate it.

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

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

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

- The residual risk rating is reviewed for acceptability. If the environmental hazard, post risk management controls, has a residual risk that meets the criteria to ALARP or not.
- If the residual risk of low is not achieved, further risk control measures should be implemented to reduce the risk to ALARP or an otherwise acceptable residual risk level. Imperial considers ALARP to be achieved where the following criteria have been met:
 - o The requirements of the Code of Practice have been met
 - o All reasonably practicable site-specific controls have been identified and implemented, and
 - o The cost of further reducing the risk is unreasonable compared to the environmental benefit gained from implementing the control measures.
- Final classifications around the controls' effectiveness are undertaken, and a review of the uncertainty within each risk sources assessment and risk reduction is undertaken.
- If either the effectiveness of controls or the uncertainty is too high, then the risk sources elements are again re-reviewed until determined as suitable.

3.3 Identification of risk events

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

3.4 Identification of the environment that may be affected

The potential environment to be affected is categorised by the Northern Territory Environment Protection Authority Factors and Objectives (2019) and sourced from the description in Appendix 01 (Description of the existing environment for the Location of the Regulated Activity).

3.5 Identification of Particular Values and Sensitivities

A review of the existing environment was performed using Imperial's independent environmental assessments, stakeholder consultation and publicly available information. This allowed for identifying the environmental values and sensitivities and their potential to occur within the Location of the Regulated Activity. Appendix 01 provides a summary of these values and sensitivities. The environmental values and sensitivities are input into the risk assessment to give the potential worst-case consequence value.

3.6 Identification and Evaluation of Potential Environmental Impacts

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

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

3.7 Pre-treatment Risk Ranking – Before controls applied

The risk evaluation process assesses the risks in terms of likelihood and consequence (Section 3.9-0) of the risk source's impact occurring. It defines the management actions required to reduce the risk to ALARP.

3.8 Control Measure Identification and ALARP Decision Framework

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

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

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

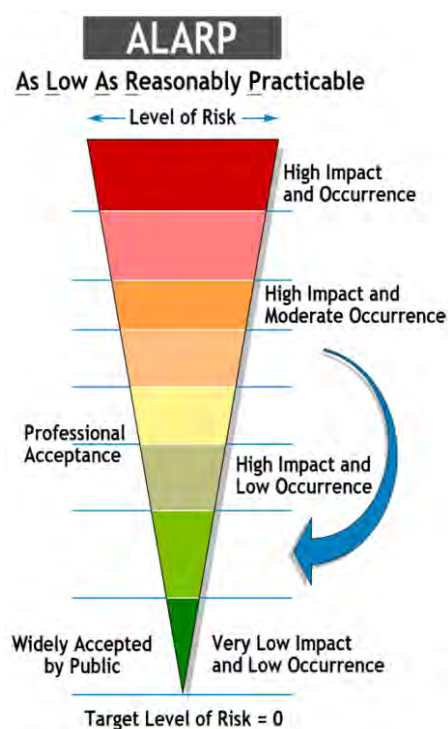


Figure 1: Risk Acceptance Model

When discussing ALARP and risk acceptance, it is important to **Risk Acceptance Model** note that the practicality and the reasonability of control measures can change over time due to technology, industry standards, and community acceptance.

3.9 Determination of Severity of Consequence

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

Imperial has undertaken a conservative approach in the determination of its consequence table.

Table 1: Imperial Environmental Consequence Classification

		Health & Safety	Natural Environment	Reputation	Financial
Critical	V	Fatality	Destruction of sensitive Environmental features. Severe impact on the ecosystem. Regulatory & high-level Government intervention/action.	Critical impact on business reputation /or international media exposure	Financial loss of \$500,000 or over
Major	IV	Permanent disabling injury and/or long term off work	Long term impact of regional significance on sensitive environmental features (e.g. wetlands). Likely to result in regulatory intervention/action	Significant impact on business reputation and/or national media exposure.	Financial loss from \$300,000 to \$400,000
Moderate	III	Injury requiring medical treatment, time off work and rehabilitation	Short term impact on Sensitive environmental features (e.g. Gibber Plain). Triggers regulatory investigation.	Moderate to small impact on business reputation.	Financial loss from \$200,000 to \$300,000
Minor	II	Injury requiring medical treatment with no lost time	Impact on fauna, flora and/or habitat but no negative effects on the ecosystem. Requires immediate regulator notification	Some impact on business reputation	Financial loss from \$100,000 to \$200,000.
Negligible	I	Minor injury - first aid treatment	Negligible impact on fauna/flora, habitat, aquatic ecosystem or water resources. Incident reporting according to routine protocols	Minimal impact to reputation	Financial loss from \$0 to \$100,000

3.10 Determination of Likelihood

Likelihood relates to the potential for a consequence to occur.

Imperial's Likelihood Classification are shown in Table 2.

Table 2: Imperial Likelihood Classification

Level	Criteria
Almost Certain	Almost certain to occur within the foreseeable future or the project lifecycle
Likely	Likely to occur within the foreseeable future or the project lifecycle
Possible	May occur within the foreseeable future or the project lifecycle
Unlikely	Not likely to occur within the foreseeable future or the project lifecycle
Remote	Will only occur in exceptional circumstances

3.11 Residual Risk Ranking

Risks are ranked by a combination of the impact consequence and the impact likelihood. Imperial uses the Corporate Risk Matrix (Table 3) and its components (Table 4 & Table 5) to measure the hazard probability (chance of occurrence), consequence severity (seriousness of consequences) and the risk ranking associated with it.

The risk ranking identified in Appendix 04 assists with determining the level of controls required to reduce the risk or impact. Based on the identified impacts and the ranking of their pre-treatment risk, control measures are determined to eliminate, prevent, reduce, or mitigate consequences associated with each associated environmental impact.

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

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

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

Table 3: Imperial Risk Matrix

Consequence		Negligible	Minor	Moderate	Major	Critical
Likelihood		I	II	III	IV	V
Almost certain	a	2	3	4	5	5
Likely	b	1	3	3	4	5
Possible	c	1	2	3	3	4
Unlikely	d	1	1	2	2	3
Remote	e	1	1	1	1	2

Table 4: Imperial Risk Significance Rating

Residual Risk	Description of risk level	Actions
1	- All controls are well designed and address the root cause/s of the risk, - All controls operate to the required level, - Little or no disruption to operations - Minimal impact to reputation - Financial loss from \$0 to \$100,000 AUS	- Undertake the activity with the existing controls in place and related work processes, - No further investigation required
2	- Majority of controls are well designed and address the root cause/s of the risk, - Majority of controls operate to the required level, - Incidents or events can be managed using simple tools - Some impact on business reputation, - Financial loss from 100,000 to \$200,000 AUS	- Undertake the activity with the existing controls in place, - No further investigation required
3	- Controls can be improved to ensure all root cause/s of the risk are addressed, - Several controls are not operating to the required level - Moderate to small impact on business reputation - Financial loss from \$200,000 to \$300,000	- Additional controls may be needed, - Ongoing monitoring required to ensure controls are operating to the required level
4	- Majority of controls are not well designed and do not address root cause/s of the risk, - Majority of controls do not operate to the required level and require improvement - Significant impact on business reputation - Financial loss from \$300,000 to \$400,000	- Improve existing controls and/or implement new controls - Involve multi-disciplinary team to review existing controls and improve where required
5	- Controls are not well designed and/or do not address root cause/s of the risk, - Controls do not operate to the required level, - Further controls are required to reduce risk level. - Activities should not commence until controls implemented to reduce the risk level. - Critical impact on business reputation, - Financial loss of \$500,000 or over	- Consider alternatives to doing the activity. - Stringent control measures will need to be implemented to ensure safety and business continuity. - Involve multidisciplinary team to review plan prior to commence any activity.

3.12 Determination of Risk Acceptability and Assessment of Scientific Uncertainty

The Petroleum (Environment) Regulations requires an assessment of uncertainty as part of the risk assessment process. The assessment of potential impacts and effectiveness of controls must demonstrate that the activities are carried out according to Ecologically Sustainable Development principles (ESD).

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

As per the Draft EMP Guidelines, scientific certainty is qualitatively assessed using a generic means of ranking the data available in Table 5.

Table 5: Acceptability and Scientific Uncertainty

Score (Uncertainty Type)	Acceptability	Uncertainty Description (DEFRA, 2013)
Low (A)	Residual risk is acceptable, and it is assumed that ALARP has been achieved. Risks are well understood and established practice.	- Comprehensive data with strong evidence in multiple peer-reviewed data - Little disagreement between authors or experts - Considerable and consistent on-ground experience and/or monitoring
Moderate-High (B)	Residual risk is acceptable, provided that ALARP has been achieved and demonstrated. Risk type B are typically in areas of increased environmental sensitivity with some stakeholder concerns.	- Some or incomplete data is available - Evidence provided based on a small number of references - Authors or experts' conclusions vary - Limited on-ground experience and/or monitoring
Extreme (C)	Residual risk is intolerable and must not be accepted or approved by Management. This risk will typically involve sufficient complexity, high potential impact, uncertainty or stakeholder interest.	- Scarce or no data available; evidence provided in unpublished reports - Few on-ground observations - Authors and experts' conclusions vary considerably

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

- The residual risk is determined to be Low, and ALARP, Uncertainty Type (A) selected and good practice control measures applied, or

- The residual risk is determined between Moderate and High and ALARP can be demonstrated
- The following have been met:
 - o Principles of ecologically sustainable development
 - o Legal and other requirements
 - o Imperial policies and standards
 - o Stakeholder expectations

3.12.1 ALARP Decision Making Tools

When determining whether the risk or impact has been reduced to ALARP, it must be asked whether environmental risks can be lowered further without a grossly disproportionate increase in impost. The following tools provide a framework for the decision making of ALARP.

- **Good Practice Control Measures** are considered: Legislation, codes and standards: Identifies the requirements of legislation, codes and standards that are to be complied with for the activity.
- **Good Industry Practice:** Identifies further engineering control standards and guidelines that may be applied over and above that are required to meet the legislation, codes and standards.
- **Professional Judgement:** Uses relevant personnel with the knowledge and experience to identify alternative controls. When formulating control measures for each environmental impact or risk, the hierarchy of controls philosophy, a system used in the industry to identify effective controls to minimise or eliminate exposure to impacts or risks, is applied.
- **Risk-based tools such as cost-based analysis or modelling:** assesses the results of probabilistic analyses, such as modelling, quantitative risk assessment and/or cost-benefit analysis to support the selection of control measures identified during the risk assessment process.
- **Precautionary approach:** uncertain analysis is replaced by conservative assumptions that will result in control measures being more likely to be implemented

3.13 Risk Determination and the Code

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

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

As discussed in Section 0, Imperial uses a model to determine residual risk acceptance specified in Imperial's Residual Risk Acceptance Model. To summarise:

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

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

- The residual risk is determined to be 1 (and ALARP Decision Type A selected and good practice control measures applied), or
- The residual risk is determined between 2 and 4, and ALARP can be demonstrated; and
- The following have been met:
 - o Principles of ESD
 - o Legal and other requirements
 - o Imperial policies and standards
 - o Stakeholder expectations.

Appendix 04 - Risk Assessment

Impact #	Risk source or environmental hazard	Environmental Factors or receptors	Potential Impact	Code of Practice Section	Risk Management Controls	Residual Risk			Acceptable Criteria Achieved	Residual risk ALARP and Acceptable Statement	Scientific Uncertainty Ranking
						C	L	R			
1	Vehicle and machinery movements	Terrestrial Environmental Quality	Soil compaction	A.3.1 Site selection and planning A.3.4 Erosion and sediment control and hydrology	Preventative - Seismic acquisition will occur only in the dry season to reduce the potential for compaction - Drive only on designated access roads or tracks - Preference to use previously disturbed areas, and align linear infrastructure along a common alignment - Access tracks will be assessed daily during periods of site activity for the impacts of wet weather - Access tracks will be closed to Imperial heavy vehicles, light vehicles or both, based on this assessment - Load Bearing capacity of access tracks will be assessed after rain events Mitigative - Areas to be rehabilitated to reduce impacts associated with damage and compaction	II	D	1	Yes	During the operation of lease pads, access tracks , camp pads etc., these sites will be compacted. Long term impacts of this compaction will be addressed during the rehabilitation of the sites. A loss of soil productivity is anticipated in the earlier stages of rehabilitation, returning back to pre-disturbed state within ~10 years. This will be accelerated through removal of hard stand areas, ripping and scarifying compacted surface. the consequences is likely to be "moderate", being locally restricted, with a minor- long (years) recovery time. The likelihood of long term productivity impairment is considered "unlikely".	Low
2	Vehicle and machinery movements	Human Health	Increased potential for accidents	A.3.1 Site selection and planning A.3.4 Erosion and sediment control and hydrology	Preventative - No driving under the influence of alcohol or drugs - Drive fatigue management policy will be implemented as per Journey Management Plan rest stops. - Implementation of Traffic Management Plan - All traffic and transport issues identified to be discussed at pre-spud meetings - All loads to and from the site will be covered to prevent the loss of materials - Vehicle movement along gravel roadways will be restricted in wet or adverse conditions 60km/hr speed limits on non-gazetted roads within exploration permit and Northern Territory speed limit on all gazetted roads - Limited driving at dawn and dusk - All vehicles to drive with lights on at all times - Sealed turnoff intersection of the Carpentaria-1 well site access track and the Carpentaria Highway - The use of flow lines to transport waste between well pads reduces the amount of potential truck movements.	III	E	1	Yes	The increased traffic from the activity is likely to be short term and within the Level of service of the existing roads. Accidents from truck turning into access tracks or from general vehicle accidents are anticipated to have a moderate consequence, with an injury to community members/tourist requiring hospitalisation. Given the lack of road users, traffic management plan for the access track turn in, zero tolerance for alcohol and drugs and use of trained drivers, the likelihood is considered remote	Low
3	Vehicle and machinery movements	Social, economic and cultural surroundings	Damage to or loss of public infrastructure, private infrastructure and equipment or community lands	A.3.1 Site selection and planning 4.3.2 Well pad site selection requirements	Preventative - Only approved access routes to be used - Implementation of the Traffic Management Plan - Adhere to road speed limits at all times or to the weather conditions, whichever is the lowest - Inductions for all employees and contractors cover pastoral, conservation, legislation and infrastructure issues - Sealed turnoff intersection of the Carpentaria-1 well site access track and the Carpentaria Highway - All activities to stay within the approved exploration licence - Vehicle movement along gravel roadways will be restricted in wet or adverse conditions	III	D	2	Yes	Land Access agreement and ongoing consultation with pastoralists is undertaken to ensure impacts on their activities or public infrastructure are mitigated. These impacts are addressed in the stakeholder agreements and access guidelines as well as the Implementation of the Traffic Management Plan. Consequences from damage to public/private infrastructure from vehicle movements are anticipated to be moderate with the likelihood unlikely.	Low
4	Vehicle and machinery movements	Social, economic and cultural surroundings	Road uses, local community and landholder's discontent or disturbance to activities	A.3.1 Site selection and planning A.3.2 Well pad site selection requirements A.3.3 Noise	Preventative - Only approved access routes to be used - Implementation of the Traffic Management Plan - Adhere to road speed limits at all times or to the weather conditions, whichever is the lowest - Inductions for all employees and contractors cover pastoral, conservation, legislation and infrastructure issues - Sealed turnoff intersection of the Carpentaria-1 well site access track and the Carpentaria Highway - All activities to stay within the approved exploration licence - Vehicle movement along gravel roadways will be restricted in wet or adverse conditions	II	D	1	Yes	The increased traffic from the activity is likely to be short term and within the Level of service of the existing roads. Increases in traffic are anticipated to have a "minor" consequence (increase in traffic observable, but temporary). The likelihood of causing a loss of experience from the activities is considered "unlikely".	Low
5	Drilling, Completion, Hydraulic Fracture & Production Test activities, Including lighting and vehicle movements	Terrestrial Flora and Fauna	Disturbance to native fauna due to light and noise from project activities	A.3.1 Site selection and planning A.3.3 Noise A.3.2 Well pad site selection requirements A.3.5 Biodiversity protection	Preventative - Majority of vehicle movements will be limited to daylight hours. - Task focussed lighting will be used, and all boundary lighting will be positioned inwards - Engines/machinery to be maintained as per planned maintenance system - Distance to dwellings is greater than 10km	I	A	2	Yes	It is 'almost certain' that native fauna will be disturbed through transport movements along access tracks and drilling, stimulation and well testing activities around the lease pad. The consequence of activity nuisance is anticipated to be negligible.	Low
6	Drilling, Completion, Hydraulic Fracture & Production Test activities, Including lighting and vehicle movements	Social, economic and cultural surroundings	Noise, light and vibration causing disturbance to landholders	A.3.1 Site selection and planning A.3.3 Noise	Preventative - Equipment guarding - No unauthorised third-party access. - SOPS - PPE - Consult with surrounding stakeholders when major activities occur - An agreement will be reached with affected stakeholders to ensure that management strategies are agreed and adhered to Mitigative - All work crews will contain at least one qualified senior first aid provider	II	E	1	Yes	The remote location and separation distances between receptors is likely to result in "minor" noise impacts. The likelihood of impacts is a function of separation distance and is therefore predicted to be remote.	Low
7	Drilling, Completion, Hydraulic Fracture & Production Test activities, Including lighting and vehicle movements	Human Health	Increased potential for accidents	A.3.1 Site selection and planning A.3.4 Erosion and sediment control and hydrology	Preventative - Equipment guarding - No unauthorised third-party access. - SOPS - PPE - Consult with surrounding stakeholders when major activities occur - An agreement will be reached with affected stakeholders to ensure that management strategies are agreed and adhered to Mitigative - All work crews will contain at least one qualified senior first aid provider	III	E	1	Yes	The increased traffic from the activity is likely to be short term and within the level of service of the existing roads. Accidents from truck turning into access tracks or from general vehicle accidents are anticipated to have a moderate consequence, with an injury to community members/tourist requiring hospitalisation. Given the lack of road users, traffic management plan for the access track turn in, zero tolerance for alcohol and drugs and use of trained drivers, the likelihood is considered remote.	Low
8	Drilling, Completion, Hydraulic Fracture & Production Test activities, Including lighting and vehicle movements	Human Health	Depletion in air quality due to emissions. Public ingesting dust	A.3.1 Site Selection and Planning A.3.4 Erosion and sediment control and hydrology D.4 Regional methane monitoring D.5 Emissions detection and management D.6 Reporting	Preventative - Closest receptors is over 10km from activity. - Sealed turnoff intersection of the Carpentaria-1 well site access track and the Carpentaria Highway - Adhere to road speed limits at all times or the weather conditions, whichever is the lowest - Flaring used to reduce pollutants associated with venting. - A reduced emission completion to be used to minimise greenhouse gas emissions and pollutant generation	III	E	1	Yes	Despite the remote location and separation distances between receptors, the risk of depleting air quality to the point it effects human health carries a "moderate" impact. The likelihood of impacts is a function of separation distance and is therefore predicted to be remote.	Low

Impact #	Risk source or environmental hazard	Environmental Factors or receptors	Potential Impact	Code of Practice Section	Risk Management Controls	Residual Risk			Acceptable Criteria Achieved	Residual risk ALARP and Acceptable Statement	Scientific Uncertainty Ranking
						C	L	R			
9	Greywater and sewerage disposal (camps)	Terrestrial Flora and Fauna	Soil contamination	A.3.1 Site selection and planning A.3.5 Biodiversity protection	Preventative •Sewerage wastewater irrigated as per Department of Health code of Practice for On-site Wastewater Management •Areas appropriately sized and fenced to accommodate irrigation volume and avoid fauna interaction • Area is remote and away from watercourse •Waste and Wastewater monitoring as per WWMP Appendix o6. •Wastewater system performance to be monitored in accordance with the manufacturers requirements	I	D	1	Yes	The management of sewerage and greywater is mature with various NT wastewater management guidelines. Due to the temporary nature of the activity, the maximum contamination resulting from sewerage and grey water irrigation is likely to be negligible, with any impacts locally restricted and temporary in nature. Irrigation is away from watercourse, with the potential contamination of these features considered unlikely.	Low
10	Civil Construction for seismic, wellpads, access tracks, gravel pits and flowlines (raking, grading, ground disturbance)	Air Quality and Greenhouse Gases	Increase in dust particles, reduction in air quality.	A.3.1. Site Selection and Planning	Preventative • 60km/hr speed limits on non-gazetted roads within exploration permit and Northern Territory speed limit on all gazetted roads • Monitor road conditions to ensure, deterioration with possible increase in dust creation does not occur and undertake road maintenance as required	I	A	2	Yes	Dust will almost certainly be generated through the construction of access tracks, seismic tracks, and lease pads. The consequence of dust is anticipated to be negligible because of the isolated location (lack of sensitive receptors) and use of dust suppression methods.	Low
11	Civil Construction for seismic, wellpads, access tracks, gravel pits and flowlines (raking, grading, ground disturbance)	Air Quality and Greenhouse Gases	Health respiratory stress by creation of atmospheric emissions	A.3.1. Site Selection and Planning		I	C	1	Yes	Impacts to sensitive receptors are not anticipated, with the closest receptor over 20km away. Flares will be utilised to minimise the release of VOC's. The potential consequence from the activities is predicted to be negligible. The likelihood is a function of source (lack of) and separation distance between receptors. the likelihood of a sensitive receptor being exposed to emissions from the activities above the NEPM guidelines is possible.	Low
12	Civil Construction for seismic, wellpads, access tracks, gravel pits and flowlines (raking, grading, ground disturbance)	Hydrological Processes	Impact to surface water due to Surface spills erosion and sediment movement.	A.3.8 Containment of Contaminants B.4.13 Hydraulic HF and Flowback Operations C.4.2 Management of produced water and flowback fluid C.7.1 Wastewater Management Plan C.7.2 Spill Management Plan	Preventative • Diesel fuel to be transported in engineered tanks • Drip trays to be used during fuel transfer • Follow the ESC plan, processes and procedures Mitigative • Spill kits to be on site during fuel transfer and civil construction machinery operations	I	C	1	Yes	The regulatory regime legislating the storage, handling and transportation of controlled wastes in the NT and Australia is mature. Imperial will adhere to the measures outlined in the EMP, Code and Management Plans. As such, the risk can be characterised as possible, with negligible impacts.	Low
13	Civil Construction for seismic, wellpads, access tracks, gravel pits and flowlines (raking, grading, ground disturbance)	Hydrological Processes	Impact to surface hydrology reduces water capture.	A.3 Surface activities mandatory requirements A.3.4 Erosion and sediment control and hydrology	Preventative • Wellpads located away from major watercourses or flow paths. • Wellpads designed to not disrupt flow paths, with overland flow diverted around • Infrastructure design in accordance with the NT Land Clearing Guidelines. • Erosion and sediment control plan implemented to prevent, detect and respond to erosion and sedimentation. • Wellpad location based on 1 in 100 year ARI Flood modelling • Contouring of gravel pits to ensure drainage of disturbed area is directed to shallow, low-sloped voids (internal).	II	E	1	Yes	Due to the lack of major water courses, impact is likely to be "minor", locally restricted and reversible. The likelihood is reduced down to remote due to the absence of watercourses and the controls implemented in accordance with NT Land Clearing Guidelines to avoid changes in the hydrological setting.	Low
14	Civil Construction for seismic, wellpads, access tracks, gravel pits and flowlines (raking, grading, ground disturbance)	Inland water environmental quality	Impact to hydrological systems (reduce quality and/or ecological function).	A.3.1 Site selection and planning A.3.2 Well pad site selection A.3.4 Erosion and sediment control and hydrology	Preventative • Buffer distances from riparian vegetation, waterways and drainage lines to be applied in accordance to "Recommended Widths for Riparian Buffers of the LCG (2019). o 1st order streams and Drainage lines = 25m buffer from outer edge of drainage depression or riparian vegetation o 2nd order streams = 50m buffer o 3rd and 4th order creeks = 100m buffer o 5th order Rivers = 250m •No clearing for seismic lines or wellpads within buffer zones • On ground supervisor during all land clearing operations • Install buffer zones and distances into clearing machinery GPS units, so machine operators be alerted when reaching buffer distances. • Access tracks and flowlines to cross watercourses at right angles, and to maintain original watercourse contours • Light contour ripping of reshaped gravel pit surfaces • Perimeter bunds are to be located to divert external 'run-on' water from entering work area; and contain internal pit runoff during rainfall events • Final voids created by gravel extraction are to be designed and located so as to receive internal pit drainage. Areas external to voids to be maintained at slopes < 2% as far as practical	III	D	2	Yes	An impact on hydrological systems is likely to be "moderate", with short term impacts on a sensitive environment. Given the controls in place during land clearing and controls implemented in accordance with NT Land Clearing Guidelines to avoid changes in the hydrological setting, the likelihood is reduced to unlikely.	Low
15	Civil Construction for seismic, wellpads, access tracks, gravel pits and flowlines (raking, grading, ground disturbance)	Inland water environmental quality	Increase in sediment load in watercourse.	A.3.1 Site selection and planning A.3.2 Well pad site selection requirements A.3.4 Erosion and sediment control and hydrology	Preventative • Buffer distances from riparian vegetation, waterways and drainage lines to be applied in accordance to "Recommended Widths for Riparian Buffers of the LCG (2019). o 1st order streams and Drainage lines = 25m buffer from outer edge of drainage depression or riparian vegetation o 2nd order streams = 50m buffer o 3rd and 4th order creeks = 100m buffer o 5th order Rivers = 250m •No clearing for seismic lines or wellpads within buffer zones • On ground supervisor during all land clearing operations • Install buffer zones and distances into clearing machinery GPS units, so machine operators be alerted when reaching buffer distances. • Access tracks and flowlines to cross watercourses at right angles, and to maintain original watercourse contours • Conduct progressive rehabilitation to minimise the total area open • Active inspection and monitoring of the effectiveness of erosion and sediment control measures adopted across the site. • Surface contouring of land will ensure free drainage • Perimeter bunds are to be located to divert external 'run-on' water from entering work area; and contain internal pit runoff during rainfall events • Gravel excavation areas are to be managed so that side slopes do not exceed 6%. • Perimeter bunds are to be formed from topsoil overburden (min 0.5m height) and woody vegetation resulting from clearing • Where runoff from within gravel pits cannot be directed internally (i.e.. to voids, contained by perimeter bunds), Type 2 sediment controls (e.g. rock check dams wrapped in geotextile, mulch berms, sediment bags, coir logs) are required at outlet areas to treat runoff prior to discharge.	II	C	2	Yes	The erosion and sediment release from cleared area is a well documented impact. The consequences of sediment releases are likely to be minor, a function of the low risk nature of the site soils types, buffer distances from watercourses, the design of lease pads and ongoing inspection and maintenance programs. The likelihood of these minor locally restricted releases of sediment is considered possible .	Low

Impact #	Risk source or environmental hazard	Environmental Factors or receptors	Potential Impact	Code of Practice Section	Risk Management Controls	Residual Risk			Acceptable Criteria Achieved	Residual risk ALARP and Acceptable Statement	Scientific Uncertainty Ranking
						C	L	R			
16	Civil Construction for seismic, wellpads, access tracks, gravel pits and flowlines (raking, grading, ground disturbance)	Terrestrial Flora and Fauna	Introduction or spread of weeds impacting native flora and fauna	A.3.1 Site selection and planning A.3.5 Biodiversity protection A.3.6 Weed management	Preventative - Vehicle and machinery to undergo weed clean down and inspection before mobilised to site - Major equipment moves will be planned from weed-free areas to infested areas and not the other way around - Site operators to undergo weed identification training and reporting (onsite training delivered by DEPWS weed officer). - Weed survey conducted before and after any disturbance or clearing operations to determine if new noxious species present and to map known weed distribution - Activities will adhere to the guidelines within the NT Weed Management Handbook and "Preventing weed spread is everybody's business" (https://denr.nt.gov.au/__data/assets/pdf_file/0011/257987/preventing-weed-spread.pdf) - Mark no-go areas if infestations of WONS and/or Class A/C weeds are found within the seismic lines	III	D	2	Yes	Land clearing is undertaken in accordance with the Land clearing guidelines. Any introduction of weeds is likely to result in localised impact, with weed management requirements likely to reduce the consequence to "moderate". Due to the inherent nature of weed prevention the risk likelihood is considered unlikely.	Low
17	Spread of weeds through vehicle movements.	Social, economic and cultural surroundings	Loss of pasture species through competition for resources	A.3.6 Weed management	Mitigative - Monitor rehabilitated areas, to undertake further weed control work as required - Photographic monitoring before and after disturbance - GPS marking of blown down sites. GPS records of all wash and blow down sites will be recorded by all operators in the field.	II	D	1	Yes	Weeds are present across the broader property in a low abundance. Any introduction of weeds is likely to result in localised impact, with weed management requirements likely to reduce the consequence down to "minor", short term. Due to the inherent nature of weed prevention the risk likelihood is considered unlikely.	Low
18	Civil Construction for seismic, wellpads, access tracks, gravel pits and flowlines (raking, grading, ground disturbance)	Social, economic and cultural surroundings	Disturbance or impedance of stakeholder use of the land	A.3.1 Site selection and planning A.3.2 Well pad Site selection requirements	Preventative - Stakeholder to be notified of all planned activities well in advance - Communication programs to be implemented - Install and maintain adequate warning signs and fences - Ongoing rehabilitation of disturbed areas not in use - All activities to stay within the approved areas - Only stakeholder approved access routes to be used - Gravel stockpiles areas to be managed to keep stockpile area to a minimum Mitigative - A full stakeholder communication log will be maintained	III	D	2	Yes	Consultation with pastoralists and relevant stakeholders is undertaken to ensure impacts on their activities are mitigated. Consequences are anticipated to be moderate for the proposed activities , with the likelihood unlikely.	Low
19	Civil Construction for seismic, wellpads, access tracks, gravel pits and flowlines (raking, grading, ground disturbance)	Social, economic and cultural surroundings	Loss of visual amenity	A.3.1 Site selection and planning A.3.2 Well pad Site selection requirements	Preventative - Minimise the extent to which the operations would be visible by the community or public by utilising natural topography and vegetation such as tree line or hill - Only stakeholder approved access routes to be used - Minimise land cleared to reduce impact on the surrounding users of the land. - Use of progressive rehabilitation to ensure that the land can be returned to other users if not required. Mitigative - A full stakeholder communication log will be maintained and recommendations implemented	I	E	1	Yes	The proposed explorational activities are located away from major transport routes, homesteads and communities. The consequences of activities may result in negligible changes in to aesthetics through visibility of exploration activities (flare glows at night, presence of workers and vehicles). The probability that the activity will result in a loss of visual amenity is considered remote.	Low
20	Civil Construction for seismic, wellpads, access tracks, gravel pits and flowlines (raking, grading, ground disturbance)	Social, economic and cultural surroundings	Fall to identify opportunities to deliver benefits to the local community	A.3.1 Site selection and planning	Preventative - Where possible, local and/or indigenous people employed - Where possible, local facilities and suppliers to be used - Communication programs to be implemented	II	C	2	Yes	Local contractors are to be used where available, with a priority on using NT businesses, where there is a fit to the workscope. The consequence of labour competition during the project activities is minor, with a likelihood of possible. Exploration activities are generally short term campaigns and are completed similar to most small infrastructure projects (such as road upgrades).	Low
21	Civil Construction for seismic, gravel pits, wellpads, access tracks, gravel pits and flowlines (raking, grading, ground disturbance)	Terrestrial Flora and Fauna	Loss of conservation of significant fauna	A.3.1 Site selection and planning A.3.5 Biodiversity protection A.3.6 Weed management	Preventative - Buffer distances from riparian vegetation, including eucalypt vegetation with hollows, will be followed in accordance to Recommended Widths for Riparian Buffers of the LCG (2019), and to be added into GPS with set alarms when approaching riparian/no-go zones. 1st order streams and Drainage lines = 25m buffer from outer edge of drainage depression or riparian vegetation 2nd order streams = 50m buffer 3rd and 4th order creeks = 100m buffer 5th order Rivers = 250m - Civil works avoid clearance of mature vegetation - On ground supervisor during all land clearing operations - An ecologist will be on site before, or during, clearing operations to undertake ground-truthing for ground disturbing activities in advance of any ground disturbance to ensure; - the actual riparian zones and the buffers for drainage depressions, and stream orders 1 to 4, and the location and density of hollow-bearing trees and their buffers are identified and mapped - the presence/absence of the six listed species identified by the Flora and Fauna division to have a low to moderate likelihood of occurrence, including the presence/absence of Grey Falcon nesting locations and Mertens' Water Monitor, is identified - the location wellpads and gravel pits will not require clearing of riparian zones, or their buffers and ensure that there are no active Grey Falcon nesting sites within 300m - Decision tree to be implemented prior to tree clearing of larger trees. - An inspection of a 300m radius around wellpads and gravel pits will be carried out prior to construction to check for Grey Falcon nesting to avoid disturbance due to noise. - Adhere to speed limits at all times - No clearing is proposed in the area where Gouldian Finch has been observed as the seismic activity is 22km away to the west - Avoid clearing of Acacia Shirleyi and Eucalypt with mistletoe. - Adherence to land clearing permit, no clearance out of approved area for the activities Mitigative - Track fauna strike/ near-miss in the fauna control register to enable knowledge sharing across Imperial personnel and contractors and implement changes where necessary - Topsoil with suitable seed bank to be re-spread over the exhausted gravel pit areas, to encourage natural regeneration	I	C	1	Yes	Fauna collisions with vehicles are a commonly associated with roads. It is anticipated that a small number of individual fauna collisions will be experienced during the activity (1-2 animals per month), with negligible impacts to fauna ecology as a whole. The likelihood of the risk is reduced through regionally extensive vegetation communities (good outside refuge away from access tracks and limited transport movements during the evenings . The likelihood of impact to flora and fauna is considered possible.	Low
22	Civil Construction for seismic, gravel pits, wellpads, access tracks, gravel pits and flowlines (raking, grading, ground disturbance)	Terrestrial Flora and Fauna	Loss of habitat impacting wildlife	A.3.1 Site selection and planning A.3.5 Biodiversity protection A.3.6 Weed management	Preventative - Adhere to speed limits at all times - No clearing is proposed in the area where Gouldian Finch has been observed as the seismic activity is 22km away to the west - Avoid clearing of Acacia Shirleyi and Eucalypt with mistletoe. - Adherence to land clearing permit, no clearance out of approved area for the activities Mitigative - Track fauna strike/ near-miss in the fauna control register to enable knowledge sharing across Imperial personnel and contractors and implement changes where necessary - Topsoil with suitable seed bank to be re-spread over the exhausted gravel pit areas, to encourage natural regeneration	III	D	2	Yes	Land clearing is undertaken in accordance with the Land clearing guidelines. The likelihood of the risk is reduced through regionally extensive vegetation communities (good outside refuge away from access tracks and limited transport movements during the evenings. Native fauna is mobile, Noise will help disperse the vagile fauna	Low

Impact #	Risk source or environmental hazard	Environmental Factors or receptors	Potential Impact	Code of Practice Section	Risk Management Controls	Residual Risk			Acceptable Criteria Achieved	Residual risk ALARP and Acceptable Statement	Scientific Uncertainty Ranking
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23	Civil Construction for seismic, wellpads, access tracks, gravel pits and flowlines (raking, grading, ground disturbance)	Terrestrial Flora and Fauna	Loss of conservation of significant flora	A.3.1 Site selection and planning A.3.5 Biodiversity protection A.3.6 Weed management	Preventative - An ecologist will be on site before, or during, clearing operations to undertake ground-truthing for ground disturbing activities in advance of any ground disturbance to ensure; - the actual riparian zones and the buffers for drainage depressions, and stream orders 1 to 4, and the location and density of hollow-bearing trees and their buffers are identified and mapped - the presence/absence of the six listed species identified by the Flora and Fauna division to have a low to moderate likelihood of occurrence, including the presence/absence of Grey Falcon nesting locations and Mertens' Water Monitor, is identified - the location wellpads and gravel pits will not require clearing of riparian zones, or their buffers and ensure that there are no active Grey Falcon nesting sites within 300m - Decision tree to be implemented prior to tree clearing of larger trees. - An inspection of a 300m radius around wellpads and gravel pits will be carried out prior to construction to check for Grey Falcon nesting to avoid disturbance due to noise. • Minimise clearing of new seismic lines to removal of logs and larger rocks necessary to ensure safe access wherever possible - New tracks shall be constructed at the minimum practical width (6m) to allow the safe travel of equipment - Respread any removed vegetation to encourage regrowth of native flora - No threatened flora species have been previously recorded within the search area - No Threatened Ecological Communities (TEC), Wetlands of International Importance, Great Barrier Reef Marine Park or Commonwealth Marine Area's occur within the study area Mitigative - Photographic monitoring before and after disturbance - Monitor rehabilitated areas un undertake further work as required.	II	D	1	Yes	Baseline Ecological Assessment, provides a well understanding of the area Fauna may be disturbed through transport movements along seismic lines, access tracks and drilling, stimulation and well testing activities around the lease pad. The consequence of activity nuisance is anticipated to be minor, with localised, short term impacts to areas immediately adjacent to access tracks. The likelihood of loss of conservation of significant flora is unlikely.	Low
24	Civil Construction for seismic, wellpads, access tracks, gravel pits and flowlines (raking, grading, ground disturbance)	Terrestrial Flora and Fauna	Loss of riparian flora	A.3.1 Site selection and planning A.3.5 Biodiversity protection A.3.6 Weed management	Preventative - An ecologist will be on site before, or during, clearing operations to undertake ground-truthing for ground disturbing activities in advance of any ground disturbance to ensure; - the actual riparian zones and the buffers for drainage depressions, and stream orders 1 to 4, and the location and density of hollow-bearing trees and their buffers are identified and mapped - the presence/absence of the six listed species identified by the Flora and Fauna division to have a low to moderate likelihood of occurrence, including the presence/absence of Grey Falcon nesting locations and Mertens' Water Monitor, is identified - the location wellpads and gravel pits will not require clearing of riparian zones, or their buffers and ensure that there are no active Grey Falcon nesting sites within 300m - Decision tree to be implemented prior to tree clearing of larger trees.. - Buffer distances from riparian vegetation, waterways and drainage lines to be applied in accordance to "Recommended Widths for Riparian Buffers of the LCG (2019) 1st order streams and Drainage lines = 25m buffer from outer edge of drainage depression or riparian vegetation 2nd order streams = 50m buffer 3rd and 4th order creeks = 100m buffer 5th order Rivers = 250m - Civil works avoid clearance of mature vegetation - On ground supervisor during all land clearing operations - Line preparation plant, to have GPS installed to alert when approaching no-go zones - No unauthorised clearing	III	D	2	Yes	The area is well understood and demarked to approved lease areas. However loss of riparian flora is considered a moderate impact. The risk mitigation measures and the implementation of the recommended widths for riparian buffers will reduce the likelihood of occurrence to unlikely.	Low
25	Flowline Construction - Trenching	Terrestrial Flora and Fauna	Fauna injury or death from entrapment in Flowline trench during construction	A.3.5 Biodiversity Protection	Preventative - Fauna ladders will be installed in trenches left open overnight - Trenching and backfilling to occur in a sequential manner to reduce the amount of open trench - Open Tranches to be inspected for trapped fauna, before work starts each day	I	C	1	Yes	The risk mitigation measures are designed to either prevent or identify and remove fauna before they are injured or killed. This results in the risk being possible but with negligible impact. Based upon the risk being ranked as a negligible and the controls being assessed as effective, the risk is determined to be ALARP and 'acceptable with no further risk reduction possible.	Low
26	Bushfire associated with project activities	Social, economic and cultural surroundings	Disturbance to cultural heritage sites	A.3.1 Site selection and planning A.3.2 Well pad Site selection requirements A.3.7 Fire Management	Preventative - Appropriate fire breaks on wellpad with minimum setbacks to infrastructure - Flares or flare stacks must be designed, prepared and operated following industry standards. - Flare stack will be monitored during flaring - Monitor weather and fire danger to plan operations accordingly - Fire extinguishers and operational VHF or UHF radio transceivers fitted to all vehicles and clearing machinery - Appropriate firefighting equipment available and serviced - No burning of waste - All personnel to be trained and informed before the commencement of the activity relating to: - Restricted smoking areas and requirements - Firefighting equipment operation and communication - Emergency Response Plan and procedures during a fire emergency - Alert of fire risk level for the day - Designated smoking areas with appropriate waste receptacles - Implementation of Fire Management Plan (Appendix 08) - Machinery and vehicles should be parked in areas of low fire risk. PE welding for flowline construction is at a low temperature, not considered an ignition source risk	III	D	2	Yes	Fire is a common occurrence within the region. Heritage survey complete with avoidance measures. A fire is likely to have a moderate impact, with short term impacts (years) on sensitive environments. With the appropriate controls in place, such as separation distances, firebreaks, and adherence to total fire bans, the likelihood of causing a fire from drilling, stimulation and well testing is anticipated to be unlikely.	Low
27	Ignition sources from plant, machinery, or flaring Inappropriate disposal of cigarettes. Well blow out	Social, economic and cultural surroundings	Injury or death to livestock, loss of pasture, dwellings and infrastructure	A.3.7 Fire Management D.5.9 Venting and Flaring	- Designated smoking areas with appropriate waste receptacles - Implementation of Fire Management Plan (Appendix 08) - Machinery and vehicles should be parked in areas of low fire risk.	IV	D	2	Yes	A fire causing loss of livestock or property is likely to have a major impact, with long term impacts. With the appropriate controls, such as separation distances, firebreaks, and adherence to total fire bans, the likelihood of causing a fire from drilling, stimulation and well testing is anticipated to be highly unlikely.	Low
28	Bushfire associated with project activities	Terrestrial Flora and Fauna	Native fauna fatality	A.3.5 Biodiversity Protection A.3.7 Fire Management	Mitigative - Availability of water to assist in fire control - Emergency Response Plan in place - Vegetation stockpiles are stored away from ignition sources and in low profile mounds	III	D	2	Yes	Fire is a common occurrence within the region. A fire is likely to have a moderate impact, with short term reversible impacts (years). With the appropriate controls, such as separation distances, firebreaks, and adherence to total fire bans, the likelihood of causing a fire from drilling, stimulation and well testing is anticipated to be highly unlikely.	Low
29	Entrapment in in-ground open pits that are used for the treatment of HF flowback and produced water and open tanks	Terrestrial Flora and Fauna	Disturbance, injury or death to terrestrial fauna	A.3.5 Biodiversity protection A.3.8. Containment of contaminants D.4.3 Routine periodic atmospheric monitoring programme	Preventative - Open-top tanks to have vertical walls with no clear access points for fauna. - Fauna ladders will be installed at all open pits and tanks - Weekly inspections of open pits and tanks	I	B	1	Yes	Risks associated with potentially trapping and drowning fauna in storage tanks and sumps are well understood, and carries negligible consequences to the greater environment. Despite controls reducing the risk to ALARP, it is likely that some fauna will become trapped in inground open pits.	Low

Impact #	Risk source or environmental hazard	Environmental Factors or receptors	Potential Impact	Code of Practice Section	Risk Management Controls	Residual Risk			Acceptable Criteria Achieved	Residual risk ALARP and Acceptable Statement	Scientific Uncertainty Ranking
						C	L	R			
30	Crossflow during drilling and HF, operations, testing and decommissioning Fracture growth into aquifer from HF activities Faults or major structures enables crossflow. Well blow out	Inland water environmental quality	Reduction in groundwater and surface water quality	B.4.1 Well integrity management B.4.2 Aquifer protection B.4.3 Well design and barriers B.4.6 Casing and tubing B.4.7 Primary cementing B.4.9 Well control B.4.13 Hydraulic stimulation and flowback operations B.4.17 Groundwater monitoring C.4.2 Management of Produced water and Flowback Fluid C.7.2 Spill management plan	Preventative - Well is constructed following the Code requirements, and passes well acceptance criteria - Shallow aquifers isolated behind cemented concentric casing strings. - Distance of target shale formations (Velkerri formation) from the nearest high-quality aquifer (Cambrian Limestone aquifer) is over 600m - Mechanical Earth Model based on Logging, core, drilling, and offset data is created to aide in understanding HF geometry and subsequent design - A geohazard assessment will be carried out using the upcoming seismic and that the risk will be addressed in the WOMP to mitigate for subsurface hazards such as abnormal pressure zones, shallow gas, lost circulation and potential zones of instability - A WOMP in place and approved. Activities will not commence until approval received from the regulator - Installation of blow-out prevention equipment systems - Hydraulic fracture diagnostics, including chemical tracers and logging is used to understand the spatial extent and orientation of the induced fracture to improve ongoing design - HF is not linked to major seismic events (re injection of wastewater is generally recognised as the main cause). No reinjection of wastewater proposed - HF stages deployment will be away from geohazards to reduce the loss of fluids into any encountered faults - Geohazard Risk Assessment will be carried out using the upcoming seismic and that the risk will be addressed in the WOMP - No significant faults within proximity of activity, and - Any faults encountered during drilling will be assessed to determine the risk before HF operations	IV	D	2	Yes	Through the adoption of the controls with the Code, and the mitigation measures outlined in the EMP meets the industry best practice requirements of the Code, API standards and the Water Act. Chemical risk assessment conducted. Risk assessment report on hydraulic fracturing flowback wastewater at Santos Tanumbirini well site. Control and monitoring bores as per preliminary guidelines: Groundwater monitoring bores for exploration petroleum wells in the Beetaloo Sub-Basin CSIRO regional baseline monitoring program is complete, and the knowledge of the regional aquifers is well established. Reduction in ground and surface water quality carries a major risk with potential long term impacts. However, the residual risk has been reduced to the greatest extent possible (unlikely) due to the consequence remaining as serious if an event did occur. Therefore, we consider this risk ALARP and acceptable with no further risk reduction warranted.	Low
31	Crossflow during drilling and HF, operations, testing and decommissioning Fracture growth into aquifer from HF activities Faults or major structures enables crossflow. Well blow out	Terrestrial Flora and Fauna	Impacts to surface water, groundwater dependant ecosystems	B.4.1 Well integrity management B.4.2 Aquifer protection B.4.3 Well design and barriers B.4.6 Casing and tubing B.4.7 Primary cementing B.4.9 Well control B.4.13 Hydraulic stimulation and flowback operations B.4.17 Groundwater monitoring C.4.2 Management of Produced water and Flowback Fluid C.7.2 Spill management plan	Mitigative - Groundwater bores monitored before hydraulic fracture operations. Baseline monitoring conducted six months before and after hydraulic fracture operations - Chemical Risk Assessment of all chemical used in the proposed HF (Appendix o6.01). - Risk assessment report on hydraulic fracturing flowback wastewater at Santos Tanumbirini well site concluded: - there are no degradants of the HF chemicals that would require additional analytical testing beyond the chemistry analyte specified in the Code - there were no unacceptable risks to birds from potential ingestion of chemicals in the wastewater over a one year period - no chemicals detected in the wastewater, at their maximum concentration, under a hypothetical maximum release scenario, would result in soil levels above soil screening criteria for the protection of terrestrial plants and animals	IV	E	1	Yes	Through the adoption of the controls with the Code, and the mitigation measures outlined in the EMP meets the industry best practice requirements of the Code, API standards and the Water Act. Chemical risk assessment conducted. Risk assessment report on hydraulic fracturing flowback wastewater at Santos Tanumbirini well site. Control and monitoring bores as per preliminary guidelines: Groundwater monitoring bores for exploration petroleum wells in the Beetaloo Sub-Basin Also, the CSIRO regional baseline monitoring program is underway, and the knowledge of the regional aquifers is well established. impacts to ground and surface water dependant ecosystems are considered major, but carry a likelihood of remote. The residual risk has been reduced to the greatest extent possible due to the consequence remaining as serious if an event did occur. Therefore, we consider this risk ALARP and acceptable with no further risk reduction warranted.	Low
32	Leak from flowline failure	Inland water environmental quality	Changes in aquifer or surface water quality. Impact on groundwater user or GDE	A.3 Surface activities mandatory requirements requirements A.3.8 Containment of Contaminants B.4.17 Groundwater monitoring C.4.2 Management of produced water and flowback fluid C.7.2 Spill Management Plan D.5.6 Leak Remediation and Notification	Preventative - Flowlines to be tested to meet the Code of Practice - Upstream Polyethylene Gathering Networks – CSG Industry - Flow balance monitoring during use of flowlines to detect leaks - Flowline high point vents monitoring when the flowlines contain wastewater - Wastewater Management Plan - Laboratory analysis and risk assessment of the HF flowback wastewater will be conducted prior to sending the wastewater to treatment tanks	III	D	2	Yes	The risk of a flowline failure is minimised by being constructed to a relevant code and by being continuously monitored for leaks By burying flowlines there is added protection against fire, flood, cyclonic winds, extreme temperatures and loading stress forces under a range of conditions. A spill management pan is in force to detect, prevent and respond to potential spills of wastewater. If a failure was to occur, the wastewater would be restricted to the immediate vicinity of the flowline. The consequences are likely to be "Moderate", being locally restricted, short term duration and reversible. The likelihood is considered unlikely.	Low
33	Leak from flowline failure	Terrestrial Flora and Fauna	Disturbance to environmentally sensitive areas and/or high valued habitat areas	A.3 Surface activities mandatory requirements requirements A.3.8 Containment of Contaminants C.4.2 Management of produced water and flowback fluid C.7.2 Spill Management Plan	Mitigative - Chemical Risk Assessment of all chemical used in the proposed HF (Appendix o6.01). Risk assessment report on hydraulic fracturing flowback wastewater at Santos Tanumbirini well site concluded: - there are no degradants of the HF chemicals that would require additional analytical testing beyond the chemistry analyte specified in the Code - there were no unacceptable risks to birds from potential ingestion of chemicals in the wastewater over a one year period - no chemicals detected in the wastewater, at their maximum concentration, under a hypothetical maximum release scenario, would result in soil levels above soil screening criteria for the protection of terrestrial plants and animals	II	C	2	Yes	The risk of a flowline failure is minimised by being constructed to a relevant code and by being continuously monitored for leaks By burying flowlines there is added protection against fire, flood, cyclonic winds, extreme temperatures and loading stress forces under a range of conditions. A spill management pan is in force to detect, prevent and respond to potential spills of wastewater. If a failure was to occur, the wastewater would be restricted to the immediate vicinity of the flowline. The consequences are likely to be minor, with localised impacts but no negative effects on the ecosystem. The likelihood is considered possible.	Low
34	Waste and Wastewater stored inappropriately attracting native fauna	Terrestrial Flora and Fauna	Fauna fatality due to waste consumption	C.7.1 Wastewater management plan	Preventative - Only waste from approved greywater systems will be disposed of to land - Drilling cuttings which have been tested and proven suitable will be mixed blended as solid waste on site. - Solid waste will be segregated and stored onsite in vertical side skip bins - All putrescible solid waste material will be held in fauna proof containers - Half-life of drilling fluid biocides used <5 days in water, and less than 14 days in sediment. - The hazard quotient for all the assessed avian species was orders of magnitude less than the threshold hazard quotient level of 1 (Appendix F, Appendix o6.01). - Results from the Risk Assessment conducted at Tanumbirini well site concluded there were no unacceptable risks to birds from potential ingestion of chemicals in the wastewater over a one year period. - Tanks that are used for treatment of HF flowback and produced water will be inspected weekly to check integrity - Open HF flowback and produced water treatment tanks will have vertical walls with no clear access points for fauna	I	D	1	Yes	Feral animals may be increased through the provision of access to water, food (camps) and hunting habitat (such as road corridors). The use of the existing site and access tracks limits the additional risk associated with provision of additional hunting habitat. Food scraps and waste will be disposed of offsite which will reduce the food availability for pests. As such, this risk carries negligible impact with a likelihood of unlikely and can be considered ALARP.	Low
35	Waste and Wastewater stored inappropriately attracting native fauna	Terrestrial Flora and Fauna	Loss of native vegetation through competition for resources	A.3.5 Biodiversity Protection C.7.1 Wastewater management plan	Preventative - Solid waste will be segregated and stored onsite in vertical side skip bins - All putrescible solid waste material will be held in fauna proof containers - Implementation of mitigation measures described in the Waste Management Plan - Open HF flowback and produced water treatment tanks will have vertical walls with no clear access points for fauna	I	D	1	Yes	Feral animals may be increased through the provision of access to water, food (camps) and hunting habitat (such as road corridors). The use of the existing site and access tracks limits the additional risk associated with provision of additional hunting habitat. Food scraps and waste will be disposed of offsite which will reduce the food availability for pests. As such, this risk carries negligible impact with a likelihood of unlikely and can be considered ALARP.	Low

Impact #	Risk source or environmental hazard	Environmental Factors or receptors	Potential Impact	Code of Practice Section	Risk Management Controls	Residual Risk			Acceptable Criteria Achieved	Residual risk ALARP and Acceptable Statement	Scientific Uncertainty Ranking
						C	L	R			
36	Waste and Wastewater stored inappropriately attracting native fauna	Terrestrial Flora and Fauna	Introduction of pest species	A.3.5 Biodiversity Protection C.7.1 Wastewater management plan	Preventative • Solid waste will be segregated and stored onsite in vertical side skip bins • All putrescible solid waste material will be held in fauna proof containers • Implementation of mitigation measures described in the Waste Management Plan • Open HF flowback and produced water treatment tanks will have vertical walls with no clear access points for fauna • Implementation of mitigation measures described in the Weed Management Plan • Vehicle and machinery to undergo weed clean down and inspection before mobilised to site • Major equipment moves will be planned from weed-free areas to infested areas and not the other way around • Site operators to undergo weed identification training and reporting (onsite training delivered by DEPWS weed officer). • Weed survey conducted before and after any disturbance or clearing operations to determine if new noxious species present and to map known weed distribution • Activities will adhere to the guidelines within the NT Weed Management Handbook and "Preventing weed spread is everybody's business" (https://denr.nt.gov.au/_data/assets/pdf_file/0011/257987/preventing-weed-spread.pdf) • Mark no-go areas if infestations of WONS and/or Class A/C weeds are found within the seismic lines	II	D	1	Yes	Weeds are present across the broader property in a low abundance. Any introduction of weeds is likely to result in localised impact, with weed management requirements likely to reduce the consequence down to "minor", short term. Due to the inherent nature of weed prevention the risk likelihood is considered unlikely.	Low
37	Civil Construction for seismic, wellpads, access tracks, gravel pits and flowlines (raking, grading, ground disturbance)	Terrestrial Environmental Quality	Disruption on landform and soils	A.3.1 Site selection and planning A.3.4 Erosion and sediment control and hydrology	Preventative • No unauthorised clearing • Geolocation and warning signals utilised to prevent any disturbance outside the seismic easement or within nominated buffer areas • Low-level watercourse crossings for access tracks to be excavated and backfilled with rock to watercourse bed level • On ground supervisor during all land clearing operations • Implementation of the Erosion and Sediment Control Plan (Appendix 05) • An ecologist will be on site before, or during, clearing operations to undertake ground-truthing for ground disturbing activities in advance of any ground disturbance to ensure; - o the actual riparian zones and the buffers for drainage depressions, and stream orders 1 to 4, and the location and density of hollow-bearing trees and their buffers are identified and mapped - o the presence/absence of the six listed species identified by the Flora and Fauna division to have a low to moderate likelihood of occurrence, including the presence/absence of Grey Falcon nesting locations and Mertens' Water Monitor, is identified - o the location wellpads and gravel pits will not require clearing of riparian zones, or their buffers and ensure that there are no active Grey Falcon nesting sites within 300m Decision tree to be implemented prior to tree clearing of larger trees. Mitigation • Daily during construction • 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 • 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 Anticipated rainfall (24h prior) • All drainage, erosion and sediment control measures • All temporary flow diversion and drainage works After rainfall (within 18h) • 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	II	D	1	Yes	The erosion and sediment release from cleared area is a well document impact. After the implementation of Erosion and Sediment Control Management Plan, the consequences of sediment releases and erosion are likely to be minor. The design of lease pads and ongoing inspection and maintenance program will reduce the likelihood of these impacts to locally and restricted areas to unlikely.	Low
38	pits overtopping from flooding inundation	Terrestrial Environmental Quality	Soil contamination	A.3.8 Containment of Contaminants C.4.2 Management of produced water and flowback fluid C.5.2 Drilling Materials C.7.1 Waste management plan C.7.2 Spill Management Plan	Preventative • Wellpad location based on 1 in 100 year ARI Flood modelling • Pits to be constructed with 500mm bund to prevent water entry from overland flow.	III	E	1	Yes	The consequence and likelihood of a wastewater storage overflowing are minimised through the onerous wastewater management requirements stipulated in the COP. This includes lease pad bunding, tank level alarms, tank freeboard requirements and use of a wastewater management plan. Any overflow is likely to be restricted to the lease pad, rapidly detected and promptly cleaned up. The use of enclosed tanks, freeboard and lease pad bunding essentially eliminates the likelihood potential for a wastewater storage tank to overflow. Given the onerous regulatory requirements, the likelihood of an overtopping event is considered remote with moderate consequences. Chemical Risk Assessment of all chemical used in the proposed HF (Appendix o6.01). Risk assessment report on hydraulic fracturing flowback wastewater at Santos Tanumbirini.	Low
39	pits overtopping from flooding inundation	Inland water environmental quality	Surface Water contamination	A.3.8 Containment of Contaminants B.4.13 Hydraulic Stimulation and Flowback Operations C.4.2 Management of produced water and flowback fluid C.5.2 Drilling Materials C.7.1 Wastewater Management Plan C.7.2 Spill Management Plan	Preventative • Wellpad location based on 1 in 100 year ARI Flood modelling • Pits to be constructed with 500mm bund to prevent water entry from overland flow.	III	D	2	Yes	The consequence and likelihood of a wastewater storage overflowing are minimised through the onerous wastewater management requirements stipulated in the COP. This includes lease pad bunding, tank level alarms, tank freeboard requirements and use of a wastewater management plan. Any overflow is likely to be restricted to the lease pad, rapidly detected and promptly cleaned up. The use of enclosed tanks, freeboard and lease pad bunding essentially eliminates the likelihood potential for a wastewater storage tank to overflow. Given the onerous regulatory requirements, the likelihood of an overtopping event is considered unlikely, with a consequence of moderate. Chemical Risk Assessment of all chemical used in the proposed HF (Appendix o6.01). Risk assessment report on hydraulic fracturing flowback wastewater at Santos Tanumbirini.	Low

Impact #	Risk source or environmental hazard	Environmental Factors or receptors	Potential Impact	Code of Practice Section	Risk Management Controls	Residual Risk			Acceptable Criteria Achieved	Residual risk ALARP and Acceptable Statement	Scientific Uncertainty Ranking
						C	L	R			
40	Pits or tanks failing from flooding inundation	Inland water environmental quality	Surface Water contamination	A.3.1 Surface activities mandatory requirements A.3.8 Containment of Contaminants C.4.2 Management of produced water and flowback fluid C.7.1 Wastewater management plan C.7.2 Spill Management Plan	Preventative - Wellpad location based on 1 in 100 year ARI Flood modelling - Pits to be constructed with 500mm bund to prevent water entry from overland flow. - Pits to be constructed with 500mm bund to prevent escape of water from a catastrophic failure will prevent water entry from overland flow.	III	D	2	Yes	The consequences of a pit failure are negated through the use of sufficient structural liners integrity to withstand cyclonic winds, extreme temperatures and loading stress forces under a range of conditions. Pits are constructed away from flooding zones. A spill management pan is in force to detect, prevent and respond to potential spills of wastewater. as well as Erosion and Sediment control devices implemented to deviate water from leases. If a storage failure was to occur, the wastewater would be restricted to the lease pad, limiting the impact on adjacent pastoral activities and community.. Flowback would be pumped into available enclosed and open tank storage, with contaminated soil removed from site. The consequences are likely to be moderate, with short term impact on a sensitive environment. The likelihood is reduced by the COP requirements , tank/pits design separation distances to the underlying aquifer. The likelihood is considered unlikely.	Low
41	Pits or tanks failing from flooding inundation	Terrestrial Environmental Quality	Soil contamination	A.3.1 Surface activities mandatory requirements A.3.8 Containment of Contaminants C.4.2 Management of produced water and flowback fluid C.7.1 Wastewater management plan C.7.2 Spill Management Plan		III	E	1	Yes	The consequences of a pit failure are negated through the use of sufficient structural liners integrity to withstand cyclonic winds, extreme temperatures and loading stress forces under a range of conditions. Pits are constructed away from flooding zones. A spill management pan is in force to detect, prevent and respond to potential spills of wastewater. as well as Erosion and Sediment control devices implemented to deviate water from leases. If a storage failure was to occur, the wastewater would be restricted to the lease pad, limiting the impact on adjacent pastoral activities and community.. Flowback would be pumped into available enclosed and open tank storage, with contaminated soil removed from site. The consequences are likely to be moderate, with short term impacts on a sensitive environment. The likelihood is reduced by the COP requirements , tank/pits design separation distances to the underlying aquifer. The likelihood is considered Remote, with a probability less than 1%.	Low
42	Runoff from sewage treatment irrigation areas	Terrestrial Environmental Quality	Soil and surface water contamination	A.3.1 Site selection and planning	Preventative - Irrigation areas located away from watercourses - Wastewater irrigation to comply with DOH requirement - Areas appropriately sized to accommodate irrigation volume - Wastewater system approved by NT performance to be monitored in accordance with the manufacturers requirements	I	D	1	Yes	The management of sewerage and greywater is mature with various NT wastewater management guideline. Due to the temporary nature of the activity, the maximum contamination resulting from sewerage and grey water irrigation is likely to be negligible. Area is located away from watercourse with the potential contamination of these features considered unlikely.	Low
43	Vehicles leave the previously constructed roads or work areas	Social, economic and cultural surroundings	Disturbance to Aboriginal archaeological sites	A.3.1 Site Selection and Planning	Preventative - All personnel inducted covering restricted work areas and cultural heritage - Driving is only permitted in designated areas,	IV	D	2	Yes	Archaeological survey conducted, with no Aboriginal archaeological or historical sites/relics encountered. Despite this, disturbance to a site/relic would result in a major impact, but is considered unlikely.	Low
44	Vehicles leave the previously constructed roads or work areas	Terrestrial Environmental Quality	Disturbance to soil	A.3.1 Site selection and planning A.3.4 Erosion and sediment control and hydrology		I	C	1	Yes	The consequence is anticipated to be negligible, and the disturbance of soil is possible.	Low

Impact #	Risk source or environmental hazard	Environmental Factors or receptors	Potential Impact	Code of Practice Section	Risk Management Controls	Residual Risk			Acceptable Criteria Achieved	Residual risk ALARP and Acceptable Statement	Scientific Uncertainty Ranking
						C	L	R			
45	Chemical spills and leaks associated with inappropriate storage and use of hazardous substances, including Drilling Muds, HF fluid Poor refuelling or fuel transfer practices	Inland water environmental quality	Reduction in groundwater and surface water quality	A.3.8 Containment of contaminants B.4.16 Site material and fluid management C.3 Wastewater management framework C.4.2 Management of Produced water and Flowback Fluid C.7.1 Wastewater management plan C.7.2 Spill management plan	Preventative - Pre-spud checks / Pre-job checks when transferring fluids - Appropriate bunding in use for storage of liquid chemicals, fuel and other lubricants - Drilling and HF fluids mixed and used in accordance with SOPs, using engineered equipment and tanks. - Use of drip trays for refuelling and transfers - Implementation of the Wastewater Management Plan (Appendix o6) Mitigative - Spill management kits located onsite for response to any small-scale spills - Spills contained and remediated - Chemical Risk Assessment of all chemical used in the proposed HF (Appendix o6.o1). Risk assessment report on hydraulic fracturing flowback wastewater at Santos Tanumbirini well site concluded: - there are no degradants of the HF chemicals that would require additional analytical testing beyond the chemistry analyte specified in the Code - there were no unacceptable risks to birds from potential ingestion of chemicals in the wastewater over a one year period - no chemicals detected in the wastewater, at their maximum concentration, under a hypothetical maximum release scenario, would result in soil levels above soil screening criteria for the protection of terrestrial plants and animals - An assessment carried out as part of the Chemical Risk Assessment showed that in the context of a potential release scenario of 100,000L outside of the containment and storage area, the maximum affected area of spreading would be less than 4.7ha and limited to the proximity of the release area (Appendix o6.o1-appendix B) - Implementation of the Spill Management Plan (Appendix o7)	III	E	1	Yes	The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the Code, Imperial Spill management plan, Wastewater management plan and the National Environment Protection (Assessment of Site Contamination) Measure. Chemical risk assessment conducted. Risk assessment report on hydraulic fracturing flowback wastewater at Santos Tanumbirini well site. Spill management plan will be implemented to prevent, detect and respond to spills to prevent offsite releases. Spills are likely to be smaller, with any spillage restricted to the lease pad. Wastewater management plan and the National Environment Protection (Assessment of Site Contamination) Measure will be implemented. If contamination occurs, it is considered to be a short-term contamination. Chemical risk assessment conducted. Risk assessment report on hydraulic fracturing flowback wastewater at Santos Tanumbirini well site. The risk is considered ALARP with moderate consequences, and remote likelihood.	Low
46	Chemical spills and leaks associated with inappropriate storage and use of hazardous substances, including Drilling Muds, HF fluid Poor refuelling or fuel transfer practices	Terrestrial Environmental Quality	Localised contamination of soil	A.3.8 Containment of contaminants B.4.16 Site material and fluid management C.4.2 Management of Produced water and Flowback Fluid C.7.2 Spill management plan	- Spill management kits located onsite for response to any small-scale spills - Spills contained and remediated - Chemical Risk Assessment of all chemical used in the proposed HF (Appendix o6.o1). Risk assessment report on hydraulic fracturing flowback wastewater at Santos Tanumbirini well site concluded: - there are no degradants of the HF chemicals that would require additional analytical testing beyond the chemistry analyte specified in the Code - there were no unacceptable risks to birds from potential ingestion of chemicals in the wastewater over a one year period - no chemicals detected in the wastewater, at their maximum concentration, under a hypothetical maximum release scenario, would result in soil levels above soil screening criteria for the protection of terrestrial plants and animals - An assessment carried out as part of the Chemical Risk Assessment showed that in the context of a potential release scenario of 100,000L outside of the containment and storage area, the maximum affected area of spreading would be less than 4.7ha and limited to the proximity of the release area (Appendix o6.o1-appendix B) - Implementation of the Spill Management Plan (Appendix o7)	II	D	1	Yes	The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the Code, Imperial Spill management plan, Wastewater management plan and the National Environment Protection (Assessment of Site Contamination) Measure. Chemical risk assessment conducted. Risk assessment report on hydraulic fracturing flowback wastewater at Santos Tanumbirini well site. The lease pad is bunded, preventing the offsite release of wastewater in the event of failure. Spill management plan will be implemented to prevent, detect and respond to spills to prevent offsite releases. Spills are likely to be smaller, with any spillage restricted to the lease pad. Wastewater management plan and the National Environment Protection (Assessment of Site Contamination) Measure will be implemented. If contamination occurs, it is considered to be a short-term contamination. Chemical risk assessment conducted. Risk assessment report on hydraulic fracturing flowback wastewater at Santos Tanumbirini well site. The risk is considered ALARP and is unlikely, with minor consequences.	Low
47	Transport vehicle accident or stuck due to mechanical or weather events	Inland water environmental quality	Reduction in surface and groundwater quality	A.3.8 Containment of contaminants	Preventative - Road conditions for heavy vehicle transport will be assessed before mobilisation on unsealed roads. - If the conditions are assessed to be unsuitable for heavy vehicle transport, there will be no transport of chemicals or wastewater - Only licenced waste transporters to be used to transport listed wastes, - In the event of a truck being stuck due to mechanical or weather reason, transfer or recovery will only occur once safe, and the risk of spills are ALARP	II	C	2	Yes	The transportation of wastes and chemicals is a tightly controlled industry with mature practices designed to prevent, detect and respond to transportation spills. All contractors must be appropriately licenced, with National uniform legislation in place to offer a high level of regulatory protection. This risk is considered identical to that of bulk diesel and other dangerous goods transportation- a common activity throughout Australia. Fuel and chemical transport accidents are rare given the number of transportation movements in Australia. Any accident is likely to be restricted to road corridors and result in minor impacts on local flora and fauna. The likelihood of an event occurring is therefore considered possible.	Low
48	Transport vehicle accident or stuck due to mechanical or weather events	Terrestrial Environmental Quality	Localised contamination of soil	A.3.8 Containment of contaminants	Mitigative - Chemical Risk Assessment of all chemical used in the proposed HF (Appendix o6.o1). Risk assessment report on hydraulic fracturing flowback wastewater at Santos Tanumbirini well site concluded: - there are no degradants of the HF chemicals that would require additional analytical testing beyond the chemistry analyte specified in the Code - there were no unacceptable risks to birds from potential ingestion of chemicals in the wastewater over a one year period - no chemicals detected in the wastewater, at their maximum concentration, under a hypothetical maximum release scenario, would result in soil levels above soil screening criteria for the protection of terrestrial plants and animals - Implementation of the Waste Management Plan (Appendix o6) and the Spill Management Plan (Appendix o7) to reduce potential consequences.	II	C	2	Yes	The transportation of wastes and chemicals is a tightly controlled industry with mature practices designed to prevent, detect and respond to transportation spills. All contractors must be appropriately licenced, with National uniform legislation in place to offer a high level of regulatory protection. This risk is considered identical to that of bulk diesel and other dangerous goods transportation- a common activity throughout Australia. Fuel and chemical transport accidents are rare given the number of transportation movements in Australia. Any accident is likely to be restricted to road corridors and result in minor, local impacts on soil quality. The likelihood of an event occurring is therefore considered possible.	Low
49	Overflow of fluid storage and treatment tanks, Pits or cuttings pits Leaching from storage tanks or treatment pits Well blow out	Terrestrial Environmental Quality	Impact to soil quality	C.6.1. Water and Wastewater tracking and reporting requirements C.7.2 Spill management plan	Preventative - Open-topped wastewater treatment tanks and pits will be marked and operated with 1.1m of freeboard during the wet season, and 0.5m of freeboard during the dry season - Closed-topped tanks will be marked and operated with 0.5m of freeboard - Wastewater tanks and pits will be fitted with level monitoring telemetry that reports back to the operations team - Wastewater tanks and pits will be inspected daily to check integrity during periods of site operations - Wellpad activities to cease if freeboard is not maintained in wastewater tanks and pits - Daily monitoring of weather and for predicted significant rainfall events will be undertaken - Pits will be appropriately designed and constructed with a 0.5m of bund to prevent entry of overland flow - Tank pad to be compacted to engineering design specifics of Original Equipment Manufacturer (OEM) - Bunded tank pad will accommodate 110% of the volume of the largest tank - Wastewater tanks and pits will be inspected weekly for liner and structural integrity - Implementation of an approved Wastewater Management Plan - Code of Practice: Onshore Petroleum Activities (the Code) will be implemented. Mitigative - Wellpad site located away from watercourses - Implementation of an approved Spill Management Plan and Wastewater Management Plan, and - Code of Practice: Onshore Petroleum Activities (the Code) will be implemented.	II	D	1	Yes	Through the adoption of the controls with the Code, and the mitigation measures outlined in the EMP meets the industry best practice requirements of the Code, API standards and the Water Act. Chemical risk assessment conducted. Risk assessment report on hydraulic fracturing flowback wastewater at Santos Tanumbirini well site. This risk may result in spills localised to the wellpad, with minor impacts. The likelihood of an event occurring is therefore considered unlikely. The residual risk has been reduced to the greatest extent possible. Therefore, we consider this risk ALARP and acceptable with no further risk reduction warranted.	Low

Impact #	Risk source or environmental hazard	Environmental Factors or receptors	Potential Impact	Code of Practice Section	Risk Management Controls	Residual Risk			Acceptable Criteria Achieved	Residual risk ALARP and Acceptable Statement	Scientific Uncertainty Ranking
						C	L	R			
50	Wellpads constructed on greater than 2% slope	Inland water environmental quality	Release of stormwater from activities to surface water	A.3.1 Surface activities mandatory requirements A.3.4 Erosion and sediment control and hydrology	Preventative - Stripped topsoil used to create a diversion bund upslope of the wellpad to prevent water entering the wellpad - A series of returns to be installed where bunds are aligned down slope to maximise ponding and reduce flow velocity along the face. - Water discharge points from diversion bund and wellpad runoff areas to be fitted with level spreaders to avoid concentrated flow - Pad runoff (dirty water) is to be dissipated through the use of coir logs or a mulch berm. The control is to be installed along the contour to promote sheet flow leaving the site. - Grass, rocks, branches and shrubs be raked to the downslope extent of works, establishing a control similar to a mulch bund. To trap coarse sediment	III	E	1	Yes	Releases must comply with the stipulated criteria to ensure contaminants are not released from site. The release of stormwater will also be via a "Sediment sock", with a reasonable consequence of moderate. The likelihood is reduced down to remote (<1% probability of occurring) based on the separation distance to the closest watercourse and routine testing requirements.	Low
51	Wellpads constructed on greater than 2% slope	Inland water environmental quality	Erosion and sediment releases from lease pads	A.3.1 Surface activities mandatory requirements A.3.4 Erosion and sediment control and hydrology	Mitigation <u>Daily inspection during construction</u> - 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 inspections on times of no operations	II	D	1	Yes	The NT has a range of technical guidance notes covering soil management, erosion and sediment control. this includes the NT Land Clearing Guidelines. With the implementation of this guidelines and Erosion Sediment Control plan the consequence of erosion will be Minor, localised and reversible in short term with an unlikely chance of occurrence.	Low
52	Wellpads constructed on greater than 2% slope	Terrestrial Environmental Quality	Soil erosion from cleared areas	A.3.4 Erosion and sediment control and hydrology	- 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 Anticipated rainfall (24h prior) - All drainage, erosion and sediment control measures - All temporary flow diversion and drainage works After rainfall (within 18h) - 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	II	C	2	Yes	The erosion and sediment release from cleared area is a well document impact. The consequences of sediment releases are likely to be minor by the implementation of the Erosion and Sediment Control Plan, design of lease pads and ongoing inspection and maintenance programs. The likelihood of these minor locally restricted releases of sediment is considered possible.	Low
53	Leaching/spills caused by structural failure from Tanks or in-ground pits	Terrestrial Environmental Quality	Impact to soil quality	A.3.8 Containment of contaminants B.4.16 Site material and fluids management C.4.2 Management of produced water and flowback fluid C.7.2 Spill management plan	Preventative - Tanks that are used for the storage or treatment of HF flowback and produced water will be appropriately designed and constructed with two impermeable containment barriers, and with a leak detection and reporting system between the two barriers - Tanks that are used for the storage or treatment of HF flowback and produced water will be inspected daily to check integrity during periods of site operations - Tanks that are used for the storage or treatment of HF flowback and produced water will be fitted with level monitoring telemetry that reports back to the operations team - Pits will be appropriately designed and constructed with an impermeable containment barrier - Pits will be inspected daily to check integrity during periods of site operations - Pits that are left open over the wet season during non- operational periods will be fitted with level monitoring telemetry that reports back to the operations team - Pits will be inspected weekly to check integrity during non- operational periods - Cuttings blending and burial or isolation and removal will be subject to sampling results and on the advice of an independent environmental consultant.	II	E	1	Yes	The consequences of a tank or pit failure are negated through the use of double lined pits and engineered above ground tanks which have continuous leak detection and alarms. Tanks and their liners are designed with sufficient structural integrity to withstand cyclonic winds, extreme temperatures and loading stress forces under a range of conditions. A spill management pan is in force to detect, prevent and respond to potential spills of wastewater. If a storage failure was to occur, the wastewater would be restricted to the lease pad. Flowback would be pumped into available enclosed and open tank storage, with contaminated soil removed from site. the consequences are likely to be minor, being locally restricted, with no negative effects on the larger ecosystem. The likelihood is reduced by the COP requirements , tank design separation distances to the underlying aquifer. The likelihood is considered remote.	Low
54	Use of groundwater for project activities	Inland water environmental quality	Reduction in groundwater quantity	A.3.1 Site Selection and Planning B.4.17 Groundwater monitoring	Preventative - All water take licenced in accordance with NT Water Act under Water Extraction Licence - Compliance with water extraction licence limits and conditions	IV	E	1	Yes	The extraction of groundwater for regulated activities under this EMP requires all take to be licenced. The proposed take is assessed as a part of the licence application, with the assessment considering current and future water take levels. Based on this assessment, it was determined that the extraction rate would not impact upon adjacent users.	Low
55	Use of groundwater for project activities	Social, economic and cultural surroundings	Reduction in groundwater available for other users	B.4.17 Groundwater monitoring		IV	D	2	Yes	The risk consequence is determined to be major given any impact will have long term effects of regional significance.	Low
56	Use of groundwater for project activities	Terrestrial Environmental Quality	Reduction in groundwater quantity	A.3.1 Site Selection and Planning B.4.17 Groundwater monitoring		IV	E	1	Yes	The likelihood of such a consequence of occurring is considered remote due to the quality of the Cambrian limestone aquifer, separation distance from surrounding users and under utilisation of the targeting aquifer.	Low
57	Surface activities (chemical and waste storage, handling and spills)	Terrestrial Environmental Quality	Contamination of aquifer impacting a receptor (groundwater user or GDE)	A.4.7 Containment of Contaminants B.4.13 Hydraulic stimulation and Flowback Operations C.4.2 Management of produced water and flowback fluid C.7.1 Wastewater Management Plan C.7.2 Spill Management Plan	Preventative - Open-topped wastewater treatment tanks and pits will be marked and operated with 1.1m of freeboard during the wet season, and 0.5m of freeboard during the dry season - Closed-topped tanks will be marked and operated with 0.5m of freeboard - Wastewater tanks and pits will be fitted with level monitoring telemetry that reports back to the operations team - Wastewater tanks and pits will be inspected daily to check integrity during periods of site operations - Wellpad activities to cease if freeboard is not maintained in wastewater tanks and pits - Daily monitoring of weather and for predicted significant rainfall events will be undertaken - Pits will be appropriately designed and constructed with a 0.5m of bund to prevent entry of overland flow - Tank pad to be compacted to engineering design specifics of Original Equipment Manufacturer (OEM) - Bunded tank pad will accommodate 110% of the volume of the largest tank - Wastewater tanks and pits will be inspected weekly for liner and structural integrity - Implementation of an approved Wastewater Management Plan - Code of Practice: Onshore Petroleum Activities (the Code) will be implemented. Mitigative - Wellpad site located away from watercourses - Implementation of an approved Spill Management Plan and Wastewater Management Plan, and - Code of Practice: Onshore Petroleum Activities (the Code) will be implemented.	IV	E	1	Yes	The risk mitigation measures outlined in the EMP meet the industry best practice requirements of the Code, Imperial Spill management plan, Wastewater management plan and the National Environment Protection (Assessment of Site Contamination) Measure. Chemical risk assessment conducted. Risk assessment report on hydraulic fracturing flowback wastewater at Santos Tanumbirini well site. Contamination of an aquifer if considered a major risk with potential long term impacts. However, due to the rigorous controls implemented, is considered a remote possibility.	Low

Impact #	Risk source or environmental hazard	Environmental Factors or receptors	Potential Impact	Code of Practice Section	Risk Management Controls	Residual Risk			Acceptable Criteria Achieved	Residual risk ALARP and Acceptable Statement	Scientific Uncertainty Ranking
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58	Stimulation activity	Inland water environmental quality	Induces seismic activity that enables cross formational flow between shallow aquifers	B.4.13 Hydraulic Stimulation and flowback operations	Preventative - Geohazard Risk Assessment will be carried out using the upcoming seismic and that the risk will be addressed in the WOMP - An induce seismicity traffic light system has been adopted and outlined in the WOMP - Where seismic activity is recorded in Imperial's tenure during hydraulic stimulation activities, the actions in the WOMP Traffic Light System will be enacted as summarised below: - Green: Local Magnitude (MI) <2.0 – no action required - Orange: ML 2.0 - <3.5 MI – report event to DITT and continue operations - Red: ML>3.5 – stimulation activity on pad suspended until a go forward plan submitted by Imperial and approved by DITT. - Stimulation activities to cease where fracture propagation is suspected to have interacted with and adjacent well. Stimulation activity on pad suspended until a go forward plan submitted by Imperial and approved by DITT. - The Beetaloo is not prone to seismic activity and there is no evidence of recent earthquake activity as most faults and the major subsurface structure are confined to Cambrian or older strata. This is supported by the National seismic Hazard Assessment completed by Allen 2018, which highlight the Beetaloo is located within a low hazard area. - Wells are located away from know geohazards, with no significant faults within proximity of activity - Any faults encountered during drilling well be assessed to determine risk of stimulating with appropriate separation distances applied	IV	E	1	Yes	The consequence of a induced seismicity, based upon evidence from the UK and US, is major, with potential long term impacts/regulatory intervention. This limits the potential for changes in terrestrial surface level. Larger events are rare and generally a factor of the existing built up stress regime of the area- rather than a factor of the intensity of hydraulic fracturing or wastewater injection. The likelihood of a seismic event is reduced to remote through the geological setting of the Beetaloo Basin itself and the safeguards implemented in the COP requiring geohazard assessment and avoidance. In the Beetaloo, there have been no earthquakes over magnitude 3 measured since records began.	Low
59	Wellbore collision risk for the drilling of multiwell pads	Inland water environmental quality	Changes in aquifer quality. Impact on groundwater user or GDE	B.4.1 Well Integrity Management B.4.3 Well design and barriers	Preventative - Separation factor between wellbores >2, unless under risk assessment/MOC - Continuous positional tracking of the drill bit to detect and respond to vertical and horizontal well deviations during drilling - Each adjacent well designed and constructed with multiple casing barriers and specifically-engineered cement in place to protect aquifers- - Well being drilled will have multiple barriers (at least the conductor casing and surface casing) and blow out prevention in place during drilling	IV	D	2	Yes	The consequence of the vertical or horizontal section of the well deviating into the adjacent well during drilling is primarily a destruction in asset value (potential plug and abandonment of both wells).	Low
60	Deviation of an Exploration well into the adjacent well during drilling.	Inland water environmental quality	Crossflow/well integrity	B.4.1 Well integrity management	Mitigative Subsurface collision of a well during drilling is unlikely to result in formation cross flow, with collision likely at depth (below Aquifers) and flow restricted to the well being drilled.	IV	D	2	Yes	Any cross flow is likely to be contained within both of the well bores- with casing and cement isolating the relevant aquifers. Given the continuous logging of GPS location of the bit, the likelihood is considered remote	Low
61	Deviation of an Exploration well into the adjacent well during drilling.	Inland water environmental quality	Localised contamination and/or depletion of aquifers impacting on ecological function and beneficial use	B.4.1 Well integrity management	Mitigative Subsurface collision of a well during drilling is unlikely to result in formation cross flow, with collision likely at depth (below Aquifers) and flow restricted to the well being drilled.	IV	D	2	Yes	All of the associated impacts carry a consequence rating of major, with an unlikely chance of occurrence.	Low
62	Fugitive emissions	Air Quality and Greenhouse Gases	Reduction in air quality. Creation of atmospheric emissions.	A.3.1 Site Selection and Planning D.4.1 Baseline Methane Assessment D.5.1 Methane Emissions management plan D.5.9.4 Other fugitive emission sources mandatory requirements	Preventative - Wells to be constructed with cement isolation - Cement placement modelling conducted before the job including but not limited to casing standoff, drilling fluid displacement, anticipated job pressures and equivalent circulating densities - All cement slurries to be laboratory tested to ensure slurry is fit for purpose - No burning of waste on site - Operational wells to be tested six-monthly for any leaks - Gas detection monitoring will be conducted during all phases of the hydraulic fracturing operations. - Equipment to be compliant with relevant pollution control device requirements and maintained to minimise emissions. Mitigative - CSIRO completed baseline methane monitoring before commencing HF as per the Code - Reporting of emissions in line with National Greenhouse and Energy Reporting Scheme - All venting to be reported as per the National Greenhouse and Energy Reporting Scheme and Petroleum Codes of Practice. - The Methane Emissions Management Plan (Appendix 10) will be implemented	II	D	1	Yes	Emissions during petroleum activities are estimated using the NGRS estimation tools. Risks and impacts associated are well known. The COP and standard drilling, stimulation and well testing safety controls are designed to prevent the uncontrolled release of hydrocarbons. Flares are used during drilling and well testing to manage any encountered hydrocarbons. Monitoring of flowlines post initial pressure. Testing will be undertaken in accordance with the respective approved EMP. The consequence is anticipated to be minor, with likelihood of occurrence to be unlikely. The impact is restricted in duration (minutes to hours), based on the well design, and construction and operations requirements mandated by the COP.	Low
63	Workers handling chemicals	Human Health	Worker ingesting chemicals	B.4.10 Drilling Fluids B.4.13 Hydraulic Stimulation and Flowback Operations B.4.16 Site Material and Fluids Management	Preventative - Trained Personnel to be utilised for handling of chemicals - Personal Protective Equipment to be utilised for handling of chemicals - Safety Data Sheets available on site - Appendix E of Appendix 06.01 Tier 2 Assessment found that exposure to chemicals in each HF system were considered of low health concern to workers - Chemical Risk Assessment of all chemical used in the proposed HF (Appendix 06.01). Risk assessment report on hydraulic fracturing flowback wastewater at Santos Tanumbirini well site concluded: - there are no degradants of the HF chemicals that would require additional analytical testing beyond the chemistry analyte specified in the Code - there were no unacceptable risks to birds from potential ingestion of chemicals in the wastewater over a one year period - no chemicals detected in the wastewater, at their maximum concentration, under a hypothetical maximum release scenario, would result in soil levels above soil screening criteria for the protection of terrestrial plants and animals	III	E	1	Yes	Risks well understood. Management practices established and proven. Chemical risk assessment conducted. Risk assessment report on hydraulic fracturing flowback wastewater at Santos Tanumbirini well site. Despite the remote possibility of workers ingesting chemicals, it carries moderate consequences.	Low
64	Leak from flowline failure caused by flooding	Terrestrial Flora and Fauna	Disturbance to environmentally sensitive areas and/or high valued habitat areas	A.3.1 Surface activities mandatory requirements A.3.8 Containment of Contaminants C.4.2 Management of produced water and flowback fluid C.7.2 Spill Management Plan	Preventative - Flowlines to be engineered and tested to meet the relevant Australian standards - Flowline construction to limit clearing operations to manage erosion risk. - Flowline high point vents monitoring weekly when the flowlines contain wastewater - Flowlines alignment to be visually inspected on surface after wet season and within 48 hours of any overland flooding events if the flowline is in use and not isolated at the inlet. - Flexible nature of flowline material means that flowline exposed or lifted during flood events is no weaker or likely to leak than when buried. Mitigative - The primary mitigation is to re-bury an exposed HDPE line to avoid risk from fauna or bushfire. - Chemical Risk Assessment of all chemical used in the proposed HF (Appendix 06.01). Risk assessment report on hydraulic fracturing flowback wastewater at Santos Tanumbirini well site concluded: - there are no degradants of the HF chemicals that would require additional analytical testing beyond the chemistry analyte specified in the Code - there were no unacceptable risks to birds from potential ingestion of chemicals in the wastewater over a one year period - no chemicals detected in the wastewater, at their maximum concentration, under a hypothetical maximum release scenario, would result in soil levels above soil screening criteria for the protection of terrestrial plants and animals - Laboratory analysis and risk assessment of the HF flowback wastewater will be conducted prior to sending the wastewater to treatment tanks• Wastewater Management Plan - Spill Management Plan	II	D	1	Yes	The risk of a flooding event impacting the flowline is even lower as the flowline is not likely to be impacted unless erosion occurs down the flowline route and uncovers the flowline. This in itself does not create a leak but it does expose the flowline to fauna or bushfire and therefore the key mitigations are to manage erosion and then to inspect the flowline after significant overland water flow if the flowline is currently in use. The consequences of a flowline failure are negated through engineered designed of flowlines and continuous leak detection and alarms. Flowlines are designed with structural integrity to withstand cyclonic winds, extreme temperatures and loading stress forces under a range of conditions. A spill management plan is in force to detect, prevent and respond to potential spills of wastewater. If a failure was to occur, a small volume of wastewater would be dispersed by floodwater, the consequences are likely to be minor, with some short term impacts on local environment. The likelihood is considered unlikely.	Low

Impact #	Risk source or environmental hazard	Environmental Factors or receptors	Potential Impact	Code of Practice Section	Risk Management Controls	Residual Risk			Acceptable Criteria Achieved	Residual risk ALARP and Acceptable Statement	Scientific Uncertainty Ranking
						C	L	R			
65	Injury to Land user from excavation impact with buried flowline	Huma Health	Health impact from striking buried flowline during excavation	A.3.8 Containment of Contaminants B.4.13 Hydraulic Stimulation and Flowback Operations B.4.16 Site Material and Fluids Management C.4.2 Management of produced water and flowback fluid C.7.1 Wastewater Management Plan C.7.2 Spill Management Plan	Preventative •Flowlines buried 750mm below the surface •Flowlines to be marked with signposts Mitigative •Flowlines will be operated at a low pressure •Flowlines will be carrying an inert substance	I	B	1	Yes	The flowlines will be buried at 750mm below the surface. The flowlines will be operated at a low pressure and contain an inert substance. The risk of an health impact from striking a flowline is very low.	Low

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

Risk Assessment conducted by:					
Name	Diana Gomez	Jon Bennett	Kelvin Wuttke	Charles Dack	Tom Carruthers
Qualification	Bachelor of Environmental Engineering		RPEQ, MBA Bachelor of Mechanical Engineering	Bachelor Environmental Engineering Masters Environmental Law	Bachelor of Mechanical Engineering
Years of experience	5	25	28	9	2