Qualitative Tier 2 Assessment

Hydrotreated Light Petroleum Distillate

In accordance with the Chemical Risk Assessment Framework (CRAF), chemicals assigned a Tier 2 designation require a hazard assessment and qualitative assessment of risk.

Consistent with National Industrial Chemicals Notification and Assessment Scheme (NICNAS), the human health hazards for each chemical are characterised by analysing the toxicokinetics (the absorption, distribution, metabolism and excretion of the chemical in humans or laboratory animals), acute toxicity, irritation and corrosivity, repeat dose toxicity, genotoxicity, carcinogenicity, reproductive toxicity, and other health effects. The environmental hazards for each chemical are characterized by analysing the environmental fate properties (such as mobility, persistence, bioavailability and bioaccumulation), acute toxicity and chronic toxicity. In support of the hazard assessment, a risk assessment dossier is prepared for each of the chemicals included in the assessment.

The qualitative assessment of risk evaluates exposure to the vendor chemical that may occur during activities that do not intentionally result in a release to the environment, but where a potential release may occur. For this evaluation, these potential releases primarily are focused on the vendor chemical transported to the well pad site or water management facility (WMF), chemicals utilised in drilling fluid systems that may impact groundwater, residual chemicals that may be present in hydraulic flowback and workover fluids and chemicals and chemicals and residues of chemicals that may be present in water undergoing treatment or beneficially re-used.

Potentially complete exposure pathways (in that a source, a migration pathway, a mechanism for exposure, and a potential receptor are present) are assessed herein to determine the potential for risk (an incomplete pathway precludes an exposure occurring and an associated potential risk). In this context, site setting and management protocols associated with the action are evaluated. Key controls limiting the potential for exposure include:

- Engineering controls (including fencing and secondary containment);
- Storage (drums, totes and storage tanks) constructed in accordance with Australian standards and managed and monitored in accordance with regulatory requirements;
- Maintenance of access control restrictions during site activities that will preclude access by the public, livestock and large native fauna; and,
- SafeWork Australia and Santos Occupational Safety Guidance used to minimise human health exposure.

As a result, the assessment for this Tier 2 chemical includes the following components: completing the screening; developing a risk assessment dossier and Predicted No Effect Concentrations (PNECs) for water and soil; and, providing a qualitative discussion of risk. Each of these components is detailed within this memorandum.

Background

Hydrotreated light petroleum distillate is a chemical in a product used in drilling and completion activities, including workovers. The workover process is designed to remove any solids from the well and facilitate placement of the pump. As part of this process, fluids and some coal fines are removed from the well and transported to produced water ponds for management within the produced water stream. Once the well has been placed and commissioned, produced water is discharged into the water gathering pipelines and conveyed to the water ponds/water treatment facilities for treatment and beneficial use (such as dust suppression, construction, operational use and stock water for cattle).

The purpose and maximum quantity for this chemical is summarised in **Table 1**.

Table 1 Initial and Underbalance Workover Fluid Chemicals

Chemical Name	CAS No.	Use	Quantity[1]
Hydrotreated light petroleum distillate	64742-47-8	Surfactant	0.00099%

[1] Volume Percent in Treatment (%)
CAS No = Chemical Abstracts Service Number

The assessment of toxicity of this chemical was used to evaluate human health exposure scenarios and is presented in **Attachment 1**. There are no carcinogenicity studies on hydrotreated light petroleum distillate, and, as a result, only a non-carcinogenic oral reference dose (RfD) was calculated. A detailed discussion of the derivation of the oral RfD and drinking water guideline values is presented in the attachment. **Table 2** provides a summary of the derivation.

Table 2 Oral Reference Doses and Derived Drinking Water Guidelines

Constituent (CAS No.)	Study	Critical Effect/ Target Organ(s)	NOAEL (mg/kg-day)	Uncertainty Factors	Oral Reference Dose (mg/kg-day)	Drinking Water Guideline (mg/L)
Hydrotreated light petroleum distillate (CAS No. 64742-47-8)	Developmental Study	Reduced maternal body weight	500	1000	0.5	1.8

Refer to **Attachment 1** for information on the key studies selected for oral reference dose and drinking water level development.
CAS = Chemical Abstracts Service
mg/kg-day = milligram per kilogram-day
mg/L = milligram per litre
NOAEL = No observed adverse effect level

For ecological receptors, the assessment utilises the information presented in the dossiers on the relative toxicity of the aquatic and terrestrial flora and fauna to the chemical. This assessment focuses on the aquatic invertebrate and fish species within the surface water resources and the soil flora and fauna associated with releases to the soil.

The determination of toxicological reference values (TRVs) was conducted according to the PNEC guidance in the *Environmental Risk Assessment Guidance Manual for Industrial Chemicals* prepared by the Australian Environmental Agency (AEA, 2009). PNECs for freshwater and sediment were developed to assess aquatic receptors, and PNECs for soil were developed for terrestrial receptors.

Table 3 present the chemical, the endpoint, no observable effects concentration (NOEC) (milligrams per litre [mg/L]), assessment factor, and the aquatic PNEC (mg/L). PNECs for sediment and soil are detailed in **Tables 4** and **5,** respectively. Refer to **Attachment 2** for the development of PNECs, or the rational for PNECs that do not have a calculated PNEC.

Table 3 PNECs Water – Tier 2 Chemicals

Constituents	Endpoint	EC_{50} or NOEC (mg/L)	Assessment Factor	$PNEC_{water}$ (mg/L)
Hydrotreated light petroleum distillate (CAS No. 64742-47-8)	*D. magna*.	0.48	100	0.005

EC_{50} = effects concentration – 50%
mg/L = milligram per litre
NOEC = no observable effects concentration
PNEC = predicted no effect concentration
Refer to **Attachment 1** for information on the development of PNECs listed above.

Table 4 PNECs Sediment – Tier 2 Chemicals

Constituents	Endpoint	EC_{50} or NOEC (mg/kg wet wt)	Assessment Factor	$PNEC_{sed}$ (mg/kg wet wt)
Hydrotreated light petroleum distillate (CAS No. 64742-47-8)	[a]	-	-	0.36

[a] Calculated using equilibrium partitioning method
EC_{50} = effects concentration – 50%
mg/kg wet wt = milligram per kilogram wet weight
NOEC = no observable effects concentration
PNEC = predicted no effect concentration
Refer to **Attachment 1** for information on the development of PNECs listed above.

Table 5 PNECs Soil – Tier 2 Chemicals

Constituents	Endpoint	EC_{50} or NOEC (mg/kg dry wt)	Assessment Factor	$PNEC_{soil}$ (mg/kg dry wt)
Hydrotreated light petroleum distillate (CAS No. 64742-47-8)	[a]	-	-	0.32

[a] Calculated using equilibrium partitioning method
EC_{50} = effects concentration – 50%
mg/kg dry wt = milligram per kilogram dry weight
NOEC = no observable effects concentration
PNEC = predicted no effect concentration
Refer to **Attachment 1** for information on the development of PNECs listed above.

A detailed assessment of the potential risks posed by this Tier 2 chemical is provided in the following sections.

General Overview

Hydrotreated light petroleum distillate is a complex combination of hydrocarbons obtained by treating a petroleum fraction with hydrogen in the presence of a catalyst. It consists of hydrocarbons having carbon numbers predominantly in the range of C9 through C16 and boiling in the range of approximately 150°C to 290°C (302°F to 554°F).

Hydrotreated light petroleum distillate is an Unknown or Variable Composition, Complex Reaction Products and Biological Materials (UVCB) substance containing aliphatic (linear, branched, and/or cyclic paraffins) molecules of carbon and hydrogen. The molecular structure for the UVCB substance was not available. The molecular structure for a representative substance in this group, hydrodesulfurized kersosine (CAS No. 64742-81-0), is presented in **Figure 1**.

Figure 1 Molecular Structure of Hydrosulfurized Kerosine[1]

Representative substances are expected to be readily biodegradable. They have a low potential to bioaccumulate. They are highly insoluble in water and have high adsorption potential. While sediment and soil are expected to be the main targets for environmental distribution, biodegradation potential is expected to offset sorption.

The Persistent, Bioaccumulative and Toxic (PBT) assessment for hydrotreated light petroleum distillate is included in the dossier provided in **Attachment 1**. Based on physico-chemical properties and screening data detailed below, the overall conclusion was that the substance is not a PBT substance.

Human Health Hazards

Hydrotreated light petroleum distillate exhibits low acute toxicity by the oral, inhalation and dermal routes. It is not irritating to the skin and eyes, but it is a skin sensitiser. Aside from minor changes in body weight, no adverse effects were seen in animals given repeated doses by the oral route. The substance is not genotoxic when tested in both in vitro and in vivo assays. There is no indication that this substance will cause malformations or have an adverse effect on reproduction and development. This information was derived in part from products of similar structure or composition.

[1] Source EPISUITE

In a developmental toxicity study, undiluted JP-8 jet fuel was administered to 30 Sprague-Dawley (Crl:CD) rats/dose by gavage at various volumes to achieve dose levels of 0 (sterile water), 500, 1000, 1500, or 2000 milligrams per kilogram body weight day (mg/kg bw/day) from days 6 through 15 of gestation. The no observed adverse effect level (NOAEL) for reduced maternal body weight is 500 milligrams per kilogram-day (mg/kg-day), based on reduced body weight in dams and in pups treated under a repeat dose regimen. NOAELs from repeated-dose toxicity studies were higher. Therefore, the NOAEL from the developmental toxicity study was used for determining the oral RfD and the drinking water guideline value (1.8 milligrams per litre [mg/L]) (see **Table 2**). Description of the oral RFD and calculation of the drinking water guideline value is included in the dossier provided in **Attachment 1**.

The lifecycle of chemicals, including hydrotreated light petroleum distillate, used during the drilling, completion and workover of wells includes the following general categories: transportation of chemicals; drilling, completion and workover operations; and, treatment, recycling, disposal and beneficial reuse. Without management controls in place, there is the potential for human receptors to be exposed to hydrotreated light petroleum distillate in workover chemicals during drilling, completion and workover operations and management of workover fluids during beneficial reuse. Based on an assessment of land use and an understanding of the project description provided in the *Santos NSW (Eastern) Pty Ltd Narrabri Gas Project Gunnedah Basin, NSW* (October 2014), the *Narrabri Gas Project Environmental Impact Statement* (EIS) (Santos, 2016) and the CRAF developed for the Narrabri Gas Project (NGP) Area, potential human receptors include:

1. Workers at the well lease involved with blending, storage, transfer, reuse, recovery and recycling of drilling fluids, workover fluids and cuttings; recycling, reuse or disposal of recovered materials including beneficial reuse activities such as land applications of drilling materials and dust suppression; and, mitigating releases at the well lease or along the transport or conveyance routes.
2. Agricultural workers or residents in irrigation areas.
3. Landholders that have access to the water supply from a bore hydraulically downgradient of the well lease.

In terms of risks associated with transport of chemicals and wastes, this risk is considered to be managed to a level as low as reasonably practicable. This is because the potential for a release is controlled through implementation of traffic management principles including use of designated trucking routes, vehicle signage, vehicle management systems (to manage speed and driving behaviour/habits) and, in the unlikely event of a vehicular accident, implementation of incident and spill response procedures. Given the highly regulated nature of transportation of chemicals (at both a Commonwealth and State level), transport-related scenarios are not evaluated further in this assessment. However, the outcome of the assessment should be used to inform emergency response actions.

Exposure of workers to drilling fluid and workover chemicals is possible via inadvertent spills and leaks, during the recycling and beneficial reuse of recovered materials (e.g., drilling fluids and cuttings), and during application of the recovered material to land. However, chemical exposures to workers are controlled through engineering, management controls and personal protective equipment, which are focused on elimination and mitigation of the potential for dermal contact and potential for incidental ingestion. In addition, Australia SafeWork Place and Santos Occupational Safety Guidance are used to minimise human health exposure. As a result, petroleum workers, are also excluded from assessment. No potentially complete exposure pathways were identified.

The management of chemicals and wastes will be conducted at the well lease using drums, totes and engineered tanks designed to contain the fluids. In the unlikely event of a release to ground, the potential for exposures (other than workers) is limited. Releases on the well pad would be of limited volumes and the well pad sites are fenced and access is controlled, which limits access to the public. If drilling fluid chemicals are spilled to ground then investigation, remediation and rehabilitation activities would be implemented to address soil impacts.

On-lease storage may utilise tanks or pits and there is the possibility that a containment failure could result in the release of the materials to the well lease and the surrounding environment. Releases on the well pad would be of limited volumes and as such these products would not be anticipated to migrate a significant distance off lease to the surrounding environment, including proximal water bodies.

The potential for a significant drilling fluid or workover fluid loss during drilling is rare, particularly given the volumes used and the management controls in place during drilling. Where lost circulation is identified during drilling, a lost circulation fluid (i.e., cellulose) is used to plug the interval and prevent further loss of fluids. Despite the limited potential for large scale losses during drilling, EHS Support (2016) completed modelling of how a conservative tracer or highly soluble organic constituents could migrate in the subsurface to assess the potential effects of potential loss of drilling muds on groundwater systems. The BIOSCREEN model was utilized to facilitate assessment of organic constituent mobility with and without biodecay and inorganic constituent mobility (only considering attenuation associated with advection and dispersion processes). The modelling indicated that the potential for impact on ground water quality is limited even under a worst-case scenario utilising conservative assumptions.

There is low potential for human receptors such as residents and agricultural workers to be exposed to residual chemicals in recovered materials via direct contact (ingestion and dermal) and inhalation pathways. Activities, including beneficial re-use, are undertaken in operational and controlled (fenced) areas of the well lease. In addition, the well leases are located in remote areas with sparse population. Around two-thirds of the NGP Area are within Pilliga Forests, with the remaining portion utilised for agricultural (dry-land cropping and livestock grazing) purposes. The NGP Area does not include the Pilliga National Park, Pilliga State Conservation Area, Pilliga Nature Reserve, and Brigalow Park Nature Reserve. However, the Brigalow State Conservation Area is within the project area. A 50-metre surface exclusion zone protects the Brigalow State Conservation Area from surface developments (EHS Support, 2016).

In addition, Environmental Approval conditions regulate project reuse. A plan for the beneficial reuse of materials has been developed by a Suitably Qualified Person (SQP) in accordance with the SSD 6456 conditions of consent which require materials of a certain quality and controls the maximum volumes that can be applied to land. The application techniques and location of application are controlled with specific monitoring required. Irrigation areas for treated produced water are sited, designed, constructed and operated so as not to impact public health. Monitoring bores are present to manage the risk of vertical migration. Additional details regarding mitigation and management controls are discussed in the CRAF.

As a result, potential exposures during the drilling, completion and workover process are low due to the employment of mechanical equipment/processes, engineering controls (including secondary containment) and other mitigation and management strategies. Finally, the probability of any surface related discharge infiltrating subsurface soils and migrating to groundwater is very low.

Environmental Hazards

In standard aquatic toxicity tests, hydrotreated light petroleum distillates is a low toxicity concern to aquatic organisms. Acute toxicity towards fish, aquatic invertebrates and algae is of the same order of magnitude.

Hydrotreated light petroleum distillates is readily biodegradable and does not persist in the environment. The chemical also has a low potential for bioaccumulation.

PNECs for hydrotreated light petroleum distillates are provided in **Tables 3 – 5**. Experimental toxicity data on water organisms was available for three trophic levels to calculate a PNECs for water (see **Table 3**). There are no toxicity data for sediment-dwelling organisms or soil organisms. Therefore, PNECs for sediment and soil were calculated using the equilibrium partitioning method (see **Tables 4 and 5**). PNEC calculations and assumptions are detailed in the dossier provided in **Attachment 1**.

During the drilling, completion and workover process, there is the potential for environmental receptors to be exposed to workover fluid chemicals such as hydrotreated light petroleum distillates. Pipelines (where treated water is conveyed) can transect sensitive ecological areas (including Matters of National Environmental Significance [MNES]). There is the concern of wildlife (terrestrial and aquatic receptors) and livestock in the vicinity of the well leases to have adverse effects from potential exposures. Potential environmental receptors include:

1. Wildlife and livestock accessing the well lease and areas adjacent to a well lease, including surface water features that have received runoff from an accidental release during drilling, completion and workover operations or loss of containment.
2. Wildlife and livestock accessing areas of the well lease where materials have been applied as well as accessing stored materials in lined pits or storage ponds.
3. Aquatic flora and fauna within a proximal surface water body that has received runoff from an accidental release during drilling, completion and workover activities or loss of containment, or from beneficial reuse applications.
4. Wildlife, including livestock, that have access to the water supply from a bore hydraulically downgradient of the well lease.

A detailed assessment of habitat in the Project Area is presented in **Attachment 2** (M. Sullivan, Eco Logical Australia Pty Ltd personal communication, 22 December 2020). The table assesses availability of habitat for ecological receptors in either forested or pasture areas. Well leases and water gathering/transmission lines can be present in either forested or pasture areas. Irrigation areas are in pasture areas. On this basis, if there is a likelihood of ecological habitat occurring in either the forested or pasture areas, there is the potential for a complete exposure scenario for that ecological receptor.

The ecological species classified in **Attachment 2** for either the pasture or forested lands (or both) that may be potentially exposed to hydrotreated light petroleum distillates include:

- Pasture Lands:
  - Australian Bustard
  - Spotted Harrier
  - Black-necked Stork
  - Grey Falcon
  - Black Falcon
  - Brolga
  - Black-breasted Buzzard
  - Black-striped Wallaby
  - Glossy Ibis

- Forested Lands:
  - Rufous Bettong
  - Bush Stone-curfew
  - Glossy Black-Cockatoo
  - Eastern Pygmy-possum
  - Spotted Harrier
  - Grey Falcon
  - Black Falcon
  - Black-breasted Buzzard
  - Little Eagle
  - Pale-headed Snake
  - Black-striped Wallaby
  - Turquoise Parrot
  - Barking Owl
  - South-eastern Long eared Bat / Corben's Long-eared Bat
  - Gilbert's Whistler
  - Squirrel Glider
  - Scarlet Robin
  - Grey-crowned Babbler (eastern subspecies)
  - Pilliga Mouse
  - Yellow-bellied Sheathtail-bat
  - Stripe-faced Dunnart
  - Diamond Firetail
  - Masked Owl
  - Eastern Cave Bat

The potential for exposure of sensitive receptors (including MNES) is considered low. The drilling, completion and workover activities occur over a short duration and are conducted in controlled/operational areas within a perimeter fence. Further, the activity level, noise, etc. will be a disincentive for wildlife and livestock to access the lease through gaps in the fencing or unsecured gates.

The rehabilitation of the well pad (establishment of vegetation and habitat) is anticipated to occur over several years; with recolonisation of the area by native fauna not anticipated to occur for one to three years post (commencement of) rehabilitation (M. Sullivan, Eco Logical Australia Pty Ltd personal communication, 22 December 2020). This is important as potential exposures will not occur until conditions are favourable for biological activity (e.g., foraging of the Pilliga mouse), providing long time periods for biodegradation of constituents.

Key strategies regarding potential impacts to MNES and other environmental values involve avoidance, minimisation, mitigation, and management. The key to this strategy is location selection provided by the Field Development Protocol discussed in the CRAF. In accordance with this protocol, **Table 6** presents exclusion zones identified for the NGP which is critical to the avoidance and mitigation of impacts on sensitive ecological receptors.

Table 6: Exclusion zones for the Narrabri Gas Project (EHS Support, 2016)

Constraints/Exclusion Areas	Applicability
Nature Reserve/National Park/Aboriginal Areas	Exclusion from the Project Area
State Conservation Areas (Brigalow)	Exclusion of all surface infrastructure, and sub-surface exclusion to a depth of 110 m
Riparian Corridors	Exclusion of all non-linear surface infrastructure and large ponds and dams
1% Annual Exceedance Probability (AEP) Flood Areas	Exclusion of all large ponds and dams
Currently known Aboriginal cultural heritage sites, Yarrie Lake	Exclusion of all surface infrastructure and a buffer of at least 200 m around Yarrie Lake

In combination with the avoidance and minimisation strategies, numerous other mitigation and management strategies are employed to ensure that chemicals are contained and do not pose an exceedances of risk threshold levels. Based on the engineering and management controls described in the previous section (Human Health Hazards), there is a low potential for ecological receptors exposed to surface water bodies that may receive runoff from an accidental release.

References

Australian Environmental Agency (AEA). (2009). Environmental Risk Assessment Guidance Manual for Industrial Chemicals, Commonwealth of Australia.

EHS Support. (2016). Chemical Risk Assessment Report. Narrabri Gas Project. Prepared for: Santos NSW (Eastern) Pty Limited. December.

Santos. (2016). Narrabri Gas Project Environmental Impact Statement https://narrabrigasproject.com.au/about/environment/

Attachment 1 Risk Assessment Dossier

HYDROTREATED LIGHT PETROLEUM DISTILLATE

This dossier on hydrotreated light petroleum distillate presents the most critical studies pertinent to the risk assessment of this substance in its use in coal seam gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

Screening Assessment Conclusion – Hydrotreated light petroleum distillate was not identified in chemical databases used by NICNAS as an indicator that the chemical is of concern and is not a PBT substance. The substance was assessed as a tier 2 chemical for acute and chronic toxicity. Therefore, hydrotreated light petroleum distillate is classified overall as a **tier 2** chemical and requires a hazard assessment and qualitative assessment of risk.

1 BACKGROUND

Hydrotreated light petroleum distillate is a complex combination of hydrocarbons obtained by treating a petroleum fraction with hydrogen in the presence of a catalyst. It consists of hydrocarbons having carbon numbers predominantly in the range of C9 through C16 and boiling in the range of approximately 150°C to 290°C (302°F to 554°F).

Representative substances are expected to be readily biodegradable. They are highly insoluble in water and have high adsorption potential. They have a low potential to bioaccumulate.

The substance has low acute toxicity by the oral and dermal route. It is not irritating to the skin and eyes, but it is a skin sensitiser. Aside from minor changes in body weight, no adverse effects were seen in animals given repeated doses by the oral route. The substance is not genotoxic when tested in both *in vitro* and *in vivo* assays. There is no indication that this substance will cause malformations or have an adverse effect on reproduction and development. The substance is of low acute concern to aquatic organisms.

2 CHEMICAL NAME AND IDENTIFICATION

Chemical Name (IUPAC): 1,4-bis(propan-2-yl)benzene; 7,7-dimethylhexadecane; octadecane
CAS RN: 64742-47-8
Molecular formula: Not available (UVCB substance)
Molecular weight: Not available (UVCB substance)

Synonyms: Distillates, petroleum, hydrotreated light

3 PHYSICO-CHEMICAL PROPERTIES

Hydrotreated light petroleum distillate is a UVCB substance containing aliphatic (linear, branched, and/or cyclic paraffins) molecules of carbon and hydrogen. Physical and chemical properties were not available for the UVCB hydrocarbon. As a result, information was obtained from a read-across substance (hydrodesulfurized kerosine). Key physical and chemical properties for the substance are shown in Table 1.

Table 1 Overview of the Physico-chemical Properties of Hydrodesulfurized Kerosine (CAS No. 64742-81-0)

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Liquid	2	ECHA
Melting Point	-49°C (pour point) @ 101.3 kPa.	2	ECHA
Boiling Point[1]	90 to 320°C @ 101.3 kPa	2	ECHA
Density	770 to 850 kg/m^3 @ 15°C	2	ECHA
Vapour Pressure	<1,000 to 37,000 Pa at 37.8°C	2	ECHA
Partition Coefficient (log K_{ow})	1.99 – 18.02 @ 20°C	2	ECHA
Water Solubility	0.000009 – 0.00645 g/L @ 25 °C	-	OECD
Viscosity	1.1 to 2.5 mm^2/s @ 20°C (kinematic)	2	ECHA

4 DOMESTIC AND INTERNATIONAL REGULATORY INFORMATION

A review of international and national environmental regulatory information was undertaken (Table 2). This chemical is listed on the Australian Inventory of Chemical Substances – AICS (Inventory). No conditions for its use were identified. No specific environmental regulatory controls or concerns were identified within Australia and internationally for hydrotreated light petroleum distillates.

Table 2 Existing International Controls

Convention, Protocol or other international control	Listed Yes or No?
Montreal Protocol	No
Synthetic Greenhouse Gases (SGG)	No
Rotterdam Convention	No
Stockholm Convention	No
REACH (Substances of Very High Concern)	No
United States Endocrine Disrupter Screening Program	No
European Commission Endocrine Disruptors Strategy	No

5 ENVIRONMENTAL FATE SUMMARY

A. Summary

Representative substances are expected to be readily biodegradable. They are highly insoluble in water and have high adsorption potential. They have a low potential to bioaccumulate.

While sediment and soil are expected to be the main targets for environmental distribution, biodegradation potential is expected to offset sorption. In fact, fugacity modelling suggest that

[1] CAS numbers in this category indicate a boiling point range of 90-320 deg Celsius.

accumulation in sediment is expected to be several orders of magnitude less than 1%, relative to soil, water and air compartments.

B. Partitioning

Based on Henry's Law Constant values > 4.76 x 10^4 Pa-m^3/mol @25 ^oC, members of this group have the potential to volatilise from water or moist soil surfaces. These chemicals are unlikely to degrade by hydrolysis as they lack a functional group that is hydrolytically reactive. However, in the air, category members have the potential to rapidly degrade through indirect photolytic processes (OECD, 2012).

C. Biodegradation

Kerosines are readily to inherently biodegradable. In the supporting OECD 301 study, naphtha solvents were readily biodegraded in 28 days but not within the 10-day window. The mean of three samples was 61% theoretical biological oxygen demand on Day 28. In a valid OECD 301F supporting study Kerosine Mid-Blend was not considered readily biodegradable in 28 days, with less than 60% degradation on day 28 (58.6%). However, according to USEPA guidance for biodegradability, it is considered inherently biodegradable because significant degradation occurred). On the basis of this and the known properties of hydrocarbons in the range C9 to C16, kerosines are often considered not readily biodegradable; but as they can be degraded by microorganisms, they are regarded as being inherently biodegradable.

If a chemical is found to be inherently or readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

D. Environmental Distribution

Standard adsorption/desorption studies are not applicable to petroleum UVCB substances. Mackay Level III modeling indicates that category member constituents partition mostly to the sediment and soil compartments rather than air compartment when an equal emission rate (1000 kg/hr) to the air, water, and soil compartment is assumed. When release occurs only to either the air, or soil compartment, constituents are indicated in the modeling to partition largely to the compartment to which they are released. When released to the water compartment, constituents are indicated by the model to partition to either water or sediment (HPVIS). However, based on the member category low solubility, partitioning to sediment would be expected.

E. Bioaccumulation

No experimental studies are available on the substance. Using BCFBAF in EPISuite™, the estimated BCF of a representative substance is 0.893 L/kg based on the Arnot-Gobas model that includes biotransformation and upper trophic. Thus, bioaccumulation is not expected (ECHA). [Kl. score = 2]

6 HUMAN HEALTH HAZARD ASSESSMENT

The information presented within this Section was derived in part from read-across substances: hydrodesulfurized kerosine (CAS No. 64742-81-0) and undiluted JP-8 jet fuel (CAS No. 8008-20-6).

A. Summary

The substance has low acute toxicity by the oral and dermal route. It is not irritating to the skin and eyes, but it is a skin sensitiser. Aside from minor changes in body weight, no adverse effects were seen in animals given repeated doses by the oral route. The substance is not genotoxic when tested in both *in vitro* and *in vivo* assays. There is no indication that this substance will cause malformations or have an adverse effect on reproduction and development. This information was derived in part from products of similar structure or composition.

B. Toxicokinetics

The studies of the pharmacokinetics (i.e. absorption, distribution, metabolism and excretion) of kerosine are scarce. There are some *in vitro* and *in vivo* studies available on jet fuels. However, because jet fuel is a complex mixture, these studies use certain constituents of jet fuels as marker compounds to describe the total jet fuel's pharmacokinetics. There are more data available for a number of kerosine constituents, and these can be used as a basis for understanding the pharmacokinetics of kerosine as a whole. There are three ways in which humans are exposed to kerosine: by inhalation; ingestion; and, dermal contact. Due to the relatively low volatility of kerosine and jet fuels, dermal exposure can be a more important route of exposure than exposure via inhalation. During many operations involving aircraft fuel tanks there is a significant potential for dermal exposure. Ingestion occurs primarily as a consequence of incidental ingestion.

Groups of five male C3H mice were dosed with a single dermal application of 15 or 60 µL kerosine (30% straight-run hydrotreated and 70% hydrocracked kerosine) spiked with radiolabeled naphthalene or tetradecane, and sacrificed after 96 h exposure (Mobil, 1994). Another group of five male C3H mice were exposed by air to the same compounds and doses in a metabolism cage to determine passive inhalation. The results of the dermal exposure show that 5% of the labelled tetradecane and 15% of the labelled naphthalene were absorbed over 96 h. The inhalation experiments showed that 2.8% of the labelled naphthalene was bioavailable. Comparison of these data with a similar dataset obtained with a 25% concentration of the test compounds diluted in mineral oil, revealed that dilution did not affect the absorption of the test compound.

Four groups of eight male Sprague-Dawley rats were exposed to 1, 4, 8,or 16 mL kerosine through the abdominal skin for 2 h at a skin area of 4, 8, 16 or 64 cm2, respectively (Tsujino et al., 2003). Before, during and after the experiment, blood samples were taken and analysed for trimethylbenzenes and aliphatic hydrocarbons. Trimethylbenzenes were detectable in blood within 5-20 min and showed a dose dependent absorption. High concentrations of aliphatic hydrocarbons were detected in the exposed skin as compared to the blood concentration. The aliphatic hydrocarbon levels were dependent on the amount of kerosine exposed per unit area.

The systemic distribution of kerosine components in the blood and tissues of rats following *in vitro* dermal exposures was investigated, using trimethylbenzenes and aliphatic hydrocarbons (C9-C16) as biomarkers (Tsujinoet al., 2002). The trimethylbenzenes were absorbed through the skin and detected in blood and tissues to a greater extent as compared to the aliphatics. The data indicate

that kerosine components are absorbed percutaneously and distributed to the various organs via the blood circulation. Distribution of trimethylbenzenes in blood and tissues following dermal exposure is (at decreasing concentrations): kidney > blood > liver > adipose > brain > spleen > lung = muscle. Distribution of aliphatics in blood and tissues following dermal exposure is (at decreasing concentrations): blood > adipose > muscle > lung > liver > kidney > spleen > brain.

The inhalation studies demonstrate that the volatile kerosine constituents are well absorbed (31 – 54%) and are distributed mainly in the fat tissue. Aromatics were metabolised at a higher rate than naphthenes, n-alkanes, isoalkanes and 1-alkenes. Dermal application of kerosine or jet fuel generally shows that the aromatics and aliphatics are well absorbed into the skin. Subsequently, the aromatics penetrate the skin at a higher rate than the alkanes. SKINPERM calculations indicate that although skin permeation rates of alkanes, naphthenes and aromatics are more or less comparable, the latency times of alkanes are longer than the latency times of naphthenes and aromatics. After absorption, the kerosine constituents are distributed via the blood circulation to the fat tissue and various organs. Studies with oral exposure to kerosine indicate that gastrointestinal absorption of kerosine is slow and incomplete, resulting in low bioavailability.

C. Acute Toxicity

Kerosines are of low acute toxicity, with an oral LD_{50} greater than 5000 mg/kg (rat), a dermal LD_{50} greater than 2000 mg/kg (rabbit), and an inhalation LC_{50} greater than 5.28 mg/L (rat). The most important effects in animals following very high oral doses were slight irritation of the stomach and the gastrointestinal tract. The only adverse effects observed in acute inhalation studies were decreased activity and breathing frequency at very high doses. Dermal application of kerosine did not lead to acute toxic systemic effects. Clinical effects observed were related to dermal irritation rather than to systemic toxicity. The acute toxicity of kerosine is not classified by EU CLP Regulation (EC No. 1272/2008).

<u>Oral</u>

In the key acute oral toxicity study (Klimisch score=1; ARCO, 1992a), groups of fasted (5 per sex), young adult, Sprague Dawley rats were given a single oral dose of undiluted thermocracked kerosine at a dose of 5000 mg/kg bw and observed for 14 days. There were no treatment related mortalities. All of the study animals exhibited one or more of the following clinical signs: nasal discharge, ocular discharge, abnormal stools, lethargy, stained coat, and alopecia. All animals gained weight during study period. At necropsy, one of the ten animals exhibited visual lesions, the remaining nine showed signs of alopecia in the inguinal and/or perineal regions. The oral LD50 was determined to be greater than 5000 mg/kg in males and females.

In supporting studies conducted on kerosine substances, rats were administered single oral gavage doses of the test substance. The results supported an oral LD50 of > 5000 mg/kg in males and females.

<u>Inhalation</u>

In the key acute inhalation toxicity study (Klimisch score = 1; API, 1987a), groups of Sprague-Dawley rats, five males and five females, were exposed by inhalation route to straight-run kerosine for 4 hours to their whole body at a single dose of 5.28 mg/L (vapour, analytical). All except one animal had normal growth rates throughout the study. The one exception on day 8 had a body weight less

than its starting body weight but by the end of the study normal growth had resumed. All animals exhibited decreased activity during the exposure. Otherwise there were no treatment-related clinical signs of toxicity. No macroscopic lesions were observed in any animal at post-mortem and no microscopic changes were observed in any lung section examined. The LC_{50} was greater than 5.28 mg/L.

In supporting studies conducted on kerosine substances, rats were administered single doses of the test substance via inhalation. The LC_{50}s as measured based on mortality and systemic effects do not indicate classification of kerosine as an acute inhalation toxicant. One supporting study on deodorised kerosine showed a lack of systemic effects after repeated exposure to rats (6 hours each day for 4 days) and resulted in an LC_{50} of > 7.5 mg/L (Carpenter et al., 1976). Another supporting study on deodorised kerosine showed a lack of systemic effects after a single 6-hour exposure to cats, and resulted in an LC_{50} of > 6.4 mg/L (Carpenter et al., 1976).

Dermal

In the key acute dermal toxicity study (Klimisch score=1; ARCO, 1992g), groups of young adult New Zealand White rabbits, five males and five females, were dermally exposed to undiluted thermocracked kerosine for 24 hours to 10% of their body surface area at a dose of 2000 mg/kg. Animals were then observed for 14 days. There were no mortalities and all animals gained weight during the study. All of the animals exhibited one or more of the following clinical signs during the observation period: dermal irritation (erythema, edema, eschar, fissuring and/or dried skin) and/or abnormal stools. Apart from skin irritation, there were no other abnormalities noted at necropsy. The dermal LD_{50} was determined to be greater than 2000 mg/kg in both males and females.

In supporting studies conducted on kerosine substances, rabbits were administered single dermal doses of the test substance, and results supported a dermal LD_{50} of > 2000 mg/kg in males and females.

D. Irritation

Skin

In the key study, young adult rabbits (6 females) were dermally exposed (occlusive coverage) to 0.5 mL of undiluted kerosine/heating oil for 24 hours on both intact and abraded skin sites. Each of the test sites was evaluated for skin responses for 9 days post-exposure and was scored using the Draize scale. The mean erythema score from 24 to 72 hours was 3.46/4 while the mean edema score from 24 to 72 hours was 2.33/4. While this protocol deviates from current guidelines that state exposure should be semi-occlusive over 4 hours, and to intact skin only, this study is included as key to show the irritating nature of kerosine products.

In another guideline study conducted according to GLP and in accordance with current guidelines, young adult New Zealand White rabbits (3 per sex) were dermally exposed (semi-occlusive coverage) to 0.5 mL of undiluted odourless kerosine, for 4 hours. Animals were observed for seven days after exposure. Irritation was scored based on the Draize method (1959). The mean erythema score from 24 to 72 hours was 0.17/4 while the mean edema score from 24 to 72 hours was 0/4.

Additional supporting studies are provided on straight run kerosine, odourless kerosine, hydrocracked kerosine, hydrodesulfurised kerosine, Jet Fuel A, Jet Fuel A1, JP-5, and Cherry Point Jet

Fuel A. Most of the studies are valid in their methodology, but they differ from the current OECD guidelines in that animals were exposed under occluded conditions for 24 hours instead of semi-occluded conditions for 4 hours. Considering the conditions of the test, results must be interpreted carefully for the purposes of classification and labelling. The mean scores for erythema and edema have been assessed against the deviations, and provided the test would be conducted under standard conditions, the overall weight of evidence indicates that kerosines are irritating to skin. Kerosines are classified as irritating to the skin according to criteria in EU CLP Regulation (EC No. 1272/2008).

Effects on skin irritation/corrosion: irritating

Eyes

A number of well-controlled (GLP) animal experiments performed on a variety of kerosines indicate that none of the kerosines and jet fuels tested were more than slightly irritating to the eyes. In addition, a number of short reports on eye irritation studies on JP-5 and JP-8 show no eye irritation whatsoever in rabbits (6 unwashed eyes; 3 washed eyes): all scores 0.0 for up to 7 days (end of the study). None of the hazard assessments of kerosine and jet fuel constituents have resulted in classification for eye irritation.

In the key study selected for primary eye irritation, 0.1mL of undiluted thermocracked kerosine was instilled into the conjunctival sac of the right eye of three female young adult New Zealand White rabbits and observed through 72 hours. Irritation was scored according to the Draize method (1959). There was no evidence of damage to the cornea or iris for all animals over all scoring periods. Mild conjunctivae indicators such as redness, chemosis, and discharge were evident at the one-hour scoring interval, but not at any of the other scoring intervals. Fluorescein staining scores were zero for all study animals over all scoring periods.

The average irritation score was 0.0 for the cornea, iris and conjunctivae.

Based on the evidence, kerosine is not an eye irritant.

E. Sensitisation

In animal assays for skin sensitisation such as the Magnusson-Kligman GPMT and the Buehler assay, kerosines and jet fuels did not trigger a positive response.

In the key dermal sensitisation study (Klimisch score=1; ARCO, 1992q), thermocracked kerosine in mineral oil was tested on male young adult Pig/Hartley guinea pigs using a modified Buehler technique. During the challenge phase, a second exposure of a 1:4 dilution of thermocracked kerosine to induced test animals did not yield higher response grades, severity, or incidence than those associated with the naive challenge control group exposed to thermocracked kerosine. During the challenge phase, exposure of 0.2% DNCB to induction positive control animals elicited significantly higher response grades, severity indices, and incidence over the naive DNCB challenge control group. The vehicle irritation control group was free of dermal irritation during the challenge phase. Therefore, under the conditions of this study, thermocracked kerosine is not considered a delayed contact sensitiser while DNCB induced an appropriate positive response.

Based on test data, there was no evidence of skin sensitisation; therefore, kerosine is not classified for skin sensitisation according to EU CLP Regulation (EC No. 1272/2008)

F. Repeated Dose Toxicity

Oral

In the key oral subchronic study (Klimisch score=1; Mattie et al., 2000), male rats were treated for 70 to 90 days with 0 (1mL of distilled water), 750, 1500, or 3000 mg/kg/day of undiluted JP-8 jet fuel, then mated to untreated females (one female at a time). Males were gavaged throughout the cohabitation period and were returned to their individual cage after successful mating. In the second part of the study, female rats were administered the test compound at doses of 0 (1mL of distilled water), 375, 750, or 1500 mg/kg/day undiluted JP-8 jet fuel for 90-day prior to mating, through mating, gestation, delivery, and lactation for a total of 21 week. During mating, they were housed with untreated males.

There were no effects on clinical signs or mortality in either sex. Haematology, clinical chemistry, and urinalysis were measured only in females without any effects noted. Body weights in male rats were decreased in a dose-dependent manner and was likely related to nephropathy, which is specific in male rats treated with hydrocarbons, and not relevant for human exposure. In females, body weight was only significantly reduced in the high-dose group. Absolute and relative liver weights were increased in mid- and high-dose females, but were not likely biologically significant due to the lack of changes in clinical chemistry or histopathology in the liver. The test compound caused perianal dermatitis (high-dose only) and stomach hyperplasia (mid- and high-dose) in the female rats. There was a dose-related decrease in pup weight that was significant in the 750 mg/kg/day group on postnatal day 4 only and in the 1500 mg/kg/day group from postnatal day 4 through postnatal day 21 but had recovered by postnatal day 90. There were no treatment-related effects on reproduction or sperm parameters in males. There were no effects on reproduction, gestation, or litter size in females.

The study LOAEL for systemic effects is 1500 mg/kg/day and the NOAEL for systemic effects is 750 mg/kg/day, based on reduced body weight in dams and in pups. The LOAEL for adult males rats exposed to JP-8 orally was 750 mg/kg/day due to changes in clinical pathology, body weight, organ weights and the same irritation seen in female rats. The decrease in male rat bodyweight is very likely due to the male rat-specific nephropathy and is therefore not taken into account for the derivation of the oral NOAEL. The reproduction NOAEL was 3000 and 1500 mg/kg/day in males and females, respectively.

Inhalation

In a key subchronic inhalation toxicity study (Klimisch score=1; Mattie et al., 1991), JP-8 jet fuel was administered to 95 male Fisher 344 rats, 75 female Fischer 344 rats, and 100 male and female C57BL/6 mice by dynamic whole body vapour exposure at concentrations of 0, 500 or 1000 mg/m3(0, 0.5, or 1.0 mg/L) as a vapour for 24 hours per day, 7 days/week for a total of 90 days. The male rats developed hydrocarbon-induced nephropathy at both treatment concentrations. Male rats had decreased body weight and decreased absolute and relative kidney weight at both treatment concentrations. Female rats were unaffected by treatment. In mice, no significant clinical signs of toxicity were noted that differentiated the groups that were treatment-related. The NOAEC for male rats is difficult to establish, since potential adverse effects may be masked by male rat specific

hydrocarbon nephropathy. However, based on the hydrocarbon-induced nephropathy and reduced body weights and increased kidney weights, the LOAEC in male rats is 500 mg/m3. The LOEC for male mice is also 500 mg/m3, but it was not treatment related. The NOAEC for female rats and mice is greater than or equal to 1000 mg/m3. This was the highest dose tested in the study.

In a subacute inhalation toxicity study (Klimisch score = 1; API, 1986), hydrodesulfurised kerosine vapour was administered to 20 Sprague-Dawley rats/sex/concentration by dynamic whole body exposure at a concentration of 24 mg/m3(0.024 mg/L) for 6 hours per day, 5 days/week for 4 weeks. There were no compound related effects in mortality, clinical signs, body weight, haematology, clinical chemistry, organ weights, or gross and histologic pathology. Therefore, the NOAEC is greater than or equal to 24 mg/m3. This was the highest dose tested in the study.

Dermal

In a key sub-chronic dermal study hydrodesulfurized kerosine was applied at concentrations of 20, 40 or 60% (v/v) at a rate of 1 ml/kg/day to the shorn intrascapular region of groups of 12 individually housed male and female, Sprague-Dawley rats (aged 7-9 weeks). This was equivalent to doses of test material of 165, 330 or 495 mg/kg/day. Dosing was continued for five days a week for 13 weeks. In addition a group of 12 male and 12 female rats of similar age were administered mineral oil at a dose rate of 1 ml/kg/day; these animals served as vehicle controls. 12 rats/sex/group each in the vehicle controls and high dose group were maintained for a 4-week recovery period. Ingestion of the test material was prevented by using a collar and removal of any residual test or control material from the skin. Animals were observed for clinical signs prior to dosing and 1, 6 and 24 hours after the first dose. Subsequently, observations were made prior to each dose being applied.

Prior to the administration of each dose, the treated skin site was evaluated for dermal irritation using the Draize scoring method. Body weights were recorded prior to the first dose and weekly thereafter. An ophthalmic examination was conducted on each rat prior to application of the first dose and again prior to sacrifice at the end of the study. During the week prior to the first dose, each rat was subjected to a functional observation battery (FOB). The FOB was conducted again 1, 6 and 24 hours after the first dose and at 7 and 14 days. During the study, the FOB, motor activity and startle response testing was conducted on all rats at weeks 4, 8 and 12. At week 14 blood samples were collected from 12 animals/sex/group. Full necropsies were performed at week 14 on 6 rats/sex/group and at week 18 on the recovery rats (vehicle and high dose groups). Each full necropsy included an examination of the external surface of the body and its contents. The remaining six rats of each group were anesthetized with an intraperitoneal injection of Pentothal and transcardially perfused in-situ using 10% neutral-buffered formalin and given a limited necropsy. For these rats, no organs were weighed and specific tissues were also collected for subsequent microscopic testing.

There was a generally dose-related increase in the incidence and severity of various skin conditions at the treated site. Males seemed to be more sensitive than females as they were affected at all doses, however, the effects indicated very little irritation. Recovery group animals revealed complete recovery in the females and minimal hyperkeratosis in the high dose group males. At necropsy no substance-related observations were made for males in any group. In the females there was a suggestion of a possible treatment-related effect which occurred in 7 rats across all groups and consisted of skin crusts or ulceration at the site of application of test material. Haematological and serum clinical parameters were unaffected by treatment.

All animals survived until scheduled termination. There were no test substance-related effects on survival, clinical observations (apart from skin irritation), neurobehavioral signs or ophthalmological findings. The NOEL for systemic toxicity was >495 mg/kg/day. The LOEL for slight dermal irritation was 165 mg/kg/day, equivalent to ~ 1mg/cm2.

G. Genotoxicity

In vitro gene mutation in mammalian cells

Key in vitro gene mutation studies in mammalian cells were identified. In a study by the American Petroleum Institute (API, 1984b), cultures of mouse lymphoma cells were exposed to hydrodesulfurised kerosine with or without metabolic activation by Aroclor 1254-induced rat liver S9 fraction. Under non-activation conditions the test material induced a good range of toxicities for evaluation (relative growths ranged from 2.8% to 65.3%). None of the assays induced a mutant frequency that exceeded the minimum criterion (40.8 x 10-6). The test material was not mutagenic under non-activation conditions. In the presence of metabolic activation a wide range of toxicities was induced (6.1 to 107.9% relative growths). The minimum criterion mutant frequency of 69.0 x 10-6 was not exceeded. The test material was therefore considered non mutagenic under activation conditions. In a study by API (1977) (Klimisch score = 1), mouse lymphoma L5178Y cells were exposed to straight-run kerosine in acetone vehicle at concentrations ranging from 0.04 to 0.065 µL/mL (with metabolic activation) or 0.006 to 0.13 µL/mL (without activation). There was no evidence that straight-run kerosine induced mutant colonies over background levels.

In vitro cytogenicity in mammalian cells

Hydrodesulfurised kerosine was tested in the sister chromatid exchange assay using Chinese hamster ovary cells (API, 1988a). The assay was conducted with Aroclor-induced rat liver S-9 activation system. A small but statistically significant increase in the frequency of sister chromatid exchanges was observed at the high and low concentrations with metabolic activation. These increases appeared to be random and of no biological significance. There were no significant increases observed at any concentration in the absence of metabolic activation. Under the conditions of the study, hydrodesulfurised kerosine is considered to be negative in the sister chromatid exchange assay with Chinese hamster ovary cells.

In vivo cytogenicity

Based on weight of evidence kerosine substances were found to be non-mutagenic through cytogenic investigations.

In six in vivo bone marrow cytogenetic studies in the rat, there were no indications of chromosomal aberrations. Although an in vivo Sister Chromatid Exchange study in the mouse gave positive findings in the male group (but not in the females) the positive findings in the males were associated with signs of toxicity (lethargy and weight loss) at the very high top dose used in the study (4000mg/kg), both on the day of the administration of the kerosine and the day after (when they were sacrificed).

In a rat bone marrow micronucleus assay (API, 1985c, Klimisch score = 1), straight run kerosine (CAS# 800-20-6) was administered to Sprague Dawley rats. Straight run kerosine was not considered to induce chromosomal aberrations in bone marrow cells of rats. In another bone marrow

micronucleus assay (API, 1984b, Klimisch score = 1), hydrodesulfurised kerosine (CAS# 64742-81-0) was administered to rats. No clinical signs of toxicity were exhibited by the rats, and there was no significant increase in frequency of micronucleated polychromatic erythrocytes in bone marrow as compared to control. In a study by API (1977) (Klimisch score = 1), straight-run kerosine (CAS# 8008-20-6) was administered to 45 male rats. No significant increase in the frequency of micronucleated polychromatic erythrocytes was observed.

In vivo gene mutation

Key in vivo gene mutation studies were identified. In a sperm cell dominant lethal mutation assay (API, 1980b, Klimisch score = 1), Jet Fuel A was administered via inhalation route to male mice at concentrations of 100 or 400 ppm for a 6-hour exposure period, 5 days per week for 8 weeks. Males were mated with females, and the uteri of pregnant females were examined for living and dead implants. Jet Fuel A did not increase the incidence of post-implantation deaths. In another study by API (1973) (Klimisch score = 1), deodorised kerosine was administered subcutaneously to 10 male Swiss-Webster mice in corn oil vehicle or intraperitoneally to 10 Long-Evans rats undiluted at a dose of 1.0 mL/kg. Males were mated with females, and no pattern of decreased pregnancy rate or increased embryo loss was observed in the females.

H. Carcinogenicity

Kerosine is not carcinogenic when animals are exposed via the oral or inhalation route (ECHA).

Male mice were administered dermally 37.5µL of jet fuel A to the shaved backs of 50 mice per dose, twice a week for 2 years or intermittently so that application of the jet fuel was suspended when dermal irritation was noted in 20% of the group and was resumed when irritation resolved in all but 20% of the affected animals. There was a significant increase in tumours at the application site with continuous treatment compared to the control (0% versus 44%), but not with intermittent treatment (0% versus 2%). With continuous treatment, there was a treatment-related increase in dermal tumour incidence compared to controls. However, stopping treatment during dermal irritation nearly eliminated the carcinogenic effect (ECHA) [Kl. Score = 1].

Male and female mice were administered dermally 25 mg of petroleum-derived jet fuel A to the shaved backs of 25 mice, three times a week for 105 weeks. Due to high mortality, jet fuel A application was discontinued during week 62, but surviving animals were observed until study termination. There was a significant increase in tumours at the application site (0%, 26%, and 26% in the controls, JP-4, and jet A groups). The majority of the tumours were squamous cell carcinomas or fibrosarcomas. At the doses tested, there was a treatment-related increase in dermal tumour incidence when compared to controls. The results of the study indicate that there was a treatment-related increase in dermal tumour incidence when compared to controls, therefore it can be concluded that Jet fuel A has a carcinogenic effect on mice at 25 mg dosage (ECHA) [Kl. Score = 1].

Straight-run kerosine (CAS # 8008-20-6) and hydrodesulfurised kerosine (CAS # 64742-81-0) were tested in standard 2-year bioassays in mice. The animals, 50 per group, were treated twice weekly with 50 µl straight-run kerosine or with hydrodesulfurised kerosine. It was concluded that both straight-run and hydrodesulfurised kerosine were moderate skin carcinogens (ECHA) [Kl. Score = 2].

In the key carcinogenicity study from NTP, JP-5 navy fuel in acetone was administered to 50 mice dermally at dose levels of 0 (vehicle control), 250, or 500 mg/kg bw/day for up to 103 weeks. There

was a significant decrease in survival in females at both treatment doses. Remaining high-dose females were sacrificed at week 90. There was no treatment-related effect on survival in male mice. The LOAEL is 250 mg/kg/day, based on dermatitis and decreased survival in females. No NOAEL can be determined. At the doses tested, there was not a treatment-related increase in tumour incidence when compared to controls (ECHA) [Kl. Score = 1].

The potential influence of skin irritation on tumour development in long-term mouse skin painting studies was investigated as part of the CONCAWE middle distillates programme. The study included straight run hydrotreated kerosine (MD3). The test material was applied to the shorn skin of three groups of 50 male mice for 104 weeks. For the straight run hydrotreated kerosine, skin tumours only developed in the group of animals in which substantial skin irritation occurred during the study. Since no polycyclic aromatic compounds were detected in the straight run kerosine it is concluded that the occurrence of tumours is likely to have been caused by a non-genotoxic mechanism. This conclusion is consistent with reports by others that lighter middle distillates are tumour promotors but not initiators and furthermore that skin irritation plays an important role in skin tumour development. These tumours are probably the consequence of a continuous cycle of cell damage and repair caused by chronic skin irritation. The conclusions gained from this study can be applied to other carcinogenicity studies on kerosines, and they show that tumours are noted in the presence of repeated dermal irritation, and that kerosines lack a genotoxic mechanism of carcinogenicity (ECHA) [Kl. Score = 1].

I. Reproductive Toxicity

There are no specific reproductive toxicity data for the substance but there are data available with ECHA as migrated information which is read-across based on grouping of substances (category approach).

An OECD Guideline 415 One-Generation Reproduction Toxicity study was conducted. This was a reproductive study performed in two parts. In the first part, males were treated for 70 to 90 days with 0 (1mL of distilled water), 750, 1500, or 3000 mg/kg/day of undiluted JP-8 jet fuel, then mated to untreated females (one female at a time). In the second part of the study, female rats were administered the test compound at doses of 0 (1mL of distilled water), 375, 750, or 1500 mg/kg/day undiluted JP-8 jet fuel for 90 -day prior to mating, through mating, gestation, delivery, and lactation for a total of 21 weeks.

There were no changes in clinical signs or mortality in parental animals. Body weights in male rats were decreased in a dose-dependent manner. Terminal body weights were approximately 545 grams, 520 grams, 475 grams, and 315 grams in the control, 750, 1500, and 3000 mg/kg/day, respectively. In females, body weight was only significantly reduced in the high-dose group, but the differences were not significant at terminal sacrifice. The body weight in females at 20 weeks (1 week before sacrifice) was approximately 400 grams, 385 grams, 382 grams, and 335 grams in the control, 375, 750, and 1500 mg/kg/day, respectively. Hematology was not measured in the males and no effects were noted in the females. Clinical chemistry was not measured in the males and no effects were noted in the females. Urinalysis was not measured in the males and no effects were noted in the females. Absolute and relative liver weights were increased in mid- and high-dose females, but were not accompanied by any histological findings. The test compound caused perianal dermatitis (high-dose only) and stomach hyperplasia (mid- and high-dose) in the female rats.

There were no treatment-related effects on reproduction or sperm parameters in males. There were no effects on reproduction, gestation, or litter size in females. The lowest NOAEL based on parental body weight was determined to be 750 mg/kg/day.

The F1 generation was not examined for clinical signs though no mention would suggest no significant signs were noted. No mortality was observed. There were no effects on offspring viability. However, there was a dose-related decrease in pup weight that was significant in the 750 mg/kg/day group on postnatal day 4 only and in the 1500 mg/kg/day group from postnatal day 4 through postnatal day 21. The 1500 mg/kg/day group recovered by postnatal day 90. The NOAEL based on offspring body weight was determined to be 750 mg/kg/day.

J. Reproductive Toxicity/Developmental Toxicity

In a developmental toxicity study, undiluted JP-8 jet fuel was administered to 30 Sprague-Dawley (Crl:CD) rats/dose by gavage at various volumes to achieve dose levels of 0 (sterile water), 500, 1000, 1500, or 2000 mg/kg bw/day from days 6 through 15 of gestation.

There was a significant decrease in maternal weight gain with doses of 1000 mg/kg/day or greater. Maternal necropsy weight was significantly different than the control in the 1500 and 2000 mg/kg/day groups. There were no apparent clinical signs of toxicity. Reproductive endpoints were not assessed in this study because females were pregnant prior to treatment and did not deliver, so only developmental endpoints can be assessed. Thirteen females (one 1000 mg/kg/day; three 1500 mg/kg/day, and nine 2000 mg/kg/day) were found dead. Although there appears to be a dose-dependent increase in the mortality, necropsy found the cause of death to be related to the presence of the test compound in the lungs indicating dosing into the lungs instead of the gastrointestinal tract. The maternal LOAEL is 1000 mg/kg/day, based on reduced body weight gain. The maternal NOAEL is 500 mg/kg/day.

There was a significant decrease in fetal weight in both male and female fetuses dosed with 1500 and 2000 mg/kg/day. The test compound did not significantly increase the incidence of malformations or variations compared to the control nor was the sex ratio altered. The developmental LOAEL is 1500 mg/kg/day, based on reduced fetal weight. The developmental NOAEL is 1000 mg/kg/day. It can be concluded that the test substance is not toxic to development.

This study received a Klimisch score of 1 and is classified as reliable without restrictions because it was carried out in a method equivalent/similar to OECD TG 414.

K. Derivation of Toxicological Reference and Drinking Water Guidance Values

The toxicological reference values developed for the substance follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

<u>Non-Cancer</u>

The NOAEL for reduced maternal body weight is 500 mg/kg/day, based on reduced body weight in dams and in pups treated under a repeat dose regimen. The NOAEL from this study will be used for determining the oral Reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:
UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 10
UF_D (database uncertainty) = 1

Oral RfD = 500 /(10 x 10 x 1 x 10 x 1) = 500/1,000 = 0.5 mg/kg-day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

where:
Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)

Drinking water guidance value = (0.500 x 70 x 0.1)/2 = 1.8 mg/L

Cancer

There are no carcinogenicity studies on the substance or related hydrocarbons. Thus, a cancer reference value was not derived.

L. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

The substance does not exhibit the following physico-chemical properties:

- Explosivity
- Oxidizing potential

The substance is classified as a “Flammable Liquid Category 3”

7 ENVIRONMENTAL EFFECTS SUMMARY

A. Summary

The substance is of low acute concern to aquatic organisms.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies on hydrotreated light petroleum distillate surrogates.

Table 3 Acute Aquatic Toxicity Studies on Hydrotreated Light Petroleum Distillate Surrogate[2]

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Oncorhynchus mykiss	96-hour LL_{50}	2-5	1	ECHA
Daphnia magna	48-hour EL_{50}	1.4	1	ECHA
Raphidocelis subcapitata	72-hour EC_{50}	<1-3 (average of 2)	1	ECHA
Selenastrum capricornutum	72-hour EC_{50}	3.7	2	ECHA

Chronic Studies

There are no long-term toxicity studies on fish. A single long term study on invertebrates is discussed below.

In a 21-day semi-static chronic reproductive toxicity test (OECD 211; KS = 1) on *Daphnia magna*, hydrodesulfurised kerosine was evaluated using water accommodated fraction methodology. The actual loading rates were 0 (control), 0.08, 0.19, 0.48, 1.2 and 3.0 mg/L. Under the conditions of this test, the 21-day chronic reproductive NOEL for kerosine is 0.48 mg/L. The LOEL is 1.2 mg/L. The EL_{50} based on reproduction is 0.89 mg/L (ECHA).

C. Terrestrial Toxicity

There are no terrestrial toxicity studies for this substance.

[2] Hydrodesulfurized Kerosine (CAS No. 64742-81-0)

D. Calculation of PNEC

The PNEC calculations for hydrotreated light petroleum distillate follow the methodology discussed in DEWHA (2009).

PNEC water

Experimental results are available from acute tests on three trophic levels. There is one long term study on a single trophic level organism, *D. magna*.

On the basis that the data consists of short-term studies from three trophic levels and a long-term study from one trophic level, an assessment factor of 100 is applied to the 21-day chronic reproductive NOEL for kerosine of 0.48 mg/L. The $PNEC_{aquatic}$ is 0.005 mg/L.

PNEC sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 0.36 mg/kg sediment wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
$= (93.4/1280) \times 1000 \times 0.005$
$= 0.36$ mg/kg

Where:
$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3) [calculated]
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]

$K_{sed\text{-}water} = 0.8 + [0.2 \times Kp_{sed}/1000 \times BD_{solid}]$
$= 0.8 + [0.2 \times 193/1000 \times 2400]$
$= 93.4\ m^3/m^3$

And:
Kp_{sed} = solid-water partition coefficient (L/kg).[calculated]
BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]

$Kp_{sed} = K_{oc} \times f_{oc}$
$= 4818 \times 0.04$
$= 193$ L/kg

Where:
K_{oc} = organic carbon normalized distribution coefficient (L/kg). The K_{oc} for hydrodesulfurized kerosine calculated from EPISUITE™ using the MCI is 4818 L/kg.
F_{oc} = fraction of organic carbon in sediment = 0.04 [default].

PNEC soil

There are no experimental toxicity testing results available for the substance or its noted surrogates. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 0.32 mg/kg soil dry weight.

The calculations are as follows:

$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$
$= (96.4/1500) \times 1000 \times 0.005$
$= 0.32$ mg/kg

Where:
Kp_{soil} = soil-water partition coefficient (m3/m3)
BD_{soil} = bulk density of soil (kg/m3) = 1,500 [default]

$Kp_{soil} = K_{oc} \times f_{oc}$
$= 4818 \times 0.02$
$= 96.4\ m^3/m^3$

And:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for hydrodesulfurized kerosine calculated from EPISUITE™ using the MCI is 4818 L/kg.
F_{oc} = fraction of organic carbon in soil = 0.02 [default].

8 CATEGORISATION AND OTHER CHARACTERISTICS OF CONCERN

A. PBT Categorisation

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

The substance or similar compounds are readily biodegradable; thus they do not meet the screening criteria for persistence.

Based on the estimated BCF values, derived from EPISuite estimates (BCF = 3.162 L/kg wet-weight) the substance does not meet the screening criteria for bioaccumulation.

The NOEC values from acute and chronic aquatic toxicity studies on the substance indicate it does not meet the screening criteria for toxicity.

Therefore, hydrotreated light petroleum distillates are not PBT substances.

B. Other Characteristics of Concern

No other characteristics of concern were identified for hydrotreated light petroleum distillates.

9 SCREENING ASSESSMENT

Chemical Name	CAS No.	Overall PBT Assessment [1]	Chemical Databases of Concern Assessment Step		Persistence Assessment Step		Bioaccumulative Assessment Step	Toxicity Assessment Step			Risk Assessment Actions Required[3]
			Listed as a COC on relevant databases?	Identified as Polymer of Low Concern	P criteria fulfilled?	Other P Concerns	B criteria fulfilled?	T criteria fulfilled?	Acute Toxicity [2]	Chronic Toxicity[2]	
Hydrotreated Light Petroleum Distillates	64742-47-8	Not a PBT	No	No	No	No	No	No	2	2	2

Footnotes:

1 - PBT Assessment based on PBT Framework.

2 - Acute and chronic aquatic toxicity evaluated consistent with assessment criteria (see Framework).

3 – Tier 1 – Hazard Assessment only.

Notes:

NA = not applicable

PBT = Persistent, Bioaccumulative and Toxic

B = bioaccumulative

P = persistent

T = toxic

10 REFERENCES, ABBREVIATIONS AND ACRONYMS

A. References

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

AUS (2018). Australian Code for the Transport of Dangerous Goods by Road & Rail Edition 7.6, 2018. Commonwealth of Australia National Transport Commission, Level 3, 600 Bourke Street MELBOURNE, VIC, 3000.

BASF (2012). GPS Safety Summary: Fatty acids, C8-C16, 2-ethylhexyl ester. Available at: http://www.safety-summaries.basf.com/group/corporate/safety-summaries/en/literature-document:/GPS+Safety+Summaries--Fatty+acids+C8+16+2+ethylhexyl+ester-English.pdf.

Bookstaff, R.C., Stuard, S.B., Ward, S.R., Pesik, P.K., and Henwood, S.M. (2004). The safety of ethyl oleate is supported by a 91-day feeding study in rats. Regul. Toxicol. Pharmacol. 39: 202-213.

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy [DoEE]. (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra. Available: www.environment.gov.au/water/coal-and-coal-seam-gas/national-assessment-chemicals/consultation-risk-assessment-guidance-manual

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA] (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency [ECHA]. (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

OECD (2012). SIDS INITIAL ASSESSMENT PROFILE. C9-C14 Aliphatic [≤2% aromatic] Hydrocarbon Solvents Category. CoCAM 3, 16-18 October 2012.

U.S. Environmental Protection Agency [EPA] (2017). EPISuite™ v. 4.11, United States Environmental Protection Agency, Office of Pollution Prevention and Toxics and Syracuse Research Corporation. Available at: https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface.

B. Abbreviations and Acronyms

°C	degrees Celsius
°F	degrees Fahrenheit
AICS	Australian Inventory of Chemical Substances
BCF	bioconcentration factor
BCFBAF	bioconcentration factor/bioaccumulation factor
CAS	Chemical Abstracts Service
CLP	Classification, Labelling, and Packaging Regulation
COC	constituent of concern
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EL	effect level
EU	European Union
IUPAC	International Union of Pure and Applied Chemistry
kg/m^3	kilogram per cubic metre
KI	Klimisch scoring system
KOCWIN™	USEPA organic carbon partition coefficient estimation model
KOWWIN	USEPA modelling program to estimate the organic carbon-normalised sorption coefficient for soil and sediment
kPa	kilopascal

L/kg	litres per kilogram
LL	Lethal loading
MCI	molecular connectivity index
mg/L	milligrams per litre
NICNAS	National Industrial Chemicals Notification and Assessment Scheme
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
Pa	Pascal
Pa.s	pascal second
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SGG	Synthetic Greenhouse Gases
USEPA	United States Environmental Protection Agency
UVCB	Unknown or Variable Composition, Complex Reaction Products and Biological Materials

Attachment 2 Assessment of Potential Ecological Receptors

No.	Scientific name	Common name	TSC Act	EPBC Act	Distribution (OEH, 2016b)	Habitat (OEH, 2016b)
1	*Aepyprymnus rufescens*	Rufous Bettong	Vulnerable	Not Listed	The original range from Coen in north Queensland to central Victoria has been reduced to a patchy distribution from Cooktown, Queensland, to north-eastern NSW as far south as Mt Royal National Park. In NSW it has largely vanished from inland areas but there are sporadic, unconfirmed records from the Pilliga and Torrington districts.	Prefers forests with a grassy to sparse understorey, from tall wet sclerophyll forests on the coast to the dry forests and open woodlands west of the Great Dividing Range. In the day they shelter in a grassy nest constructed in a shallow depression at the base of a tussock or fallen log (Dennis & Johnson, 2008).
2	*Anseranas semipalmata*	Magpie Goose	Vulnerable	Not Listed	Still relatively common in the northern Australian tropics, from Fitzroy River in Western Australia across to Rockhampton in Queensland, but disappeared from south-east Australia by 1920 due to drainage and overgrazing of reed swamps used for breeding. Since the 1980s, however, there have been an increasing number of records in central and northern NSW, and vagrants can even follow food sources to south-eastern NSW. This species is known north of the study area, mainly around Narrabri Lake and Wee Waa (OEH, 2016a). It has not been recorded in the study area.	Mainly found in shallow (less than 1 metre deep) sedge or rush-dominated wetlands; mainly those on floodplains of rivers (Marchant & Higgins, 1993; Simpson & Day, 2010). The species forages in terrestrial as well as aquatic habitats, including grasslands, pastures, wetlands, well-vegetated dams and crops. It roosts in tall vegetation and nests are formed in trees over deep water or on a floating platform of flattened reeds.
3	*Anthochaera phrygia*	Regent Honeyeater	Critically Endangered	Critically Endangered	An extremely patchy distribution across the inland slopes of south-east Australia between north-eastern Victoria and south-eastern Queensland. Birds are also found in drier coastal woodlands and forests in some years. In NSW, most records are from the Great Dividing Range, mainly on the North-West Plains, North-West and South-West Slopes, Northern Tablelands, Central Tablelands and Southern Tablelands regions; as well as the Central Coast and Hunter Valley regions. Regent Honeyeaters have been recorded sporadically in the Pilliga (in 1991, 1992, 1997 and 2003; OEH 2014a).	Associated with temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts, and riparian forests of Casuarina cunninghamiana (River Oak) (Garnett, 1993). The Regent Honeyeater primarily feeds on nectar from box and ironbark eucalypts and occasionally from banksias and mistletoes. Eucalypts that reliably produce large amounts of nectar occurring in the Pilliga are *E. sideroxylon, E. melliodora* and *E. albens* .
4	*Apus pacificus*	Fork-tailed Swift	Not Listed	Marine; Migratory	A non-breeding visitor to all states and territories of Australia. In NSW, the Fork-tailed Swift is recorded in all regions. Many records occur east of the Great Divide, however, a few populations have been found west of the Great Divide. These are widespread but scattered further west of the line joining Bourke and Dareton. Sightings have been recorded at Milparinka, the Bulloo River and Thurloo Downs (DotE, 2014c).	Varied habitat with a possible tendency to more arid areas but also over coasts and urban areas (Simpson & Day, 2010).

No.	Scientific name	Common name	Distribution (OEH 2020)	Habitat (OEH 2020)
1	*Aepyprymnus rufescens*	Rufous Bettong	The original range from Coen in north Queensland to central Victoria has been reduced to a patchy distribution from Cooktown, Queensland, to north-eastern NSW as far south as Mt Royal National Park. In NSW it has largely vanished from inland areas but there are sporadic, unconfirmed records from the Pilliga and Torrington districts.	Rufous Bettongs inhabit a variety of forests from tall, moist eucalypt forest to open woodland, with a tussock grass understorey. A dense cover of tall native grasses is the preferred shelter.;1|They sleep during the day in cone-shaped nests constructed of grass in a shallow depression at the base of a tussock or fallen log.;2|At night they feed on grasses, herbs, seeds, flowers, roots, tubers, fungi and occasionally insects.;3|
2	*Anseranas semipalmata*	Magpie Goose	The Magpie Goose is still relatively common in the Australian northern tropics, but had disappeared from south-east Australia by 1920 due to drainage and overgrazing of reed swamps used for breeding. Since the 1980s there have been an increasing number of records in central and northern NSW. Vagrants can follow food sources to south-eastern NSW.	Mainly found in shallow wetlands (less than 1 m deep) with dense growth of rushes or sedges.;1|Equally at home in aquatic or terrestrial habitats; often seen walking and grazing on land; feeds on grasses, bulbs and rhizomes. ;2|Activities are centred on wetlands, mainly those on floodplains of rivers and large shallow wetlands formed by run-off; breeding can occur in both summer and winter dominated rainfall areas and is strongly influenced by water level; most breeding now occurs in monsoonal areas; nests are formed in trees over deep water; breeding is unlikely in south-eastern NSW.;3|Often seen in trios or flocks on shallow wetlands, dry ephemeral swamps, wet grasslands and floodplains; roosts in tall vegetation.;4|
3	*Anthochaera phrygia*	Regent Honeyeater	The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. Once recorded between Adelaide and the central coast of Queensland, its range has contracted dramatically in the last 30 years to between north-eastern Victoria and south-eastern Queensland. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands. In some years flocks converge on flowering coastal woodlands and forests.	The Regent Honeyeater is a flagship threatened woodland bird whose conservation will benefit a large suite of other threatened and declining woodland fauna. The species inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Regent Honeyeaters inhabit woodlands that support a significantly high abundance and species richness of bird species. These woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes.;1|Every few years non-breeding flocks are seen foraging in flowering coastal Swamp Mahogany and Spotted Gum forests, particularly on the central coast and occasionally on the upper north coast. Birds are occasionally seen on the south coast.;2| In the last 10 years Regent Honeyeaters have been recorded in urban areas around Albury where woodlands tree species such as Mugga Ironbark and Yellow Box were planted 20 years ago.;3|The Regent Honeyeater is a generalist forager, although it feeds mainly on the nectar from a relatively small number of eucalypts that produce high volumes of nectar. Key eucalypt species include Mugga Ironbark, Yellow Box, White Box and Swamp Mahogany. Other tree species may be regionally important. For example the Lower Hunter Spotted Gum forests have recently been demonstrated to support regular breeding events. Flowering of associated species such as Thin-leaved Stringybark Eucalyptus eugenioides and other Stringybark species, and Broad-leaved Ironbark E. fibrosa can also contribute important nectar flows at times. Nectar and fruit from the mistletoes Amyema miquelii, A. pendula and A. cambagei are also utilised. When nectar is scarce lerp and honeydew can comprise a large proportion of the diet. Insects make up about 15% of the total diet and are important components of the diet of nestlings. ;4|Colour-banding of Regent Honeyeater has shown that the species can undertake large-scale nomadic movements in the order of hundreds of kilometres. However, the exact nature of these movements is still poorly understood. It is likely that movements are dependent on spatial and temporal flowering and other resource patterns. To successfully manage the recovery of this species a full understanding of the habitats used in the non-breeding season is critical.;5|There are three known key breeding areas, two of them in NSW - Capertee Valley and Bundarra-Barraba regions. The species breeds between July and January in Box-Ironbark and other temperate woodlands and riparian gallery forest dominated by River Sheoak. Regent Honeyeaters usually nest in horizontal branches or forks in tall mature eucalypts and Sheoaks. Also nest in mistletoe haustoria.;6|An open cup-shaped nest is constructed of bark, grass, twigs and wool by the female. Two or three eggs are laid and incubated by the female for 14 days. Nestlings are brooded and fed by both parents at an average rate of 23 times per hour and fledge after 16 days. Fledglings fed by both parents 29 times per hour.;7|
4	*Apus pacificus*	Fork-tailed Swift		

No.	Scientific name	Common name	Availability of habitat in the study area	Likelihood of occurrence in the study area	Assessment of likely interaction with soils at well leases	Forest areas	Pasture areas
1	*Aepyprymnus rufescens*	Rufous Bettong	Moderate	Potential	Rufous Bettong forages in grassy forest and shelters within dense vegetation. This species may graze on newly rehabilitated areas where there is new growth of grasses and shrubs (i.e. 1-3 years post rehabilitation).	Potential	No
2	*Anseranas semipalmata*	Magpie Goose	Moderate	Potential	Magpie Goose forages in well structured vegetated wetlands and roosts in vegetation within or adjoining these wetlands. As such this species is unlikely to interact with soils within well leases.	No	No
3	*Anthochaera phrygia*	Regent Honeyeater	High	Potential	Regent Honeyeater forages in woodland and forest within the mid and canopy layers. As such this species is unlikely to interact with soils within well leases.	No	No
4	*Apus pacificus*	Fork-tailed Swift	High	Known	Fork-tailed Swift forages is an almost exclusive aerial species, foraging aerially up to hundreds of metres above ground. As such this species is unlikely to interact with soils within well leases.	No	No

Source: Eco Logical Australia Pty Ltd. E-mail correspondence to Santos Ltd dated December 21, 2020.

No.	Scientific name	Common name	TSC Act	EPBC Act	Distribution (OEH, 2016b)	Habitat (OEH, 2016b)
5	*Bubulcus ibis*	Cattle Egret	Not Listed	Marine	Widespread and common species in Australia. recorded in the northern portion of the study area (DotE, 2014a).	Occur in tropical and temperate grasslands, wooded lands and terrestrial wetlands, and very rarely in arid and semi-arid regions. It uses predominately shallow, open and fresh wetlands including meadows and swamps with low emergent vegetation and abundant aquatic flora.
6	*Ardea modesta*	Great Egret, White Egret	Not Listed	Marine	Widespread in Australia. They occur in all states/territories of mainland Australia and in Tasmania. They have also been recorded as vagrants on Lord Howe, Norfolk and Macquarie Islands (DotE, 2014a).	Reported in a wide range of wetland habitats including swamps and marshes; margins of rivers and lakes; damp or flooded grasslands, pastures or agricultural lands; reservoirs; sewage treatment ponds; drainage channels; salt pans and salt lakes; salt marshes; estuarine mudflats, tidal streams; and mangrove swamps (Kushlan & Hancock, 2005; Marchant & Higgins, 1990).
7	*Ardeotis australis*	Australian Bustard	Endangered	Not Listed	Occurs in inland Australia and is now scarce or absent from southern and south-eastern Australia. In NSW, they are mainly found in the north-west corner and less often recorded in the lower western and central west plains regions. Occasional vagrants are still seen as far east as the western slopes and Riverine plain. Breeding now only occurs in the north-west region of NSW.	Mainly inhabits tussock and hummock grasslands, though prefers tussock grasses to hummock grasses; also occurs in low shrublands and low open grassy woodlands; occasionally seen in pastoral and cropping country, golf courses and near dams.
8	*Artamus cyanopterus cyanopterus*	Dusky Woodswallow	Vulnerable	Not Listed	The eastern population is found from Atherton Tableland, Queensland south to Tasmania and west to Eyre Peninsula, South Australia.	Found in open forests and woodlands, and may be seen along roadsides and on golf courses.
9	*Botaurus poiciloptilus*	Australasian Bittern	Endangered	Endangered	Widespread but uncommon over south-eastern Australia. In NSW they may be found over most of the state except for the far north-west.	Tussock and hummock grasslands, preferring the former to the latter. It also occurs in low shrublands and low open grassy woodlands, and is occasionally seen in pastoral and cropping country, golf courses and near dams.
10	*Burhinus grallarius*	Bush Stone-curlew	Endangered	Not Listed	Found throughout Australia except for the central southern coast and inland, the far south-east corner, and Tasmania. Only in northern Australia is it still common however and in the south-east it is either rare or extinct throughout its former range.	Occurs in lowland grassy woodland and open forest (DEC, 2006). West of the Great Dividing Range, Bush Stone-curlews are associated with Grey Box (*Eucalyptus microcarpa*), River Red Gum (*E. camaldulensis*), Black Box (*E. largiflorens*) and Yellow Box (*E. melliodora*), with a sparse ground cover of native grasses and few or no shrubs (Johnson & Baker-Gabb, 1994; Marchant & Higgins, 1993). They also occasionally occur in box-ironbark forests and patches of she-oaks (*Allocasuarina* spp.).

No.	Scientific name	Common name	Distribution (OEH 2020)	Habitat (OEH 2020)
5	*Bubulcus ibis*	Cattle Egret		
6	*Ardea modesta*	Great Egret, White Egret		
7	*Ardeotis australis*	Australian Bustard	The Australian Bustard mainly occurs in inland Australia and is now scarce or absent from southern and south-eastern Australia. In NSW, they are mainly found in the north-west corner and less often recorded in the lower western and central west plains regions. Occasional vagrants are still seen as far east as the western slopes and Riverine plain. Breeding now only occurs in the north-west region of NSW.	Mainly inhabits tussock and hummock grasslands, though prefers tussock grasses to hummock grasses; also occurs in low shrublands and low open grassy woodlands; occasionally seen in pastoral and cropping country, golf courses and near dams.;1|Breeds on bare ground on low sandy ridges or stony rises in ecotones between grassland and protective shrubland cover; roosts on ground among shrubs and long grasses or under trees.;2|Forages on insects, young birds, lizards, mice, leaves, seeds and fruit.;3|Dispersive, with irregular widespread movements over long distances; movements are thought to be in response to habitat and climatic conditions; known to converge on areas with high mice numbers and in recently burnt areas.;4|
8	*Artamus cyanopterus cyanopterus*	Dusky Woodswallow	Dusky woodswallows are widespread in eastern, southern and south western Australia. The species occurs throughout most of New South Wales, but is sparsely scattered in, or largely absent from, much of the upper western region. Most breeding activity occurs on the western slopes of the Great Dividing Range.	Primarily inhabit dry, open eucalypt forests and woodlands, including mallee associations, with an open or sparse understorey of eucalypt saplings, acacias and other shrubs, and ground-cover of grasses or sedges and fallen woody debris. It has also been recorded in shrublands, heathlands and very occasionally in moist forest or rainforest. Also found in farmland, usually at the edges of forest or woodland.;1|Primarily eats invertebrates, mainly insects, which are captured whilst hovering or sallying above the canopy or over water. Also frequently hovers, sallies and pounces under the canopy, primarily over leaf litter and dead timber. Also occasionally take nectar, fruit and seed. ;2|Depending on location and local climatic conditions (primarily temperature and rainfall), the dusky woodswallow can be resident year round or migratory. In NSW, after breeding, birds migrate to the north of the state and to southeastern Queensland, while Tasmanian birds migrate to southeastern NSW after breeding. Migrants generally depart between March and May, heading south to breed again in spring. There is some evidence of site fidelity for breeding. Although dusky woodswallows generally breed as solitary pairs or occasionally in small flocks, large flocks may form around abundant food sources in winter. Large flocks may also form before migration, which is often undertaken with other species. ;3|Nest is an open, cup-shape, made of twigs, grass, fibrous rootlets and occasionally casuarina needles, and may be lined with grass, rootlets or infrequently horsehair, occasionally unlined. Nest sites vary greatly, but generally occur in shrubs or low trees, living or dead, horizontal or upright forks in branches, spouts, hollow stumps or logs, behind loose bark or in a hollow in the top of a wooden fence post. Nest sites may be exposed or well concealed by foliage. ;4|
9	*Botaurus poiciloptilus*	Australasian Bittern	Australasian Bitterns are widespread but uncommon over south-eastern Australia. In NSW they may be found over most of the state except for the far north-west.	Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (Typha spp.) and spikerushes (Eleocharis spp.).;1|Hides during the day amongst dense reeds or rushes and feed mainly at night on frogs, fish, yabbies, spiders, insects and snails.;2|Feeding platforms may be constructed over deeper water from reeds trampled by the bird; platforms are often littered with prey remains.;3|Breeding occurs in summer from October to January; nests are built in secluded places in densely-vegetated wetlands on a platform of reeds; there are usually six olive-brown eggs to a clutch.;4|
10	*Burhinus grallarius*	Bush Stone-curlew	The Bush Stone-curlew is found throughout Australia except for the central southern coast and inland, the far south-east corner, and Tasmania. Only in northern Australia is it still common however and in the south-east it is either rare or extinct throughout its former range.	Inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber.;1|Largely nocturnal, being especially active on moonlit nights.;2|Feed on insects and small vertebrates, such as frogs, lizards and snakes.;3|Nest on the ground in a scrape or small bare patch.;4|Two eggs are laid in spring and early summer.;5|

No.	Scientific name	Common name	Availability of habitat in the study area	Likelihood of occurrence in the study area	Assessment of likely interaction with soils at well leases	Forest areas	Pasture areas
5	*Bubulcus ibis*	Cattle Egret	Moderate	Known	This species has recently been delisted as a migratory species under the EPBC Act and is therefore no longer a species of consideration for this assessment	N/A	N/A
6	*Ardea modesta*	Great Egret, White Egret	Moderate	Known	This species has recently been delisted as a migratory species under the EPBC Act and is therefore no longer a species of consideration for this assessment	N/A	N/A
7	*Ardeotis australis*	Australian Bustard	High	Potential	Australian Bustard inhabits grasslands and occasionally open environments such as farmland and golf courses. May utilise rehabilitated low grassy and/or shrubby areas once established (i.e. 1-3 years post rehabilitation)	No	Potential
8	*Artamus cyanopterus cyanopterus*	Dusky Woodswallow	High	Known	Dusky Woodswallow inhabit open forest and woodland and are unlikely to interact with soils within well leases.	No	No
9	*Botaurus poiciloptilus*	Australasian Bittern	Low	Potential	Australasian Bittern forages in well structured vegetated wetlands and roosts in vegetation within or adjoining these wetlands. As such this species is unlikely to interact with soils within well leases.	No	No
10	*Burhinus grallarius*	Bush Stone-curlew	High	Potential	Bush Stone-curlew occur in grassy woodland and open forest and are often recorded in open areas but require sheltered sites for nesting. May utilise rehabilitated sites with grassy woodland vegetation once established (i.e. 1-3 years post rehabilitation).	Potential	No

No.	Scientific name	Common name	TSC Act	EPBC Act	Distribution (OEH, 2016b)	Habitat (OEH, 2016b)
11	*Calidris acuminata*	Sharp-tailed Sandpiper	Not Listed	Marine; Migratory	Spends the non-breeding season in Australia with small numbers occurring regularly in New Zealand. Most of the population migrates to Australia, mostly to the south-east and are widespread in both inland and coastal locations and in both freshwater and saline habitats. Many inland records are of birds on passage (Marchant & Higgins, 1993).	Prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline saltlakes inland. They also occur in saltworks and sewage farms. They use flooded paddocks, sedgelands and other ephemeral wetlands, but leave when they dry (Higgins & Davies, 1996).
12	*Calyptorhynchus lathami*	Glossy Black-Cockatoo	Vulnerable	Not Listed	Uncommon although widespread throughout suitable forest and woodland habitats, from the central Queensland coast to East Gippsland in Victoria, and inland to the southern tablelands and central western plains of NSW, with a small population in the Riverina. An isolated population exists on Kangaroo Island, South Australia	Associated with a variety of open eucalypt forest and woodland types containing a midstorey of sheoaks (*Allocasuarina* spp. and *Casuarina* spp.). This vegetation is usually indicative of the poor nutrient status of underlying soils (S.T. Garnett & Crowley, 2000). In the study area, this species was observed feeding on *Allocasuarina diminuta* subsp. *diminuta* and *Callitris* spp..
13	*Cercartetus nanus*	Eastern Pygmy-possum	Vulnerable	Not Listed	Found in south-eastern Australia, from southern Queensland to eastern South Australia and in Tasmania. In NSW it extends from the coast inland as far as the Pilliga, Dubbo, Parkes and Wagga Wagga on the western slopes.. It occupies small home ranges, rarely greater than 1 ha.	Found in wet and dry eucalypt forest, subalpine woodland, coastal banksia woodland and wet heath (Menkhorst & Knight, 2004). In general woodlands and heath are its preferred habitat. Small tree hollows are favoured for nesting during the day, but nests have also been found under bark, in rotten stumps, holes in the ground, old bird nests, Ringtail Possum drays, thickets of vegetation and in the branch forks of tea-trees (Turner & Ward, 1995).
14	*Chalinolobus dwyeri*	Large-eared Pied Bat	Vulnerable	Vulnerable	Found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. There are scattered records from the New England Tablelands and North West Slopes, including the Southern Pilliga forest area.	Recorded in a variety of habitats, including wet and dry sclerophyll forests, Cyprus Pine dominated forest, woodland, sub-alpine woodland, edges of rainforests and sandstone outcrop country (DotE, 2014c). This species roosts in caves, rock overhangs and disused mine shafts and as such is usually associated with rock outcrops and cliff faces (Churchill, 2008). It also possibly roosts in the hollows of trees (Duncan, Baker, & Montgomery, 1999).
15	*Chalinolobus picatus*	Little Pied Bat	Vulnerable	Not Listed	Found in inland Queensland and NSW (including Western Plains and slopes) extending slightly into South Australia and Victoria. The species has been detected within the study area, predominately in the north-western section of the study area, although the species was also recorded in the south, in Pilliga East State Forest and Bibblewindi State Forest.	Found in a wide range of habitats, including dry open forest, open woodland, mulga woodlands, chenopod shrublands, cypress-pine forest, mallee and Bimbil box woodland. It mainly roosts in tree hollows (G. I. Ford, Pennay, Young, & Richards, 2008), but also uses caves, rock outcrops, mine shafts, tunnel and buildings.

No.	Scientific name	Common name	Distribution (OEH 2020)	Habitat (OEH 2020)
11	*Calidris acuminata*	Sharp-tailed Sandpiper		
12	*Calyptorhynchus lathami*	Glossy Black-Cockatoo	The species is uncommon although widespread throughout suitable forest and woodland habitats, from the central Queensland coast to East Gippsland in Victoria, and inland to the southern tablelands and central western plains of NSW, with a small population in the Riverina. An isolated population exists on Kangaroo Island, South Australia.	Inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of sheoak occur. Black Sheoak (Allocasuarina littoralis) and Forest Sheoak (A. torulosa) are important foods.;1|Inland populations feed on a wide range of sheoaks, including Drooping Sheoak, Allocasuaraina diminuta, and A. gymnathera. Belah is also utilised and may be a critical food source for some populations.;2|In the Riverina, birds are associated with hills and rocky rises supporting Drooping Sheoak, but also recorded in open woodlands dominated by Belah (Casuarina cristata).;3|Feeds almost exclusively on the seeds of several species of she-oak (Casuarina and Allocasuarina species), shredding the cones with the massive bill.;4|Dependent on large hollow-bearing eucalypts for nest sites. A single egg is laid between March and May.;5|
13	*Cercartetus nanus*	Eastern Pygmy-possum	The Eastern Pygmy-possum is found in south-eastern Australia, from southern Queensland to eastern South Australia and in Tasmania. In NSW it extents from the coast inland as far as the Pilliga, Dubbo, Parkes and Wagga Wagga on the western slopes.	Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently encountered in rainforest.;1|Feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes; an important pollinator of heathland plants such as banksias; soft fruits are eaten when flowers are unavailable.;2|Also feeds on insects throughout the year; this feed source may be more important in habitats where flowers are less abundant such as wet forests.;3|Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum (Pseudocheirus peregrinus) dreys or thickets of vegetation, (e.g. grass-tree skirts); nest-building appears to be restricted to breeding females; tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks.;4|Appear to be mainly solitary, each individual using several nests, with males having non-exclusive home-ranges of about 0.68 hectares and females about 0.35 hectares.;5|Young can be born whenever food sources are available, however most births occur between late spring and early autumn.;6|Agile climbers, but can be caught on the ground in traps, pitfalls or postholes; generally nocturnal.;7|Frequently spends time in torpor especially in winter, with body curled, ears folded and internal temperature close to the surroundings.;8|
14	*Chalinolobus dwyeri*	Large-eared Pied Bat	Found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. There are scattered records from the New England Tablelands and North West Slopes.	Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (Petrochelidon ariel), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves and overhangs. They remain loyal to the same cave over many years.;1|Found in well-timbered areas containing gullies.;2|The relatively short, broad wing combined with the low weight per unit area of wing indicates manoeuvrable flight. This species probably forages for small, flying insects below the forest canopy.;3|Likely to hibernate through the coolest months.;4|It is uncertain whether mating occurs early in winter or in spring.;5|
15	*Chalinolobus picatus*	Little Pied Bat	The Little-Pied Bat is found in inland Queensland and NSW (including Western Plains and slopes) extending slightly into South Australia and Victoria.	Occurs in dry open forest, open woodland, mulga woodlands, chenopod shrublands, cypress pine forest and mallee and Bimbil box woodlands.;1|Roosts in caves, rock outcrops, mine shafts, tunnels, tree hollows and buildings.;2|Can tolerate high temperatures and dryness but need access to nearby open water.;3|Feeds on moths and possibly other flying invertebrates.;4|

No.	Scientific name	Common name	Availability of habitat in the study area	Likelihood of occurrence in the study area	Assessment of likely interaction with soils at well leases	Forest areas	Pasture areas
11	*Calidris acuminata*	Sharp-tailed Sandpiper	Low	Potential	Sharp-tailed Sandpiper forages in wetlands with inundated or emergent vegetation. As such this species is unlikely to interact with soils within well leases.	No	No
12	*Calyptorhynchus lathami*	Glossy Black-Cockatoo	High	Known	Glossy Black-Cockatoo inhabits open forest, utilising hollows for breeding and foraging on Allocasuarina spp. and Callitris spp. This species may forage on suitable species once rehabilitation has reached flowering/fruiting stages (i.e. 1-3 years post rehabilitation)	Potential	No
13	*Cercartetus nanus*	Eastern Pygmy-possum	Moderate	Known	The Eastern Pygmy-possum utilises a variety of vegetation types including Box-Ironbark forest and shrubby heathland and are unlikely to interact with soils. May potentially utilise rehabilitated areas where shrubby nectar-producing species are abundant (i.e. 1-3 years post rehabilitation) but are unlikely to interact directly with soils.	Potential	No
14	*Chalinolobus dwyeri*	Large-eared Pied Bat	High	Potential	Large-eared Pied Bat roosts in caves and forages amongst the mid and canopy layers of forest. As such this species is unlikely to interact with soils within well leases.	No	No
15	*Chalinolobus picatus*	Little Pied Bat	High	Known	The Little-Pied Bat occurs in a variety of vegetation types and can utilise a range of structures for roosting, however are unlikely to interact with soils within well leases.	No	No

No.	Scientific name	Common name	TSC Act	EPBC Act	Distribution (OEH, 2016b)	Habitat (OEH, 2016b)
16	*Chthonicola sagittata*	Speckled Warbler	Vulnerable	Not Listed	Patchy distribution throughout south-eastern Queensland, the eastern half of NSW and into Victoria, as far west as the Grampians. The species is most frequently reported from the hills and tablelands of the Great Dividing Range, and rarely from the coast. There has been a decline in population density throughout its range, with the decline exceeding 40% where no vegetation remnants larger than 100ha survive. The Speckled Warbler has been recorded throughout the study area and previous records are throughout the Pilliga (OEH, 2016a).	Occupies a wide range of eucalypt-dominated communities with a grassy understorey, often on rocky ridges or in gullies. Typical habitat includes scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy.
17	*Circus assimilis*	Spotted Harrier	Vulnerable	Not Listed	The Spotted Harrier occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Individuals disperse widely in NSW and comprise a single population .	Occurs in grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.
18	*Daphoenositta chrysoptera*	Varied Sittella	Vulnerable	Not Listed	Widespread in mainland Australia. Distribution in NSW is nearly continuous from the coast to the far west .	Found in eucalypt woodlands and forests throughout their range. They prefer rough-barked trees like stringybarks and ironbarks or mature trees with hollows or dead branches .
19	*Dasyurus maculatus*	Spotted-tailed Quoll	Vulnerable	Endangered	Now found on the east coast of NSW, Tasmania, eastern Victoria and north-eastern Queensland.	Inhabits a range of environments including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Den sites are found in hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces.
20	*Ephippiorhynchus asiaticus*	Black-necked Stork	Endangered	Not Listed	Widespread in coastal and subcoastal northern and eastern Australia, south to central-eastern NSW and with vagrants recorded at scattered sites well away from the coast (for example, near Moree, north-east of Hay and in Victoria). In NSW, the species becomes more uncommon south of the Northern Rivers region, and rarely occurs south of Sydney . Recorded at Yarrie Lake by Central Coast Bird Observers in 2012 (OEH, 2016a).	Associated with tropical and warm temperate terrestrial wetlands, estuarine and littoral habitats, and occasionally woodlands and grasslands floodplains (Marchant & Higgins, 1993). Forages in fresh or saline waters up to 0.5m deep, mainly in open fresh waters, extensive sheets of shallow water over grasslands or sedgeland, mangroves, mudflats, shallow swamps with short emergent vegetation and permanent billabongs and pools on floodplains (Marchant & Higgins, 1993).

No.	Scientific name	Common name	Distribution (OEH 2020)	Habitat (OEH 2020)
16	*Chthonicola sagittata*	Speckled Warbler	The Speckled Warbler has a patchy distribution throughout south-eastern Queensland, the eastern half of NSW and into Victoria, as far west as the Grampians. The species is most frequently reported from the hills and tablelands of the Great Dividing Range, and rarely from the coast. There has been a decline in population density throughout its range, with the decline exceeding 40% where no vegetation remnants larger than 100ha survive.	The Speckled Warbler lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies.;1|Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy.;2|Large, relatively undisturbed remnants are required for the species to persist in an area.;3|The diet consists of seeds and insects, with most foraging taking place on the ground around tussocks and under bushes and trees.;4|Pairs are sedentary and occupy a breeding territory of about ten hectares, with a slightly larger home-range when not breeding.;5|The rounded, domed, roughly built nest of dry grass and strips of bark is located in a slight hollow in the ground or the base of a low dense plant, often among fallen branches and other litter. A side entrance allows the bird to walk directly inside.;6|A clutch of 3-4 eggs is laid, between August and January, and both parents feed the nestlings. The eggs are a glossy red-brown, giving rise to the unusual folk names ‘Blood Tit’ and ‘Chocolatebird’.;7|Some cooperative breeding occurs. The species may act as host to the Black-eared Cuckoo.;8|Speckled Warblers often join mixed species feeding flocks in winter, with other species such as Yellow-rumped, Buff-rumped, Brown and Striated Thornbills.;9|
17	*Circus assimilis*	Spotted Harrier	The Spotted Harrier occurs throughout the Australian mainland, except in densly forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Individuals disperse widely in NSW and comprise a single population.	Occurs in grassy open woodland including Acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.;1|Builds a stick nest in a tree and lays eggs in spring (or sometimes autumn), with young remaining in the nest for several months.;2|Preys on terrestrial mammals (eg bandicoots, bettongs, and rodents), birds and reptile, occasionally insects and rarely carrion.;3|
18	*Daphoenositta chrysoptera*	Varied Sittella	The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands. Distribution in NSW is nearly continuous from the coast to the far west. The Varied Sittella's population size in NSW is uncertain but is believed to have undergone a moderate reduction over the past several decades.	Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland.;1|Feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy.;2|Builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years.;3|Generation length is estimated to be 5 years.;4|
19	*Dasyurus maculatus*	Spotted-tailed Quoll	The range of the Spotted-tailed Quoll has contracted considerably since European settlement. It is now found in eastern NSW, eastern Victoria, south-east and north-eastern Queensland, and Tasmania. Only in Tasmania is it still considered relatively common.	Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline.;1|Quolls use hollow-bearing trees, fallen logs, other animal burrows, small caves and rock outcrops as den sites.;2|Mostly nocturnal, although will hunt during the day; spend most of the time on the ground, although also an excellent climber and will hunt possums and gliders in tree hollows and prey on roosting birds.;3|Use communal ‘latrine sites’, often on flat rocks among boulder fields, rocky cliff-faces or along rocky stream beds or banks. Such sites may be visited by multiple individuals and can be recognised by the accumulation of the sometimes characteristic ‘twisty-shaped’ faeces deposited by animals.;4|A generalist predator with a preference for medium-sized (500g-5kg) mammals. Consumes a variety of prey, including gliders, possums, small wallabies, rats, birds, bandicoots, rabbits, reptiles and insects. Also eats carrion and takes domestic fowl.;5|Females occupy home ranges of 200-500 hectares, while males occupy very large home ranges from 500 to over 4000 hectares. Are known to traverse their home ranges along densely vegetated creeklines.;6|Average litter size is five; both sexes mature at about one year of age. Life expectancy in the wild is about 3-4 years.;7|
20	*Ephippiorhynchus asiaticus*	Black-necked Stork	The species Ephippiorhynchus asiaticus comprises two subspecies, E. a. asiaticus in India and south-east Asia, and E. a. australis in Australia and New Guinea. In Australia, Black-necked Storks are widespread in coastal and subcoastal northern and eastern Australia, as far south as central NSW (although vagrants may occur further south or inland, well away from breeding areas). In NSW, the species becomes increasingly uncommon south of the Clarence Valley, and rarely occurs south of Sydney. Since 1995, breeding has been recorded as far south as Buladelah.	Floodplain wetlands (swamps, billabongs, watercourses and dams) of the major coastal rivers are the key habitat in NSW for the Black-necked Stork. Secondary habitat includes minor floodplains, coastal sandplain wetlands and estuaries.;1|Storks usually forage in water 5-30cm deep for vertebrate and invertebrate prey. Eels regularly contribute the greatest biomass to their diet, but they feed on a wide variety of animals, including other fish, frogs and invertebrates (such as beetles, grasshoppers, crickets and crayfish).;2|Black-necked Storks build large nests high in tall trees close to water. Trees usually provide clear observation of the surroundings and are at low elevation (reflecting the floodplain habitat).;3|In NSW, breeding activity occurs May - January; incubation May - October; nestlings July - January; fledging from September. Parents share nest duties and in one study about 1.3-1.7 birds were fledged per nest.;4|The NSW breeding population has been estimated at about 75 pairs. Territories are large and variable in size. They have been estimated to average about 9,000ha, ranging from 3,000-6,000ha in high quality habitat and 10,000-15,000ha in areas where habitat is poor or dispersed.;5|

No.	Scientific name	Common name	Availability of habitat in the study area	Likelihood of occurrence in the study area	Assessment of likely interaction with soils at well leases	Forest areas	Pasture areas
16	*Chthonicola sagittata*	Speckled Warbler	High	Known	Speckled Warbler utilise grassy Eucalypt woodlands often associated with rocky ridges or gullies and require large, relatively undisturbed remnants thus are unlikely to interact with soils within well leases.	No	No
17	*Circus assimilis*	Spotted Harrier	Moderate	Known	The Spotted Harrier mostly occurs in grassy open woodland but also may utilise open farmland and inland wetlands for foraging, therefore the Spotted Harrier may indirectly interact with soils at well leases by foraging around these areas, particularly at rehabilitated sites once prey becomes available (i.e. 1-3 years post rehabilitation)	Potential	Potential
18	*Daphoenositta chrysoptera*	Varied Sittella	High	Known	The Varied Sittella utilises eucalypt woodlands, foraging around trees in tree bark, tree canopies and standing dead trees, therefore is unlikely to interact with soils within well leases.	No	No
19	*Dasyurus maculatus*	Spotted-tailed Quoll	Moderate	Potential	Spotted-tailed Quoll is a carnivorous mammal which forages on a wide range of species across its home range and lives in dens in rocky areas, logs or trees. This species is likely to avoid open disturbed areas when areas of contiguous habitat are available in surrounding areas.	No	No
20	*Ephippiorhynchus asiaticus*	Black-necked Stork	Low	Known	The Black-Necked Stork utilises wetlands and have potential to forage in well leases once suitable grassy rehabilitation has been achieved once prey becomes available (i.e. 1-3 years post rehabilitation)	No	Potential

Source: Eco Logical Australia Pty Ltd. E-mail correspondence to Santos Ltd dated December 21, 2020.

No.	Scientific name	Common name	TSC Act	EPBC Act	Distribution (OEH, 2016b)	Habitat (OEH, 2016b)
21	*Falco hypoleucos*	Grey Falcon	Endangered	Not Listed	Found throughout the arid and semi-arid zones of Australia. It is sparsely distributed in NSW, found chiefly throughout the Murray-Darling Basin, with the occasional vagrant east of the Great Dividing Range.	Usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions, although it is occasionally found in open woodlands near the coast. Also occurs near wetlands where surface water attracts prey .
22	*Falco subniger*	Black Falcon	Vulnerable	Not Listed	Widely but sparsely distributed in NSW, occurring mostly in inland regions. In New South Wales there is assumed to be a single population that is continuous with a broader continental population, given that falcons are highly mobile, commonly travelling hundreds of kilometres (Marchant & Higgins, 1993).	Inhabits woodland, shrubland and grassland in the arid and semi-arid zones, especially wooded watercourses and agricultural land with scattered remnant trees. The Black Falcon is usually associated with streams or wetlands, visiting them in search of prey and often using standing dead trees as lookout posts.
23	*Gallinago hardwickii*	Latham's Snipe, Japanese Snipe	Not Listed	Marine; Migratory	Recorded along the east coast of Australia from Cape York Peninsula through to south-eastern South Australia. The range extends inland over the eastern tablelands in south-eastern Queensland (and occasionally from Rockhampton in the north), and to west of the Great Dividing Range in New South Wales (DotE, 2014c).	Occurs in permanent and ephemeral wetlands up to 2000 m above sea-level, usually inhabiting open, freshwater wetlands with low, dense vegetation such as swamps, flooded grasslands or heathlands, around bogs and other water bodies. This species can also occur in habitats with saline or brackish water and in modified or artificial habitats.
24	*Glossopsitta pusilla*	Little Lorikeet	Vulnerable	Not Listed	Distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia. NSW provides a large portion of the species' core habitat, with lorikeets found westward as far as Dubbo and Albury. Nomadic movements are common, influenced by season and food availability, although some areas retain residents for much of the year and 'locally nomadic' movements are suspected of breeding pairs .	Mostly occur in dry, open eucalypt forests and woodlands. They have been recorded from both old-growth and logged forests in the eastern part of their range, and in remnant woodland patches and roadside vegetation on the western slopes. They feed primarily on nectar and pollen in the tree canopy, particularly on profusely-flowering eucalypts, but also on a variety of other species including melaleucas and mistletoes. On the western slopes and tablelands Eucalyptus albens and E. melliodora are important food sources for pollen and nectar respectively.
25	*Grantiella picta*	Painted Honeyeater	Vulnerable	Vulnerable	Occurs at low densities throughout its range. The greatest concentrations of the bird (and almost all breeding), occurs on the inland slopes of the Great Dividing Range in NSW, Victoria and southern QLD. During the winter it is more likely to be found in the north of its distribution	Inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. It feeds on mistletoes growing on woodland eucalypts and acacias. It nests from spring to autumn in a small, delicate nest hanging within the outer canopy of drooping eucalypts, she-oak, paperbark or mistletoe branches.
26	*Grus rubicunda*	Brolga	Vulnerable	Not Listed	Formerly found across Australia, except for the south-east corner, Tasmania and the south-western third of the country. It still abundant in the northern tropics, but very sparse across the southern part of its range .	Inhabits large open wetlands (including ephemeral and permanent swamps), grassy plains, coastal mudflats and irrigated croplands and, on the coast, mangrove-studded creeks and estuaries. It is less common in arid and semi-arid regions, but will occur close to water in these areas. Brolgas will feed in dry grassland or ploughed paddocks; however, they also depend on access to wetland habitats.

No.	Scientific name	Common name	Distribution (OEH 2020)	Habitat (OEH 2020)
21	*Falco hypoleucos*	Grey Falcon	The Grey Falcon is sparsely distributed in NSW, chiefly throughout the Murray-Darling Basin, with the occasional vagrant east of the Great Dividing Range. The breeding range has contracted since the 1950s with most breeding now confined to arid parts of the range. There are possibly less than 5000 individuals left. Population trends are unclear, though it is believed to be extinct in areas with more than 500mm rainfall in NSW.	Usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions, although it is occasionally found in open woodlands near the coast.;1|Also occurs near wetlands where surface water attracts prey.;2|Preys primarily on birds, especially parrots and pigeons, using high-speed chases and stoops; reptiles and mammals are also taken.;3|Like other falcons it utilises old nests of other birds of prey and ravens, usually high in a living eucalypt near water or a watercourse; peak laying season is in late winter and early spring; two or three eggs are laid.;4|
22	*Falco subniger*	Black Falcon	The Black Falcon is widely, but sparsely, distributed in New South Wales, mostly occurring in inland regions. Some reports of 'Black Falcons' on the tablelands and coast of New South Wales are likely to be referable to the Brown Falcon. In New South Wales there is assumed to be a single population that is continuous with a broader continental population, given that falcons are highly mobile, commonly travelling hundreds of kilometres (Marchant & Higgins 1993). The Black Falcon occurs as solitary individuals, in pairs, or in family groups of parents and offspring.	
23	*Gallinago hardwickii*	Latham's Snipe, Japanese Snipe		
24	*Glossopsitta pusilla*	Little Lorikeet	The Little Lorikeet is distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia. NSW provides a large portion of the species' core habitat, with lorikeets found westward as far as Dubbo and Albury. Nomadic movements are common, influenced by season and food availability, although some areas retain residents for much of the year and 'locally nomadic' movements are suspected of breeding pairs.	Forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in Angophora, Melaleuca and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity.;1|Isolated flowering trees in open country, e.g. paddocks, roadside remnants and urban trees also help sustain viable populations of the species.;2|Feeds mostly on nectar and pollen, occasionally on native fruits such as mistletoe, and only rarely in orchards;3|Gregarious, travelling and feeding in small flocks (<10), though often with other lorikeets. Flocks numbering hundreds are still occasionally observed and may have been the norm in past centuries.;4|Roosts in treetops, often distant from feeding areas.;5|Nests in proximity to feeding areas if possible, most typically selecting hollows in the limb or trunk of smooth-barked Eucalypts. Entrance is small (3 cm) and usually high above the ground (2–15 m). These nest sites are often used repeatedly for decades, suggesting that preferred sites are limited. Riparian trees often chosen, including species like Allocasuarina.;6|Nesting season extends from May to September. In years when flowering is prolific, Little Lorikeet pairs can breed twice, producing 3-4 young per attempt. However, the survival rate of fledglings is unknown.;7|
25	*Grantiella picta*	Painted Honeyeater	The Painted Honeyeater is nomadic and occurs at low densities throughout its range. The greatest concentrations of the bird and almost all breeding occurs on the inland slopes of the Great Dividing Range in NSW, Victoria and southern Queensland. During the winter it is more likely to be found in the north of its distribution.	Inhabits Boree/ Weeping Myall (Acacia pendula), Brigalow (A. harpophylla) and Box-Gum Woodlands and Box-Ironbark Forests.;1|A specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus Amyema.;2|Insects and nectar from mistletoe or eucalypts are occasionally eaten.;3|Nest from spring to autumn in a small, delicate nest hanging within the outer canopy of drooping eucalypts, she-oak, paperbark or mistletoe branches.;4|
26	*Grus rubicunda*	Brolga	The Brolga was formerly found across Australia, except for the south-east corner, Tasmania and the south-western third of the country. It is still abundant in the northern tropics, but very sparse across the southern part of its range.	Though Brolgas often feed in dry grassland or ploughed paddocks or even desert claypans, they are dependent on wetlands too, especially shallow swamps, where they will forage with their head entirely submerged.;1|They feed using their heavy straight bill as a 'crowbar' to probe the ground or turn it over, primarily on sedge roots and tubers. They will also take large insects, crustaceans, molluscs and frogs.;2|The famous Brolga 'dance' is apparently at least in part a courtship or bonding display where a pair or many pairs face each other, crouch down and stretch upwards, trumpet, leap and toss grass and sticks into the air.;3|The nest comprises a platform of grasses and sticks, augmented with mud, on an island or in the water. Two eggs are laid from winter to autumn.;4|

No.	Scientific name	Common name	Availability of habitat in the study area	Likelihood of occurrence in the study area	Assessment of likely interaction with soils at well leases	Forest areas	Pasture areas
21	*Falco hypoleucos*	Grey Falcon	Moderate	Potential	The Grey Falcon forages across a wide range of habitats and may indirectly interact with soils at well leases by foraging around these areas, particularly at rehabilitated sites once prey becomes available (i.e. 1-3 years post rehabilitation)	Potential	Potential
22	*Falco subniger*	Black Falcon	Moderate	Known	The Black Falcon utilise wetlands for foraging where surface water attracts prey, therefore may indirectly interact with soils at well leases once prey becomes available (i.e. 1-3 years post rehabilitation)	Potential	Potential
23	*Gallinago hardwickii*	Latham's Snipe, Japanese Snipe	Low	Potential	Latham's Snipe forages in well structured vegetated wetlands. As such this species is unlikely to interact with soils within well leases.	No	No
24	*Glossopsitta pusilla*	Little Lorikeet	High	Known	The Little Lorikeet feed mostly on nectar, pollen and occasionally fruits, roosting in treetops in open Eucalypt woodland and nesting in hollows. Therefore, the Little Lorikeet is unlikely to interact with soils within well leases.	No	No
25	*Grantiella picta*	Painted Honeyeater	High	Known	The Painted Honeyeater occurs in woodlands and open forests, feeding on mistletoes which generally occur on mature trees, therefore are unlikely to interact with soils within well leases	No	No
26	*Grus rubicunda*	Brolga	Low	Potential	The Brolga forages in well structured vegetated wetlands as well as grassy plains and croplands. As such this species is unlikely to interact with soils within well leases until rehabilitation is sufficiently advanced (i.e. 1-3 years post rehabilitation)	No	Potential

No.	Scientific name	Common name	TSC Act	EPBC Act	Distribution (OEH, 2016b)	Habitat (OEH, 2016b)
27	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	Vulnerable	Not Listed	Distributed along the coastline of mainland Australia and Tasmania. It also extends inland along some of the larger waterways, especially in eastern Australia. The inland limits of the species are most restricted in south-central and south-western Australia, where it is confined to a narrow band along the coast (DotE, 2014c).	Areas of large open water bodies. It has been recorded at or in the vicinity of freshwater swamps, rivers, lakes, reservoirs, billabongs, saltmarsh and sewage ponds, as well as coastal waters. Terrestrial habitats include coastal dunes, tidal flats, grassland, heathland, woodland, forest and even urban areas.
28	*Hamirostra melanosternon*	Black-breasted Buzzard	Vulnerable	Not Listed	Found sparsely in areas of less than 500 mm rainfall, from north-western NSW and north-eastern South Australia to the east coast at about Rockhampton, then across northern Australia south almost to Perth, avoiding only the Western Australian deserts .	Lives in a range of inland habitats including open forests, riverine woodlands, scrubs and heathlands. It is often found along timbered watercourses, which is preferred breeding habitat. It can also hunt over grasslands.
29	*Hieraaetus morphnoides*	Little Eagle	Vulnerable	Not Listed	Found throughout the Australian mainland excepting the most densely forested parts of the Dividing Range escarpment. It occurs as a single population throughout NSW .	Known over woodland and forested lands and open country, extending into the arid zone. It tends to avoid rainforest and heavy forest .It occupies open eucalypt forest, Sheoak and Acacia woodland and riparian woodland within inland NSW. It favours tall living trees for nesting in remnant habitat.
30	*Hirundapus caudacutus*	White-throated Needletail	Not Listed	Vulnerable	Found throughout eastern and south-eastern Australia. In eastern NSW, it is found to extend inland to the western slopes of the Great Divide and occasionally to the adjacent inland plains (DotE, 2014c).	In Australia, this species is almost exclusively aerial and found over most types of habitat (DotE, 2014c). No breeding habitat in southern hemisphere.
31	*Hoplocephalus bitorquatus*	Pale-headed Snake	Vulnerable	Not Listed	A patchy distribution from north-east Queensland to north-east NSW. In NSW it occurs from the coast to the western side of the Great Divide as far south as Tuggerah . Historically been recorded in NSW as west as Mungindi and Quambone on the Darling Riverine Plains, across North West Slopes; also form the New England Tablelands.	Wide range of habitats from rain or wet sclerophyll forest to drier eucalypt forests and favours streamside habitat in drier areas. In the study area the species has been found in redgum communities at Yarrie Lake, remnant roadside and regrowth Brigalow vegetation communities.
32	*Lathamus discolor*	Swift Parrot	Endangered	Critically Endangered	Breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW mostly occurs on the coast and south west slopes .	On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as *Eucalyptus robusta* , *Corymbia maculata* , *C. gummifera* , *E. sideroxylon* and *E. albens* Commonly used lerp infested trees include *E. microcarpa, E. moluccana and E. pilularis* .

No.	Scientific name	Common name	Distribution (OEH 2020)	Habitat (OEH 2020)
27	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	The White-bellied Sea-eagle is distributed around the Australian coastline, including Tasmania, and well inland along rivers and wetlands of the Murray Darling Basin. In New South Wales it is widespread along the east coast, and along all major inland rivers and waterways. <o:p></o:p> <o:p></o:p>	Habitats are characterised by the presence of large areas of open water including larger rivers, swamps, lakes, and the sea.;1|Occurs at sites near the sea or sea-shore, such as around bays and inlets, beaches, reefs, lagoons, estuaries and mangroves; and at, or in the vicinity of freshwater swamps, lakes, reservoirs, billabongs and saltmarsh. ;2|Terrestrial habitats include coastal dunes, tidal flats, grassland, heathland, woodland, and forest (including rainforest). ;3|Breeding habitat consists of mature tall open forest, open forest, tall woodland, and swamp sclerophyll forest close to foraging habitat. Nest trees are typically large emergent eucalypts and often have emergent dead branches or large dead trees nearby which are used as ‘guard roosts’. Nests are large structures built from sticks and lined with leaves or grass. ;4|Feed mainly on fish and freshwater turtles, but also waterbirds, reptiles, mammals and carrion.;5|Hunts its prey from a perch or whilst in flight (by circling slowly, or by sailing along 10–20 m above the shore). Prey is usually carried to a feeding platform or (if small) consumed in flight, but some items are eaten on the ground.;6|May be solitary, or live in pairs or small family groups consisting of a pair of adults and dependent young. ;7|Typically lays two eggs between June and September with young birds remaining in the nest for 65-70 days.;8|
28	*Hamirostra melanosternon*	Black-breasted Buzzard	The Black-breasted Buzzard is found sparsely in areas of less than 500mm rainfall, from north-western NSW and north-eastern South Australia to the east coast at about Rockhampton, then across northern Australia south almost to Perth, avoiding only the Western Australian deserts.	Lives in a range of inland habitats, especially along timbered watercourses which is the preferred breeding habitat.;1|Also hunts over grasslands and sparsely timbered woodlands.;2|Not a powerful hunter, despite its size, mostly taking reptiles, small mammals, birds, including nestlings, and carrion.;3|Also specialises in feeding on large eggs, including those of emus, which it cracks on a rock.;4|Breeds from August to October near water in a tall tree. The stick nest is large and flat and lined with green leaves. Normally two eggs are laid.;5|
29	*Hieraaetus morphnoides*	Little Eagle	The Little Eagle is found throughout the Australian mainland excepting the most densely forested parts of the Dividing Range escarpment. It occurs as a single population throughout NSW.	Occupies open eucalypt forest, woodland or open woodland. Sheoak or Acacia woodlands and riparian woodlands of interior NSW are also used.;1|Nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter.;2|Lays two or three eggs during spring, and young fledge in early summer.;3|Preys on birds, reptiles and mammals, occasionally adding large insects and carrion.;4|
30	*Hirundapus caudacutus*	White-throated Needletail		
31	*Hoplocephalus bitorquatus*	Pale-headed Snake	A patchy distribution from north-east Queensland to the north-eastern quarter of NSW. In NSW it has historically been recorded from as far west as Mungindi and Quambone on the Darling Riverine Plains, across the north west slopes, and from the north coast from Queensland to Sydney. A small number of historical records are known for the New England Tablelands from Glenn Innes and Tenterfield; however, the majority of records appear to be from sites of relatively lower elevation. Although the Pale-headed snake distribution is very cryptic, it now appears to have contracted to a patchy and fragmented distribution.	The Pale-headed Snake is a highly cryptic species that can spend weeks at a time hidden in tree hollows.;1|Found mainly in dry eucalypt forests and woodlands, cypress forest and occasionally in rainforest or moist eucalypt forest.;2|In drier environments, it appears to favour habitats close to riparian areas.;3|Shelter during the day between loose bark and tree-trunks, or in hollow trunks and limbs of dead trees.;4|The main prey is tree frogs although lizards and small mammals are also taken.;5|The Pale-headed Snake is relatively unusual amongst elapid snakes in that it is well adapted to climbing trees.;6|
32	*Lathamus discolor*	Swift Parrot	Breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW mostly occurs on the coast and south west slopes. You can help map Distribution and Habitat Each year the Swift Parrot Recovery Team relies on the involvement of volunteers to identify areas the birds are visiting and what resources they are using. This information directly helps the recovery effort for this species. Surveys are conducted twice a year and aim to cover the migratory winter range of this species. Mainland surveys are held on the 3rd weekend in May and the first weekend in August every year. All information helps and the Recovery Team is also very interested to receive sighting information of these birds outside the survey dates. Surveys are run in combination with the Regent Honeyeater survey effort, another Endangered migratory woodland bird. Please contact the relevant coordinator for your state (specified below) and let us know which sites you would like to survey or to request some suggestions for new sites to explore. Survey sheets and instructions can be downloaded from the 'Related Information' pane on the left hand side of your screen. The Swift Parrot Volunteer Survey Coordinators are: Victoria/NSW/ACT/Qld/SA - Chris Tzaros (Birds Australia) freecall 1800 66 57 66 or 03 9347 0757 e-mail c.tzaros@birdsaustralia.com.au Tasmania - Matt Webb (Department of Primary Industries and Water, Tas) ph 03 6233 6952, e-mail matthew.webb@dpiw.tas.gov.au	Migrates to the Australian south-east mainland between February and October.;1|On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations.;2|Favoured feed trees include winter flowering species such as Swamp Mahogany Eucalyptus robusta, Spotted Gum Corymbia maculata, Red Bloodwood C. gummifera, Forest Red Gum E. tereticornis, Mugga Ironbark E. sideroxylon, and White Box E. albens.;3|Commonly used lerp infested trees include Inland Grey Box E. microcarpa, Grey Box E. moluccana, Blackbutt E. pilularis, and Yellow Box E. melliodora.;4|Return to some foraging sites on a cyclic basis depending on food availability.;5|Following winter they return to Tasmania where they breed from September to January, nesting in old trees with hollows and feeding in forests dominated by Tasmanian Blue Gum Eucalyptus globulus.;6|

No.	Scientific name	Common name	Availability of habitat in the study area	Likelihood of occurrence in the study area	Assessment of likely interaction with soils at well leases	Forest areas	Pasture areas
27	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	Moderate	Known (Note that this species was removed from the migratory list in the EPBC Act on 30 June 2015 and hence doesn't need assessment of significance using EPBC Act)	White-bellied Sea-Eagle forages across large open water bodies where suitable prey occur. As such this species is unlikely to interact with soils within well leases.	No	No
28	*Hamirostra melanosternon*	Black-breasted Buzzard	Low	Potential	The Black-breasted Buzzard utilises open forests and grasslands for foraging. There is potential for indirect interaction with soils where prey (such as reptiles) has interacted with these materials, with most potential occurring on newly rehabilitated well leases (i.e. 1-3 years post rehabilitation)	Potential	Potential
29	*Hieraaetus morphnoides*	Little Eagle	High	Known	The Little Eagle utilises woodlands and open forests for foraging, utilising tall living trees for nesting. There is potential for indirect interaction with soils where prey (such as reptiles) has interacted with these materials once rehabilitation has established (i.e. 1-3 years post rehabilitation)	Potential	No
30	*Hirundapus caudacutus*	White-throated Needletail	High	Known	White-throated Needletail is an almost exclusive aerial species, foraging aerially. As such this species is unlikely to interact with soils within well leases.	No	No
31	*Hoplocephalus bitorquatus*	Pale-headed Snake	High	Known	The Pale-headed Snake utilises open forest near riparian areas or sources of water. The Pale-headed Snake may indirectly interact with soils through preying on frogs which may occur following successful rehabilitation (i.e. 1-3 years post rehabilitation)	Potential	No
32	*Lathamus discolor*	Swift Parrot	High	Potential	Swift Parrot forages in woodland and forest within the mid and canopy layers. As such this species is unlikely to interact with soils within well leases.	No	No

No.	Scientific name	Common name	TSC Act	EPBC Act	Distribution (OEH, 2016b)	Habitat (OEH, 2016b)
33	*Lophoictinia isura*	Square-tailed Kite	Vulnerable	Not Listed	Ranges along coastal and subcoastal areas from south-western to northern Australia, Queensland, NSW and Victoria. In NSW, scattered records of the species throughout the state indicate that it is a regular resident in the north, north-east and along the major west-flowing river systems.	Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses. In arid north-western NSW, has been observed in stony country with a ground cover of chenopods and grasses, open acacia scrub and patches of low open eucalypt woodland.
34	*Macropus dorsalis*	Black-striped Wallaby	Endangered	Not Listed	From the Townsville area in Queensland to northern NSW where it occurs on both sides of the Great Divide. On the North West Slopes of NSW it occurs to south of Narrabri. On the north coast it is confined to the upper catchments of the Clarence and Richmond Rivers.	Preferred habitat is characterised by dense woody or shrubby vegetation within three metres of the ground. This dense vegetation must occur near a more open, grassy area to provide suitable feeding habitat. On the North West Slopes, it is associated with dense vegetation, including brigalow, ooline and semi-evergreen vine thicket.
35	*Melanodryas cucullata cucullata*	Hooded Robin (south-eastern form)	Vulnerable	Not Listed	The Hooded Robin is, found across Australia, except for the driest deserts and the wetter coastal areas - northern and eastern coastal Queensland and Tasmania. However, it is common in few places, and rarely found on the coast. The south-eastern form (subspecies cucullata is found from Brisbane to Adelaide and throughout much of inland NSW, with the exception of the extreme north-west, where it is replaced by subsp. picata.	Associated with a wide range of Eucalypt woodlands, Acacia shrubland and open forests. In temperate woodlands, the species favours open areas adjoining large woodland blocks, with areas of dead timber and sparse shrub cover.
36	*Melithreptus gularis gularis*	Black-chinned Honeyeater (eastern subspecies)	Vulnerable	Not Listed	This subspecies extends south from central Queensland, through NSW, Victoria into south eastern SA. In NSW it is widespread, with records from the tablelands and western slopes of the Great Dividing Range to the north-west and central-west plains and the Riverina. It is rarely recorded east of the Great Dividing Range, although regularly observed from the Richmond and Clarence River areas. It has also been recorded at a few scattered sites in the Hunter, Central Coast and Illawarra regions.	Predominantly associated with box-ironbark association woodlands, especially Eucalyptus sideroxylon, *E. albens, E. microcarpa* and *E. tereticornis* . Also inhabits open forests of smooth-barked gums, stringybarks, ironbarks and tea-trees, and River Red Gum .
37	*Merops ornatus*	Rainbow Bee-eater	Not Listed	Marine	Distributed across much of mainland Australia, and occurs on several near-shore islands. It is not found in Tasmania, and is thinly distributed in the most arid regions of central and Western Australia (DotE, 2014c).	Occurs in open country, chiefly at suitable breeding places in areas of sandy or loamy soil: sand-ridges, riverbanks, road-cuttings, sand-pits, occasionally coastal cliffs.
38	*Miniopterus schreibersii oceanensis*	Eastern Bentwing-bat	Vulnerable	Not Listed	Occur along the east and north-west coasts of Australia. There are capture records for the Kaputar Ranges to the north-east of the study area and previous records for west and south of the study area (OEH, 2016a).	Associated with a range of habitats: rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grassland (Churchill, 2008). It forages above and below the tree canopy (Dwyer, 1981, 1995).
39	*Myiagra cyanoleuca*	Satin Flycatcher	Not Listed	Marine; Migratory	In NSW, they are widespread on and east of the Great Divide and sparsely scattered on the western slopes, with very occasional records on the western plains (DotE, 2014c).	Inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests (DotE, 2014c).
40	*Neophema pulchella*	Turquoise Parrot	Vulnerable	Not Listed	Range extends from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range .	Steep rocky ridges and gullies, rolling hills, valleys and river flats and the plains of the Great Dividing Range compromise the topography inhabited by this species (Marchant & Higgins, 1993).

Source: Eco Logical Australia Pty Ltd. E-mail correspondence to Santos Ltd dated December 21, 2020.

No.	Scientific name	Common name	Distribution (OEH 2020)	Habitat (OEH 2020)
33	*Lophoictinia isura*	Square-tailed Kite	The Square-tailed Kite ranges along coastal and subcoastal areas from south-western to northern Australia, Queensland, NSW and Victoria. In NSW, scattered records of the species throughout the state indicate that the species is a regular resident in the north, north-east and along the major west-flowing river systems. It is a summer breeding migrant to the south-east, including the NSW south coast, arriving in September and leaving by March.	Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses.;1|In arid north-western NSW, has been observed in stony country with a ground cover of chenopods and grasses, open acacia scrub and patches of low open eucalypt woodland.;2|Is a specialist hunter of passerines, especially honeyeaters, and most particularly nestlings, and insects in the tree canopy, picking most prey items from the outer foliage.;3| Appears to occupy large hunting ranges of more than 100km2.;4|Breeding is from July to February, with nest sites generally located along or near watercourses, in a fork or on large horizontal limbs.;5|
34	*Macropus dorsalis*	Black-striped Wallaby	From the Townsville area in Queensland to northern NSW where it occurs on both sides of the Great Divide. On the north west slopes of NSW it occurs in Brigalow remnants to south of Narrabri. On the north coast it is confined to the upper catchments of the Clarence and Richmond Rivers.	Preferred habitat is characterised by dense woody or shrubby vegetation within three metres of the ground. This dense vegetation must occur near a more open, grassy area to provide suitable feeding habitat.;1|On the north west slopes, associated with dense vegetation, including brigalow, ooline and semi-evergreen vine thicket.;2|On the north coast, closely associated with dry rainforest but also occur in moist eucalypt forest with a rainforest understorey or a dense shrub layer.;3|
35	*Melanodryas cucullata cucullata*	Hooded Robin (south-eastern form)	The Hooded Robin is widespread, found across Australia, except for the driest deserts and the wetter coastal areas - northern and eastern coastal Queensland and Tasmania. However, it is common in few places, and rarely found on the coast. It is considered a sedentary species, but local seasonal movements are possible. The south-eastern form (subspecies cucullata) is found from Brisbane to Adelaide and throughout much of inland NSW, with the exception of the extreme north-west, where it is replaced by subspecies picata. Two other subspecies occur outside NSW.	Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas.;1|Requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses.;2|Often perches on low dead stumps and fallen timber or on low-hanging branches, using a perch-and-pounce method of hunting insect prey.;3|Territories range from around 10 ha during the breeding season, to 30 ha in the non-breeding season.;4|May breed any time between July and November, often rearing several broods.;5|The nest is a small, neat cup of bark and grasses bound with webs, in a tree fork or crevice, from less than 1 m to 5 m above the ground.;6|The nest is defended by both sexes with displays of injury-feigning, tumbling across the ground.;7|A clutch of two to three is laid and incubated for fourteen days by the female. Two females often cooperate in brooding.;8|
36	*Melithreptus gularis gularis*	Black-chinned Honeyeater (eastern subspecies)	The Black-chinned Honeyeater has two subspecies, with only the nominate (gularis) occurring in NSW. The other subspecies (laetior) was formerly considered a separate species (Golden-backed Honeyeater) and is found in northern Australia between central Queensland west to the Pilbara in Western Australia. The eastern subspecies extends south from central Queensland, through NSW, Victoria into south eastern South Australia, though it is very rare in the last state. In NSW it is widespread, with records from the tablelands and western slopes of the Great Dividing Range to the north-west and central-west plains and the Riverina. It is rarely recorded east of the Great Dividing Range, although regularly observed from the Richmond and Clarence River areas. It has also been recorded at a few scattered sites in the Hunter, Central Coast and Illawarra regions, though it is very rare in the latter.	Occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark (Eucalyptus sideroxylon), White Box (E. albens), Inland Grey Box (E. microcarpa), Yellow Box (E. melliodora), Blakely's Red Gum (E. blakelyi) and Forest Red Gum (E. tereticornis).;1|Also inhabits open forests of smooth-barked gums, stringybarks, ironbarks, river sheoaks (nesting habitat) and tea-trees.;2|A gregarious species usually seen in pairs and small groups of up to 12 birds.;3|Feeding territories are large making the species locally nomadic. Recent studies have found that the Black-chinned Honeyeater tends to occur in the largest woodland patches in the landscape as birds forage over large home ranges of at least 5 hectares.;4|Moves quickly from tree to tree, foraging rapidly along outer twigs, underside of branches and trunks, probing for insects. Nectar is taken from flowers, and honeydew is gleaned from foliage.;5|Breeds solitarily or co-operatively, with up to five or six adults, from June to December.;6|The nest is placed high in the crown of a tree, in the uppermost lateral branches, hidden by foliage. It is a compact, suspended, cup-shaped nest.;7|Two or three eggs are laid and both parents and occasionally helpers feed the young.;8|
37	*Merops ornatus*	Rainbow Bee-eater		
38	*Miniopterus schreibersii oceanensis*	Eastern Bentwing-bat		
39	*Myiagra cyanoleuca*	Satin Flycatcher		
40	*Neophema pulchella*	Turquoise Parrot	The Turquoise Parrot’s range extends from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range.	Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland.;1|Usually seen in pairs or small, possibly family, groups and have also been reported in flocks of up to thirty individuals.;2|Prefers to feed in the shade of a tree and spends most of the day on the ground searching for the seeds or grasses and herbaceous plants, or browsing on vegetable matter.;3|Forages quietly and may be quite tolerant of disturbance. However, if flushed it will fly to a nearby tree and then return to the ground to browse as soon as the danger has passed.;4|Nests in tree hollows, logs or posts, from August to December. It lays four or five white, rounded eggs on a nest of decayed wood dust.;5|

No.	Scientific name	Common name	Availability of habitat in the study area	Likelihood of occurrence in the study area	Assessment of likely interaction with soils at well leases	Forest areas	Pasture areas
33	*Lophoictinia isura*	Square-tailed Kite	High	Known	The Square-tailed Kite is found in woodlands and open forests, preying on passerines therefore is unlikely to interact with soils within well leases.	No	No
34	*Macropus dorsalis*	Black-striped Wallaby	High	Known	The Black-striped Wallaby is associated with dense woody or shrubby vegetation, occurring adjacent to open grassy areas where it feeds. May forage on rehabilitation areas both within the forest and in pasture areas (where they adjoin native forest) once established (i.e. 1-3 years post rehabilitation)	Potential	Potential
35	*Melanodryas cucullata cucullata*	Hooded Robin (south-eastern form)	High	Known	The Hooded Robin is associated with Eucalypt woodlands and open forest, requiring structurally diverse habitat features, therefore is unlikely to interact with soils within well leases	No	No
36	*Melithreptus gularis gularis*	Black-chinned Honeyeater (eastern subspecies)	High	Potential	The Black-chinned Honeyeater occurs in open forest and woodland foraging around tree canopies and bark, and is unlikely to interact with soils within well leases	No	No
37	*Merops ornatus*	Rainbow Bee-eater	High	Known	This species has recently been delisted as a migratory species under the EPBC Act and is therefore no longer a species of consideration for this assessment	N/A	N/A
38	*Miniopterus schreibersii oceanensis*	Eastern Bentwing-bat	High	Known. Detected from ultrasonic recordings only.	Eastern Bentwind-bat occurs in a range of habitat foraging around tree canopies and roosting in hollows or crevices in bark, and is unlikely to interact with soils within well leases	No	No
39	*Myiagra cyanoleuca*	Satin Flycatcher	High	Known	Satin Flycatcher forages in woodland and forest within the mid and canopy layers. As such this species is unlikely to interact with soils within well leases.	No	No
40	*Neophema pulchella*	Turquoise Parrot	High	Known	The Turquoise Parrot utilises eucalyptus woodland, mostly foraging on the ground for seeds, grasses and herbaceous plants. May forage on rehabilitation areas once established (i.e. 1-3 years post rehabilitation)	Potential	No

Source: Eco Logical Australia Pty Ltd. E-mail correspondence to Santos Ltd dated December 21, 2020.

No.	Scientific name	Common name	TSC Act	EPBC Act	Distribution (OEH, 2016b)	Habitat (OEH, 2016b)
41	*Ninox connivens*	Barking Owl	Vulnerable	Not Listed	Found throughout continental Australia except for the central arid regions. Although common in parts of northern Australia, the species has declined greatly in southern Australia and now occurs in a wide but sparse distribution in NSW. Core populations exist on the western slopes and plains (especially the Pilliga) and in some northeast coastal and escarpment forests..	Associated with a variety of habitats such as savannah woodland, open eucalypt forests, wetland and Riverine forest. Habitat is typically dominated by Eucalypts (often Redgum species), but can also be dominated by Melaleuca species in the tropics. Roosts in dense shaded foliage in large trees such as *Casuarina cunninghamiana* , other *Casuarina* spp., *Allocasuarina* spp., *Eucalyptus* spp., *Angophora* spp*., Acaci* a spp. and other large trees.
42	*Nyctophilus corbeni* (syn. *Nyctophilus timoriensis* (South-eastern form))	South-eastern Long eared Bat / Corben's Long-eared Bat	Not Listed	Vulnerable	The distribution of the south eastern form coincides approximately with the Murray Darling Basin with the Pilliga Scrub region being the distinct stronghold for this species.	Inhabits a variety of vegetation types including mallee, bulloke and box eucalypt dominated communities. However, it is more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland. Roosts in tree hollows, crevices and under loose bark.
43	*Oxyura australis*	Blue-billed Duck	Vulnerable	Not Listed	Endemic to south-eastern and south-western Australia. It is widespread in NSW, but most common in the southern Murray-Darling Basin area.	Prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. The species is completely aquatic, swimming low in the water along the edge of dense cover They are partly migratory, with short-distance movements between breeding swamps and over-wintering lakes with some long-distance dispersal to breed during spring and early summer .

No.	Scientific name	Common name	Distribution (OEH 2020)	Habitat (OEH 2020)
41	*Ninox connivens*	Barking Owl	The Barking Owl is found throughout continental Australia except for the central arid regions. Although still common in parts of northern Australia, the species has declined greatly in southern Australia and now occurs in a wide but sparse distribution in NSW. Core populations exist on the western slopes and plains and in some northeast coastal and escarpment forests. Many populations crashed as woodland on fertile soils was cleared over the past century, leaving linear riparian strips of remnant trees as the last inhabitable areas. Surveys in 2001 demonstrated that the Pilliga Forest supported the largest population in southern Australia. The owls sometimes extend their home range into urban areas, hunting birds in garden trees and insects attracted to streetlights. Extensive wildfires in 2019-20 reduced habitat quality further, burnt many old, hollow-bearing trees needed as refuge by prey species and reduced the viability of some regional owl populations.	Inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. It is flexible in its habitat use, and hunting can extend in to closed forest and more open areas. Sometimes able to successfully breed along timbered watercourses in heavily cleared habitats (e.g. western NSW) due to the higher density of prey found on these fertile riparian soils.;1|Roost in shaded portions of tree canopies, including tall midstorey trees with dense foliage such as Acacia and Casuarina species. During nesting season, the male perches in a nearby tree overlooking the hollow entrance.;2|Preferentially hunts small arboreal mammals such as Squirrel Gliders and Common Ringtail Possums, but when loss of tree hollows decreases these prey populations the owl becomes more reliant on birds, invertebrates and terrestrial mammals such as rodents and rabbits. Can catch bats and moths on the wing, but typically hunts by sallying from a tall perch.;3|Requires very large permanent territories in most habitats due to sparse prey densities. Monogamous pairs hunt over as much as 6000 hectares, with 2000 hectares being more typical in NSW habitats.;4|Two or three eggs are laid in hollows of large, old trees. Living eucalypts are preferred though dead trees are also used. Nest sites are used repeatedly over years by a pair, but they may switch sites if disturbed by predators (e.g. goannas).;5|Nesting occurs during mid-winter and spring, being variable between pairs and among years. As a rule of thumb, laying occurs during August and fledging in November. The female incubates for 5 weeks, roosts outside the hollow when chicks are 4 weeks old, then fledging occurs 2-3 weeks later. Young are dependent on their parents for several months.;6|Territorial pairs respond strongly to recordings of Barking Owl calls from up to 6 km away, though humans rarely hear this response farther than 1.5 km. Because disturbance reduces the pair's foraging time, and can pull the female off her eggs even on cold nights, recordings should not be broadcast unnecessarily nor during the nesting season.;7|
42	*Nyctophilus corbeni* (syn. *Nyctophilus timoriensis* (South-eastern form))	South-eastern Long eared Bat / Corben's Long-eared Bat		
43	*Oxyura australis*	Blue-billed Duck	The Blue-billed Duck is endemic to south-eastern and south-western Australia. It is widespread in NSW, but most common in the southern Murray-Darling Basin area. Birds disperse during the breeding season to deep swamps up to 300 km away. It is generally only during summer or in drier years that they are seen in coastal areas.	The Blue-billed Duck prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. The species is completely aquatic, swimming low in the water along the edge of dense cover. It will fly if disturbed, but prefers to dive if approached.;1|Blue-billed Ducks will feed by day far from the shore, particularly if dense cover is available in the central parts of the wetland. They feed on the bottom of swamps eating seeds, buds, stems, leaves, fruit and small aquatic insects such as the larvae of midges, caddisflies and dragonflies.;2|Blue-billed Ducks are partly migratory, with short-distance movements between breeding swamps and overwintering lakes with some long-distance dispersal to breed during spring and early summer.;3|Blue-billed Ducks usually nest solitarily in Cumbungi over deep water between September and February. They will also nest in trampled vegetation in Lignum, sedges or Spike-rushes, where a bowl-shaped nest is constructed. The most common clutch size is five or six. Males take no part in nest-building or incubation.;4|Young birds disperse in April-May from their breeding swamps in inland NSW to non-breeding areas on the Murray River system and coastal lakes.;5|

No.	Scientific name	Common name	Availability of habitat in the study area	Likelihood of occurrence in the study area	Assessment of likely interaction with soils at well leases	Forest areas	Pasture areas
41	*Ninox connivens*	Barking Owl	High	Known	The Barking Owl utilises woodland and open forest in the study area and prefers areas with dense canopies for roosting. There is potential for indirect interaction with soils where prey (such as invertebrates, rodents and rabbits) has interacted with these materials, with most potential occurring on newly rehabilitated well leases (i.e. 1-3 years post rehabilitation)	Potential	No
42	*Nyctophilus corbeni* (syn. *Nyctophilus timoriensis* (South-eastern form))	South-eastern Long eared Bat / Corben's Long-eared Bat	High	Known	South-eastern Long eared Bat forages in woodland and forest within the mid and canopy layers, but occasionally taking prey from the ground. As such this species has potential to interact with soils within well leases once rehabilitation is established (i.e. 1-3 years post rehabilitation)	Potential	No
43	*Oxyura australis*	Blue-billed Duck	Low	Potential	The Blue-billed Duck utilises wetlands and swamps and is unlikely to interact with soils within well leases	No	No

No.	Scientific name	Common name	TSC Act	EPBC Act	Distribution (OEH, 2016b)	Habitat (OEH, 2016b)
44	*Pachycephala inornata*	Gilbert's Whistler	Vulnerable	Not Listed	Occurs across most of NSW's semi-arid and arid regions. The eastern population extends from the central NSW mallee (Yathong, Nombinnie and Round Hill NRs), south and east through the Cocoparra Range to Pomingalama Reserve (near Wagga Wagga) then north through the South West Slopes east as far as Cowra and Burrendong Dam, to the Goonoo reserves (with scattered records as far north as Pilliga).	Occurs in arid and semi-arid timbered habitats in mallee shrubland, and occasionally in box-ironbark woodlands, Cypress Pine and Belah woodlands and River Red Gum forests. Within mallee the species often occurs in association with an understorey of Spinifex and low shrubs of acacias, hakeas, sennas and grevilleas. In woodland habitats, the understorey contains areas of dense shrubbery .
45	*Petaurus norfolcensis*	Squirrel Glider	Vulnerable	Not Listed	Widely though sparsely distributed in eastern Australia, from northern Queensland to western Victoria.	Associated with dry hardwood forest and woodlands (Menkhorst, Weavers, & Alexander, 1988; Quinn, 1995). Habitats typically include gum barked and high nectar producing species, including winter flower species (Menkhorst et al., 1988). The presence of hollow bearing eucalypts is a critical habitat value (Quinn, 1995).
46	*Petroica boodang*	Scarlet Robin	Vulnerable	Not Listed	Found from SE Queensland to SE South Australia and also in Tasmania and SW Western Australia. In NSW, it occurs from the coast to the inland slopes. After breeding, some Scarlet Robins disperse to the lower valleys and plains of the tablelands and slopes. Some birds may appear as far west as the eastern edges of the inland plains in autumn and winter .	Primarily a resident in forests and woodlands, but some adults and young birds disperse to more open habitats after breeding. It lives in dry eucalypt forests and woodlands with an understorey that is usually open and grassy with few scattered shrubs. It can live in both mature and regrowth vegetation with an abundance of logs and fallen timber are an important component of its habitat.
47	*Phascolarctos cinereus*	Koala	Vulnerable	Vulnerable	Fragmented distribution throughout eastern Australia from north-east Queensland to the Eyre Peninsula in South Australia. In NSW it mainly occurs on the central and north coasts with some populations in the west of the Great Dividing Range. A population is known in the Pilliga, predominantly in the west.	Associated with both wet and dry Eucalypt forest and woodland with a canopy cover of approximately 10 –70% (Reed, Lunney, & Walker, 1990), that contains acceptable eucalypt food trees. Primary feed tree in study area: *Eucalyptus camaldulensis* . Secondary food trees in the study area: *E. albens* , *E. blakelyi* , *E. chloroclada* , *E. conica* , *E. dealbata, E. dwyeri* , *E. macrocarpa* , *E. melliodora, E. pilligaensis* and *E. populnea* . Supplementary food tree in study area: *Eucalyptus macrorhyncha* , *Callitris glaucophylla* is common, and is listed as a tree species used for daytime shelter.

No.	Scientific name	Common name	Distribution (OEH 2020)	Habitat (OEH 2020)
44	*Pachycephala inornata*	Gilbert's Whistler	The Gilbert's Whistler is sparsely distributed over much of the arid and semi-arid zone of inland southern Australia, from the western slopes of NSW to the Western Australian wheatbelt. The species was probably once distributed almost continuously across the woodlands and mallee of southern NSW, but this range has been greatly reduced, chiefly by clearance of habitat. The eastern population extends from the central NSW mallee (Yathong, Nombinnie and Round Hill NRs), south and east through the Cocoparra Range to Pomingalama Reserve (near Wagga Wagga) then north through the South West Slopes east as far as Cowra and Burrendong Dam, to the Goonoo reserves (with scattered records as far north as Pilliga). The north western limits of this population are poorly known, with records from as far west as Cobar and recent records from Quanda NR, though records further west may be due to confusion with the Golden Whistler. In a number of reserves in this area there have been no recent records (last records from Pulletop NR 1982, Pomingalama Reserve 1995 and Ingalba NR 1999) and this species may be locally extinct. Occasional records are also made of this species in the Capertee Valley. The species is also recorded in River Red Gum forests along the Murray River valley between Mathoura and Wentworth, with the eastern populations (between Mathoura and Barham) apparently isolated from other NSW populations. West of Swan Hill, this population may interact with populations found to the north of the Murray River west of Balranald and as far north as the Scotia country (Tarawi NR and Scotia Sanctuary).	The Gilbert's Whistler occurs in a range of habitats within NSW, though the shared feature appears to be a dense shrub layer. It is widely recorded in mallee shrublands, but also occurs in box-ironbark woodlands, Cypress Pine and Belah woodlands and River Red Gum forests, though at this stage it is only known to use this habitat along the Murray, Edwards and Wakool Rivers. Within the mallee the species is often found in association with an understorey of spinifex and low shrubs including wattles, hakeas, sennas and hop-bushes. In woodland habitats, the understorey comprises dense patches of shrubs, particularly thickets of regrowth Callitris pine. Parasitic 'cherries' (Exocarpus species) appear to be an important habitat component in Belah and Red Gum communities, though in the latter case other dense shrubs, such as Lignum and wattles, are also utilised.;1|The Gilbert's Whistler forages on or near the ground in shrub thickets and in tops of small trees. Its food consists mainly of spiders and insects such as caterpillars, beetles and ants, and occasionally, seeds and fruits are eaten.;2|Breeding takes place between August and November. Nests are usually built below about two and a half metres (but up to six metres) above the ground in the fork of dense foliage of plants such as wattles or cypress pines. At Cowra three pairs nested in a 25 ha area. The nest is either a lined cup or sometimes birds use the old nests of other species, particularly disused babblers' nests. Two, three or occasionally four eggs are laid.;3|The movements of this species are poorly known but it is believed that generally it does not make any regular large-scale movements and pairs may hold and defend territories all year round. However, the occasional record outside the normal distribution may indicate some dispersal does occur, particularly given the difficulty in detecting this species outside the breeding season when it isn't calling.;4|
45	*Petaurus norfolcensis*	Squirrel Glider	The species is widely though sparsely distributed in eastern Australia, from northern Queensland to western Victoria.	Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas.;1|Prefers mixed species stands with a shrub or Acacia midstorey.;2|Live in family groups of a single adult male one or more adult females and offspring.;3|Require abundant tree hollows for refuge and nest sites.;4|Diet varies seasonally and consists of Acacia gum, eucalypt sap, nectar, honeydew and manna, with invertebrates and pollen providing protein.;5|
46	*Petroica boodang*	Scarlet Robin	The Scarlet Robin is found from south east Queensland to south east South Australia and also in Tasmania and south west Western Australia. In NSW, it occurs from the coast to the inland slopes. After breeding, some Scarlet Robins disperse to the lower valleys and plains of the tablelands and slopes. Some birds may appear as far west as the eastern edges of the inland plains in autumn and winter.	The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs.;1|This species lives in both mature and regrowth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps.;2|Scarlet Robin habitat usually contains abundant logs and fallen timber: these are important components of its habitat.;3|The Scarlet Robin breeds on ridges, hills and foothills of the western slopes, the Great Dividing Range and eastern coastal regions; this species is occasionally found up to 1000 metres in altitude.;4|The Scarlet Robin is primarily a resident in forests and woodlands, but some adults and young birds disperse to more open habitats after breeding.;5|In autumn and winter many Scarlet Robins live in open grassy woodlands, and grasslands or grazed paddocks with scattered trees.;6|The Scarlet Robin is a quiet and unobtrusive species which is often quite tame and easily approached.;7|Birds forage from low perches, fence-posts or on the ground, from where they pounce on small insects and other invertebrates which are taken from the ground, or off tree trunks and logs; they sometimes forage in the shrub or canopy layer.;8|Scarlet Robin pairs defend a breeding territory and mainly breed between the months of July and January; they may raise two or three broods in each season.;9|This species' nest is an open cup made of plant fibres and cobwebs and is built in the fork of tree usually more than 2 metres above the ground; nests are often found in a dead branch in a live tree, or in a dead tree or shrub.;10|Eggs are pale greenish-, bluish- or brownish-white, spotted with brown; clutch size ranges from one to four.;11|Birds usually occur singly or in pairs, occasionally in small family parties; pairs stay together year-round.;12|In autumn and winter, the Scarlet Robin joins mixed flocks of other small insectivorous birds which forage through dry forests and woodlands.;13|
47	*Phascolarctos cinereus*	Koala	The Koala has a fragmented distribution throughout eastern Australia from north-east Queensland to the Eyre Peninsula in South Australia. In New South Wales, koala populations are found on the central and north coasts, southern highlands, southern and northern tablelands, Blue Mountains, southern coastal forests, with some smaller populations on the plains west of the Great Dividing Range.	Inhabit eucalypt woodlands and forests.;1|Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species.;2|Inactive for most of the day, feeding and moving mostly at night.;3|Spend most of their time in trees, but will descend and traverse open ground to move between trees.;4|Home range size varies with quality of habitat, ranging from less than two ha to several hundred hectares in size.;5|Generally solitary, but have complex social hierarchies based on a dominant male with a territory overlapping several females and sub-ordinate males on the periphery.;6|Females breed at two years of age and produce one young per year.;7|

No.	Scientific name	Common name	Availability of habitat in the study area	Likelihood of occurrence in the study area	Assessment of likely interaction with soils at well leases	Forest areas	Pasture areas
44	*Pachycephala inornata*	Gilbert's Whistler	Moderate	Potential	Gilbert's Whistler utilises forests with a dense shrub layer and forages in shrubs thickets targeting spiders and insects, and therefore is unlikely to interact with soils within well leases. This species has some potential to utilise rehabilitated areas once established (i.e. 1-3 years post rehabilitation) but is unlikely to directly interact with soils.	Potential	No
45	*Petaurus norfolcensis*	Squirrel Glider	High	Known	The Squirrel Glider is associated with dry Eucalypt forest and woodlands, requiring tree hollows for nesting. This species has some potential to utilise rehabilitated areas once established (i.e. 1-3 years post rehabilitation) for browsing on vegetation and insects, but is highly unlikely to interact with soils within well leases.	Potential	No
46	*Petroica boodang*	Scarlet Robin	High	Potential	The Scarlet Robin is associated with open dry eucalypt forest and woodlands, foraging primarily on invertebrates. This species has some potential to forage in rehabilitated areas once established (i.e. 1-3 years post rehabilitation) but is highly unlikely to interact with soils within well leases	Potential	No
47	*Phascolarctos cinereus*	Koala	High	Likely	Koala forages in woodland and forest within canopy layer. As such this species is unlikely to interact with soils within well leases.	No	No

No.	Scientific name	Common name	TSC Act	EPBC Act	Distribution (OEH, 2016b)	Habitat (OEH, 2016b)
48	*Plegadis falcinellus*	Glossy Ibis	Not Listed	Marine; Migratory	Recorded over much of NSW. Spring/summer breeding migrant to southern Murray-Darling region and Macquarie Marshes. Recorded previously at Yarrie Lake.	Edges of lakes and rivers, lagoons, flood-plains, wet meadows, swamps, reservoirs, sewage ponds, rice-fields and cultivated areas under irrigation. Occasionally estuaries, deltas, saltmarshes and coastal lagoons.
49	*Polytelis swainsonii*	Superb Parrot	Vulnerable	Vulnerable	Found throughout eastern inland NSW. On the South-western Slopes their core breeding area is roughly bounded by Cowra and Yass in the east, and Grenfell, Cootamundra and Coolac in the west. Birds breeding in this region are mainly absent during winter, when they migrate north to the region of the upper Namoi and Gwydir Rivers. The other main breeding sites are in the Riverina along the corridors of the Murray, Edward and Murrumbidgee Rivers where birds are present all year round.	Inhabits box-gum woodland, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest. Populations that migrate to the Namoi region in winter forage and roost in forests and woodlands dominated by *Callitris glaucophylla* and Box-gum. Previous sightings of Superb Parrot in the Pilliga Forest have been associated with drainage lines, foraging in Eucalypt canopy and grassland and flying through the landscape (OEH, 2016a).
50	*Pomatostomus temporalis temporalis*	Grey-crowned Babbler (eastern subspecies)	Vulnerable	Not Listed	The eastern subspecies (temporalis) occurs from Cape York south through QLD, NSW and Vic and formerly to the south east of SA. This subspecies also occurs in the Trans-Fly Region in southern New Guinea. In NSW, the eastern sub-species occur on the western slopes of the Great Dividing Range, and on the western plains reaching as far as Louth and Balranald. It also occurs in woodlands in the Hunter Valley and in some locations on the north coast.	Found in open woodlands dominated by mature eucalypts with regenerating trees, tall shrubs, and an intact ground cover of grass and forbs .This species avoids very wet areas (Blakers, Davies, & Reilly, 1984). It favours Box-gum woodlands on the slopes and Box-cypress and open Box woodlands on alluvial plains.
51	*Pseudomys pilligaensis*	Pilliga Mouse	Vulnerable	Vulnerable	Distribution restricted to the Pilliga region of New South Wales. Fox and Briscoe first described this species in 1980 (Fox & Briscoe, 1980). There is still some conjecture on its specific status.	Occurs in Pilliga Scrub on an isolated area of low-nutrient deep sand. They seem to prefer areas with a high species diversity and dense low shrub layer.
52	*Rostratula australis* (syn. *Rostratula benghalensis australis*)	Australian Painted Snipe	Endangered	Endangered; Marine	Recorded at wetlands in all states of Australia. It is most common in eastern Australia, where it has been recorded at scattered locations throughout much of Queensland, NSW, Victoria and south-eastern South Australia.	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds.
53	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail-bat	Vulnerable	Not Listed	Wide-ranging species found across northern and eastern Australia. In the most southerly part of its range - most of Victoria, south-western NSW and adjacent South Australia - it is a rare visitor in late summer and autumn. There are scattered records of this species across the New England Tablelands and North West Slopes.	Found in almost all habitats, from wet and dry sclerophyll forest, open woodland, open country, mallee, rainforests, heathland and waterbodies (Churchill, 2008). It roosts in tree hollows and may also use caves.

No.	Scientific name	Common name	Distribution (OEH 2020)	Habitat (OEH 2020)
48	*Plegadis falcinellus*	Glossy Ibis		
49	*Polytelis swainsonii*	Superb Parrot	The Superb Parrot is found throughout eastern inland NSW. On the South-western Slopes their core breeding area is roughly bounded by Cowra and Yass in the east, and Grenfell, Cootamundra and Coolac in the west. Birds breeding in this region are mainly absent during winter, when they migrate north to the region of the upper Namoi and Gwydir Rivers. The other main breeding sites are in the Riverina along the corridors of the Murray, Edward and Murrumbidgee Rivers where birds are present all year round. It is estimated that there are less than 5000 breeding pairs left in the wild.	Inhabit Box-Gum, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest.;1|In the Riverina the birds nest in the hollows of large trees (dead or alive) mainly in tall riparian River Red Gum Forest or Woodland. On the South West Slopes nest trees can be in open Box-Gum Woodland or isolated paddock trees. Species known to be used are Blakely's Red Gum, Yellow Box, Apple Box and Red Box.;2|Nest in small colonies, often with more than one nest in a single tree.;3|Breed between September and January.;4|May forage up to 10 km from nesting sites, primarily in grassy box woodland.;5|Feed in trees and understorey shrubs and on the ground and their diet consists mainly of grass seeds and herbaceous plants. Also eaten are fruits, berries, nectar, buds, flowers, insects and grain.;6|
50	*Pomatostomus temporalis temporalis*	Grey-crowned Babbler (eastern subspecies)	The Grey-crowned Babbler has two distinctive subspecies that intergrade to the south of the Gulf of Carpentaria. West of here the subspecies rubeculus, formerly considered a separate species (Red-breasted Babbler) is still widespread and common. The eastern subspecies (temporalis occurs from Cape York south through Queensland, NSW and Victoria and formerly to the south east of South Australia. This subspecies also occurs in the Trans-Fly Region in southern New Guinea. In NSW, the eastern sub-species occurs on the western slopes of the Great Dividing Range, and on the western plains reaching as far as Louth and Balranald. It also occurs in woodlands in the Hunter Valley and in several locations on the north coast of NSW. It may be extinct in the southern, central and New England tablelands.	Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains. Woodlands on fertile soils in coastal regions. ;1|Flight is laborious so birds prefer to hop to the top of a tree and glide down to the next one. Birds are generally unable to cross large open areas.;2|Live in family groups that consist of a breeding pair and young from previous breeding seasons. A group may consist of up to fifteen birds. All members of the family group remain close to each other when foraging. A soft 'chuck' call is made by all birds as a way of keeping in contact with other group members. ;3|Feed on invertebrates, either by foraging on the trunks and branches of eucalypts and other woodland trees or on the ground, digging and probing amongst litter and tussock grasses.;4|Build and maintain several conspicuous, dome-shaped stick nests about the size of a football. A nest is used as a dormitory for roosting each night. Nests are usually located in shrubs or sapling eucalypts, although they may be built in the outermost leaves of low branches of large eucalypts. Nests are maintained year round, and old nests are often dismantled to build new ones. ;5|Breed between July and February. Usually two to three eggs are laid and incubated by the female. During incubation, the adult male and several helpers in the group may feed the female as she sits on the nest. Young birds are fed by all other members of the group.;6|Territories range from one to fifty hectares (usually around ten hectares) and are defended all year. Territorial disputes with neighbouring groups are frequent and may last up to several hours, with much calling, chasing and occasional fighting.;7|
51	*Pseudomys pilligaensis*	Pilliga Mouse	Distribution restricted to the Pilliga region of New South Wales. However, a Pilliga Mouse was reportedly trapped in the Warrumbungles after a major wildifire in January 2013, suggesting a sparse local population may have previously existed that could now respond to early stages of the post-fire succession.	The Pilliga Mouse typically occurs at low densities and appears to prefer areas with sparse ground cover. Evidence exists of marked population fluctuations.;1|Within the Pilliga region this species is largely restricted to low-nutrient deep sand soils which are recognised as supporting a distinctive vegetation type referred to as the Pilliga Scrub. Recent studies indicate that the Pilliga Mouse is found in greatest abundance in recently burnt moist gullies, areas dominated by broombush and areas containing an understorey of kurricabah (Acacia burrowii) with a bloodwood (Corymbia trachyphloia) overstorey. Consistent features of the latter two habitats were: a relatively high plant species richness; a moderate to high density of low-level shrub cover; and a moist groundcover of plants, litter and fungi. The gully where the highest rates of capture were encountered had an extensive cover of low grasses and sedges, with little shrub cover and large areas of ash-covered ground.;2|It is nocturnal, seeking refuge in burrows.;3|
52	*Rostratula australis* (syn. *Rostratula benghalensis australis*)	Australian Painted Snipe		
53	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail-bat	The Yellow-bellied Sheathtail-bat is a wide-ranging species found across northern and eastern Australia. In the most southerly part of its range - most of Victoria, south-western NSW and adjacent South Australia - it is a rare visitor in late summer and autumn. There are scattered records of this species across the New England Tablelands and North West Slopes.	Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows.;1|When foraging for insects, flies high and fast over the forest canopy, but lower in more open country.;2|Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory.;3|Breeding has been recorded from December to mid-March, when a single young is born.;4|Seasonal movements are unknown; there is speculation about a migration to southern Australia in late summer and autumn.;5|

No.	Scientific name	Common name	Availability of habitat in the study area	Likelihood of occurrence in the study area	Assessment of likely interaction with soils at well leases	Forest areas	Pasture areas
48	*Plegadis falcinellus*	Glossy Ibis	Moderate	Known	Glossy Ibis is known to occasionally forage on cultivated areas under irrigation, and has potential to interact with well leases in pasture areas once suitable rehabilitation has been undertaken (i.e. 1 year post rehabilitation)	No	Potential
49	*Polytelis swainsonii*	Superb Parrot	Moderate	Potential	Superb Parrot forages in woodland and forest within the mid and canopy layers. As such this species is unlikely to interact with soils within well leases.	No	No
50	*Pomatostomus temporalis temporalis*	Grey-crowned Babbler (eastern subspecies)	High	Known	The Grey-crowned Babbler occupies open woodlands feeding on invertebrates in trees or on the ground. The species has some potential to utilise young rehabilitated sites once rehabilitated (i.e. 1-3 years post rehabilitation), but is unlikely to interact with soils within well leases	Potential	No
51	*Pseudomys pilligaensis*	Pilliga Mouse	High	Known	Pilliga Mouse forages on the ground and lives in burrows in sandy soil . As such this species has potential to interact with soils within well leases, particularly once rehabilitation has occurred (i.e. 1-3 years post rehabilitation)	Potential	No
52	*Rostratula australis* (syn. *Rostratula benghalensis australis*)	Australian Painted Snipe	Low	Potential	Australian Painted Snipe forages in well structured wetlands and is unlikely to interact with soil within well leases.	No	No
53	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail-bat	High	Known	Yellow-tailed Sheathtail-bat occupies a range of habitats roosting in tree hollows and foraging for insects in canopies or open environments. Moderate potential to forage around newly rehabilitated areas but highly unlikely to interact with soils within well leases (i.e. 1-3 years post rehabilitation).	Potential	No

Source: Eco Logical Australia Pty Ltd. E-mail correspondence to Santos Ltd dated December 21, 2020.

No.	Scientific name	Common name	TSC Act	EPBC Act	Distribution (OEH, 2016b)	Habitat (OEH, 2016b)
54	*Sminthopsis macroura*	Stripe-faced Dunnart	Vulnerable	Not Listed	Throughout much of inland central and northern Australia, extending into central and northern NSW, western Queensland, Northern Territory, South Australia and Western Australia. They are rare on the NSW Central West Slopes and North West Slopes with the most easterly records of recent times located around Dubbo, Coonabarabran, Warialda and Ashford.	Native dry grasslands and low dry shrublands, often along drainage lines. During periods of hot weather they shelter in cracks in the soil, in grass tussocks or under rocks and logs .
55	*Stagonopleura guttata*	Diamond Firetail	Vulnerable	Not Listed	Endemic to south-eastern Australia, extending from central QLD to the Eyre Peninsula in SA. It is widely distributed in NSW, with a number of records from the Northern, Central and Southern Tablelands, the Northern, Central and South Western Slopes and the North West Plains and Riverina.	Typically found in grassy eucalypt woodlands, but also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities. It is often found in riparian areas and sometimes in lightly wooded farmland. Appears to be sedentary, though some populations move locally, especially those in the south.
56	*Stictonetta naevosa*	Freckled Duck	Vulnerable	Not Listed	Found primarily in south-eastern and south-western Australia, occurring as a vagrant elsewhere. It breeds in large temporary swamps created by floods in the Bulloo and Lake Eyre basins and the Murray-Darling system, particularly along the Paroo and Lachlan Rivers, and other rivers within the Riverina .	Prefers permanent freshwater swamps and creeks with heavy growth of Typha, Lignum or Tea-tree. During drier times they move from ephemeral breeding swamps to more permanent waters such as lakes, reservoirs, farm dams and sewage ponds.
57	*Tyto novaehollandiae*	Masked Owl	Vulnerable	Not Listed	Extends from the coast where it is most abundant to the western plains. Overall records for this species fall within approximately 90% of NSW, excluding the most arid north-western corner. There is no seasonal variation in its distribution.	Associated with forest with sparse, open, understorey, typically dry sclerophyll forest and woodland and especially the ecotone between wet and dry forest, and non-forest habitat. The species is known to utilise forest margins and isolated stands of trees within agricultural land and heavily disturbed forest where its prey of small and medium sized mammals can be readily obtained (Kavanagh & Peake, 1993).
58	*Vespadelus troughtoni*	Eastern Cave Bat	Vulnerable	Not Listed	Found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW. The western limit appears to be the Warrumbungle Range, and there is a single record from southern NSW, east of the ACT .	The species inhabits tropical mixed woodland and wet sclerophyll forest on the coast and the dividing range but extend into the drier forest of the western slopes and inland areas. It has been found roosting in sandstone overhand caves, boulder piles, mine tunnels and occasionally in buildings (Churchill, 2008).

No.	Scientific name	Common name	Distribution (OEH 2020)	Habitat (OEH 2020)
54	*Sminthopsis macroura*	Stripe-faced Dunnart	Throughout much of inland central and northern Australia, extending into central and northern NSW, western Queensland, Northern Territory, South Australia and Western Australia. They are rare on the NSW Central West Slopes and North West Slopes with the most easterly records of recent times located around Dubbo, Coonabarabran, Warialda and Ashford.	Native dry grasslands and low dry shrublands, often along drainage lines where food and shelter resources tend to be better.;1|They shelter in cracks in the soil, in grass tussocks or under rocks and logs.;2|Co-occupies areas with the more common Fat-tailed Dunnart, but prefers relatively ungrazed habitats with greater diversity and healthier understorey vegetation.;3|
55	*Stagonopleura guttata*	Diamond Firetail	The Diamond Firetail is endemic to south-eastern Australia, extending from central Queensland to the Eyre Peninsula in South Australia. It is widely distributed in NSW, with a concentration of records from the Northern, Central and Southern Tablelands, the Northern, Cental and South Western Slopes and the North West Plains and Riverina. Not commonly found in coastal districts, though there are records from near Sydney, the Hunter Valley and the Bega Valley. This species has a scattered distribution over the rest of NSW, though is very rare west of the Darling River.	Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum Eucalyptus pauciflora Woodlands.;1|Also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities.;2|Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland.;3|Feeds exclusively on the ground, on ripe and partly-ripe grass and herb seeds and green leaves, and on insects (especially in the breeding season).;4|Usually encountered in flocks of between 5 to 40 birds, occasionally more.;5|Groups separate into small colonies to breed, between August and January.;6|Nests are globular structures built either in the shrubby understorey, or higher up, especially under hawk's or raven's nests.;7|Birds roost in dense shrubs or in smaller nests built especially for roosting.;8|Appears to be sedentary, though some populations move locally, especially those in the south.;9|Has been recorded in some towns and near farm houses.;10|
56	*Stictonetta naevosa*	Freckled Duck	The Freckled Duck is found primarily in south-eastern and south-western Australia, occurring as a vagrant elsewhere. It breeds in large temporary swamps created by floods in the Bulloo and Lake Eyre basins and the Murray-Darling system, particularly along the Paroo and Lachlan Rivers, and other rivers within the Riverina. The duck is forced to disperse during extensive inland droughts when wetlands in the Murray River basin provide important habitat. The species may also occur as far as coastal NSW and Victoria during such times.	Prefer permanent freshwater swamps and creeks with heavy growth of Cumbungi, Lignum or Tea-tree. During drier times they move from ephemeral breeding swamps to more permanent waters such as lakes, reservoirs, farm dams and sewage ponds.;1|Generally rest in dense cover during the day, usually in deep water. Feed at dawn and dusk and at night on algae, seeds and vegetative parts of aquatic grasses and sedges and small invertebrates.;2|Nesting usually occurs between October and December but can take place at other times when conditions are favourable.;3|Nests are usually located in dense vegetation at or near water level.;4|
57	*Tyto novaehollandiae*	Masked Owl	Extends from the coast where it is most abundant to the western plains. Overall records for this species fall within approximately 90% of NSW, excluding the most arid north-western corner. There is no seasonal variation in its distribution.	Lives in dry eucalypt forests and woodlands from sea level to 1100 m.;1|A forest owl, but often hunts along the edges of forests, including roadsides.;2|The typical diet consists of tree-dwelling and ground mammals, especially rats.;3|Pairs have a large home-range of 500 to 1000 hectares.;4|Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting.;5|
58	*Vespadelus troughtoni*	Eastern Cave Bat	The Eastern Cave Bat is found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW. The western limit appears to be the Warrumbungle Range, and there is a single record from southern NSW, east of the ACT.	Very little is known about the biology of this uncommon species.;1|A cave-roosting species that is usually found in dry open forest and woodland, near cliffs or rocky overhangs; has been recorded roosting in disused mine workings, occasionally in colonies of up to 500 individuals.;2|Occasionally found along cliff-lines in wet eucalypt forest and rainforest.;3|Little is understood of its feeding or breeding requirements or behaviour.;4|

No.	Scientific name	Common name	Availability of habitat in the study area	Likelihood of occurrence in the study area	Assessment of likely interaction with soils at well leases	Forest areas	Pasture areas
54	*Sminthopsis macroura*	Stripe-faced Dunnart	Low	Potential	The Stripe-faced Dunnart occupies grasslands and low dry shrublands, sheltered in cracks in the soils. While this species is unlikely to utilise newly rehabilitated sites, it may interact with soils at well leases where rehabilitated has led to shrubland by sheltering in the soil (i.e. 1-3 years post rehabilitation)	Potential	No
55	*Stagonopleura guttata*	Diamond Firetail	High	Known	Diamond Firetail is associated with grassy eucalypt woodlands and open forest where it feeds exclusively on the ground. Potential to interact with soils within well leases once rehabilitation is established (i.e. 1-3 years post rehabilitation)	Potential	No
56	*Stictonetta naevosa*	Freckled Duck	Low	Potential	The Freckled Duck utilises freshwater swamps and creeks for breeding and foraging and is unlikely to interact with soils within well leases.	No	No
57	*Tyto novaehollandiae*	Masked Owl	High	Known	Masked Owl is associated with eucalypt forest and woodlands, sometimes foraging on open areas such as roads and forest edges. Potential to forage on newly rehabilitated areas but there is unlikely to be sufficient prey in these areas, therefore this species is unlikely to interact with soils within well leases until established (i.e. 1-3 years post rehabilitation)	Potential	No
58	*Vespadelus troughtoni*	Eastern Cave Bat	High	Known	The Eastern Cave Bat primarily roosts in caves with little known about feeding or breeding requirements. Potential to forage around newly rehabilitated areas but unlikely to interact with soils within well leases until established (i.e. 1-3 years post rehabilitation)	Potential	No

Source: Eco Logical Australia Pty Ltd. E-mail correspondence to Santos Ltd dated December 21, 2020.