Neckarboo Trough Potential Strategic Release Area

Prepared by the Geological Survey of NSW

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Executive Summary

In June 2016, the NSW Government introduced the NSW Strategic Release Framework for Coal and Petroleum Exploration. The Framework implements a new process for issuing prospecting titles and is overseen by the Advisory Body for Strategic Release. The Advisory Body will make recommendations to the Minister about release of areas for petroleum exploration based on consideration of geological, social, environmental, economic and operator capability factors.

The Geological Survey of NSW (GSNSW) identifies potential areas for release for petroleum exploration, based on geological resource assessments, for consideration by the Advisory Body.

The GSNSW recommends the Neckarboo Trough for consideration by the Advisory Body under the Strategic Release Framework. The Neckarboo Trough is a sedimentary sub-basin in the Darling Basin in Western NSW and the assessed petroleum prospectivity, relative to other underexplored basins and sub-basins in the State's west, is in the highest tier. The Neckarboo Trough is predominantly prospective for tight gas and has some potential for conventional gas. There is no potential for coal seam gas.

Introduction

NSW contains ten main sedimentary basins that have known petroleum resources or prospectivity potential (Figure 1). There have been oil and gas shows from previous exploration in the main sedimentary basins and potential for discovery of conventional gas/oil, tight gas/oil, shale gas/oil and coal seam gas.

The relatively well explored coal-bearing basins in the eastern one third of NSW have identified coal seam gas resources. In contrast, the basins in the western two thirds of NSW are relatively underexplored, but have potential for the discovery of petroleum resources.

The GSNSW has an ongoing program to acquire, analyse and deliver new precompetitive data to improve understanding of the prospectivity of the underexplored basins in the western two thirds of NSW. This program is a part of the New Frontiers Minerals and Energy Exploration Initiative and is expected to progressively identify additional areas for consideration for strategic release.

The GSNSW has identified the Neckarboo Trough for consideration by the Advisory Body for release as new petroleum prospecting area (Figure 1).

This area was selected based on the current understanding of the level of prospectivity and history of petroleum exploration. The Neckarboo Trough is considered a "Frontier Basin" with respect to petroleum exploration – it is relatively underexplored.

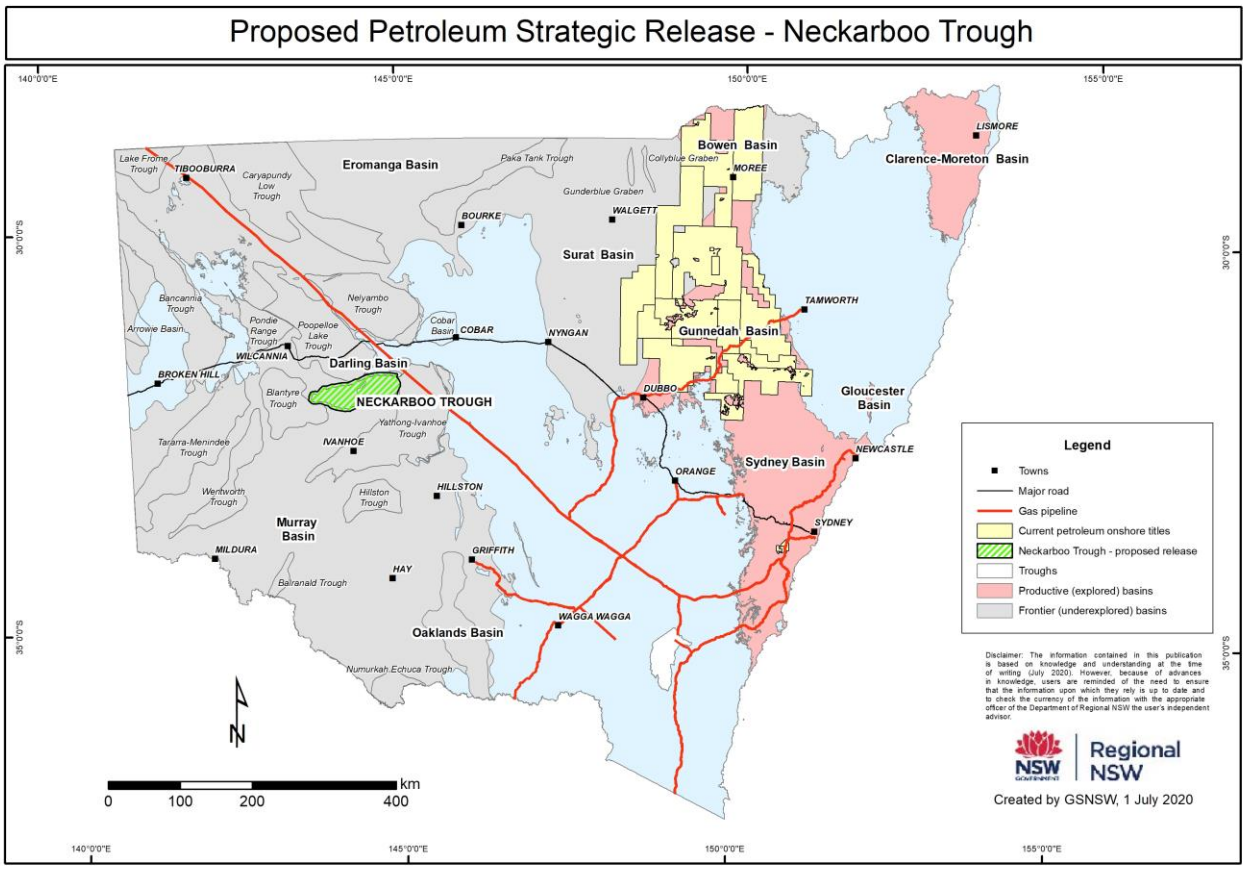

Figure 1 - Neckarboo Trough - potential strategic release area and current petroleum titles in NSW.

Neckarboo Trough Strategic Release Area

The Neckarboo Trough is an east-west trending sedimentary sub-basin within the Late Silurian to Early Carboniferous Darling Basin, located in western NSW. The centre of the Neckarboo Trough is approximately 80 km north of Ivanhoe and 150 km southwest of Cobar. There are no towns within the trough (Figure 2).

The Neckarboo Trough is approximately 30 km wide and 125 km long and covers an area of 3320 km^2. The estimated maximum sediment thickness in the trough is approximately 5.5 km, comprising predominantly Devonian (419Ma to 359Ma) aged sandstone and siltstone. The western half of the trough is overlain by Cenozoic sediments of the Murray Basin.

Based on current understanding, the Neckarboo Trough is one of the more prospective areas for petroleum exploration in western NSW. All the elements of a petroleum system required to form a petroleum deposit appear to be present within it. The trough is also relatively close to the Moomba to Sydney gas pipeline.

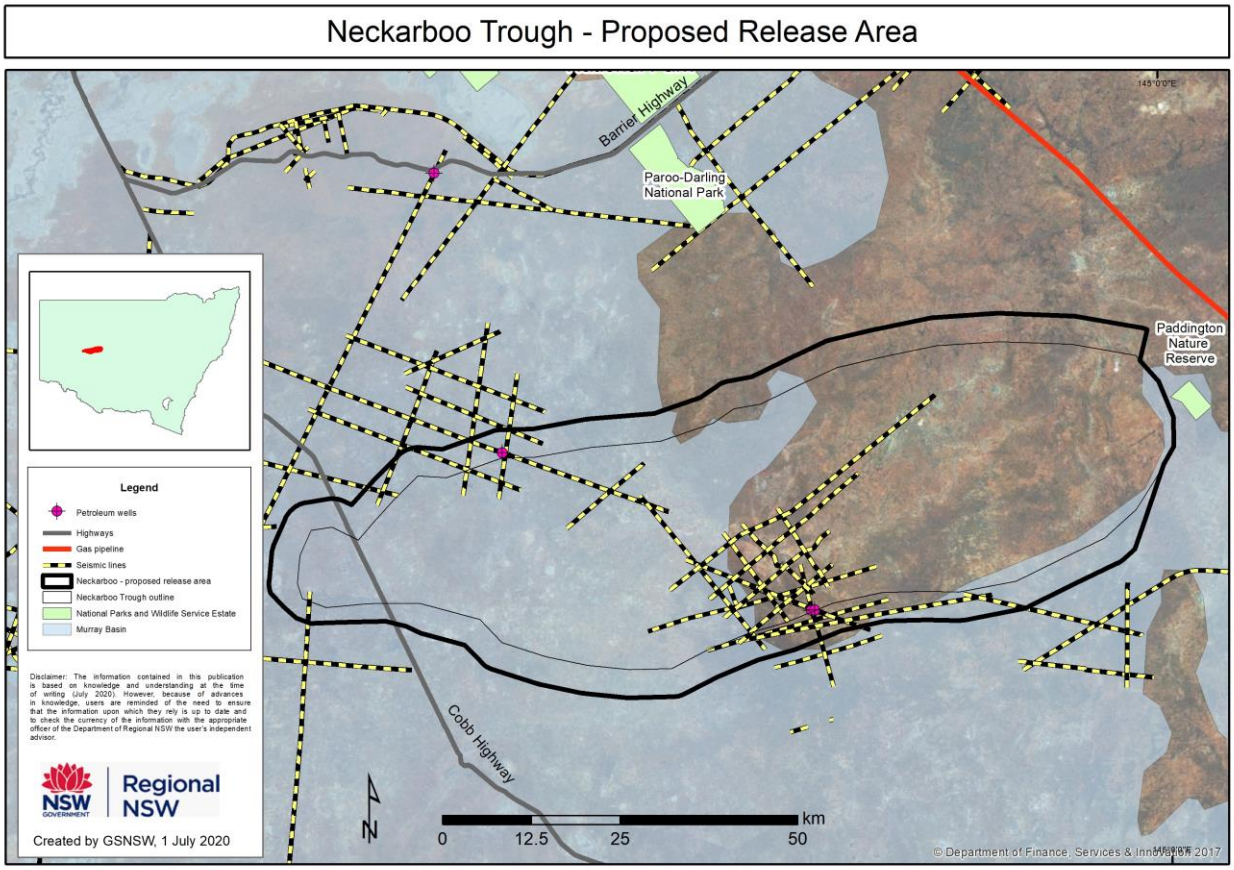

Figure 2 - Neckarboo Trough showing the proposed release area, seismic lines and wells. The proposed release has a buffer of 4 km outwards from the interpreted geological boundary of the trough.

History of exploration

The Neckarboo Trough is moderately explored, although there have been no valid tests of possible 'traps' for petroleum. Exploration began in the mid 1950s and was relatively continuous until it ceased in 2013, with only two short breaks at the end of 1970s and in 1990s

The history of previous petroleum exploration titles is shown in Table 1. In total, 20 petroleum exploration titles (17 PELs and three PSPAUTHs) have been granted over parts of the trough (Figure 3).

Exploration data

Exploration data includes well completion reports, geochemical analyses and seismic, aeromagnetic and gravity surveys (Table 1). There are also geological interpretative reports available for the Neckarboo Trough.

Two exploration wells have been drilled within the Neckarboo Trough namely: Berangabah-1 and BMR Ivanhoe-1. There were petroleum indicators in all three wells in form of fluorescence or fluid or gas inclusions. That suggests that good potential source rocks are present. The wells were drilled on the flanks of the trough and did not test possible reservoirs or seals that are likely to be deposited in deeper parts of the trough.

Seismic surveys were conducted across the Neckarboo Trough between 1966 and 2007. A total of 21 seismic lines covering 315 km within the boundaries of the Neckarboo Trough were acquired.

The quality of the seismic data varies from poor to good and original seismic field data has not been reprocessed using modern processing software.

Table 1 - Historic petroleum exploration titles over or partially over the Neckarboo Trough.

TITLE CODE	TITLE NO	TITLE HOLDER(S)	ACT	APPROX. YEAR OF OPERATION	EXPLORATION HIGHLIGHTS	AREA
PEL	15	Frome Broken Hill Co. Pty Ltd	1955	1956-1958	Field mapping (PGR1958/05)	all the Neckarboo Trough, except the most southern edge
PEL	51	Texam Oil Corporation	1955	1960-1968	Aeromagnetic survey: Ivanhoe (AM009); Gravity survey: Ivanhoe (GR025); Interpretation of airborne magnetometer survey (AM017); Drilling: Berangabah-1 (WCR127)	southern Neckarboo Trough
PEL	56	Planet Exploration Company Pty Ltd	1955	1960-1964	Interpretation of airborne magnetometer survey (AM015); Gravity survey: East Darling (GR012); Seismic survey: Ivanhoe (SS057)	central and northern Neckarboo Trough
PEL	115	Planet Exploration Company Pty Ltd	1955	1963-1968	Drilling: Blantyre-1 (WCR110) (outside of the trough).	central and north-western Neckarboo Trough
PEL	122	Texam Oil Corporation	1955	1965-1967	Desktop studies	eastern Neckarboo Trough
PEL	138	Texam Oil Corporation	1955	1967	Desktop studies	eastern Neckarboo Trough

TITLE CODE	TITLE NO	TITLE HOLDER(S)	ACT	APPROX. YEAR OF OPERATION	EXPLORATION HIGHLIGHTS	AREA
PEL	163	Planet Exploration Company Pty Ltd	1955	1968-1971	Gravity survey: Blantyre (GR034) (outside of trough); Seismic survey: Mt Emu (SS089) (outside of the trough); Drilling: Mt Emu-1 (WCR146) (outside of the trough).	central and north-western Neckarboo Trough
PEL	166	North Star Oil of Australia Ltd (Energy Resource Corporation)	1955	1969-1973	Desktop studies	eastern and southern Neckarboo Trough
PEL	193	Beaver Exploration Australia NL	1955	1972-1977	Seismic survey: Menindee regional (SS105) (outside of the trough).	western tip of Neckarboo Trough
PEL	247	Comserv (No. 779) Pty Ltd	1955	1980-1991	Airborne hydrocarbon remote sensing (PGR1982/14); Seismic surveys: Darling (SS134) and Blantyre (SS143).	central and western Neckarboo Trough
PEL	248	Comserv (No. 779) Pty Ltd	1955	1980-1985	Airborne hydrocarbon remote sensing (PGR1982/14)	eastern Neckarboo Trough
PEL	251	Comserv (No. 779) Pty Ltd	1955	1980-1991	Seismic surveys: Darling (SS134) and Blantyre (SS143).	northern margin of Neckarboo Trough
PEL	252	Comserv (No. 779) Pty Ltd	1955	1980-1985	Seismic survey: Darling (SS134)	northern margin of Neckarboo Trough
PSPAUTH	1	Department of Mineral Resources	1991	1993-1994	No exploration reported	all of the Neckarboo Trough, except the south-eastern edge

TITLE CODE	TITLE NO	TITLE HOLDER(S)	ACT	APPROX. YEAR OF OPERATION	EXPLORATION HIGHLIGHTS	AREA
PSPAUTH	4	Department of Mineral Resources	1991	1995-1996	No exploration reported	all of the Neckarboo Trough
PEL	420	Red Sky Energy Ltd	1991	1997-2008	Ground interstitial hydrocarbon gas survey (GS2000/057); Interpretation of gravity and magnetic data (GS2008/0477)	eastern and central Neckarboo Trough
PEL	422	Acer Energy Ltd	1991	1998-2013	Darling Basin 2D seismic survey (GS2012/0770) (outside of the trough)	northern margin of Neckarboo Trough
PEL	448	Red Sky Energy Ltd	1991	2006-2010	Airborne hydrocarbon microseepage survey (GS2012/0294); Interpretation of gravity and magnetic data (GS2008/0477).	northern margin of Neckarboo Trough
PEL	451	Red Sky Energy Ltd	1991	2006-2009	Airborne hydrocarbon microseepage survey (GS2008/0481); Seismic survey: Corinya-Yallock 2D (GS2009/0818); Interpretation of gravity and magnetic data (GS2008/0477).	central and western Neckarboo Trough
PSPAUTH	32	Energetica Resources Pty Ltd	1991	2009-2010	Desktop studies	southern, central-eastern Neckarboo Trough
EL	8065	Secretary of Regional NSW	1992-minerals	2013-current	Geothermal potential and carbon capture and storage assessments.	1.5 km overlap with eastern Neckarboo Trough

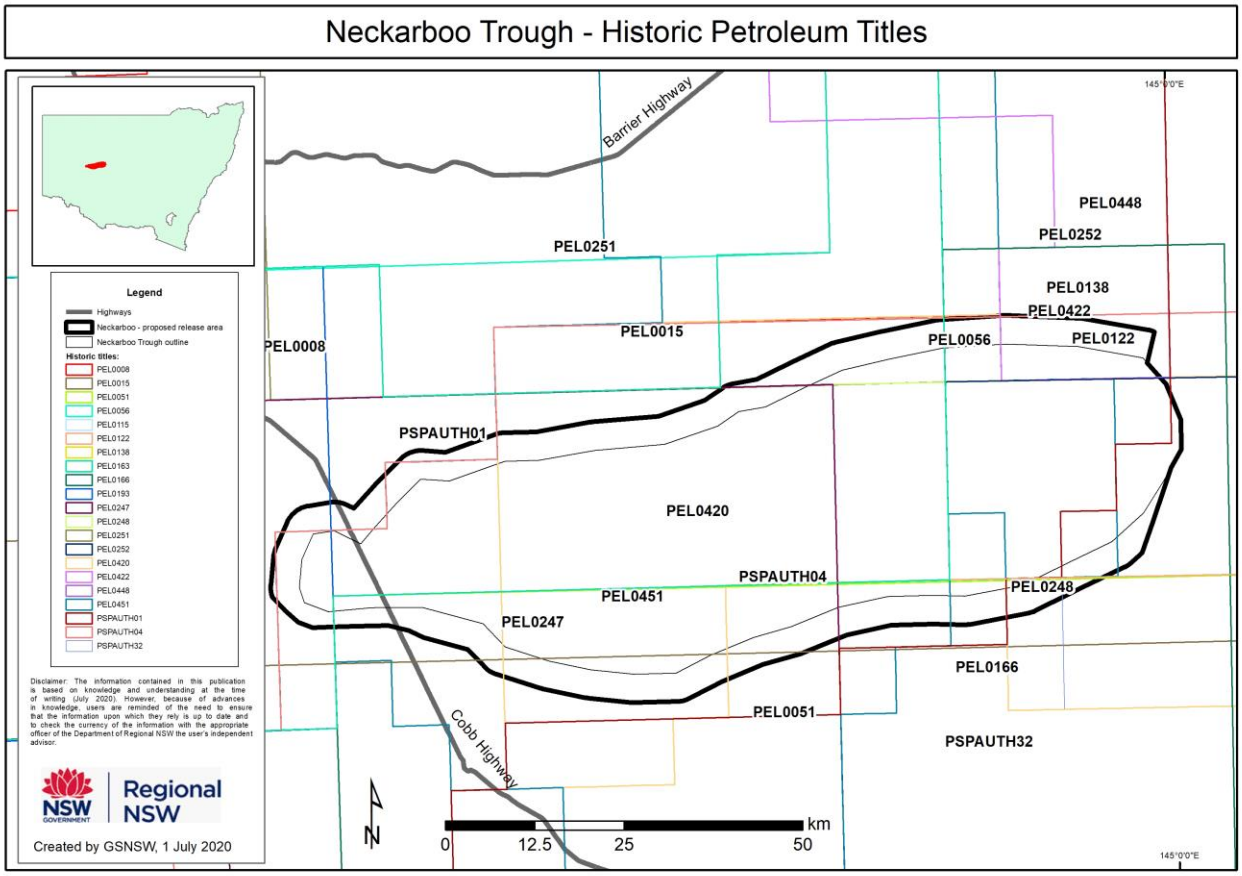

Figure 3 - Historic petroleum titles granted over parts of the Neckarboo Trough.

Petroleum Assessment Analysis – Neckarboo Trough

Name of area: **Neckarboo Trough**

Location: 1:250,000: SI/54-04 (Manara), SI/55-01 (Ivanhoe), SH/55-13 (Barnato)

Factor	Issue	Considerations	Petroleum Rating [MEG to tick one in each column]	Analysis
Availability of Geological data	Data density and veracity	Is the data sufficient to define a resource or potential resource and inform decision making?	☐ Data are sufficient to define a petroleum resource. ☒ Data indicate the potential for the discovery of a petroleum resource. ☐ Data are insufficient to assess the exploration potential for the discovery of a petroleum resource. ☐ No petroleum resource potential exists.	Historic Data: 2 wells have been drilled Berangabah-1 and BMR Ivanhoe-1. A total of 21 seismic lines cross or partially cross the trough. Gravity and aeromagnetic surveys Soil gas sampling Airborne geochemistry 63 water bores Petroleum prospectivity indications: Each of the wells intersected the Early Devonian sediments, which is known to be a potential source rock. Bitumen was detected in Berangabah-1. Wet and dry gas and liquid petroleum occur in fluid inclusions. Petroleum titles history: 17 PELs have been granted over parts of the sub-basin and 3 PSPAUTHs.

Continue Resource Assessment if ‘data are sufficient’ or indicate the potential for resource discovery.

Factor	Issue	Considerations	Petroleum Rating [MEG to tick one in each column]	Analysis
Resource body characteristics	Resource type		☒ Conventional (oil, gas) ☒ Unconventional (oil, gas) • Shale (oil, gas) • Tight Sand / Carbonate (oil, gas)	Unconventional and the possibility of conventional systems.
	Resource quality	Does product quality meet the likely market/utilisation?	☐ Yes ☐ No ☒ Cannot be determined	If gas has a high percentage of methane it will meet market requirements. Unconventional and conventional petroleum quality has not been tested.
	Resource size	What is the resource size/potential resource size?	☐ Likely sufficient to support a stand-alone operation. ☐ Requires further appraisal or testing to assess resource size. ☒ Requires further exploration to identify resource potential.	Further seismic data are needed to define the distribution of potential source rocks. Drilling and testing are needed to increase the understanding of the trough and its petroleum potential including reservoirs, seals and traps.
	Geological resource constraints	Do other geological considerations impact the potential development of the Resource?	☒ No significant resource constraints identified. ☐ Resource constraints are identified but unlikely to be detrimental to the development of the resource. ☐ Resource constraints indicate significant hurdles must be overcome if production were to proceed in the future.	There are insufficient data to identify resource and geological constraints.

Factor	Issue	Considerations	Petroleum Rating [MEG to tick one in each column]	Analysis
Ease of access	Existing infrastructure	Suitability of roads, power, water and outbound logistics (pipeline, rail or road)	☐ Would require little or no change to existing infrastructure. ☒ Would require some upgrade to existing infrastructure. ☐ Would require provision of new infrastructure.	Pipeline: The Moomba-Sydney gas pipeline is 13 km from the eastern edge of the trough. Roads: The sealed portion of the Cobb Highway runs from through the western edge of the trough north to the sealed Barrier Highway. Rail: The Orange- Broken Hill Railway is to the south of the trough. Towns: Approximately equidistant between the towns of Wilcannia, Cobar and Ivanhoe.
	Proximity to existing operations	Ability to share or leverage infrastructure of existing operations	☐ Yes. Established petroleum district with local labour and service industry. ☒ Possibly. Potential synergies with existing operations and infrastructure. ☐ No. No synergies presently exist.	There are no existing petroleum operations in the region, but the gas pipeline is about 70 km from the centre of the trough and 13 km from the basin edge.
	Capital costs	Style of operation the resource would support and likely capital costs and lead times	☐ Potential conventional operations with relatively low capital and earliest product to market. ☐ Potential unconventional operations with likely favourable geological characteristics to facilitate resource flow with probable medium capital outlays. ☐ Potential unconventional operations with likely less favourable geological characteristics to facilitate resource flow, with probable significant capital outlays. ☒ Unable to reasonably determine at this time.	Cannot determine until results from further exploration and studies.

Factor	Issue	Considerations	Petroleum Rating [MEG to tick one in each column]	Analysis
	Distance from market and outbound logistics (e.g. pipeline, port, rail, road)	Distance of resource from pipeline, port or a domestic market.	☐ Close. ☒ Medium. ☐ Far.	The Orange-Broken Hill Railways is about 85 km from the centre of the trough. The Moomba-Sydney pipeline is about 70 km from the centre of the trough.
		Level of establishment of pipeline, port or domestic market.	☒ Established. ☐ Mostly established. ☐ Not yet established.	Market in NSW is established with only 3.5% of gas supplied from NSW gas fields, with the sole operating field at Camden expected to cease production in 2023.
Market characteristics	Customer demand		☒ Current customer demand exists. ☐ Current customer demand is moderate. ☐ Current customer demand is low or may not exist.	NSW requires approx. 140 PJ of gas annually. Only 3.5% of gas is produced within NSW.
Preliminary commercial viability assessment	Likely commercial viability as a stand-alone operation	Commercial viability of stand-alone operation at current market prices.	☐ Project is likely to be financially robust. ☐ Project is currently marginal. ☐ Project is marginal to not commercially viable at this time. ☒ Unable to reasonably determine.	The region needs extensive exploration in order to determine its value.
Other strategic matters *Note that some of these issues will be further or more fully*	Existing land uses	Likelihood of competing land uses impacting on the resource.	☐ Existing land uses would not impact extraction of the resource. ☒ Existing land uses would have some impact on extraction of the resource but could be managed. ☒ Existing land uses would likely prohibit extraction of the resource.	The land is currently being used for grazing cattle, sheep and goats. There are heritage sites that may impact exploration.

Factor	Issue	Considerations	Petroleum Rating [MEG to tick one in each column]	Analysis
considered in DRNSW's strategic issues assessment	Environment/ hydrology	Environmental/ hydrological constraints to the resource and likelihood to prohibit resource extraction	☐ Yes. Environmental constraints are likely. ☒ Some constraints that could be managed. ☐ No environmental constraints identified under current policy settings.	The Darling River and Talyawalka Creek are located more than 45 km to the west of the western edge of the trough. Sandy Creek, an ephemeral creek, flows across the eastern two thirds of the trough. There may be some mallee fowl habitat.
	Accessibility to market		☐ Product can be delivered with no hindrance. ☒ Product can be delivered but with some issues. ☐ Product can only be delivered with major changes.	The gas pipeline is about 70 km from centre of the trough; therefore a pipeline extension would be needed. Rail access is about 85 km from the centre of the trough. The Cobb Highway runs through the western tip of the trough.
	Other constraints and critical risks	Other constraints that would prohibit or restrict further exploration or future extraction of the resource.	☐ Yes ☒ Possibly ☐ No	Land access may be difficult in some locations due to landholder opposition to petroleum exploration.
Additional Comments				

END OF PETROLEUM RESOURCE ASSESSMENT TEMPLATE