Review of Environmental Factors

Area 1 of Narran-Warrambool Reserve

Prepared for Department of Regional NSW
July 2022

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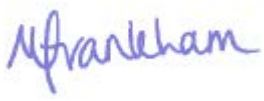

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14 August 2023

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1 Introduction

1.1 Background to this document

The Department of Regional NSW (DRNSW) commissioned EMM Consulting Pty Limited (EMM) to prepare this Review of Environmental Factors (REF) as an internal assessment tool for activities associated with opal prospecting and opal mining in REF Area 1 of the Narran-Warrambool Reserve (NWR). The activities assessed are outlined in Section 3 and include shaft sinking, auger drilling, percussion drilling, SIROTEM and underground mining.

1.2 Important caveats

This REF is based on certain assumptions and therefore has certain important limitations.

Firstly, it is not assessing a specific proposed activity currently the subject of an application for a licence or a lease, but rather it assumes that such applications may be received by DRNSW in the future.

Secondly, the scope of the assessment is limited to the most common methods of opal prospecting and mining likely to be used by applicants, should a licence or lease be granted. Activities outside that set of common methods cannot fully rely on this REF and may require additional assessment. Broadly, underground mining is assessed, not open cut or trenching methods.

Thirdly, the REF assumes that if licences or leases are granted for opal prospecting and mining, that conditions may be attached to any licence or lease to mitigate impacts but that those conditions must be simple, practical and within the means of most applicants. If the impacts cannot be managed through conditions which require simple, practical management measures, then either (a) the activity should not occur in the nominated location or (b) further assessment and/or bespoke conditions should be considered.

Fourthly, this REF is limited to the land within Area 1 of the NWR (see map at Figure 1.1).

Fifthly, the preparation of a REF does not compel DRNSW or any other public authority to (a) make land available for opal prospecting and mining within Area 1; or (b) grant a licence or lease. The REF addresses the relevant environmental factors *if* land is made available and *if* a licence or lease is granted. The broader policy for opal mining in NSW remains a matter for DRNSW and other relevant public authorities.

Finally, noting that this REF has been prepared to assess future applications for opal prospecting and mining, but has been prepared within the applicable statutory and policy context at a particular point in time (March 2022), it is important to maintain currency and accuracy by updating the REF in response to any future changes to statutory or policy instruments.

1.3 Site description

The NWR was gazetted in 1989 pursuant to Section 24 of the (now repealed) *Mining Act 1973* and covers approximately 5,000 square kilometres (km^2). The NWR also includes the Lightning Ridge Mineral Claims District which was established pursuant to Section 173 of the (current) *Mining Act 1992* and mirrors the area originally gazetted as the NWR. There are four defined opal prospecting areas (OPAs) numbered 1 to 4 within the NWR.

This REF considers activities within an area comprising approximately 1,972 km^2 within the southern portion of the NWR. This southern portion of the NWR is known as REF Area 1 (Area 1) and is broadly bounded by the Barwon River and Narran River to the south-east and north-west respectively; includes Narran Lake Nature Reserve to the west; and sits immediately south of (but does not include) the existing opal fields of Glengarry, Grawin and Sheepyard to the north (Figure 1.1). Incorporated within Area 1 is Opal Prospecting Area 4 (OPA4), however this REF examines opal prospecting and opal mining across the entirety of Area 1.

1.4 Purpose

The Department of Regional NSW (DRNSW) has an approval role pursuant to the *Mining Act 1992* (Mining Act) for the granting of an Opal Prospecting Licence or Mineral Claim within the NWR.

Under the *Environmental Planning and Assessment Act 1979* (EP&A Act), the activities associated with opal prospecting and mining are classified as permissible without consent.

While a development consent is not required for those opal prospecting and mining activities, the provisions of Part 5.1 of the EP&A Act place upon DRNSW a duty to consider the likely environmental impacts of granting such licences and leases. This establishes DRNSW as a determining authority for the proposed activities and in order to appropriately discharge the obligation to consider the likely environmental impacts of the activities, an assessment report in the form of a Review of Environmental Factors has been prepared.

The purpose of the REF is to describe the project, document the likely impacts of the project on the environment, and detail measures to mitigate impacts that cannot be avoided. The REF is the key document which DRNSW would use to discharge its duty under Section 5.5 of the EP&A Act. Section 5.5 provides that DRNSW must examine and consider to the fullest extent possible, all matters affecting or likely to affect the environment from the proposed activity – in this case being opal prospecting and opal mining.

When considering the likely impact of an activity on the environment, the determining authority (DRNSW) must consider the environmental factors specified in the environmental factors guidelines that apply to the activity. If there are no environmental factors guidelines in force, the determining authority must consider the environmental factors prescribed pursuant to clause 171 of the Environmental Planning and Assessment Regulation 2021 (EP&A Regulation). Note that clause 171 replaces clause 228 of the now repealed Environmental Planning and Assessment Regulation 2000.

The EP&A Regulation also states at subclause 171(3) that the determining authority must prepare a REF that demonstrates how the environmental factors specified in the environmental factors guidelines, or the environmental factors specified in subsection (2) if no guidelines are in force, were taken into account when considering the likely impact of an activity.

A provision at subclause 171(4) also requires that the REF be published subject to certain matters, including whether the determining authority considers it to be in the public interest to publish the REF.

1.5 Scope

This REF has been prepared in accordance with the NSW Department of Planning and Environment (DPE) Resources Regulator *ESG2: Guideline for Preparing a Review of Environmental Factors* (Resources Regulator 2018). It considers the potential environmental and community impacts associated with opal prospecting and mining activities within Area 1 as described in Section 3. The REF describes the existing environment, the socio-economic context, stakeholder and community engagement, provides an impact assessment, and proposes appropriate management and mitigation measures for opal prospecting and mining within Area 1.

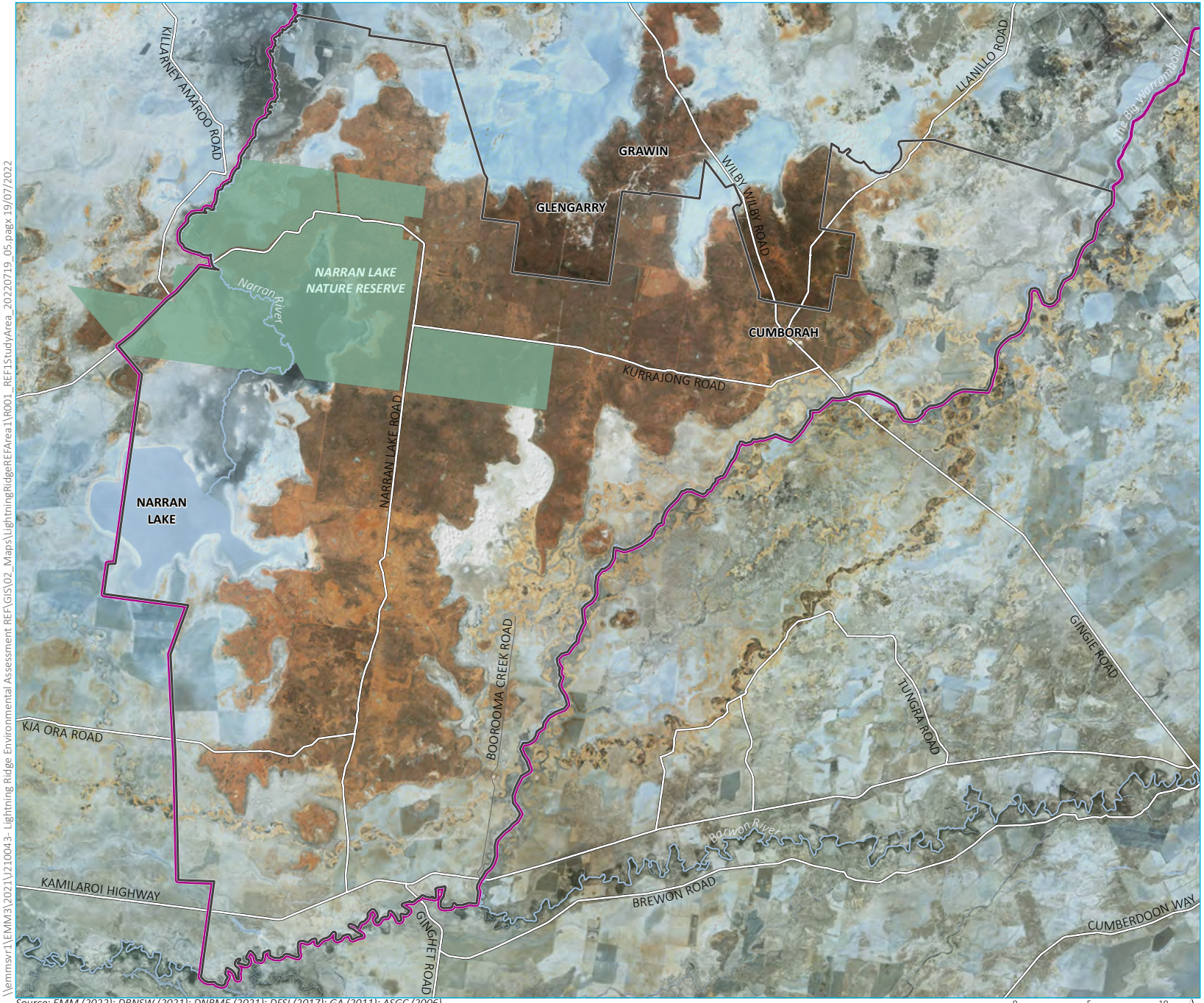
1.6 Environmental factors

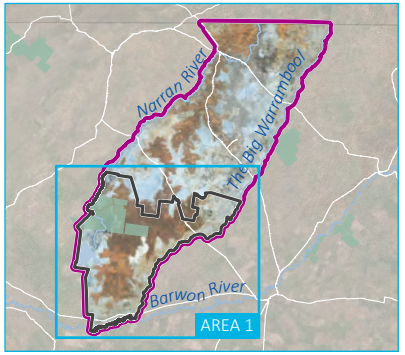
No specific environmental factors guideline has been prepared with respect to opal prospecting and mining. The provisions of clause 171(2) of the EP&A Regulation 2021 therefore apply. Refer to Table 1.1 for guidance on the sections within this REF where specified matters are considered.

Table 1.1 Environmental factors

Clause 171(2) environmental factors	Relevant REF sections	Notes
(a) the environmental impact on the community,	Section 6.14 and Appendix D and Appendix F	Capturing the socio-economic aspects.
(b) the transformation of the locality,	Section 6.14 and Appendix F	Capturing the socio-economic aspects.
(c) the environmental impact on the ecosystems of the locality,	Section 6.5 and Appendix A	Capturing the biodiversity aspects and assessment.
(d) reduction of the aesthetic, recreational, scientific or other environmental quality or value of the locality,	Section 6.8, 6.9, 6.13, 6.14, Appendix B, Appendix C, Appendix E and Appendix F	Capturing the heritage, visual and socio-economic aspects and assessments.
(e) the effects on any locality, place or building that has— (i) aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance, or	Section 6.8, 6.9, 6.13, 6.14, Appendix B, Appendix C, Appendix E, Appendix F	Capturing the heritage, visual and socio-economic aspects and assessments.
(ii) other special value for present or future generations,	Section 6.14	Capturing the socio-economic aspects and assessment.
(f) the impact on the habitat of protected animals, within the meaning of the *Biodiversity Conservation Act 2016*,	Section 6.5 and Appendix A	Capturing the biodiversity aspects and assessment.
(g) the endangering of a species of animal, plant or other form of life, whether living on land, in water or in the air,	Section 6.5 and Appendix A	Capturing the biodiversity aspects and assessment.
(h) long-term effects on the environment,	Section 4, Appendix A, Appendix B, Appendix C, Appendix E, Appendix F	Capturing all environmental impact assessments.
(i) degradation of the quality of the environment,	Section 6.1, 6.2, 6.3, 6.6, 6.10, 6.12	Capturing soils, rehabilitation, surface water, air quality, contaminated land and waste management aspects and assessment.
(j) risk to the safety of the environment,	Section 6.11	Captures public safety aspects.
(k) reduction in the range of beneficial uses of the environment,	Section 4.21, 6.17	Captures land use conflicts.
(l) pollution of the environment,	Section 6.1, 6.2.1, 6.3, 6.6, 6.7, 6.10, 6.12, 6.13 and Appendix D, Appendix E	Capturing soils, rehabilitation, surface water, air quality, noise and vibration, contaminated land, waste management, and visual aspects.

Clause 171(2) environmental factors	Relevant REF sections	Notes
(m) environmental problems associated with the disposal of waste,	Section 6.2, 6.10, 6.12	Capturing rehabilitation, contaminated and waste management aspects.
(n) increased demands on natural or other resources that are, or are likely to become, in short supply,	Section 4.21, 6.1, 6.2 6.3, and 6.17	Capturing soils, rehabilitation surface water aspects and land use conflict.
(o) the cumulative environmental effect with other existing or likely future activities,	Section 6.19	Capturing the cumulative effects associated with parallel land uses, as well as cumulative opal prospecting and opal mining claims.
(p) the impact on coastal processes and coastal hazards, including those under projected climate change conditions,	Not applicable	
(q) applicable local strategic planning statements, regional strategic plans or district strategic plans made under the Act, Division 3.1,	Section 2	Captures the regulatory and statutory context of this REF.
(r) other relevant environmental factors.	Section 6	Capturing groundwater and roads and traffic aspects, which are additional to matters identified above.





KEY

- Area 1
- Narran- Warrambool Reserve

Existing environment

- Major road
- Minor road
- Named watercourse
- Named waterbody
- NPWS reserve

Area 1
Narran- Warrambool Reserve

Review of Environmental Factors
Figure 1.1

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\\emmsvr1\EMM3\2021\P210043- Lightning Ridge Environmental Assessment REF\GIS\02_Maps\LightningRidgeREFArea1\R001_REF1StudyArea_20220719_05.pagx 19/07/2022

Source: EMM (2022); DRNSW (2021); DNRME (2021); DFSI (2017); GA (2011); ASGC (2006)

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2 Statutory and regulatory context

This section examines the key legislation and regulatory instruments which need to be considered to determine the characterisation and approval pathway for the activities described in Section 3 of this REF.

2.1 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) is the primary statutory instrument for the management and regulation of land use and development in NSW.

The EP&A Act (Section 1.5) defines development as follows:

> 1.5 Meaning of "development"
>
> (cf previous s 4)
>
> (1) For the purposes of this Act, development is any of the following;
>
> (a) the use of land,
>
> (b) the subdivision of land,
>
> (c) the erection of a building,
>
> (d) the carrying out of a work,
>
> (e) the demolition of a building or work,
>
> (f) any other act, matter or thing that may be controlled by an environmental planning instrument.
>
> (2) However, development does not include any act, matter or thing excluded by the regulations (either generally for the purposes of this Act or only for the purposes of specified provisions of this Act).
>
> (3) For the purposes of this Act, the carrying out of development is the doing of the acts, matters or things referred to in subsection (1).

This means that, unless specifically excluded by the EP&A Regulation 2021, activities such as opal prospecting and opal mining are a form of *development* and therefore captured by the EP&A Act.

The EP&A Act also provides for some development to be classified as *exempt development* on the basis that the development has a minor impact. There are environmental planning instruments (such as State environmental planning policies) which include such provisions for exempt development, and these are discussed in the relevant sections below.

If development is not *exempt development*, then Parts 4 and 5 of the EP&A Act become relevant.

2.1.1 The Part 4 approvals pathway

Broadly, Part 4 of the EP&A Act is essentially the default setting for approval pathways. Part 4 applies unless there is a provision under an environmental planning instrument (EPI) that provides for a development to be *permitted without consent* or *exempt development.* If a development is specified in an EPI as being *permitted with consent*, then a Part 4 pathway will apply.

Part 4 includes approval pathways such as local development (ie a development application to a local council), complying development (ie development authorised by a certifying authority), or other pathways such as State significant development.

There are other provisions under Part 4. This snapshot illustrates only the more relevant provisions to aid a broad understanding of the instrument and should not be taken as exhaustive due diligence advice.

2.1.2 The Part 5 approvals pathway

Part 5 of the EP&A Act broadly deals with two circumstances:

- where a public authority is the proponent for a development; and
- where a third party is the proponent for a development which is *permitted without consent,* but that same development nevertheless requires the proponent to obtain a permit, licence or other statutory authorisation from a public authority.

Section 5.5 of the EP&A Act creates a requirement for a *determining authority* to consider the environmental impact of a proposed activity.

The definition of *determining authority* is key here. There are two ways to become a determining authority. Section 5.1 of the EP&A Act provides (underlining added):

> ***determining authority*** means a Minister or public authority and, in relation to any activity, means the Minister or public authority by or on whose behalf the activity is or is to be carried out or any Minister *or* public authority whose approval is required in order to enable the activity to be carried out.

This means that if a public authority is the proponent (ie the first half of the definition), then Section 5.5 will require that public authority to consider the environmental impact before initiating the proposed activity.

It also means if a public authority is required to issue an approval (under other legislation, such as the *Mining Act 1992*) then the obligation is also placed upon that public authority to consider the environmental impact before issuing the approval, licence or other statutory authorisation (ie the second half of the definition).

Note that the obligation in both cases is with the *determining authority* (ie the public authority).

The conventional means by which a determining authority discharges those duties is by considering a review of environmental factors (REF). The REF need not be prepared by the determining authority but the procedural obligation to consider the environmental impacts of the proposed activity remains a matter for the public authority. Some public authorities require the third party to engage and pay for a consultant to prepare the REF, but this is a matter of administrative policy for the public authority.

The provisions of the EP&A Act Section 5.5 are reproduced below:

> **5.5 Duty to consider environmental impact**
>
> (cf previous s 111)
>
> (1) For the purpose of attaining the objects of this Act relating to the protection and enhancement of the environment, a determining authority in its consideration of an activity shall, notwithstanding any other provisions of this Act or the provisions of any other Act or of any instrument made under this or any other Act, examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity.
>
> (2) (Repealed)
>
> (3) Without limiting subsection (1), a determining authority shall consider the effect of an activity on any wilderness area (within the meaning of the *Wilderness Act 1987*) in the locality in which the activity is intended to be carried on.
>
> (4) (Repealed)

Note also that Section 5.7 of the EP&A Act requires that if a proposed activity is likely to *significantly affect the environment*, then the activity must be assessed under an environmental impact statement (EIS) and the associated processes such as public exhibition.

Where there are multiple determining authorities (ie if licences or permissions are required by more than one public authority for a given activity) then separate REFs are not usually commissioned for each authority. Rather, one authority acts as the *nominated determining authority* and commissions the REF on behalf of all. Section 5.4 of the EP&A Act removes the requirement for a determining authority to address the provisions of Section 5.5 (regarding the duty to consider environmental impact) provided that the activity has been approved by another determining authority after environmental assessment in accordance with EP&A Act Division 5.1.

Refer to Section 2.18 of this REF for further details regarding multiple determining authorities.

2.1.3 Designated development

There is a specific classification of development called *designated development*, as provided for under Section 4.10 of the EP&A Act. Designated development tends to be activities which have more significant impacts and if the activity is classified as *designated development,* then an environmental impact statement (EIS) must be prepared, as provided for under Section 4.12(8) of the EP&A Act.

The EP&A Act provides for designated development to be declared under the EP&A Regulation 2021 or an EPI such as a State environmental planning policy (SEPP).

2.2 Environmental Planning and Assessment Regulation 2021

The Environmental Planning and Assessment Regulation 2021 (EP&A Regulation) makes a number of provisions which may be relevant to opal prospecting and mining.

Subclause 3(5) of the EP&A Regulation excludes the *demolition of a temporary structure* from the definition of development, meaning that such an activity is no longer captured under the EP&A Act.

One of the main topics of interest under the EP&A Regulation, in terms of activities within the NWR, is the provision for a class of development called *designated development* (see clause 4).

Part 2 of Schedule 3 of the EP&A Regulation lists the types of development which are deemed to be *designated development*. The list includes (examples only):

- artificial waterbodies (generally greater than 0.5 hectares in surface area and within 40 metres of a natural waterbody);
- crushing, grinding or separating works that process materials such as rock or minerals (processing more than 150 tonnes per day or more than 30,000 tonnes per year);
- extractive industries (processing more than 30,000 cubic metres per year); and
- mines which mine, process or handle minerals (noting that opal is defined as a mineral under the Mining Regulation 2016) with a disturbance area of more than 4 hectares.

All of the above have a number of caveats, such as proximity to water bodies, area of disturbance, production volumes, and soil types. The full provisions for each activity should be read in full.

Development which meets the criteria of being *designated development* will require an EIS to be prepared (pursuant to Section 4.12(8) of the EP&A Act).

Alterations or additions to a development characterised as designated development may or may not require an EIS, depending on the increase (if any) in environmental impact. Refer to Part 3 of Schedule 3 of the EP&A Regulation.

2.3 State Environmental Planning Policy (Resources and Energy) 2021

The NSW Government consolidated 45 pre-existing State environmental planning policies (SEPPs) into thematic groups, effective 1 March 2022.[1]

The new State Environmental Planning Policy (Resources and Energy) 2021 (Resources and Energy SEPP) incorporates, amongst other things, the previous State Environmental Planning Policy (Mining, Petroleum and Extractives Industries) 2007 (Mining SEPP).

Chapter 2 of the new Resources and Energy SEPP makes provision for a range of mining activities and sets approval pathways and development controls for specific activities.

Part 2.2 of Chapter 2 sets out provisions for certain activities for be permitted with consent and permitted without consent, as well as activities which are prohibited and those that are exempt.

[1] Note that as part of the SEPP consolidation initiative, clauses are now called sections in all SEPPs.

Relevantly, Section 2.8 makes provision as follows:

> **2.8 Development permissible without consent**
>
> Development for any of the following purposes may be carried out without development consent—
>
> (a) mineral exploration and fossicking,
>
> (b) rehabilitation, by or on behalf of a public authority, of an abandoned mine site,
>
> (c) mining within a mineral claims district pursuant to a mineral claim under the *Mining Act 1992*,
>
> (d) petroleum exploration,
>
> (e) the construction, maintenance or use (in each case, outside an environmentally sensitive area of State significance) of any pollution control works or pollution control equipment required as a result of the variation of a licence under the *Protection of the Environment Operations Act 1997*, being a licence that applies to an extractive industry, mine or petroleum production facility in existence immediately before the commencement of this section.
>
> Note;
>
> Development to which this section applies may require approval under Part 3A of the Act or be subject to the environmental assessment and approval requirements of Part 5 of the Act.

Note that mineral exploration (subsection 2.8(a)) and mining within a mineral claims district pursuant to a mineral claim under the Mining Act (subsection 2.8(c)), are classified as activities which are *permitted without consent*.

This means that a development consent from a consent authority such as a local council is not required for these activities, but the Resources and Energy SEPP does not 'switch off' any other authorisations which may be required under other statutes, such as the Mining Act.

As the note at the end of Section 2.8 states, the development may nevertheless require determination under Part 5 of the EP&A Act if those other authorisations, licences or permits are triggered under other statutes.

In the case of opal prospecting and mining, authorisations (licences and leases) are required under other legislation, and this then brings the process back under Part 5 of the EP&A Act. The obligations on those public authorities to consider the factors described under clause 171 of the EP&A Regulation therefore comes into force, and a REF is prepared to consider those factors.

The Resource and Energy SEPP makes provision for some activities to be exempt development and these are noted at Section 2.13 of the SEPP. Generally, to be exempt development it must be an activity causing minimal impact and cannot be located within an environmentally sensitive area of State significance. These activities, pursuant to subsection 2.13(2)(b) may include:

> (i) geological mapping and airborne surveying,
>
> (ii) sampling and coring using hand-held equipment,
>
> (iii) geophysical (but not seismic) surveying and downhole logging,
>
> (iv) accessing of areas by vehicle that does not involve the construction of an access way such as a track or road.

Any activity which meets the characterisation under subsection 2.13(2)(b) – notably 'sampling and coring using hand-held equipment' – and which causes minimal environmental impact and is not undertaken in an environmentally sensitive area of State significance, is not the subject of this REF.

2.4 State Environmental Planning Policy (Exempt and Complying Development Codes) 2008

State Environmental Planning Policy (Exempt and Complying Development Codes) 2008 (Codes SEPP) offers streamlined assessment processes for specified development provided that certain development standards and other controls are met.

There are general requirements for any development to be considered as *exempt development* (refer to Section 1.16 of the Codes SEPP). These requirements include standards such as structural adequacy and satisfying the *Building Code of Australia*; and not being on land identified as outstanding biodiversity value under the *Biodiversity Conservation Act 2016*.

Similarly, there are general requirements for *complying development* (refer to Section 1.18 of the Codes SEPP). Complying development must be a type of development which is permitted with consent (a complying development certificate is a type of consent).

The requirements for complying development specifically preclude development requiring an environment protection licence or if it is designated development.

The Codes SEPP also lists a series of specific forms of development and assigns to those types of development a set of development standards which must be satisfied in order to be considered *exempt development* or *complying development*.

There is no specific provision for opal prospecting or mining under the Codes SEPP and the activities assessed under this REF are unlikely to trigger Codes SEPP pathways. Some minor works, such as the erection of a communication dish or antenna, the installation of a rainwater tank, or demolition (subject to development standards), may still occur in Area 1 and may be available as exempt development under the Codes SEPP.

2.5 State Environmental Planning Policy (Biodiversity and Conservation) 2021

The NSW Government consolidated 45 pre-existing State environmental planning policies (SEPPs) into thematic groups, effective 1 March 2022.

The new State Environmental Planning Policy (Biodiversity and Conservation) 2021 (Biodiversity and Conservation SEPP) incorporates, amongst other things, the previous State Environmental Planning Policy (Koala Habitat Protection) 2021 (Koala SEPP 2021).

Chapter 4 of the new Biodiversity and Conservation SEPP applies to specified local government areas (LGAs) which are listed in Schedule 2 of the Biodiversity and Conservation SEPP.

Schedule 2 includes Walgett LGA and Brewarrina LGA.

Chapter 2 of the Biodiversity and Conservation SEPP aims to encourage the conservation and management of areas of natural vegetation that provide habitat for koalas to support a permanent free-living population over their present range and reverse the current trend of koala population decline.

Section 4.4 of the Biodiversity and Conservation SEPP provides (at subsection 4.4(3)(d)) that the SEPP does not apply to:

> land in the following land use zones, or an equivalent land use zone, unless the zone is in a local government area marked with an * in Schedule 1—
>
> (i) Zone RU1 Primary Production,
>
> (ii) Zone RU2 Rural Landscape,
>
> (iii) Zone RU3 Forestry.

Brewarrina and Walgett LGAs are not marked with an asterisk in the Schedule 2 list of LGAs, and therefore Chapter 2 of the Biodiversity and Conservation SEPP does not apply to the land use zones RU1, RU2 or RU3 as noted above.

2.5.1 Brewarrina LGA land

Area 1 land within the Brewarrina LGA is zoned RU1, other than Narran Lake Nature Reserve which is zoned E1.

Opal mining and prospecting is prohibited in Narran Lake Nature Reserve and therefore that land is not a relevant consideration. Chapter 2 of the Biodiversity and Conservation SEPP does not apply on land elsewhere both inside Area 1 and inside Brewarrina LGA.

2.5.2 Walgett LGA land

Area 1 land within the Walgett LGA is mostly zoned RU1, other than Narran Lake Nature Reserve which is zoned E1. The are some areas zoned SP1 Special Activities (Mining) near Grawin and Glengarry but these are not within Area 1.

Opal mining and prospecting is prohibited in Narran Lake Nature Reserve and therefore that land is not a relevant consideration. Chapter 2 of the Biodiversity and Conservation SEPP does not apply on land elsewhere both inside Area 1 and inside Walgett LGA.

2.6 Mining Act 1992

The *Mining Act 1992* (Mining Act) provides for opal prospecting areas (Division 1 of Part 10), opal prospecting licences (Division 2 of Part 10) and mineral claims (Part 9).

With respect to opal prospecting areas, certain land cannot be included without Ministerial approval, such as land within a national park or nature reserve (ie Narran Lake Nature Reserve).

With respect to an opal prospecting licence, the Mining Regulation provides that an application for a licence must be made in writing, providing the required information and the fee payable (refer to Section 226). Conditions can be attached to the issue of a licence (refer to Section 229).

Mineral claims and opal prospecting licences are both defined as *small scale titles* pursuant to the Mining Act.

Opal prospecting blocks must be within a Gazetted opal prospecting area and must not exceed an area of 500 hectares or a smaller area if prescribed by the regulations.

Any person can apply for an opal prospecting licence over an opal prospecting block, provided the individual is 18 years of age (Section 2274(1)(a)).

An opal prospecting licence linked to an opal prospecting block must not exceed 5 years duration. Licence periods for each opal prospecting block are reviewed and gazetted annually, as per Section 225(2)(c).

Opal prospecting licences cannot be granted over an opal prospecting block if that land has another licence in force; or over a mineral claim which is in force or pending.

Section 223A of the Mining Act enables conditions to be applied to an opal prospecting licence, including areas prohibited from prospecting, the nature of prospecting operations and rehabilitation requirements.

It is the issue of a licence for opal prospecting which triggers Section 5.5 of the EP&A Act and obliges the public authority issuing the licence to first consider the environmental effects of issuing the licence. This makes DRNSW a determining authority under Part 5 of the EP&A Act.

2.7 Mining Regulation 2016

The Mining Regulation 2016 (Mining Regulation) sets out definitions, operational and licensing arrangements for mining activities, including opal prospecting and mining.

The Definitions under the Mining Regulation define minerals by reference to Schedule 1 of the Regulation. Schedule 1 identifies *opal* as a mineral. Opal is also classified as a specific group of minerals (Group 7) under Schedule 2 Groups of Minerals.

There is a specific class of activity called ancillary mining activity (refer to clause 7) and this includes opal puddling; the construction and use of mining plant; and the removal, stockpiling and management of overburden.

2.8 National Parks and Wildlife Act 1974

The *National Parks and Wildlife Act 1974* (NPW Act) provides for the conservation of nature, the establishment of protected areas and the protection of Aboriginal objects and places.

Narran Lake Nature Reserve (26,480 hectares) is one protected area within the Area 1 of the NWR. Narran Lake Nature Reserve is listed under the Ramsar Convention for its wetlands and ecological communities. A Narran Lake Nature Reserve Plan of Management has been prepared pursuant to Part 5 of the NPW Act.

Part 6 of the NPW Act provides for the management of activities which may harm Aboriginal objects and places. Aboriginal heritage impact permits (AHIP) are required where harm is likely to occur. Activities which involve ground disturbance such as prospecting or mining may pose a risk to Aboriginal heritage.

NPWS has published a *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (2011). Under certain circumstances an AHIP may not be required, such as where the activity is trivial, negligible or of low impact. Part 6 of the NPW Act also provides for defences and exemptions.

If the proposed opal mining or prospecting activity requires a permit from the National Parks and Wildlife Service (NPWS) then the NPWS is also an authority for whom Section 5.5 of the EP&A Act triggers a determining authority role, meaning that both DRNSW and NPWS may need to consider the likely environmental effects of their licence or permit prior to issuing that licence or permit.

Refer to Section 2.18 of this REF for details of how multiple determining authorities integrate their respective obligations under Section 5.5 of the EP&A Act.

2.9 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) deals with a range of scheduled activities and seeks to regulate the operations to minimise impacts on the environment and human health in terms of discharges, waste and pollution.

Scheduled activities are listed in Schedule 1 of the POEO Act with these activities requiring an environment protection licence (EPL). The list of scheduled activities includes:

- contaminated soil treatment;
- contaminated groundwater treatment;
- crushing, grinding and separating of rock or minerals (over 30,000 tonnes per annum);
- mineral processing (more than 150 tonnes per day); and
- mining for minerals (if total disturbance area is greater than 4 hectares).

These are larger scale operations and are unlikely to be associated with small scale titles in Area 1 of the NWR. Nevertheless, these provisions could conceivably be triggered by any larger scale operations.

2.10 Heritage Act 1977

The *Heritage Act 1977* (Heritage Act) provides for the identification, registration and protection of the State's historic heritage.

Walgett LGA has one item listed under the Heritage Act:

- Collarenebri Aboriginal Cemetery.

Brewarrina LGA has three items listed under the Heritage Act:

- Brewarrina Aboriginal Fish Traps/Baiame's Ngunnhu;
- Brewarrina Aboriginal Mission Site; and
- Weilmoringle Shearing Complex.

None of the items recorded on the NSW State Heritage Register lie within Area 1 of the NWR.

2.11 Biodiversity Conservation Act 2016

Threatened species, populations and ecological communities are protected by the *Biodiversity Conservation Act 2016* (BC Act) and Part 7A of the *Fisheries Management Act 1994* (Fisheries Act).

The *Biodiversity Conservation Act 2016* (BC Act) is the legislation responsible for the conservation of biodiversity in NSW through the protection of threatened flora and fauna species, populations and ecological communities. The BC Act, together with the Biodiversity Conservation Regulation 2017 (BC Regulation), established the Biodiversity Offsets Scheme (BOS).

The BOS includes establishment of the *Biodiversity Assessment Method* (the BAM, OEH 2017a) for use by accredited persons in biodiversity assessment under the scheme. The purpose of the BAM is to assess the impact of actions on threatened species and threatened ecological communities, and their habitats and determine offset requirements.

The BAM sets out the requirements for a repeatable and transparent assessment of terrestrial biodiversity values on land in order to:

- identify the biodiversity values on land subject to proposed development area;
- determine the impacts of a proposed development, following all measures to avoid, minimise and mitigate impacts; and
- quantify and describe the biodiversity credits required to offset the residual impacts of proposed development on biodiversity values.

The BC Act also identifies the concept of serious and irreversible impacts (SAII) and imposes various obligations on decision-makers in relation to impacts on biodiversity values that are considered SAII. Under Part 5 of the EP&A Act the determining authority is required to take SAII into consideration and must determine whether there are any additional and appropriate measures that will minimise those impacts if the activity is to be carried out or approved.

Within Area 1 of the NWR there are at least eight threatened ecological communities listed under the BC Act.

2.12 Fisheries Management Act 1994

The *Fisheries Management Act 1994* (FM Act) contains provisions for the conservation of fish stocks, key fish habitat, biodiversity, threatened species, populations and ecological communities. It regulates the conservation of fish, vegetation and some aquatic macroinvertebrates and the development and sharing of the fishery resources of NSW for present and future generations. The FM Act lists threatened species, populations and ecological communities, key threatening processes (KTPs) and declared critical habitat. Assessment guidelines to determine whether a significant impact is expected are detailed in Sections 220ZZ and 220ZZA of the FM Act.

Another objective of the FM Act is to conserve key fish habitat (KFH). These are defined as aquatic habitats that are important to the sustainability of recreational and commercial fishing industries, the maintenance of fish populations generally and the survival and recovery of threatened aquatic species. KFH is defined in Section 3.2.1 and 3.2.2 of the *Policy and Guidelines for Fish Conservation and Management* (DPI 2013).

There are a number of KFHs noted within Area 1 of the NWR, including but not limited to Narran Lake, Narran River, Barwon River and Yambie Lagoon.

2.13 Crown Land Management Act 2016

The *Crown Land Management Act 2016* (Crown Land Management Act) provides for the ownership, use and management of Crown land in NSW.

The land within Area 1 of the NWR falls within the Western Division of NSW. The majority of this area is Crown land and vested in other parties through Western Lands leases. The Crown Land Management Act allows eligible Western Lands leases to be purchased and converted to freehold (except Lightning Ridge residential leases).

2.14 Water Management Act 2000

The objects of the *Water Management Act 2000* (WM Act) include the protection and sustainable use of water resources and to provide to the orderly, efficient and equitable sharing of water access.

Part 3 of the WM Act provides for the making of water sharing plans for any given water source or water management area in NSW.

The following water sharing plans are relevant to Area 1 of the NWR:

- Water Sharing Plan for the Intersecting Streams Unregulated River Water Sources 2011 – the Narran River Water Source applies to surface water in the NWR;
- *Water Sharing Plan for the Barwon-Darling Unregulated River Water Source 2012* – this WSP regulates the Barwon River that forms the southern boundary to the NWR;
- Water Sharing Plan for the NSW Great Artesian Basin Shallow Groundwater Sources 2020; and
- Water Sharing Plan for the NSW Great Artesian Basin Groundwater Sources 2020.

Opal mining does not tend to encounter groundwater due to the relatively shallow depth of the excavation. Water is required for some opal prospecting or mining activities such as wet puddling but the source of water supply can vary (including recycled water, bores and town water supplies).

If the opal mining activity requires access to groundwater or extraction of water from river flows, then the WM Act may be triggered. Access licences are provided for under Part 2 of the WM Act.

2.14.1 Activity approvals

The Water Management Act establishes two types of approvals, namely *controlled activity approvals* and *aquifer interference approvals*.

i Controlled activity approvals

The Water Management Act requires controlled activity approvals for certain activities on waterfront land, being:

a) the erection of a building or the carrying out of a work (within the meaning of the *Environmental Planning and Assessment Act 1979*), or

b) the removal of material (whether or not extractive material) or vegetation from land, whether by way of excavation or otherwise, or

c) the deposition of material (whether or not extractive material) on land, whether by way of landfill operations or otherwise, or

d) the carrying out of any other activity that affects the quantity or flow of water in a water source.

Waterfront land means:

a) the bed of any river, together with any land lying between the bed of the river and a line drawn parallel to, and the prescribed distance inland of, the highest bank of the river, or

i) the bed of any lake, together with any land lying between the bed of the lake and a line drawn parallel to, and the prescribed distance inland of, the shore of the lake, or

ii) the bed of any estuary, together with any land lying between the bed of the estuary and a line drawn parallel to, and the prescribed distance inland of, the mean high water mark of the estuary, or

b) if the regulations so provide, the bed of the coastal waters of the State, and any land lying between the shoreline of the coastal waters and a line drawn parallel to, and the prescribed distance inland of, the mean high water mark of the coastal waters,

where the prescribed distance is 40 metres or (if the regulations prescribe a lesser distance, either generally or in relation to a particular location or class of locations) that lesser distance. Land that falls into 2 or more of the categories referred to in paragraphs (a), (i) and (ii) may be waterfront land by virtue of any of the paragraphs relevant to that land.

Hence opal mining activities near rivers or lakes may trigger the need for a controlled activity approval.

ii Aquifer interference approval

An aquifer interference approval confers a right on its holder to carry out one or more specified aquifer interference activities at a specified location, or in a specified area, in the course of carrying out specified activities.

2.14.2 Water Sharing Plans

Water Sharing Plans (WSPs) are statutory documents dictating the management and sharing of water sources. The WSPs set the water management vision and objectives, management rules for Water Access Licences (WALs), what water is available within the various water sources, and procedures for dealing in licences and water allocations, water supply works approvals and the extraction of water. WSPs are designed to establish sustainable use and management of water resources and are periodically reviewed (every 10 years).

Each WSP documents the water available and how it is shared between environmental, extractive, and other uses. The WSPs outline the water availability for extractive uses within different categories, such as: local water utilities, domestic and stock, basic rights, and access licences. WSPs also establish trading rules and mandatory licence conditions that apply to licence holders within each water source.

2.14.3 Harvestable rights

Owners or occupiers of a landholding are entitled to collect a proportion of the runoff from their property in one or more dams located on a minor stream or unmapped stream and use the water without the need for a licence or water supply work or water use approvals. Harvestable Rights Orders are published in the NSW Government Gazette and specify the rules relating to harvestable rights.

Minor streams are defined as any stream or part of a stream that is a first or second order stream (defined using the Strahler system of stream ordering) that does not permanently flow and that does not at any time carry flows from a third or higher order stream.

In the Western Division of NSW (where the LRMCD is located), landholders may capture, store and use up to 100% of the average regional runoff for their property. The total capacity of all dams on a property allowed under the harvestable right is called the maximum harvestable right dam capacity (MHRDC). A MHRDC calculator is available on the WaterNSW website (WaterNSW 2021), which considers location, rainfall and variations in rainfall patterns.

If the total capacity of dams on a property exceeds the maximum harvestable right volume, a WAL and water use approval is required to authorise the take and use of water for the volume in excess of the maximum harvestable right volume. In addition, a water supply work approval is required for dams that exceed the maximum harvestable right volume.

The following classes of dam are not included in harvestable rights calculations:

- dams solely for the control or prevention of soil erosion, provided no water is reticulated or pumped from such dams and the size of the structure is the minimum necessary to fulfil the erosion control function;
- dams solely for flood detention and mitigation, provided no water is reticulated or pumped from such dams;
- dams solely for the capture, containment and recirculation of drainage and/or effluent, consistent with best management practice or required by a government agency or local government Council to prevent the contamination of a water source;
- dams approved in writing for specific environmental management purposes;
- dams without a catchment, such as 'turkey's nest' dams and ring tanks, provided no water from harvestable right works is diverted into them; and
- dams licensed under Part 2 of the *Water Act 1912*, which were initially licensed prior to 1 January 1999.

2.15 Rural Fires Act 1997

The *Rural Fires Act 1997* (Rural Fires Act) provides for the protection of people and property from bush fires, for the prevention and suppression of bush fires, and for the coordination of bush fire management in NSW.

In relation to environmental assessments and planning approvals, the Rural Fires Act (Sections 100C and 124A) broadly removes normal planning assessment and approval requirements under the EP&A Act and its instruments if the works are undertaken for emergency works. Those sections provide:

> **100C Carrying out bush fire hazard reduction work**
>
> (1) An environmental planning instrument under the *Environmental Planning and Assessment Act 1979* cannot prohibit, require development consent for or otherwise restrict the doing of—
>
> (a) emergency bush fire hazard reduction work on any land, or
>
> (b) managed bush fire hazard reduction work on land other than excluded land.
>
> (2) Part 5 of the *Environmental Planning and Assessment Act 1979* does not apply to or in respect of emergency bush fire hazard reduction work carried out on any land.
>
> (3) Part 5 of the *Environmental Planning and Assessment Act 1979* does not apply to or in respect of managed bush fire hazard reduction work carried out on land other than excluded land if—

(a) the work is carried out in accordance with a bush fire risk management plan that applies to the land, and

(b) there is a bush fire hazard reduction certificate in force in respect of the work and the work is carried out in accordance with any conditions specified in the certificate, and

(c) the work is carried out in accordance with the provisions of a bush fire code applying to the land specified in the certificate.

Note—

If work to which Part 5 of the *Environmental Planning and Assessment Act 1979* would apply but for this subsection is not carried out in accordance with this subsection, the person carrying out the work will be in breach of that Act.

124A Application of Environmental Planning and Assessment Act 1979

(1) An environmental planning instrument made under the *Environmental Planning and Assessment Act 1979* cannot prohibit, require development consent for or otherwise restrict the doing of any emergency firefighting act.

(2) Part 5 of the *Environmental Planning and Assessment Act 1979* does not apply to or in respect of any emergency firefighting act.

(3) A development control order within the meaning of the *Environmental Planning and Assessment Act 1979* does not have effect to the extent that it prevents or interferes with the doing of any emergency firefighting act.

(4) Subsection (1) applies to an environmental planning instrument made before or after the commencement of this section.

An emergency firefighting act means anything (other than emergency bush fire hazard reduction work) done or authorised to be done by a firefighting authority, during the course of bush firefighting operations, by or under this or any other Act.

Non-emergency works, including the establishment of fire trails and asset protection zones etc, are termed *managed bush fire hazard reduction work* and these works may require planning approvals or determination.

Note that Section 63 of the Rural Fires Act places certain duties on public authorities and the owners and occupiers of land to prevent or minimise bush fires.

The Rural Fire Service (RFS) has an Area Command for the North-Western region, which includes Walgett LGA; and an Area Command for the Western region which includes Brewarrina LGA. Area 1 of the NWR sits across both regions.

2.16 Biosecurity Act 2015

The NSW *Biosecurity Act 2015* (Biosecurity Act) provides a framework or the prevention, elimination and minimisation of biosecurity risks.

Biosecurity is a shared responsibility between government, industry and communities.

A biosecurity matter can include living things (other than humans), a disease or contaminant. Anybody (including public authorities) who deals in a biosecurity matter and who knows, or ought to reasonably know, the biosecurity risk posed, has a duty under the Biosecurity Act to prevent, eliminate or minimise that risk.

Relevant to Area 1 of the NWR, the duties imposed on occupiers of land include the need to prevent, eliminate or minimise any biosecurity risk from weeds (terrestrial an aquatic).

2.16.1 Biosecurity Regulation 2017

The Biosecurity Regulation 2017 (Biosecurity Regulation) includes provisions at Division 12 of the Regulation for the making of biosecurity management strategies and plans.

There is a published NSW Biosecurity Strategy 2013–2021 and also a North West Regional Strategic Weed Management Plan 2017–2022.

A North West Regional Strategic Weed Management Plan 2017–2022 has been prepared along with the broader NSW Biosecurity Strategy 2013–2021.

Division 8 of the Biosecurity Regulation deals with weeds and lists at Schedule 3 those weeds which must not be imported to or sold in NSW. Listed weeds include *Cylindropuntia* species, such as Hudsons Pear.

Biosecurity zones are established under the Biosecurity Regulation for various animals, plants and diseases.

Amongst other things, Area 1 of the NWR is within the declared biosecurity zone for the Cane Toad (*Rhinella marina*), Alligator Weed (*Alternanthera philoxeroides*), Water Hyacynth (*Eichhornia crassipes)* and Bitou Bush *(Chrysanthemoides monilifera* subsp. *rotundata*).

2.17 Environment Protection and Biodiversity Conservation Act (Commonwealth) 1999

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides for the protection of the environment and related assessment and approvals processes.

The key EPBC Act section of relevance is Section 12 which sets out the requirements for assessing impacts to matters of national environmental significance.

The nine matters of national environmental significance (MNES) are:

- world heritage properties;
- national heritage places;
- wetlands of international importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed);
- nationally threatened species and ecological communities;
- migratory species;
- Commonwealth marine areas;
- the Great Barrier Reef Marine Park;
- nuclear actions (including uranium mining); and
- a water resource, in relation to coal seam gas development and large coal mining development.

The EPBC Act applies to any group or individual (including State public sector agencies) whose proposed actions may have an impact on MNES. The assessment of MNES impacts is triggered if the proposal has the potential to have a *significant* impact on a MNES.

Note that one MNES is concerned with Ramsar wetlands, and the Narran Lake Nature Reserve is listed as a Ramsar site.

Narran Lake Nature Reserve also supports a significant number of migratory species including 14 species listed under international migratory species treaties and a further 26 species which are migratory within Australia.

2.18 Multiple determining authorities

It is conceivable that for a proposed opal mining or prospecting activity there may be more than one public authority which is required to authorise that activity through the issue of a licence, permit or approval.

When this occurs, there is no need for each public authority to separately prepare their own REF. One REF, if prepared properly, can allow each public authority to discharge their obligations under Section 5.5 of the EP&A Act.

Section 5.2 of the EP&A Act provides for such situations. It states:

> (1) Where the approval of more than one determining authority is required in relation to an activity or an activity of a specified class or description (either in respect of the carrying out of the activity or the granting of an approval in respect of the activity), the Minister may, by a Ministerial planning order, nominate a determining authority to be the nominated determining authority in relation to the activity or an activity of that class or description for the purposes of this Division.
>
> (2) Where, under subsection (1), the Minister has nominated a determining authority to be the nominated determining authority in relation to an activity or an activity of a specified class or description, any other determining authority which would otherwise be required to comply with the provisions of this Division in relation to the activity or an activity of that class or description is not required—
>
> (a) to comply with section 5.7(2) or (3), or
>
> (b) to comply with section 5.8,
>
> in relation to the activity or any activity which comes within that class or description but shall, in all other respects, comply with the relevant provisions of this Division.
>
> (3) A determining authority (other than the nominated determining authority) is required to forward to the nominated determining authority a copy of any submissions made to it under section 5.8(2) and to provide other information to the nominated determining authority, as required by the regulations, to enable the nominated determining authority to co-ordinate the preparation and furnishing of reports in relation to the activity or activity of the specified class or description.

No ministerial nomination has been made with respect to determining authorities for opal mining and prospecting.

There is, however, an established convention that the nominated determining authority is the authority proposing the activity (if that is the case) or the authority with principal control.

For the determination of Part 5 matters related to opal mining or prospecting, it is reasonable that DRNSW act as the nominated determining authority and prepare the REF on behalf of other determining authorities.

Section 5.4 of the EP&A Act provides, at subsection (c) that:

> Sections 5.5 and 5.7 do not apply to or in respect of the following (despite the terms of those sections)—
>
> …
>
> (c) an activity (or part of an activity) that has been approved, or is to be carried out, by another determining authority after environmental assessment in accordance with this Division

If there are, therefore, multiple determining authorities for any of the common activities assessed under this REF, then Section 5.5 of the EP&A Act (ie the duty to consider the environmental impact of an activity) does not apply to those determining authorities, provided that the REF has been prepared in accordance with the statutory requirements.

Although other determining authorities do not need to prepare separate REFs, those authorities do need to be aware of the existence of this REF in order for them to avail themselves of the provisions under subsection 5.4(c).

2.19 Strategic planning

Subsection 171(2)(q) of the EP&A Regulation requires consideration of applicable local strategic planning statements, regional strategic plans or district strategic plans made under the Act, Division 3.1.

2.19.1 Far West Regional Plan 2036

The NSW Government's *Far West Regional Plan 2036* is a 20 year blueprint for the future of the Far West, including the local government areas (LGAs) of Walgett and Brewarrina, as well as several other LGAs.

Walgett and Brewarrina LGAs are in the 'eastern area' of the Far West region. The Far West Regional Plan notes that the area is underpinned by mining and agriculture. The opal mining in Lightning Ridge, and diverse irrigated and broadacre cropping and grazing land uses are acknowledged.

The priorities for the eastern area of the Far West are:

- grow and diversify agribusiness;
- establish value-added manufacturing industries;
- capture economic benefits from mining;
- promote unique tourism opportunities to enhance the Far West as a quality tourism destination;
- sustainably manage water resources, including the Macquarie, Castlereagh, Barwon and Darling rivers;
- plan for and build community resilience to population and demographic change;
- resolve skilled worker shortages;
- build resilience to climate change and natural hazards; and
- capitalise on key freight corridors, including the Kamilaroi, Mitchell, Castlereagh, Cobb, Gwydir and Barrier highways and Kidman Way.

The main economic drivers are stated to be agribusiness, value-added manufacturing, mining and tourism.

2.19.2 Walgett Local Strategic Planning Statement

Walgett Local Strategic Planning Statement (LSPS) acknowledges to respective roles of "flat productive alluvial soils, opal enriched underground, red sandy ridges and occasional rocky outcrops over the Great Artesian Basin" (p7). Tourism is also a significant employment sector.

Relevantly, the Walgett LSPS states:

> Rich productive agricultural land and black opal deposits in Lightning Ridge are the natural assets which provide the foundations for supporting long term prosperity. In order to capitalise on these natural assets, agricultural and opal mining sectors will be supported, and the most productive land protected from land use conflict. (p 29)
>
> Opal mining has occurred within parts of the Lightning Ridge and Cumborah localities for more than 100 years and continues to be integral to the identity and economy of the area. (p 30)
>
> The contribution of Opal to the Shire's economy is significant both in terms of mining ($70 million) and as a visitor attraction. (p 30)
>
> Management and rehabilitation of opal prospecting sites in and around the Lightning Ridge area has historically been ad-hoc. This has resulted in changes to the landscape and remains a source of land use conflict. Council recognises that it will be important for the Shire to work with the Lightning Ridge Miners Association and NSW Government to improve the regulatory environment in a way which both avoids and mitigates sources of land use conflict, while supporting the continued viability of opal mining in the Shire. (p 30)

2.19.3 Brewarrina Local Strategic Planning Statement

The *Brewarrina Local Strategic Planning Statement* (LSPS) makes no specific commitments regarding opal mining or agricultural production in Area 1 however the vision is "a united and inspired community, valuing country and our heritage, working together for the future of our people and land".

The key industries are noted to be agribusiness, tourism and transport. The Brewarrina LSPS also seeks to protect and manage environmental assets and heritage.

2.19.4 NSW Minerals Strategy

The *NSW Minerals Strategy* (NSW Government, 2019) makes no specific reference to opal mining.

The stated goal of the Strategy is to significantly grow investment in mineral exploration and mining in NSW to position the state as a major global supplier of metals for the economies of today and the future.

2.20 Quality of the environment

There is no statutory definition of 'the quality of the environment' however the *Protection of the Environment Operations Act 1987* (POEO Act) includes, under Section 3, the objects of the Act which include:

c) to protect, restore and enhance the *quality of the environment* in New South Wales, having regard to the need to maintain ecologically sustainable development.

The interpretation of that expression is aided by refence to the other objects of the POEO Act at Section 3 which include:

d) to reduce risks to human health and prevent the degradation of the environment by the use of mechanisms that promote the following;

i) pollution prevention and cleaner production;

ii) the reduction to harmless levels of the discharge of substances likely to cause harm to the environment,

iii) (iia) the elimination of harmful wastes;

iv) the reduction in the use of materials and the re-use, recovery or recycling of materials;

v) the making of progressive environmental improvements, including the reduction of pollution at source;

vi) the monitoring and reporting of environmental quality on a regular basis.

Climate change can be added noting that a recent (2021) Land and Environment Court matter – *Bushfire Survivors for Climate Action Incorporated v Environment Protection Authority* [2021] NSWLEC 92 – Chief Justice Preston on found that the NSW Environment Protection Authority needed to develop guidelines and policies to protect the environment from climate change. The Court considered the EPA's statutory duty under Section 9(1) of the *Protection of the Environment Administration Act 1991* (NSW) (POEA Act), which provides as follows:

> The Authority is required to—
>
> (a) develop environmental quality objectives, guidelines and policies to ensure environment protection…
>
> In defining the nature and scope of the duty contained in section 9(1)(a), the Court had regard to the context and purpose of the duty. For reasons which are set out in the judgment, this necessitated reference to the objectives of the EPA itself, which are set out in s 6(1) of the POEA Act. The first objective in s 6(1) is "to protect, restore and enhance the quality of the environment in NSW, having regard to the need to maintain ecologically sustainable development".

Hence the provision at clause 171(2)(i) of the EP&A Regulation can be said to require consideration of:

- pollution and harmful waste;
- waste reduction and management; and
- climate change.

3 Activities

3.1 Why the REF is required

Part 10 of the Mining Act makes provision for persons to apply for an opal prospecting licence over an opal prospecting block. There is also provision under Division 2 of Part 10 for an opal prospecting licence to be subject to conditions. Mining leases are also provided for under Part 5 of the Mining Act. It is the exercising of these approval powers by the relevant public authority which triggers the need for a REF to be prepared so that the public authority can discharge duties imposed on it as a determining authority under Section 5.5 of the EP&A Act.

The activities assessed are those which are the subject of the licensing or leasing process although for this specific REF, not all of the activities are assessed. This REF assesses the likely environmental impacts of commonly used 'standard methods' for opal prospecting and opal mining in this region; and considers those methods if applied in Area 1 of the NWR. The details regarding the assumed standard methods are provided at Sections 3.4 and 3.5.

It is feasible that some opal prospectors or miners may propose to use methods other than those assessed within this REF. It is important to note that this REF does not consider those non-standard methods and a separate assessment of those methods may be required if they are proposed.

To ensure that the proposed methods of prospecting or mining align with those assessed in this REF, a checklist is used at the time of an application being made for a licence or lease. If the checklist confirms that the proposed methods conform with those assessed under this REF, then this REF can be relied upon as a basis for environmental assessment. If the methods do not conform with those assessed under this REF, then supplementary assessment may be required to adequately discharge the requirements of clause 171 of the Environmental Planning and Assessment Regulation 2021.

Note that the obligation to consider the environmental impacts of an activity pursuant to Section 5.5 of the EP&A Act is only discharged for a specific application to undertake opal prospecting or mining if both this REF and the checklist declaration by the applicant are *both* considered by DRNSW or other determining authorities. It is not sufficient to rely on this REF in the absence of a checklist declaration by the applicant for the permit, licence or lease.

For more information regarding the statutory and regulatory requirements, please refer to Section 2.

An example application checklist declaration is provided at Appendix G.

3.2 Opal prospectivity in Area 1

Opals in the Narran-Warrambool Reserve are found in two forms: rounded nodules, termed 'nobbies'; or in seams. The opal bearing material is a soft greyish claystone often referred to as 'opal dirt'. Opal is generally extracted by underground mining and a typical mining operation involves sinking a vertical shaft and driving horizontal shafts, or 'levels', to obtain opal dirt. Some open cut mining is also undertaken in the area. In areas where opals are found in seams, gemstones are usually recovered at the working face of the mine.

Mining generally occurs along defined low ridgelines (known as 'ridge country') where the opal bearing material is closer to the surface.

3.3 Description of the activity

Mineral exploration for opals is generally referred to as *opal prospecting*. It is conducted under an Opal Prospecting Licence or Mineral Claim. Opal Prospecting Licences are granted over much larger areas than those granted under a Mineral Claim but are purely for prospecting and do not authorise mining.

An Opal Prospecting Licence can only be granted over lands defined as an Opal Prospecting Block within an area designated as an Opal Prospecting Area under the Mining Act. An opal prospecting block may not exceed and area of 500 hectares.

Opal mining at within the NWR takes place within Opal Prospecting Areas (OPAs). There are four OPAs currently designated within the NWR. Notably certain land is not to be included in an opal prospecting area (refer to Section 233 of the Mining Act) such as land which forms part of a reserve or if the land has been determined to be *agricultural land* – which is a defined term under Schedule 2 of the Mining Act.

There are numerous methods used for opal prospecting and mining. Not all methods are assessed under this REF with Sections 3.4 and 3.5 providing details of standard methods assessed by the REF.

Importantly, if the proposed method is 'non-standard' and is not assessed under this REF, then the REF does not, for the purposes of Part 5 of the EP&A Act, discharge the duty to consider the environmental impacts of that 'non-standard' activity.

3.3.1 What is assessed under this REF?

There are two principal activities assessed:

- Opal prospecting; and
- Opal mining.
- Four standard methods of opal prospecting are considered (refer to Section 3.4). Only one method of opal mining is considered, being underground mining (Section 3.5).

3.3.2 What is not assessed under this REF?

Please note that some activities associated with opal prospecting and opal mining are not included in this REF.

Specifically, opal mining which uses trenching or open cut methods is not included. These methods, if proposed, will require assessment under a separate protocol.

The construction and occupation of dwellings, regardless of whether or not constructed in association with an opal mining operation, is also development not assessed under this REF.

Fossicking is not an assessed activity in this REF because DRNSW does not have an approval role for fossicking activities pursuant to Section 5.5 of the EP&A Act. Fossicking is identified as an existing and on-going activity at opal fields and is considered only in the context of cumulative impacts at Section 6.19.

Noodling is not assessed in the REF because it is not an authorised activity.

Note that some reference to these 'non-assessed' activities may be made within the REF but this is for completeness only.

3.4 Opal prospecting

Mineral exploration for opals is termed prospecting, conducted under an Opal Prospecting Licence or Mineral Claim. Opal Prospecting Licences are granted over much larger areas than those granted under mineral claims but are purely for prospecting and do not authorise mining.

An Opal Prospecting Licence can only be granted over lands defined as an 'Opal Prospecting Block' within an area designated under the *Mining Act 1992* as an 'Opal Prospecting Area'. There is one Opal Prospecting Area in REF Area 1 – OPA 4.

Opal is found by working underground from shafts, by auger/percussion drilling, by geophysical method, or remining old workings. Prospecting methods used are extremely variable and includes:

- Shaft sinking – this method includes sinking a shaft to intersect the claystone, then developing drives horizontally to test the value of the opal dirt. The shafts were traditionally sunk by hand or by Caldwell drill. This process is relatively slow and costly.

- Auger drilling – this method includes the introduction of the 230 mm diameter auger drill. This technology redirected the emphasis in prospecting away from shaft-sinking to gain access to the opal clays toward testing for the existence of the necessary overlying sandstone and looking for colour in the small sample of clays that the auger drill produces. In most cases, the use of auger drills to assess the opal-bearing potential of an area is quicker and more cost-effective than shaft-sinking.

- Percussion drilling – smaller-diameter (>120 mm) percussion drilling rigs have also been used in recent years with some success. Although they create a smaller hole, with smaller samples than auger drills, they are quicker and readily penetrate silcrete. Prospectors are required to backfill percussion drilling holes in accordance with department's standards.

- SIROTEM – a geophysical method – this method uses electrical current to measure the varying resistance of the underlying rocks, and in doing so, provides information that can be readily interpreted to indicate where sandstone, claystone and faults are likely to exist. The benefits of this method are that large areas of ground can be tested quickly to provide a comparative assessment of the areas before drilling. These geophysical techniques remain in their infancy as far as the opal fields are concerned but have the potential to become an important tool for the opal prospector.

In areas of multiple existing or proposed opal prospecting/mining claims it is important to be aware of the combined effects, or cumulative impacts of multiple activities on the environment. Generally mineral claims adjoin so whilst one mineral claim is small in size (generally 50 m x 50 m), the majority of mining takes place in clusters which increases the impact footprint. These clusters have the potential to create cumulative environmental impacts on the surrounding environment and should be considered when assessing any new mining activity. The Minerals Council of Australia *Cumulative Environmental Impact Assessment Industry Guide, 2015* can assist when assessing cumulative impacts of opal prospecting/mining clusters.

Please refer to Section 6 of this REF for further information on potential impacts associated with opal prospecting or opal mining for specific environmental aspects.

3.5 Opal mining

Opal mining and associated mining purposes are conducted on mineral claims granted by Mining, Exploration and Geoscience (MEG). By virtue of the grant of a mineral claim, mining using shaft sinking methods, and some mining purposes, are approved under the Mining Act for specific classes of mineral claims without the requirement for further approvals. There are seven classes of mineral claims and these are described in Table 3.1 below.

Table 3.1 Classes of mineral claims

CLASS A Standard Mineral Claim	**Size:**	Claim area must not exceed 2,500m².
	Shape:	Claim should be square in shape with sides 50m x 50m. Claim may be granted over a different shaped area if physical or legal constraints make a square claim area impracticable. In such case no single side is to be greater than 100m.
	Permitted Operations*:	Mining – Yes Prospecting – Yes Mining Purposes – Yes but only mining purposes related to mining operations carried out on the claim. Wet processing (opal puddling) is not permitted.
CLASS B A person who is, at the time of lodgement of an application for a mineral claim, the holder of an opal prospecting licence (being a licence having a term of 3 months)	**Size:**	Claim area must not exceed 2 hectares.
	Shape:	Claim must not have any side being greater than 200m in length. The claim area must be wholly within the boundary of the relevant opal prospecting licence.
	Permitted Operations*:	Mining – Yes Prospecting – Yes Mining Purposes – Yes but only mining purposes related to mining operations carried out on the claim. Wet processing (opal puddling) is not permitted.
CLASS C A person who is, at the time of lodgement of an application for a mineral claim, the holder of an opal prospecting licence (being a licence having a term of 28 days)	**Size:**	Claim area must not exceed 2 hectares.
	Shape:	Claim must not have any side being greater than 200m in length. The claim area must be wholly within the boundary of the relevant opal prospecting licence.
	Permitted Operations:	Prospecting: Yes. Mining and Mining purposes not permitted.
CLASS D Mining Purpose – processing,	**Size:**	Claim area must not exceed two hectares.
	Shape:	Claim must not have any side being greater than 200m in length.
	Permitted Operations:	Mining: No Prospecting: No Mining Purposes: Yes – "processing" only, subject to 5 (c) below
CLASS E Mining Purpose – Mullock stockpiling	**Size:**	Claim area must not exceed two hectares.
	Shape:	Claim must not have any side being greater than 200m in length.
	Permitted Operations:	Mining: No Prospecting: No Mining Purposes: Yes – stockpiling or depositing of overburden, ore or tailings only
CLASS F Prospecting Claim areas within the boundaries of Opal Prospecting Areas 1, 2 & 3, but not within opal prospecting blocks in the Narran-Warrambool mining reserve	**Size:**	Claim area must not exceed two hectares.
	Shape:	Claim must not have any side being greater than 200m in length.
	Permitted Operations:	Prospecting: Yes. Mining and Mining purposes not permitted.
CLASS G	**Size:**	Claim area must not exceed two hectares.
	Shape:	Claim must not have any side being greater than 200m in length.
	Permitted Operations:	Mining: Open Cut Mining Operations. Prospecting: Only in conjunction with open cut mining operations. Mining Purposes: Yes but only mining purposes related to mining operations carried out on the claim. Opal Puddling not permitted.

Source: NSW Government Gazette, No. 49, Friday 12 June 2015

Generally, opal mining is conducted on Class A and Class B mineral claims, however other classes of claims exist for other purposes such as wet puddling (Class D), storage of mullock (Class E), or large-scale open-cut mining (Class G). More than one class of claim can be held by a person at one time (such as a Class B for mining and a Class E for mullock stockpiling). Note that Class G claims for open cut mining are *not assessed* under this REF.

There are limitations on what activities are authorised under certain classes of mineral claims. Under Section 175 of the Mining Act, the Minister may include conditions that specify the nature and extent of prospecting and mining operations that can be carried out in respect of mineral claims.

Restricted (ie prohibited) operations on Class A and Class B mineral claims are:

- open cut operations (trenching);
- the use of a dry tumbler, a wet rumbler or other motorised revolving drum for the purpose of opal puddling; and
- the use of power operated equipment or machinery, which includes a bulldozer, ripper (whether self-propelled or towed), backhoe, dragline, cable scraper, face shovel, front end or overhead loader, skimmer, grab, bucketwheel excavator, trench cutter, grader, or suction pump.

Power operated equipment activities which *are* permitted on Class A and Class B mineral claims include:

- handheld pneumatic or electric pick, hammer or road breaker;
- shaft sinking equipment or machinery or drilling or boring equipment or machinery when used to sink a vertical or near vertical shaft or exploratory shaft, drill hole or borehole;
- windlass winch or elevator for transporting mined or excavated material to the surface; or
- equipment or machinery used to: load and transport previously mined or excavated material to a treatment plant; fill in, make safe or securely protect any shaft or excavation.

The above restrictions do not apply if operations are conducted in accordance with an approval issued by the NSW Resources Regulator (under delegation from the Secretary DRNSW).

For the purposes of assessment, being for all classes of mineral claim except Class G, the mining activities therefore included in this REF are:

- underground mining;
- the use of a dry tumbler, a wet rumbler or other motorised revolving drum for the purpose of opal puddling;
- the use of power operated equipment or machinery, which includes a bulldozer, ripper (whether self-propelled or towed), backhoe, dragline, cable scraper, face shovel, front end or overhead loader, skimmer, grab, bucketwheel excavator, trench cutter, grader, or suction pump;
- mullock stockpiling;
- handheld pneumatic or electric pick, hammer or road breaker;
- shaft sinking equipment or machinery or drilling or boring equipment or machinery when used to sink a vertical or near vertical shaft or exploratory shaft, drill hole or borehole;

- windlass winch or elevator for transporting mined or excavated material to the surface; or
- equipment or machinery used to: load and transport previously mined or excavated material to a treatment plant; fill in, make safe or securely protect any shaft or excavation.

3.5.1 Underground mining

Underground mining using the method of shaft sinking to gain access to underground operations is approved on grant of a mineral claim Class A or Class B.

This method involves sinking a shaft through the sandstone and conglomerate layers, either by hand or with a one metre Caldwell drill, to reach the claystone or ‘opal dirt’, where ‘drives’ or 'levels' are then dug horizontally through potential opal bearing material. These 'levels' are dug either by hand or using power tools such as jackhammers or underground hydraulic digging machines.

The claystone mined from the 'levels' is brought to the surface by motorised hoist or winch where it is transferred to a truck for transport to a wet puddling facility to process the opal dirt. Larger operators use a 'blower' that works like a large vacuum-cleaner, drawing the claystone to the surface through a series of pipes.

All underground operations require pillars to be retained and timber props to support the roof. If the pillars are mined out a ‘ballroom’ (vast unsupported areas) is created underground which over time can result in catastrophic cave-ins. Timber props are the most common type of support used and are commonly constructed from Cypress Pine (*Callitris glaucophylla*).

Source: EMM Consulting (A Young)

Photograph 3.1 Underground mining – shaft

Source: EMM Consulting (A Young)

Photograph 3.2 Underground mining – motorised hoist

3.5.2 Open-cut mining

Small scale open-cut mining can be conducted on Class A and Class B mineral claims with an approval as outlined above, or as part of a large-scale operation on a Class G two-hectare open-cut mineral claim. Open-cut mining involves excavating a large area with a bulldozer, cutting through thin layers of sandstone until the claystone level is reached. This kind of mining is generally restricted to areas where there has been previous significant underground working, or where subsidence has occurred. Once complete, open cut mines must be backfilled and revegetated.

Note that opal mining via trenching or open cut methods are *not assessed as part of this REF.*

The use of trenching and open cut methods is assessed under separate protocols.

Source: EMM Consulting (A Young)

Photograph 3.3 Open cut mining method

3.5.3 Opal prospecting

i Wet puddling

Wet puddling operations are conducted on Class D puddling mineral claims, or on an ancillary mining activity title granted under the Mining Act. Wet puddling processing operations typically serve 10 to 20 individual mining operations. Wet puddling is a process whereby opal dirt is delivered to the processing site and transferred into transit mixers, or agitators, and water is pumped in and mixed with the opal dirt. The fine portion of the opal dirt separates out and is discarded to a sediment dam. The coarse material is collected in a tray at the back of the mixer and hand sorted.

ii Dry puddling

Dry puddling employs the same principles as wet puddling, using a mechanical action to break up the dirt, instead of water. The machinery or 'trommel' can be driven by a small motor, or by hand. This method is generally less efficient than wet puddling and is generally used to reduce the bulk of the opal dirt before it is transported to a remote wet puddling site. Dry puddling is a restricted operation and requires further approval as stated above.

Source: EMM Consulting (A Young)

Photograph 3.4 Motorised opal puddling (wet)

3.5.4 Mullock stockpiling

Mullock is the material which is extracted in opal mining and left as overburden. Refer to Photograph 3.5.

Opal mining overburden (mullock) can be stockpiled in association with an individual mining operation. It is also common practice for opal miners to stockpile opal mining overburden (mullock) in communal locations colloquially known as 'communal mullock stockpiles' used by more than one opal miner.

Communal stockpiles in the mineral claims districts can reduce the environmental footprint of opal mining as they concentrate mullock stockpiling at specific locations.

Under the Mining Act, all mining operations and 'designated ancillary mining activities' such as mullock stockpiles need to be rehabilitated to be safe and stable.

Source: EMM Consulting (A Young)

Photograph 3.5 Mullock stockpiles

3.5.5 Fossicking

Fossicking is a lawful activity under the Mining Act but is *not assessed under this REF.*

DRNSW is not a determining authority for this activity under the EP&A Act because the approval of DRNSW is not required in order to enable fossicking to be carried out.

Nevertheless, for completeness it is noted that fossicking is a popular activity for tourists to the opal fields.

Consent from the holder of a mining authority, mineral claim or opal prospecting licence holder must be obtained before any fossicking activity on the land subject to the authority, claim or licence can commence.

Fossicking is allowed on Crown lands provided the consent of the lease holder or Crown land manager is first obtained.

Consent of the landholder must be obtained prior to fossicking on private land.

3.5.6 Noodling

Noodling (sometimes referred to as ‘specking’) refers to the informal methods of searching for opal specimens by picking over mullock heaps or mined areas.

Noodling is not an authorised activity and is *not assessed under this REF.*

3.6 Environmental impact assessment of these activities

The environmental impact assessment of the standard methods of opal prospecting, opal mining and mullock stockpiling within Area 1 (as described above) are discussed in Section 6.

4 Existing environment

4.1 Climate and weather

Area 1 of the NWR area is described by the *Bureau of Meteorology* (BoM) as having hot dry summers, with cold winters based on a standard 30-year climate (1961–1990). The regional climate is semi-arid with hot summers and mild winters.

The closest meteorological station to Area 1 is the Bureau of Meteorology (BoM) *Walgett Airport Automatic Weather Station* (AWS) located approximately 45 km to the south-east.

The mean annual rainfall measured at BoM station #048243, located at the Lightning Ridge Visitor Information Centre, is listed as 450 mm based on the data ranges since the station opened in 1997 to present day. Station #048168 located at Angledool, which has been measuring rainfall since year 1886 (to present), has a mean annual rainfall value of 460 mm. The rainfall is characteristic of wet summers and low winter rainfalls.

Table 4.1 displays a summary of the two BoM weather stations, one showing recent data series, with the second having a significant longer dataset (+130 years) of rainfall values. The monthly average temperature for station #048243 is also included.

Table 4.1 BoM mean climate summary at nearby stations

Month	Station #048243 (1997–2021)		Station #048168 (1890–2021)
	Temperature (˚C)	Rainfall (mm)	Rainfall (mm)
January	36.3	48.2	59.4
February	34.8	43.4	53.9
March	32.3	48.4	43.5
April	28.1	25.7	31.4
May	23.1	23.5	32.5
June	19.5	43.9	33.2
July	19.4	29.4	32.1
August	21.6	17.6	23.8
September	26.2	28.4	25.6
October	29.5	38.7	36.0
November	32.2	51.4	39.5
December	34.8	55.9	49.7

Meteorological data recorded by the BoM Walgett Airport AWS for the period between 2015 and 2019 were analysed and annual wind roses are presented in Figure 4.1. The winds recorded across all five years were predominately from the north-east and south-west. Annual average wind speeds ranged between 3.7 metres per second (m/s) and 4.1 m/s. The annual average frequency of calm conditions (wind speeds less than 0.5 m/s) ranged between 3.2% and 4%.

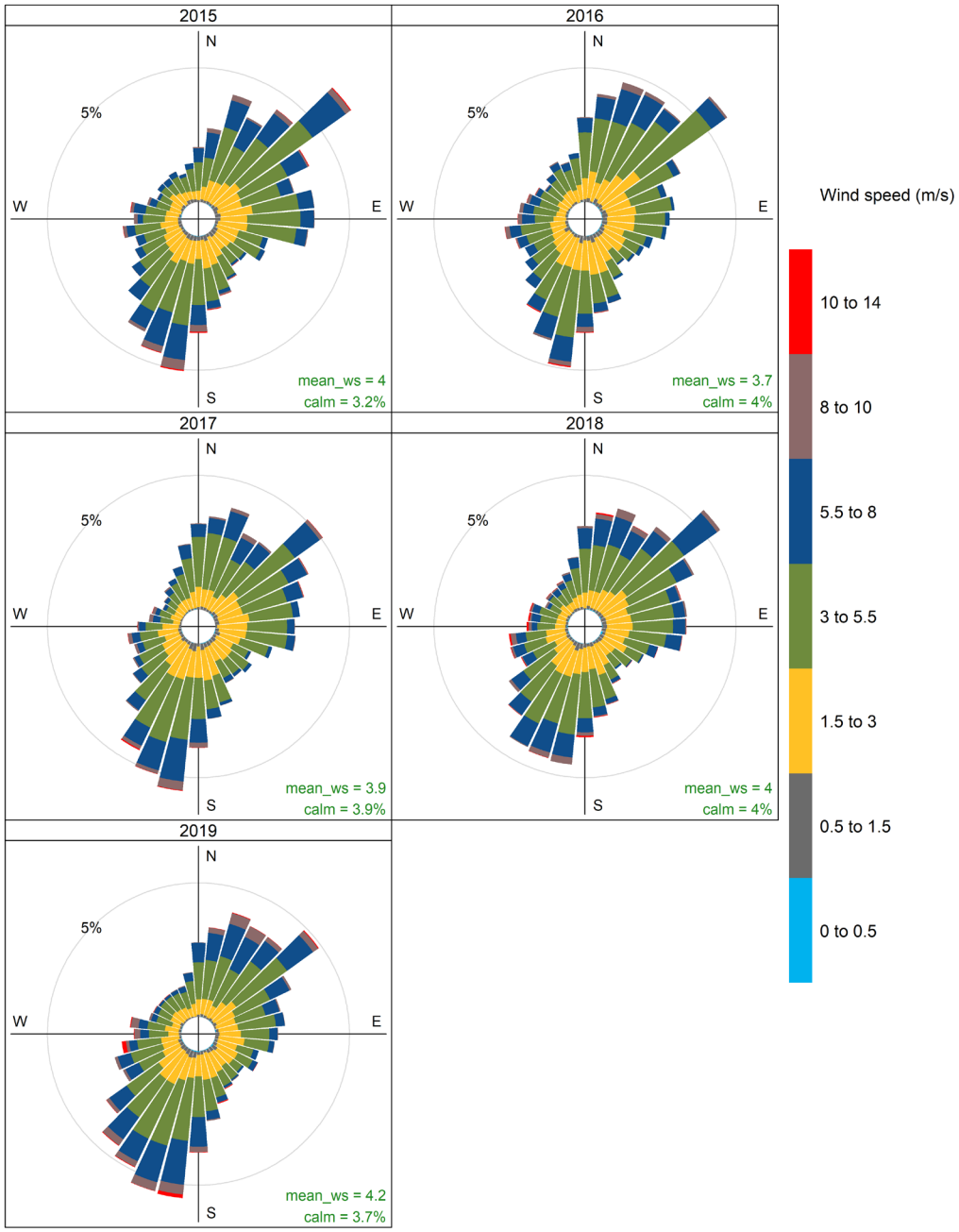


Figure 4.1 Annual wind roses for BoM Walgett Airport AWS, 2015–2019

The NSW Government has published the *Far West Climate Change Snapshot* (OEH 2014) which considers the mid-term (2030) and long-term (2070) projections for western NSW. An infographic illustrating the key trends is provided at Figure 4.2.

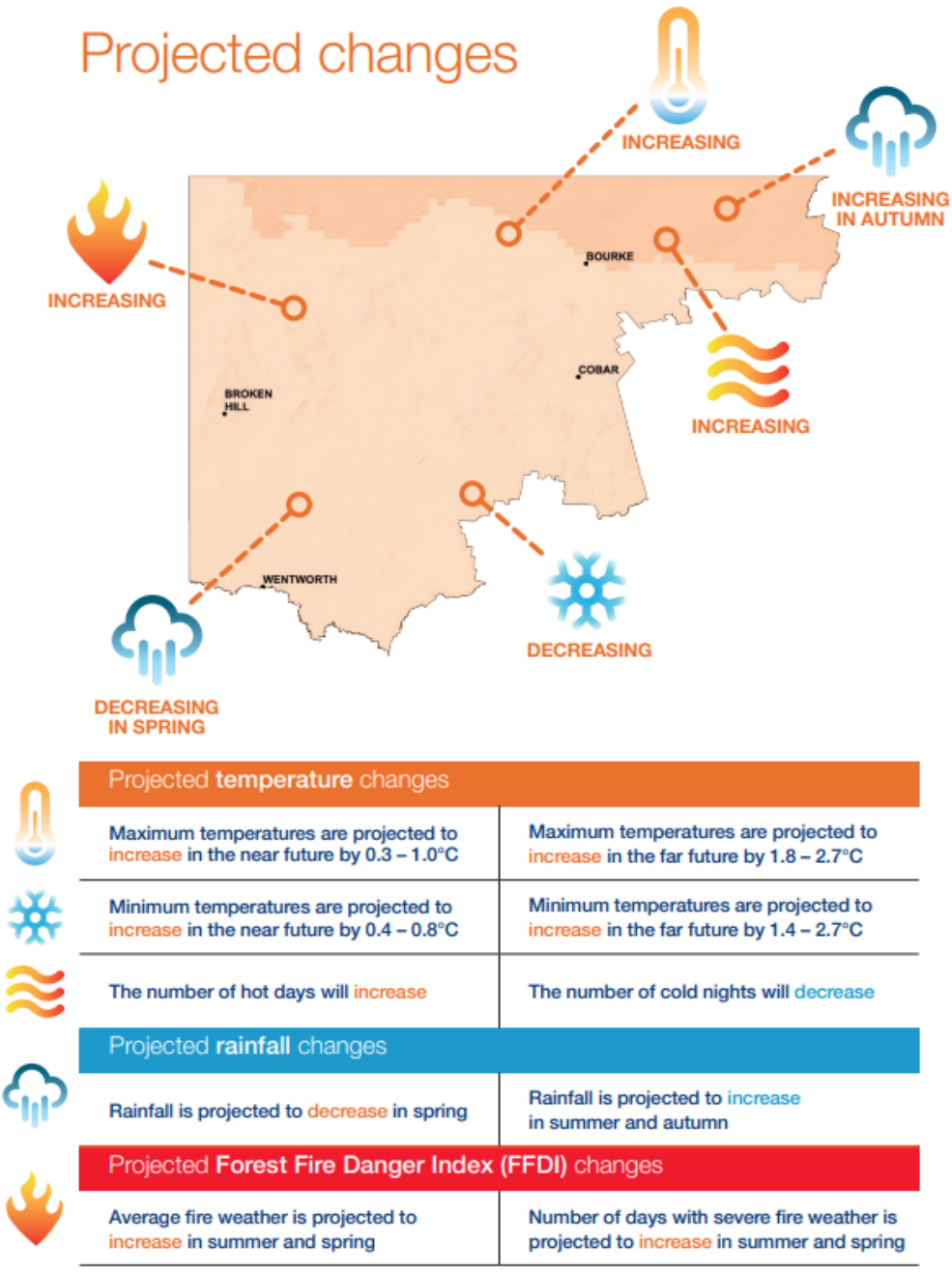


Figure 4.2 Far west climate change snapshot

Source: OEH 2014 Far West Climate Change Snapshot

4.2 Geology, topography and land use

Area 1 of the NWR falls within the southern portion of the Surat Basin, with opal-bearing geology associated with deeply weathered Cretaceous era sedimentary sandstones, mudstones and siltstones (Refer to Figure 4.3). Opal is primarily recovered in discontinuous clay beds (Finch Clay Facies, otherwise known as 'opal dirt') within or immediately below the Wallangulla Sandstone Member.

Area 1 is located within Australia's Great Artesian Basin (GAB). According to the Angledool 250,000 geological map of the area (2011b NSW) and the 2012 CSIRO report on the hydrostratigraphy of the GAB, the geological sequence from ground surface to depth is as follows:

- Czu – Quaternary aged undifferentiated unconsolidated sand, silt and clay, of fluvial, colluvial and minor aeolian deposits;
- Qc – Quaternary aged colluvial deposits unconsolidated red-brown fine to coarse grained sand with minor silt;
- T-Qg – Tertiary aged silcrete gravel with or without insitu silcrete;
- Krg – Cretaceous aged Griman Creek Formation (shallow Surat Basin) interbedded sandstone with rhyolitic detritus, siltstone and claystone, zone up to 30 metres below ground level (mbgl) hosts rock for opal mineralisation, regionally defined as a leaky aquitard;
- Krs – Cretaceous aged Surat siltstone interbedded siltstone and carbonaceous and pyritic mudstone defined as a leaky aquitard;
- Kwc – Cretaceous aged Coreena Member siltstone interbedded with mudstone, defined as an aquifer;
- Kwd – Cretaceous aged Doncaster Member mudstone with subdominant siltstone, defined as a leaky aquitard;
- Klb – Cretaceous aged Bungil Member fine grained lithic sandstone, siltstone, and mudstone, defined as an aquifer; and
- followed by Jurassic aged deposits which also form part of the deeper GAB.

Undifferentiated Quaternary colluvium and minor alluvial deposits cover most of Area 1 area except in the higher elevation areas where there are residual Tertiary gravels overlying weathered Cretaceous Griman Creek Formation. The shallowest Cretaceous formations (Krg to Kwd) are all part of the Rolling Downs Group.

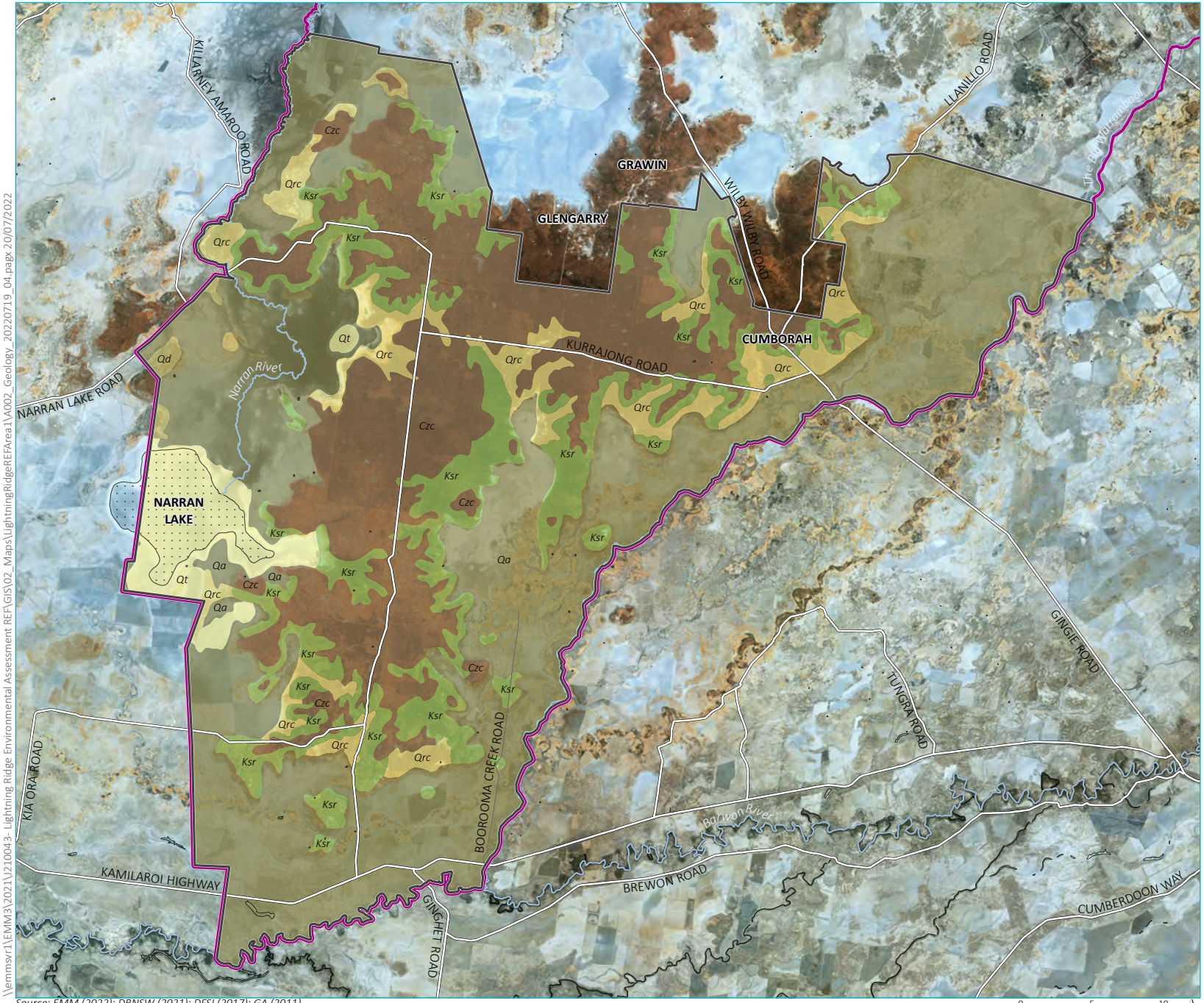
The mined opal is found at relatively shallow mining depths in the weathered Cretaceous sedimentary rocks. Opal is formed when there has been silica-rich water seepage into cavities, cracks, fossils and other structures in the weathered rock. Loss of water from the silica gel results in the hardening of the material and the gradual formation of opal.

Opal mined in the NWR is generally found at 6 to 18 mbgl in the deeply weathered claystone layer of the Griman Creek Formation of Early Cretaceous age. This formation forms a distinct layer below the sparse residual sandstone and conglomerate caps of Tertiary age (PB 2004).

Two types of opals are found in Area 1 of the NWR: rounded nodules, termed 'nobbies'; or in seams. In the southern part of the NWR, including Area 1, seams are more common. The opal bearing material is a soft greyish claystone often referred to as 'opal dirt' (PB 2004).

This main opal bearing geology typically presents as defined low ridgelines ('ridge country') where the opal is closer to the surface (DPIE 2021d). These ridgelines are slightly elevated (ranging from 150–170 m Australian Height Datum, mAHD) relative to the surrounding low-relief plains areas which are generally between 125–145 mAHD, with regional topographic relief tending from the north-east to south-west between the NSW-QLD border and Narran Lakes. Although the ridge country is the principal source of opal, the low relief planes also host opal, and opal prospects and mines (Friend 2012).

Land in Area 1 is predominantly used for rangeland grazing and areas categorised as ‘minimal use’ (OEH 2016). These minimal use areas correlate with the main opal-bearing ridge country (Lightning Ridge Land System) when cross-referenced with land capability and geological mapping (OEH 2016; DCA and CSIRO 2018) and hence opal prospecting and mining activities. Isolated areas of grazing (modified pasture) and dryland cropping also occur in the NWR (OEH 2016; RW Corkery 2002; Thompson, Mullins and Kent 2003).



KEY

- Area 1
- Narran- Warrambool Reserve

Existing environment

- Major road
- Minor road
- Named watercourse
- Named waterbody

Geology

Quaternary

- Quaternary lake deposits (Qt)
- Quaternary colluvium (Qrc)
- Quaternary dunes (Qd)
- Quaternary alluvium (Qa)

Cretaceous

- Cretaceous Rolling Downs Group (Ksr)

Cainozoic

- Cainozoic sedimentary rocks (Czc)

Source: EMM (2022); DRNSW (2021); DFSI (2017); GA (2011)

0 5 10 km

GDA 1994 MGA Zone 55

N

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Geology

Review of Environmental Factors
Figure 4.3

EMM
creating opportunities

4.3 Soils

i Australian Soil Classification

The Australian Soil Classification scheme (Isbell 1996) is a multi-category scheme with soil classes defined on the basis of diagnostic horizons or materials and their arrangement in vertical sequence as seen in an exposed profile. State-wide mapping identifies that Area 1 encompasses four soil orders; Vertosols, Chromosols, Rudosols and Kandosols), described in Table 4.2. Of the soil classifications identified, the Vertosols have the highest erosion risk (gully and tunnel erosion) and also the highest risk of generating turbid runoff, though the soil chemistry of individual soil types, primarily the Chromosols and Kandosols, could lead to dispersive behaviour such as high potential for erosion and sediment loss when exposed to concentrated surface water flows when disturbed or where appropriate soil protection measures are not implemented during rehabilitation.

Table 4.2 Summary of regional ASC soil mapping

Soil Type	ASC description [1]	Agricultural potential [2]
Chromosols (CH)	• Soils with strong texture contrast between A horizons and B horizons. The latter are not strongly acid and are not sodic. • Soils other than Hydrosols with: – a clear or abrupt textural B horizon; – in which a major part of the upper 0.2 m of the B2 horizon (or the major part of the entire B2 horizon if it is less than 0.2 m thick) is not sodic and not strongly acid; and – soils with strongly subplastic upper B2 horizons are also included even if they are sodic.	• Generally moderate agricultural productivity. • Moderate chemical fertility and water holding capacity, can be susceptible to soil acidification and soil structural decline.
Vertosols (VE)	• Clay soils with shrink-swell properties that exhibit strong cracking when dry and at depth have slickensides and/or lenticular structural aggregates. • Soils which have all the following: – a clay field texture of 35% or more clay throughout the solum except for thin, surface crusty horizons 0.03 m or less thick; – when dry, open cracks occur at some time in most years[3]. These are at least 5 mm wide and extend upward to the surface or to the base of any plough layer, self-mulching horizon, or thin, surface crusty horizon; and – slickensides and/or lenticular peds occur at some depth in the solum.	• Generally high agricultural potential. • High chemical fertility and water holding capacity but require significant amounts of rain before water is available to plants. • Gypsum and/or lime may be required to improve the structure. • Heavy plastic clays can be difficult to respread and cultivate, especially when wet. • Shrink-swell phenomena creates foundation problems for buildings and infrastructure.

Soil Type	ASC description [1]	Agricultural potential [2]
Kandosols (KA)	• Soils which lack strong texture contrast, have massive or only weakly structured B horizons, and are not calcareous throughout. • Soils other than Hydrosols which have all of the following: – B2 horizons in which the major part is massive or has only a weak grade of structure; – a maximum clay content in some part of the B2 horizon which exceeds 15% (ie heavy sandy loam, SL+); – do not have a tenic B horizon; – do not have clear or abrupt textural B horizons; and – are not calcareous throughout the solum, or below the A1 or Ap horizon or a depth of 0.2 m if the A1 horizon is only weakly developed.	• Generally low to moderate agricultural productivity. • Moderate chemical fertility and water holding capacity.
Rudosols (RU)	• Soils with negligible pedological development apart from minimal development of an A horizon or presence of less than 10% of a B horizon in fissures of the parent material or sapriolite. • Typically young soils where soil forming factors have had little time to pedologically modify parent rock or sediments.	• Most have low or very low agricultural potential. • Typically thin, rocky and/or sandy with low chemical fertility. • Alluvial soils can often have high agricultural potential.

1. per Isbell (2002)
2. per Gray and Murphy (2002)

ii Land systems mapping

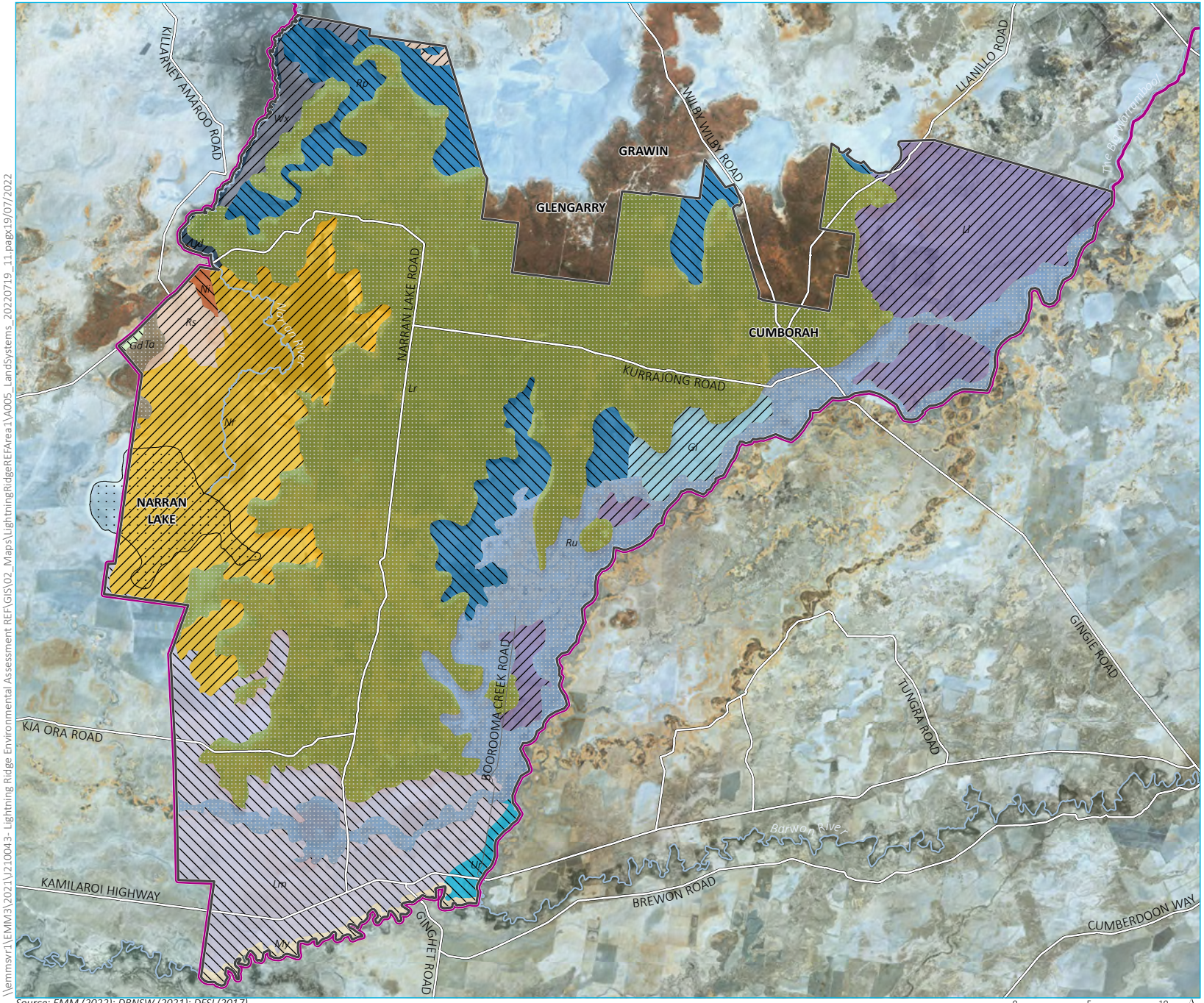
Soil landscape mapping for the western NSW area was undertaken by Walker (1991) and presented as the *'Land systems of Western New South Wales'*. A land system is an area characterised by recurring topographical, soil and vegetation systems. Land systems mapped in the Area 1 study area are depicted in Figure 4.4 and described in Table 4.3.

Table 4.3 Area 1 soil landscapes

Soil landscape	Overview	Geomorphology	Soils and vegetation	Erosion
Lightning Ridge (LSLr)	Gravelly red ridges with sandy plateaux and drainage lines, in the vicinity of Lightning Ridge.	Undulating ridges of Cretaceous claystone, siltstone and sandstone, with slightly sloping sandy plateaux, narrow dendritic drainage lines and small rounded pans; relief to 20 m.	Shallow to moderately deep red earths, sands and lithosols, with moderate to dense white cypress pine, bimble box, mulga and silver-leaf ironbark; clumps of budda; wire grass, wanderrie grass, buck spinifex, mulga grass, galvanized burr and forbs.	Minor to moderate watersheeting; some rilling on gravelly ridges.
Rotten Plain (LSRp)	Drainage plains with cracking clay soils, around Lightning Ridge.	Low-lying back-plains of Quaternary alluvium, periodically partially inundated by local run-off or floodwaters; depressed to 4 m.	Deep grey cracking clays, minor non-cracking clays; open with fringing coolibah and swamp wilga; copperburrs, dark roly-poly and forbs.	Nil.

Soil landscape	Overview	Geomorphology	Soils and vegetation	Erosion
Long Meadow (LSLm)	Open floodplains of the upper Darling and Barwon Rivers.	Extensive level floodplain of grey Quaternary alluvium, small level or slightly elevated areas of (older) brown Quaternary alluvium; narrow drainage lines; relief to 1 m.	Grey cracking clays, small areas of texture-contrast soils; coolibah and black box; Dillon bush, miljee, lignum, prickly wattle, golden goosefoot and thorny saltbush; neverfail, copperburrs, annual saltbushes and forbs, areas of mitchell grass.	Severe scalding of texture-contrast soils.
Llanillo (LSLl)	Timbered floodplain of the upper Barwon River.	Extensive floodplain of older (brown) and younger (grey) Quaternary alluvium; relief to 1 m.	Grey cracking and non-cracking clays, brown texture-contrast soils; dense to scattered coolibah, belah, bimble box, myall and whitewood; scattered to moderate budda, warrior bush, nepine and thorny saltbush; mitchell grasses, neverfail, annual saltbushes, copperburrs, grasses and forbs.	Minor to moderate scalding or pseudo-scalding of texture-contrast soils and non-cracking clays.
Gingie (LSGi)	Extensive plains north west of Walgett.	Plains of older (brown) and younger (grey) Quaternary alluvium; small sandy rises and minor drainage lines; relief to 3 m.	Grey cracking clays and brown texture-contrast soils; scattered to moderate myall, coolibah, belah, rosewood, leopardwood and whitewood; thorny saltbush, budda and warrior bush; mitchell grass, copperburrs and forbs.	Minor to severe scalding of more elevated plains with texture-contrast soils; minor windsheeting of sandy rises.
Narran (LSNr)	Narran Lake.	Extensive lakebed of Quaternary alluvium, filled by Narran River; associated lunette, salinas and small drainage basins; lunette relief to 5 m.	Grey cracking clays with bordering non-cracking clays, texture-contrast soils and sandy soils; treeless bed with fringing black box, coolibah and river cooba; areas of dense lignum; neverfail, copperburrs, sedges and forbs.	Moderate to severe windsheeting; watersheeting, scalding and rilling of lunette and eastern margins.
Rugby (LSRu)	Slightly elevated plains associated with minor tributaries of the Barwon River, east of the Narran River.	Slightly elevated older Quaternary alluvium, with through running and discontinuous drainage channels of younger alluvium; low sand dunes in some channel loops; relief to 3 m.	Red-brown texture-contrast soils, sands, non-cracking and cracking clays; sparse to dense bimble box, leopardwood, white cypress pine, coolibah and carbeen; dense to scattered budda; perennial grasses, copperburrs and forbs.	Minor to severe scalding of texture-contrast soils; minor windsheeting of dunes.
Nidgery (LSNi)	Floodplains associated with the Bogan, Culgoa and lower Barwon Rivers.	Extensive plains of grey and minor slightly elevated red-brown Quaternary alluvium; minor narrow, poorly defined drainage lines and swamps; relief to 1 m.	Deep grey cracking clays and minor red-brown texture-contrast soils; dense to open coolibah, black box, belah and myall; scattered lignum and swamp wilga; neverfail, warrego summer grass, copperburrs, annual saltbushes, other grasses and forbs.	Severe scalding of texture-contrast soils.
Rostella (LSRs)	Scalded and floodplain country along minor drainage tributaries of the Barwon River, west of the Narran River.	Older (brownish) and younger (grey) Quaternary alluvium with through-running drainage channels; dunes in some channel loops; relief to 5 m.	Grey cracking clays, non-cracking clays, brown texture-soils and sands; sparse to-dense coolibah and whitewood, leopardwood, gidgee and bimble box; scattered to moderate budda, warrior bush, nepine and thorny saltbush; warrego summer grass, annual saltbushes, copperburrs, grasses and forbs.	Moderate to severe scalding of texture-contrast soils and non-cracking clays.

Soil landscape	Overview	Geomorphology	Soils and vegetation	Erosion
Wombeira (LSWx)	Extensive, highly channelized floodplains along tributaries of Barwon River.	Extensive floodplain with dense network of incised shallow, stable channels of grey Quaternary alluvium; areas of slightly elevated, yellow and red-brown Quaternary alluvium; relief to 1 m.	Grey cracking clays, small areas of texture-contrast soils; generally treeless, with areas of scattered coolibah, whitewood and colane; miljee, lignum, thorny, saltbush, golden goosefoot, nitre goosefoot, cottonbush and old man saltbush; mitchell grasses, rigid panic, neverfail, warrego summer grass, annual saltbushes, copperburrs and forbs.	Severe scalding of texture-contrast soils.
Tatala (LSTa)	Undulating sandhills on Barwon floodplain.	Sandhills and hummocks of Quaternary sands, depressions of grey Quaternary alluvium; relief to 5 m, locally to 8 m.	Sands, along with yellow texture-contrast soils and grey cracking clays; open to dense white cypress pine, supplejack, wild lemon, wilga, coolibah, black box, bimble box and river red gum; scattered narrow-leaf hopbush, sandplain wattle and western boobialla; woollybutt, purple lovegrass, tall kerosene grass, other grasses, copperburrs and forbs.	Minor drift with minor to moderate windsheeting on lighter soils.
Eurie (LSUr)	Floodplain with well defined channels, adjacent to the Barwon River.	Floodplain of Quaternary alluvium dissected by many stable channels and with small levees of relief to 1 m.	Deep grey cracking clays with self-mulching surface, minor areas of brown texturecontrast soils; scattered to moderate black box, coolibah and belah; clumps of swamp wilga and lignum; rigid panic, neverfail, copperburrs, annual saltbushes and forbs.	Negligible except for scalding of levees and minor rilling of channel banks.
Goodooga (LSGd)	Extensive level mitchell grass plains in the Goodooga district.	Floodplain of Quaternary alluvium, with some slightly elevated areas and minor drainage sinks and channels; relief to 1 m.	Grey crab-holey clays and some non-cracking clays; open, with scattered gidgee, whitewood, prickly wattle; mitchell grass, neverfail, copperburrs, annual saltbushes and forbs.	Negligible except for minor windsheeting and scalding of slightly elevated non-cracking clays.
Mid-Darling (LSMy)	Darling - Barwon River and fringing river red gum forests.	Sinuous perennial stream incised into grey Quaternary alluvium; bed to 15 m deep.	Grey cracking clays; dense forests of river red gum, black box and coolibah, scattered lignum; annual forbs, warrego summer grass and other grasses.	Minor areas of sloping scalds near banks.
Upper Darling (LSUd)	Tributaries and distributaries of the Darling-Barwon Rivers, including the Culgoa, Birrie, Bokhara, Narran and Bogan rivers.	Sinuous, perennial major drainage tracts and associated floodplains of grey Quaternary alluvium, to 1 km wide; relief to 2 m; channels depressed to 15 m.	Grey cracking clays, small areas of texture-contrast soils; moderate to dense river red gum, coolibah, black box and river cooba; swamp wilga and lignum; neverfail, warrego summer grass, panics, copperburrs, annual saltbushes and forbs.	Moderate rilling of channel banks; localized gullying and scalding.



KEY

- Area 1
- Narran- Warrambool Reserve

Existing environment

- Major road
- Minor road
- Named watercourse
- Named waterbody

Land and soil capability

- Class 3
- Class 4
- Class 5 and 6

Land system name

- Eurie (Ur)
- Gingie (Gi)
- Goodooga (Gd)
- Lightning Ridge (Lr)
- Llanillo (Ll)
- Long Meadow (Lm)
- Mid- Darling (My)
- Narran (Nr)
- Nidgery (Ni)
- Rostella (Rs)
- Rotten Plain (Rp)
- Rugby (Ru)
- Tatala (Ta)
- Upper Darling (Ud)
- Wombeira (Wx)

Source: EMM (2022); DRNSW (2021); DFSI (2017)

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Land systems within Area 1

Review of Environmental Factors
Figure 4.4

EMM
creating opportunities

The Lightning Ridge Land System covers the majority of the Area 1. This land system is characterised by long (up to 1 km) gravelly ridges, plateaux and slopes, with relief between 3–20 m and slope up to 4%. Moderately deep sandy deposits and/or red earths with loamy sand topsoils occur on slopes and plateaux, with soil depth decreasing on ridges. Localised drainage depressions may be present, and some level dendritic drainage lines also occur; the latter are subject to minor sheet wash.

Much of the study area is covered by fifteen (15) soil landscapes generally characterised by gently undulating to flat alluvial plains with cracking and non-cracking deep grey Quaternary clays, commonly present around drainage lines such as the Barwon River and The Big Warrambool. These plains exhibit minimal to low relief (1–5 m) with large areas being subject to flooding, and small, localised areas of slightly elevated plains may also occur.

The Rugby and Gingie Land Systems (covering much of the south-eastern edge of the study area) exhibit some texture-contrast with some sandy rises and low dunes, with slopes of 1%–3% and relief up to 3 m.

The Tatala Land System is present in a small pocket of the western study area and is likewise characterised by undulating sandy rises on alluvial plains. Tatala Land Systems feature slopes of 2%–3% and relief up to 8 m. Soils are variable, including sands, texture-contrast soils and cracking clays.

iii Land and soil capability

The *Land and Soil Capability Assessment Scheme* (OEH 2012) ('LSC Scheme') assesses the inherent physical capacity of the land to sustain a range of land uses (and management practices) in the long term without leading to degradation of soil, land, air and water resources. The LSC Scheme considers the inherent biophysical features of the land and soil, and their associated hazards and limitations, to these land uses (Table 4.4). Each hazard is given a rating between 1 (best, highest capability land) and 8 (worst, lowest capability land). The overall LSC class of the land is based on the most limiting feature/hazard.

The LSC Scheme classes present withing Area 1 can be determined at various scales, ranging from state, regional to farm scale, varying in accuracy according to the information and resolution associated with them. With reference to the eSPADE database (OEH (2016) and OEH (2017e)) the state scale mapping completed for NSW shows the study area is Class 3, 4, 5 and 6. This represents land with a range of capability, from high capability to low capability land (Table 4.4).

Table 4.4 Land and soil classifications mapped for Area 1

LSC Class	Description	ASC (Land system)
Class 3 – high capability land	• Land has moderate limitations and is capable of sustaining high-impact land uses, such as cropping with cultivation, using more intensive, readily available and widely accepted management practices. Careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.	Vertosols (LSUr, LSGd, LSLm, LSMy, LSNi, LSRp)
Class 4 – moderate capability land	• Land has moderate to high limitations for high-impact land uses. • Will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology.	Vertosol (LSLl, LSNr, LSRs, LSUd, LSWx), Chromosols (LSGi)
Class 5 – moderate-low capability land	• Land has high limitations for high-impact land uses. • Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation.	Chromosols (LSRu)
Class 6 – low capability land	• Land has very high limitations for high-impact land uses. • Land use restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation.	Kandosols (LSLr), Rudosols (LSTa)

iv Inherent soil fertility

Inherent soil fertility is used as a general indication of a soil's capacity to retain and release nutrients and soil water for use by vegetation and is a function of the interrelationship between physical, chemical and biological components in the soil. The inherent fertility is derived using a relative classification based on the great soil group (GSG) classes.

Per the eSPADE database (OEH 2016) the soils of the project area have variable inherent soil fertility ranging from ‘moderate’ to ‘low’, being predominantly ‘moderate’ (Table 4.5).

Table 4.5 Inherent soil fertility

Inherent soil fertility	ASC	Description[1]
Low	Rudosols	Soils which, due to their poor physical and/or chemical status, only support limited plant growth. The maximum agricultural use of these soils is sparse grazing.
Moderately low	Kandosols	Soils with low fertilities that, generally, will only support vegetation suited to grazing with large inputs of fertiliser required to improve the soils and make them suitable for arable purposes.
Moderate	Vertosols, Chromosols	Soils with low to moderate fertilities which usually require fertilizer and/or have some physical restrictions for arable use.

1. Per Chapman (1978)

a Acid sulphate soils

The desktop assessment identified that there are no acid sulfate soils (ASS) or potential acid sulphate soils along the pipeline corridor, in accordance with the *Guidelines for the Use of Acid Sulfate Soil Risk Maps* (DLWC 2000). The *NSW OEH Acids Sulphate Risk Map* (OEH 2018) indicates that the nearest site with a high probability of ASS is more than 520 km east of the study area and as such the study area is at little risk from ASS. Acid sulfate soils are typically found in coastal areas which does not apply to Area 1.

4.4 Surface water

4.4.1 Overview

Area 1 forms part of the north-east portion of the Murray Darling Basin, draining generally to the south-west. Watercourses in the vicinity of Area 1 include the Narran River to the north-west, the Big Warrambool to the east and the Barwon River system which borders the southern extent of Area 1 and the NWR (Figure 4.5). The flow regimes of these river systems have been extensively modified since European settlement through construction of weirs and dams, vegetation clearing, and agricultural activity. Narran Lake, as well as a series of smaller surface water features including minor creeks, wetlands, swamps and waterholes, are scattered throughout Area 1. Water quality in the Narran River catchment and Barwon River in the vicinity of the NWR has been rated by DPIE (2019) as fair to good.

4.4.2 Regional hydrology

i Narran River system

The Narran River is an ephemeral eighth order watercourse which drains along the north-western border of Area 1 and has a catchment area of approximately 14,000 km^2. The Narran River is a terminating branch of the Balonne River, which is part of the Condamine-Balonne catchment. When in flood, every two to five years on average, the Narran River fills a series of lakes in the Narran Lakes ecosystem. Narran Lake is the terminal basin of the Narran River. When full, Narran Lake is one of the largest freshwater lakes in NSW. The most recent flow event in Narran Lake was in March 2020 following extended periods of drought. As Narran Lake is a terminal lake, outflow from the Narran River system only occurs through drainage into Narran Lake and by evaporation and seepage.

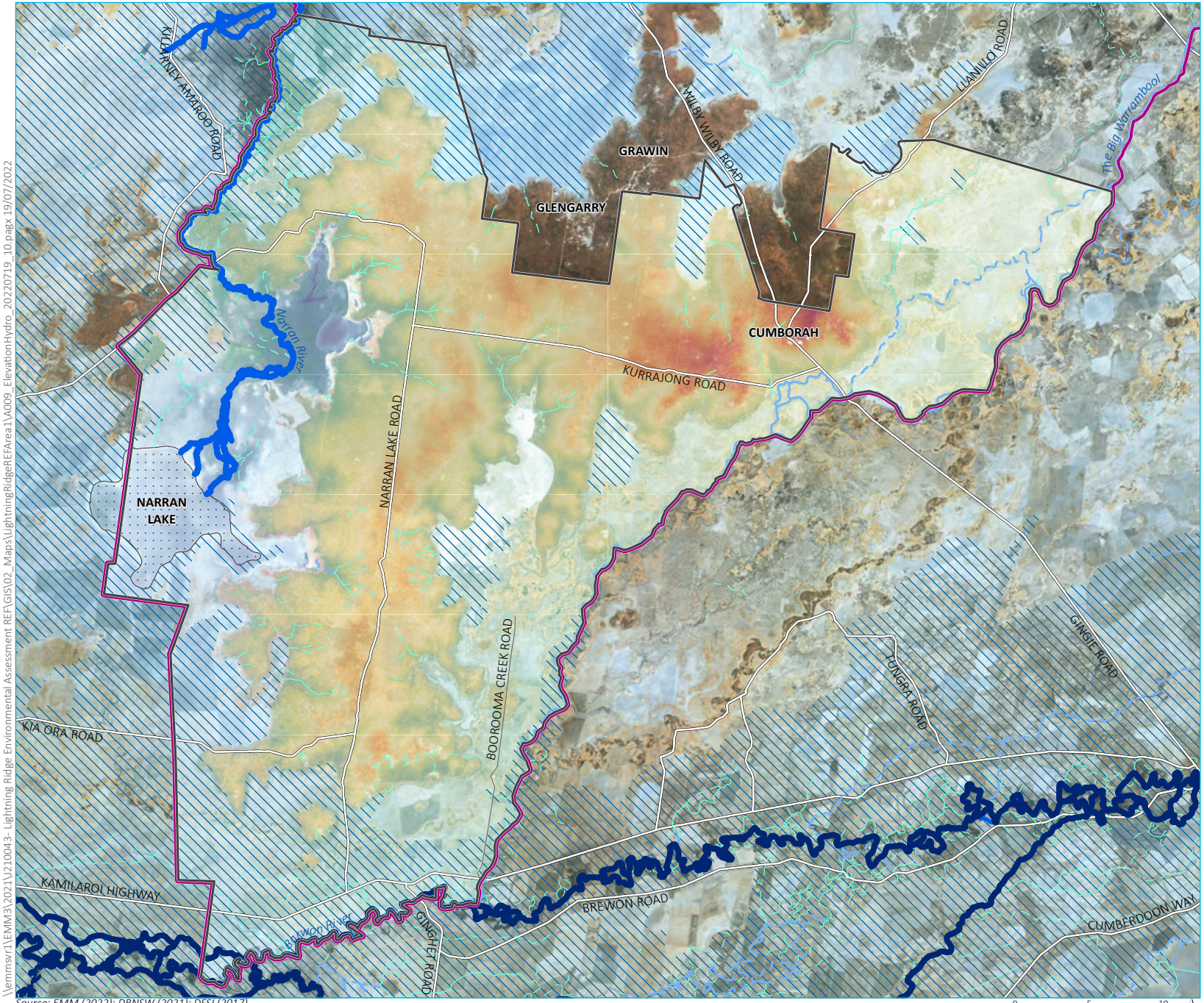
The Narran Lakes system includes portions of the Narran Lake Nature Reserve, which is listed as a site under the Ramsar Convention and has recognition as a wetland of international importance. The Narran Lakes area is also of extremely high value to the local Aboriginal people as a significant cultural site and meeting place.

ii The Big Warrambool system

The Big Warrambool is an ephemeral fourth order watercourse which drains along the eastern border to the Barwon River at the south-eastern extent of Area 1. Named watercourses that are tributaries to the Big Warrambool include the Forty Mile Warrambool and the Twenty Nine Mile Warrambool. The lower half of the Forty Mile Warrambool forms a third order watercourse which drains through the north-eastern extent of Area 1.

iii Barwon River system

The Barwon River system headwaters originate as the Macintyre River in the New England plateau, before flowing north to the Queensland border at Goondiwindi, then west to become the Barwon River outside of Mungindi. From Mungindi, the Barwon River flows south-west to Walgett, then forms the southern border of the NWR between Walgett and Brewarrina.



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Source: EMM (2022); DRNSW (2021); DFSI (2017)

Hydrology and elevation within Area 1

Review of Environmental Factors
Figure 4.5

EMM
creating opportunities

4.5 Groundwater

Area 1 is situated in the NSW portion of the Surat Basin, within the Great Artesian Basin (GAB). Minor shallow groundwater (unconfined) is likely to occur in saturated colluvial and alluvium formations located across the lowland areas of the landscape. Shallow groundwater (semi-confined) occurs in sandstone lenses within the competent rocks of the Cretaceous Rolling Downs Group. Deeper, regional groundwater is confined and artesian, occurring in the Jurassic Pilliga Sandstone (common name for the Gubberamunda Sandstone in this area).

The water table across Area 1 occurs in the localised saturated colluvial/alluvial formations, and uppermost rocks of the Rolling Downs Group, although depths are not easily identifiable from a review of reported standing water levels in nearby landholder bores. Generally, in the ridgeline areas groundwater is expected to exceed 15 metres Below Ground Level (mBGL) as opal workings within the area are all reported to be 'dry' and absent of groundwater inflow.

4.5.1 Groundwater use

Groundwater is used across Area 1 and its surrounds by both the environment and consumptive users as a water supply for commercial, stock and domestic and town water supply purposes. The following sections summarise the level of dependence on groundwater access.

There is very limited environmental dependence on groundwater across the area except in the immediate vicinity of Narran Lake. The water table and shallow semi-confined aquifers have no expression in the ridgeline areas of the landscape and do not support any terrestrial or aquatic ecosystems in these areas. Groundwater from the deep artesian aquifers can flow to the surface through defects in the sedimentary rocks and form mound springs. This is a rare occurrence across this area with only one mound spring known in the area. Most consumptive use is from deep artesian and sub-artesian bores in the productive Jurassic sandstone aquifers.

i Environmental users

A desktop assessment was undertaken to identify potential groundwater dependent ecosystems within the vicinity of Area 1 and the surrounding area. The desktop assessment involved:

- review of the *Groundwater Dependent Ecosystem* (GDE) *Atlas* (Bureau of Meteorology (BoM) 2021);
- review of the Water Sharing Plan (WSP) for the NSW Great Artesian Basin Shallow Groundwater Sources (2021a), GAB Surat Shallow Groundwater Source;
- review of the WSP for the NSW Great Artesian Basin Groundwater Sources 2020 (2021b), GAB Surat Groundwater Source;
- collation of depth to groundwater information from the NSW Department of Primary Industries and Environment (DPIE) Water database; and
- a review of aerial photographs, topographic and geological maps.

There is one 'high priority' GDE (Cumborah Springs) listed in the *WSP for the NSW Great Artesian Basin Shallow Groundwater Sources*. Cumborah Springs is located at the north-eastern extent of Area 1. There are four 'high priority' GDEs listed within the *WSP for the NSW Great Artesian Basin Groundwater Sources 2020*, of which one 'high priority' GDE is located within Area 1; a geothermal mound spring. This Cumborah Springs, the same GDE that is listed in the shallow GAB WSP.

A review of the Bureau of Meteorology (BoM) GDE Atlas (BoM 2021) identified various potential aquatic and terrestrial GDEs with a mapped 'high potential for groundwater interaction' located within the wider region. These include:

- the various wetlands making up the Narran Lake Nature Reserve (Aquatic GDE);
- riverine Chenopod Shrublands (Terrestrial GDE); and
- riverine Coolabah Woodland (Terrestrial GDE).

The majority of the potential terrestrial and aquatic GDE mapping centres around Narran Lake, as well as a series of minor creeks, wetlands, swamps and waterholes, scattered throughout Area 1. These aquatic and terrestrial ecosystems are thought to have a proportionate to obligate access on groundwater within the riparian corridor of creeks and wetland systems. The ridgeline areas do not support any terrestrial or aquatic ecosystems.

The locations of both high priority GDEs and those aquatic and terrestrial environmental users characterised as having a high potential for groundwater interaction are shown on Figure 4.5.

ii Third party or landholder bores

A review of the DPIE-Water groundwater bore database indicates that 35 regional groundwater bores are located within Area 1. Table 4.6 summarises the type and use of the groundwater bores identified within the study area. Abandoned, decommissioned, or non-functioning bores have been removed from Table 4.6.

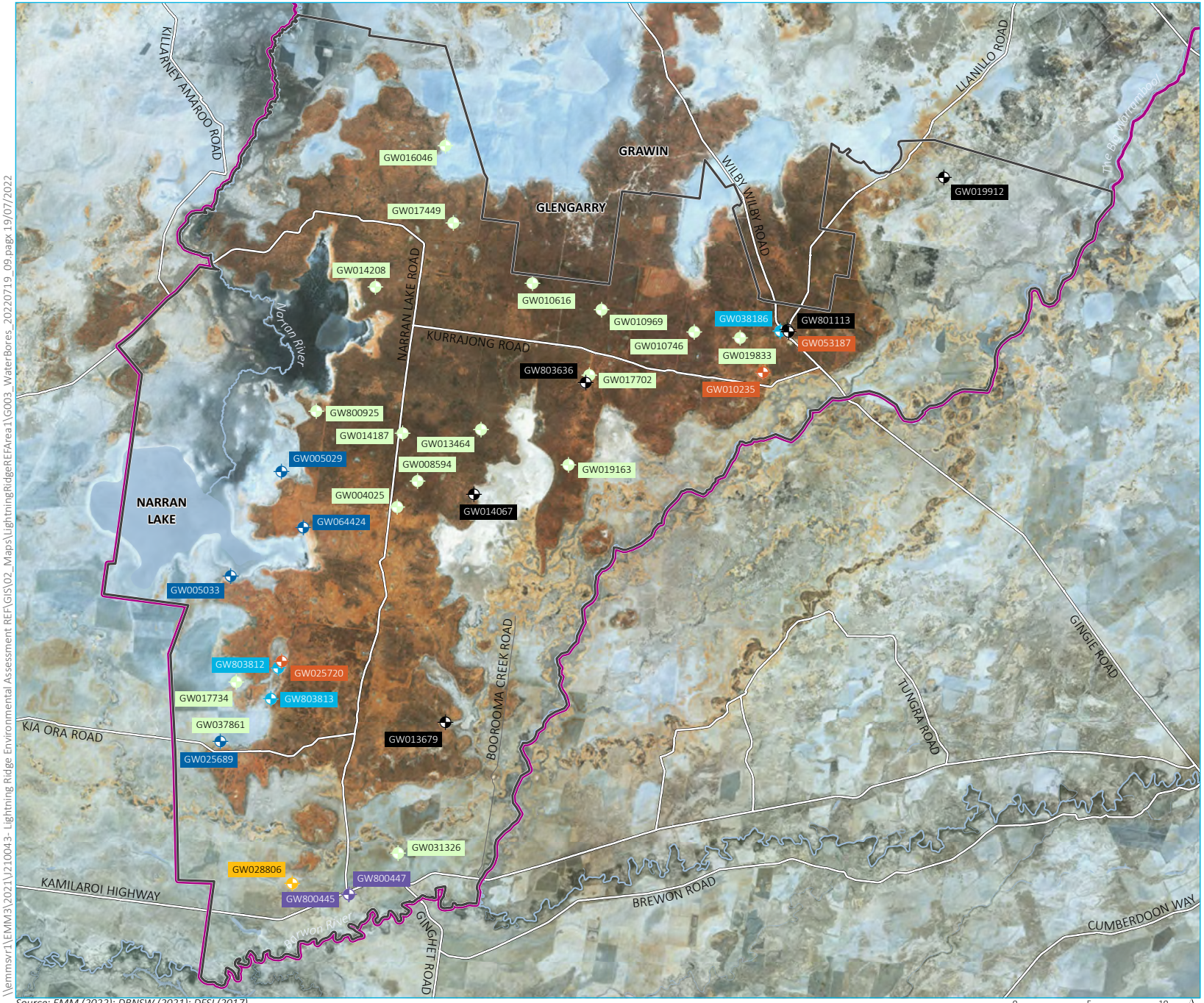
Table 4.6 Types and number of bores within Area 1

Use	Number of bores
Commercial and industrial	3
Exploration	3
Irrigation	3
Monitoring	1
Stock and domestic	16
Water supply	5
Unknown	4

Note - these actual or intended uses are taken from the WaterNSW groundwater data base and are known to not accurately represent the current uses of the existing bores

Most of the 35 registered bores access groundwater from the deeper aquifers of the GAB. Very few target the shallower and less productive groundwater stored in the sandstone lenses of the Rolling Downs Group.

Figure 4.6 shows the location of all the water bores within Area 1 based on the uses as described in the DPIE-Water groundwater bore database.



KEY

- Area 1
- Narran- Warrambool Reserve

Existing environment

- Major road
- Minor road
- Named watercourse
- Named waterbody

Water bore type

- Commercial and industrial
- Exploration
- Irrigation
- Monitoring
- Stock and domestic
- Unknown
- Water supply

Groundwater users located within Area 1

Review of Environmental Factors
Figure 4.6

Source: EMM (2022); DRNSW (2021); DFSI (2017)

0 5 10 km
GDA 1994 MGA Zone 55

N

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4.6 Vegetation

State Vegetation Type Mapping (SVTM – VIS_ID 4492) for the Western region (DPIE, 2018) predicts that there are 48 Plant Community Types (PCTs) present within Area 1 (refer to Table 4.7 for descriptions), conforming to 18 different vegetation classes and comprising more than 75% of the total of Area 1 (refer to Table 4.7). Of these, Western Peneplain Woodlands (60,188 ha), North-west Floodplain Woodlands (54,541ha), and Semi-arid Floodplain Grasslands (19,512 ha) are the most extensive, demonstrating a range of habitat types across Area 1.

Table 4.7 Vegetation classes within Area 1 (DPIE 2018)

Vegetation class	Number of vegetation communities (PCTs) mapped	Area (ha)
Floodplain Transition Woodlands	2	182.08
Gibber Chenopod Shrublands	1	1.84
Gibber Transition Shrublands	1	466.48
Inland Floodplain Shrublands	4	12,846.89
Inland Floodplain Swamps	3	262.59
Inland Riverine Forests	1	640.61
Inland Saline Lakes	3	7,052.58
North-west Alluvial Sand Woodlands	2	3,140.25
North-west Floodplain Woodlands	7	54,541.88
North-west Plain Shrublands	2	759.92
Riverine Chenopod Shrublands	7	5,358.57
Riverine Plain Woodlands	1	5,143.99
Sand Plain Mulga Shrublands	3	214.29
Semi-arid Floodplain Grasslands	3	19,512.35
Semi-arid Sand Plain Woodlands	1	392.34
Stony Desert Mulga Shrublands	1	10,526.99
Subtropical Semi-arid Woodlands	3	15,870.23
Western Peneplain Woodlands	3	60,188.58
Non-native vegetation	-	192.52
Total	**48**	**197,295**

4.7 Description of threatened species and ecological communities

Mapped within Area 1 are potentially eight threatened ecological communities listed under the BC Act and four also listed under the EPBC Act (Table 4.9 and Figure 4.7). The PCTs associated with these TECs are distributed evenly throughout Area 1 (DPIE 2018).

Two TECs are likely to be Serious and Irreversible Impacts (SAII) entities, these are:

- Artesian Springs Ecological Community in the Great Artesian Basin (*Endangered*); and
- Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions (*Endangered*).

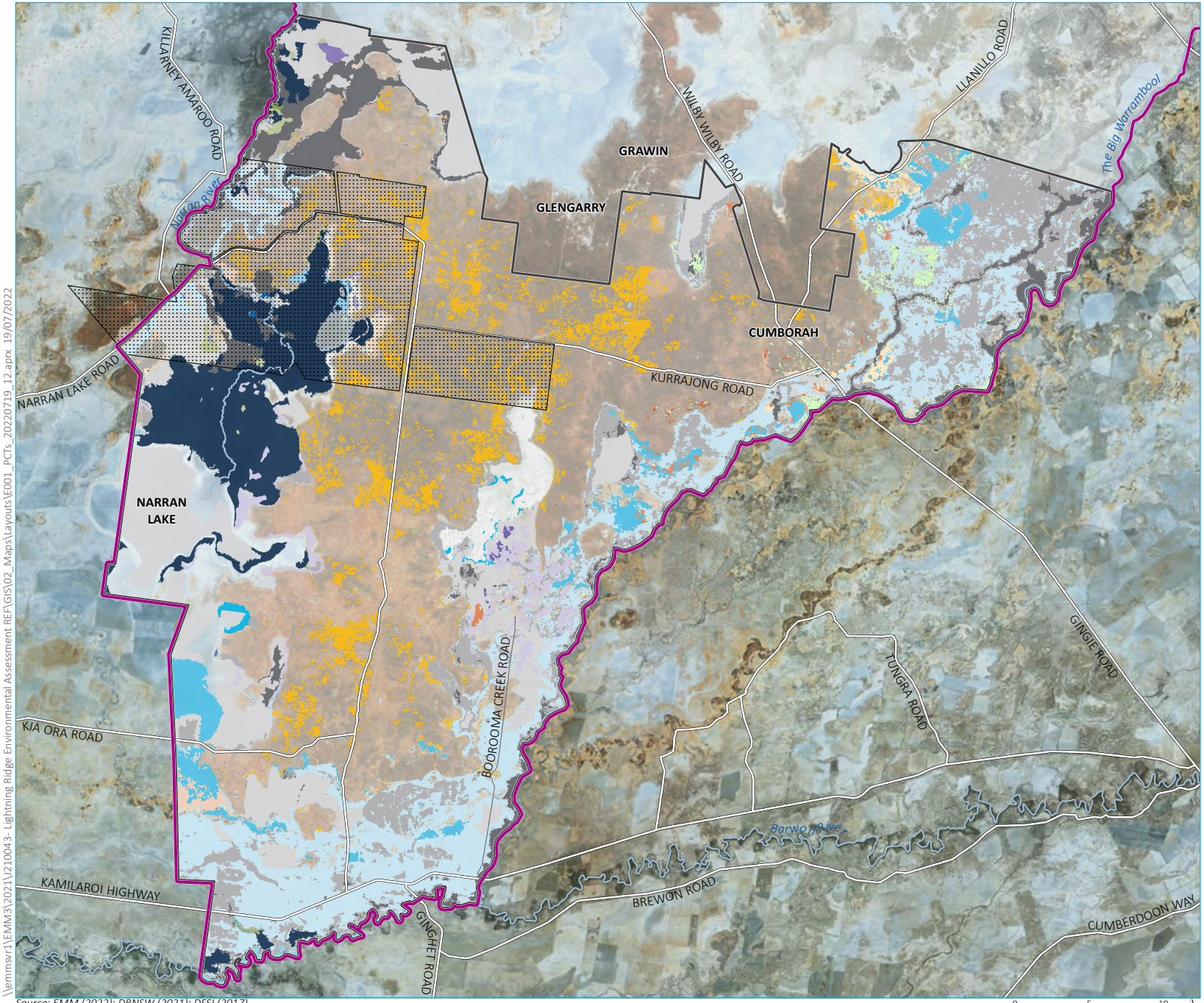
SAII entities can be communities or species but are identified as those at risk of serious and irreversible impact as assessed against the principles set out in clause 6.7 of the Biodiversity Conservation Regulation 2017 (BC Regulation). Under the guiding principles of SAII, the impacts from development or similar activities are likely to contribute significantly to the risk of extinction of a threatened species or ecological community, and may require further assessment in accordance with Section 9.1 of the BAM (DPIE 2020) as part of a biodiversity impact assessment for a future development application.

Table 4.8 PCT associations with Threatened Ecological Communities

Listing under the BC Act	Listing under the EPBC Act	Likely presence within Area 1	Associated PCTs
Acacia loderi shrublands (Endangered)	Not Listed	Not known or predicted to occur in Area 1	59, 118, 120, 125, 134, 139
Artesian Springs Ecological Community in the Great Artesian Basin (*Endangered*)[1]	Not listed	The known and predicted distribution occurs within the Area 1	24, 27, 36, 37, 39, 40, 43, 49, 53, 56, 87, 144, 158, 163, 168, 181, 195, 211, 212, 214, 238, 241, 244, 247
Native Vegetation on Cracking Clay Soils of the Liverpool Plains (*Endangered*)	Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland (*Critically Endangered*)	Not known or predicted to occur in Area 1	214
Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions (*Endangered*)	Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions (*Critically Endangered*)	Not known or predicted to occur in Area 1	27, 37, 49
Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions (*Endangered*)	Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions (*Endangered*)	The known and predicted distribution occurs within the Area 1	37, 39, 40, 55
Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions (*Endangered*)	Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions (*Endangered*)	Not known or predicted to occur in Area 1	55
Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions (*Endangered*)[1]	Not listed	The known and predicted distribution occurs within the Area 1	56, 87, 244
Carbeen Open Forest Community in the Darling Riverine Plains and Brigalow	Not listed	The known and predicted distribution occurs within the Area 1	56

Listing under the BC Act	Listing under the EPBC Act	Likely presence within Area 1	Associated PCTs
Acacia loderi shrublands (Endangered)	Not Listed	Not known or predicted to occur in Area 1	59, 118, 120, 125, 134, 139
Belt South Bioregions (*Endangered*)			

[1]Serious and Irreversible Impact (SAII) entity



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Source: EMM (2022); DRNSW (2021); DFSI (2017)

PCTs within Area 1 associated with State or Commonwealth listed Threatened Ecological Communities

Review of Environmental Factors
Figure 4.7

EMM
creating opportunities

4.7.1 Threatened terrestrial fauna

Threatened flora and fauna predicted or known to occur within a 25 km buffer of Area 1 are summarised in Table 4.9. These species were those collated from the BioNet records (OEH 2020) and the Protected Matters Search Tool (DAWE 2021). A low number of existing records were recorded within Area 1; this is likely to reflect low survey effort undertaken rather than a true reflection of species presence. The threatened species that were recorded within 25 km of Area 1 are concentrated around Narran Lake Nature Reserve (and associated Narran River), and the riparian zone of the Barwon River.

The predicted and known threatened fauna assemblage is dominated by bird species, with the highest number of sightings represented by bird species, including species associated with wetlands, woodlands, and grasslands (OEH 2020).

Koala Phascolarctos cinereus, Stripe-faced Dunnart (Sminthopsis macroura), Five-clawed Skink (Anomalopus mackayi), Kultarr (Antechinomys laniger), Yellow-bellied Sheathtail-bat (Saccolaimus flaviventris), Pale-headed Snake (Hoplocephalus bitorquatus) and Little Pied Bat (Chalinolobus picatus) were also recorded within Area 1 or in close proximity to Area 1. These species have a range of habitats from grasslands, shrublands, woodlands and riparian areas (OEH 2020).

There are two threatened fauna species likely to occur within Area 1 that are SAII entities, these are (Table 4.9):

- Red Goshawk (Erythrotriorchis radiatus); and
- Large-eared Pied Bat (*Chalinolobus dwyeri*).

Table 4.9 Threatened fauna species known or predicted to occur within 25 km of Area 1

Common name	Scientific name	NSW Status	EPBC Status	SAII entity
Amphibians				
Sloane's Froglet	*Crinia sloanei*	V	E	-
Birds				
Australasian Bittern	*Botaurus poiciloptilus*	E	E	-
Curlew Sandpiper	*Calidris ferruginea*	E	CE	-
Grey Falcon	*Falco hypoleucos*	E	-	-
Black Falcon	*Falco subniger*	V	-	-
Painted Honeyeater	*Grantiella picta*	V	V	-
Superb Parrot	*Polytelis swainsonii*	V	V	-
Australian Painted Snipe	*Rostratula australis*	E	E	-
Magpie Goose	*Anseranas semipalmata*	V	-	-
Blue-billed Duck	*Oxyura australis*	V	-	-
Freckled Duck	*Stictonetta nervosa*	V	-	-
Fork-tailed Swift	*Apus pacificus*	-	M	-
Black-necked Stork	*Ephippiorhynchus asiaticus*	E	-	-

Common name	Scientific name	NSW Status	EPBC Status	SAII entity
Spotted Harrier	*Circus assimilis*	V	-	-
Red Goshawk	*Erythrotriorchis radiatus*	E	V	Yes
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	V	-	-
Black-breasted Buzzard	*Hamirostra melanosternon*	V	-	-
Little Eagle	*Hieraaetus morphnoides*	V	-	-
Brolga	*Grus rubicunda*	V	-	-
Australian Bustard	*Ardeotis australis*	E	-	-
Bush Stone-curlew	*Burhinus grallarius*	E	-	-
Black-tailed Godwit	*Limosa limosa*	V	M	-
Red-tailed Black-Cockatoo (inland subspecies)	*Calyptorhynchus banksii samueli*	V	-	-
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	V	-	-
Major Mitchell's Cockatoo	*Lophochroa leadbeateri*	V	-	-
Barking Owl	*Ninox connivens*	V	-	-
Masked Owl	*Tyto novaehollandiae*	V	-	-
Brown Treecreeper (eastern subspecies)	*Climacteris picumnus victoriae*	V	-	-
White-fronted Chat	*Epthianura albifrons*	V	-	-
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis gularis*	V	-	-
Grey-crowned Babbler (eastern subspecies)	*Pomatostomus temporalis temporalis*	V	-	-
Varied Sittella	*Daphoenositta chrysoptera*	V	-	-
Dusky Woodswallow	*Artamus cyanopterus cyanopterus*	V	-	-
Hooded Robin (south-eastern form)	*Melanodryas cucullata cucullata*	V	-	-
Diamond Firetail	*Stagonopleura guttata*	V	-	-
Mammals				
Kultarr	*Antechinomys laniger*	E	-	-
Koala	*Phascolarctos cinereus*	V	V	-
Corben's Long-eared Bat	*Nyctophilus corbeni*	V	V	-
Little Pied Bat	*Chalinolobus picatus*	V	-	-
Large-eared Pied Bat	*Chalinolobus dwyeri*	V	V	Yes
Long-haired Rat	*Rattus villosissimus*	V	-	-

Common name	Scientific name	NSW Status	EPBC Status	SAII entity
Spotted-tailed Quoll	*Dasyurus maculatus*	V	E	-
Stripe-faced Dunnart	*Sminthopsis macroura*	V	-	-
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	V	-	-
Reptiles				
Five-clawed Worm-skink	*Anomalopus mackayi*	E	V	-
Pale-headed snake	*Hoplocephalus bitorquatus*	V	-	-
Yakka Skink	*Egernia rugosa*	V	V	-
Western Blue-tongued Lizard	*Tiliqua occipitalis*	V	-	-

Key: V = Vulnerable, E = Endangered, EP = Endangered population, CE = Critically endangered, M = Migratory
Data source: BioNet and PMST

4.7.2 Threatened terrestrial flora

There are eight threatened flora species predicted or known to occur within 25 km of Area 1. Winged Peppercress (*Lepidium monoplocoides*) and Phyllanthus (*Phyllanthus maderaspatensis*) were the only threatened flora recorded within Area 1 (refer to Table 4.10). Flora species such as Winged Peppercress and Slender Darling Pea (*Swainsona murrayana*) are typical species associated with floodplain habitats.

There is one threatened flora species likely to occur within Area 1 that is a SAII entity, Desert Cow-Vine (*Ipomoea diamantinensis*) (Table 4.10).

Table 4.10 Threatened flora species known or predicted to occur within 25 km of Area 1

Family	Scientific name	Common name	BC Act Status	EPBC Act Status	SAII
Shrubs					
Chenopodiaceae	*Atriplex infrequens*	Saltbush	V	V	-
Malvaceae	*Sida rohlenae*	Shrub Sida	E	-	-
Euphorbiaceae	*Phyllanthus maderaspatensis*	Phyllanthus	E	-	-
Forbs and grasses					
Brassicaceae	*Lepidium monoplocoides*	Winged Peppercress	E	E	-
Fabaceae	*Swainsona murrayana*	Slender Darling Pea	V	V	-
Fabaceae	*Swainsona sericea*	Silky Swainson-pea	V	-	-

Family	Scientific name	Common name	BC Act Status	EPBC Act Status	SAII
Climbers					
Convolvulaceae	*Ipomoea diamantinensis*	Desert Cow-Vine	E	-	Yes
Fabaceae	*Desmodium campylocaulon*	Creeping Tick-trefoil	E	-	-

Key: V = Vulnerable, E = Endangered, EP = Endangered population, CE = Critically endangered
Data source: BioNet and PMST

4.7.3 Aquatic ecology

The distributions of the following threatened species listed under the NSW *Fisheries Management Act 1994* (FM Act) are mapped within Area 1 (NSW DPI, 2021) and includes the Narran River and Barwon River catchments:

- Darling River Snail (*Notopala sublineata*) – critically endangered species;
- Silver Perch (*Bidyanus bidyanus*) – vulnerable species; and
- Olive Perchlet (*Ambassis agassizii*) – endangered population.

Additional freshwater fish species listed under the EPBC Act are predicted to occur in catchments in the locality (DAWE 2021). These include:

- Murray Cod (*Maccullochella peelii)* – vulnerable species;
- Trout Cod (*Maccullochella macquariensis)* – endangered species; and
- Macquarie Perch (*Macquaria australasica*) – endangered species.

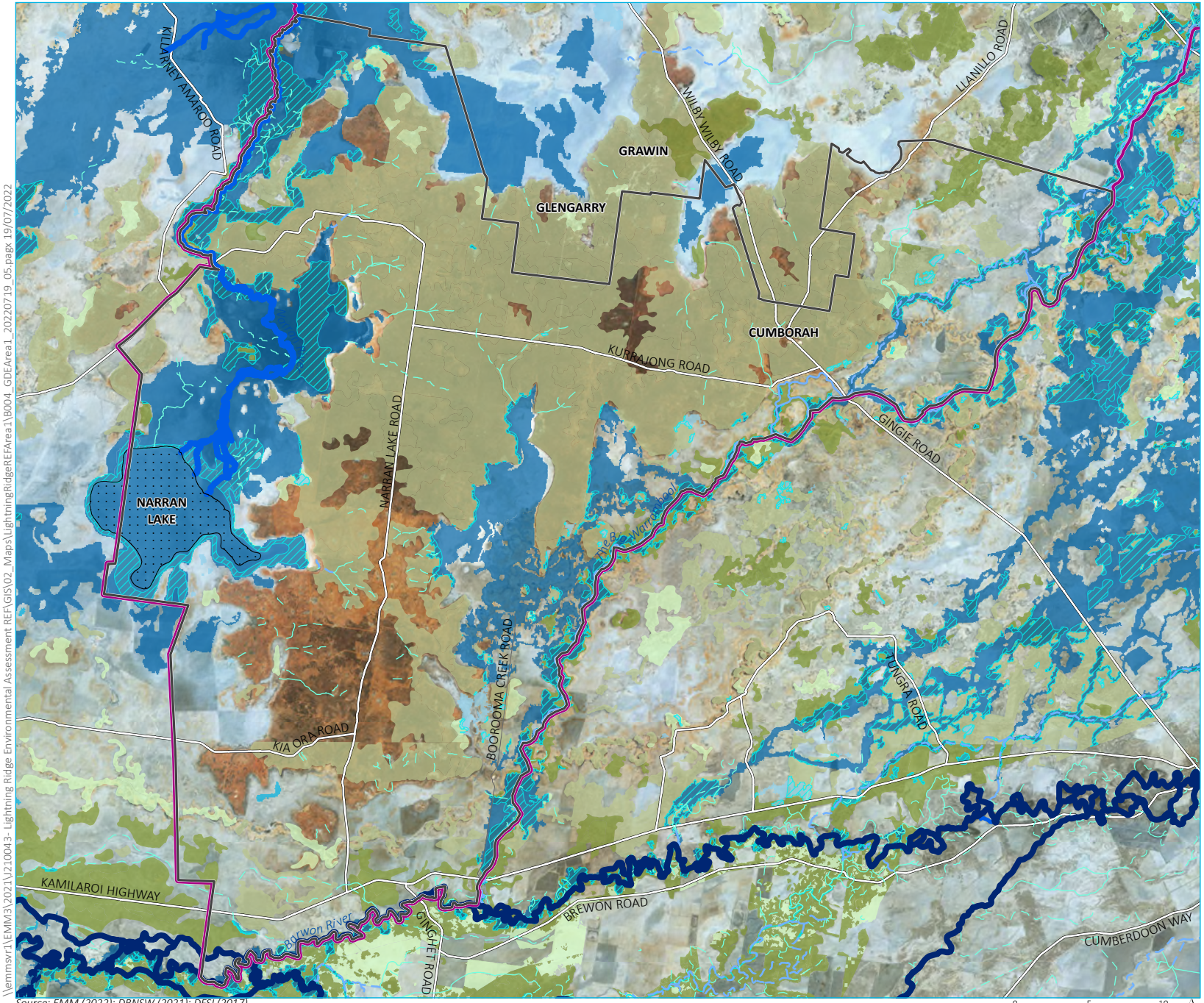
No threatened aquatic ecological community or other threatened fish species listed under the FM Act and EPBC Act, are relevant to Area 1 (DPI 2021).

4.7.4 Key fish habitat

The majority of the Narran Lake wetland complex within Area 1 is mapped as Key Fish Habitat as defined and mapped by the NSW Department of Primary Industries (DPI 2021), as too are the Narran River, Barwon River and parts of The Big Warrambool (tributary to Barwon River). Area 1 occurs within the broader Murray-Darling Basin – North Key Fish Habitat area (DPI, 2021).

4.8 Groundwater dependent ecosystems

Groundwater Dependent Ecosystems (GDEs) are represented within Area 1 by high potential terrestrial ecosystems, including low lying stony plains and low flat-topped hills surrounding the Narran Lake wetland complex and Barwon River flat areas, dominated by Coolibah (*Eucalyptus coolabah*) (BoM 2021). Moderate and low potential GDEs comprise a large area in the north of Area 1 and comprise low-lying stony plains and mesas with Bimble Box (*Eucalyptus populnea*) (BoM 2021). The dependence of native plant community types and streams within Area 1 on both groundwater and from the Great Artesian Basin GAB) would require further assessment for a future development application, supported by a groundwater assessment, if groundwater resources are to be intersected.



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Source: EMM (2022); DRNSW (2021); DFSI (2017)

Groundwater dependent ecosystems within Area 1

Review of Environmental Factors
Figure 4.8

EMM
creating opportunities

There are high potential aquatic GDEs mapped within Area 1, predominantly around Narran Lake complex and the multi-channelled floodplain of the Barwon River. These areas contain ecosystems that rely on surface expression of groundwater (BoM 2021).

4.8.1 Nationally important wetlands

Narran Lakes (No. NSW011) is listed on the Directory of Nationally Important Wetlands (DoEE 2018). It is also listed as a Ramsar wetland.

4.9 Matters of National Environmental Significance

A Protected Matters Search listed seven TECs, six birds, four fish, four mammals, four flora, two reptiles and 11 migratory terrestrial/marine/wetland bird species. These species are included in the Section 4.9 and Appendix A.

4.9.1 Ramsar wetlands

Narran Lake Nature Reserve is classified as a Ramsar wetland with the associated tributaries classified as Protected Riparian Land. Narran Lake Nature Reserve is located approximately 70 kilometres south-west of Lightning Ridge, 75 km north-west of Walgett and 50 km east of Brewarrina (Figure 1.1). The site is located on the terminal wetland system of the Narran River in the Murray Darling Basin. The site was listed as a Ramsar wetland in 1999 covering an area of 5,343 ha. In 2011 an extension of the site was proposed to capture additional waterbird breeding and foraging habitat adding a further 3,104 ha.

The Ramsar site contains two open water areas, Clear Lake and Back Lake. Annual inflows to the Narran wetlands are highly variable and is considered a boom-and-bust wetland in a semi-arid environment. Narran Lake Nature Reserve supports a significant number of migratory bird species including those listed under international migratory species treaties and those which are migratory within Australia. The site also supports substantial numbers of breeding waterbirds (Butcher et al 2011).

4.9.2 Threatened ecological communities and species

The following TECs were listed in the protected Matters Search as having the potential to occur within Area 1:

- Brigalow (*Acacia harpophylla* dominant and codominant) – Endangered Community;
- Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions – Endangered Community;
- natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland – Critically Endangered Community;
- Poplar Box Grassy Woodland on Alluvial Plains – Endangered Community;
- the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin – Endangered Community;
- Weeping Myall Woodlands – Endangered Community; and
- wetlands and inner floodplains of the Macquarie Marshes.
- Threatened flora and fauna species listed in the Protected Matters Search are included in discussions on Section 4.9.

4.9.3 Migratory species

There are a number of migratory species listed under international bilateral migratory agreements Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA), and Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA) utilising the riparian and lake areas, especially in the Ramsar listed Narran Lakes Nature Reserve, Narran River, and Barwon River (DAWE 2021).

There are 11 of migratory species predicted or known to occur with Area 1 as summarised in Table 4.11:

Table 4.11 Terrestrial and wetland migratory species known or predicted to occur within 25 km of Area 1 (DAWE 2021)

Common name	Scientific name	NSW Status	EPBC Status
Terrestrial			
Yellow Wagtail	*Motacilla flava*		
Fork-tailed Swift	*Apus pacificus*		
Satin Flycatcher	*Myiagra cyanoleuca*		
Rufous Fantail	*Rhipidura rufifrons*		
Wetland			
Common Sandpiper	*Actitis hypoleucos*		
Sharp-tailed Sandpiper	*Calidris acuminata*		
Curlew Sandpiper	*Calidris ferruginea*	E	CE
Pectoral Sandpiper	*Calidris melanotos*		
Latham's Snipe	*Gallinago hardwickii*		
Osprey	*Pandion haliaetus*		
Common Greenshank	*Tringa nebularia*		

Key: V = Vulnerable, E = Endangered, EP = Endangered population, CE = Critically endangered
Data source: PMST

4.10 Protected areas

Protected areas are set aside for conservation and managed by the NSW NPWS. The category of a protected area guides its management, and this differs according to the natural, cultural and social values of an area. Protected areas include Aboriginal areas, state conservation areas (SCAs), flora reserves, historic sites, Karst conservation reserves, national parks, nationally and internationally significant areas, nature reserves, regional parks, community conservation areas, wild rivers, wilderness areas and World Heritage areas.

There is one protected area within Area 1 of the NWR:

- Narran Lake Nature Reserve.

The Narran Lake Nature Reserve (NLNR) is located within the south-western portion of the NWR. The surrounding district is part of the semi-arid pastoral zone and is used primarily for sheep and cattle grazing. Some cropping occurs on floodplain and lakebed areas and there are extensive opal fields to the northeast and east of the NLNR.

The NLNR is managed in accordance with the *Narran Lake Nature Reserve Plan of Management* (2000).

Values associated with the NLNR include geomorphological, biological, Aboriginal cultural heritage, and historic cultural heritage. The reserve is of state significance for the following reasons:

- the NLNR contains a distinctive suite of important Aboriginal sites including extensive archaeological deposits with high potential to add to knowledge about Aboriginal use of north-western NSW;
- the NLNR is part of an area of very high Aboriginal cultural significance as an important meeting and ceremonial site for several tribal groups and the place of convergence of a number of major dreaming paths;
- the NLNR supports substantial breeding of waterbirds with 44 species having been recorded breeding at the reserve. Significant breeding populations of colonial breeding species including great eastern egret, glossy ibis, Australian white ibis straw-necked ibis, and royal spoonbill are supported at the site;
- the NLNR provides habitat for a number of waterbird species listed under the NSW *Biodiversity Conservation Act 2016*, such as the Australian Bittern, Brolga, Freckled Duck, Blue-billed Duck, Magpie Goose and Black-tailed Godwit; and
- the reserve supports populations of a number of mammal species which have disappeared from many areas of their former range in western NSW.

The management of the NLNR is subject to the following specific objectives:

- maintenance of diverse, healthy and productive wetland habitat and the value of the reserve as a major waterbird breeding area;
- improvement in knowledge of the species diversity and management needs of the reserve;
- fulfilment of the objectives of the Ramsar Convention and other international nature conservation agreements to which Australia is signatory;
- protection of significant Aboriginal sites from further erosion and improvement in knowledge about traditional Aboriginal use of the area;
- encouragement of regeneration of a natural vegetation cover in areas degraded by past grazing;
- control, and if possible elimination, of introduced species; and
- promotion of community awareness and appreciation of the conservation value of the Narran Lake system.

Use of the NLNR is restricted to public use and promotion, research and management operations.

Opal prospecting and mining are not provided for under the declaration of the NLNR nor under the Plan of Management for the NLNR. No assessment of opal prospecting or mining within NLNR is therefore undertaken.

4.11 Air quality

The air quality environment within and surrounding Area 1 is expected to be primarily influenced by fugitive dust during dry conditions, from agricultural activity and continental scale wind erosion from exposed ground, and to a lesser extent, local traffic travelling along sealed and unsealed roads, seasonal emissions from wood heaters or burning and episodic emissions from bushfires.

There are no proposed or existing major projects in the vicinity of Area 1 that would result in significant cumulative impacts with potential opal mining operations. Similarly, there are no commercial or industrial facilities in the vicinity of Area 1 that currently reports particulate matter concentrations to the National Pollutant Inventory (NPI). It is noted that the Kia Ore Feedlot is located to the south-west of the Area 1 boundary however, this facility has not reported particulate matter emissions to the NPI since financial year 2017/2018. It is noted that the feedlot has been registered for sale in previous years. The operation of the feedlot is currently unknown however the lack of particulate matter reporting in the last three years may indicate that it is no longer operating.

The closest NSW Department of Planning and Environment (DPE) air quality monitoring station (AQMS) is located at Narrabri, approximately 200 km east of Area 1. The Community DustWatch network, also operated by DPE, measures the dust PM_{10} concentrations. This data is used as an indicator for land management ie adequacy of ground cover in delivering healthy soils, clean air, functioning ecosystems and agricultural production). The Community DustWatch network includes 'nodes' at Walgett, immediately south-east of Area 1, recording hours of dust activity, defined as PM_{10} concentrations >25 µg/m³.

4.12 Noise

The noise environment of Area 1 is expected to be typical of a rural environment with ambient noise levels dominated by natural elements, with little or no road traffic noise and characterised by low background noise levels. Settlement patterns are typically sparse. There may be areas within the north of Area 1 that are possibly exposed to existing opal mining activities.

It is noted that much of the small mineral claims sites, prospecting and excavation of the claim in the search for opals is completed with simple hand tools.

4.13 Historic heritage

Area 1 is located within both the Brewarrina local Government area (LGA) and the Walgett LGA, County of Finch, and crosses over both the Parish of Boorooma and Parish of Cumborah. Area 1 extends through four pastoral runs, *Boorooma*, *Llanillo*, *Milrea* and *Wilkie Plains,* and encompasses Cumborah Town. Due to ample supply of water from Narran River, The Big Warrambool River and Narran Lake the four pastoral runs were criss-crossed with travelling stock routes (TSR), water reserves (WR) and cattle reserves (CR). Although the region has a history of mining and sheep, cattle also tended to do well throughout the runs. *Boorooma* was one of the largest and earliest stations in the region. Outstations, huts, woolsheds, wells and homesteads are peppered throughout Area 1, showing evidence of a strong and continuous agricultural history.

4.13.1 The environment of pre and early contact

Area 1 lies within the Kamilaroi language group. The Kamilaroi (also known as Gamilaraay, Gamilaroi and Goomilaroi) is one of the largest language groups in Australia. The Kamilaroi Peoples rely on the resources provided by the Barwon, Namoi, Peel and Darling rivers. The Narran Lake is also of significant value to the local mobs, as it includes both tangible and intangible cultural connections throughout the generations, and is part of a dreaming path (NSW National Parks and Wildlife Service 2000).

Evidence of occupation throughout the project area includes fish traps, rock art sites, shelters, quarry sites, modified trees, scatters, hearths, and burials (AHIMS 2021). The Kamilaroi have been caring for the land around Brewarrina and Walgett for over 40,000 years, and was home to at least 15,000 people.

4.13.2 Exploration and displacement of Aboriginal people

Settlement of the New South Wales interior began soon after Blaxland, Lawson and Wentworth's crossing of the Blue Mountains in 1813, but it took some time before Europeans passed into the Walgett region. In 1818 John Oxley led an expedition along the Castlereagh and Macquarie Rivers opening land south of the district (AMBS 2011, 22) Similarly, Charles Sturt's 1829 expedition to discover a fabled inland sea passed 32 km south of the current town of Walgett (Terry Kass 2003, 13). Oxley and Sturt's expedition encouraged squatters and pastoralists to spread into the region and by 1839 squatters from the east and south had established stock runs in the area (Terry Kass 2003, 13).

During this time numerous massacres were carried out on the Aboriginal Peoples throughout the area. The most well-known is the Myall Creek massacre which occurred in 1838 and resulted in the slaughter of 28 unarmed people from the Wirrayaraay mob (Tedeschi 2016, 1192).

4.13.3 Squatters and pastoralists

Land within the Walgett Shire was quickly claimed in the 1840s (Terry Kass 2003, 13). Drought from 1838 to 1840, and the British financial crisis of 1839 meant the first few years of the 1840s were a time of depression in the New South Wales colony, as such much of the land of the region was taken up by wealthy pioneering families (Fitz-Gibbon and Gizycki 2001). The wealthy families did not settle the runs themselves but employed managers to oversee the daily business of their investment (Terry Kass, 2003, p. 13). Sheep were believed to be too delicate to survive the arid conditions of the north-western plains and so cattle was initially the main focus of pastoral pursuits in the region (Terry Kass, 2003, p. 13).

Squatting landscapes had been driven by the settlers' desires to claim their land, the Lands Acts and regulations around improvement, and the environment itself. Settlers built huts, erected fencing, ringbarked trees and cleared the land. Huts were improved or abandoned, and larger, more modern, dwellings and farm infrastructure was built, trees were planted and grew tall, fences were replaced, and dry-stone walls were built and dismantled. The resulting landscapes were shaped by both broader economic and political processes and by the responses of the individuals (Stuart 1999, p. v). The very process of clearing and developing the land was seen as virtuous, productive and contributing to the progress of the colony. Moreover, the *Robertson Lands Acts* (1861) required settlers to improve the landscape. This was largely done by ring-barking to open up the land, promote grass coverage and fulfil their obligation to improve (Stuart 1999, p.320).

4.13.4 Travelling Stock Routes (TSR)

As pastoral holdings spread over New South Wales, interconnected parcels of land were reserved for the transport of stock from farms to markets. Travelling stock routes (TSRs), also known as long paddocks, are specially designated sections of Crown Land which form a continuous network of droving tracks, and include fenced areas and water sources allowing for drovers and their stock to camp overnight (Lennon, 2014, p. 47).

Two major travelling stock routes were established through the region running through the township of Walgett; the Lightning Ridge track; and the Wilby Wilby route (Terry Kass, 2003, p. 28). In 1888, a Travelling Stock and Camping Reserve (TS&CR) was proclaimed at the Cumborah Springs on the Wilby Wilby to Walgett route, drawing settlers to the area to take advantage of the TSR and travelling trade (Terry Kass, 2003, p. 28). From 1888, the Public Works Department began constructing water tanks along the routes and in 1889 the springs were fenced and established as Public Watering Places for the newly formed settlement of Cumborah. The township of Cumborah was proclaimed in 1896 and the settlement continued to be solely supplied by the spring into the 1920s (Walgett Shire Council, n.d.).

A significant north/south TSR is marked on the *Boorooma* plan. The route was proclaimed on 31 December 1883 and is numbered 1066, 1070, 1071 and 1072.

A TSR camp No.20 (C & TSR 678) was also established on the southeast boundary of *Boorooma* on the Barwon River in 1883. The camp offered a blacksmith shop, travellers' rest, store, kitchen, and stables. Stock yards and water tanks and wells are present along the route. An earlier camp reserve (No. 613), proclaimed in 1881, is present in the north of the property at the termination of the marked sections of the stock route and an outstation cottage and hut sits on the northern border of *Boorooma*, which likely also served a function in the TSR (HLRV *Boorooma Pastoral Run*).

The numerous Water Reserves (WR) in the project area are likely due to the artesian basin, which means a consistent supply of water all year round; an extremely attractive addition when considering Australia's harsh climate.

4.13.5 Opal

Opal had first been discovered at Lightning Ridge in the 1880s, but did not start being mined until the twentieth century (Kass, 2003, P. 26). Jack Murray established a shaft at Lightning Ridge in around 1901 and by 1903 local mining warden, T A Ridley, recorded a number of mine shafts and 18 men prospecting for opal (Terry Kass, 2003, p. 28). By 1906 the Lightning Ridge opal boom was well under way and 2,000 acres (809 ha) within Western Lands Lease 544 had been reserved for opal mining (Terry Kass, 2003, p. 26). The opal mining activity was considered a significant enterprise and the miners camp, which included places of leisure and businesses, was declared the *Wallangulla* village.

A second opal field was discovered in the district at Grawin, northwest of Cumborah, in 1926 (Terry Kass, 2003, p. 27). Opal mining activity in the region decreased over the middle of the twentieth century and the in 1959 Lightning Ridge Township was declared as 'almost dead' (Terry Kass, 2003, p. 28). Electricity, piped water and the construction of paved roads brought new life to the town in the 1960s and the discovery of major opal finds in the region over the 1980s made Lightning Ridge a tourist destination (Kass 2003, p.28).

4.13.6 Cumborah

In 1861 *Cumborah Springs* run was leased by Thomas Gordon Dangar (Member of Parliament) for £ 3 and 5/ ("Advertising" 1861) after the enactment of the *Crown Lands (Alienation of) Act* (24 Victoria c 15, 1860). By 1862, *Cumborah Springs* was advertised as '…first-class sheep country…' and available for sale through the Squatters Exchange in Sydney ("Advertising" 1862). W.B Walford and W. Sparke are shown as the lessees of *Cumborah Springs* by 1866 ("Appraisement Of Runs." 1866). The succession is unclear from this point.

The town of Cumborah was gazetted in 1896, which is the same year a portion of land within the town of Cumborah was reserved from sale for use as a public school ("Reserve From Sale For Public School Purposes." 1896). The Cumborah public school was of mud brick build. It is unclear whether the school still exists, but aerial imagery identifies buildings in the vicinity of the school block. As the town was becoming established, a general cemetery at Cumborah was dedicated on 5 June 1897, with a section for both the church of England and the Roman Catholic Church ("Lands Department Notices." 1907). In 1915 a small timber church (WLEP item I40) was built in town, known as St Peter's In The Pines.

4.13.7 Pastoral runs

The original boundaries of *Boorooma* run makes up over half of Area 1, the rest includes the eastern runs, *Llinillo, Milrea* and *Wilkie Plains*. Each of these runs produced cattle initially in the 1840s and then sheep; many of these properties still run stock today. The runs, as shown in early parish maps consisted of stock yards, woolsheds, homesteads, outstations, huts, wells, tanks and dams. Each of the properties appears to use the available TSRs to move the stock (likely encouraged by different seasons) around the runs freely.

i Boorooma run

Boorooma was one of the earliest runs taken up on the Barwon River (Terry Kass, 2003, P.13). The 80,000 acre (32374.8 ha) property was claimed in 1839 (M. Rutledge, n.d.; Bailliere 1866) (Barker, n.d.). At this time the Barwon River was the sole water source for the run which had an estimated grazing capability for 2000 head of cattle (New South Wales Government Gazette 1848). A TSR was established running north/south through the property and Water Reserves were resumed along the stock routes and around outstations between 1874 and 1884. The *Boorooma* station was often visited by travelers as they made their way through the countryside, especially during shearing time. The land along the Barwon River also housed the Boorooma Hotel, otherwise known as the *Travellers Inn Rest*. Surrounding the inn, a small village formed, called the 'Travellers Inn Village', which included a blacksmiths shop, stables, store and kitchen. The inn closed in 1926 (T Kass 2003, 270), which is largely attributed to nearby town growth drawing in clientele with larger social centres.

ii Llanillo run

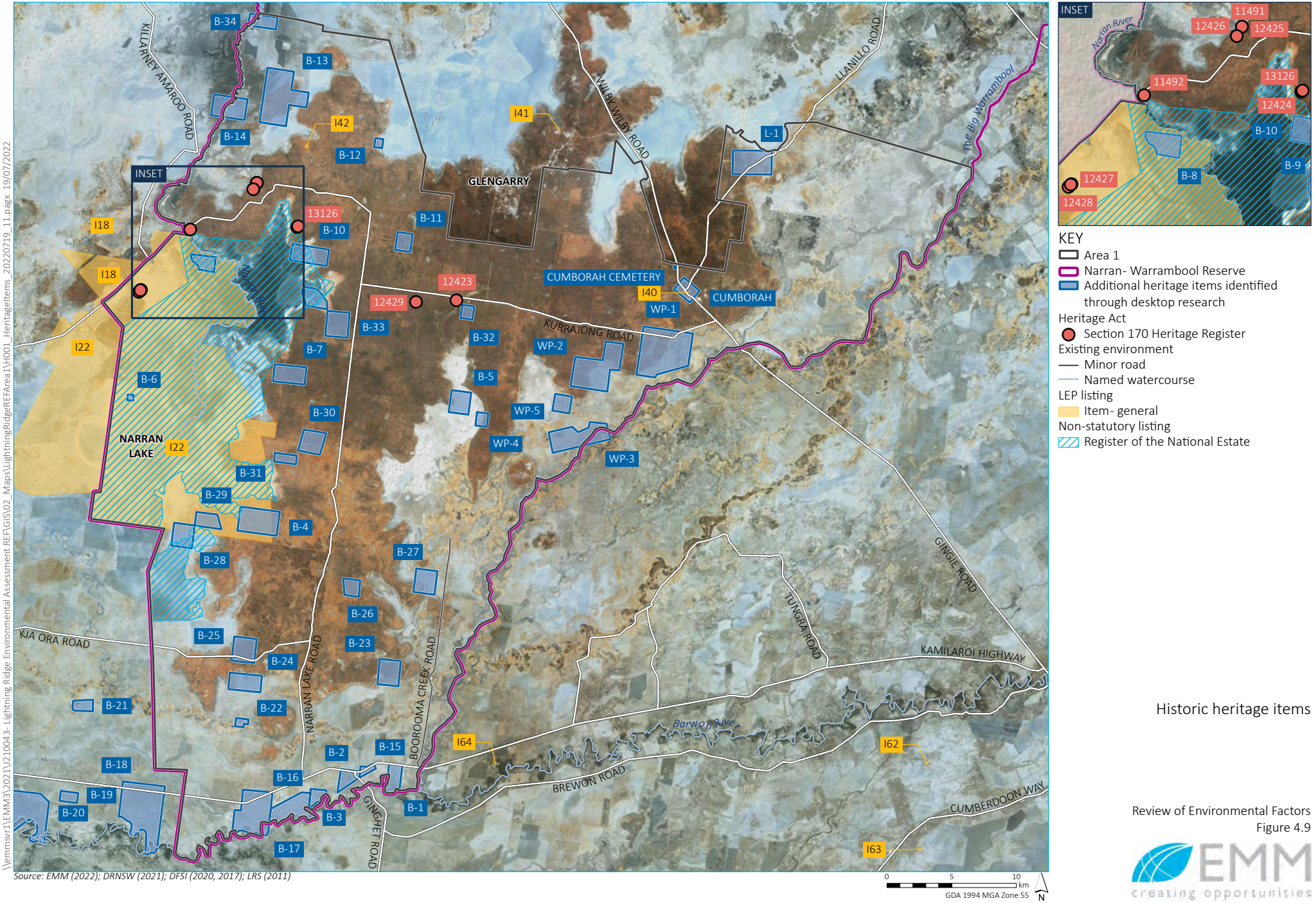
Llanillo is located northeast of *Boorooma*. The station covered an area of 41,600 acres (16,834.9 ha) and was estimated to have grazing capabilities for 4,000 sheep (Bailliere, 1866, p. 319). *Llianillo* held a homestead including a store and kitchen.

iii Milrea run

Milrea run is located east of *Boorooma* on the Barwon River. The pastoral lease for the 51,200 acres of the *Milrea* run was claimed by Campbell and Smith in 1848 (N*ew South Wales Government Gazette*, 1848, p. 1229). By 1866 the run had been subdivided into *Milrea* and *Milrea Minor* stations (Bailliere, 1866; Empire, 1855, p. 3).

iv Wilkie Plains run

The *Wilkie Plains* run is located east of *Boorooma* and north of *Milrea*. The pastoral lease for *Wilkie Plains* was not claimed in 1848 so it is not clear when the property was taken up. The property was subdivided into north and south portions in the early 1880s and the subdivided areas were incorporated into the subdivided runs of neighbouring properties. *Wilkie Plains* was a complete station, with a homestead located in the lower east corner, yards, wells and a woolshed on The Big Warrambool River.



Source: EMM (2022); DRNSW (2021); DFSI (2020, 2017); LRS (2011)

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Historic heritage items

Review of Environmental Factors
Figure 4.9

EMM
creating opportunities

4.14 Aboriginal cultural heritage

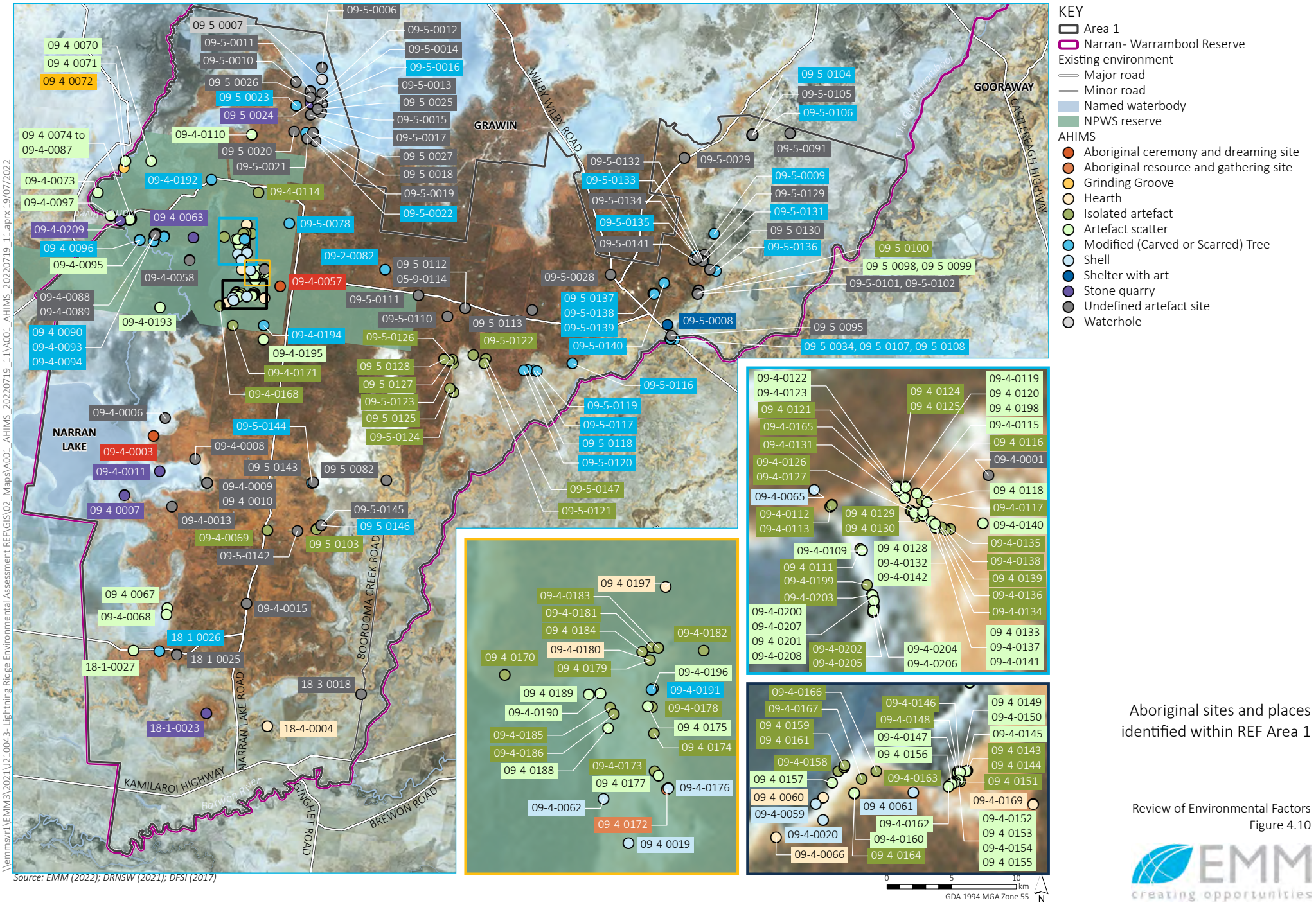
Aboriginal cultural heritage studies have been undertaken in Area 1 of the NWR in the past. These have been relatively limited, with many undertaken over 30 years ago. These have included regional studies, as well as smaller investigations directly associated with mining and/or development activities. There are two active claims for Native Title within Area 1, which may have future potential impact on land use agreements or compensation (see Section 4.15.1 and Figure 4.12).

A search of the Aboriginal Heritage Information Management System (AHIMS) register was conducted on 19 April 2021 of Area 1. The search covered an area of ~2,000 km^2. The search identifies any Aboriginal sites or places registered within Area 1; and aids predictions for the project footprint showing the frequency and distribution of Aboriginal site types in the broader landscape. A copy of the AHIMS site types and search results is provided in Appendix C and Figure 4.10.

A total of 239 sites have been previously recorded within the Area 1 (Figure 4.10), including 59 sites OPA4. These 59 sites are dominated by stone artefacts (n=41, 69%) and culturally modified trees (n=16, 27%). Other significant sites include a potential burial tree (site 09-5-0008) and Aboriginal paintings (site 09-5-0009). Of the artefactual sites, most common are artefact scatters (sites with at least two artefacts, n=28, 68%), isolated artefacts (n=11, 27%) or quarries (n=2, 5%). Many of the sites concentrate around key water sources (eg Mooredale Wells) or in the vicinity of Cumborah Knob, clearly indicating the importance of these environmental features to past Aboriginal visitation and use.

The distribution of these sites and places aligns well with environmental characteristics of the NWR and previous investigations. These all suggest that the large river systems surrounding the NWR, such as the Barwon River, result in substantial flooding and inundation of the landscape. As such, past use of the region appears to have focussed on smaller creeks and/or waterholes, as well as elevated areas over-looking these major river systems. Indeed, nearly 30% of the documented sites are found in the vicinity of Narran Lake and/or Narran River found in the southwest and western fringe of the NWR. This settlement behaviour aligns with a home base strategy well documented in the last 5,000 years in which people establish themselves at a reliable water source, but initially use surrounding ephemeral water sources until they run out (Smith, 2013). Taphonomically, flooding would also likely have had an adverse effect on cultural materials near any major river systems, with them often being constrained to the surface and/or upper soil profile.

Given the deep geological age of many of these land systems, commonly cultural materials are constrained to the surfaces, and less frequently in the upper portion (A1 horizon). Previous archaeological work in the NWR has not incorporated test excavations; as a result, the potential depth of archaeological deposits is unknown at this stage. Given their frequent shallow and/or surface distribution, cultural materials are highly susceptible to impacts from historical and surface activities, and areas of minor elevation and/or accumulation (such as alluvial terraces, sand dunes) are more conducive to preservation.



Source: EMM (2022); DRNSW (2021); DFSI (2017)

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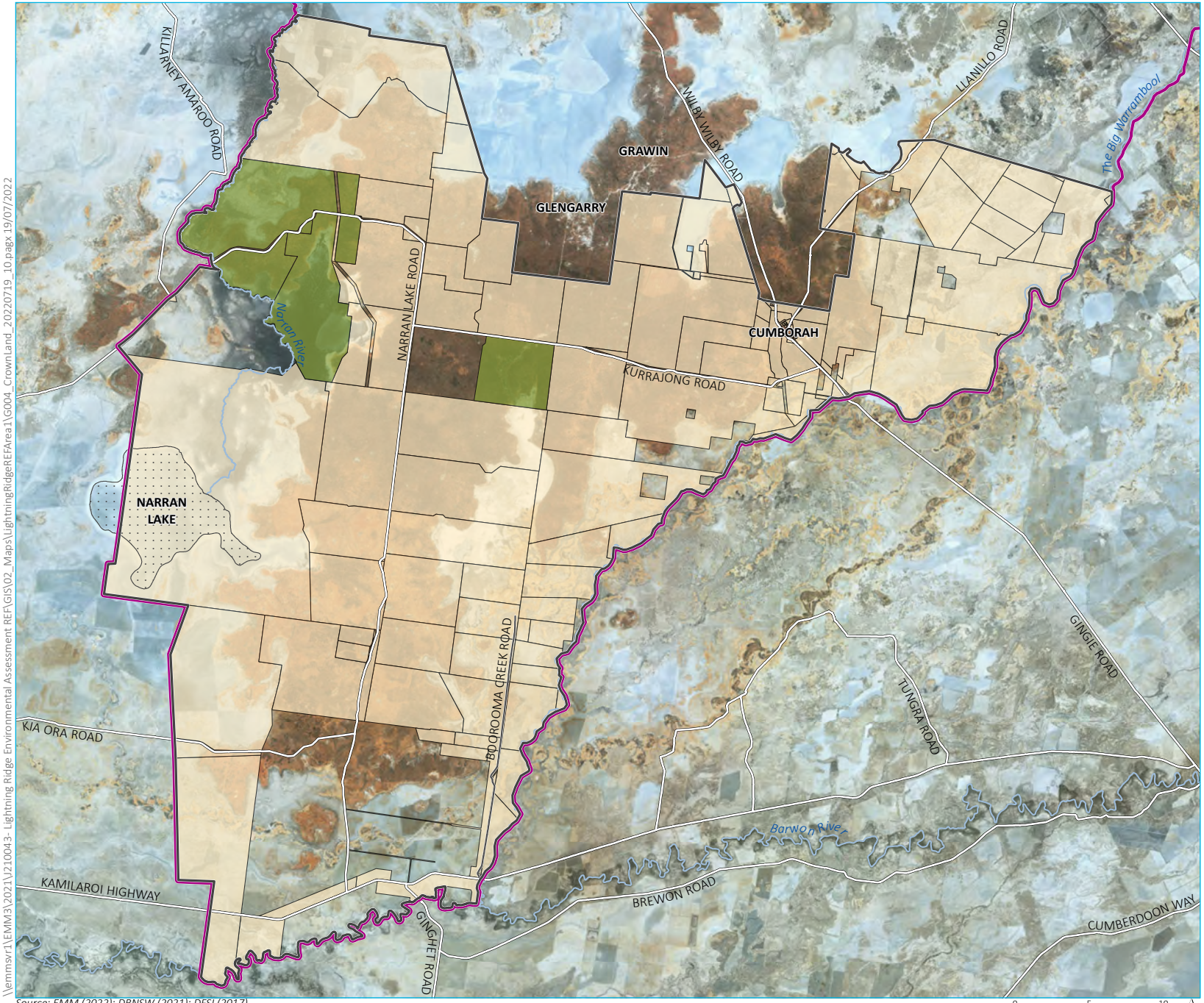
Aboriginal sites and places identified within REF Area 1

Review of Environmental Factors
Figure 4.10

EMM creating opportunities



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Source: EMM (2022); DRNSW (2021); DFSI (2017)

Areas of Crown Land within Area 1

Review of Environmental Factors
Figure 4.11

EMM
creating opportunities

4.14.1 Statutory considerations

There are no identified places on the National Heritage List or Commonwealth Heritage Lists. However, the Brewarrina Aboriginal Fish Traps (Baiame's Ngunnhu) – a series of rock walls within the Darling River – situated west of the NWR are listed. Similar structures may be present within the NWR and would potentially have similar values of significance.

Several parts of the NWR are identified as Crown land and are therefore potentially subject to the provisions of the *Native Title Act 1993* where there is no determination that native title does not exist, or the Minister cannot be satisfied that native title has been extinguished. Currently, there are no finalised claims within the Area 1, but two active claims are abutting the NWR – the Gomeroi people to the east, and the Ngemba, Ngiyampaa, Wangaaypuwan and Wayilwan people to the south.

Two specified areas of the NWR are approved opal or gem mining areas for the purpose of Section 26C of the *Native Title Act 1992* (Cwlth).

Where activities are occurring outside these areas where the Minister is not satisfied native title rights have been extinguished prior to the grant of mining rights, there is potential for native title claimants (if determined) to negotiate compensation for any impact that the works have had upon their rights outlined in the claim (access to land, hunting, fishing, etc).

Any applicant seeking to undertake work in such areas must be validated for the purpose of the *Native Title Act 1992* (Cwlth) and must liaise with DRNSW Mining, Exploration and Geoscience to ensure required processes are considered and addressed. These processes may require several months to complete.

4.14.2 Areas of cultural sensitivity

Understanding environmental context assists with predictions of archaeological potential, such as the likelihood of archaeological material being present in the landscape, its spatial distribution and its preservation. Landscape features were an important factor for the choice of camping, transitory and ceremonial areas used by Aboriginal people. Similarly, these landscape features and historical land-use play a role in the level of preservation and the integrity of archaeological sites.

Based on this high-level desktop review, the archaeological and cultural resource of Area 1 has a number of definable characteristics that can be used to predict sensitivity in other areas. The distribution of known sites and places suggest that the large river systems surrounding the area, can cause substantial flooding and inundation of the landscape. This can result in both the burial of sites and places, but also the erosion and loss of cultural materials that may be present along their margins. Locations that are above such inundation areas, such as elevated areas over-looking the major river systems, will therefore have a higher likelihood of retaining cultural materials where present. Cultural materials have the potential to be present in areas with the environmental characteristics of sediment deposition, including sand dunes, source-bordering dunes and alluvial terraces, etc. Often these deposits will contain stratified cultural materials and/or human remains and can therefore be of high significance.

It is important to highlight that no consultation was undertaken throughout this process and that previous criticisms have been provided by the traditional elders group throughout the region. In light of this limitation, it is vital to acknowledge that the entire area is a cultural landscape, and that locations with no physical evidence of past human occupation may still have significant meaning to first nations people. To mitigate this issue, great care was taken to buffer landscape features with the potential for both archaeological and intangible heritage with a stoplight system (outlined below).

4.14.3 Dreaming pathways

Creation stories and songlines hold high significance for Aboriginal people and their culture. These myths are one of the foundational spiritual features of the world's oldest continuing culture, which help connect indigenous people to the land and their community. Some stories are widespread and connect multiple language groups within Aboriginal culture. There are two major dreaming pathways present within the study area and should be highlighted for their intangible significance.

i Narran Lake Creation

Dharriwaa (the Narran Lakes) have been an important site to Aboriginal people for thousands of years. For local Aboriginal people, this dreamtime story physically links to the Brewarrina Fish traps (important heritage sites) to a waterhole at Byrock and Mt Gundabooka, which are all hundreds of kilometres apart (Somerville, 2008). The events of the story (below), mark the events at each of these places on the landscape.

The Lake's creation began with the Great Spirit Father (Baiame or Byamee) who went hunting with his two wives Birrahgnooloo and Cunnunbeillee (Lovett, 2022). He sent them off to collect frogs and yams and the women were very tired when they met him later at Coorigel Spring. Spotting the cool, fresh water, the wives decided to bathe.

The wives were swallowed by two kurreahs (crocodile like creatures) which dived into an underground watercourse that led to the Narran River, leaving all other watercourses dried up in their wake. When the Great Spirit Father reached Coorigel Spring, he soon realised what happened and went in pursuit of the kurreah. He went through the underground channel that joined to the Narran, seeing nothing but dried waterholes on the way. When he reached the end of the Narran the hole was still wet and muddy.

Seeing his enemies, the Great Spirit Father hurled spears, wounding both kurreahs who flailed in pain lashing their tails, creating great hollows in the ground where water began to quickly fill. To trap them further, the Great Spirit Father drove them from the water and killed them. Ever afterward during flood times, the Narran flowed into these hollows, forming the wetland today. His wives then came back to life and were warned to never bathe in the deep holes of the Narran again.

ii The Black Duck Storyline

Recent studies surrounding the saltwater Aboriginal people have retraced a significant songline that potentially travels across 300 km of Australia's south-east (Fuller et al., 2021). There are a range of theories where the Black Duck songline travelled (eg from Hawkesbury River north, eventually turning south west to Narran Lakes and the Snow Mountains, connecting into a circle at its origin on the Gippsland Coast), however knowledge holders describe how their people would have traveled these songlines in order to conduct trade, attend ceremonies and to enable greater access to resources.

The story revolves around Umbarra (Yuin people)/Wumbarra (Dharawal people) the Black Duck, who is an animal hero or totem (rather than a Creator) (Fuller, 2020). By diving into the water or making splashes, a man named Merriman was warned by the Black Duck every time there was danger coming. One day, Merriman's tribe was fishing when he saw the Black Duck give a warning. He told his people to take the women, children and elders in canoes to Merriman's Island. All the warriors waited by the lakeside until nightfall, when the invaders came. The other men were trying to reach the island to steal the women, but Merriman's men got another got another warning from the Black Duck. A battle ensued but Merriman was victorious.

Local groups attribute this story to their long-term survival, stating that the Black Duck saved their people (Fuller, 2020).

4.15 Contaminated land

Documented contamination risks within Area 1 are primarily associated with the operation, maintenance and disposal of opal mining infrastructure and associated activities including impacts related to the use of vehicle, plant and equipment. Historical projects removing derelict machinery and vehicles from former mining areas reported observations of surface hydrocarbons staining resulting from machinery and equipment leaks or spills (Parsons Brinckerhoff, 2004).

The management of spoil material (commonly referred to as mullock) is a further potential operational contamination risk. Limited available data (Bickmore, 2000) suggests that soils within NWR can be saline and sodic with a variable pH. Soil mapping by the CSIRO's Atlas of Australian Acid Sulfate Soil (ASS) indicates ASS have the potential to occur throughout the NWR, with soils variably classified as having an extremely low to high probability of occurrence (Land Insight Resources, 2021a, 2021b, 2021c and Enviro-Screen Lightning Ridge Mineral Claims District REF – Area 1), associated with the proximity of inland lakes, wetlands, waterways and riparian zones.

It is understood that a centralised waste management facility or service for the management of waste produced as a result of opal mining activities or the residences within NWR has not historically existed. Poor waste management practices have been identified in previous reports as requiring mitigating actions to be implemented with waste being observed at current and historical opal mining operations (Parsons Brinckerhoff, 2004). The management of wastewater and sewage has also been identified as presenting a potential contamination risk within the NWR where municipal services are not available. The management of wastewater and sewage at mining operations and residences are generally reported to include unregulated septic or long-drop style ablutions.

4.15.1 NSW EPA records and other potential regulatory contamination issues

To assess the potential for contamination risk in the existing environment, a background search of publicly available data has been completed with search results provided in Appendix D. Review of the search data did not identify NSW EPA records or other potential regulatory contamination issues within Area 1 relating to the following:

- per- and poly-fluoroalkyl substances (PFAS) site investigations;
- Department of Defence sites (including unexploded ordnance sites);
- former gasworks;
- aviation firefighting facilities;
- cattle dip sites;
- derelict mines/quarries;
- dry cleaners;
- waste management facilities;
- power stations;
- liquid fuel facilities;

- waste management facilities and recycling centres; and
- telephone exchanges.

Additionally, there were no records for underground storage tanks (USTs) or properties affected by loose-fill asbestos insulation within Area 1.

4.15.2 Licensed activities under the POEO Act 1997

There is one reported location with the NWR which holds a current environment protection licence (EPL). The Kia Ora Feedlot (EPL 12073) is licensed for 'cattle, sheep or horse accommodation' and is located to the southwest of Area 1. The licence holder has previously been issued with a penalty notice (notice number 1547959) for not submitting an annual return. No other notices or penalties were reported.

4.15.3 National Pollution Inventory

The Kia Ora Feedlot property located within Area 1 is also listed on the National Pollution Inventory (NPI). This facility has not reported particulate matter emissions to the NPI since financial year 2017/2018 and the operation of the feedlot if currently unknown. Given the lack of NPI reporting in recent years, the feedlot may no longer be operational.

4.15.4 Potential sources of contaminated land

A number of potential contamination sources have been identified within the Area 1. These are described in Table 4.12.

Table 4.12 Potential source areas of contaminated land within Area 1

Sources of contamination	Contaminant of Potential Concern (CoPC)	Presence within the Area 1
Historical and future opal mining and prospecting activities – equipment operation and maintenance	• asbestos • total recoverable hydrocarbons (TRH) • heavy metals/metalloids	Potential to exist at historical or future operations where plant and equipment are used. This also includes the storage and transfer of petroleum hydrocarbons for operational purposes.
Spoil (mullock) and soil management	• soil pH • ASS • sodicity/dispersivity • soil salinity	Potential for impacts associated with historical and future mining and spoil (mullock) management practices includes: • acidic or alkaline properties; • salinity; and • sodic and dispersive soils.
Historical illegal dumping and future opal mining and prospecting - uncontrolled fill	• asbestos • TRH • heavy metals/metalloids • putrescible and non-putrescible waste	Potential historical and future uncontrolled waste disposal.

Sources of contamination	Contaminant of Potential Concern (CoPC)	Presence within the Area 1
Future opal mining and prospecting activities – wastewater management and ablutions	• E.coli • coliforms • nutrients	Potential to exist at historical or future operations and residences.
Cattle feedlots	• E.coli • coliforms • nutrients	Potential to be present at the Kia Ora Feedlot, or other cattle feedlot areas, if present.
Historical application of herbicides and pesticides on agricultural land	• OCP/OPP	Potential to exist on areas used for agricultural purposes, which comprise large portions of Area 1.
Ageing and historical infrastructure containing asbestos cement materials	• asbestos	Potential to exist within the Area 1 where ageing or historical infrastructure is present or has been illegally disposed.

4.16 Visual Landscape

The local topography is generally flat. There are some elevated areas immediately east of Narran Lake, with the highest features being Cumborah Knob at 172 m AHD and Mount Charlotte at 156 m AHD. The majority of Area 1 has an elevation of approximately 130 m to 140 m AHD.

There are two main landscape character units (VCUs) within Area 1:

- Visual Character Unit 1: cleared and modified agricultural landscape, generally in flatter terrain:
    - The cleared and modified landscapes are generally associated with land used for primary production. Within these landscapes there are also pockets of vegetated landscape but these are typically along creeks or drainage lines where vegetation has been preserved to protect riparian systems. The VCU 1 patchwork of cleared fields is also characterised by the presence of dispersed agricultural infrastructure such as farm dams, fences, power lines and sheds.
- Visual Character Unit 2: Vegetated landscapes, predominantly at elevated rises and ridges:
    - The vegetated rises and ridges comprise an identifiable portion of the local landscape character. Narran Lake Nature Reserve is the largest landholding in the VCU 2 landscapes.

The primary urban settlement within the bounds of Area 1 is the town of Cumborah. There are some public recreational facilities, such as a cricket oval, within the town of Cumborah. Outside Area 1, the nearest towns are Lightning Ridge and Walgett.

Most landholdings within Area 1 associated with agricultural land uses include a residential premises and associated outbuildings, such as equipment sheds.

There are no promoted tourist destinations within Area 1 but there are localities immediately outside Area 1 – such as Grawin, Glengarry and Sheepyard – which can be accessed via roads transecting Area 1.

There is farmstay accommodation offered to tourists at Kigwigil Country Escape, on ‘Kigwigil’ property, approximately 8 km east of Cumborah.

4.17 Travelling stock reserves

There are a small number of travelling stock reserves (TSRs) within Area 1. These include:

- Bunghill Tank Stock Watering Place (SWP);
- Gingie TSR SWP;
- Moramina SWP;
- Boorooma SWP;
- Rocky Tank SWP; and
- Kamilaroi Highway TSR.

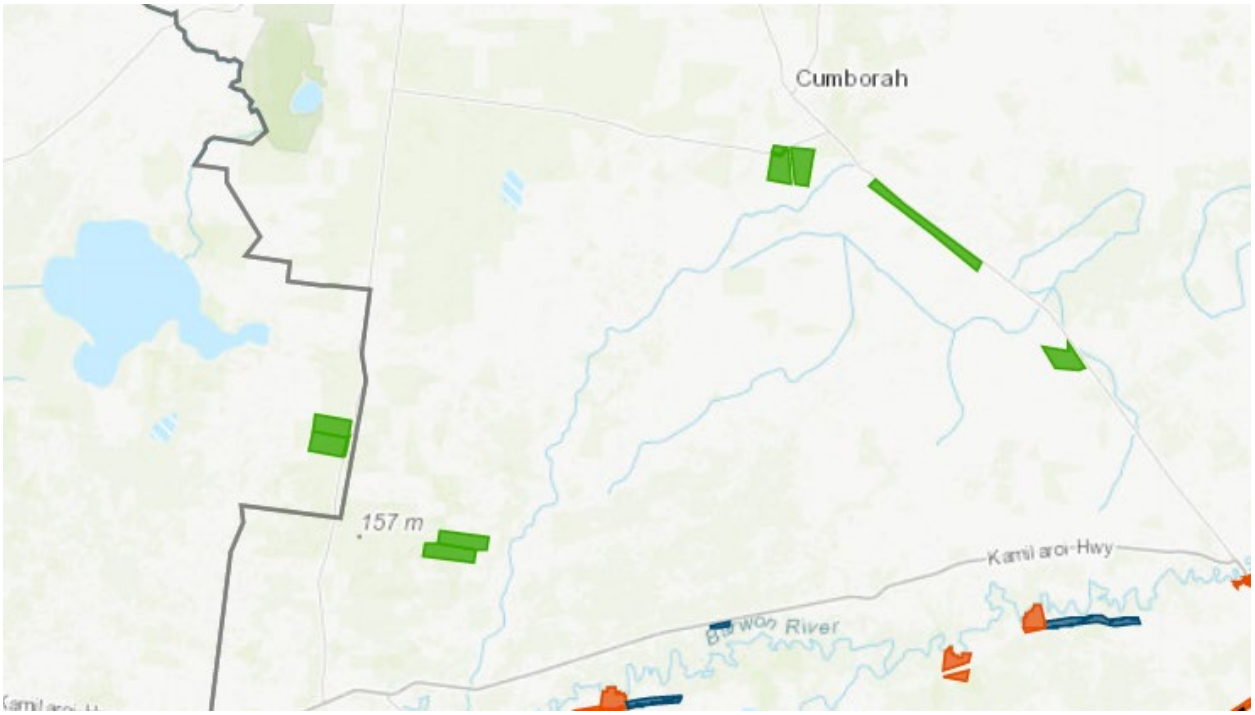
All of these – other than Kamilaroi Highway TSR – are Category 4 TSRs (green). Kamilaroi Highway TSR is Category 3 (blue). Refer to Figure 4.12.

As noted in the Travelling Stock Reserves State-wide Plan of Management (LLS, no date) for Category 4 TSRs:

> TSRs, in the Western Division only, that are rarely, if ever used for travelling stock or emergency management, but are important, valued and used for other reasons such as biodiversity conservation or First Nations Peoples' heritage. These TSRs are Stock Watering Places.

Similarly, Category 3 TSRs are:

> TSRs that are rarely, if ever used for travelling stock or emergency management, but are important, valued and used for other reasons such as biodiversity conservation, First Nations Peoples' heritage or recreation. These TSRs are not Stock Watering Places.



Source: Travelling Stock Reserve State Classification Map (LLS)

Figure 4.12 Travelling Stock Reserves

4.18 Roads and access

4.18.1 Major roads

The Kamilaroi Highway (B76) is situated at the southern extent of Area 1 and is the only classified road in the Study Area. The highway is a sealed, two-way road in this location. Refer to Photograph 4.1.

Source: Google Earth Streetview

Photograph 4.1 Kamilaroi Highway

4.18.2 Minor roads

There are several lesser local roads including:

- Gingie Road;
- Wilby Wilby Road;
- Llanillo Road;
- Narran Lake Road (refer to Photograph 4.2);
- Ginghet Road (refer to Photograph 4.3); and
- Boorooma Creek Road.

Source: Google Earth Streetview

Photograph 4.2 Narran Lake Road

Source: Google Earth Streetview

Photograph 4.3 Ginghet Road

4.19 Existing services

The main settlement within Area 1 is the town of Cumborah. The town has basic services and amenities such as church, camping site, tennis courts, and playground.

Cumborah is accessible from the Kamilaroi Highway (B76) near Walgett via Gingie Road (sealed); from the Castlereagh Highway (B55) near Lightning Ridge via Llanillo Road (sealed); and from the north-west near Goodooga via Wilby Wilby Road and Cumborah Road (unsealed). The settlements of Sheepyard and Grawin, outside Area 1, offer limited services.

4.20 Existing land uses

Land within Area 1 falls within the Brewarrina Local Government Area (LGA) and Walgett LGA. Land within Area 1 is zoned under Brewarrina LEP and Walgett LEP as RU1 Primary Production, E1 National Parks and Nature Reserves (for Narran Lake Nature Reserve) and SP1 Special Activities (mining)

The objectives for land zoned RU1 under Walgett LEP are:

- To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.
- To encourage diversity in primary industry enterprises and systems appropriate for the area.
- To minimise the fragmentation and alienation of resource lands.
- To minimise conflict between land uses within this zone and land uses within adjoining zones.
- To enable small-scale rural tourism uses associated with primary production and environmental conservation.

The objectives for land zoned RU1 under Brewarrina LEP are:

- To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.
- To encourage diversity in primary industry enterprises and systems appropriate for the area.
- To minimise the fragmentation and alienation of resource lands.
- To minimise conflict between land uses within this zone and land uses within adjoining zones.

The objectives for land zoned E1 under Brewarrina LEP are:

- To enable the management and appropriate use of land that is reserved under the *National Parks and Wildlife Act 1974* or that is acquired under Part 11 of that Act.
- To enable uses authorised under the National Parks and Wildlife Act 1974.
- To identify land that is to be reserved under the *National Parks and Wildlife Act 1974* and to protect the environmental significance of that land.

There are small portions of land zoned SP1 Special Activities (Mining) within the Walgett LEP. The objectives of SP1 are:

- To provide for special land uses that are not provided for in other zones.
- To provide for sites with special natural characteristics that are not provided for in other zones.
- To facilitate development that is in keeping with the special characteristics of the site or its existing or intended special use, and that minimises any adverse impacts on surrounding land.
- To ensure that opal mining is the main type of development in the zone.
- To enable small-scale tourism uses that are ancillary to agriculture and mining.

Land uses within Area 1 tend to align with these objectives. The 2016 Census conducted by the Australian Bureau of Statistics (ABS) identified the main local industries for employment (Cumborah Census District) as:

- Non-Metallic Mining and Quarrying;
- Grain-Sheep or Grain-Beef Cattle Farming; and
- Other Grain Growing.

Much of the land within Area 1 is held by Crown Lands under Western Lands Leases. Consultation with lease and land holders indicated that a number of properties are transitioning from Western Lands Leases to freehold title.

Land protected for ecological purposes within Area 1 includes the Narran Lakes Nature. Use of the NLNR is restricted to public use and promotion, research and management operations. The NLNR is listed as a site under the Ramsar Convention and has recognition as a wetland of international importance. The Narran Lakes area is also of extremely high value to the local Aboriginal people as a significant cultural site and meeting place.

4.21 Land use conflict

There has been a longstanding acknowledgement that the interaction of the two primary land uses in the region, being agriculture and opal mining, can give rise to community concerns, contested values and challenges in terms of land use management.

These two dominant land uses are not the only factor. It is also recognised that conservation areas and tourism development can also introduce a level of contention regarding land uses which are difficult to integrate.

Land use planning begins with strategic planning instruments. The NSW Government's *Far West Regional Plan 2036* signals an intention for the region to continue to support agribusiness, value-added manufacturing, mining and tourism.

The *Walgett Local Strategic Planning Statement* (LSPS) focusses specifically on the issues experienced near Lightning Ridge and is relevant to consider as part of the strategic framework. It states (underlining added):

> Rich productive agricultural land and black opal deposits in Lightning Ridge are the natural assets which provide the foundations for supporting long term prosperity. In order to capitalise on these natural assets, agricultural and opal mining sectors will be supported, and *the most productive land protected from land use conflict.* (p 29)

The intention expressed in the Walgett LSPS appears to be to ensure that highly prospective opal mining land is made available for that purpose, and conversely that highly productive agricultural land is similarly preserved for that economic activity.

A primary consideration in this REF is therefore the identification of land which qualifies as either highly productive agricultural land or as highly prospective opal mining land. The choice is not binary. There will clearly be land which is moderately suited to either activity; or of little value to either activity; or in many cases capable of being integrated. However, the task of optimising land use for social and economic benefit will clearly need to spatially allocate land to its highest and best use.

5 Socio-economic context

The social and economic context of opal prospecting and opal mining activities within Area 1 encompasses a larger study area than Area 1 alone. Therefore, the study area has been identified as the localities of Lightning Ridge, Cumborah, Brewarrina, Walgett and Narran Lakes locally, and Walgett local government area (LGA) and Brewarrina LGA regionally, as shown in Table 5.1. The primary town within Area 1 is Cumborah, depicted in Photograph 5.1.

Table 5.1 Locations within the study area mapped to ABS category

Location	ABS Category	Study area
Lightning Ridge	Lightning Ridge State Suburb (SSC)	Local area
Cumborah	Cumborah SSC	
Brewarrina	Brewarrina SSC	
Walgett	Walgett SSC	
Narran Lakes	Narran Lakes SSC	
Walgett Shire	Walgett LGA	Regional area
Brewarrina Shire	Brewarrina LGA	

Notes: SSC – State Suburb Code as defined by the Australian Bureau of Statistics.

Source: Wikipedia

Photograph 5.1 Cumborah town centre

5.1 Demographic profile

According to the ABS 2016 Census of Population and Housing, Lightning Ridge SSC has a total population of 2,284 people, Cumborah SSC has a total population of 249 people, Brewarrina SSC has a total population of 1,143 people, Walgett SSC has a total population of 2,145 and Narran Lakes SSC currently has a population of zero people. Despite having population of zero, Narran Lakes SSC has been included due to the ecological value it brings to the local and regional area. Narran Lakes encompasses both the Narran Wetlands and the Narran Lake Nature Reserve.

These comprise a total population of 5,821 people in the study area. Population within the study area is presented in Table 5.2.

Table 5.2 Population 2016

Area	Population	Male (%)	Female (%)	Median age
Lightning Ridge SSC	2,284	54.3%	45.8%	51
Cumborah SSC	249	58.2%	42.2%	55
Brewarrina SSC	1,143	52.0%	47.9%	32

Area	Population	Male (%)	Female (%)	Median age
Walgett SSC	2,145	50.7%	49.5%	33
Narran Lakes SSC	0	0.0%	0.0%	0
Walgett LGA	6,107	53.0%	47.1%	43
Brewarrina LGA	1,651	51.4%	48.6%	34
NSW	**7,480,228**	**49.3%**	**50.7%**	**38**

Source: ABS 2016, Census of Population and Housing: General Community Profiles.

The study area has a varied median age compared to NSW (38) with Lightning Ridge SSC (51), Cumborah SSC (55) and Walgett LGA (43) displaying a higher median age than broader NSW. Meanwhile, the median age in Brewarrina SSC (32), Walgett SSC (33) and Brewarrina LGA (34) are all lower than the median age across NSW. Within the local area and regional area there is a slightly higher proportion of males which differs from NSW.

Throughout the local area and regional area, there is a much higher proportion of persons aged 45–74 compared to NSW, specifically in the 55–64 years age bracket. However, there is a much smaller proportion of persons aged 85 years and older, particularly in Cumborah SSC (0.0%) where there are no people in this age bracket. There is also a slightly higher proportion of persons aged 5–14 across the local area and regional area. Due to the small populations within these suburbs, there is substantial variation in the age distributions. A breakdown of the aged group distribution is presented in Table 5.3.

Table 5.3 Age group distribution, 2016

Age group	Lightning Ridge SSC	Cumborah SSC	Brewarrina SSC	Walgett SSC	Walgett LGA	Brewarrina LGA	NSW
0–4 years	4.6%	3.2%	7.9%	8.6%	6.6%	7.4%	6.2%
5–14 years	10.2%	13.7%	16.5%	15.3%	12.9%	15.7%	12.3%
15–19 years	4.0%	6.8%	6.3%	4.5%	4.4%	5.6%	6.0%
20–24 years	4.3%	2.4%	8.0%	6.9%	5.1%	7.1%	6.5%
25–34 years	9.0%	1.2%	13.9%	15.2%	12.0%	14.0%	14.3%
35–44 years	9.9%	12.0%	9.8%	11.4%	11.0%	9.6%	13.4%
45–54 years	14.2%	13.7%	16.4%	13.1%	13.5%	16.4%	13.1%
55–64 years	16.3%	22.9%	12.4%	13.3%	15.1%	13.2%	11.9%
65–74 years	16.5%	17.7%	5.8%	7.3%	12.1%	6.5%	9.1%
75–84 years	9.0%	4.0%	3.1%	2.8%	5.7%	2.6%	5.0%
85 years and older	1.4%	0.0%	1.5%	1.0%	1.3%	1.5%	2.2%

Source: Source: ABS 2016, Census of Population and Housing: General Community Profiles.

5.1.1 Aboriginal and/or Torres Strait Islander peoples

Throughout the local area and regional area there is much higher proportion of persons who identify as Aboriginal and/or Torres Strait Islander than across NSW (2.9%). A significant proportion of the population in Brewarrina SSC (64.7%), Walgett SSC (43.6%) and Brewarrina LGA (61.2%) identified as Aboriginal and/or Torres Strait Islander compared to NSW (2.9%). Within the local and regional area, Cumborah SSC (8.8%) had the lowest proportion of Aboriginal and/or Torres Strait Islander people. The distribution of Aboriginal and/or Torres Strait Islander males and females across the study area is generally consistent with NSW. A summary of the Aboriginal and/or Torres Strait Islander population is presented in Table 5.4.

Table 5.4 Summary Aboriginal and/or Torres Strait Islander population

Area	Indigenous population	Indigenous population % total	Male (%)	Female (%)	Median age
Lightning Ridge SSC	517	22.6%	51.6%	49.3%	31
Cumborah SSC	22	8.8%	45.8%	54.2%	17
Brewarrina SSC	740	64.7%	51.5%	48.0%	27
Walgett SSC	935	43.6%	46.5%	53.3%	27
Walgett LGA	1798	29.4%	48.6%	51.4%	27
Brewarrina LGA	1011	61.2%	49.8%	50.0%	28
NSW	**216,176**	**2.9%**	**49.7%**	**50.3%**	**22**

Source: ABS 2016, Census of Population and Housing: General Community Profiles.

Notes: Please note that there are small random adjustments made to all cell values to protect the confidentiality of data. These adjustments may skew population totals.

The Aboriginal and/or Torres Strait Islander population's lower median age, which indicates a smaller proportion of the population (both males and females) living beyond 65 years, and aligns with the lower life expectancy among Indigenous Australians nationally.

5.1.2 Employment

The unemployment rate across the study area in general is much higher than the NSW rate (6.3%), with Brewarrina SSC (18.9%) and Brewarrina LGA (16.0%) having a notably greater rate of unemployment. The youth unemployment rate in both the local and regional area is significantly higher than the NSW rate (13.6%) with 33.8% in Brewarrina LGA, 32.3% in Brewarrina SSC, 24.4% in Lightning Ridge SSC, 20.3% in Walgett LGA and 16.3% in Walgett SSC. Youth unemployment in Cumborah SSC is 0.0% which is significantly lower than NSW, however, this would be distorted by a very small population of which only a small proportion are youth.

Labour force participation across the local and regional area is lower than the NSW rate of 59.2%. Walgett SSC (52.2%) has highest rate of labour force participation in the area while Cumborah SSC (27.9%) has the lowest.

The unemployment and labour force participation rates are presented in Table 5.5.

Table 5.5 Unemployment and labour force participation rates, 2016

Area	Unemployment rate	Youth unemployment rate	Labour force participation rate (15 years and older)
Lightning Ridge SSC	14.8%	24.4%	37.9%
Cumborah SSC	10.3%	0.0%	27.9%
Brewarrina SSC	18.9%	32.3%	44.2%
Walgett SSC	9.4%	16.3%	52.2%
Walgett LGA	10.6%	20.3%	47.2%
Brewarrina LGA	16.0%	33.8%	46.6%
NSW	**6.3%**	**13.6%**	**59.2%**

Source: ABS 2016, Census of Population and Housing: General Community Profiles.

The most common industry providing employment in the study area is agriculture, forestry and fishing, which is the top industry of employment in Walgett SSC (21.1%), Walgett LGA (27.4%) and Brewarrina LGA (24.1%) and the second largest in Cumborah SSC (19.1%). The top industries of employment in Lightning Ridge SSC, Cumborah SSC and Brewarrina SSC are education and training (15.3%), accommodation and food services (21.3%) and public administration and safety (19.3%) respectively. Other top industries of employment in the local and regional areas include:

- heath care and social assistance;
- mining;
- professional, scientific, and technical services; and
- retail trade.

The top industries of employment in the study area are summarised in Table 5.6.

Table 5.6 Top three industries of employment by SSC, 2016

	Ranking					
	First		Second		Third	
Lightning Ridge SSC	Education and training	15.3%	Accommodation and food services	14.2%	Health care and social assistance	13.1%
Cumborah SSC	Accommodation and food services	21.3%	Agriculture, forestry, and fishing	19.1%	Mining	8.5%
					Professional, scientific and technical services	8.5%
					Retail trade	8.5%
Brewarrina SSC	Public administration and safety	19.3%	Health care and social assistance	19.0%	Education and training	18.4%

	Ranking					
	First		Second		Third	
Walgett SSC	Agriculture, forestry, and fishing	21.1%	Public administration and safety	15.0%	Health care and social assistance	13.5%
Walgett LGA	Agriculture, forestry, and fishing	27.4%	Education and training	12.3%	Health care and social assistance	11.4%
Brewarrina LGA	Agriculture, forestry, and fishing	24.1%	Education and training	17.7%	Health care and social assistance	16.7%

Source: ABS 2016, Census of Population and Housing: General Community Profiles.

5.1.3 Local business

In 2020, there were 710 registered businesses in Walgett LGA and 118 registered businesses in Brewarrina LGA. Of these, 30.3% of businesses in Walgett LGA and 25.4% of businesses in Brewarrina LGA employed fewer than 20 people. In addition to this, 69.3% of businesses in Walgett LGA and 70.3% in Brewarrina LGA were non-employing (ABS 2018). Only 1.3% of businesses in Walgett LGA and 0.0% of businesses in Brewarrina LGA employed more than 20 employees.

The highest percentage of registered businesses in Walgett LGA were in the industries of agriculture, forestry, and fishing (46.2%) and rental, hiring and real estate services (8.9%). Brewarrina LGA is similar with 68.6% in agriculture, forestry, and fishing and 6.8% in transport, postal and warehousing.

5.1.4 Vulnerable groups

To determine the potential vulnerable groups in the study area, the Socio-Economic Indexes for Areas (SEIFA), rates of homelessness, and persons with a disability has been considered.

i Socio-economic Indexes for Areas

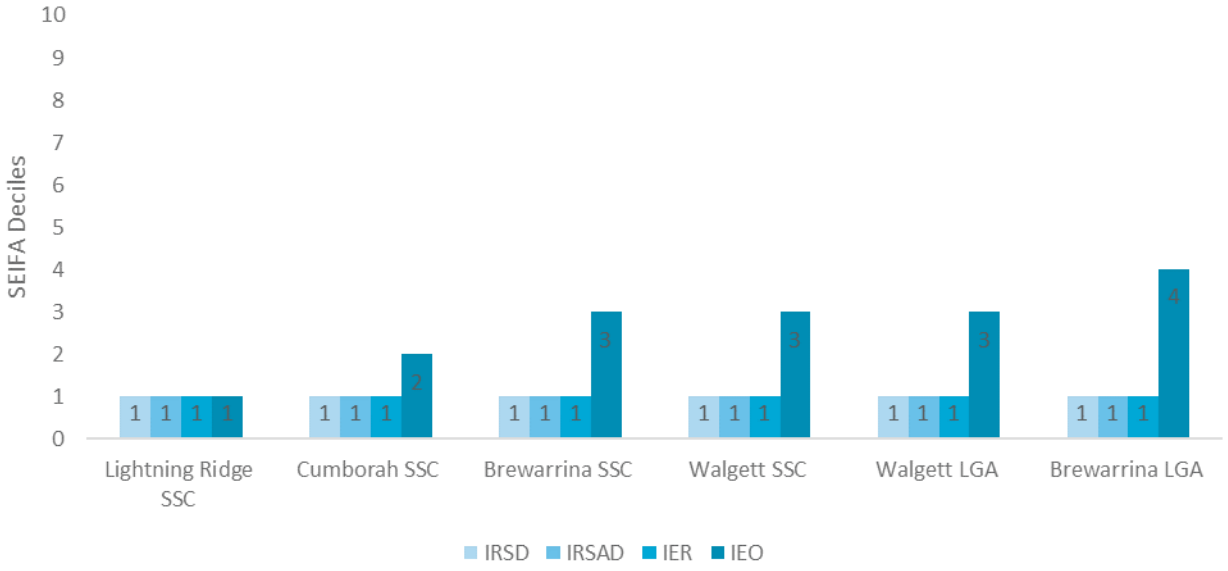
The level of disadvantage or advantage in the population is indicated in the SEIFA, which focuses on low-income earners, relatively lower education attainment, high unemployment and dwellings without motor vehicles. SEIFA is a suite of four summary measures created from Census data, including:

- the Index of Relative Socio-Economic Disadvantage (IRSD);
- the Index of Relative Socio-Economic Advantage and Disadvantage (IRSAD);
- the Index of Education and Occupation (IEO); and
- the Index of Economic Resources (IER).

Each index is a summary of a different subset of Census variables and focuses on a different aspect of socio-economic advantage and disadvantage. Low rankings are deemed most disadvantaged and high rankings least disadvantaged within a decile ranking system where the lowest 10% of areas are given a decile number of 1 and the highest 10% of areas are given a decile number of 10. The rankings of the communities within the study area for each of the four summary measures are demonstrated in Figure 5.1.

According to the 2016 SEIFA, the local area experiences significantly higher levels of disadvantage compared to other suburbs, LGAs, and regions in NSW and Australia. In the IRSD, IRSAD and the IEO, each of the identified suburbs fall within decile 1 (ie the bottom 10% of communities in NSW). This means that there are likely many households with low income, low/no qualifications, low skilled occupations, fewer high-income household and high rates of low rent households in the area. A decile ranking of 3 or below for the IEO could be attributable to the local area having fewer people with qualifications and in highly skilled occupations. A low IEO could also be indicative that there may be a higher number of unemployed persons compared to other areas of NSW, as the unemployment rate in the local area is significantly higher than that of NSW as a whole (see Table 5.5).

Within the regional area, the SEIFA scores indicate high levels of disadvantage and low levels of advantage. Walgett LGA and Brewarrina LGA are ranked within the 1st decile for the IRSD, IRSAD and IER. This is likely attributable to fewer people with qualifications and in highly skilled occupation, compounded by higher unemployment rate, lower incomes and a higher rate of households who pay low rent. For the IEO, Walgett LGA is ranked in 3rd decile and Brewarrina LGA in the 4th decile indicating low to medium numbers of higher education qualifications and low numbers of skilled occupations compared to other LGAs within NSW. The rankings of the communities within the study area for each of the four summary measures are demonstrated in Figure 5.1.



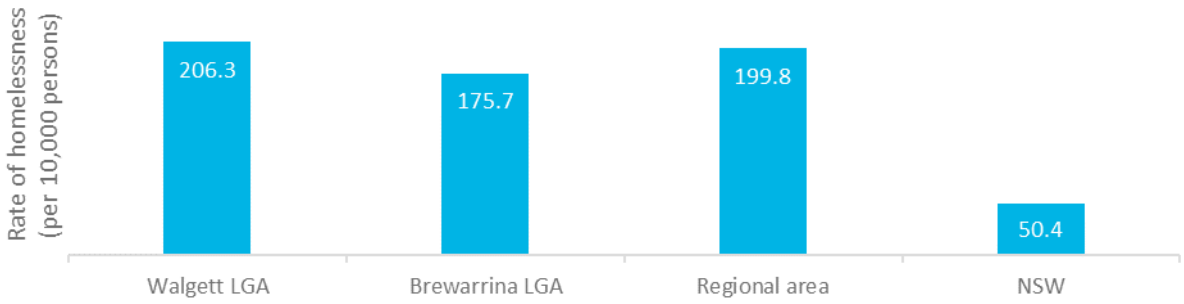
Source: ABS 2016, 2033.0.55.001 – Census of Population and Housing: Socio-Economic Indexes for Areas (SEIFA).

Each index is a summary of a different subset of Census variables and focuses on a different aspect of socio-economic advantage and disadvantage. Low rankings are deemed most disadvantaged and high rankings least disadvantaged within a decile ranking system where the lowest 10% of areas are given a decile number of 1 and the highest 10% of areas are given a decile number of 10.

Figure 5.1 SEIFA deciles in the study area, 2016

ii Homelessness

Rates of homelessness according to the 2016 Census are only available at the LGA level, which include Walgett LGA and Brewarrina LGA. Across the regional area, rates of homelessness (199.8 per 10,000 persons) are significantly higher than NSW (50.4 per 10,000 persons). Walgett LGA has a homelessness rate of 206.3 per 10,000 persons and Brewarrina LGA has a rate of 175.7 per 10,000 persons. Respectively, Walgett LGA and Brewarrina LGA have four and three times the rate of homelessness that can been seen across NSW (see Figure 5.2).



Source: ABS 2016, 2049.0 – Census of Population and Housing: Estimating Homelessness.

Figure 5.2 Rates of homelessness per 10,000 persons, 2016

iii Disability

There is some variation within the local area in the proportion of the population living with a disability. The rate of persons identifying as having a need for assistance in Cumborah SSC (6.8%), Brewarrina SSC (5.5%) and Walgett LGA (6.3%) is higher than the NSW proportion (5.4%). However, Lightning Ridge SSC (9.5%) stands out as having a significantly higher proportion of persons having a need for assistance. Both Walgett SSC (3.9%) and Brewarrina LGA (4.4%) fall below the NSW proportion (5.4%) of persons needing assistance.

5.1.5 Health

The Western NSW Local Health District (LHD) encompass both the local and regional area. Three major health risk factors can be used as an indicator of population health: alcohol consumption, smoking, and obesity. In 2020, the proportion of persons who consumed alcohol at levels considered to be high risk to health[2] in the Western NSW LHD (35.8%) was higher than the NSW rate. The rate of daily smoking in adults in the LHD also exceeded the NSW proportion (32.5%). In the Western NSW LHD, 71.2% of adults are overweight or obese. This is substantially greater than the NSW rate of 56.8%. In addition, asthma appears to be more prevalent within the LHD (19.3%) than what can be seen across NSW (11.5%). However, the Western NSW LHD (10.5%) appears to have a lower rate of persons experiencing high or very high psychological distress than in the NSW region (16.7%)

The percentage rates of various health indicators in the regional area for 2020 are presented in Table 5.7.

Table 5.7 Health indicators summary, percentage rates, 2020

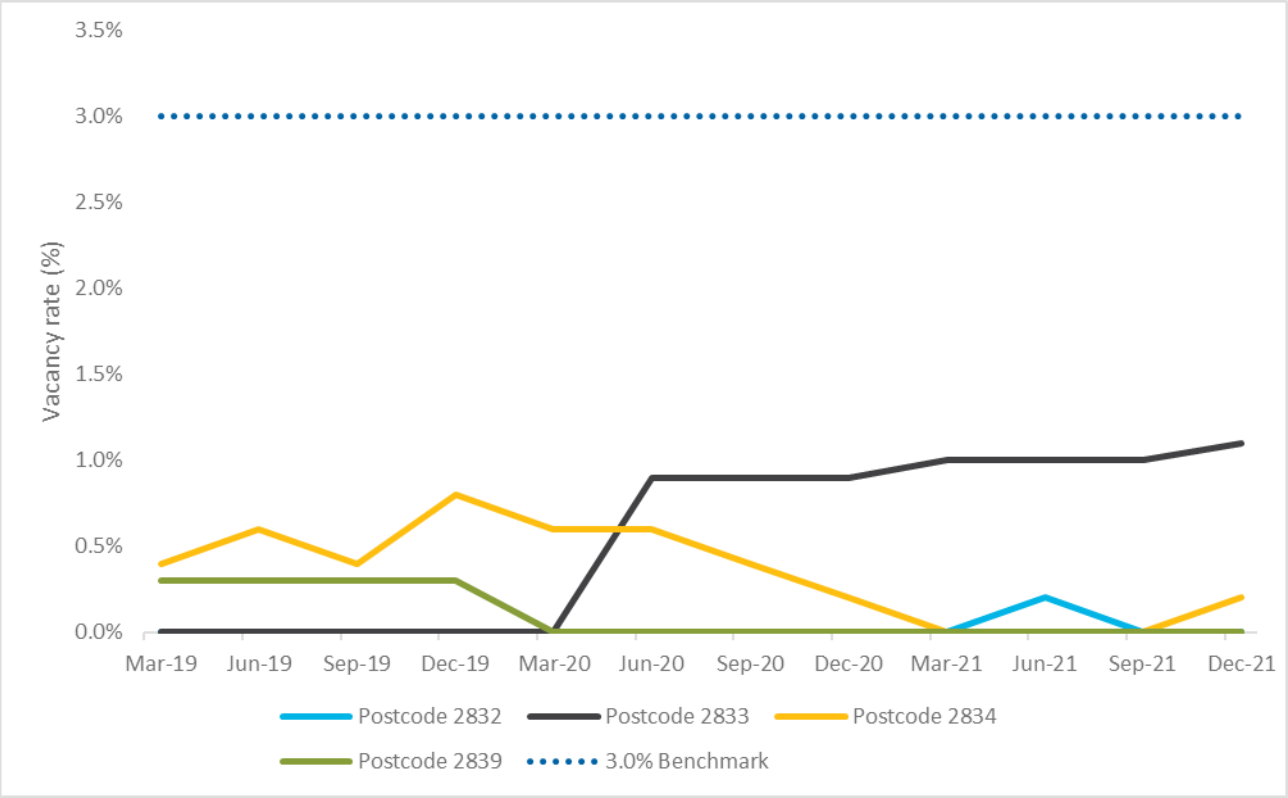
	Western NSW LHD	NSW
Alcohol drinking, long term risk in adults	35.8%	32.5%
Daily smoking in adults	11.2%	9.2%
Overweight or obesity in adults	71.2%	56.8%
Asthma prevalence in adults	19.3%	11.5%
High and very high psychological distress in adults	10.5%	16.7%

Source: NSW Ministry of Health 2020, *HealthStats NSW*.

[2] High risk drinking is defined as the consumption of more than 2 standard drinks per day.

5.1.6 Housing and rental market

On 3 February 2022 there were a total of 21 properties for sale and one property for rent in the local area, with an additional three properties for sale in the regional area (REA Group 2021). Most of the properties for sale are in Walgett SSC, Lightning Ridge SSC and Brewarrina SSC. The residential vacancy rates have been captured for Postcodes 2832, 2833, 2834 and 2839, which encompass most of the local and regional area. From March 2019 – December 2021 the residential vacancy rate for these postcodes have consistently remained significantly below the equilibrium level of 3.0% (SQM Research 2021). This indicates that there has been a substantial undersupply of rental housing in the local area and regional area. Residential vacancy rates for the local and regional area have been presented in Figure 5.3.



Source: SQM Research 2021, Residential Vacancy Rates.

Figure 5.3 Residential vacancy rate trends, March 2019 – December 2021

5.1.7 Community profile summary

Across the local area, unemployment rates and youth unemployment are significantly higher than the NSW average indicating fewer job opportunities and higher job insecurity. In the SEIFA analysis, all SSCs and LGAs were scored in the 3rd decile and below across all indices. This indicates a substantial level of disadvantage across the local and regional area. Moreover, a large proportion of the population identify as Aboriginal and/or Torres Strait Islander which could also indicate greater levels of vulnerability in local and regional areas. Walgett LGA and Brewarrina LGA had significantly greater levels of homelessness compared to NSW which may be indicative of the higher levels of unemployment and lower levels of workforce participation. The local and regional area also have low residential vacancy rates which has indicated that there is a significant under supply of rental housing. The analysis of health indicators for the regional area showed that there is a higher prevalence of being overweight or obese in adults as well as greater rates of asthma prevalence in Western NSW LHD compared to NSW.

5.2 Community planning

5.2.1 Walgett Community Strategic Plan

The *Walgett Shire Council Community Strategic Plan 2017–2027* (the Walgett CSP) identifies the issues facing the community and the proposed strategies, priorities, goals and actions proposed for the ten-year planning period. Council uses the Walgett CSP to develop operational plans and delivery programs. It forms part of the Council's Integrated Planning and Reporting Framework. It also enables State agencies and other organisations to reflect the community vision in their planning and resourcing arrangements.

The vision statement for the Walgett local government area is:

> That the community utilise the opportunities that arise from our environment to improve their quality of life whilst embracing its ethnic and social diversity, for the benefit of all.

The Walgett CSP focusses on five themes:

- looking after the community;
- building a strong local economy;
- accountable and transparent local government and civic leadership;
- caring for the environment; and
- management and provision of infrastructure.

Specific goals and strategies are identified for each of these themes.

5.2.2 Brewarrina Community Strategic Plan

The *Community Strategic Plan Brewarrina Shire 2026* (the Brewarrina CSP) identifies the issues facing the community and the proposed strategies, priorities, goals and actions proposed for the ten-year planning period. Council uses the Brewarrina CSP to develop operational plans and delivery programs. If forms part of the Council's Integrated Planning and Reporting Framework. It also enables State agencies and other organisations to reflect the community vision in their planning and resourcing arrangements.

The vision statement for the Brewarrina local government area is:

> Create an economic and socially sustainable Brewarrina Shire for our children.

The key challenges identified through the community consultation were:

- the hollowing out of the population – trend toward increases in older, less skilled, more welfare dependent population. Need to boost the population (and skill levels) by attracting and retaining working families and employed young adults;
- need to attract new industry and enterprises to reduce reliance on agriculture industry and help boost employment – particularly semi-skilled industry;
- provision of community services and facilities, such as health services and law enforcement, to service existing residents and attract new residents;
- infrastructure and services across the Shire need to be of an adequate standard to support local business and the community – such as local and rural roads, water supply, waste management and drainage; and
- need to support the youth of the community and encourage their development, education and ensure there are adequate facilities and services to meet their needs.

Specific goals and strategies are identified for each of these issues within the plan.

5.3 Stakeholder and community consultation

5.3.1 Overview of engagement

A range of contemporary approaches to key stakeholder and community consultation were drawn upon for the REF, including key International Association of Public Participation's (IAP2) Core Values to proactively:

- involve affected and high-interest stakeholders;
- provide information and opportunities, to support meaningful and representative stakeholder participation in the consultation process and inputs into the REF; and
- communicate how stakeholder and community inputs were considered, in preparing the REF.

Due to the COVID-19 pandemic, the avenues for stakeholder and communication were limited, and modified to account for lockdown periods and in consideration of containment. Consultation was therefore limited to phone calls, emails, letters to land and leaseholders and community information sessions conducted via 'Zoom' teleconference. Consultation was undertaken by DRNSW, the EMM approvals team, and the EMM social assessment team.

Engagement with Aboriginal stakeholders was not included within the scope of EMM's assessment.

5.3.2 Objectives of stakeholder engagement and community consultation

The communication and engagement objectives for the REF were to:

- build high levels of key stakeholder awareness, understanding and acceptance of the project purpose, scope, timeframes and outcomes;
- ensure there is consistent and accurate project information in the public domain;
- collect and consider representative key stakeholder and community inputs and contemporary local knowledge, about existing and potential future, opal prospecting and mining impacts on the environment

and land use practices, as part of developing a robust Review of Environmental Factors (REF) for Area 1 within the NWR, which includes Opal Prospecting Area 4; and

- support field teams to obtain private property access, in safe, suitable and timely ways.

5.3.3 Community engagement

A brief overview of consultation activities associated with the REF is provided in Table 5.8.

Table 5.8 Stakeholder engagement and community consultation record

Stakeholder group	Date	Engagement type	Issues raised
DRNSW and Lightning Ridge Miners Association and Garwin-Glengarry Sheepyards Miners Association (GGSMA)	May 2021	Email	DRNSW advised the LRMA and GGSMA of the commencement of the Area 1 environmental study.
DRNSW to land and lease holders within Area 1	October 2021	Letter and factsheet	DRNSW advised land and leaseholders within Area 1 of the environmental study, and notification of the online community information sessions.
DRNSW, EMM approvals team, LRMA and GGSMA	November 2021	Community information sessions conducted via teleconference	DRNSW and EMM gave presentations on the Area 1 environmental study.
EMM approvals team to land and leaseholders within Area 1, where field studies were required to be undertaken	November 2021	Telephone calls	EMM advised land and leaseholders of Area 1 environmental study, and requested permission to conduct biodiversity field work on their land. Issues raised were communicated to the EMM social assessment team.
EMM social assessment team to land and lease holders within Area 1, Walgett Shire Council, LRMA, and GGSMA	December 2021 and January 2022	Telephone calls and teleconference meetings	See Section 6.14 and Appendix F.

5.3.4 Community information sessions

To ensure that important local knowledge and experience was captured as part of the project, online information sessions were conducted on Wednesday 3 November 2021 and Friday 5 November 2021. The community information sessions were conducted via 'Zoom' teleconference and provided interested parties an opportunity to ask questions about the environmental study and provide feedback.

DRNSW provided an overview of the Area 1 environmental study (REF) via Powerpoint presentation. EMM provided a detailed Powerpoint presentation on the study which included an overview of EMM Consulting, the study area, activities being assessed, and the components of the assessment.

The online sessions concluded with an opportunity for questions and discussions.

6 Impact assessment

6.1 Soils

6.1.1 Methodology

The assessment of soils, erosion and land comprised:

- a desktop review of existing information on soils and soil environments for the development footprint sourced from:
  - NSW soil and land information system (SALIS) (OEH 2018);
  - Australian Soil Classification system soil type mapping of NSW (OEH 2018);
  - Inherent soil fertility (OEH 2018);
  - NSW OEH Acids Sulphate Risk Map (OEH 2018);
  - Land and Soil Capability Mapping for NSW (OEH 2018); and
  - Land Systems of Western New South Wales (eSPADE 2.0) online database (OEH 2018);
- an assessment of erosion hazard using mapped data.

6.1.2 Desktop review summary

A summary of the available land and soil mapping available from eSPADE (OEH 2016) characteristics and their associations is presented in Table 6.1.

Table 6.1 Regional soil mapping summary

Soil landscapes	ASC	Inherent soil fertility	LSC class
Lightning Ridge (LSLr)	Kandosols	Moderately low	6
Rotten Plain (LSRp)	Vertosols	Moderate	3
Long Meadow (LSLm)	Vertosols	Moderate	3
Llanillo (LSLi)	Vertosols	Moderate	4
Gingie (LSGi)	Chromosols	Moderate	4
Narran (LSNr)	Vertosols	Moderate	4
Rugby (LSRu)	Chromosols	Moderate	5
Nidgery (LSNi)	Vertosols	Moderate	3
Rostella (LSRs)	Vertosols	Moderate	4
Wombeira (LSWx)	Vertosols	Moderate	4
Tatala (LSTa)	Rudosols	Low	6

Soil landscapes	ASC	Inherent soil fertility	LSC class
Eurie (LSUr)	Vertosols	Moderate	3
Goodooga (LSGd)	Vertosols	Moderate	3
Mid-Darling (LSMy)	Vertosols	Moderate	3
Upper Darling (LSUd)	Vertosols	Moderate	4

6.1.3 Soils summary

The Lightning Ridge Land System (LSLr; the main opal-bearing ridge country), predominately Kandosol soils, is the most extensive land system present, consisting of 46% of Area 1. The surrounding low-relief plains country, predominantly the Narran, Kong Meadow and Rugby land systems, host to Vertosols and Chromosols. Both the Kandosols and Chromosol soil types feature hardsetting and scalding behaviour, with rilling also present on the Kandosols.

The Vertosols in the low-relief plains areas have moderate land capability and are well suited to and actively used for livestock grazing. However, the shrink-swell nature of these soils can lead to subsoil erosion, gullying and tunnelling and poor pedal structural integrity at depth ('slickensides'). Vertosol properties obtained from the SALIS database indicate the Vertosols commonly have sodic (exchangeable sodium percentage >6%) subsoils (DPI 2012) which have high potential for erosion and sediment loss and are sensitive to concentrated surface water flows when disturbed or where appropriate soil protection measures are not implemented during rehabilitation. Opal prospecting and mining in these Vertosols therefore presents a significant risk of erosion and ground collapse/subsidence with demonstrated examples of ground failure at both unrehabilitated workings and 'rehabilitated' sites (DPI 2012; McKenzie 2015). Erosion impacts and ground failure are an impact to both concurrent and future agricultural use of affected land.

6.1.4 Soils impacts

Impacts on the soil resources would occur during the prospecting, construction and operation of underground opal mines, including associated temporary infrastructure and access tracks. A combination of impacts on the soil resource can also lead to the reduction of the capacity of the soil to support a particular land use. Impacts to land capability and use can occur from a reduction in the fertility (soil chemistry and biology) and/or soil physical structure and an increase in erosion potential of the soils (loss of soil).

i Soil construction impacts

General construction impacts can include:

- topsoil and subsoil impacts including;
  - degradation and loss of topsoil;
  - compaction of the soil, through vehicle movement and poor reinstatement;
  - soil inversion or mixing resulting in changes in salinity and sodicity within the soil profile; and
  - changes in land capability;
- disturbance and form changes affecting natural surface drainage;
- erosion, during clearance and soil exposure activities;

- contamination from spills or disturbance of unknown contaminated sites; and
- increased dust generation.

ii Opal prospecting and mining soil impacts

The potential soil resource impacts associated with opal prospecting and opal mining are outlined below:

- The practice of exploratory pilot holes for opal mining can result in pathways for water to infiltrate the soil and lead to subsoil erosion and subsidence, which is common, especially on the Vertosol soil types (DPI 2012).
- Underground workings can result in ground subsidence or collapse despite the backfilling of shafts with waste rock and mullock. This may occur where underground drives/tunnels/ballrooms are only partially or not backfilled. Erosion and subsidence/collapse of underground workings is particularly prevalent in the low relief plains areas due to the unstable nature of the Vertosol soils.
- While measures to prevent or minimise water inundation into underground workings may partly mitigate potential ground subsidence (DPI 2012; McKenzie 2015), the inherent geotechnical instability of the Vertosol soils and 'slickensides' at depth (>4 m) is a key uncertainty and rehabilitation risk to achieving safe, stable and non-polluting landforms in these plains areas.
- Ground collapse can result in the inadvertent loss of surface topsoil and result in a soil deficit for rehabilitation. A deficit of topsoil material for rehabilitation can also occur if topsoil resources are not stripped and preserved prior to the commencement of open-cut mining or contaminated with other substrate (eg subsoil or mullock) due to poor handling and stockpiling practices.
- Mullock waste generated during opal prospecting and mining generally has high-clay content and is highly saline, moderately-to-highly dispersive and prone to crusting (armouring) after rainfall. These properties are limiting to vegetation establishment, particularly from seed. This is particularly negative on the Kandosol and Chromosol soils which are already highly susceptible to hardsetting and scaling soil surfaces.
- The low annual rainfall means that rehabilitated landforms cannot achieve sufficient vegetation cover for erosion protection.
- Sub-standard rehabilitation across multiple small workings could result in potentially significant cumulative impacts to the environment and end land users at the local and sub-regional scale.

iii Impact to land and soil capability

The land and soil capability impacts of Area 1 will be most noticeable on the moderate to high capability land of the Vertosol soil types. These can be highly productive soil types, with their self-mulching topsoils capable of great resilience against many typical soil limitations. However, the possible impacts of opal mining must be carefully managed to avoid not only localised loss of capability during mining operations, but also wider-ranging and long-term impacts such as subsidence, collapse, topsoil loss and increased soil salinity.

Impacts to the Kandosol and Chromosol soil types can include similar subsoil limitations due to erosion risk from dispersive subsoils, but these are typically less productive soils. The commonly hardsetting and scalded topsoils greatly limit agriculture, and would be particularly susceptible to mullock dumping impacts.

Based on modelled Land and Soil Capability classes for the NWR (via eSPADE; OEH 2017b) land capability is variable but ranges from Class 4 to Class 6 indicating land with moderate to very high limitations to productive agricultural use. Opal mining and prospecting is predominantly associated with Class 6 land (low capability land with very high limitations). Class 6 land is typified by steep slopes (20%–33% slope) prone to severe erosion (particularly wind erosion), poor soil (skeletal, rocky, low fertility and acidic) and salinity.

6.1.5 Erosion

Modelled sheet and rill (hillslope) soil erosion potential for the project sites based on bare soil, expressed in tonnes per hectare per year (t/ha/yr) of soil loss, is indicated within the eSPADE database (OEH 2016). This modelling was undertaken using the revised universal soil loss equation (RUSLE) and rainfall-runoff erosivity factors (R-Factors) and soil erodibility factors (K-Factors) per Yang and Yu (2015) and Yang et al. (2017).

The modelled K-Factors for the project area were determined from the eSpade 2.1 database (OEH 2017c). The modelled K-Factors range from 0.02–0.05 t ha h ha-1MJ-1mm-1 on the low relief plains (Rotten Plain, Llanillo, Gingie and Goodooga land systems) and from 0.05–0.08 t ha h ha-1MJ-1mm-1 on the main opal-bearing ridge country (Lightning Ridge Land System) which indicate that the project soils have a high erosion potential when assessed against Rosewell (1993) (Table 6.2). The modelled K-Factors apply to a maximum depth of 100 mm (Yang et al. 2017) and it likely that subsoils at depth will have higher erosivity.

Table 6.2 Rosewell (1993) soil erosion ranking

K-Factor (t ha h $ha^{-1}MJ^{-1}mm^{-1}$)	Erosion Potential
<0.02	Low
>0.02 to <0.04	Moderate
>0.04	High

The modelled soil erosion only considers rainfall erosivity and not wind erosion hazard or soil electrochemical instability. Given the nature of a desktop assessment, available information on the electrochemical stability of the soils is limited**.**

This modelled data suggests that erosion potential is variable across the project site ranging from 20 t/ha/yr up to <50 t/ha/year on the low relief plains and ranging from 20 t/ha/yr up to <500 t/ha/year on the opal-bearing ridge country (OEH 2017d). These represent generally low rates of erosion based on the scale applied to this data.

Data from the USA (Figure 6.1) indicates that peak erosion rates occur where annual rainfall ranges from 300-350 mm/yr (Kirby 1969), slightly less than the 450 mm/yr for Lightening Ridge. As annual rainfall increases, vegetation cover becomes increasingly effective in controlling erosion. The key conclusions to be drawn from the data are:

- vegetation impacts on slope stability are likely to be minimal where rain is less than 450 mm/yr;
- other materials such as timber debris and rock are likely to be major determinants of slope stability where rainfall is less 450 mm/yr; and
- soil stabilisation methods that are effective on sites with rainfall greater than 500 mm/yr and good vegetation cover are likely to be irrelevant for sites where annual rainfall is less than 450 mm/yr.

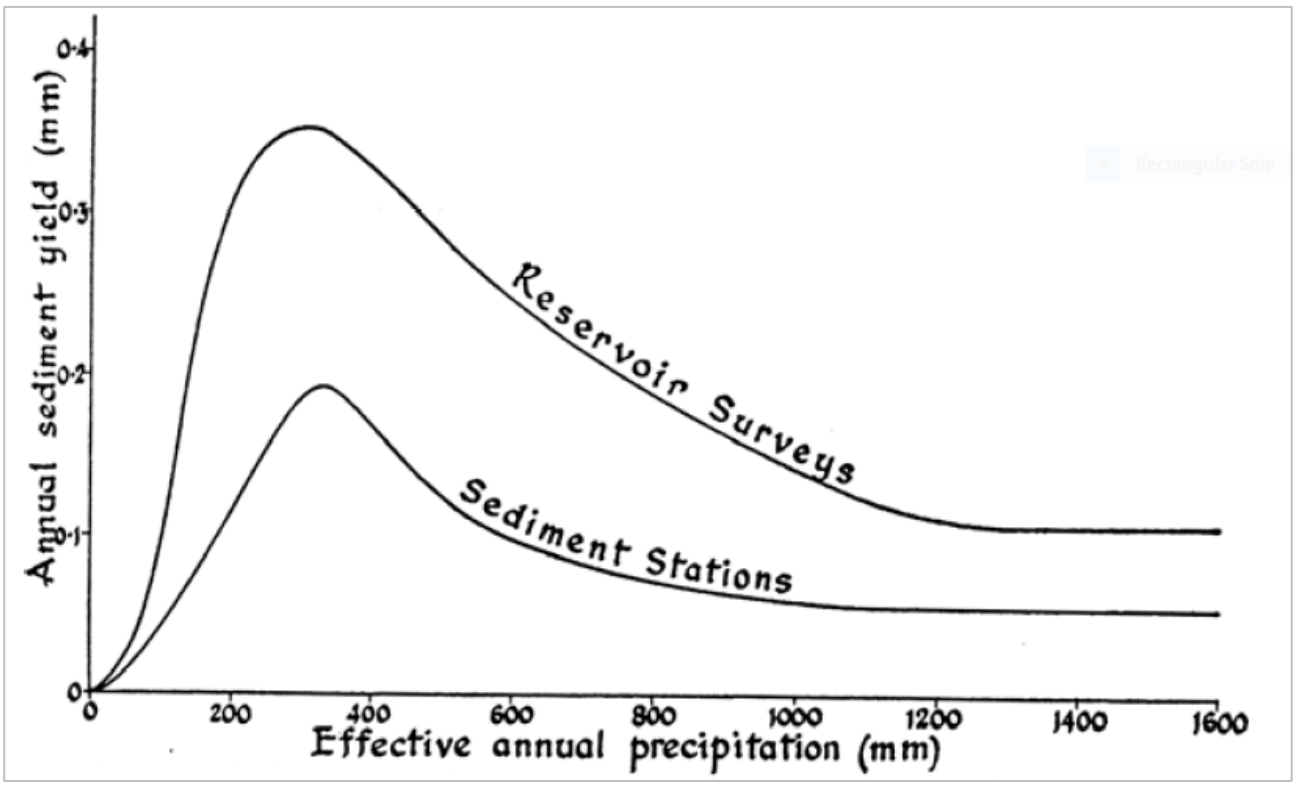


Figure 6.1 Relationship between annual rain and erosion – USA data for natural catchment (Kirby 1969)

i Soil hazards

The soil types mapped pose a variety of potential risks to the proposed project development activities. Due to a lack of site-specific soil chemistry data, it is not possible to assess the specific soil types and their associated chemical constrains and electrochemical instability.

a Regional mapping

The information provided in the Land Systems (Walker 1991) contains no specific description of soil limitations, though information can be inferred from the highlighted hazards of the land systems and the modelled ASC soil types. Scalding in the Llanillo, Gingie, and Goodooga systems (Vertosols) can indicate soil salinity constraints in the surface. The noted water erosion control requirement in the Lightning Ridge land system (Kandosols) could indicate the presence of soil sodicity, dispersive soils or hard-setting topsoils which result in water sheeting across the surface.

b Site specific studies

Area-specific soil assessments include works by DPI (2012) and McKenzie (2015) considering the impact of opal mining on the soils of the Lightning Ridge area.

The Vertosols are noted to commonly have sodic, dispersive subsoils, as well as salinity constraints at depth (DPI 2012). Due to the nature of Vertosols as reactive, shrink-swell soils the movement of water through these profiles is variable and their soil chemistry and subsequent erosion risk needs to be carefully managed. When dry the soils have open macropores, cracks, which allow ready infiltration of water into the soil profile which can lead to subsoil erosion, gullying and tunnelling. The practice of exploratory pilot holes for opal mining can result in further pathways for water to infiltrate the soil and lead to erosion and subsidence, which is common (DPI 2012).

These macropores close up when the soil is wetted, leading to issues with poor infiltration and waterlogging which can be worsened by the sodic nature of the subsoils.

An additional concern is the lenticular structure of Vertosols, known as 'slickensides', which are platelet-like peds which act like shear planes, derived from the shrink-swell nature of the soils. These peds can slide over each other, which can result in poor structural stability in these soils, causing hazards regarding mining activities in proximity, predominantly below, these soil types (DPI 2012). The DPI report shows numerous examples of mines that had suffered collapse due to water infiltration and inundation into Vertosols in proximity to the mining area.

McKenzie (2015) focuses on mining impacts on the alluvial 'plains' soils but highlights common issues for the 'ridge' soils (Kandosols) as compaction from trafficking, low fertility and increased salinity and sodicity constraints from mullock spreading. Impacts on the alluvial soils is primarily focused on the issues of subsidence from underground mining practices, the conservation of topsoils and reducing constraints introduced from mullock and saline/sodic dust.

6.2 Rehabilitation

6.2.1 Mining

Opal mining in the NWR is primarily as underground mining using vertical shafts to access the opal-bearing lithology and underground horizontal drives/tunnels for excavation of opal bearing material (known as 'ballrooms' in larger underground operations) which is then brought to the surface for processing. Open-cut mining is also undertaken but typically where significant underground mining has already occurred or where cave-ins/subsidence preclude underground mining techniques (DPIE 2021).

Rehabilitation risks associated with these mining methods are summarised below.

i Underground mining

While current guidelines and OPL conditions for underground prospects and mines for require the backfilling of shafts with mullock as part of site rehabilitation, underground drives/tunnels/ballrooms may only be partially or not backfilled due to the effort required thus resulting in underground voids with potential for tunnel erosion, subsidence or collapse after mining has ceased and the surface 'rehabilitated'. Saline pore water may be flushed from mullock used to backfill shafts when exposed to freshwater from rainfall, runoff and seepage, and may disperse and collapse.

Ground collapse and subsidence can also result in the inadvertent loss of topsoil into formed voids and a deficit of soil material available for rehabilitation (McKenzie 2015).

As discussed in Section 6.1.5, erosion and subsidence/collapse of underground workings is particularly prevalent in the low relief plans areas due to the unstable nature of the Vertosol soils; DPI (2012) identified several examples of ground collapse and sinkhole formation in 'rehabilitated' opal exploration areas and associated safety risks to livestock and graziers. While measures to prevent or minimise water inundation into underground workings may partly mitigate potential ground subsidence (DPI 2012; McKenzie 2015), the inherent geotechnical and electrochemical instability of the Vertosol soils and 'slickensides' at depth (>4 m) is a key uncertainty and rehabilitation risk to achieving safe, stable and non-polluting landforms in these plains areas. DPI (2012) also identified landowner concerns regarding land productivity impacts associated with the ongoing erosion of failed, abandoned or poorly rehabilitated workings.

ii Mullock waste

Sampling and characterisation of mullock dump material from several opal prospects and mines in the NWR was conducted by the former NSW Department of Land and Water Conservation in 2000 (DWLC) (DWLC 2000). The program involved representative sampling to assess mullock erodibility and ability to support and sustain vegetation.

From the material characterisation results (Table 6.3) mullock was described as medium to heavy clay material, generally high saline with moderate to high dispersibility (electro chemical instability with severe erosion risk), prone to crusting (armouring) after rainfall and therefore limiting to vegetation establishment without treatment (eg gypsum amelioration, application of a soil cover). Stratford (1995) identified the difficulty of establishing vegetation from seed directly in mullock or mullock affected soil but noted improved success from tubestock planting for more tolerant species such as *Eucalyptus populnea.*

Table 6.3 Mullock material erosion characterisation – average values[1]

Particle size analysis (g/100g soil)					Dispersion percentage (%)	Emerson Aggregate Test (E.A.T) (1:5)	EC (1:5) (dS/m)[2]	pH (1:5)
Clay	Silt	Fine sand	Coarse sand	Gravel				
44.47	24.88	18.71	11.53	0.41	49.76	2(1) – 2(2)	1.47	7.21

1. Adapted from DWLC (2000). Average values determined from representative sampling provided, except E.A.T which is expressed as the range of observed values.
2. Equivalent to an average saturated electrical conductivity (ECe) of 10.29 (highly saline).

Key recommendations of the study were that rehabilitation policy be updated to specifically address mullock erosion and sediment hazard (eg mullock dump sediment containment bunds), and re-use of stripped soil as a covering layer on mullock material to support rehabilitation (DWLC 2000).

Flushing of saline pore water via rainfall will increase clay dispersion in the mullock heaps leading to tunnel and gully erosion.

Mullock heaps (ie above backfilled shafts) established during backfilling and rehabilitation may be targeted for 'noodling' to sieve for missed opals. While noodling is typically undertaken by individuals and by hand, these activities can nonetheless re-disturb emplaced mullock and reinitiate erosion, impeding rehabilitation progress.

6.2.2 Processing

i Wet processing

Wet processing ('wet puddling') involves washing opal-bearing material to separate fine soils from coarse sediments which are then hand sorted for any opals. The wet fines are collected in separated earthen dams for settlement of fines and to capture water for re-use. The mixer drums of concrete trucks are often used for the washing and agitation of opal excavated soils.

Given the saline and dispersive nature of overburden materials in the region, the consolidated fines materials captured in puddling dams will have similar challenges for rehabilitation as for dry mullock waste (Section 6.2.1) although could be expected to be harder-setting due to the concentration of fines and salts. Incorporation of rock and gypsum via contour scarification to increase infiltration, flush saline pore water and reduce sodicity followed by capping with topsoil, would improve rehabilitation success.

ii Dry processing

Dry processing ('dry puddling') similarly involves the separation of fines from coarse sediments using mechanical mixing. This method is generally less efficient than wet puddling and may therefore be used prior and in combination with wet puddling. Fines and coarse sediments separated by dry puddling would pose rehabilitation risks and require management consistent with that for mullock waste (Section 6.2.1).

6.2.3 Key issues for rehabilitation

The key issues for rehabilitation in Area 1, based on the environmental setting and techniques used for opal mining and prospecting, are summarised below. These issues are considered in the context of risks to agricultural (grazing) post-mining land use.

- The dominant soils are Kandasols and Vertosols, found in the elevated ridge country (Lightning Ridge Land System) and low-relief alluvial plains country (Rotten Plain, Llanillo, Gingie and Goodooga land systems), respectively. Both soil types are characterised as sodic, dispersive and hardsetting. These soils have high potential for erosion and sediment loss and are extremely sensitive to concentrated surface water flows when disturbed or where appropriate soil protection measures are not implemented during rehabilitation.

- The Vertosols in the low-relief plains areas have moderate land capability and are well suited to and actively used for livestock grazing. However, the shrink-swell nature of these soils can lead to subsoil erosion, gullying and tunnelling and poor pedal structural integrity at depth ('slickensides'). Opal prospecting and mining in these Vertosols therefore presents a significant risk of erosion and ground collapse/subsidence with demonstrated examples of ground failure at both unrehabilitated workings and 'rehabilitated' sites (DPI 2012; McKenzie 2015). Erosion impacts and ground failure are an impact to both concurrent and future agricultural use of affected land.

- Underground workings can result in ground subsidence or collapse despite the backfilling of shafts with waste rock and mullock. This may occur where underground drives/tunnels/ballrooms are only partially or not backfilled. Ground collapse can result in the inadvertent loss of surface topsoil and result in a soil deficit for rehabilitation. A deficit of topsoil material for rehabilitation can also occur if topsoil resources are not stripped and preserved prior to the commencement of open-cut mining or contaminated with other substrate (eg subsoil or mullock) due to poor handling and stockpiling practices.

- Mullock waste generated during opal prospecting and mining generally has high-clay content and is highly saline, moderately-to-highly dispersive and prone to crusting (armouring) after rainfall. These properties are limiting to vegetation establishment, particularly from seed.

- The low annual rainfall means that rehabilitated landforms cannot achieve sufficient vegetation cover for erosion protection therefore identification and preservation of appropriate soil surface cover materials is required.

6.3 Surface water

Impacts to the surface water environment may occur from site establishment, management of material stockpiles, utilisation of plant and equipment and the management of water utilised in processing activities. Impacts to the surface water resource could lead to a degradation of receiving water quality due to sedimentation or contamination and a reduction in flows effecting the stream health.

The following section outlines a qualitative surface water impact assessment for opal mining, prospecting and processing in Area 1.

6.3.1 General impacts

The potential surface water impacts relating to general activities are outlined below:

- Surface water take for operational use, if in excess of an exemption, right or licence presents a key compliance issue which can reduce flows and the environmental health of receiving water including the Narran Lakes.
- Erosion and sedimentation issues may be associated with site preparatory works including vegetation clearing, topsoil stripping and minor earthworks.
- Modification of natural drainage channels within worksites present a direct impact to surface water resources.
- Contamination of runoff can be associated with plant and equipment use including:
    - washdown of plant and equipment; and
    - spills of fuel and chemicals from improper storage and refuelling of plant and equipment.

6.3.2 Opal prospecting impacts

The potential surface water impacts associated with opal prospecting and opal mining are outlined below:

- Disturbance of the ground surface for mining activities can lead to increased erosion and sediment-laden runoff entering watercourses. Mullock waste generated during opal prospecting and mining can also lead to increased erosion and sediment-laden runoff.
- Disturbance of the ground surface may also provide a pathway to release existing sources of contamination (Section 4.15) to downstream watercourses.
- Flooding of work sites and compounds and inundation of shafts/excavations could lead to temporary contamination of waterways.

Wet fines that are a by-product of wet puddling are generally collected in separated earthen dams for settlement of fines and to capture water for re-use. Improper site water management may lead to uncontrolled overflow of dams and tanks, causing potentially contaminated discharge to watercourses.

The described hydrologic impacts are anticipated to be localised and are unlikely to materially impact the hydrology of the Ramsar site at Narran Lake Nature Reserve.

6.4 Groundwater

6.4.1 Introduction

This groundwater impact assessment assesses the potential impacts of the proposed activity, being opal mining and prospecting in Area 1, on the local and regional groundwater resource.

A characterisation of the existing environment is presented in Section 4.6, as it relates to the groundwater resource, and identified sensitive environmental and consumptive groundwater users that are dependent on access to both shallow and deep groundwater across Area 1. This assessment discusses the interaction of the current and proposed activities with the existing environment.

Groundwater occurrence across Area 1 is generally highly variable. Within the ridgeline areas and in the vicinity of historic opal mining activities, groundwater generally exceeds the depth of mining, with the water table residing within the underlying sandstone lenses of the semi-confined Rolling Downs Group. Elsewhere across the area, and principally within the vicinity of mapped watercourses and wetlands areas, shallow groundwater can occur in saturated alluvial/colluvial sediments.

Deep groundwater from artesian aquifers can discharge as mound springs; however they are rare in this portion of the Surat Basin and there is only one mound spring known within Area 1. Shallow groundwater discharging from localised alluvial/colluvial sediments is suspected in the vicinity of Narran Lake. There are numerous registered water bores located within Area 1, most of which target the deeper regional and confined GAB sandstone aquifers. Most of these bores are sub-artesian with a few deeper bores at lower elevations being artesian. Groundwater is used primarily for stock, domestic, mining and town water supply purposes.

6.4.2 Mining, prospecting activities

The proposed opal mining and prospecting activities are highly unlikely to intercept groundwater, given the depth to groundwater is expected to exceed the depth of opal mining operations. It is not expected that the proposed activities will impact on groundwater recharge/discharge processes, and the availability or quality of both shallow and deep groundwater across Area 1. Therefore, mining and prospecting activities are highly unlikely to impact on environmental and third-party groundwater users.

6.4.3 Processing activities

Processing of mined opal ore occurs primarily via two methods, as described in Section 3.5.3; wet puddling and dry puddling. This section focuses on the groundwater-related impacts associated with wet puddling.

Wet puddling processes, broadly involving the separation of opal ore from rocks and soil using agitators, requires the continuous circulation of water to separate ore from the clay, silt and sand matrix. Process water is contained in earth dams and tanks and recirculated for each processing cycle. Most water has been historically sourced from existing water supply bores located within Area 1, some of which have been drilled specifically for opal mining and processing purposes. Registered water bores within Area 1 are shown on Figure 4.6. Those that are known to be used for mining and processing purposes are itemised in Table 6.4, together with their known water licensing details.

Table 6.4 Summary details of water bores known to be used for mining purposes

Bore ID	Work approval #	WAL #	Water source	Annual Share Volume (ML)	Notes
GW900987 – Coocoran GW900988 – Emu	85WA751201	15693	NSW GAB Surat GW	250	Solely mining use
GW027398 – Muttabun	BLR licence	n/a	NSW GAB Surat GW	n/a	Ceased to flow in 1994, started flowing again in 2001
GW800546 – Olga	85WA751217	15643	NSW GAB Surat GW	30	

Bore ID	Work approval #	WAL #	Water source	Annual Share Volume (ML)	Notes
GW012451 – Llanillo No. 2	85WA751499	27426	NSW GAB Surat GW	200	Bore baths use with excess used for mining
GW034677	85CA751393	27155 30320	NSW GAB Surat GW	407 168	Town water supply and mining use

It is assumed that future mining operations requiring access to a water supply to meet processing demands would utilise existing processing sites and water allocation rights held by water access licence (WAL) holders and linked to a relevant works approval and existing water supply bore. As no increased use of groundwater (beyond what is currently authorised under the *WSP for the NSW Great Artesian Basin Groundwater Sources 2020*) is proposed, there will be no impact on groundwater resources or artesian pressures with the expansion of opal mining activities in Area 1.

If new processing sites are planned in the future, and new bore sites are required to obtain process water, this activity will require further environmental and groundwater impact assessment before any new WALs or work approvals are issued, and production bores are drilled.

6.5 Biodiversity

A Biodiversity Assessment (BA) which identifies flora and fauna constraints associated with the proposed activities was undertaken (Appendix A) and is summarised below.

6.5.1 Biodiversity assessment pathway

The *Biodiversity Conservation Act 2016* ('BC Act') is responsible for the conservation of biodiversity in NSW. The BC Act, together with the NSW Biodiversity Conservation Regulation 2017, establishes the Biodiversity Offsets Scheme (BOS), the Biodiversity Assessment Method (the BAM) and a method for determining if developments are likely to significantly affect threatened species, ecological communities or their habitats.

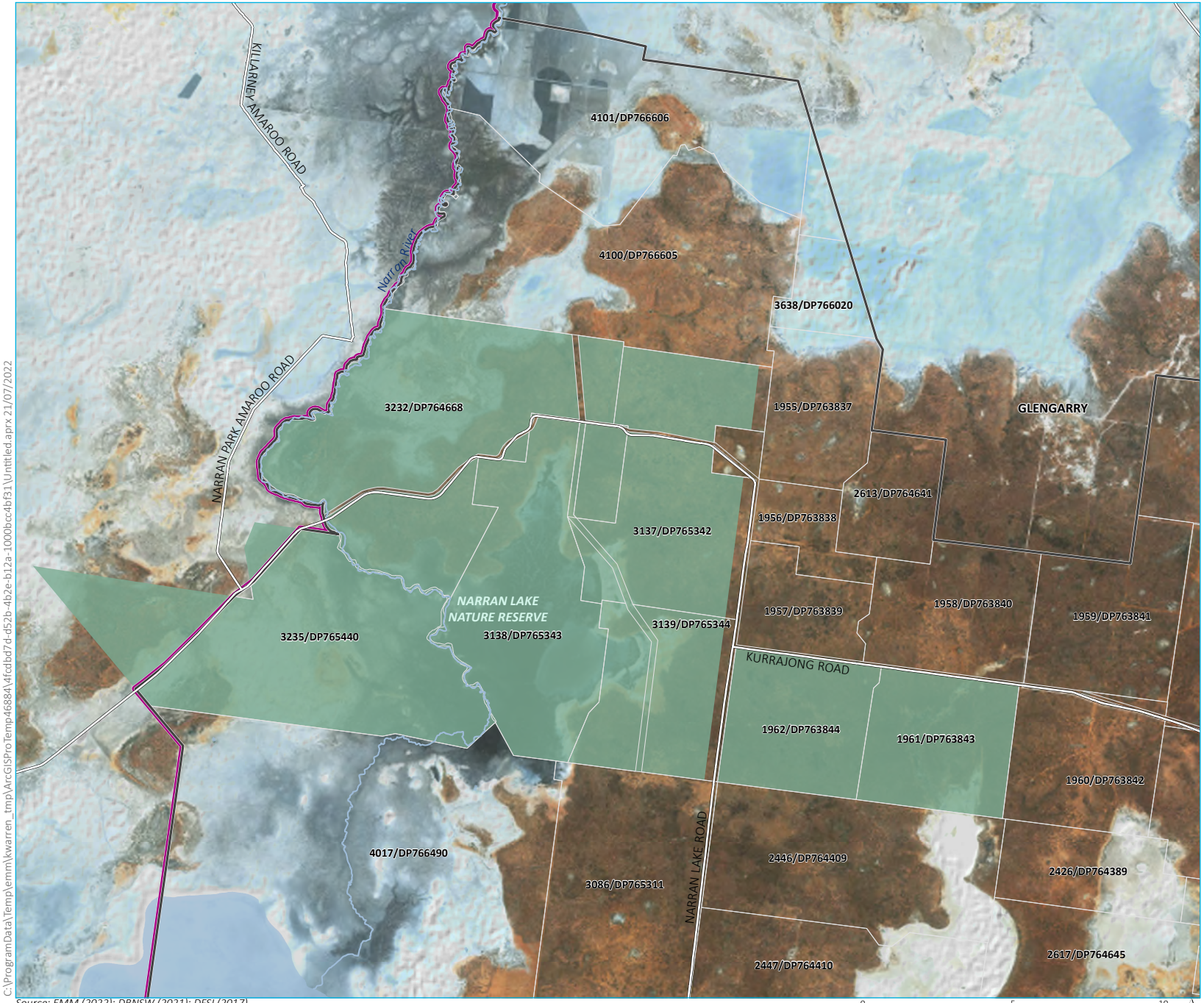
The requirement for assessment under the BOS is dependent on a series of thresholds. EMM has assessed the project against these thresholds (refer to Section 5.3.1) and found that the BOS is not triggered and a biodiversity development assessment report (BDAR) is not required.

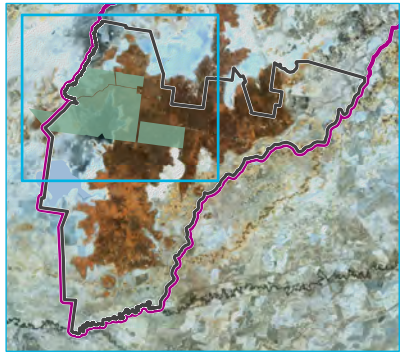
The proposed activity will not be undertaken in a declared area of outstanding biodiversity value.

The focus is therefore on a description and assessment of the likely impacts of the proposed activity on threatened species and communities, and their habitats and assesses the significance of the predicted impacts.

6.5.2 Methods

This assessment utilised both a desktop assessment and field investigation. The study area is shown in Figure 6.2.





KEY

Area 1

Narran- Warrambool Reserve

Existing environment

Major road

Minor road

Named watercourse

Named waterbody

NPWS reserve

Cadastral boundary

REF Area 1 of the Narran-Warrambool Reserve (NWR) West

Review of Environmental Factors
Figure 6.2

EMM creating opportunities

Source: EMM (2022); DRNSW (2021); DFSI (2017)

0 5 10 km

GDA 1994 MGA Zone 55

N

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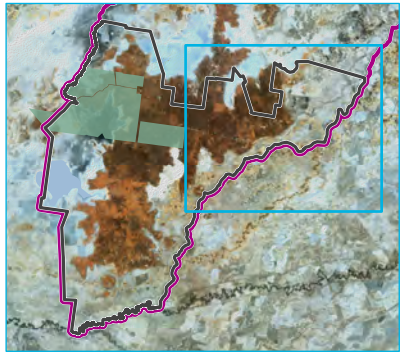

KEY

Area 1

Narran- Warrambool Reserve

Existing environment

Major road

Minor road

Named watercourse

Named waterbody

NPWS reserve

Cadastral boundary

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Source: EMM (2022); DRNSW (2021); DFSI (2017)

0 5 10 km

GDA 1994 MGA Zone 55

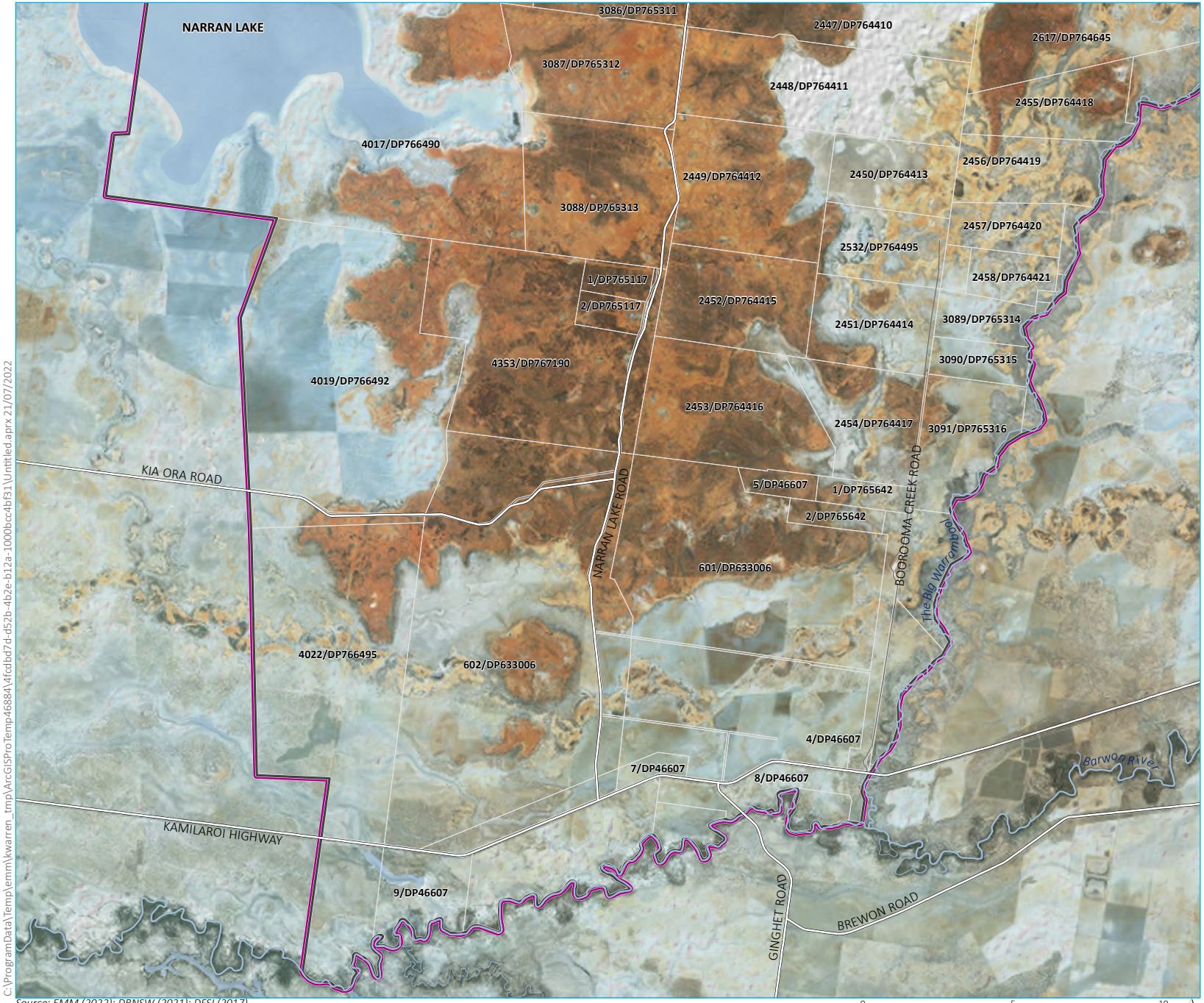
N

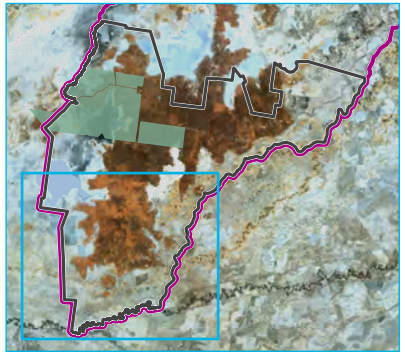
REF Area 1 of the Narran-Warrambool Reserve (NWR) East

Review of Environmental Factors

Figure 6.2

EMM creating opportunities





KEY

- Area 1
- Narran- Warrambool Reserve

Existing environment

- Major road
- Minor road
- Named watercourse
- Named waterbody
- NPWS reserve
- Cadastral boundary

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Source: EMM (2022); DRNSW (2021); DFSI (2017)

REF Area 1 of the Narran-Warrambool Reserve (NWR) South

Review of Environmental Factors
Figure 6.2

EMM
creating opportunities

A desktop assessment and database search were undertaken to determine the biodiversity values that are known or potentially present across Area 1.

The field investigation was undertaken by two ecologists on Thursday 18 November 2021 through to Monday 22 November 2021 and included:

- rapid vegetation mapping and condition assessment; and
- habitat assessments for threatened species.
- Note that access was not available for all properties in Area 1.

i Constraints assessment

The criteria for assessing biodiversity constraints within Area 1 are described in Table 6.5.

Table 6.5 Constraints criteria

Biodiversity constraint	Constraint definition
High	Intact native vegetation, minimal disturbance, potential habitat features for threatened species/communities, riparian corridors, potential presence of GDE and potential presence of serious and irreversible impacts (SAII).
Moderate	Native vegetation with minor disturbances of clearing or weeds and potential habitat features for threatened species/communities.
Low	Land contains native vegetation with: • high percentage of weed cover; and/or • some stratum is missing or in poor condition.
Negligible	Vegetation, if present, contains largely non-native species ie agriculture, infrastructure, cleared, highly disturbed, dominated by weeds.

ii Likelihood of occurrence assessment

The criteria for assessing likelihood of occurrence for threatened species, used to inform the assessments are listed in Table 6.6.

Table 6.6 Likelihood of occurrence criteria

Likelihood	Description	Further assessment conducted?
Negligible	• The potential for the species to occur is considered so unlikely as to not be worth considering.	No
Low	• Based on data collected during field investigations it was considered that the species was unlikely to occur in the study area or use habitats in the study area. A species may utilise the study area on rare occasions. • Species is considered vagrant in the bioregion and is thus considered unlikely to occur in the study area.	No
Moderate	• The species is known to occur in the bioregion and the study area provides some habitat value for the species. Habitat values are somewhat degraded and considered suboptimal.	Yes
High	• The species is known to occur in the bioregion and the study area supports optimal habitat features for the species.	Yes
Recorded	• The species was recorded during site visit.	Yes

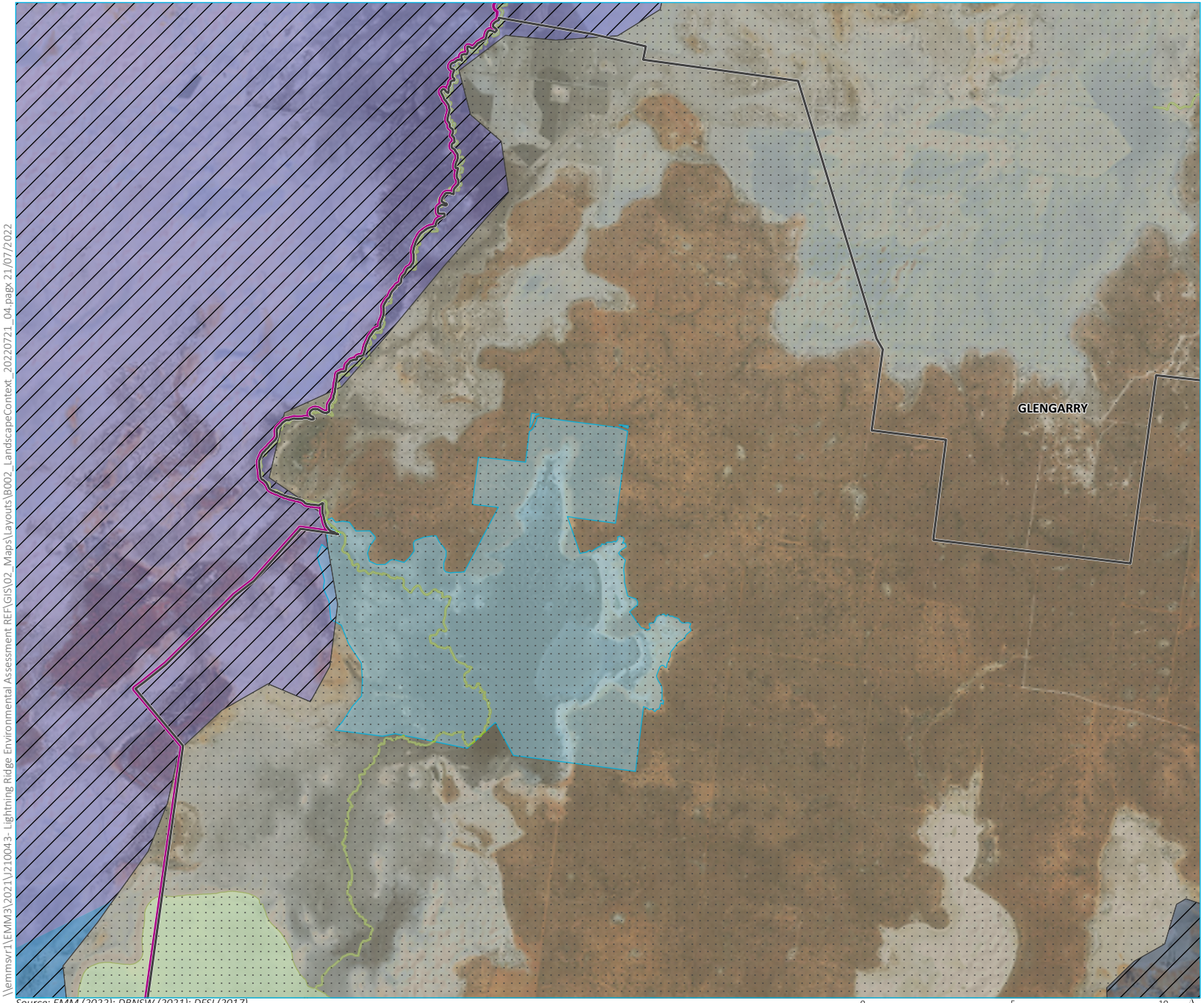
6.5.3 Results

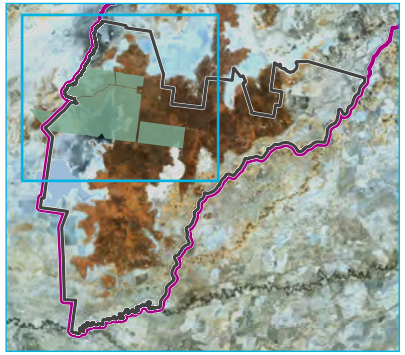
i The local landscape context

The study area (Area 1) contains the south-eastern edge of the Great Artesian Basin. The Narran Lake Nature Reserve, is within the study area and is considered a Wetland of International Importance (RAMSAR). Narran Lake Nature Reserve covers part of a large terminal wetland of the Narran River in NSW at the end of the Condamine River system which flows from Queensland. The Narran River lies within the Murray-Darling Basin.

The study area predominantly occurs within the Brigalow Belt South Interim Biogeographic Regionalisation for Australia (IBRA) region but also occurs within the Darling Riverine Plain IBRA region, Narran rivers and the Narran Lake wetland complex. Soils and vegetation reflect past patterns of sedimentation and deposition of sandy soils and heavy dark clays. Landscape context is illustrated at Figure 6.3.

Based on current knowledge, the study area does not include land that is constrained by BioBanking or Stewardship agreements established under the repealed NSW *Threatened Species Conservation Act 1995* (TSC Act) or the NSW *Biodiversity Conservation Act 2016* (BC Act).





KEY

Area 1

Narran- Warrambool Reserve

IBRA region

Brigalow Belt South (BBS)

Darling Riverine Plains (DRP)

IBRA sub-region

BBS | Narrandool

DRP | Castlereagh-Barwon

DRP | Culgoa-Bokhara

DRP | Warrambool-Moonie

Biodiversity values

Riparian corridor

Ramsar wetland

Source: EMM (2022); DRNSW (2021); DFSI (2017)

0 5 10 km

GDA 1994 MGA Zone 55

N

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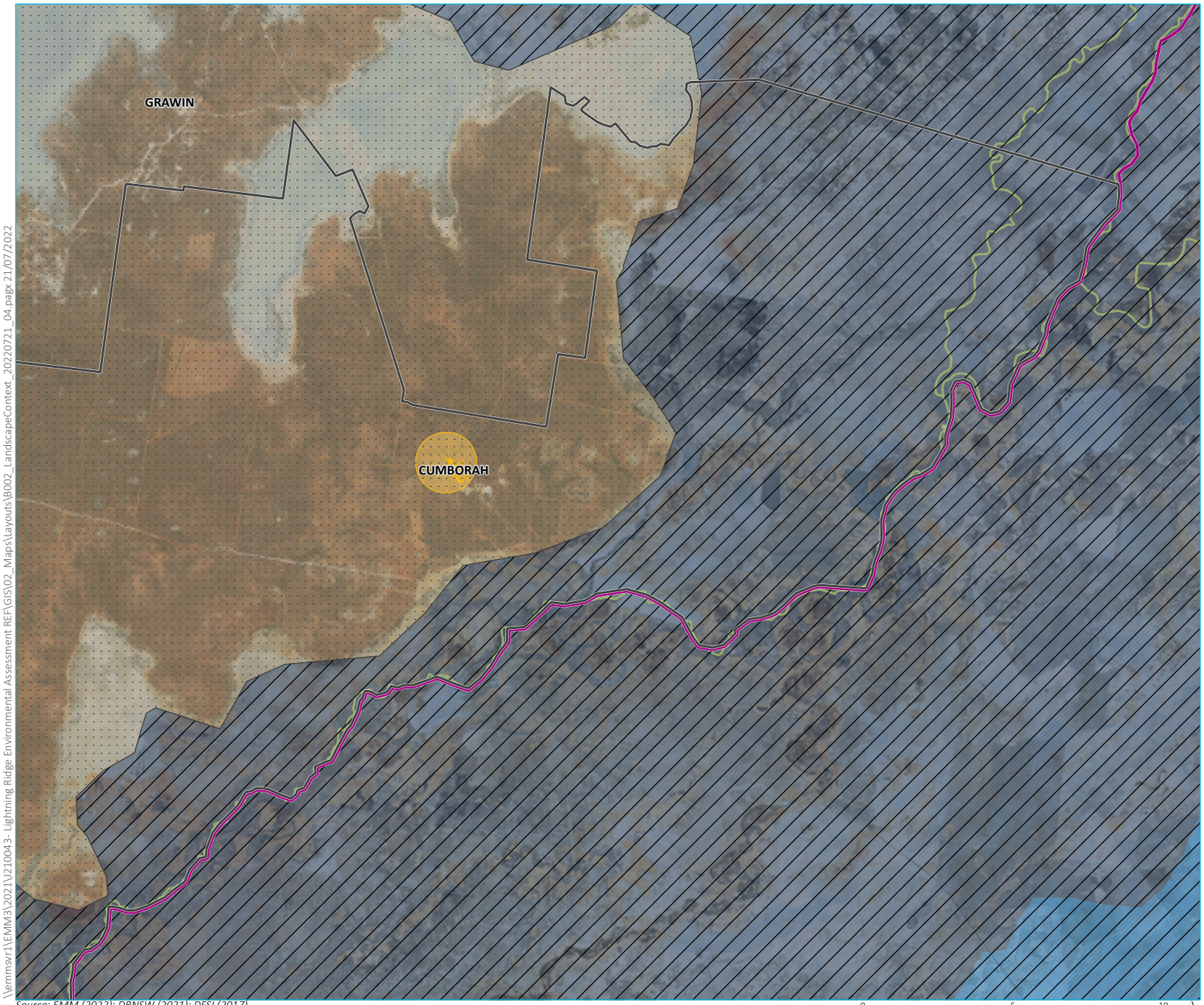
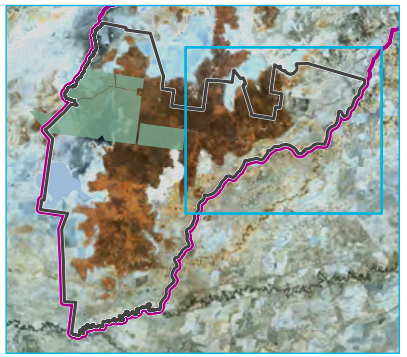
Landscape context — West

Review of Environmental Factors

Figure 6.3

EMM creating opportunities





KEY

Area 1

Narran- Warrambool Reserve

IBRA region

Brigalow Belt South (BBS)

Darling Riverine Plains (DRP)

IBRA sub-region

BBS | Narrandool

DRP | Castlereagh-Barwon

DRP | Warrambool-Moonie

Biodiversity values

Riparian corridor

Threatened species or communities with potential for serious and irreversible impacts

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Source: EMM (2022); DRNSW (2021); DFSI (2017)

0 5 10 km

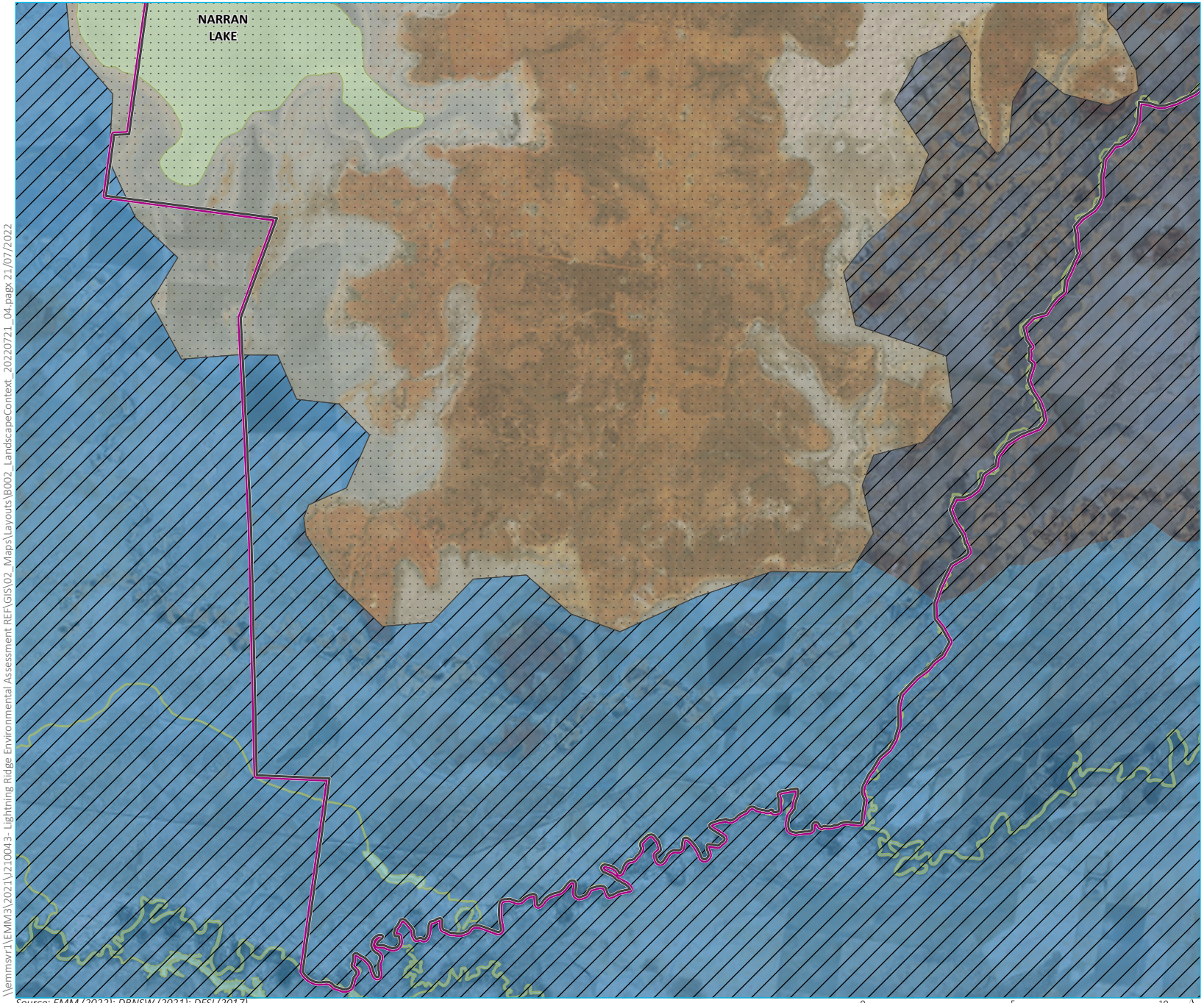
GDA 1994 MGA Zone 55

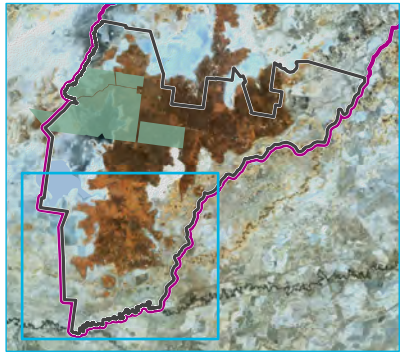
N

Landscape context — East

Review of Environmental Factors
Figure 6.3

EMM
creating opportunities





KEY
- Area 1
- Narran- Warrambool Reserve

IBRA region
- Brigalow Belt South (BBS)
- Darling Riverine Plains (DRP)

IBRA sub-region
- BBS | Narrandool
- DRP | Castlereagh-Barwon
- DRP | Warrambool-Moonie

Biodiversity values
- Riparian corridor

Source: EMM (2022); DRNSW (2021); DFSI (2017)

0 5 10 km

GDA 1994 MGA Zone 55

N

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Landscape context — South

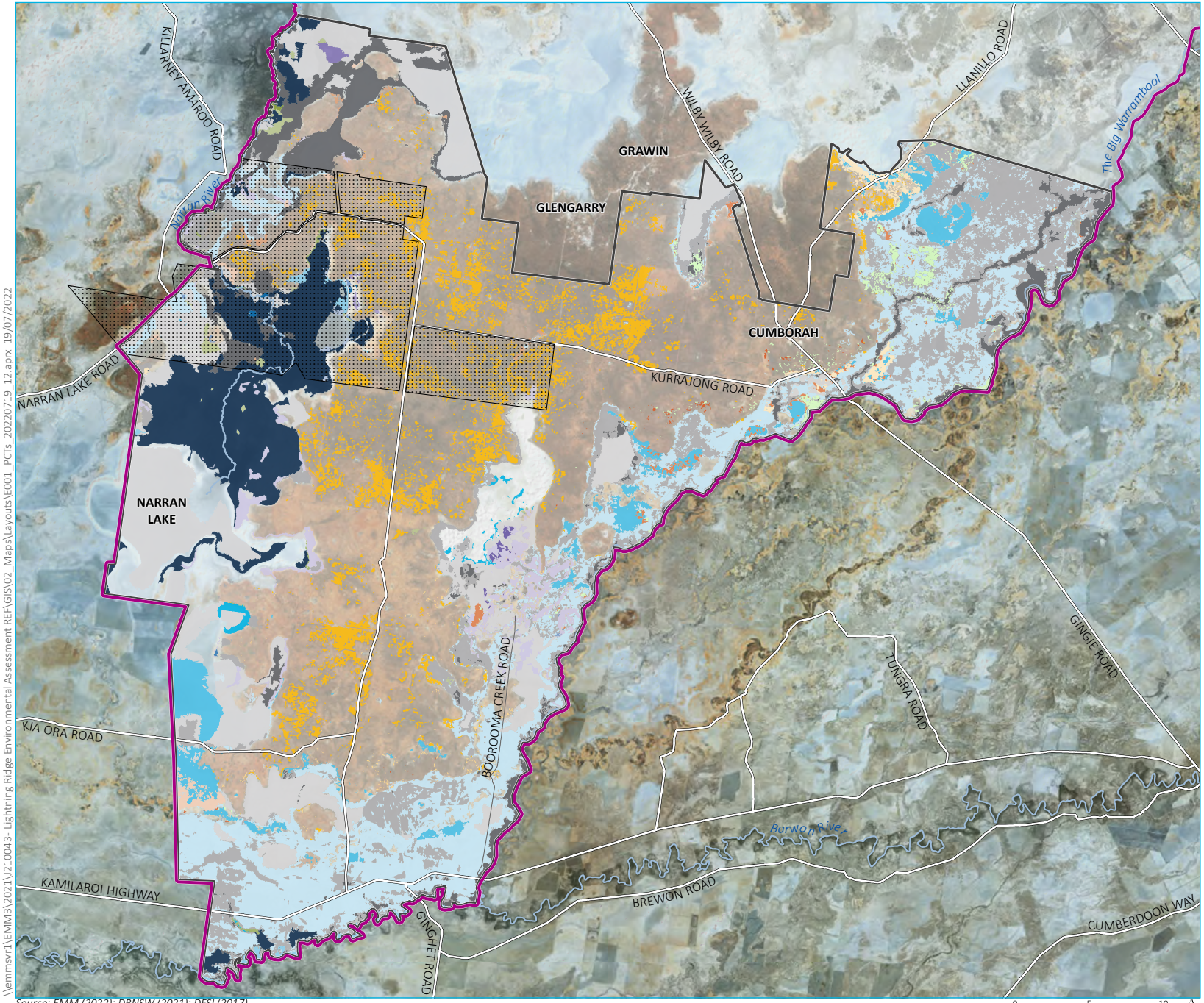
Review of Environmental Factors
Figure 6.3

EMM
creating opportunities

ii Terrestrial values

a Vegetation

State Vegetation Type Mapping (SVTM – VIS_ID 4492) for the Western region (DPIE, 2018) predicts that there are 48 plant community types (PCTs) present within Area 1, conforming to 18 different vegetation classes and comprising more than 75% of the total study area. Of these, Western Peneplain Woodlands (60,188 ha), North-west Floodplain Woodlands (54,541 ha), and Semi-arid Floodplain Grasslands (19,512 ha) are the most extensive, demonstrating a range of habitat types across the study area.



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PCTs within Area 1 associated with State or Commonwealth listed Threatened Ecological Communities

Review of Environmental Factors
Figure 6.4

EMM
creating opportunities

Eight threatened ecological communities (TECs) listed under the BC Act and four also listed under the EPBC Act are known or predicted to occur within Area 1. The PCTs associated with these TECs are distributed evenly throughout the study area.

Two TECs are listed as entities at risk of Serious and Irreversible Impacts (SAII), these are:

- Artesian Springs Ecological Community in the Great Artesian Basin (*Endangered*); and
- Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions (*Endangered*).

Under the guiding principles of SAII, the impacts from development or similar activities are likely to contribute significantly to the risk of extinction of a threatened species or ecological community, and require further assessment in accordance with Section 9.1 of the Biodiversity Assessment Method (BAM) as part of a biodiversity impact assessment.

iii Threatened terrestrial fauna

Threatened flora and fauna predicted or known to occur within a 10 km buffer of the study area are concentrated around Narran Lake Nature Reserve (and associated Narran River), and the riparian zone of the Barwon River.

The predicted and known threatened fauna assemblage is dominated by bird species, with the highest number of sightings represented by bird species, including species associated with wetlands, woodlands, and grasslands.

There are three threatened fauna species likely to occur within the study area that are SAII entities:

- Squatter Pigeon (southern subspecies) (*Geophaps scripta scripta*);
- Thick-billed Grasswren (central NSW subspecies) (*Amytornis modestus inexpectatus*); and
- Pale Imperial Hairstreak (*Jalmenus eubulus*).

iv Threatened terrestrial flora

There are 15 flora species predicted or known to occur within 10 km of Area 1. Flora species such as Winged Peppercress and Slender Darling Pea (*Swainsona murrayana*) are typical species associated with floodplain habitats.

There are four threatened flora species likely to occur within the study area that are an SAII entity:

- Yetman Wattle (*Acacia jucunda*);
- Bindweed (Convolvulus tedmoorei);
- Desert Cow-Vine (*Ipomoea diamantinensis*); and
- Braid Fern (Platyzoma microphyllum).

6.5.4 Aquatic values

i Threatened fish distributions

The distributions of the following threatened species listed under the NSW *Fisheries Management Act 1994* (FM Act) are mapped within the study area (NSW DPI, 2021) and includes the Narran River and Barwon River catchments:

- Darling River Snail (*Notopala sublineata*) – critically endangered species;
- Silver Perch (*Bidyanus bidyanus*) – vulnerable species; and
- Olive Perchlet (*Ambassis agassizii*) – endangered population.

Additional freshwater fish species listed under the EPBC Act are predicted to occur in catchments in the locality (DAWE 2021). These include:

- Murray Cod (*Maccullochella peelii)* – vulnerable species;
- Trout Cod (*Maccullochella macquariensis)* – endangered species; and
- Macquarie Perch (*Macquaria australasica*) – endangered species.

No threatened aquatic ecological community or other threatened fish species listed under the FM Act and EPBC Act, are relevant to the study area (DPI 2021).

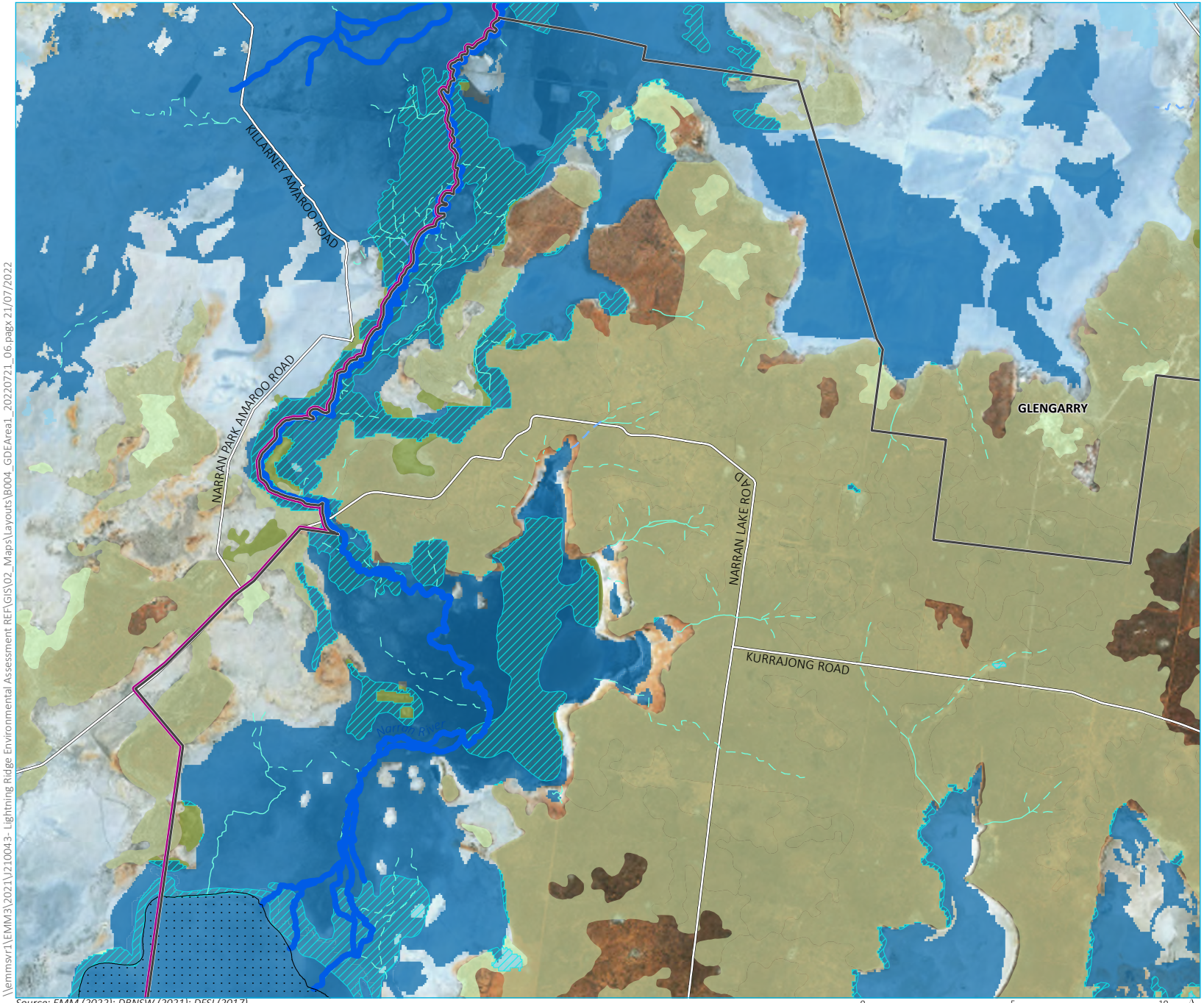
ii Key fish habitat

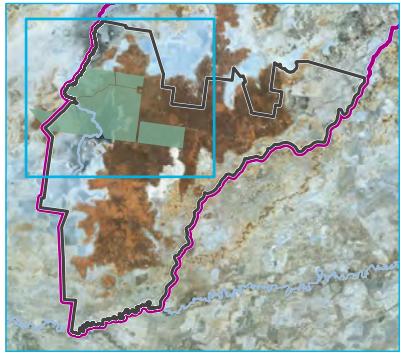
The majority of the Narran Lake wetland complex within the study area is mapped as Key Fish Habitat as defined and mapped by the NSW Department of Primary Industries (DPI 2021), as too are the Narran River, Barwon River and parts of The Big Warrambool (tributary to Barwon River). The study area is located within the broader Murray-Darling Basin – North Key Fish Habitat area (DPI, 2021).

6.5.5 Groundwater dependent ecosystems

Groundwater Dependent Ecosystems (GDEs) are mapped within the study area including high potential terrestrial ecosystems, such as low lying stony plains and low flat-topped hills surrounding the Narran Lake wetland complex and Barwon River flat areas, dominated by Coolibah (*Eucalyptus coolabah*) (BoM 2021). Moderate and low potential GDEs comprise a large area in the north of the study area and comprise low-lying stony plains and mesas with Bimble Box (*Eucalyptus populnea*) (BoM 2021). The dependence of native plant community types and streams within the study area on both groundwater, and from the Great Artesian Basin would require further assessment, supported by a groundwater assessment, if groundwater resources are to be intersected by activities.

There are high potential aquatic GDEs mapped within the study area, predominantly around Narran Lake complex and the multi-channelled floodplain of the Barwon River. These areas contain ecosystems that rely on surface expression of groundwater (BoM 2021). The presence of GDEs is shown in Figure 6.5.





KEY

- Area 1
- Narran- Warrambool Reserve

Existing environment

- Major road
- Minor road
- Named waterbody

Groundwater dependent ecosystem (GDE)

- Aquatic and terrestrial GDEs

Aquatic GDE

- High potential
- Moderate potential
- Low potential

Terrestrial GDE

- High potential
- Moderate potential
- Low potential

Strahler stream order

- 1st order
- 2nd order
- 3rd order
- 8th order

Source: EMM (2022); DRNSW (2021); DFSI (2017)

0 5 10 km

GDA 1994 MGA Zone 55

N

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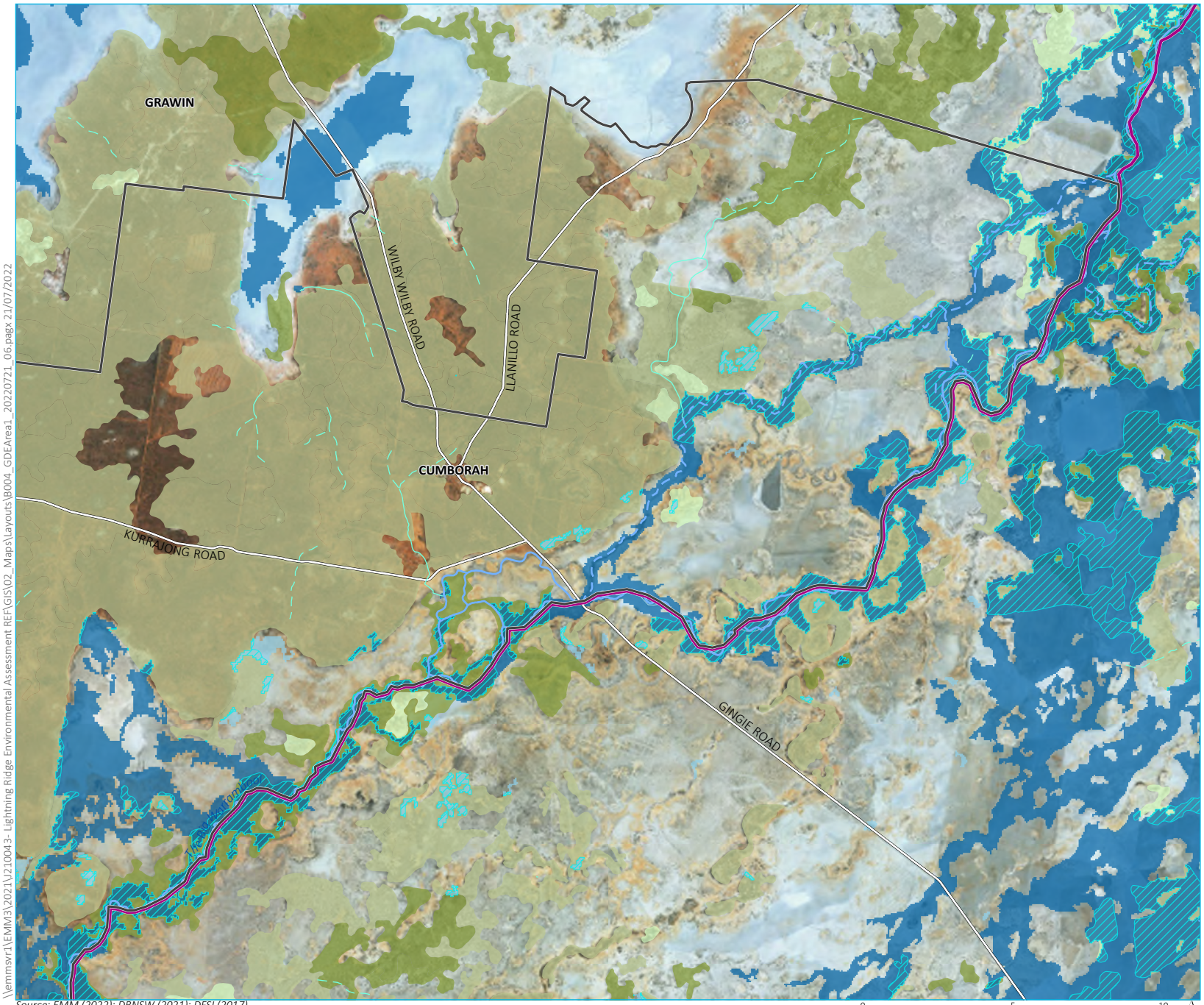
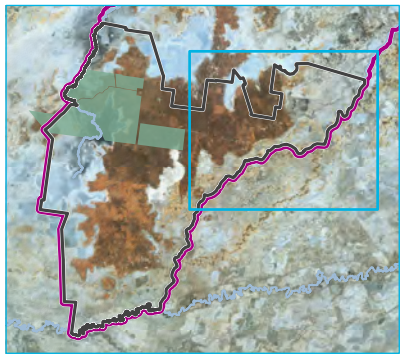
Predicted or known distribution of GDEs West

Review of Environmental Factors
Figure 6.5

EMM
creating opportunities





KEY

- Area 1
- Narran- Warrambool Reserve

Existing environment

- Major road
- Minor road
- Named waterbody

Groundwater dependent ecosystem (GDE)

- Aquatic and terrestrial GDEs

Aquatic GDE

- Known
- High potential
- Moderate potential
- Low potential
- Unclassified potential

Terrestrial GDE

- High potential
- Moderate potential
- Low potential

Strahler stream order

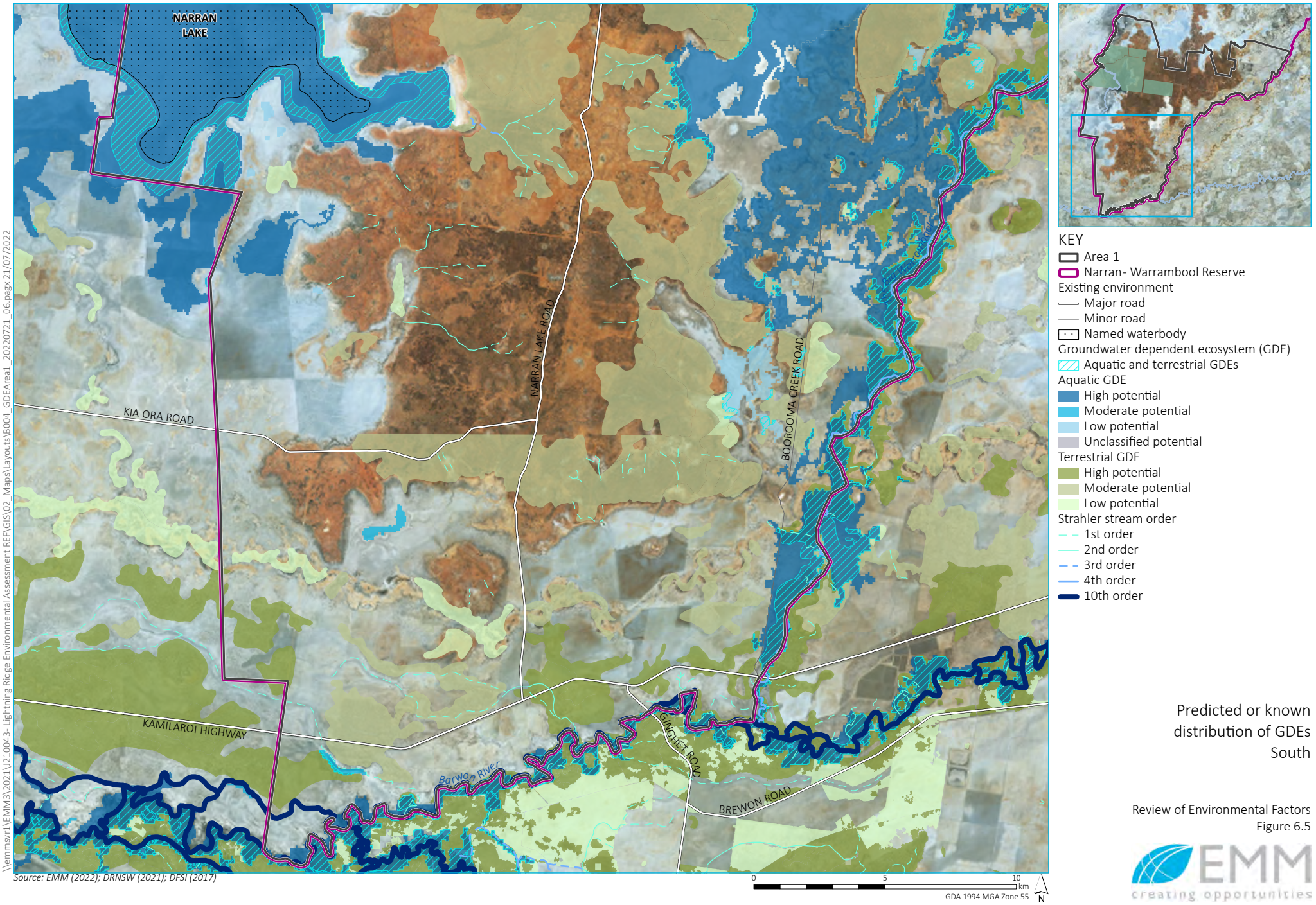
- 1st order
- 2nd order
- 3rd order
- 4th order
- 5th order

Predicted or known distribution of GDEs East

Review of Environmental Factors
Figure 6.5

EMM creating opportunities

Source: EMM (2022); DRNSW (2021); DFSI (2017)



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Source: EMM (2022); DRNSW (2021); DFSI (2017)

Predicted or known distribution of GDEs South

Review of Environmental Factors
Figure 6.5

EMM
creating opportunities

6.5.6 Matters of National Environmental Significance

i RAMSAR wetlands

Narran Lake Nature Reserve is classified as a RAMSAR wetland with the associated tributaries classified as Protected Riparian Land. The RAMSAR site contains two open water areas, Clear Lake and Back Lake. Annual inflows to the Narran wetlands are highly variable and is considered a boom-and-bust wetland in a semi-arid environment.

ii Threatened ecological communities and species

The following TECs were listed in the protected Matters Search as having the potential to occur in the study area:

- Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions – Endangered Community;
- Poplar Box Grassy Woodland on Alluvial Plains – Endangered Community;
- The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin – Endangered Community; and
- Weeping Myall Woodlands – Endangered Community.

Threatened flora and fauna species listed in the Protected Matters Search listed four TECs, six birds, three aquatic species, three mammals, four flora, one reptile and eight migratory/marine bird species.

iii Migratory species

There are a number of migratory species listed under international bilateral migratory agreements (Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA), and Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)) utilising the riparian and lake areas, especially in the RAMSAR listed Narran Lakes Nature Reserve, Narran River, and Barwon River (DAWE 2021).

There are eight migratory species predicted or known to occur with the study area as summarised in Table 6.7.

Table 6.7 Terrestrial and wetland migratory species known or predicted to occur within 10 km of the study area (DAWE 2021)

Common name	Scientific name	NSW Status	EPBC Status
Terrestrial			
Yellow Wagtail	*Motacilla flava*		Mi
Fork-tailed Swift	*Apus pacificus*		Mi
Wetland			
Common Sandpiper	*Actitis hypoleucos*		Mi
Sharp-tailed Sandpiper	*Calidris acuminata*		Mi
Curlew Sandpiper	*Calidris ferruginea*	E	CE, Mi
Pectoral Sandpiper	*Calidris melanotos*		Mi

Common name	Scientific name	NSW Status	EPBC Status
Latham's Snipe	*Gallinago hardwickii*		Mi
Common Greenshank	*Tringa nebularia*		Mi

Key: V = Vulnerable, E = Endangered, EP = Endangered population, CE = Critically endangered, Mi = Migratory
Data source: PMST

6.5.7 Summary of key biodiversity values in the study area

The key biodiversity values of the study area are summarised below:

- RAMSAR listed wetland, Narran Lakes Nature Reserve;
- potential for presence of SAII entities (threatened ecological communities and threatened species);
- threatened ecological communities that are listed under both state and Commonwealth legislation;
- aquatic and terrestrial groundwater dependent ecosystems, predominantly adjacent to riparian areas;
- riparian corridors that function as wildlife movement corridors, as well as habitat refugia during period of extreme climactic conditions; and
- habitat for a suite of wetland, woodland and grassland threatened terrestrial flora and fauna species listed under both the BC Act and EPBC Act.

6.5.8 Constraint assessment

Field investigations were undertaken to categorise the constraint level as per criteria set out in Table 6.5. The assessment results are itemised in Table 6.8.

Table 6.8 Constraints per lot

Lot no and name	Constraints category	Land Access	Land use	PCT as mapped (emboldened if observed as present)	Weed/disturbance	Native vegetation integrity
Amooroob Lot 2453 DP764416	**High** Potential GDEs and TECs present **Moderate** Remainder of the lot	Lot not accessed. Observed from access track adjacent to SW corner of lot.	Moderate grazing	37, 40, 43, 72, **98**, 120	Lot not accessed.	The desktop study indicates the presence of several ephemeral wetlands in the western section and borders edges of floodplain in the western section. Presence of terrestrial GDE, noting presence of *Eucalyptus populnea*.

Lot no and name	Constraints category	Land Access	Land use	PCT as mapped (emboldened if observed as present)	Weed/disturbance	Native vegetation integrity
Barfield Lot 1960 DP763842	High for PCTs that align with TECs	Lot not accessed. Observed from Cumborah-Narran Lake Road.	Residential	27, 37, 40, 72, 98, 120, 192, 376	Aerial imagery depicts clearing around residential structures, dams and internal tracks.	Aquatic GDE in south-east corner of lot associated with floodplain of The Big Warrambool. PCTs that are associated with TECs are mapped as present (underlined). Field surveys confirmed the PCT mapping observed from road was accurate. Aerial imagery indicates moderate to high condition native vegetation continuous cover.
Blowhard Lot 2613 DP764641	**High** For PCTs that align with TECs **Moderate** Remainder of the lot	Lot not accessed.	No land use at time of survey (pers. Comm, Wills)	40, 72, 87, 98, 117, 120, 376	Aerial imagery depicts clearing associated with dam and internal tracks	PCTs that are associated with TECs are mapped as present (underlined). No aquatic GDEs mapped. Aerial imagery indicates high condition vegetation cover.
Brookhill Lot 1963 DP763829	**High** Potential GDE and TECs present **Moderate** Remainder of the lot	Lot not accessed.	Not observed	37, 40, 43, 55, 56, 69, 72, 98, 120, 192, 244, 376	Aerial imagery depicts minor clearing associated with dam and internal tracks	Small area of aquatic GDE wetland and Strahler 3 intermittent tributary associated with The Big Warrambool on eastern boundary. PCTs that are associated with TECs are mapped as present (underlined).
Corrie Downs Lot 2446 DP764409	**High** Potential TECs, aquatic and terrestrial GDEs	Lot not accessed. Observed from Narran Lake Road.	No land use evident	40, 62, 72, **98**, 120	Not observed. Aerial imagery indicates minor disturbance along internal tracks.	PCTs that are associated with TECs are mapped as present (underlined). Eastern half of lot is mapped as aquatic GDE as a floodplain wetland. Terrestrial GDE of *E.populnea* stony plains community in western section. Aerial imagery indicates high condition woodland.

Lot no and name	Constraints category	Land Access	Land use	PCT as mapped (emboldened if observed as present)	Weed/disturbance	Native vegetation integrity
Corrie Downs Lot 2447 DP764410	**High** Potential TECs, aquatic and terrestrial GDEs	Lot not accessed. Observed from Narran Lake Road.	No land use evident	37, 40, 43, 62, **98**, 120, 241	Not observed. Aerial imagery indicates minor disturbance along internal tracks.	PCTs that are associated with TECs are mapped as present (underlined). Eastern half of lot is mapped as aquatic GDE as a floodplain wetland. Terrestrial GDE of *E.populnea* stony plains community in western section. Aerial imagery indicates high condition woodland, with minor disturbances caused by internal tracks.
Corrie Downs Lot 3086 DP765311	**High** Potential TECs, aquatic and terrestrial GDEs	Lot not accessed. Observed from Narran Lake Road.	No land use evident	69, 72, 117, 120, 247, 376, 377	Not observed. Aerial imagery indicates minor disturbance along internal tracks.	North-western corner of lot is mapped as aquatic GDE as a floodplain wetland associated with Narran Lake. Terrestrial GDE of *E.populnea* stony plains community across majority of lot. Aerial imagery indicates high condition woodland, with minor disturbances caused by internal tracks. PCTs that are associated with TECs are mapped as present (underlined).
Corrie Downs Lot 2454 DP764417,	**High** Intact vegetation associated with TECs, aquatic GDE.	Lot not accessed.	Not observed	37, 39, 40, 43, 53, 62, 72, 98, 120, 134, 241	Not observed.	Mapping indicates substantial presence of floodplain communities of The Big Warrambool. Vegetation appears to be continuous structural dense. PCTs that are associated with TECs are mapped as present (underlined). Presence of aquatic GDE across approximately half of the lot, noting presence of a floodplain wetland.
East Mullane Lot 1957 DP763839	**Moderate**	Lot not accessed. Lot observed from Narran Lake Road.	National Parks	69, 72, 117, 120, 376	Minor clearing around dam and internal tracks.	No PCTs mapped as present are associated with TECs. No aquatic GDEs or natural waterbodies. Vegetation is in high condition and is as mapped.

Lot no and name	Constraints category	Land Access	Land use	PCT as mapped (emboldened if observed as present)	Weed/disturbance	Native vegetation integrity
Glengai Lot 4022 DP766495	**High** Yambil swamp & Barwon River riparian areas. All areas mapped as aquatic GDE. **Low** PCTs present are associated with TECs, but PCTs present are missing strata, have weed incursions and are highly fragmented and disturbed. **Negligible** Non native vegetation	Full access.	Cropping and moderate grazing.	24, 27, 36, **37, 39, 40**, 43, **98**, 117, 118, **120**, **134**, **168, 244**, 247, 375		Areas mapped as non native are accurate. Areas not grazed contain moderate to high condition vegetation. The Barwon River, Yambil Swamp, and The Big Warrambool are categorised as Key Fish Habitat (DPI).
Guiseley Lot 6286 DP769143	**High** For all mapped aquatic GDE and TECs **Moderate** For the areas north of the mapped tributary and uncropped areas south of the tributary. **Negligible** All non native, cropped areas	Lot not accessed.	Cropping in approximately one-third of lot.	27, 37, 39, 40, 55, 59,	Large areas cleared for cropping, dams, channels and internal tracks.	Aquatic GDEs associated with The Big Warrambool form the eastern boundary. A Strahler 3 tributary runs through the middle of the block that appears on aerial imagery to have intact riparian vegetation (PCT 39). The Big Warrambool is mapped as Key Fish Habitat (DPI). PCTs that are associated with TECs are mapped as present (underlined).
Guiseley Lot 1965 DP763831	**High** For all areas mapped as aquatic GDE and TECs. **Moderate** For remaining areas.	Lot not accessed.	Not observed.	37, 39, 40, 55, 72, 98, 120	Aerial imagery indicates ground disturbance form internal tracks, channels, and dams.	PCTs that are associated with TECs are mapped as present (underlined). Strahler 2 and 3 tributaries (floodplain wetlands) of The Big Warrambool are listed as aquatic GDEs.

Lot no and name	Constraints category	Land Access	Land use	PCT as mapped (emboldened if observed as present)	Weed/disturbance	Native vegetation integrity
Karingle Lot 6319 DP769207	**High** Area of SAII potential around Cumborah, 1km radius around the township. Areas of TECs **Moderate** PCTs not associated with TECs **Low** South of Kurrajong Road.	Full access.	Grazing, mining related activities.	27, 37, 39, 40, 43, 55, 56, 59, 69, 72, 98, 120, 144, 192, 244, 376	The northern section of the lot and areas around the township of Cumborah shows large areas of ground disturbance and small cleared areas for dams. Hudson pear and other weed species were present in significant numbers in disturbed areas.	The southern portion of the lot south of Kurrajong Road shows low vegetation density and thinning of canopy species. Poor condition vegetation was observed throughout with weed incursions and loss of native vegetation stratum. PCTs that are associated with TECs are mapped as present (underlined). Strahler 4 stream associated with The Big Warrambool in section south of Kurrajong Road. No associated aquatic GDEs. Area of SAII potential around Cumborah, 1km radius around the township.
Kigwigil Lot 17 DP752679	**High** For mapped aquatic GDE and TECs. **Low** In remaining areas	Land not accessed due to flooding. Observed from Gingie Road.	Grazing	37, 39, 40, 43, 59, 144	Groundcover pasture weeds present.	Small area of aquatic GDE in south-east corner of lot, associated with the floodplain of The Big Warrambool. Strahler 4 runs intermittently through northern section into The Big Warrambool. The Big Warrambool is mapped as Key Fish Habitat (DPI). Vegetation observed from Gingie Road was highly compromised by grazing. Woodland PCTs in low to moderate condition. PCTs that are associated with TECs are mapped as present (underlined).

Lot no and name	Constraints category	Land Access	Land use	PCT as mapped (emboldened if observed as present)	Weed/disturbance	Native vegetation integrity
Kigwigil Lot 12 DP752741, Lot 1964 DP763830	**High** For mapped aquatic GDE and TECs **Low** In all remaining areas **Negligible** In all cropped areas.	Land not accessed due to flooding. Observed from Gingie Road.	Lot 12: Grazing, Lot 1964: grazing, cropping	27, 36, 37, 39, 43, 59, 98, 72, 120, 144, 244, 376	Floodplain areas are used for cropping.	The Big Warrambool forms the south-eastern boundary of the lot, with a Strahler order 4 tributary running through lot 1964. Vegetation (PCT 39) immediately surrounding The Big Warrambool and its tributary were observed to be in moderate to good condition are associated with a TEC. The Big Warrambool is mapped as Key Fish Habitat (DPI). Lot 12 in aerial imagery appears to have moderate vegetation integrity with minor disturbance associated with internal tracks. Lot 1964 is highly disturbed with cleared areas for cropping and farm infrastructure, dams and internal tracks. The northern section of this lot has remnant vegetation of unknown condition. Potential TECs as associated PCTs are mapped as present (underlined).
Kigwigil Lot 6251 DP769107	**High** For potential aquatic GDE and TECs. **Low** In all remaining areas. **Negligible** for cropped areas.	Land not accessed due to flooding.	Grazing, dam channels, cropping	27, 37, 39, 40, 55, 59, 98, 144, 244	Not observed	Aquatic GDEs: The Big Warrambool forms the southern and eastern boundary of the lot, with a Strahler order 3 tributary running through the north-western corner. Aerial imagery indicates that vegetation (PCT 39) immediately surrounding The Big Warrambool and its tributary to be in moderate to good condition. The Big Warrambool is mapped as Key Fish Habitat (DPI). Potential TECs as associated PCTs are mapped as present (underlined).

Lot no and name	Constraints category	Land Access	Land use	PCT as mapped (emboldened if observed as present)	Weed/disturbance	Native vegetation integrity
Kurrajong Lot 1958 DP763840	**High** For potential TECs. **Low** In all remaining areas	Lot not accessed. Observed from Kurrajong Road.	Residential	36, 37, 40, 43, 69, 72, 87, 98, 117, 120, 376	Patches of clearings around dams. Low vegetation density indicates historic clearing.	No aquatic GDEs or natural waterbodies present. Potential TECs as associated PCTs are mapped as present (underlined).
Llanillo Lot 3886 DP766359, Lot 4362 DP767199	**High** Potential TECs **Negligible** Grazing and cropped areas	Full access	Grazing, cropping on Lot 3886	27, 37, 39, 40, 43, 72, 87, 98, 118, 120, 144, 192, 244, 247, 376	Small clearings associated with agricultural activities, internal tracks, and dams. Minor groundcover weeds present.	Vegetation present was observed to be in high condition, with small areas of moderate condition associated with groundcover disturbances. Large tracts contained high condition diverse vegetation communities and habitat diversity. Potential TECs as associated PCTs are mapped as present (underlined). No aquatic GDEs present.
Lyndon Lot 2456 DP764419, Lot 3082 DP765307	**High** In areas of aquatic GDE and TECs. **Moderate** In all remaining areas	Lot not accessed.	Not observed	27, 37, 39, 40, 55, 72, 98, 134, 212	Not observed. Aerial imagery indicates disturbances to vegetation density, clearing for dams and internal tracks.	Presence of aquatic GDE across majority of site as a Floodplain wetland. Floodplain areas appear to be of low to moderate condition in aerial imagery. The Big Warrambool is an Area of Outstanding Biodiversity Value (AOBV) IN Lot 2456. Potential TECs as associated PCTs are mapped as present (underlined).
Milrea Lot 2532 DP 764495	**High** In areas of aquatic GDE and TECs. **Moderate** In all remaining areas	Lot not accessed for assessment.	Not observed	37, 39, 40, 43, 59, 62, 72, 168, 212, 241	Not observed. Aerial imagery indicates disturbances to vegetation density, clearing for dams and internal tracks.	Presence of floodplain wetland GDE over approximately half of lot. Aerial imagery indicates low density vegetation that may suggest clearing of native vegetation and lower vegetation integrity. Potential TECs as associated PCTs are mapped as present (underlined).

Lot no and name	Constraints category	Land Access	Land use	PCT as mapped (emboldened if observed as present)	Weed/disturbance	Native vegetation integrity
Mooredale Lot 4100 DP766605	**High** In areas of aquatic GDE and TECs. **Low** In remaining vegetated areas **Green** In cropped areas	Lot not accessed.	Cropped areas.	36, 37, 39, 40, 43, 49, 72, 87, 98, 120, 146, 212, 241, 247, 376, 377	More than 20% of lot cleared for cropping. Further substantive clearing for dams, farm infrastructure and internal tracks.	Presence of Narran River and associated floodplain and intermittent tributaries are aquatic GDEs in western portion. Potential TECs as associated PCTs are mapped as present (underlined). Remaining remnant native vegetation appears compromised by disturbance to undergrowth, and fragmentation.
Mureabun Lot 1955 DP763837, Lot 4101 DP766606	**High** In areas of TECs and GDEs **Low** In remaining vegetated areas and Narran River floodplain and entirety of lot 1955. **Negligible** In current cropped areas, roads and farm infrastructure areas.	Lot not accessed.	Cropping, grazing, residential.	39, 43, 87, 98, 117, 118, 139, 166, 241, 247,	More than 20% of lot cleared for cropping. Clearing for dams, farm infrastructure and internal track evident.	Potential TECs as associated PCTs are mapped as present (underlined). Most of Lot 4101 is mapped as aquatic GDE as a floodplain wetland. Remnant vegetation may be regrowth form historic clearing or cropping, as observed in aerial imagery.
Narran Lake Lot 4353 DP767190, Lot 4017 DP766490	**High** Eastern section contains intact vegetation potentially associated with TECs. Western section contains Narran Lake, Narran River and associated floodplains that contains areas with disturbed groundcover and weed incursions.	Full access.	Eastern section: light grazing. Western section: Moderate Grazing with groundcover disturbed.	27, 37, 39, 40, 43, 69, 72, **98**, 117, **120**, **212**	1-5% patchy occurrences of exotic groundcover.	Heavily impacted and bare areas in western portion. Eastern section in high to moderate condition, with native groundcover intact. Western section on floodplain is moderately impacted by grazing and weed incursions. Potential TECs as associated PCTs are mapped as present (underlined).

Lot no and name	Constraints category	Land Access	Land use	PCT as mapped (emboldened if observed as present)	Weed/disturbance	Native vegetation integrity
Oban Lot 2452 DP764415	Moderate Land contains high condition vegetation not associated with TECs.	Lot not accessed. Observed from north and western boundaries.	Not known	37, 40, **72,** 98, 117, 120	Less than 1%.	Terrestrial GDE of *Eucalyptus populnea* on stony plains.
Remington Lot 3087 DP765312, Lot 2448 DP764411	High Potential TECs.	Full access.	Native pasture improvement and light grazing in NE corner of lot. Residential.	**24**, 37, 39, 40, **43,** 53, 62**, 98**, 117, **120**, 195, **212,** 241, **377**	Less than 1%.	High condition *E.populnea* (Poplar Box) grassy woodland. Western boundary includes high water line of Narran Lake. Potential TECs as associated PCTs are mapped as present (underlined).
Springvale Lot 2426 DP764389	High Potential TECs and GDEs.	Lot not accessed for assessment.	Not observed	37, 39, 40, 43, 56, 72, 98, 120, 376	Aerial imagery indicates minor clearing associated with dam and internal tracks	Aquatic GDE present as floodplain wetland. Potential TECs as associated PCTs are mapped as present (underlined). Aerial imagery indicates moderate to good vegetation integrity throughout.
Springvale Lot 2683 DP764759	High	Lot not accessed. Observed from Kurrajong Road.	Not observed	27, 37, 40, 56, 69, 72, 87, 98, 120, 144, 192, 244, 376	Aerial imagery indicates minor clearing associated with dam and internal tracks	Aquatic GDE present as a floodplain wetland of The Big Warrambool. Aerial imagery indicates moderate to good vegetation integrity throughout. Potential TECs as associated PCTs are mapped as present (underlined).
Summer Hill Lot 5 DP752679 Lot 14 DP752679	Moderate	Lot not accessed. Lot 14 observed from Cumborah cemetery.	Not observed	72, 98, 120, 192	Aerial imagery indicates minimal disturbance associated with internal tracks. No weeds observed form boundary.	Strahler class 1 stream in south-eastern corner of Lot 5. No PCTs mapped that are associated with TECs. Aerial imaging indicates moderate to good vegetation integrity.

Lot no and name	Constraints category	Land Access	Land use	PCT as mapped (emboldened if observed as present)	Weed/disturbance	Native vegetation integrity
Wee Warra Lot 6248 DP 769104 Lot 6318 DP 769206	**Moderate** Southern half of lot 6318 **Low** In all remaining areas **Negligible** In all cropped areas.	Limited access.	Grazing, mining, cropping in eastern portion of lot	27, 36, 37, 39, 40, 55, 59, 62, 69, 72, 87, 98, 117, 120, 192, 376,	High levels of disturbance related to cropping, irrigation channels, internal track networks and historic ground disturbance related to mining activities. Hudson Pear observed in northern sections.	Potential TECs as associated PCTs are mapped as present (underlined). Cropping occurring in Aquatic GDE areas in Lot 6248. Observed vegetation was in poor to moderate condition and fragmented by numerous internal tracks and historic mining impacts. Moderate condition vegetation observed in lower portion of Lot 6318.
Westleigh Lot 2449 DP764412, Lot 3088 DP765313	**High** Contains diverse native vegetation in high-medium condition with minimal disturbance. Potential TECs.	Full access.	Light grazing	**27, 37, 39, 40, 43,** 53, 62, **98,** 117, **120**, **212, 238**, **377.**	Less than 1%. Groundcover weeds less than 5% in Coolibah woodland patch.	High condition *E.populnea* (Poplar Box) grassy woodland. Western boundary includes high water line of Narran Lake. Small patch of Coolabah woodland around small dam near Narran Lake. Potential EPBC & BC listed Artesian Springs Ecological Community in the Great Artesian Basin.
Wilkie Lot 2617 DP 764645	**High** All areas mapped as aquatic GDE and TECs. **Moderate** In all other areas **Negligible** In cropped areas in central north section of lot.	Lot not accessed.	Cropping in eastern section	27, 37, 39, 40, 43, 55, 56, 59, 62, 69, 72, 98, 120, 241	Minor clearing associated with dams, channels and internal tracks.	Eastern two-thirds of lot and western boundary is mapped as aquatic GDE associated with The Big Warrambool. Potential TECs as associated PCTs are mapped as present (underlined). Aerial imagery indicates moderate to good condition vegetation integrity.

Lot no and name	Constraints category	Land Access	Land use	PCT as mapped (emboldened if observed as present)	Weed/disturbance	Native vegetation integrity
National Parks Lot 1961 DP 763843 Lot 1962 DP 763844 Lot 3139 DP 765344 Lot 3138 DP 765343 Lot 3137 DP 765342 Lot 3232 DP 764668 Lot 3235 DP 765440	**High** All areas containing aquatic GDE, and high condition vegetation with TECs potentially present	Lot not accessed. Observed from boundaries.	National Parks reserve	36, 38, 39, 40, 43, 62, 69, 72, 98, 117, 118, 120, 144, 168, 181, 198, 212, 238, 241, 247, 376, 377	None observed. Minor internal tracks.	Native vegetation was observed to be in high condition. Narran Lake, Narran River, and floodplain/wetland areas are classified as aquatic GDEs. Potential TECs as associated PCTs are mapped as present (underlined).

6.5.9 Assessment against key legislation and policy

i Environment Protection and Biodiversity Conservation Act 1999

An assessment of the impacts of the proposed activity on MNES was undertaken to determine whether referral of the proposed activity to the Commonwealth Minister for the Environment is required. MNES relevant to the proposed activity are summarised in Table 6.9. In determining the significance of impact associated with the proposed activity, the relevant criteria listed in the *Matters of National Environmental Significance – Significance Impact Guidelines 1.1* (DoE 2013b) were applied.

Table 6.9 Assessment of the proposed activity against the EPBC Act

MNES	Activity specifics	Potential for significant impact
Threatened species	Six birds, three aquatic fish, three mammals, four flora, and one reptile species have the potential to occur within Area 1 (Section 6.5.6)	A significant impact is unlikely to result from the proposed activity on threatened species due to the measures outlined in Section 7.
Threatened ecological communities (TECs)	Four TECs have the potential to occur within Area 1 (Section 6.5.6)	A significant impact is unlikely to result, as the assessed activities will not take place within these communities.
Migratory species	Eight migratory bird species have the potential to occur within Area 1 (Section 6.5.6)	A significant impact is unlikely to result, as the assessed activities will not take place within habitats that these species rely upon.
Wetlands of international importance	The subject site contains Narran Lake Nature Reserve a RAMSAR wetland. (Section 6.5.6)	A significant impact is unlikely to result, as the assessed activities will not take place within the wetland or in close proximity.

ii Biodiversity Conservation Act 2016

The constraints assessment outlines areas of high and moderate biodiversity value and therefore areas to avoid. In addition, with the recommended measures to avoid, mitigate and minimise impacts, it is determined that the assessed activities will not result in a significant effect on threatened species or communities.

The proposed activity will not significantly affect threatened species or communities and thus preparation of a Species Impact Statement (SIS) or BDAR is not required.

iii Fisheries Management Act 1994

Assuming mitigation measures will be implemented to avoid all aquatic habitats and riparian corridors, the assessed activities associated with opal mining are unlikely to result in any indirect impacts to aquatic habitat, and therefore, the proposed activity is unlikely to result in any impacts, direct or indirect, to threatened aquatic species, populations, communities, habitats.

iv Biosecurity Act 2015

Assuming mitigation measures will be implemented for the activity, the proposed activity is unlikely to result in any indirect impacts to aquatic habitat, and therefore, the proposed activity is unlikely to result in any impacts, direct or indirect, to threatened aquatic species, populations, communities, habitats.

v Water Management Act 2000

Assuming that, as recommended, the proposed activity will not occur within 40 m of a riverbank, creek, lake, wetland or estuary, a controlled activity permit would not be required.

vi State Environmental Planning Policy (Biodiversity and Conservation) 2021

The new State Environmental Planning Policy (Biodiversity and Conservation) 2021 (Biodiversity and Conservation SEPP) incorporates, amongst other things, the previous State Environmental Planning Policy (Koala Habitat Protection) 2021 (Koala SEPP 2021).

Chapter 4 of the new Biodiversity and Conservation SEPP applies to specified local government areas (LGAs) which are listed in Schedule 2 of the Biodiversity and Conservation SEPP.

Schedule 2 includes Walgett LGA and Brewarrina LGA. Chapter 2 of the Biodiversity and Conservation SEPP aims to encourage the conservation and management of areas of natural vegetation that provide habitat for koalas to support a permanent free-living population over their present range and reverse the current trend of koala population decline.

Section 4.4 of the Biodiversity and Conservation SEPP provides (at subsection 4.4(3)(d)) that the SEPP does not apply to:

> land in the following land use zones, or an equivalent land use zone, unless the zone is in a local government area marked with an * in Schedule 1—

- Zone RU1 Primary Production,
- Zone RU2 Rural Landscape,
- Zone RU3 Forestry.

Brewarrina and Walgett LGAs are not marked with an asterisk in the Schedule 2 list of LGAs, and therefore, Chapter 2 of the Biodiversity and Conservation SEPP does not apply to the land use zones RU1, RU2 or RU3 as noted above.

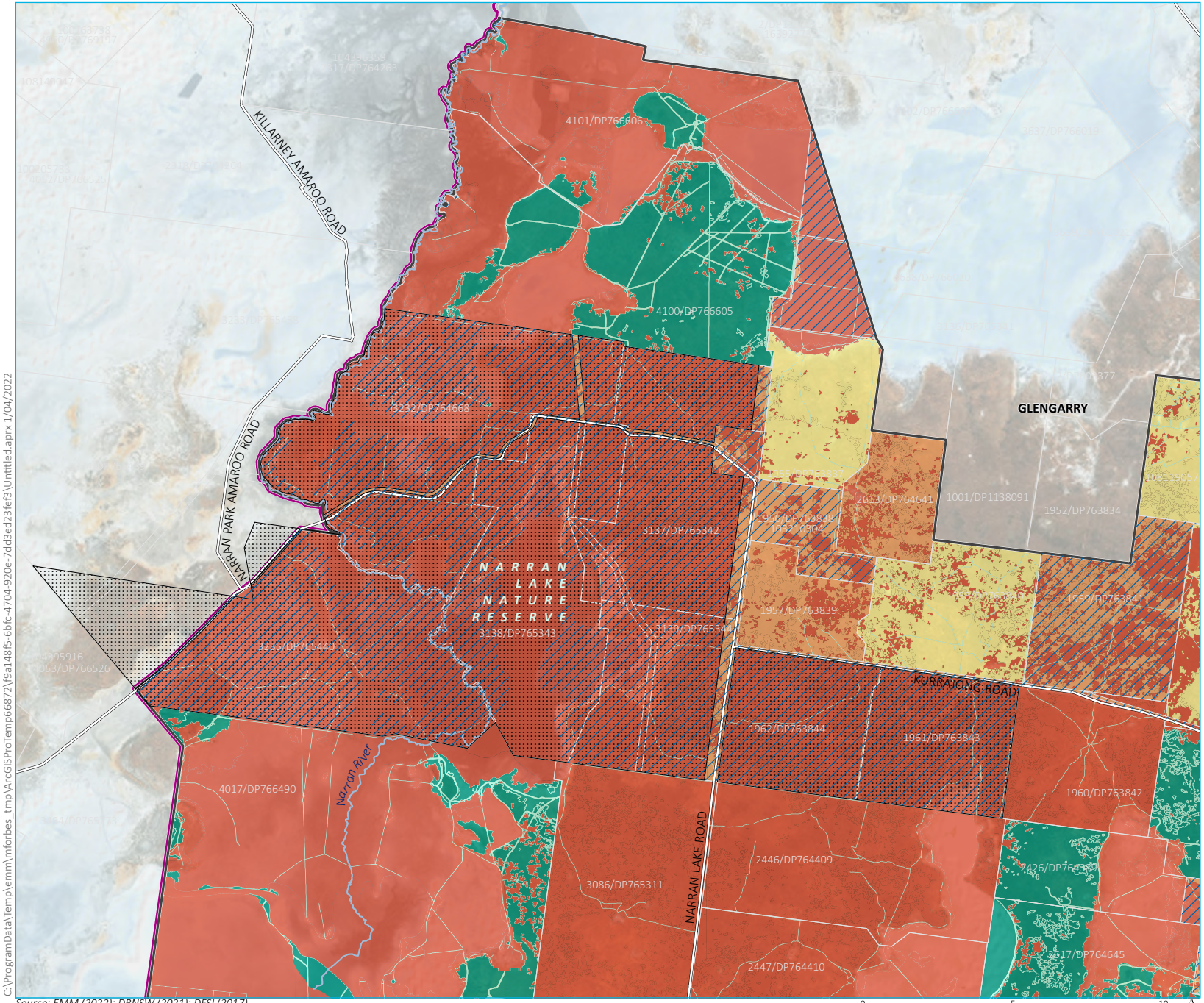
6.5.10 Conclusion

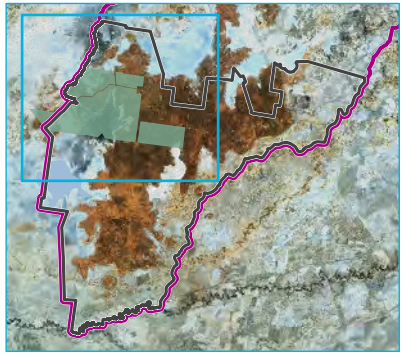
The biodiversity assessment was completed to assess the level of biodiversity constraint across Area 1 and determine the potential impacts of the assessed activities on species and communities listed under the BC Act and EPBC Act. The assessed activities of prospecting and underground mining must avoid high constraints areas and follow the mitigation measures set out in Section 7 of this REF to avoid and/or minimise the impacts on threatened communities, GDEs, threatened species and their habitats. Residual impacts arising from the proposed activity, following all measures to avoid, minimise and mitigate impacts, include:

- impact (direct and indirect) to native vegetation and flora and fauna habitat; and
- indirect impacts to adjacent vegetation and fauna habitat.

The assessed activities will impact (directly and indirectly) native vegetation however, with measures in place that mitigate these impacts further, the impacts are not considered to be significant to threatened communities, threatened species or their habitats.

The mapped areas comprising constraints in terms of biodiversity are shown in Figure 6.6.





KEY

Area 1

Narran- Warrambool Reserve

Existing environment

Major road

Minor road

Named watercourse

Named waterbody

NPWS reserve

Cadastral boundary

No access

Constraints_REFArea1_Working_v3f

Constraint category

Green- no constraint

Orange- moderate constraint

Red- high constraint

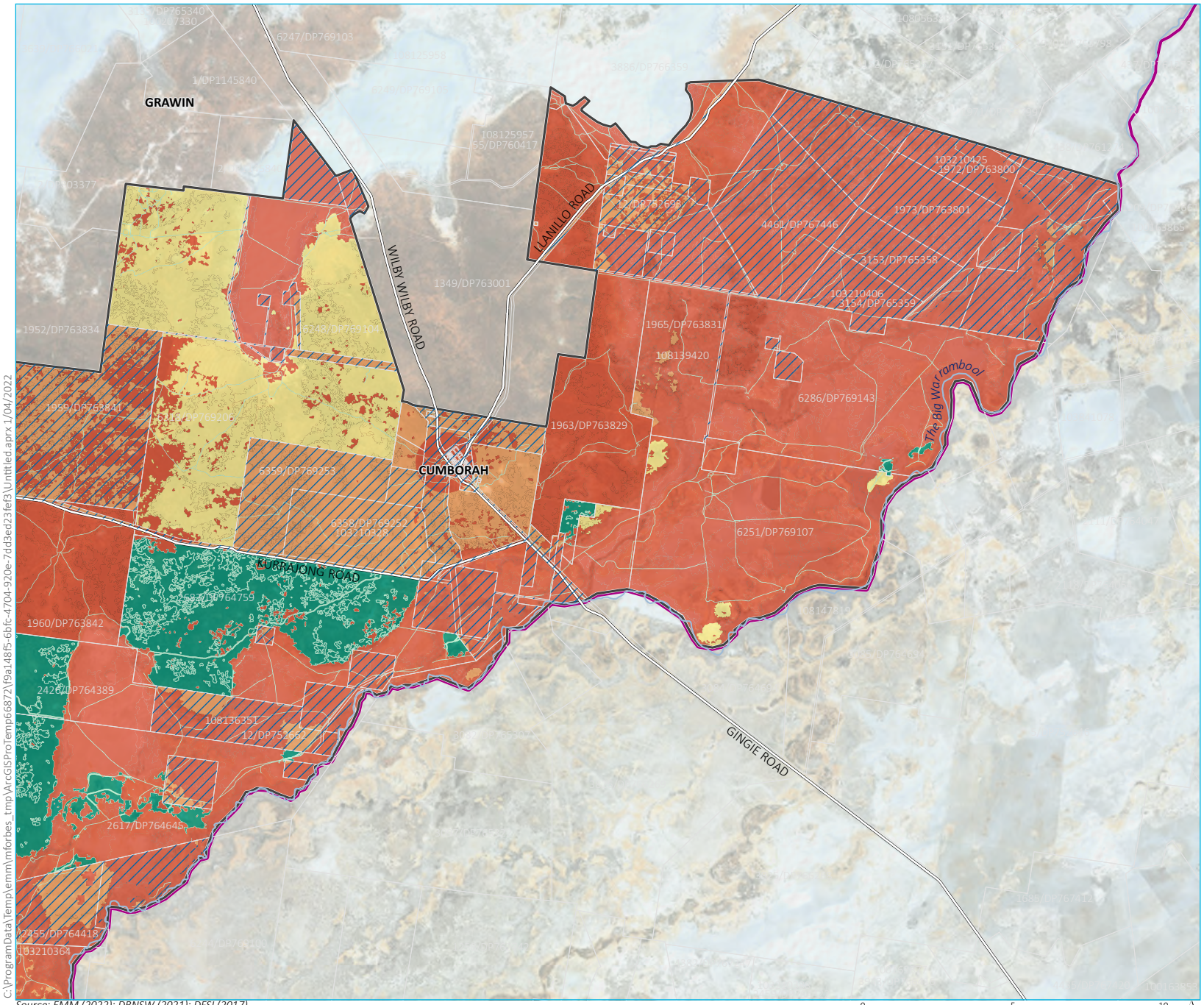
Yellow- low constraint

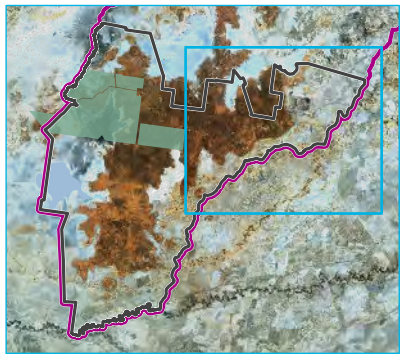
Biodiversity constraints — West

Review of Environmental Factors

Figure 6.6

EMM creating opportunities





KEY

Area 1

Narran- Warrambool Reserve

Existing environment

- Major road
- Minor road
- Named watercourse
- Named waterbody
- NPWS reserve
- Cadastral boundary
- No access

Constraints_REFArea1_Working_v3f

Constraint category

- Green- no constraint
- Orange- moderate constraint
- Red- high constraint
- Yellow- low constraint

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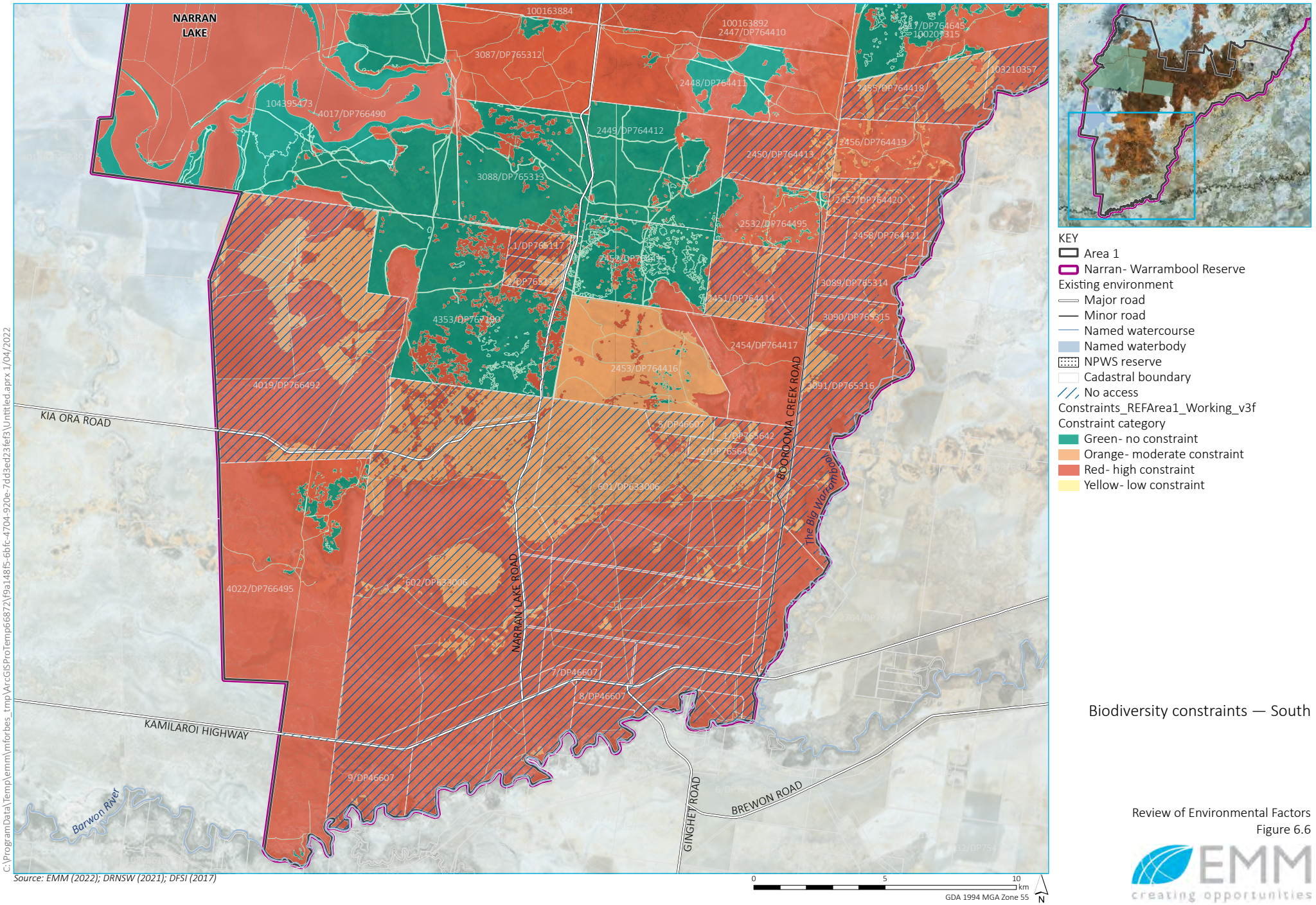
Source: EMM (2022); DRNSW (2021); DFSI (2017)

Biodiversity constraints — East

Review of Environmental Factors

Figure 6.6

EMM creating opportunities



KEY

- Area 1
- Narran- Warrambool Reserve

Existing environment

- Major road
- Minor road
- Named watercourse
- Named waterbody
- NPWS reserve
- Cadastral boundary
- No access

Constraints_REFArea1_Working_v3f

Constraint category

- Green- no constraint
- Orange- moderate constraint
- Red- high constraint
- Yellow- low constraint

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Source: EMM (2022); DRNSW (2021); DFSI (2017)

0 5 10 km

GDA 1994 MGA Zone 55

N

Biodiversity constraints — South

Review of Environmental Factors
Figure 6.6

EMM creating opportunities

6.6 Air Quality

A qualitative assessment of potential air quality impacts is provided below based on available data.

6.6.1 Pollutants and assessment criteria

The key emissions sources and pollutants applicable to the construction and operations of extractive activities such as opal mining include:

- fugitive dust from clearing, excavation, material handling, movement of plant and equipment, and wind erosion of exposed surfaces, comprising:
  - total suspended particulate matter (TSP);
  - particulate matter less than 10 micrometres (µm) in aerodynamic diameter (PM_{10}); and
  - particulate matter less than 2.5 µm in aerodynamic diameter ($PM_{2.5}$);
- diesel exhaust emissions from mining equipment and trucks:
  - oxides of nitrogen (NO_x)[3], including nitrogen dioxide (NO_2);
  - sulphur dioxide (SO_2);
  - carbon monoxide (CO); and
  - volatile organic compounds (VOCs).

The NSW EPA impact assessment criteria for common or 'criteria' air pollutants, as documented in Section 7 of the Approved Methods for Modelling, are presented in Table 6.10. The assessment criteria for PM_{10} and $PM_{2.5}$ are consistent with the *National Environment Protection (Ambient Air Quality) Measure* (AAQ NEPM) national reporting standards (DoE 2016).

For the pollutants listed in Table 6.10, the assessment criteria are applied at the nearest existing or likely future sensitive receptor[4]. Typically, the following must be reported for the pollutants in Table 6.10:

- The incremental impact (ie the predicted impact due to the project alone).
- The total impact (ie the incremental impact plus the existing background concentration. Guidance on the selection of background concentrations is provided in NSW EPA (2017)).
- TSP, which relates to airborne particles less than around 50 µm in diameter, is used as a metric for assessing amenity impacts (reduction in visibility, dust deposition and soiling of buildings and surfaces) rather than health impacts (NSW EPA 2013). Dust deposition impacts are derived from TSP emission rates and particle deposition calculations in the dispersion modelling process.

[3] By convention, NO_x = Nitrous oxide (NO) + NO_2.

[4] NSW EPA (2016) defines a sensitive receptor as a location where people are likely to work or reside; this may include a dwelling, school, hospital, office or public recreational area.

- Particles less than 10 µm in diameter, accounted for in this assessment by PM_{10} and $PM_{2.5}$, are a subset of TSP and are fine enough to enter the human respiratory system and can therefore lead to adverse human health impacts. The NSW EPA impact assessment criteria for PM_{10} and $PM_{2.5}$ are therefore used to assess the potential impacts of airborne particulate matter on human health.

Table 6.10 Impact assessment criteria – common pollutants

Pollutant	Averaging period	Impact assessment criteria
TSP	Annual	90 µg/m^3
PM_{10}	24 hour	50 µg/m^3
	Annual	25 µg/m^3
$PM_{2.5}$	24 hour	25 µg/m^3
	Annual	8 µg/m^3
Dust deposition	Annual	2 g/m^2/month (project increment only)
		4 g/m^2/month (cumulative)
NO_2	1 hour	246 µg/m^3
	Annual	62 µg/m^3
CO	15 minute	100 mg/m^3
	1 hour	30 mg/m^3
	8 hour	10 mg/m^3
SO_2	10 minute	712 µg/m^3
	1 hour	570 µg/m^3
	24 hour	228 µg/m^3
	Annual	60 µg/m^3

Notes: µg/m3: micrograms per cubic metre; g/m2/month: gram per square metre per month.

There are no impact assessment criteria for total VOCs, however impact assessment criteria are prescribed for various individual toxic and odorous VOCs in the Approved Methods document. Impact assessment criteria for VOCs are applied at and beyond the boundary of the emitting source, with the incremental impact (ie predicted impacts due to the pollutant source alone) reported as the 99.9th percentile concentration for an averaging period of 1 hour.

6.6.2 Potential emission sources

Potential sources of air quality impacts from opal mining activities in Area 1 include:

- dust generated from construction activities related to demolition, construction, earthworks and dust track-out from trucks;
- fugitive dust from activities including:
  - clearing of vegetation and topsoil;

- drilling and excavation of shafts;
- material handling from hoisting to trucks and processing;
- movement of plant and equipment on unpaved surfaces;
- dry processing of extracted materials;
- wind erosion of exposed areas including material stockpiles;
- diesel exhaust from plant equipment and trucks; and
- underground ventilation shafts;

- emissions from petrol or diesel-powered plant, equipment and vehicles travelling to/from the mining locations.

It is understood that there would be communal mullock stockpiles formed and located as necessary within Area 1 (Section 3.5.4). The number and locations of the stockpiles will be dependent on the location of opal mining activities. If located within the vicinity of homesteads, the stockpiles could act as a potential source of dust due to wind erosion during high-wind conditions.

6.6.3 Potential air quality impacts

- The main contributors to air quality emissions from opal mining in Area 1 are likely to be wheel-generated dust on unpaved roads, wind erosion from the mullock stockpiles, and excavated material handling processes.
- There are several homesteads located within Area 1 (see Figure 1.1). The number and location of opal mining sites and mullock stockpiles is unknown at this point in time and therefore it is not known how close mining activities will be to the homesteads or whether they will be located upwind/downwind etc.
- Given the anticipated relatively small scale of operations at each mining site, it is considered that potential adverse air quality impacts will be minor and can be managed using a range of air quality mitigation measures.

6.7 Noise and vibration

There are two principal activities assessed in terms of noise and vibration. Those activities are:

- opal prospecting; and
- opal mining.

There are numerous methods used for opal prospecting and mining. The noise and vibration assessment has assumed that standard methods of opal prospecting and underground mining (which importantly exclude open cut or trenching methods) will be used.

The assessment of noise and vibration impacts was based on the NSW *Noise Policy for Industry* (EPA, 2017). The assessment considered:

- intrusiveness noise levels;
- amenity noise levels; and
- sleep disturbance.

Operational noise levels were predicted using DGMR Software proprietary modelling software, iNoise. The model allows predictions which comply with algorithms detailed in ISO9613-2 *Acoustics – Attenuation of Sound during Propagation Outdoors – general method*.

6.7.1 Existing acoustic environment

The noise environment is expected to be typical of a rural location with ambient noise levels dominated by natural elements, with little or no road traffic noise and characterised by low background noise levels. Settlement patterns are typically sparse.

Noise monitoring was not conducted in the Area 1 for the purpose of establishing a baseline. Considering the size of the area and low human activity, this assessment has adopted the minimum thresholds outlined within the Noise Policy for Industry (NPfI) for the project's baseline levels, specifically:

- day LA90 35 dB;
- evening LA90 30 dB; and
- night LA90 30 dB.

6.7.2 Potential sources of noise and vibration

Noise from opal mining activities is associated with operational plant and equipment, and will include but is not limited to:

- generators (diesel fuelled);
- compressors (electric or diesel fuelled);
- drilling plant (hand held), auger or truck mounted;
- pumps, aerators and processing plant;
- hoists; and
- trucks.

The sound power levels assigned to each item (refer to Table 6.11) have been sourced from EMM measurement database of similar equipment, Department of Environment, Food and Rural Affairs (DEFRA) 2005, *Update of Noise Database for Prediction of Noise on Construction and Open Sites*, manufacturer data and other equivalent facilities.

Table 6.11 Plant and equipment sound power levels (dB) – per operator

Equipment	Octave band sound power levels (Hz) dB								SWL dBA
	63	125	250	500	1k	2k	4k	8k	
Diesel generator	108	102	85	82	81	76	73	65	89
Compressor	112	101	92	87	85	83	86	75	94
Water pump	103	102	88	82	82	81	76	74	90
Cable percussion drilling rig	105	105	95	94	98	96	90	84	102
Truck mounted blower (based on vacuum excavation truck)	111	109	108	102	106	101	98	94	109
Total	**116**	**112**	**108**	**103**	**107**	**102**	**99**	**95**	**110**

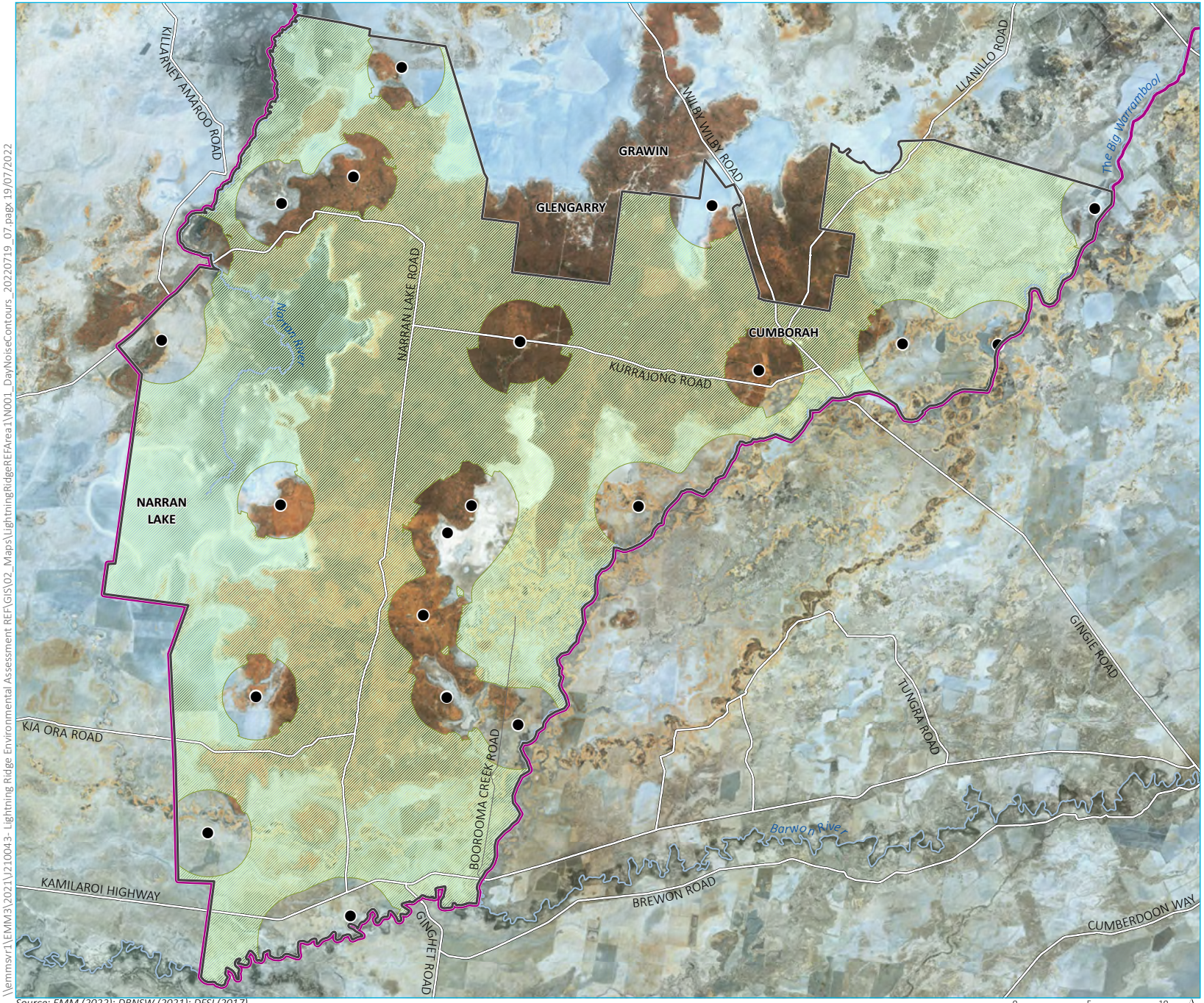
The assessment also assumes up to 90 operators being active within a square kilometre. Accordingly, the sound power level per operator (Table 6.11) was upgraded from L_{Aeq} 110 dB to L_{Aeq} 130 dB to account for 90 operators with a point source located at each of the identified homesteads and residential properties in order to develop an outer limit of noise impact for day and evening/night operations.

6.7.3 Impact assessment

Predicted $L_{Aeq,15min}$ operational noise contours were produced for day and evening/night operations under ISO9613 noise enhancing conditions. The noise contours were developed into zoned areas where noise levels would be below $L_{Aeq,15min}$ 40dB for day and below $L_{Aeq,15min}$ 35dB for evening/night operation to identify where prospecting and mining can occur based on the assumptions of plant and equipment presented in this assessment and a total of 90 operators within a square kilometre.

The zones where the standard prospecting and mining activities can occur without adversely impacting the identified homesteads and residential receivers are shown in Figure 6.7 and Figure 6.8. These zones were mapped using a 'reverse modelling' approach to establish an appropriate set back from sensitive receivers, in day and night scenarios, for opal mining activities to occur without unacceptable impacts.

Where prospecting or mining is proposed outside of the identified zones, detailed noise assessments would be required to demonstrate that there would be no adverse impacts or cumulative impacts on identified sensitive receivers.



KEY

- Area 1
- Narran- Warrambool Reserve
- Homestead

Day mining areas with noise goal ($L_{Aeq,15min}$)

- 40 dB

Existing environment

- Major road
- Minor road
- Named watercourse

Acoustically acceptable prospecting and mining areas, day, ISO9613

Review of Environmental Factors
Figure 6.7

Source: EMM (2022); DRNSW (2021); DFSI (2017)

0 5 10 km

GDA 1994 MGA Zone 55

N

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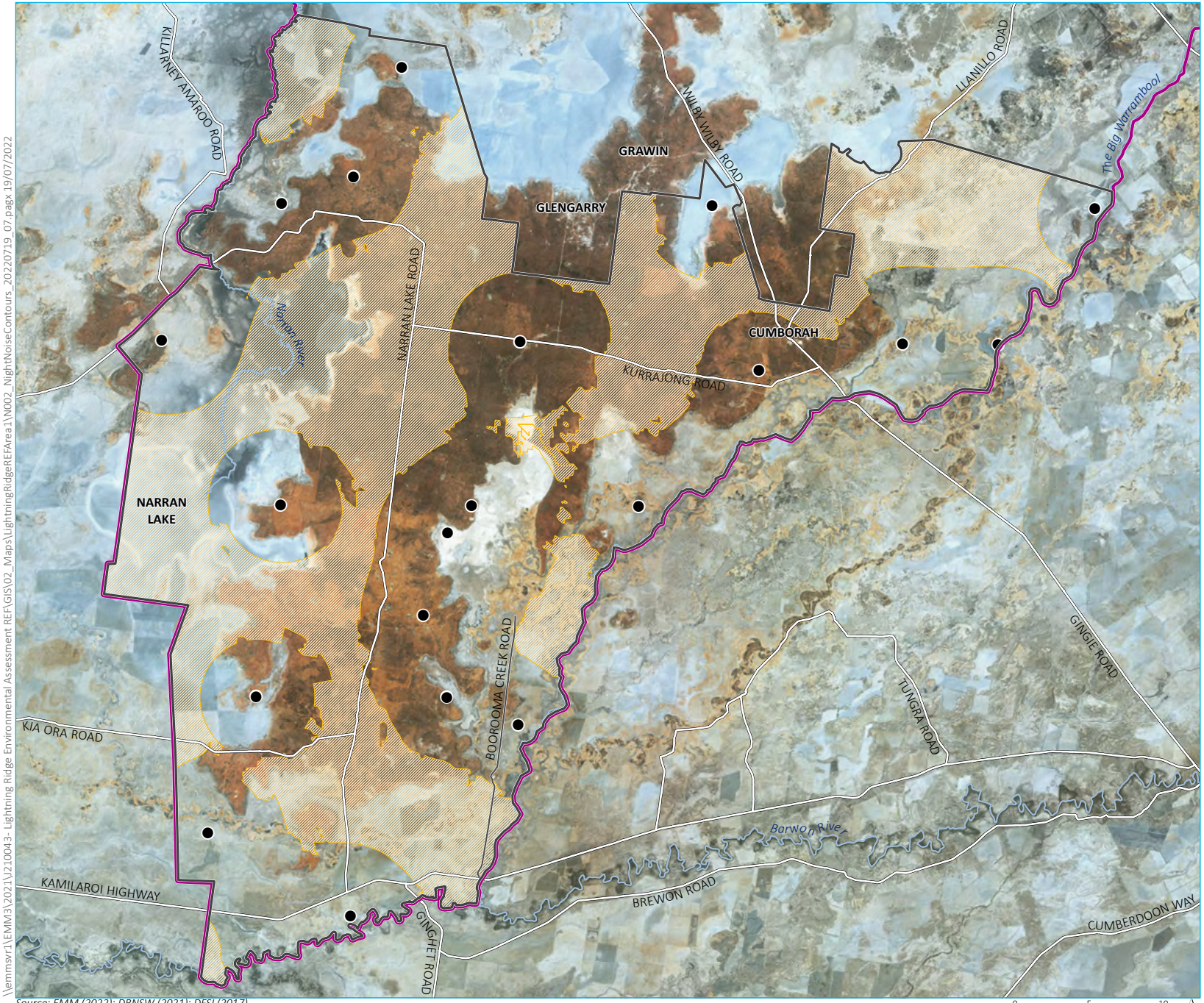
EMM creating opportunities



KEY

- Area 1
- Narran- Warrambool Reserve
- Homestead

Existing environment

- Major road
- Minor road
- Named watercourse

Evening/night mining areas noise goal ($L_{Aeq,15min}$)

- 35 dB

Source: EMM (2022); DRNSW (2021); DFSI (2017)

0 5 10 km

GDA 1994 MGA Zone 55

N

\\emmsvr1\EMM3\2021\P210043- Lightning Ridge Environmental Assessment REF\GIS\02_Maps\LightningRidgeREFArea1\N002_NightNoiseContours_20220719_07.pagx 19/07/2022

Acoustically acceptable prospecting and mining areas, evening/night, ISO9613

Review of Environmental Factors
Figure 6.8

EMM
creating opportunities

6.8 Historic heritage

An Historic Heritage Assessment (HHA) of the proposed activity was undertaken using the principles of *The Australian International Council on Monuments and Sites, Charter for Places of Cultural Significance* (also known as the *Burra Charter,* Australia ICOMOS 2013) and the New South Wales (NSW) *Heritage Manual* (Heritage Office 1996 with regular additions). The full HHA is provided at Appendix B and is summarised below.

Key areas have been described to facilitate the assessment of direct and indirect impacts of opal prospecting and opal mining on historic heritage. The project areas considered as part of the assessment include:

- Project area: the project area is Area 1 of the NWR.
- Study area: the study area is not a specifically defined area, when referring to the study area this generally means regionally.

6.8.1 Assessment methodology

Development of a predictive model for the survey was based on background research, which includes documentary sources, maps and plans, and where possible, landholder discussions and field observations. Further, the data used to inform the predictive model for Aboriginal heritage sites are useful for planning historical survey. Access to water, soil landscapes, geomorphology and land disturbance are characteristics that would have been valuable to Aboriginal people and squatters alike.

The historical summary has provided information that suggests that archaeological sites that may exist in the project area include:

- mud or slab huts and a stockyards;
- detached kitchen areas, privies and other associated buildings;
- stockyards from later periods constructed in timber or stone;
- stone flooring or flagging for domestic or pastoral purposes;
- sheep washes and scouring sheds;
- modifications in the landscape to manage water flows such as flooding and to create pens etc;
- bridges and other river crossings;
- historically modified trees;
- roads;
- camps in the stock reserve (indicated by fire and rubbish pits) and;
- possible grave sites outside the current boundary of Cumborah cemetery.

Historical sites have been identified via desktop assessment and aerial imagery interrogation have not been validated by a field survey. The desktop assessment includes an assessment of archaeological potential and sensitivity of Area 1. The consistent agricultural use of land throughout the last 180 years has shaped Area 1 into a historical working landscape. Aerial imagery suggests that many of the structures recorded on the early run plans may not survive; but in many locations, archaeological resources may be present.

Area 1 has been subject to ground disturbance in the form of inundation and pastoral uses throughout the years. This disturbance is unlikely to have removed all evidence of early occupation of the runs as these uses are low impact and usually only affect the top of the soil profile.

The HHA includes assessments of significance for each pastoral run and the township of Cumborah.

6.8.2 Impact assessment

The assessment of a project's impacts to the heritage significance of a place or an item is to understand change, if it is beneficial to the place or item, and how changes can be managed to best retain significance. The historical landscape in Australia, be it rural or urban, is by social agreement, a significant aspect of our identity. That agreement is codified in legislation, the intent of which is to encourage the conservation of cultural heritage by incorporating it into development where feasible. In many situations avoiding impacts is impossible, but the aim is to reduce those impacts by either project re-design or managing the loss of information through methods that reduce and/or record significance before it is removed.

The framework around assessing significance and therefore suitable levels of impact is to understand how the place or item came to be, how important it was (and may be still) in the development of the local area or the state (the colony at the time) and providing guidance on its management.

The desktop assessment of the heritage constraints within Area 1 identified a minimum of 50 historical sites within Area 1 which could be potentially impacted by opal prospecting or opal mining activities. As there was no field survey conducted for this REF, these historical sites have not yet been verified. Due to restrictions associated with COVID-19 it was not possible to access the State Archives or the State Library of NSW for the desktop assessment. As not all documents are digitalised this meant some background research was unable to be completed.

Table 6.12 and Table 6.13 list the historical sites identified by desktop research across Area 1. This list could change upon a field investigation. The locations of the registered sites are depicted in Figure 4.9, and the newly identified sites are available in Figure 8.1 in Appendix B.

Table 6.12 Indicative impact to registered sites

S170 Register

Item number	Name	Impact from opal prospecting and mining
114941	Site of Homestead; Terewah – DEMOLISHED	Works at this site would impact heritage values
12426	Shearing Shed – Terewah – Demolished	Works at this site would impact heritage values
12423	East Mullane Shearing Shed	Works at this site would impact heritage values
13126	Stockyard: Snake Hut Tank	Works at this site would impact heritage values
12424	Snake Hut Tank	Works at this site would impact heritage values

12427	Bundah Shearing Shed	Works at this site would impact heritage values
13127	Stockyard: Bundah	Works at this site would impact heritage values
12428	Bundah Quarters	Works at this site would impact heritage values
12423	Lumeah Shearing Shed	Works at this site would impact heritage values
11492	Cattle Yards: Terewah DEMOLISHED	Works at this site would impact heritage values
LEP Register		
Item number	**Name**	**Impact from opal prospecting and mining**
I42 (WLEP)	Earth Walled Buildings	Works at this site would impact heritage values
I40 (WLEP)	Anglican Church	Works at this site would impact heritage values
I22 (BLEP)	Narran Lake	Works at this site would impact heritage values
SHR		
Item number	**Name**	**Impact from opal prospecting and mining**
5062951	Moordale Wells (Aboriginal Place)	Works at this site would impact heritage values
RNE		
513	Narran Lakes Area	Works at this site would impact heritage values

Table 6.13 Indicative impact to newly identified sites

Item number	Impact from opal prospecting and mining within Area 1
B–1	Works at this site would impact heritage values
B–2	Works at this site would impact heritage values
B–3	Works at this site would impact heritage values
B–4	Works at this site would impact heritage values
B–5	Works at this site would impact heritage values
B–6	Works at this site would impact heritage values
B–7	Works at this site would impact heritage values
B–8	Works at this site would impact heritage values
B–9	Works at this site would impact heritage values
B–10	Works at this site would impact heritage values
B–11	Works at this site would impact heritage values
B–12	Works at this site would impact heritage values
B–13	Works at this site would impact heritage values
B–14	Works at this site would impact heritage values
B–15	Works at this site would impact heritage values
B–16	Works at this site would impact heritage values
B–17	Works at this site would impact heritage values
B–22	Works at this site would impact heritage values
B–23	Works at this site would impact heritage values
B–24	Works at this site would impact heritage values
B–25	Works at this site would impact heritage values
B–26	Works at this site would impact heritage values
B–27	Works at this site would impact heritage values
B–28	Works at this site would impact heritage values
B–29	Works at this site would impact heritage values
B–30	Works at this site would impact heritage values
B–31	Works at this site would impact heritage values
B–32	Works at this site would impact heritage values
B–33	Works at this site would impact heritage values
B–34	Works at this site would impact heritage values
L–1	Works at this site would impact heritage values
WP–1	Works at this site would impact heritage values
WP–2	Works at this site would impact heritage values
WP–3	Works at this site would impact heritage values

Item number	Impact from opal prospecting and mining within Area 1
WP–4	Works at this site would impact heritage values
WP–5	Works at this site would impact heritage values
Cumborah Town	Works within the township would impact heritage values
Cumborah Cemetery	Works at this site would impact heritage values
Travelling Stock Routes	Works within the TSRs would impact heritage values
Water Reserves	Works within WRs would impact heritage values

6.9 Aboriginal cultural heritage

A consideration of Aboriginal heritage within the proposed activity was undertaken and is summarised below. The assessment adopted several processes and requirements outlined in Heritage NSW guidelines, including the *Due Diligence Code of Practise for the Protection of Aboriginal Objects in NSW* and *Code of Practise for the Archaeological Investigation of Aboriginal Objects in NSW* to determine cultural materials that may be present across the activity area. The investigations did not undertake Aboriginal consultation in development of this section.

6.9.1 Assessment limitations

The Aboriginal heritage impact assessment was limited to a desktop review of available dataset and previous reports. No field work was conducted, which limits the capacity to accurately assess whether Aboriginal heritage exists outside of previously investigated areas. Therefore, caution should be taken outside of identified areas of cultural sensitivity; and the unexpected finds procedure (Table 7.1) should be utilised.

No Aboriginal consultation was undertaken for the project, which limits the identification of intangible and/or cultural sites and places that may be within the activity area. Such sites are known to exist within the broader region. Likewise it should be noted that in previous consultation with the Dharriwaa Elders Group (DEG) on opal mining in the NWR, the group has identified the importance of comprehensive and transparent consultation and engagement with the Indigenous communities of the region (Dharriwaa Elders Group, 2005) (Bangalay Botanical Surveys, 2008). The DEG proposed a process of engagement to ensure that key cultural features are correctly identified and managed.

6.9.2 Assessment methodology

The Aboriginal heritage impact assessment utilised existing environmental information and archaeological data to develop predictions about Aboriginal sites, places and/or deposits within Area. 1. This included a review of the elevation, hydrology, vegetation and other environmental variables that may influence the types and survivability of cultural materials (eg rockshelters require steep escarpments to be present); and a review of previous cultural heritage management reports and studies and the Heritage NSW Aboriginal Heritage Information Management System (AHIMS) (Appendix C) to identify known cultural material, their types and distribution.

Upon researching the local archaeology and site reports a predictive model was utilised to assess the potential for unidentified sites across Area 1. The existing sites and publicly available landscape/hydrology data were correlated and then mapped. The entirety of Area 1 was checked manually to capture any areas of likely cultural sensitivity based on satellite imagery. Areas of likely cultural sensitivity included waterholes, floodplains and traveling stock routes. These landscape features were assigned buffers to limit the potential risk of disturbing unsurveyed Aboriginal heritage sites.

Site cards and reports were consulted to accurately represent each site boundary and their significance. A 'traffic light system' (outlined in Appendix C) was developed to transparently communicate the different limitations of cultural sensitivity areas with the intent of avoiding potential impacts to Aboriginal heritage sites and places. This detailed risk appreciation process allows for land outside of those areas of identified cultural sensitivity to be targeted for opal prospecting and opal mining, with diminished possibility of uncovering Aboriginal heritage.

6.9.3 Results

A review of the broader review of the Narran-Warrambool Reserve has previously been undertaken (EMM 2021). This demonstrated that various parts of the region have been previously investigated over the past 30 or so years. Some 555 Aboriginal sites and places have been previously recorded. These sites are dominated by stone artefacts (n=227; ~41%) and culturally modified trees (n =231; ~41.5%). The database also includes a number of site types that are increasingly rare in NSW, including ceremonial and Dreaming sites (n=8), fish traps (n=3), burials (n=15), rock engravings (n=1), and bora sites (n=2). Many of the ceremonial sites appear related to key water sources such as springs, including the Gaurageel Springs, Cumborah Springs, Coorigul Springs, and Mooredale Wells; and clearly indicate the importance of these environmental features to past Aboriginal visitation and use. A number of post-Contact sites, notably burials and cemetery grounds were also documented.

This broader picture is reflected within Area 1. Of the 239 previously documented sites within its curtilage, 175 (73%) are various densities of stone artefacts and 33 (14%) are culturally modified trees. Lesser occurrences of ceremonial and Dreaming sites (n=5), burials (n=1), earth mounds (n=5), grinding grooves (n=1), hearths (n=2), middens (n=8), quarries (n=1) and rock art (n=1) are also documented (Figure 4.10). These are extensively found along the Narran River and associated tributaries.

The distribution of these sites and places aligns well with environmental characteristics and suggest that the large river systems surrounding the region, such as the Barwon River, result in substantial flooding and inundation of the landscape. As such, past use of the region appears to have focussed on smaller creeks and/or water-holes, as well as elevated areas over-looking these major river systems. Given the deep geological age of many of these land systems, commonly cultural materials are constrained to the surfaces, and less frequently in the upper portion (A1 horizon). As such, there are a number of definable characteristics that can be used to predict sensitivity in other areas. Locations that are above such inundation areas, such as elevated areas over-looking the major river systems, will have a higher likelihood of retaining cultural materials where present. Cultural materials have the potential to be present in areas with the environmental characteristics of sediment deposition, including sand dunes, source-bordering dunes and alluvial terraces, etc. Often these deposits will contain stratified cultural materials and/or human remains and can therefore be of high significance.

To develop a suitable cultural sensitive ranking across Area 1, each of the previously identified sites and culturally sensitive landforms were broadly categorised and assigned a unique sensitivity value (see constraints figure within Appendix C). These rankings have been based on a general knowledge of the research potential, representativeness, rarity and cultural values of certain site types compared with another. For example, rockshelters will typically have a higher level of research potential (containing art works, deep stratified cultural deposits, etc) compared with a surface stone artefact. Some sites (Table 6.14) were assigned a higher cultural sensitivity due to their importance and rarity, for example, the orange sensitivity site (09-5-0008, pigment painting).[5] Further, some sites may include more than one site type, for example, some artefact scatter sites had evidence of hearths (potential Aboriginal camp sites), which can increase their cultural sensitivity. In most cases, the rankings are not based on site specific knowledge of the site in question, although where presented in available cultural heritage management reports and/or site cards, this has been adopted.

[5] This site is unlikely to be in the position provided from the AHIMS database due to being located on a floodplain instead of a cave. Based on the description on the site card, a large buffer around adjacent Cumborah Knob has been produced in the likely location of the culturally significant site. Multiple site descriptions surrounding the rock art describe the significance of this landscape feature and it should be avoided. This is a high-risk area, and no work should be permitted without further assessment to properly locate and record the site.

Table 6.14 Previously identified sites and places within Area 1 that are considered to have a greater levels of archaeological and cultural significance based on their site types and available descriptions.

Site ID	Site Name	Site Type	Cultural Sensitivity	Location
09-5-0008	Guisley Caves	Rock Art (pigment)	Orange	Unknown, given large boundary covering several opal leases
09-5-0009	Brigalowe Canoe Tree	Burial Tree	Red	Known, within opal lease 736
09-5-0005	Mooredale Wells	Aboriginal Ceremony and Dreaming Site	Red	Known, adjacent to opal lease 956
09-5-0007	Morendah Plain, Morgans Wells	Aboriginal Ceremony and Dreaming Site	Red	Known, adjacent to opal lease 956
09-4-0003	Terewah Mythological Site	Aboriginal Ceremony and Dreaming Site	Red	Known, east of Narran Lake
09-5-0002	Cumborah Springs	Aboriginal Ceremony and Dreaming Site	Red	Known, 98 m west of opal lease 1101
09-4-0014	Narran Lake Burial, Terrawah	Burial	Red	Known, north of Narran Lake
09-4-0057	Marngi Warramul Mythological Area, Narran Lake	Aboriginal Ceremony and Dreaming Site	Red	Known, east of Narran Lake

6.9.4 Impact assessment

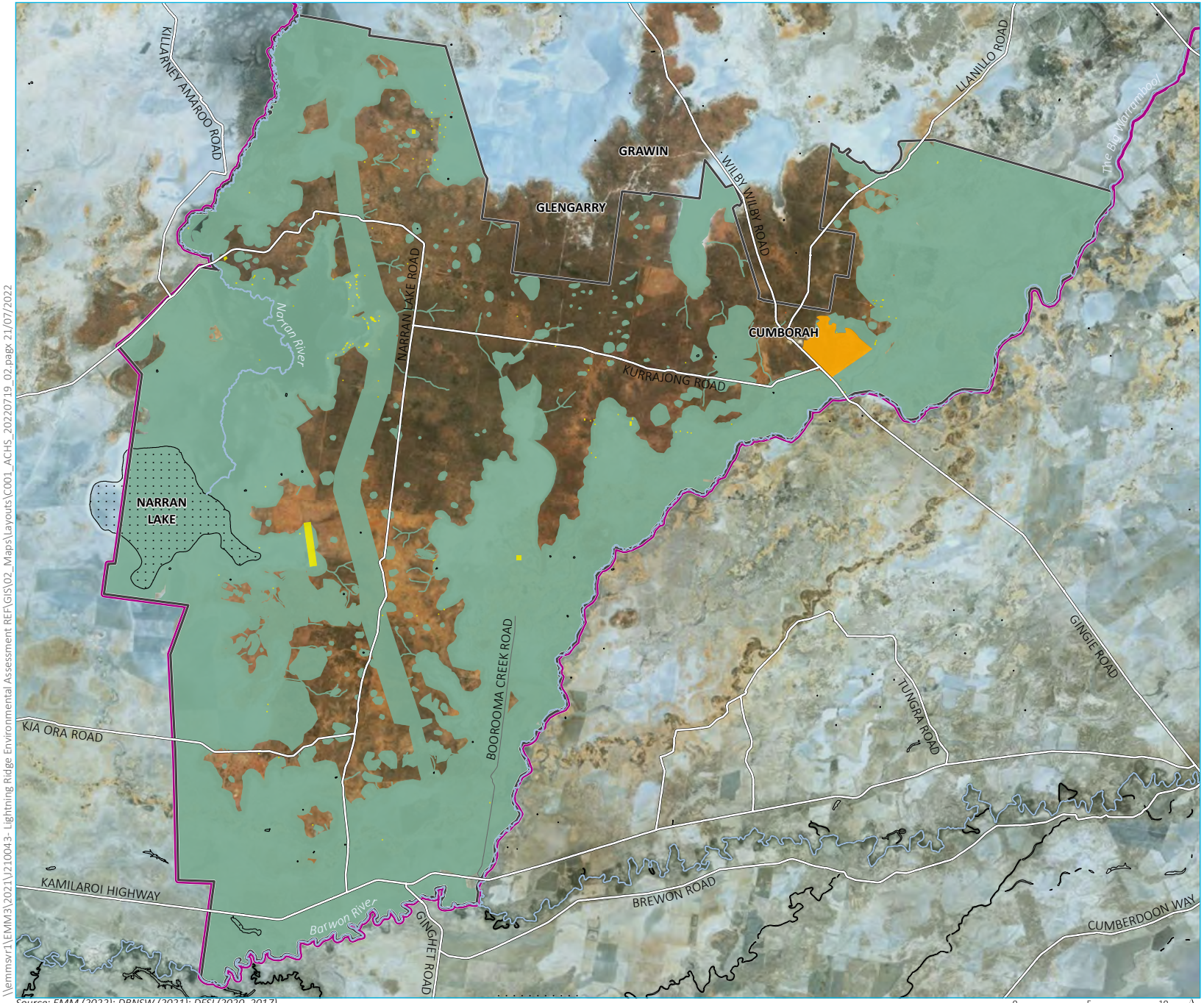
Opal prospecting and opal mining has the potential to impact recorded, and unidentified Aboriginal heritage sites, places and deposits. To help identify areas where any proposed activity may intersect with cultural materials, the following buffers were assigned to areas of cultural sensitivity:

- archaeological sites – 50 m (unless otherwise stated in report);
- watercourses, waterholes, traveling stock routes and creeks – 50 m;[6] and
- lakes – 200 m.

These areas of cultural sensitivity were assigned a colour to represent the mitigation measured required to undertake activities within those areas (Figure 6.9). These mitigation measures are summarised in Section 7.

[6] While Heritage NSW guidelines typically stipulate 200 m for this buffer, an analysis of the available information from the Narran Warrambool Reserve suggests that the majority of the data are all situated within 50m of these types of environmental feature.

Of the 245 existing opal leasing lots within Area 1, a total of 169 have partial cultural sensitivity limitations. Some 76 are considered to be entirely encompassed by cultural sensitivity restrictions. This is a total of roughly 65 km^2 of land. Of these 169 lots, 64 have over 90% usable land (n=11, 100% unconstrained) and 24 lots have less than 10% of the total area available for opal leases without Aboriginal heritage restrictions. A detailed summary of Aboriginal heritage constraints per opal lease lot has been provided in spatial format to DRNSW.



KEY

- Area 1
- Narran- Warrambool Reserve

Existing environment

- Major road
- Minor road
- Named watercourse
- Named waterbody

Landscape features and cultural sensitivity (indicative only)

- Significant
- High
- Moderate
- Low

Source: EMM (2022); DRNSW (2021); DFSI (2020, 017)

0 5 10 km

GDA 1994 MGA Zone 55

N

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Landscape features and cultural sensitivity (Indicative only)

Review of Environmental Factors
Figure 6.9

EMM
creating opportunities

6.10 Contaminated Land

6.10.1 Existing sources

The follow existing or potential sources of contamination have been identified within Area 1 (Appendix D):

- historical illegal dumping of waste;
- soil properties including soil pH, ASS, sodicity/dispersivity and soil salinity;
- cattle feedlots;
- historical use of herbicides and pesticides; and
- historical infrastructure.

6.10.2 Potential impacts on existing sources from opal mining and fossicking

Mining and prospecting could potentially disturb or alter soils with variably affected by high or low pH, ASS, sodicity/dispersivity and soil salinity. In addition, mining activities may also lead to the disturbance of historically buried waste or historical infrastructure. This has the potential to mobilise contaminants from the subsoil to the surface and may result in contamination transportation around mining/prospecting titles.

Opal mining or prospecting activities which require consideration of potential contamination are primarily related to excavation works (open pit or underground), and may include the following:

- excavations or earthworks which encounter historical illegal dumped waste;
- spoil stockpiling; and
- establishment activities for mining titles.

6.10.3 Potential introduced sources from opal mining and prospecting

New sources of contamination may be introduced as mining and prospecting commences. These include and are not limited to:

- contamination from vehicle, plant and equipment operation, servicing and maintenance;
- soil and spoil (mullock) management;
- illegal dumping or disposal of operational waste; and
- wastewater and ablution waste.

6.10.4 Potential exposure pathways and receptors

- If not managed appropriately, potentially complete ecological and human exposure pathways from contamination sources to receptors (where identified) may be present, including:
- direct dermal contact and incidental ingestion of contaminated soil by mining workers or prospectors during excavation and stockpiling of potentially impacted spoil where present;
- inhalation of fibres or dust from soil by mining workers or prospectors;
- inhalation of soil/groundwater vapours within an excavation or outdoor air by mining workers; and
- exposure of ecological receptors via plant uptake and/or animal ingestion.

6.10.5 Preliminary conceptual site model

i Sources

Several sources of potential contamination have been identified (refer to Section 4.15.3).

Disturbance, transport and inappropriate management of spoil at mining titles may potentially lead to contamination of mining and prospecting areas not previously contaminated and thus present new sources.

ii Pathways

The following transport mechanisms may apply at the site:

- surface run-off of CoPC into drainage lines, Narran Lake or Barwon River catchment area;
- excavation and re-location of soil and fill material during construction activities; and
- atmospheric dispersion (aeolian transport) of dust, derived from contaminated soil or historical illegally dumped waste.

Identified potential exposure pathways for the nominated CoPC include:

i. dermal contact and incidental ingestion of soil;

ii. inhalation of dust (including soil derived) or fibres;

iii. inhalation of soil vapours in outdoor air; and

iv. plant uptake and/or ingestion by animals.

Based on the physical and chemical features of the CoPC identified, the exposure pathways that may be applicable to each CoPC at Area 1 are presented in Table 6.15.

Table 6.15 CoPC and applicable exposure pathways

CoPC	Applicable pathways
Asbestos (historic infrastructure, or buried waste)	ii
Total recoverable hydrocarbons (TRH)/benzene, toluene, ethylbenzene and xylenes (BTEX)	i, ii, iii, iv
Volatile organic compounds (VOCs)	i, ii, iii, iv
heavy metals/metalloids	i, ii, iii, vi
Soil pH; ASS, sodicity/dispersivity and soil salinity	iv
E.coli, coliforms, nutrients	i, ii
Organochlorine pesticides (OCPs)/Organophosphorus pesticides (OPP)	i, ii
Putrescible and non-putrescible waste	i, ii, iii, iv

iii Receptors

The conceptual site model has been developed to identify existing known sources and areas of contamination, associated potential impacts to human health and ecological receptors, and to identify exposure source, pathway and receptor linkages. Typical receptors resulting from mining and prospecting activities include:

- mine workers and prospectors;
- surrounding human users such as agricultural workers; and
- ecological receptors, including terrestrial and aquatic ecosystems in receiving surface water bodies.

6.11 Public safety

Work health and safety obligations that apply to opal mines in NSW are outlined within the *Work Health and Safety (Mines and Petroleum) Act 2013* and the supporting Work Health and Safety (Mines and Petroleum) Regulation 2014. The most common occupational injuries throughout the mining sectors as identified by Safe Work Australia and the Resources Regulator (2021a) include body stressing, manual handling and musculoskeletal disorders, slips, trips and falls, being hit by moving objects or machinery and working with high plant risk.

The operators of opal mines must ensure that a safety management system for the mine sets out the systems, procedures, plans and other control measures that will be used to control any risks to health and safety at the mine associated with the following:

- ground or strata failure;
- inundation or inrush of any substance;
- mine shafts and winding systems;
- roads or other vehicle operating areas;
- air quality or dust or other airborne contaminants;
- the mechanical aspects of plant or structures;
- electricity;
- ventilation; and
- any hazard identified by the mine operator that has reasonable potential to result in multiple deaths in a single incident or a series of recurring incidents.

The opal title holder is responsible for ensuring public safety on their claim area. If public safety is not considered or mitigated against, liability issues can result.

A small number of opal prospecting blocks and mineral claims are located in the northern portion of Area 1 and within OPA4. These are the only historical opal operations within Area 1 which may require rehabilitation and pose public safety risks. These historical titles should be considered when granting contemporary titles.

Communal mullock stockpiles also pose a public safety risk, with anecdotal evidence of tourists sifting through these communal stockpiles in search for opals. Communal mullock stockpiles are not structurally sound and pose a public safety risk in the event of catastrophic failure. Mitigation measures associated with communal mullock stockpiles are provided in Table 7.1.

Open shafts and active workings pose a public safety risk, as well as risk to native fauna and livestock. Public safety measures such as signage, fencing and covering of open shafts are provided in Table 7.1.

6.12 Waste management

Wastes generated by opal mining include waste rock (mullock), fine-grained waste material from puddling (fines), oils, lubricants, sewage and discarded machinery. The long term impacts of mining waste, particularly mullock on the surrounding environment, are largely unknown.

Historic or disused prospecting and mineral claims can contain significant waste if abandoned without proper rehabilitation conducted. Waste may include general waste, discarded machinery, car bodies etc.

Residential use of opal titles was historically permissible under a residential claim. Residential claims are no longer granted. While sewage associated with mining camps (if permitted) is generally not considered a problem, because of the arid environment, potential exists for the development of unsanitary conditions where camps are concentrated and remain for a long period of time. It is recommended that residential claims are therefore not permitted within Area 1 (Section 7).

It is important that the mineral claim holder ensures all wastes (including drilling by-products contaminated by chemicals, contaminated residues, chemicals, oils or fuels) are collected, segregated and appropriately disposed of at an authorised waste management or recycling facility.

6.12.1 Waste classification

The *Waste Classification Guidelines* (NSW EPA, 2014) describe a number of pre-classified wastes and provides specific direction on the classification of waste, based on chemical composition and associated environmental impacts. Waste streams require different management, transportation and disposal depending on their classification. The six waste categories potentially occurring within Area 1 include:

- special waste (eg clinical, asbestos and tyres);
- liquid waste (eg human waste);
- hazardous waste (eg waste with a pH ≤2, coal tar, lead paint waste);
- restricted solid waste;
- general solid waste (putrescibles) (eg household waste, manure, food waste); and
- general solid waste (non-putrescibles) (eg glass, plastic, rubber, garden waste).

It is illegal to deposit waste, as defined by the *Waste Classification Guidelines* (EPA 2014), on land unless it is an appropriately licensed waste facility, or the material is subject to an exemption issued in relation to the Protection of the Environment Operations (Waste) Regulation 2014.

6.12.2 Waste avoidance and resource recovery

NSW Waste Avoidance and Resource Recovery Strategy the WARR Strategy (NSW EPA, 2014) sets out principles incorporating the adoption of measures which avoid unnecessary resource consumption and promotes resource recovery, including reuse, reprocessing, recycling and energy recovery. The WARR Strategy identifies six key areas where outcomes must be achieved in order to avoid and manage waste, as follows:

- avoiding and reducing waste generation;
- increasing recycling;
- diverting more waste from landfill;
- managing problem wastes better;
- reduce litter; and
- reduce illegal dumping.

A philosophy of reuse of materials and equipment exists on the opal fields, where old machinery is repaired, rather than replaced, which reduces demand for new resources. This sees machinery that would often be discarded adapted to an alternative function. When machinery eventually breaks beyond repair, or a claim is completely worked, this machinery may not be disposed of properly due to financial constraints.

6.13 Visual

A Visual Impact Assessment (VIA) of the proposed activity was undertaken (Appendix E) and is summarised below. The VIA seeks to assess only the proposed project activities, not legacy issues or the impact of historical practices. All existing infrastructure, including roads and agricultural facilities, form part of the base case. The visual effect of the proposed development and the sensitivity of the receptors to the visual effect are considered and synthesised to assess the overall visual impact of the project.

Visual effect is concerned with the development or activities and the extent to which they will contrast to or integrate with the existing landscape. It considers the size or scale of the change, the duration of the change, and reversibility of the change. It also considers design elements such as form, shape, texture and line relative to the host landscape.

Visual sensitivity is concerned with the people or locations likely to have visibility of the development. It considers the nature of the receptors and considers factors such as the planar distance between the receptor and the proposed development, relative elevations, the relationship of the receptor to the development, and any intervening or mitigating factors such as vegetation.

In short, visual effects describe the characteristics of the source and visual sensitivity describes the characteristics of the receivers. When combined, those two variables determine the significance of the overall visual impact.

6.13.1 Visual effect

Visual effect was assessed utilising three elements which combine to create the magnitude of visual effect – being contrast, integration and magnitude. Mullock stockpiles, mining and prospecting surface structures were assessed.

i Contrast

Mullock material tends to be a distinctly paler colour compared to the naturally occurring surface material within Area 1. Whilst a similar texture, the colour difference creates a noticeable contrast. The contrast potential therefore is considered moderate.

Mining surface structures tend to be minor facilities such as small sheds, mobile or stationary equipment or plant. The facilities, equipment and plant are similar in size and nature to those utilised by the agriculture industry within Area 1 and are generally smaller in bulk and scale, and are generally finished in muted colour materials. Therefore, while some contrast to the host environment is evident, the contrast is considered to be low.

Prospecting surface structures tend to be minor facilities such as plant and equipment. These are not significant in terms of bulk, scale or height. Therefore, while some contrast to the host environment is evident, the contrast is considered to be low.

ii Integration

The existing landscape within Area 1 currently exhibits limited mullock stockpiles, concentrated in a small portion in the north. The potential for mullock stockpiles to integrate into the surrounding landscape will depend on the scale and disturbance footprint of the stockpiling. Remnant vegetation has the capacity to screen or filter the mullock stockpiles and to achieve partial integration with the existing landscape. The integration is therefore considered to be moderate.

Mining surface structures tend to be minor facilities such as small sheds, mobile or stationary equipment or plant. The facilities, equipment and plant are similar in size and nature to those utilised by the agriculture industry within Area 1. These are not significant in terms of bulk, scale or height, and are unlikely to dominate the existing landscape. Therefore, the integration is considered to be high.

Prospecting surface structures tend to be equipment or plant. These are not significant in terms of bulk, scale or height, and unlikely to dominate a landscape. Therefore, the integration is considered to be high.

iii Magnitude

The magnitude of the development is determined by the extent to which the size and scale result in the loss of landscape elements, features or characteristics. Area 1 comprises both relatively intact vegetated landscapes and highly modified landscapes which support agricultural activity. In this context, the presence of mullock stockpiles can, depending on the immediate environment, register a loss of some features. The magnitude largely depends on the site-specific character and the extent to which rehabilitation is possible.

A standard requirement of opal mining and prospecting titles, and ancillary activities within the NWR is for miners to stockpile mullock separately to topsoil, and to finish the rehabilitation works with the stored topsoil, not mullock. If that is achieved, it promotes both the re-establishment of vegetation and a return to a less intrusive visual element at the site. The extent to which this ideal scenario is accomplished is difficult to determine however media reports and court records (Parkins v Lightning Ridge Miners Association Limited [2009] NSWSC) suggest that there is a persistent issue in terms of proper rehabilitation of mines at the end of operational life.

The magnitude associated with mullock stockpiles is therefore considered to be moderate.

Mining surface structures tend to be minor facilities such as small sheds, mobile or stationary equipment or plant. The facilities, equipment and plant are similar in size and nature to those utilised by the agriculture industry within Area 1. These are not significant in terms of bulk, scale or height, and are unlikely to result in negligible loss of landscape characteristics. Therefore, the magnitude is considered to be low.

Prospecting surface structures tend to be equipment or plant. These are not significant in terms of bulk, scale or height, and are unlikely to result in any material loss of landscape characteristics. Therefore, the magnitude associated with prospecting is considered to be low.

iv Overall visual effect

Mullock stockpiles rated as moderate contrast, moderate integration and moderate magnitude. The overall visual effect is therefore considered to be *moderate*.

Mining surface structures rated as low contrast, high integration and low magnitude. The overall visual effect is therefore considered to be *low*.

Prospecting surface structures rated as low contrast, high integration and low magnitude. The overall visual effect is therefore considered to be *low*.

6.13.2 Visual impact

The visual impact is assessed here under various categories of receptor locations, such as urban residences, rural residences, roads and community facilities.

i Residential dwellings

The residential dwellings located within Area 1 can be classified as either urban or rural.

The urban development of Cumborah, although a small settlement, includes a number of dwellings. The dwellings are substantially separated meaning that, although the dwellings on the perimeter of the settlement are likely to have the most unimpeded view of any nominated activity, all dwellings potentially have view lines beyond the town to areas potentially available for prospecting or mining.

The visual impact diminishes with distance and therefore the likely visual impact for the activities is shown in Table 6.16. Note that this does not take into account any intervening structures, topography or vegetation which may obscure or filter the view line.

Table 6.16 Visual impact at residential premises

Activity	Distance	Sensitivity	Visual impact
Prospecting surface structures	<200 m	High	Moderate
[Visual effect = low]	200 m to 500 m	High/moderate	Moderate
	500 m to 1 km	Moderate	Low
	>1 km	Low	Low
Mining surface structures	<200 m	High	High/moderate
[Visual effect = low]	200 m to 500 m	High/moderate	Moderate
	500 m to 1 km	Moderate	Moderate
	>1 km	Low	Low
Mullock stockpiles	<200 m	High	High/moderate
[Visual effect = moderate]	200 m to 500 m	High/moderate	High/moderate
	500 m to 1 km	Moderate	Moderate
	>1 km	Low	Moderate/low

Rural residential premises are scattered throughout the Area 1. The rural residential premises typically have landscaping, trees or outbuildings situated around the premises, and these may obscure or filter view lines. Nevertheless, the VIA takes a conservative position to assume that view lines are not filtered. The visual impact diminishes with distance and therefore the likely visual impact for the activities is shown in Table 6.16.

ii Community facilities and commercial accommodation

The local community facilities and commercial accommodation within Area 1 are the town of Cumborah and the farm stay accommodation at 'Kigwigil' property (Table 6.17).

Table 6.17 Visual impact at community facilities and commercial accommodation

Activity	Distance	Sensitivity	Visual impact
Prospecting surface structures	<200 m	High	Moderate
[Visual effect = low]	200 m to 500 m	High/moderate	Moderate
	500 m to 1 km	Moderate	Low
	>1 km	Low	Low
Mining surface structures	<200 m	High	High/moderate
[Visual effect = low]	200 m to 500 m	High/moderate	Moderate
	500 m to 1 km	Moderate	Moderate
	>1 km	Low	Low
Mullock stockpiles	<200 m	High	High/moderate
[Visual effect = moderate]	200 m to 500 m	High/moderate	High/moderate
	500 m to 1 km	Moderate	Moderate
	>1 km	Low	Moderate/low

iii Designated lookout, picnic site and recreational destination

The only recreational destination within Area 1 is likely to be the sporting facilities at Cumborah.

The visual impact for those recreational facilities is already captured by the consideration of residential premises within Table 6.16 above.

iv Travelling stock reserves

Travelling stock reserves are located within Area 1. These are identified by Local Land Services as being primarily low usage for stock transport but potentially supporting Aboriginal cultural heritage and biodiversity. The potential presence of Aboriginal cultural heritage values will be addressed through the separate assessment of Aboriginal cultural heritage in Area 1. From a visual perspective, it is assumed that Aboriginal cultural heritage values exist within the reserve. The visual impact at travelling stock reserves is provided in Table 6.18.

Table 6.18 Visual impact at travelling stock reserves

Activity	Distance	Sensitivity	Visual impact
Prospecting surface structures	<200 m	Moderate	Moderate
[Visual effect = low]	200 m to 500 m	Moderate	Moderate
	500 m to 1 km	Low	Low
	>1 km	Low	Low
Mining surface structures	<200 m	Moderate	Moderate
[Visual effect = low]	200 m to 500 m	Moderate	Moderate
	500 m to 1 km	Low	Low
	>1 km	Low	Low
Mullock stockpiles	<200 m	Moderate	Moderate
[Visual effect = moderate]	200 m to 500 m	Moderate	Moderate
	500 m to 1 km	Low	Low
	>1 km	Low	Low

v Roads

There are no designated tourist roads or scenic routes within the area of theoretical visibility within Area 1 and therefore no visual impact is registered.

The Kamilaroi Highway (B76) links the local regional centres of Bourke and Walgett. Note – both towns are outside of Area 1. The Highway in this location provides a single lane in each direction with a 110 km/hr speed limit and landscaped verges with remnant vegetation. The duration of any possible line of sight is therefore extremely brief.

All of the minor public roads in Area 1 serve a very low volume of local traffic.

Sealed roads, such as Gingie Road which links Cumborah with the Kamilaroi Highway near Walgett, are likely to carry marginally more traffic than the unsealed roads. The visual impact of the project to roads is provided in Table 6.19.

Table 6.19 Visual impact at roads

Activity	Distance	Sensitivity	Visual impact
Prospecting surface structures	<200 m	Moderate	Moderate
[Visual effect = low]	200 m to 500 m	Low	Low
	500 m to 1 km	Low	Low
	>1 km	Low	Low
Mining surface structures	<200 m	Moderate	Moderate
[Visual effect = low]	200 m to 500 m	Low	Low
	500 m to 1 km	Low	Low
	>1 km	Low	Low
Mullock stockpiles	<200 m	Moderate	Moderate
[Visual effect = moderate]	200 m to 500 m	Low	Low
	500 m to 1 km	Low	Low
	>1 km	Low	Low

vi Broadacre rural

Broadacre rural land is a feature of much of Area 1. The incidence of sensitive receptors in that setting is, however, based on the likely agricultural activities which require human presence. This includes activities such as mustering, repair and maintenance of fences, spraying, harvesting etc. These activities, while ongoing, are infrequent in any specific location and the presence of a receptor is generally temporary in nature.

This means that the sensitivity levels are generally low, similar to the experience of vehicle passengers. Note that the experience of receptors at rural residences are considered separately.

Within broadacre lands there can be farm workshops or storage sheds where it can be expected that a receptor may be present at those points for a period of hours but less than one day, rather than in a transitory mode such as in a tractor or farm vehicle. For those outbuildings, the impact assessment is provided in Table 6.20.

For general transitory activity on broadacre rural land the impact is considered to be low in all cases.

Table 6.20 Visual impact in broadacre rural settings (farm outbuildings)

Activity	Distance	Sensitivity	Visual impact
Prospecting surface structures	<200 m	Moderate	Moderate
[Visual effect = low]	200 m to 500 m	Low	Low
	500 m to 1 km	Low	Low
	>1 km	Low	Low
Mining surface structures	<200 m	Moderate	Moderate
[Visual effect = low]	200 m to 500 m	Low	Low
	500 m to 1 km	Low	Low
	>1 km	Low	Low
Mullock stockpiles	<200 m	Moderate	Moderate
[Visual effect = moderate]	200 m to 500 m	Low	Low
	500 m to 1 km	Low	Low
	>1 km	Low	Low

6.13.3 Other visual considerations

i The relationship between the nominated activities

This VIA has considered opal prospecting, opal mining and mullock stockpiling as the nominated activities proposed for Area 1 (the project).

From a visual impact perspective, one of those activities – mullock stockpiling – represents a more substantial visual impact than underground mining or the four nominated methods of opal prospecting.

In reality, the activities are a sequence of events. Opal prospecting precedes opal mining, and opal mining generates the production of mullock which needs to be stockpiled.

If there are, therefore, locations which may have a significant and unacceptable visual impact due to mullock stockpiling, then the mining activity which generates the mullock should logically not occur in that area. It might further be argued that if underground opal mining is to be restricted in certain areas, then the activity of prospecting has little purpose.

Opal prospecting could conceivably have a purpose other than a precursor to opal mining, but those instances are likely to be the exception and not the rule. Broadly, an applicant for an opal prospecting licence can be assumed to have an intention to subsequently mine for opals if the prospecting activity demonstrates a workable claim.

The VIA therefore recommends that opal prospecting and opal mining be prohibited in areas where mullock stockpiling has serious and unacceptable visual impacts which cannot be readily mitigated.

ii Tourism

A significant component of the local economy, particularly to the north of Area 1, in Lightning Ridge, is tourism. Most websites promoting tourism to Lightning Ridge point to an 'iconic' town with historic and contemporary links to opal mining. The opal mining structures and the mullock moonscape of the local opal mining claims is part of the experience when tourists take the car door tours. Indeed, the visibility of old mines and rusting machinery is a feature within the town of Lightning Ridge itself.

There is therefore an alternative visual aspect to visual elements such as mullock stockpiling.

The tourism motivation to experience a modified landscapes such as worked mineral claims appears to persist in locations such as Lightning Ridge. This may be primarily due to proximity to other services in the town of Lightning Ridge. A similar approach to mining activity as an attractant is evident in other opal mining destinations such as Cooper Pedy which promotes the local 'lunar landscape' of mullock heaps as part of the tourism appeal.

It is difficult to evaluate if the visual value of a worked opal mining claim for tourism purposes extends beyond the immediately accessible (and promoted) car door tour routes of Lightning Ridge.

iii Dark sky

The visual impact assessment also considers the impact of opal prospecting and mining activities on the Dark Sky region of NSW. The assessment found that there is little risk of glow impacts on astronomical observation, assuming normal mining practices, and that some minor conditions should nevertheless be included to ensure that night sky darkness is preserved.

6.13.4 Recommended setback distances

The local receptors for any visual effects associated with opal prospecting and mining are mainly the occupants of rural residences and to a lesser extent the people using community or recreational facilities, tourist destinations and the occupants of vehicles on local roads or travelling stock routes.

The assessment has considered the relative sensitivities for the various receptors, and the potential visual effect of the prospecting and mining activities, and established the distance at which the visual impact should be considered to be adequately ameliorated by intervening landscape features and remoteness from the mining activity.

This has allowed a mapped area to be identified where, based on visual impact, mining and prospecting activity should be constrained. The recommended distances are outlined in Table 6.21.

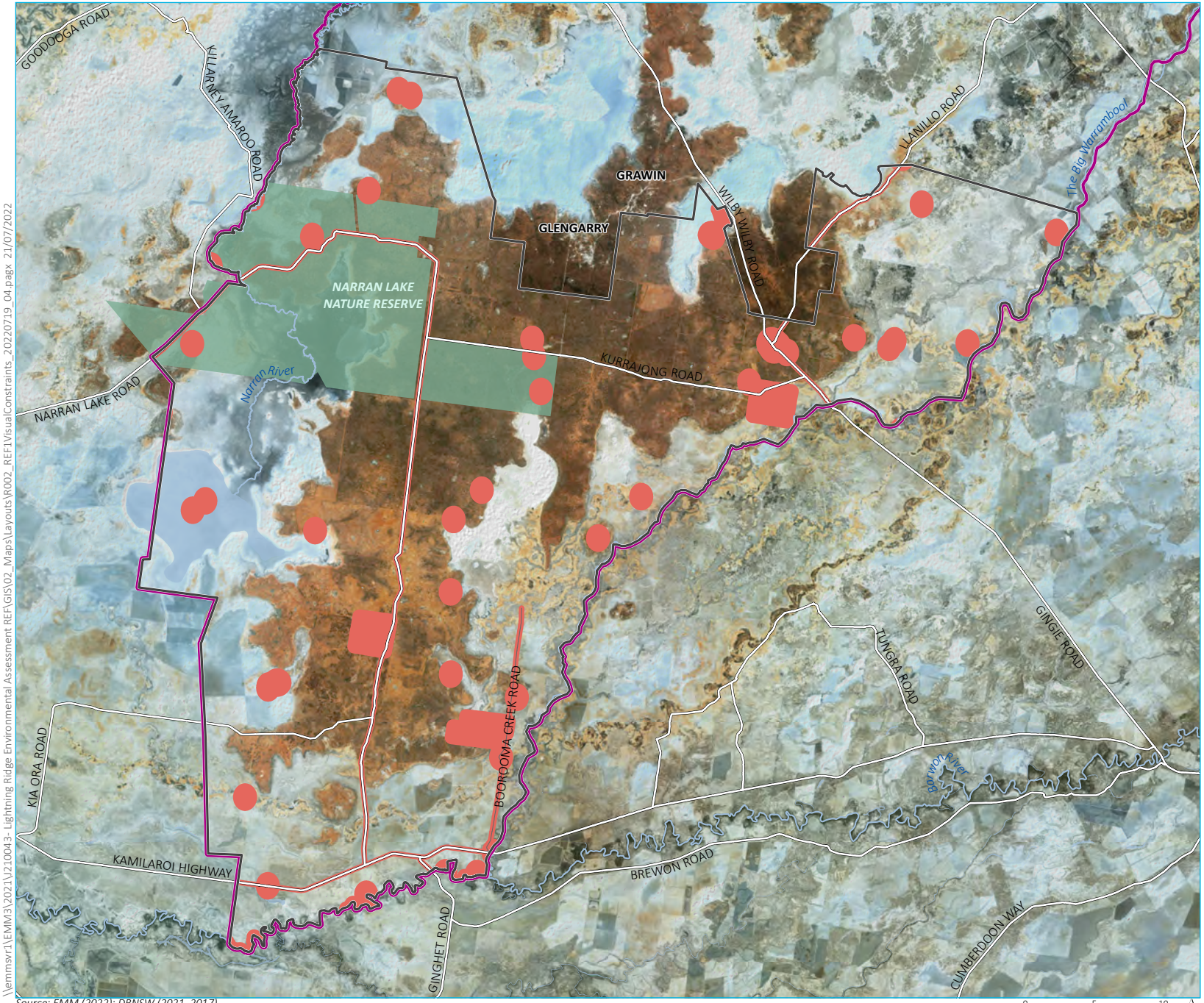
Table 6.21 Recommended setback distances

Receptor type	Linear, point or area	Recommended minimum 'set back' distance
Residential dwelling	Point	1 km
Community facility; commercial accommodation	Point	1 km
Recreational destination	Point; area	1 km
Travelling stock reserve	Area	500 m
Public road	Linear	200 m

Receptor type	Linear, point or area	Recommended minimum 'set back' distance
Broadacre rural land (farm outbuildings)	Point	200 m

The mapped constraint areas for visual impacts are shown at Figure 6.10. Note that point data for 'broadacre rural land (farm outbuildings)' within Figure 6.10 is limited by publicly available information. These points of interest should be ground-truthed to validate the location of farm outbuildings.

The constraints map in this visual impact assessment is based on the premise that the conditioning of a mineral claims or opal prospecting licence to address visual impact should be simple, easy to enforce and within the means of most applicants. This means that it is possible to consider the visual impacts of opal prospecting and mining within the constraints area, but only if those activities are (a) subject to separate assessment and (b) subject to more specific mineral claims or opal prospecting licence conditions to address the increased risk of visual impact on local receptors.



KEY

- Area 1
- Narran- Warrambool Reserve
- Visual constraints

Existing environment

- Major road
- Minor road
- Named watercourse
- Named waterbody
- NPWS reserve

Visual constraints- setback distances

Source: EMM (2022); DRNSW (2021, 2017)

0 5 10 km

GDA 1994 MGA Zone 55

N

\\emmsvr1\EMM3\2021\P210043- Lightning Ridge Environmental Assessment REF\GIS\02_Maps\Layouts\R002_REF1Visual\Constraints_20220719_04.pagx 21/07/2022

Review of Environmental Factors
Figure 6.10

EMM creating opportunities

6.14 Social and economic aspects

6.14.1 Social assessment field study participation

A social assessment has been conducted to assess the potential changes to the current social conditions and determine the potential social impacts and benefits to the local community and businesses as a consequence of future opal prospecting and mining activities within Area 1 of the NWR. The study used both primary and secondary data sources to develop a layered picture of the potential social impacts that are likely consequences or changes potentially experienced by the community in which future opal prospecting and opal mining activities are proposed. Information pertaining to the proposed opal prospecting and mining activities in Area 1, along with Australian Bureau of Statistic (ABS) demographic and economic data was used to inform the study area and to identify potentially affected communities and key stakeholders. The study area was mapped to identify surrounding stakeholders who could potentially be directly or indirectly affected by the Project. This includes identifying land and lease holders, businesses and social services who may have an interest in future opal prospecting and mining activities and who could be impacted.

Identified key stakeholders and land and lease holders within Area 1 were consulted utilising COVID-19 safe practices, which included the following activities:

- phone and videoconference in-depth interviews with Walgett Shire Council, land and lease holders, and other key stakeholders; and
- distribution of information sheets via email.
- The limited scope and short timeframe constrained the identification of all potential social impacts. The extent, likelihood and magnitude of social impacts and benefits identified in the social assessment drew on valid, but limited, evidence and hence should not preclude further inquiry regarding social impacts or consideration of supplementary evidence.

Social assessment field study activities were undertaken during December 2021 through to January 2022 remotely with a range of key stakeholders as summarised in Table 6.22. In-depth interviews were offered to 22 stakeholders of which 12 took place with an EMM representative who provided:

- a briefing on the REF;
- an overview of the social assessment processes; and
- questions to each stakeholder related to identified potential impacts and benefits of opal prospecting and opal mining.

Table 6.22 Consultation activities undertaken relevant to the social assessment

Stakeholder	Method	Format	Date	Invited	Participation
Local council					
Walgett Shire Council	In-depth interview	Microsoft Teams	17 December 2021 9.00 am – 10.00 am (NSW time)	1	1
Brewarrina Council	In-depth Interview	Microsoft Teams	Not conducted.	1	0
Additional stakeholder groups					
Lightning Ridge Miners' Association	In-depth interviews	Online via Microsoft Teams	15 December 2021 2.00 pm – 2.30 pm (NSW time)	1	1
Glengarry Grawin Sheepyard Miners Association Inc	In-depth interviews	Online via Microsoft Teams	20 December 2021 2.00 pm – 2.30 pm (NSW time)	1	1
Land and lease holders					
Land and lease holders	In-depth interviews	Teleconference (phone or online)	December 2021 – January 2022	22	12

6.14.2 Potential social and economic impacts

The social assessment field study activities sought to understand how participants viewed their community and sought to identify how opal prospecting and opal mining may impact on their community.

i Way of life

a Impacts

Impacts to way of life relate to increased disturbances caused by the introduction of mining vehicles and machinery. Such impacts can detract from the current amenity of the local community and significantly affect neighbouring land and lease holders. These amenity related impacts may impede upon the ability for residents to engage in relaxation and carry out business operations.

Due to the physical injury Hudson Pear can cause, the spread of the plant may contribute to way of life impacts related to ability to engage in many forms of outdoor recreation, including bushwalking and camping, as well as making access on horse-back exceptionally difficult (QLD Department of Agriculture and Fisheries 2020).

b Benefits

During in-depth interviews, there was a consensus that opal mining has built and facilitated the way of life present in the area, particularly in Lightning Ridge. Due to reliance on tourism stemming from opal activities, opal mining and prospecting may benefit the continuation and growth of the way of life and culture that surrounds opal mining. In bringing more tourism to the area, opal activities may create way of life benefits through increase of the resident population.

ii Community

a Impacts

Opal mining and prospecting has the potential to impact upon the community's character which local land and lease holders and stakeholders described as having a quiet country charm. Impacts relating to community may also include the potential to instigate community conflict between miners, land and lease holders and the Department of Regional NSW surrounding issues of land use, non-compliance and mismanagement. Expanded opal activities may impact upon community cohesion and resilience.

b Benefits

The continuation and potential increase of community events, such as the Lightning Ridge Opal Festival, which are driven by the opal industry may benefit community cohesion and create a sense of unity amongst community members. The community's sense of identity may also be bolstered by the expansion of opal mining, particularly in Lightning Ridge as stakeholders expressed that the area is reliant on the opal industry for many aspects of its community culture.

Many of the services in area, including an Olympic swimming pool, diving complex, theme park, a PCYC facility and gymnasium, have been built using community money raised from the sale of opal. Moreover, the expanding of opal activity in the area may increase the number of spaces for a sense of community to be supported and maintained.

iii Accessibility

a Impacts

During in-depth interviews, stakeholders raised concerns related to access for emergency services in mining claim areas. Insufficient information to facilitate access of emergency services due to a lack of rural addressing and signage for mining claims may impact accessibility in the local area. Without rural addressing and signage for these mining claims, there is a significant possibility that emergency services could be delayed and inconvenienced, creating increased safety risks and impacts upon accessibility (Geographical Names Board of NSW 2012). Lack of established roads for mining claims may be an impediment to the access of emergency services. Accessibility impacts for mining claims may arise due to issues of unreliable telecommunication.

Access to rental accommodation was reported by many stakeholders as being a key issue. Stakeholders acknowledged that currently there is little accommodation for an increase in population or tourist visitors. The increased population that expanded opal mining may attract could place pressure on the existing rental housing market. Access to housing is an existing vulnerability in the local and regional area as residential vacancy rates have been consistently below the equilibrium level of 3.0% since 2019, suggesting a vast undersupply of rental housing in the area (see Section 5.1.6).

b Benefits and opportunities

There is opportunity to work with both the Walgett Shire Council and Brewarrina Council to establish rural addressing for mining claims, including appropriate roads, tracking and signage. A benefit arising from this opportunity would include an accurate and standardised system for the accessibility of emergency services (Geographical Names Board of NSW, 2012). In addition, economic activity stimulated by increased opal prospecting and opal mining is likely to improve the local economy, which may then facilitate increased provision of health and social infrastructure and services.

iv Culture

Due to the limited scope of the assessment, Aboriginal and/or Torres Strait Islander stakeholders were not engaged as part of the social assessment. A significant proportion of people in local and regional area identify as Aboriginal and/or Torres Strait Islander (see Table 5.4), with 64.7% of the population in Brewarrina SSC, 43.6% in Walgett SSC and 22.6% in Lightning Ridge SSC. Given their low SEIFA Index rating they are particularly vulnerable to experiencing the negative impacts associated with opal prospecting and mining. Consultation with Aboriginal and/or Torres Strait Islander persons may be worth considering identifying and assess potential unknown social impacts and benefits relating to the Aboriginal and/or Torres Strait Islander community in the area.

v Health and well-being

a Impact

The potential impacts of opal mining and prospecting upon health and well-being are substantial. Due to issues surrounding unreliable telecommunication, risks to safety may arise due to miners failing to communicate their location to land and lease holders. Land and lease holders noted that they use firearms on their property for pest management and that this could have impacts upon public safety should they be unaware of people (the public or miners) being on their property. Both the Walgett Shire Council and the miner's association acknowledge the public safety concern of tourists entering mining claims and suggest that greater signage as well as education around where tourists can and cannot go is needed.

Unattended mine shafts can pose a significant fall hazard, for both the public and animals, if they are not fenced or screened to prevent accidental entry (Walgett Shire Council 2016). If mining shafts are not adequately rehabilitated, this can leave mining holes which can increase the risk of injury or death due to fall hazards. Extensive underground mining operations can pose substantial risks to health and safety should a mine shaft collapse in what is known as a subsidence event.

The spread of Hudson pear which is known to be exacerbated by mining activities poses physical health risks to both humans and animals. The reverse-barbed spines can injure livestock, humans and native animals (Department of Agriculture and Fisheries QLD, 2020), which not only poses significant health risks but also cumulative impacts upon grazing activities and most forms of outdoor recreation. Whilst not as pervasive as the Hudson pear, the spread of Parthenium weed from mining activities also needs to be noted as the invasive plant can cause severe human health problems as well as posing significant risk to the health of livestock (NSW Weedwise 2020).

The Walgett Shire Council also raised health and well-being impacts surrounding workplace health and safety management on mining claims, particularly on the impacts of silica dust on opal miner's lung health. Exposure to silica dust can lead to the development of multiple health problems, including lung cancer and silicosis (NSW Resource Regulator 2022).

Increasing opal activity in the local area may also exacerbate the emotional toll on land and lease holders that arise from non-compliance and poor land rehabilitation practices surrounding opal prospecting and mining. Multiple land and lease holders raised that opal mining has previously affected their mental health, particularly due to concerns over the substantial impact of opal activities on their land and livelihoods.

b Benefits

Designated fossicking areas specifically for tourists and locals has been suggested as a way to reduce risk exposure whilst also benefitting and promoting tourism associated with opal fossicking. Note that fossicking is not an activity assessed under this REF but is referenced here as a social issue.

vi Surroundings

a Impacts

Land and lease holders in the area, Walgett Shire Council and the miners' associations raised concerns that expanded opal prospecting and mining may worsen the existing biosecurity issue of Hudson pear. Hudson pear was first detected in Australia in the Lightning Ridge area in the 1970s and its spread has been aided and exacerbated by opal mining activity (NSW Weedwise 2021).

Infestations of Hudson pear can lead to the displacement of native flora and may impact on the biodiversity of the land (NSW Weedwise 2021). Multiple land and lease holders stated that they valued the local natural area, lifestyle, and terrain. Multiple land and lease holders expressed that the spread of Hudson pear is an 'environmental disaster' and would be made irrevocably worst should more land for opal mining be opened up. It was stressed on several occasions by land and lease holders that the Hudson pear has the potential to become a serious biosecurity issue which would impact their surroundings through contamination should mitigation and prevention measures not be put in place. To fully assess the impact of the spread of Hudson pear, further consultation and additional investigation is needed.

During in-depth interviews, concerns were raised by land and lease holders regarding opal miners living on mining claims and how the build-up of rubbish has had a significant impact on the amenity of the surroundings.

vii Livelihood

a Impacts

Potential impacts upon livelihood, specifically for land and lease holders involved in the agricultural industry, are substantial. The identified potential livelihood impacts primarily relate to farming activity and property prices.

b Farming activity

A significant livelihood impact derives from the problem of Hudson pear and the challenges it poses to graziers in terms of the safety of their livestock, the quality of their land and biosecurity. The plant significantly reduces the viability of agricultural enterprises, including the potential to present a severe impediment to mustering operations. Land and lease holders made frequent note of the financial burden, in both time and money, that the infestation presents and put forward that a more comprehensive management plan is needed to the halt the spread of the invasive species. As Hudson pear primarily spreads through penetrating footwear and vehicles tyres, land and lease holders suggested that the NSW Resources Regulator put in place increased preventative measures and levels of compliance to mitigate the impacts of the plant.

The spread of Hudson pear has the potential to significantly reduce the agricultural viability of land (NSW Weedwise 2021). An issue that was repeatedly raised during in-depth interviews with graziers was how the spread of Hudson pear from mining operations limits the range of stock that can be held on infested land, with sheep noted as more at risk to Hudson pear. This limitation placed on stock range reduces the grazier's opportunities for multiple streams of income. Opal prospecting and opal mining also puts restraints on future opportunities for land and lease holders to diversity their income source in some areas. For example, one landholder raised that their plans for a carbon sequestration project would be impacted by the presence of opal prospecting and mining on their land. In both Walgett Shire LGA and Brewarrina LGA, agriculture, forestry and fishing is the top industry of employment, as well as holding the highest percentage of registered businesses (see Section 5.1.2 and Section 5.1.3). Therefore, impacts upon the agricultural industry in the area is likely to flow out into the greater community.

Should opal prospecting and mining take place on their land, some land and lease holders reported that this would impact upon their ability to obtain accreditation for their livestock. Gaining livestock accreditation is essential for grazing businesses and land and lease holders stressed that they would be 'put out of business' should this be impacted. Due to the public safety impacts, land and lease holders face another impact to their livelihood as having miners on their land means that their ability to safely shoot vermin is obstructed.

Land and lease holders also reported that large mullock heaps have often been left in and around mining claims which have led to significant impacts upon the land and natural environment. These mullock heaps contain high levels of salt and silica that leak onto the property when it rains, thus killing vegetation and damaging soil quality. One miners' association suggested that OPA 4 will need a communal mullock dump to mitigate the impacts on soil quality. Moreover, land and lease holders also raised concerns of the soil compaction that arises when opal miners use heavy mining machinery and vehicles. Soil compaction has implications for the quality of the soil, water drainage and the type of vegetation that can grow.

In addition, land and lease holders have reported that they have had issues previously with miners as well as other members of the public cutting fences to gain access to new mining claims. Land and lease holders were clear that fence cutting places a significant burden on their livelihoods due to the time it takes to replace fences, the potential loss of livestock from fences that have been cut, the subsequent input needed to recover lost livestock as well as the cost of the materials to repair fences. It was suggested by both Walgett Shire Council and land and lease holders that potential boundary agreements should be put in place for mining activities to limit the impact upon agricultural livelihoods.

Implications of public liability was raised by land and lease holders as a potential impact upon their livelihood and the running of their agricultural businesses. Land and lease holders expressed concern over the financial responsibility of public safety on mining claims and whether they would be held liable should an incident be reported.

As mentioned previously, agriculture is the top industry of employment in the regional area (see Section 5.1.2 and Section 5.1.3) and provides a great deal of support to the local community. Whilst opal mining may have benefits to the livelihood of people in the community, several land and lease holders pressed that opening more land to opal mining would damage the thriving agricultural industry in the area.

c Property prices

Multiple land and lease holders raised their concerns that the damage to soil quality and grazing land resulting from opal activity would significantly diminish the resell value of the property and magnify difficulties to sell the land. Namely, an increase in mining vehicles being driven across agricultural properties was raised by land and lease holders as a key concern for the quality of the land for grazing. In addition, if a property is plagued by an infestation of Hudson pear, the value of the land is reduced significantly. The inadequacy of current mining rehabilitation practices was also raised as a key factor for concern and to mitigate impacts upon livelihood improved rehabilitation practices should be implemented.

d Benefits

For the local and regional area, the community heavily depends on the opal industry for its income flow. The Lightning Ridge Miners Association acknowledges that Lightning Ridge is built upon the opal industry. Moreover, the opal industry drives both the resident population and tourism in the area which then supports the retail, hospitality, hardware, accommodation, and social service sectors. For example, the 4 day annual Lightning Ridge Opal Festival drives substantial amounts of tourism in the area, with approximately 15% of profits being donated back into the local community (Lightning Ridge Opal Festival 2020). Opening up OPA 4 for opal mining and prospecting would generate more opportunities for work and the subsequent sale of opal is anticipated to support livelihoods in the community.

Stakeholders raised a concern that new opportunities for opal mining may have the potential to increase opal commodity prices and attract a more international market. Moreover, the opening of the new Australian Opal Centre is expected to attract a substantial increase in tourism and additional opportunities for opal mining which will allow new supply of opal to be brought into the community. Some opportunities that have been identified include the potential for additional micro-businesses to be supported, specifically jewellery businesses, tour businesses and increased investment into accommodation to facilitate growth in tourism. Whilst it has been noted that opal activity on their land restricts land and lease holders' ability to diversify their income in some sectors, there is also opportunity for farmers to engage in opal mining to diversity their income, specifically in times of drought or during off-seasons.

viii Decision-making systems

a Impacts

An important aspect of decision-making systems are stakeholders having access to complaint, remedy and grievance mechanisms. Most land and lease holders expressed the difficulties in reporting issues and grievances regarding mining operations as the police would often redirect complaints to the NSW Resources Regulator and vice versa. Issues over non-compliance to rehabilitation standards were identified by land and lease holders as difficult to report and rectify. Enforcement of mining standard compliance was noted as a key impact upon decision-making systems. Multiple stakeholders suggested that more stringent compliance management and reporting systems need to be implemented.

Land and lease holders expressed that the spread of Hudson pear has not been adequately managed by the mines department and the onus of mitigating and preventing the spread has fallen onto the responsibility of graziers. It was felt the Mines Department needs to establish a more comprehensive management plan to alleviate the spread of the invasive species and to take the onus of responsibility off land and lease holders.

Graziers expressed how their rights as land and lease holders to make decisions about their own land use has, at times, been superseded by mining priorities. Both Walgett Council and land and lease holders have noted the need for greater planning in how mining claims are distributed and allotted. The miner's association also found issues with reporting illegal fossicking to the NSW Resources Regulator, expressing that no responsibility has been claimed to deal with the issue nor has any compliance been enforced.

b Benefits

Walgett Council expressed that OPA 4 could be a leader in improved mining planning. The council suggested a planning system using subdivisions and allotments to bring greater transparency to both land and lease holders and miners over decisions of land use.

6.15 Economic impact

Approximately 95% of opals produced worldwide originate from Australia. Opal mining towns, which include Lightning Ride, White Cliffs and Cooper Pedy, generate income from both mining and supplying opal, and also the tourism associated with mines and the opal mining lifestyle. Tourism is likely the economic activity with the greatest multiplier effect because tourism supports accommodation, food, fuel entertainment and general retail industries.

Lightning Ridge is marketed as the home of the black opal. The *Western Plains Regional Economic Development Strategy 2018–2022* (State of NSW (Department of Premier and Cabinet) 2018) was prepared by the Balmoral Group and found that quantifying the economic contribution of opal mining was difficult. The report identified a 'hole' in the data because:

> Lightning Ridge has many resident opal miners, but many do not list it as their profession, nor Walgett Shire as their place of residence. The Lightning Ridge Miners' Association lists approximately 860 financial members; however, only 45 people in Walgett (2.2% of the workforce) listed their industry of employment as in the Mining sector. This may partly be explained by the fact that many miners are semi-permanent, leaving the area during the hot summer months. (p 12)

Agriculture employment was noted to be in decline for the Western Plains Region – which includes several local government areas, including Brewarrina and Walgett but also key mining areas such as Cobar – while the mining sector experienced consistent growth in employment. Note that these statistics include Cobar which alone accounts for approximately 73% of the mining sector employment. Nevertheless, the minerals and gemstones of the region are acknowledged as a significant endowment which contributes to the local economy.

In terms of tourism, this activity is noted as a key to diversifying the regional economy. The extent to which it is attributable to opal mining at Lightning Ridge is unclear. Noting the persistent reference to black opal, mining history and 'colourful locals' in all marketing material for Lighting Ridge, it is assumed that the attraction of the town and region is synonymous with opal mining. As the Balmoral Group Report notes:

> Further employment gains are possible to fully capitalise on the Region's significant drawcards and endowments, such as the Macquarie Marshes, Opal Fields and other natural attractions, as well as significant Aboriginal cultural heritage. The existence of a healthy Leisure and Recreation sector will also have positive flow on effects for the rest of the economy, improving the Region's standard of living and making it a more attractive place to live, work, and do business. (p12)

While the long-term economic mix recommended in the Balmoral Group Report does not specifically infer any particular arrangement for Area 1, it does signal the need to maintain some level of viable opal mining as one to the 'endowments' underpinning economic growth and diversity for the region, particularly growth in the tourism sector. There is opportunity to implement strategies which support both agriculture and opal mining.

6.16 Climate change

Consideration of climate change represents two aspects: mitigation and adaptation.

6.16.1 Mitigation

Mitigation refers to the reduction in emissions and other factors which are known to drive or exacerbate climate change. Emissions attributable to opal prospecting and mining are generally associated with the operation of machinery, plant and vehicles.

Most of the innovations aimed at reducing greenhouse gas emissions and decarbonising the environment, including changes to energy technologies and their relative cost, are operating independently of the opal mining sector. This will eventually influence decisions by opal miners in choices of operational equipment and energy sources, and incrementally reduce the carbon footprint of the industry over time.

The net contribution to greenhouse gas emissions by opal mining operations in minor at anything other than a local scale. Nevertheless, the mitigation can be improved in advance of availability of renewable energy and other technologies by (a) reducing the clearing of vegetation and (b) restoring or rehabilitating areas which have suffered historic vegetation loss. Consideration is also required for the closure stage of any opal mine which should anticipate the on-going need for mitigation. Revegetating the site with an appropriate selection of heat tolerant or drought resistant species is recommended.

6.16.2 Adaptation

Adaptation in terms of opal prospecting and mining, relative to the geophysical circumstances of Area 1 currently and under a hotter climate in the future, would involve a capacity to safely operate with more days of extreme heat per year.

While underground mining itself assures a certain degree of protection to miners operating in that environment, the retention of vegetation at the surface would provide a mitigating element against heat stress.

Drought and water scarcity are also key adaptation considerations. Water is essential for humans but also for local fauna. It is an input to some opal processing methods such as wet 'puddling' of extracted material. In the future, this scarcity of water may exacerbate existing vulnerabilities and place water users in direct competition. Preference should, over time, bias towards opal mining processes which minimise water reliance or consumption.

In circumstances of extreme heat, some opal miners may seek to reschedule activities to night-time when temperatures are generally cooler. If undertaken at night, these activities may however introduce countervailing issues such as acoustic pacts on sensitive receptors in some locations. Consideration of adaptation responses should therefore be cognisant of potential adverse impacts elsewhere.

DRNSW may consider discussions with local councils and state authorities regarding long term water supply constraints and opportunities.

6.17 Land use conflict

Taking the definition of land use conflict in its meaning under land use planning instrument, there is not any adverse consequence arising from different adjoining land use zones. The main zone differences are between land zoned as RU1 Primary Production and C1 National Parks and Nature Reserves, but issues associated with the boundary between these zones has not been raised by stakeholders in the Social Assessment field study. There are some areas zoned SP1 Special Activities (Mining) near Grawin and Glengarry but these are not within Area 1. Hence, it can be assumed that 'land use conflict', to the extent that it exists, does not arise from the interaction of activities permissible in separate but adjoining land zones, but rather from the interaction of activities within land zoned RU1 Primary Production.

Overlays within a single land zone may be the more likely source of conflict. As is usually the case, local planning instruments provide for a range of development to be permitted with consent, or prohibited, under a single land zone; and overlays such as opal mining leases or mapping of flooding risk, biodiversity values, heritage or natural hazards, can also guide or constrain specific types of development.

The evidence prepared for this REF regarding Area 1 suggests that the approach to managing potential land use conflict needs to be based on a staged process.

There is little benefit in prematurely allocating land for either agriculture or opal mining until key technical assessments are complete. If technical assessments for factors such as ecology, Aboriginal cultural heritage, or acoustics indicate that the impacts of certain activities cannot be easily managed through authorisations such as mineral claims or opal prospecting licence conditions, then those areas where impacts cannot be easily managed are already acknowledged to be unsuited to the scoped activities.

The other benefit of deferred consideration of land use allocation between agriculture and opal mining is that the issue often characterised as 'land use conflict' is in fact a matter of neighbour relations. Notwithstanding the genuine need to preserve prime agricultural land for agricultural activities, and opal prospective land for opal mining, the issues identified in the Social Assessment section of this REF confirm that it is behavioural matters often create the friction or concern.

In considering the potential impacts of opal prospecting and mining activity in Area 1, it is recognised that the issues raised by some stakeholders during the social assessment field study could manifest themselves in the event that further opal mining occurs in Area 1.

Matters raised by stakeholders during the Social Assessment field studies include a number of legacy issues associated with past practices and experience, not specifically identified as issues limited to Area 1, nor the particular types of activity considered under this REF. For some issues it is therefore relevant to consider the findings of various technical reports. For example, stakeholders identified disturbance to local amenity as a concern. The technical assessments for factors such as acoustics and visual impact will include mitigation measures or spatial limitations to protect local amenity. Those technical assessments should therefore form the basis of conditions which may be imposed on new opal mining or prospecting activity in Area 1.

Other land use conflicts have a compliance basis. Again, the Social Assessment field studies identified concerns over a perceived lack of enforcement capacity in public authorities. For example, conditions attached to existing mineral claims or opal prospecting licences would generally require work health and safety standards to be met. There were concerns raised over abandonment of machinery and equipment, and poor rehabilitation. These matters can be conditioned, as they have in the past, however the ability of public authorities to be able to undertake enforcement remains a legitimate factor in terms of managing 'land use conflicts'. It is not strictly an 'impact' of the proposed activities which can be the subject of an REF but rather a contextual matter which can inform decision-making.

6.18 Long term effects

Long term effects are those attributes of the proposed activity – both positive and negative – which are likely to persist as a feature of the natural, social or economic environment at an inter-generational time scale. It is necessary to consider:

- invasive species – weeds and pest animals;
- culture and heritage;
- contaminants and hazardous materials;
- threatened species and ecological communities;
- soil characteristics;
- vegetation and landscape; and
- local economy.

6.18.1 Invasive species - weeds and pest animals

Invasive pest animals and weeds can be difficult to control or eradicate and therefore represent a long term risk if known or emerging invasive species become established in Area 1. Relevant to Area 1, the duties imposed by the NSW *Biosecurity Act 2015* on occupiers of land include the need to prevent, eliminate or minimise any biosecurity risk from weeds (terrestrial an aquatic). Biosecurity is a shared responsibility between government, industry and communities. Biosecurity zones are established under the Biosecurity Regulation for various animals, plants and diseases.

The spread of Hudson pear, which is known to be exacerbated by mining activities, poses physical health risks to both humans and animals. Whilst not as pervasive as the Hudson pear, Parthenium weed also needs to be noted as an invasive plant can cause severe human health problems as well as posing significant risk to the health of livestock.

All future opal mining activity should be undertaken consistent with the *North West Regional Strategic Weed Management Plan 2017–2022* or subsequent versions of the Plan.

6.18.2 Culture and heritage

The long-term risk to historical and Aboriginal culture and heritage arises from the loss or degradation of historic assets or culturally significant sites and places. When these sites and places are not able to be restored, the loss persists.

These matters are separately considered in Section 6.8 and Section 6.9.

6.18.3 Contaminants and hazardous materials

There are several potential sources of contaminants for Area 1:

- the operation, management and disposal of plant and equipment, which can introduce surface hydrocarbons from machinery fuels and equipment leaks or spills;
- the management of spoil material (mullock) which can be saline and sodic with a variable pH;
- dumping and uncontrolled fill;
- waste water and sewage;
- intensive agriculture (feedlots);
- pesticides and herbicides; and
- the introduction of asbestos or other hazardous materials.

The presence of contaminants and hazardous materials can persist in the landscape and constrain subsequent uses or occupation of the land. Legacy issues regarding contamination in Area 1 are discussed in Section 6.10, which concludes that most of the listed sources of contamination are potentially present in Area 1.

The risk of new contamination or hazardous materials being introduced can be addressed through conditions which reference standards, such as Australian Standard AS1940 for the Storage and Handling of Flammable and Combustible Liquids, and relevant EPA Guidelines. These mitigation measures are outlined in Section 7.

6.18.4 Threatened species and ecological communities

Threatened species, by definition, represent a long-term effect if impacted by activities. Within Area 1, there are several threatened ecological communities listed under the *Biodiversity Conservation Act 2016* and four also listed under the *Commonwealth Environment Protection and Biodiversity Conservation Act*. Threatened species and ecological communities have been assessed and the findings are found in Section 6.5 and Appendix A.

Two Threated Ecological Communities (TECs) face increased risk if exposed to Serious and Irreversible Impacts (SAII). These TECs include:

- Artesian Springs Ecological Community in the Great Artesian Basin (*Endangered*); and
- Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions (*Endangered*).

Excluding known locations of these TECs from opal prospecting and mining activities is the best way to manage long term effects, or alternatively require further assessment in accordance with Section 9.1 of the *Biodiversity Assessment Method* (DPIE 2020) as part of a biodiversity impact assessment for a future development application.

6.18.5 Soil characteristics

Long term issues such as topsoil loss, erosion and soil compaction are considered in Section 6.1. Arrangements outlined by the NSW Resources Regulator (*Environmental management and rehabilitation at Lightning Ridge* https://www.resourcesregulator.nsw.gov.au/) should be implemented. These include:

- progressive rehabilitation;
- topsoil management; and
- minimise vegetation clearing and surface disturbance

6.18.6 Vegetation and landscape

The clearing of woody vegetation is acknowledged to be a long-term issue in NSW (refer to Woody vegetation change, *Statewide landcover and tree study for 2018* (DPIE 2020)). The calculated annual reduction of woody vegetation across NSW for 2018 was 60,800 ha/year or 0.08% of the area of NSW, and the trend is increasing. The loss of woody vegetation (49%) is predominantly attributable to agriculture. The loss attributed to 'infrastructure' which includes roads, water pipelines and mining activity, is 13%. Small scale opal mining is therefore not a major contributor, yet should still be managed to minimise the loss of vegetation.

The introduction of opal prospecting and mining in Area 1 has the potential to modify the landscape in terms of visual setting. The Visual Impact Assessment conducted for this REF (Section 6.13 and Appendix E) identifies the key receptor points, such as rural dwellings, roads and tourism locations, and proposes certain distance setbacks to mitigate visual impacts. The placement of mullock is the principle change to the visual landscape and is a practice which is unavoidable while opal mining in active. However, the long-term effects on the visual landscape can be mitigated by measures such as progressive rehabilitation, minimising vegetation clearance and storage of topsoil for final rehabilitation of the opal prospecting or mining site.

6.18.7 Local economy

The economic impact of opal prospecting and opal mining within Area 1 has the potential to contribute positively to economic growth in the region if Area 1 was to be opened up to opal prospecting and mining activities. Opal mining towns and areas, generate income from both mining and supplying opal, and also the tourism associated with mines and the opal mining lifestyle.

The economic assessment (Section 6.15) identifies opal prospecting and mining, and the associated economic contribution of tourism as being fundamental components of a stable and diversified economy in the long term, whilst also acknowledging the need to balance these contributors, with the agricultural industry.

6.19 Cumulative effects

Cumulative effects relate to the combined impacts associated with multiple land uses, as well as the cumulative effects associated with the potential granting of multiple opal prospecting and mining titles within Area 1.

Agriculture, including livestock grazing and cropping is the existing primary land use within Area 1. There is limited existing opal prospecting or mining activities currently undertaken within Area 1. Vegetation modification and vegetation clearing have been assessed as the primary cumulative impacts associated with the introduction of new mineral claims and opal prospecting licences within Area 1. Other potential impacts include demand for water resources, both surface and ground waters, degradation of soil resources, soil erosion and sedimentation of waterways, displacement of fauna, dust generation, noise and vibration generation and potential impacts to historic and Aboriginal cultural heritage.

Prior to the granting of any new mineral claim or opal prospecting licences, the number of existing claims and licences and their locations should be considered. The potential cumulative impacts of the granting of numerous claims and licences in close proximity includes concentrated vegetation modification or clearing, loss or degradation of faunal habitat corridors, concentration of mullock dumps and associated air quality and visual amenity impacts, increased traffic on public roads and unsealed and unformed tracks and the associated air quality impacts. In the event that mineral claims or opal prospecting licences are not adequately rehabilitated there is potential for the loss of agricultural land. If sub-standard rehabilitation takes place across multiple small workings, the cumulative impacts to the environment and end-users of land could potentially be significant at a land and sub-regional scale.

Cumulative impacts also extend to the potential positive contribution of economic stimulus from the opal industry, and the associated tourism generated as a by-product of opal prospecting and mining activities. These economic injections to the region will help diversify the local economy.

With the implementation of mitigation measures proposed within Section 7, the potential for cumulative impacts from the granting of mineral claims and opal prospecting licences within Area 1 would be significantly reduced.

7 Mitigation measures

Mitigation measures for each environmental aspect assess within this REF have been collated and are presented in Table 7.1.

Table 7.1 Area 1 recommended mitigation measures

General aspect	Mitigation measure
Licence/conditioning	Limit hours of operation to daylight hours on mineral claims and opal prospecting licence conditions. Reference to the limitation of activities to daylight hours should be incorporated into the existing DRNSW guidelines, handbooks, codes of conduct and induction presentations.
Landholder interactions/proximity to homesteads	Locate mining activities, communal mullock stockpiles and access tracks as far away from homesteads as possible. Maintain landholder consent to operate on land within 200 m of the principal homestead of a property.
	Notify residents prior to the commencement of intensive works that could impact them.
	Locate access roads and tracks as far away from homesteads as practicable.
	Orient activities, plant and equipment to provide acoustic shielding for adjacent occupied leases and residential areas.
Environmental aspect	**Mitigation measure**
Soils and rehabilitation	The development of more prescriptive mineral claim and opal prospecting licence conditions for rehabilitation, addressing the risks outlined in Section 6.3, would improve rehabilitation outcomes and reduce legacy risks to agricultural users and the State of New South Wales.
	Underground workings in the low-relief plains areas containing Vertosols are particularly prone to sink hole formation, tunnelling and ground failure. EMM recommends that workings are limited in these areas to open cut methods only, unless the mineral claim holder or prospector can comprehensively demonstrate methods for backfilling of underground tunnels, shafts and exploration drill holes that prevents the formation of sink holes and tunnels and longer-term ground failure.
	Development of a contemporary best-practice standard for rehabilitation that mineral claim holders and prospectors can implement to achieve these conditions, acknowledging the typically small-scale nature of these operations and hence the need for guidance to be reasonable and practical. The rehabilitation standard would need to include but not necessarily limited to: • Consistent with rehabilitation policy and guidelines mullock waste must be preferentially disposed at depth through shaft backfilling or placement in the bottom of open-cut voids. Mullock disposal at surface should be minimised, ameliorated (if required as informed by soil testing) and covered with topsoil to support vegetation establishment. Similar management measures should apply to dried and consolidated wet puddling material, and dry puddling. • Management and mitigation of dispersive materials (eg minimise slope steepness, chemical amelioration using gypsum, capping with non-dispersive materials). • Use of non-vegetative solutions to provide soil cover to minimise erosion due to low rainfall (eg use of rock/soil matrices, rock mulches, timber debris). • Management and mitigation of saline materials (eg rock/soil matrices, gypsum treatment). • Backfilling techniques to minimise the formation of sink holes and tunnels. The updated standard should incorporate and build on the complimentary rehabilitation principles already addressed in the current *Rehabilitation Standards for Cancelled Claims* (DPI 2001) and *Code of Practice* (DPI 2006).

General aspect	Mitigation measure
Surface water	Mineral claim or opal prospecting licence holders must not operate within 10 m of a natural drainage line or watercourse, including ephemeral drainage lines which do not always hold water. A drainage line may be subtle, yet can be identified as an incised channel with a bed and bank.
	Laydown areas, equipment compounds and material stockpiles should not be located within watercourses, gullies or drainage lines, including those ephemeral in nature.
	No works permitted within riparian corridors of mapped watercourses in accordance with *Guidelines for Controlled Activities on Waterfront Land* – Riparian Corridors (DoI 2018).
	Mineral claim or opal prospecting licence holders must not interfere with the flow of water in any stream or watercourse.
	Appropriate handling and storage of fuels and chemicals in accordance with *Storage and Handling of Liquids: Environmental Protection: Participants Manual* (DECC 2007).
	Maximise the retention of sediment on-site through the use of sediment and erosion control structures such as sediment fencing, sediment retention dams, or clean water diversion bunds. These sediment controls and erosion management to be planned in compliance with the 'Blue Book' (DPIE 2004).
	Appropriately sized water supply dams and tanks, in accordance with the *Harvestable Rights Orders* (NSW Government Gazette 40, 2006).
	Appropriately sized settlement/sediment dams and best practice erosion and sediment controls, in accordance with *Managing Urban Stormwater: Soils and Construction – Volume 1* (Landcom 2004).
	Storage of silt and sediment generated from puddling operations to be within designated bunded storage areas.
	No dams are to be constructed within 3 km of a RAMSAR wetland site as per the *Harvestable Rights Orders* (NSW Government Gazette 40, 2006).
	Recycling of water from sediment dams to water supply dams to reduce the reliance on raw water supplies.
	Conduct plant and equipment washdown within designated bunded areas. Ensure no wastewater leaves the bounds of the claim.
	No water extraction from surface or underground sources is permitted through the granting of mineral claims or opal prospecting licences.
Groundwater	No extraction/harvesting of groundwater is permitted through the granting of mineral claims or opal prospecting licences.
	Groundwater should not be used for opal prospecting or mining activities, including processing.
Biodiversity	Ensure mineral claims and opal prospecting licences are granted outside of highly sensitive ecological areas, in accordance with the ecological constraints mapping within Figure 6.6. Areas of high constraint (red) should be avoided, or have the highest scrutiny during assessment and when considering the Rehabilitation Plan and Claim conditions. These areas require a full ecological and soil assessment under the *EPA* Act 1979. Compliance and ecological monitoring should be commensurate with the scale of the activity. Areas of moderate constraint, it is recommended that an environmental assessment be completed as for a high constraint area, excepting the level of rehabilitation must be commensurate with the previous condition of the affected area. Areas of low constraint include croplands, cleared areas and roads. These areas do not require an environmental assessment. These areas require a rehabilitation plan that returns the affected areas to a state that is suitable to its prior land use in accordance with progressive rehabilitation and the standards for rehabilitating mine shafts, trenches, and auger holes (NSW Government, 2022).
	Minimise areas of vegetation loss.

General aspect	Mitigation measure
	Conserve topsoil that contains seedbank and used during rehabilitation to assist in the regeneration of native flora species.
	Design mining infrastructure to ensure it does not cut off habitat connectivity or isolate native areas from surrounding areas by more than 10 metres.
	Fencing should be erected to prevent fauna from accessing open and unattended holes and shafts (see also public safety).
	All mining licences to include requirement to implement site hygiene measures (to prevent spread of pathogens or weeds) in all mining and mining-related areas as per the DPI procedures (DPI 2018a).
	All mining operators and associated contractors to regularly complete a DPI biosecurity task risk assessment (DPI 2018b) before entering or passing through all properties associated with the mining activity. Biosecurity task risk assessments to be submitted to the landowner or leaseholder and department within one (1) month. Landowner or leaseholder and DRNSW should review risk assessments, with the landowner or lease holder given the opportunity to query the effectiveness of risk assessments.
	Weed control within mineral claims and opal prospecting licences must be completed by the claim holder in accordance with the Biosecurity Regulations and NSW WeedWise (DPI 2022). The claim holder has the biosecurity duty to comply with and must keep appropriate records of weed management in accordance with the regulations.
	Native tree removal must be avoided wherever possible and no mining-related infrastructure or activity to be placed in a position that will risk the current and future health of native trees. This includes the root zone of mature habitat trees.
	Trees exceeding 20 cm DBH should not be removed. In the event that tree removal cannot be avoided, it should be conducted with a qualified wildlife carer present and outside of arboreal mammal and bird breeding periods.
	Where vegetation clearing is required, all fallen timber is to be moved into adjacent vegetation, but not piled, where it may be available to use as habitat. Pre-existing fallen timber must not be used for other purposes.
	Do not permit opal prospecting or mining activities within aquatic GDE areas.
	DRNSW should compile a list of suppliers who can supply the required species seed or tube stock to be used in rehabilitation activities in addition to a list of appropriate species for revegetation. These lists should be appended to each mineral claim and opal prospecting licence.
	Prior to the release of rehabilitation bonds the site must meet acceptable vegetation condition thresholds, as determined by the DRNSW assessing officer.
	Increase the value of rehabilitation bonds to match the value (including inflation) of rehabilitation and monitoring. This will enable department to rehabilitate areas abandoned by proponents. Recommend use of BAM Total Fund Deposit calculator to ascertain future rehabilitation costs (DPIE 2022b). All mining equipment and infrastructure to be removed post mining activity prior to release of the bond.
Air Quality	Locate mining activities and communal mullock stockpiles as far away from homesteads as possible. Maintain landholder consent to operate on land within 200m of the principal homestead of a property.
	Minimise exposed surfaces in mining areas.
	Minimise size and number of communal mullock stockpiles.
	Minimise access roads and tracks and locate them as far away from homesteads as practicable.
	Utilise water sprays on exposed areas (including mullock stockpiles) and unsealed access roads during high-wind conditions and when visible dust is present.
	Minimise material handling and drop heights.

General aspect	Mitigation measure
	Operations (eg dumping) to be modified or ceased during excessively windy conditions.
	Apply water during material processing where appropriate to do so.
	Utilise cyclone and water injection on drills.
	Minimise vegetation disturbance to maintain vegetative screens where possible.
	Conduct progressive rehabilitation of disturbed areas.
	Increase value of rehabilitation bond the aim of ensuring successful rehabilitation is undertaken.
	Minimise truck travel speeds on unsealed access roads.
	Minimise truck idle time.
	Air quality monitoring (particulate matter and dust deposition) may also be a useful tool in the event that air quality complaints are received from surrounding homesteads. Additional mitigation may be applied where adverse air quality impacts are experienced.
Noise and vibration	Environmental awareness training and regular reinforcement (such as at toolbox talks) of the need to minimise noise and vibration.
	Review and implementation of feasible and reasonable mitigation measures that reduce mining noise levels.
	Orientation of activities, plant and equipment to assist in providing a level of acoustic shielding for adjacent occupied historic legacy mining leases.
	Develop routes for the delivery of materials and parking of vehicles to minimise noise.
	Where possible, avoid the use of equipment that generates impulsive noise.
	Notify residents prior to the commencement of intensive works that could impact them.
	Where possible, choose quieter plant and equipment based on the optimal power and size to most efficiently perform the required tasks.
	Operate plant and equipment in the quietest and most efficient manner.
	Regularly inspect and maintain plant and equipment to minimise noise and vibration level increases, to ensure that all noise and vibration reduction devices are operating effectively.
	Approximate noise reductions provided by some of these measures are provided below:

Noise control	Nominal noise reduction possible, in total A-weighted sound pressure level, dB
Increase source to receiver distance[1]	Approximately 6 dB for each doubling of distance
Reduce equipment operating times or turn off idling machinery[2]	Approximately 3 dB per halving of operating time
Operating training on quiet operation[2]	Up to 3 to 5 dB
Screening (eg noise barrier)[1]	Normally 5 dB to 10 dB, maximum 15 dB
Enclosure (eg shed/building)[1]	Normally 15 dB to 25 dB, maximum 50 dB
Silencing (eg exhaust mufflers) [1]	Normally 5 dB to 10 dB, maximum 20 dB

1. Sourced from AS2436-2010
2. Based on EMM's measurement experience at construction and mining sites

General aspect	Mitigation measure
Historic heritage	A field program should be devised in order to ground truth the identified historical sites to assess the condition, re-assess significance and identify any additional sites not identified during the desktop survey.
	An amended assessment of significance and impacts should be undertaken in accordance with the relevant government assessment requirements, guidelines and policies including the principal articles of the *Burra Charter* and the *Heritage Manual.*
	Prior to the opening up of Area 1 of the NWR to opal prospecting and mining activities, and prior to any work commencing, a historic heritage management plan (HHMP) should be prepared to guide the conservation of heritage items, unexpected finds and human remains including skeletal material, for the duration of the project. The HHMP should also identify where additional investigation is required. The relevant measures in the HHMP would be incorporated into conditions of granted Opal Prospecting Licences or Mineral Claims to avoid accidental impacts during the construction and operational phase of the project.
	The HHMP should include, as a minimum, the following: • all sites will be listed, along with their significance, approved actions and level of protection; • a table listing all management measures for each site; • figures to accompany and support the text; • a detailed unanticipated finds protocol – including information on when to enact it, potential timeframes and a contacts protocol; • a detailed archaeological research design for each potential archaeological site; • a detailed procedure for preparing the digital photographic archival record; and • a detailed procedure in the event that suspected human remains or burials are encountered. The HHMP should be prepared in accordance with the NSW Heritage Manual and should include (as an appendix), this report, along with the updated assessment of significance and impacts.
Aboriginal cultural heritage	To protect existing and potential Aboriginal heritage throughout Area 1 generous buffers were given to all previously identified cultural sites, places and deposits, and areas where they are predicted to occur. The methodology for protecting cultural heritage was formulated into a traffic light system, with different colours indicating potential risk and suggested mitigation measures needed. This tool acts as the risk assessment for any activity on the opal lease lots and is simplified in Appendix C.

General aspect	Mitigation measure
	The Aboriginal heritage constraints tool is utilised as follows: 1. No colour sensitivity: Land has been previously disturbed from both construction, mining and/or agricultural activities, or is in landforms deemed to be of limited cultural heritage sensitivity. The potential for cultural material to have survived is considered to be of low likelihood. Works may proceed without further assessment but should include the adoption of an unexpected finds procedures (below). 2. Green sensitivity: This category includes landforms of potential cultural heritage sensitivity. For these areas, a standardized buffer was applied to each landform (200 m for lakes and 50 m for all other features including watercourses, waterholes and traveling stock routes). These mapped locations represent areas where Aboriginal cultural heritage may be present (tangible and intangible heritage values). An activity specific due diligence assessment should be undertaken for all works proposed for these areas to determine the risk to cultural materials and whether further investigation is required prior to works occurring. 3. Yellow sensitivity: This category includes previously documented and/or AHIMS registered Aboriginal sites. Each site was given a 50 m buffer around the existing recorded site boundary or centroid. These buffers are expected to capture the extent of the registered AHIMS sites, as well as areas of archaeological subsurface potential. These areas should be avoided. If impacts are proposed, an approved Aboriginal Heritage Impact Permit (AHIP) (which involves consultation with the wider Aboriginal community as well as a program of archaeological and anthropological investigation) is required before works are allowed in these areas. 4. Orange sensitivity: This category was created for high significance previously documented and/or AHIMS registered Aboriginal heritage sites where accurate locational data does not exist. For Area 1 there is one site categorized as 'orange' - AHIMS #09-5-0008, a rock art site located in a cave. The site card does not provide enough detail to relocate this potentially rare and significant site accurately. In light of this, an orange buffer has been mapped to capture its possible location based on available information. A field survey with adequate Aboriginal consultation is required to confirm the location, nature, extent and significance of this site, and determine next steps. Given the general significance of these sites, a formal assessment would be required to suitably characterize and defined the cultural materials prior to determining whether a development activity is feasible, and an AHIP obtained prior to any potential disturbance. Given the high significance of these sites, it is likely that they would be re-classified as of red sensitivity through the above assessment process and the local Aboriginal community and/or Heritage NSW would reject any attempts at obtaining an AHIP for these locations. 5. Red sensitivity: This category reflects previously documented and/or AHIMS registered Aboriginal heritage sites that are considered to be of high heritage significance. A 50m buffer has been applied to all sites within this category. As areas identified as being within this category are of a high cultural and scientific significance, AHIPs authorizing impact to these sites are unlikely to be approved by the NSW Government and these areas should be avoided. Unexpected finds procedure: • All workers should be made aware of their obligations under the *NSW National Parks and Wildlife Act 1974*. A basic understanding of how to identify Aboriginal cultural heritage sites should be included in this training. • All permit holders should be made aware of the cultural sensitivity traffic light cultural heritage sensitivity system and the requirements for undertaking work or development in a given area. • In the event that previously unknown Aboriginal object(s) and/or sites are discovered during the proposed activity, all works must stop, and an appropriately qualified heritage specialist should be contacted to assess the nature, extent, and significance of the potential heritage sites. Notification should be provided to Heritage NSW once the nature of the potential heritage site has been confirmed. Works should not proceed without advice from Heritage NSW and/or an appropriately qualified heritage specialist. • In the unlikely event that human remains are discovered, all activities must stop, the affected area must be cordoned-off and NSW Police contacted. Where determined to be of Aboriginal ancestry, Heritage NSW must also be contacted on (02) 9873 8500.

General aspect	Mitigation measure
Public Safety	Develop Plan of Management for communal mullock stockpiles.
	All necessary controls should be implemented to minimise the potential for risks to public safety during all stages of opal prospecting and mining. This may include the erection and maintenance of fencing and warning signs around areas that have the potential to cause harm and that are accessible to the public.
	Include in mineral claims and opal prospecting licence conditions that no access to open shafts by the public is permissible, and appropriate controls, such as security fencing and signage or placement of temporary mesh coverings over open shafts must be erected.
	Open shafts should be backfilled and rehabilitated as soon as practicable following cessation of prospecting or mining activities.
	Tourism operators within the opal fields should be encouraged to attend the same safety inductions as opal prospectors and miners.
Contaminated land and waste management	All operational waste should be managed or disposed of appropriately and not illegally dumped or disposed within small scale title areas.
	Operations should adopt practices that do not permit the discharge of contaminants (ie oils, fuels and fluids) to the environment. This should include: • the storage of all flammable, combustible and hazardous chemicals must be in accordance with the relevant AS1940, including appropriate spill protection, bunding etc; • all vehicle, plant and equipment maintenance activities be completed in a manner which is non-polluting; and • all waste products such as chemicals, oils, fuels and contaminated material is to be disposed of at an appropriately licenced waste facility.
	Ensure communal waste depots are available proximate to Area 1 operations and includes general waste, recycling, scrap steel, and hydrocarbon disposal facilities. This will require further consultation with Walgett Council.
	Ensure residential claims are not permitted within Area 1 to reduce waste generation, and requirement for ablution and wastewater facilities.
	Sensitive environmental areas, such as wetlands and surface water systems, should be excluded from future mining/ prospecting activities to ensure contaminants do not enter these environments, this may include buffers or minimum distances for new titles.
	Ensure any chemicals, hydrocarbons or other hazardous substances are stored in accordance with the Australian Standard: *The Storage and Handling of Flammable and Combustible Liquids* (AS1940-2004) and the relevant Material Safety Data Sheet (MSDS) for the product(s).
	Ensure appropriate emergency spill response kits are located within work sites and refuelling areas.
	No discharge of contaminants (ie dirty water, oils, fuels and other fluids) to the environment is permitted. This may require education, support and guidance to operations, requirements within the title authorisation, regulatory inspections and enforcement.
Visual	Opal prospecting and opal mining should be prohibited in areas where mullock stockpiling has serious and unacceptable visual impacts which cannot be readily mitigated.
	Opal prospecting and opal mining should be 'setback' from receptors, as per Table 7.1 of the VIA.
	Follow rehabilitation recommendations. Ensure mullock is preferentially buried at depth and topsoil is reapplied to the surface.
	Increase value of rehabilitation bond.

General aspect	Mitigation measure
	Consider two-tiered security deposit: • refundable bond for completion of rehabilitation to DRNSW standards; and • refundable bond for formal notification to DRNSW that the mineral claim or opal prospecting licence cancelled. Both bonds would be surrendered if the claim/licence holder abandons the title.
	Limit operations to daylight hours only. In the event that evening and night-time operations are permissible at surface level: • restrict surface lighting to the minimum required for operational and safety requirements; • use unidirectional lighting techniques; and • use light shields to limit the spill of lighting.
Roads, traffic and access	Minimise the creation of new, or temporary tracks.
	Minimise site vehicle travel speeds to avoid dust pollution on adjacent vegetation.
	Designation of access tracks to work sites for the delivery of materials and parking of vehicles to minimise noise and disturbance areas.
	Minimise travel along unsealed access tracks during wet weather.
Social and economic	Ongoing monitoring of identified social risks to ensure the assumptions of this assessment are correct. This would allow for reassessment of potential impacts and their mitigation measures as required and appropriate.
	Additional consultation and engagement by the DRNSW with local emergency service representatives, Aboriginal and/or Torres Strait Islander groups, workshops with local businesses and service providers.
	Develop a mitigation and management plan that addresses the identified impacts. Recommended mitigation and management measures are provided as follows:
	a) To enhance the potential community benefits, is it recommended that sponsorship is explored for established community events and festivals in the area, such as the Lightning Ridge Opal Festival and the Lightning Ridge Easter Festival to ensure they thrive and continue to drive a sense of community and community mindedness. In supporting these community events, the local economy will be bolstered through the increase in tourism they provide.
	b) The DRNSW liaise with public landholders to facilitate dedicated fossicking sites for tourists and locals to enhance the tourism already increased through additional opal activity in the area.
	c) The DRNSW liaise with relevant housing providers and regulators, such as local councils, to encourage greater accommodation capacity for a potential increase in tourism and resident population.
	d) An assessment of risks or gaps in emergency service responses, preferably in consultation with representatives from local emergency services.
	e) Explore working with both Walgett Shire Council and Brewarrina Council to establish rural addressing for mining claims, including appropriate roads, tracking and signage to ensure an accurate and standardised system for emergency services to access rural mining claims.
	f) Signage around mining claims is increased to deter members of the public from entering unsafe and unattended mining sites.
	g) Improved workplace health and safety management is implemented on mining claims, particularly emphasising the need for increased personal protective equipment (PPE) to reduce the impacts of silica dust on lung health.
	h) A notification system is explored in which land and lease holders are notified about miners whereabouts thereby reducing risk when pest management is being carried out.

General aspect	Mitigation measure
	i) Advisable that DRNSW liaise with relevant public authorities to implement a more comprehensive mitigation plan to mitigate the risk of Hudson pear spreading through mining activities.
	j) Advisable that the DRNSW liaise with relevant public authorities to increase levels of compliance towards the preventative measures to limit the spread of Hudson pear and implement sanctions should compliance not be met.
	k) Mining rehabilitation practices and rehabilitation compliance is improved to ensure environmental protection and agricultural land quality and maintenance.
	l) A bond system is explored whereby miners pay a bond to the relevant licensing authority to ensure that adequate rehabilitation practices are followed; this is to enable accountability and to protect agricultural livelihoods.
	m) The DRNSW explores putting boundary agreements in place for mining claims so that impacts on agricultural activities and enterprises is limited.
	n) DRNSW consider alternatives for the management of mullock, such as communal mullock heaps, to mitigate erosion effects on the surroundings, agricultural properties and agricultural livelihoods.
	o) It is recommended that the DRNSW consider having greater transparency surrounding sub-divisions and allotments of mining claims through exploring the implementation of an online searchable register.
Cumulative effects	Prior to the granting of mineral claims and opal prospecting licences, the number and location of existing claims and licences and the potential associated cumulative impacts should be considered by the assessing officer.
	Cumulative impacts can be managed by the implementation of the mitigation measures outlined within this table.
Climate change	Minimise clearing of vegetation.
	Restore or rehabilitate areas which have suffered historic vegetation loss.
	Upon rehabilitation, the site should be revegetated with an appropriate selection of heat tolerant or drought resistant species.
	At underground mine site, retain vegetation at the surface to mitigation against heat stress.
	Preference should, over time, bias towards opal mining processes which minimise water reliance or consumption.
	In circumstances of extreme heat, some opal miners may seek to reschedule activities to night-time when temperatures are generally cooler. If undertaken at night, these activities may however introduce countervailing issues such as acoustic pacts on sensitive receptors in some locations. Consideration of adaptation responses should therefore be cognisant of potential adverse impacts elsewhere.
	DRNSW may consider discussions with local councils and state authorities regarding long term water supply constraints and opportunities for opal prospecting and opal mining.
Land use conflict	Neighbour relations in the context of opal mining and agricultural activities could consider the range of options identified in the *NSW Government Right to Farm Policy* (DPI 2015). While this policy was developed for a different set of neighbour relations, some of the proposed responses can be adapted for the purposes of managing neighbour relations in Area 1. Those tools include: • improving education and awareness; • reinforcing rights and responsibilities; and • establishing a baseline for on-going monitoring and evaluation.

General aspect	Mitigation measure
Mullock	Mullock should be stockpiled separately from topsoil and should not be spread across the completed operation as this has the potential to inhibit vegetation from re-establishing.
	Mullock waste must be preferentially disposed at depth through shaft backfilling or placement in the bottom of open-cut voids.
	Mullock disposal at the surface should be minimised, ameliorated (where required) and covered with topsoil to support vegetation establishment. Similar management measures should apply to dried and consolidated wet puddling material, and dry puddling.
	Mullock waste should be managed in a manner which mitigates risks to the surrounding environment. This may include drainage management to control and capture stormwater run-off, such as sediment dams and retention basins.
Communal mullock stockpiles	A specific plan of management for communal mullock stockpiles should be developed which identifies environmental and safety risks associated with the stockpiles, and proposed management and mitigation measures, including sediment and erosion controls, safety controls such as security fencing, training associated with the risks and management of mullock, and structural restrictions (eg height and width restrictions). The management plan should also account for the timely and effective rehabilitation of mullock stockpiles, and accountability, such as contribution to a rehabilitation fund by all mineral claim or opal prospecting licence holders.
	Communal mullock stockpiles should be positioned in close proximity to mineral claims and opal prospecting licences to reduce traffic and air quality impacts associated with the transportation of mullock and located away from sensitive receivers.

8 Conclusion

8.1 Duty to consider the environmental impact of the activities

Section 5.5 of the EP&A Act outlines the duty of determining authorities to consider the environmental impact of an activity.

Specifically, that section states:

> (1) For the purpose of attaining the objects of this Act relating to the protection and enhancement of the environment, a determining authority in its consideration of an activity shall, notwithstanding any other provisions of this Act or the provisions of any other Act or of any instrument made under this or any other Act, examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity.
>
> (2) (Repealed)
>
> (3) Without limiting subsection (1), a determining authority shall consider the effect of an activity on any wilderness area (within the meaning of the *Wilderness Act 1987*) in the locality in which the activity is intended to be carried on.

Subsection 5.5(1) of the EP&A Act is discharged by this REF.

With reference to Subsection 5.5(3), the activities will not have an impact on any wilderness areas.

8.2 Is an environmental impact statement required?

Section 5.7 of the EP&A Act requires a decision by a determining authority as to whether granting an approval in relation to these activities is likely to *significantly affect the environment*.

If the activities are likely to significantly affect the environment, then the determining authority must obtain or be furnish with, and have examined and considered, and environmental impact statement (EIS) in relation to the activities.

It is important to note that this REF is not an assessment of any decision by DRNSW or other public authority to make available any land within Area 1 for opal prospecting and mining. The REF may inform such a decision, however the actual decision to 'open up' land from a policy perspective is not an *activity* pursuant to Division 5.1 of Part 5 of the EP&A Act. It is the action of issuing an approval, in the form of a licence or lease, that triggers Part 5.

The finding of this REF is that:

- if the granting of a licence or lease within Area 1 pertains only to land which is not shown as constrained by any technical assessment;
- if the conditions attached to those licences or leases reflect the relevant mitigation measures listed in Table 7.1; and
- if the recommendations in the REF regarding further research, assessment and ongoing engagement do not identify additional risks of adverse impact then the activities are not likely to significantly affect the environment.

9 Statement of commitments

The REF must include a consolidated summary statement of any commitments.

The statement of commitments must be consistent with the content of the REF. The statement of commitments shall describe the measures for management, mitigation and monitoring of impacts of the activity.

If the Statement of Commitments is inadequate to define and constrain the potential impacts of the activity, an EIS may be required, or relevant approval terms may be imposed at the discretion of the Department.

The commitments may, for example, include:

- Imposition of conditions consistent with the recommended mitigation measures.
- Consultation with Aboriginal community, or heritage field work, prior to opening up Area 1.
- Variations to the size of mineral claims.
- Additional investigations.
- Increase cost of rehab bonds.
- Resourcing/staffing.
- Environmental levy.
- Rationalisation of tracks.
- Mullock stockpile management.

References

References appearing in the main body of the REF only

Brewarrina Shire Council (2017) *Community Strategic Plan Brewarrina Shire 2026*

Brewarrina Shire Council (2020) *Local strategic planning statement*

State of NSW, Department of Primary Industries (2013) *New South Wales Biodiversity Strategy 2013-2021*

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State of NSW, Department of Planning and Environment (2020) *Statewide landcover and tree study 2018*

State of NSW, Local Land Services (2017) *North West Regional Strategic Weed management Plan 2017-2022*

State of NSW, Office of Environment and Heritage (2014) *Far West Climate Change Snapshot*

State of NSW, Resources Regulator (2018) *ESG2: Guideline for Preparing a Review of Environmental Factors*

State of NSW, Resources Regulator (2022) *Environmental management and rehabilitation at Lightning Ridge* (https://www.resourcesregulator.nsw.gov.au/rehabilitation/opal-mining/environmental-management-and-rehabilitation-at-lightning-ridge)

Walgett Shire Council (2017) Walgett Shire Council Community Strategic Plan 2017-2027

Walgett Shire Council (2020) Local strategic planning statement

Case law

State of NSW, Land and Environment Court - *Bushfire Survivors for Climate Action Incorporated v Environment Protection Authority* [2021] NSWLEC 92

References appearing in full technical reports (Appendices)

Please refer to the reference lists in the relevant technical assessment in the Appendices.


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