Australian Government

BIOREGIONAL ASSESSMENTS

PROVIDING SCIENTIFIC WATER RESOURCE INFORMATION ASSOCIATED WITH COAL SEAM GAS AND LARGE COAL MINES

Description of the water-dependent asset register for the Pedirka subregion

Product 1.3 for the Pedirka subregion from the Lake Eyre Basin Bioregional Assessment

11 November 2015

A scientific collaboration between the Department of the Environment, Bureau of Meteorology, CSIRO and Geoscience Australia

The Bioregional Assessment Programme

The Bioregional Assessment Programme is a transparent and accessible programme of baseline assessments that increase the available science for decision making associated with coal seam gas and large coal mines. A bioregional assessment is a scientific analysis of the ecology, hydrology, geology and hydrogeology of a bioregion with explicit assessment of the potential direct, indirect and cumulative impacts of coal seam gas and large coal mining development on water resources. This Programme draws on the best available scientific information and knowledge from many sources, including government, industry and regional communities, to produce bioregional assessments that are independent, scientifically robust, and relevant and meaningful at a regional scale.

The Programme is funded by the Australian Government Department of the Environment. The Department of the Environment, Bureau of Meteorology, CSIRO and Geoscience Australia are collaborating to undertake bioregional assessments. For more information, visit http://www.bioregionalassessments.gov.au.

Department of the Environment

The Office of Water Science, within the Australian Government Department of the Environment, is strengthening the regulation of coal seam gas and large coal mining development by ensuring that future decisions are informed by substantially improved science and independent expert advice about the potential water related impacts of those developments. For more information, visit http://www.environment.gov.au/coal-seam-gas-mining/.

Bureau of Meteorology

The Bureau of Meteorology is Australia's national weather, climate and water agency. Under the *Water Act 2007*, the Bureau is responsible for compiling and disseminating Australia's water information. The Bureau is committed to increasing access to water information to support informed decision making about the management of water resources. For more information, visit http://www.bom.gov.au/water/.

CSIRO

Australia is founding its future on science and innovation. Its national science agency, CSIRO, is a powerhouse of ideas, technologies and skills for building prosperity, growth, health and sustainability. It serves governments, industries, business and communities across the nation. For more information, visit http://www.csiro.au.

Geoscience Australia

Geoscience Australia is Australia's national geoscience agency and exists to apply geoscience to Australia's most important challenges. Geoscience Australia provides geoscientific advice and information to the Australian Government to support current priorities. These include contributing to responsible resource development; cleaner and low emission energy technologies; community safety; and improving marine planning and protection. The outcome of Geoscience Australia's work is an enhanced potential for the Australian community to obtain economic, social and environmental benefits through the application of first class research and information. For more information, visit http://www.ga.gov.au.

ISBN-PDF 978-1-925315-24-0

Citation

Sparrow A, Raisbeck-Brown N and Wang J (2015) Description of the water-dependent asset register for the Pedirka subregion. Product 1.3 for the Pedirka subregion from the Lake Eyre Basin Bioregional Assessment. Department of the Environment, Bureau of Meteorology, CSIRO and Geoscience Australia, Australia. http://data.bioregionalassessments.gov.au/product/LEB/PED/1.3.

Authorship is listed in relative order of contribution.

Copyright

Disclaimer

The information contained in this report is based on the best available information at the time of publication. The reader is advised that such information may be incomplete or unable to be used in any specific situation. Therefore decisions should not be made based solely on this information or without seeking prior expert professional, scientific and technical advice.
The Bioregional Assessment Programme is committed to providing web accessible content wherever possible. If you are having difficulties with accessing this document please contact bioregionalassessments@bom.gov.au.

Cover photograph

Eringa waterhole in the Macumba catchment, SA. April 2013

Credit: Catherine Miles (Miles Environmental Consulting)

Australian Government
Department of the Environment
Bureau of Meteorology
Geoscience Australia

CSIRO

Contents

Figures

Tables

Contributors to the Technical Programme

The following individuals have contributed to the Technical Programme, the part of the Bioregional Assessment Programme that undertakes bioregional assessments.

Role or team	Contributor(s)
Assistant Secretary	Department of the Environment: Matthew Whitfort
Programme Director	Department of the Environment: Anthony Swirepik
Technical Programme Director	Bureau of Meteorology: Bronwyn Ray
Projects Director	CSIRO: David Post
Principal Science Advisor	Department of the Environment: Peter Baker
Science Directors	CSIRO: Brent Henderson Geoscience Australia: Steven Lewis
Integration Lead	Bureau of Meteorology: Richard Mount
Programme management	Bureau of Meteorology: Graham Hawke, Louise Minty CSIRO: Paul Hardisty, Warwick McDonald Geoscience Australia: Stuart Minchin
Project Leaders	CSIRO: Alexander Herr, Tim McVicar, David Rassam Geoscience Australia: Hashim Carey, Kriton Glenn, Tim Evans, Martin Smith Bureau of Meteorology: Natasha Herron
Assets and receptors	Bureau of Meteorology: Richard Mount (Discipline Leader), Eliane Prideaux Department of the Environment: Larry Guo, Glenn Johnstone, Brad Moore, Wasantha Perera, Jin Wang
Bioregional Assessment Information Platform	Bureau of Meteorology: Lakshmi Devanathan (Team Leader), Derek Chen, Trevor Christie-Taylor, Melita Dahl, Angus MacAulay, Christine Panton, Paul Sheahan, Kellie Stuart, Carl Sudholz CSIRO: Peter Fitch Department of the Environment: Geraldine Cusack Geoscience Australia: Neal Evans
Communications	Bureau of Meteorology: Karen de Plater CSIRO: Chris Gerbing Department of the Environment: Lea Locke, Milica Milanja Geoscience Australia: Chris Thompson
Coordination	Bureau of Meteorology: Julie Burke, Sarah van Rooyen CSIRO: Ruth Palmer Department of the Environment: James Hill, Angela Kaplish, Megan Stanford, Craig Watson Geoscience Australia: Tenai Luttrell
Ecology	CSIRO: Anthony O'Grady (Discipline Leader), Tanya Doody, Brendan Ebner, Kate Holland, Craig MacFarlane, Patrick Mitchell, Justine Murray, Chris Pavey, Jodie Pritchard, Nat Raisbeck-Brown, Ashley Sparrow, Georg Wiehl

Role or team	Contributor(s)
Geology	CSIRO: Deepak Adhikary, Luke Connell, Emanuelle Frery, Jane Hodgkinson, James Kear, Manoj Khanal, Zhejun Pan, Kaydy Pinetown, Matthias Raiber, Hayley Rohead-O'Brien, Regina Sander, Peter Schaubs, Garth Warren, Paul Wilkes, Andrew Wilkins, Yanhua Zhang Geoscience Australia: Steven Lewis (Discipline Leader), Stephen Hostetler, Bruce Radke
Geographic information systems	CSIRO: Caroline Bruce, Jody Bruce, Steve Marvanek, Arthur Read Geoscience Australia: Adrian Dehelean
Groundwater modelling	CSIRO: Russell Crosbie (Discipline Leader), Olga Barron, Tao Cui, Warrick Dawes, Lei Gao, Sreekanth Janardhanan, Luk Peeters, Praveen Kumar Rachakonda, Wolfgang Schmid, Saeed Torkzaban, Chris Turnadge, Binzhong Zhou
Hydrogeology	CSIRO: Konrad Miotlinski Geoscience Australia: Tim Ransley (Discipline Leader), Rebecca Cassel, Steven Hostetler, Jim Kellett, Jessica Northey, Baskaran Sundaram, Gabrielle Yates
Information management	Bureau of Meteorology: Brendan Moran (Team Leader), Belinda Allison, Jill McNamara, Suzanne Slegers CSIRO: Nick Car, Phil Davies, Andrew Freebairn, Mick Hartcher, Geoff Hodgson, Brad Lane, Ben Leighton, Trevor Pickett, Ramneek Singh, Matt Stenson Geoscience Australia: Luke Caruana, Matti Peljo
Products	CSIRO: Becky Schmidt (Products Manager), Maryam Ahmad, Daniel Aramini, Clare Brandon, Heinz Buettikofer, Sonja Chandler, Simon Gallant, Karin Hosking, Frances Marston, Linda Merrin, Sally Tetreault-Campbell, Catherine Ticehurst Geoscience Australia: Penny Kilgour, Kathryn Owen
Risk and uncertainty	CSIRO: Simon Barry (Discipline Leader), Jeffery Dambacher, Jess Ford, Keith Hayes, Geoff Hosack, Yang Liu, Warren Jin, Dan Pagendam, Carmel Pollino
Surface water hydrology	CSIRO: Neil Viney (Discipline Leader), Santosh Aryal, Mat Gilfedder, Fazlul Karim, Lingtao Li, Dave McJannet, Jorge Luis Peña-Arancibia, Xiaogang Shi, Tom Van Niel, Bill Wang, Ang Yang, Yongqiang Zhang

Acknowledgements

This technical product was reviewed by several groups:

- Discipline Leaders: Steven Lewis (geology, Geoscience Australia), Richard Mount (assets, Bureau of Meteorology), Anthony O'Grady (ecology, CSIRO)
- Senior Science Leaders: David Post (Projects Director), Steven Lewis (Science Director, Geoscience Australia), Brent Henderson (Science Director, CSIRO), Maryam Ahmad (Deputy Products Manager, CSIRO)
- Technical Assurance Reference Group: Chaired by Peter Baker (Principal Science Advisor, Department of the Environment), this group comprises officials from the NSW, Queesland, South Australian and Victorian governments.
- DEWNR: Daniel Rogers (Principal Ecologist), Lloyd Sampson (Principal Hydrogeologist), Kumar Savadamuthu (Principal Hydrologist)
- Justin Costelloe (Research Fellow, University of Melbourne).

Valuable comments were also provided by Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC).

The South Australian Department of Environment, Water and Natural Resources (DEWNR) delivered the contextual statements to the OWS as part of its Coal Seam Gas and Coal Mining Water Knowledge program which consisted of three projects: Lake Eyre Basin Rivers Monitoring; Lake Eyre Basin Springs Assessment; and Arckaringa and Pedirka Groundwater Investigations. Technical advice to these projects was provided through reference committees comprising representatives as appropriate of: Bureau of Meteorology; CSIRO Land and Water; Department for Land and Resource Management (NT); Department of Natural Resources and Mines (QLD); Department of Environment Water and Natural Resources (SA); Department of Science, Information Technology, Innovation, and the Arts (QLD); Department of State Development (SA); Flinders University; Geoscience Australia; Goyder Institute for Water Research; Lake Eyre Basin Community Advisory Committee; Lake Eyre Basin Rivers Assessment, Department of the Environment; SA Arid Lands Natural Resources Management Board; South Australian Research and Development Institute; The University of Adelaide.

Introduction

The Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) was established to provide advice to the federal Minister for the Environment on potential water-related impacts of coal seam gas (CSG) and large coal mining developments.

Bioregional assessments (BAs) are one of the key mechanisms to assist the IESC in developing this advice so that it is based on best available science and independent expert knowledge. Importantly, technical products from BAs are also expected to be made available to the public, providing the opportunity for all other interested parties, including government regulators, industry, community and the general public, to draw from a single set of accessible information. A BA is a scientific analysis, providing a baseline level of information on the ecology, hydrology, geology and hydrogeology of a bioregion with explicit assessment of the potential direct, indirect and cumulative impacts of CSG and coal mining development on water resources.

The IESC has been involved in the development of *Methodology for bioregional assessments of the impacts of coal seam gas and coal mining development on water resources* (the BA methodology; Barrett et al., 2013) and has endorsed it. The BA methodology specifies how BAs should be undertaken. Broadly, a BA comprises five components of activity, as illustrated in Figure 1. Each BA will be different, due in part to regional differences, but also in response to the availability of data, information and fit-for-purpose models. Where differences occur, these are recorded, judgments exercised on what can be achieved, and an explicit record is made of the confidence in the scientific advice produced from the BA.

The Bioregional Assessment Programme

The Bioregional Assessment Programme is a collaboration between the Department of the Environment, the Bureau of Meteorology, CSIRO and Geoscience Australia. Other technical expertise, such as from state governments or universities, is also drawn on as required. For example, natural resource management groups and catchment management authorities identify assets that the community values by providing the list of water-dependent assets, a key input.

The Technical Programme, part of the Bioregional Assessment Programme, will undertake BAs for the following bioregions and subregions:

- the Galilee, Cooper, Pedirka and Arckaringa subregions, within the Lake Eyre Basin bioregion
- the Maranoa-Balonne-Condamine, Gwydir, Namoi and Central West subregions, within the Northern Inland Catchments bioregion
- the Clarence-Moreton bioregion
- the Hunter and Gloucester subregions, within the Northern Sydney Basin bioregion
- the Sydney Basin bioregion
- the Gippsland Basin bioregion.

Technical products (described in a later section) will progressively be delivered throughout the Programme.

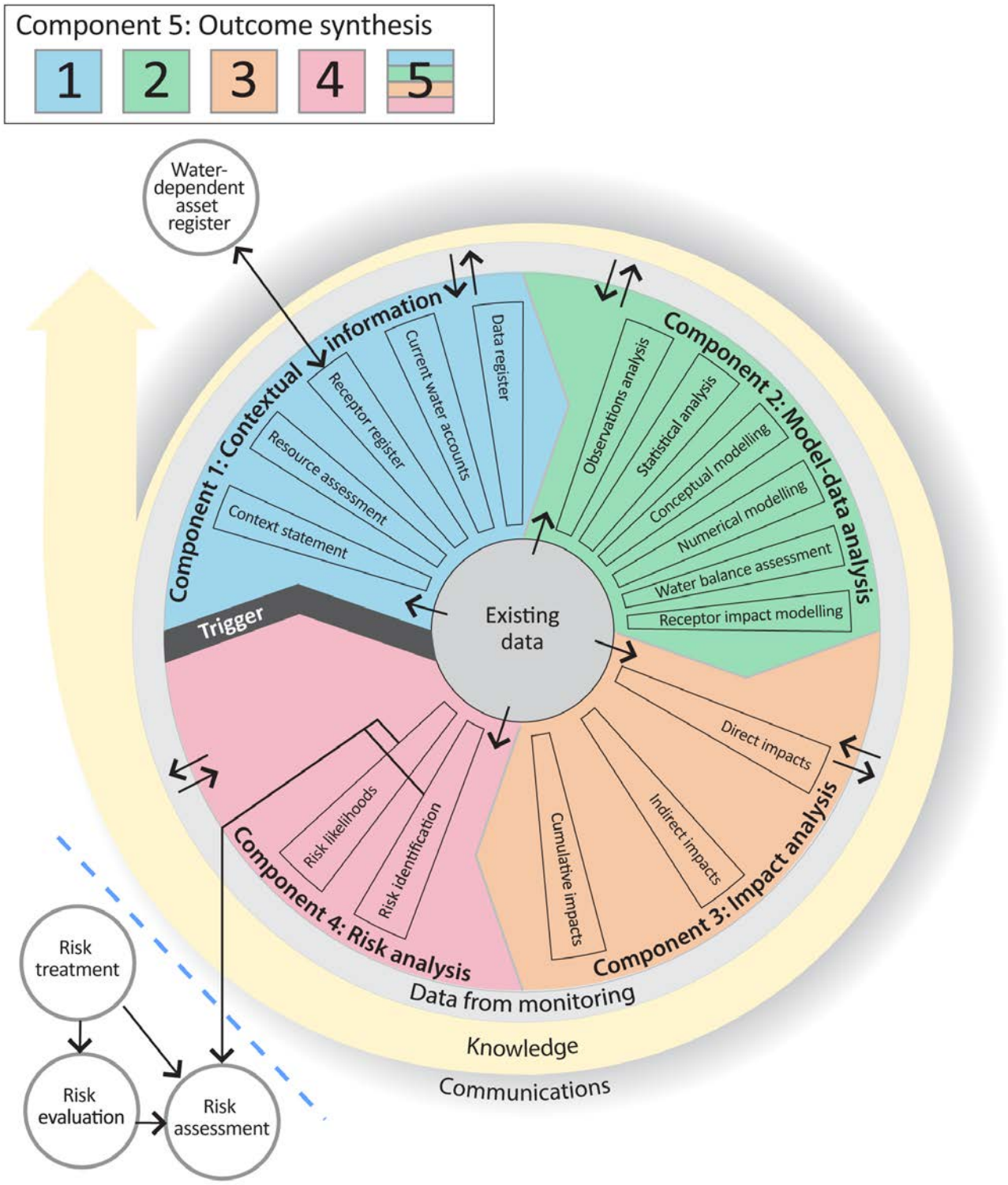


Figure 1 Schematic diagram of the bioregional assessment methodology

The methodology comprises five components, each delivering information into the bioregional assessment and building on prior components, thereby contributing to the accumulation of scientific knowledge. The small grey circles indicate activities external to the bioregional assessment. Risk identification and risk likelihoods are conducted within a bioregional assessment (as part of Component 4) and may contribute activities undertaken externally, such as risk evaluation, risk assessment and risk treatment. Source: Figure 1 in Barrett et al. (2013), © Commonwealth of Australia

Methodologies

For transparency and to ensure consistency across all BAs, submethodologies have been developed to supplement the key approaches outlined in the *Methodology for bioregional assessments of the impact of coal seam gas and coal mining development on water resources* (Barrett et al., 2013). This series of submethodologies aligns with technical products as presented in Table 1. The submethodologies are not intended to be 'recipe books' nor to provide step-by-step instructions; rather they provide an overview of the approach to be taken. In some instances, methods applied for a particular BA may need to differ from what is proposed in the submethodologies – in this case an explanation will be supplied. Overall, the submethodologies are intended to provide a rigorously defined foundation describing how BAs are undertaken.

Table 1 Methodologies and associated technical products listed in Table 2

Code	Proposed title	Summary of content	Associated technical product
M01	*Methodology for bioregional assessments of the impacts of coal seam gas and coal mining development on water resources*	A high-level description of the scientific and intellectual basis for a consistent approach to all bioregional assessments	All
M02	*Compiling water-dependent assets*	Describes the approach for determining water-dependent assets	1.3 Description of the water-dependent asset register
M03	*Assigning receptors and impact variables to water-dependent assets*	Describes the approach for determining receptors associated with water-dependent assets	1.4 Description of the receptor register
M04	*Developing a coal resource development pathway*	Specifies the information that needs to be collected and reported in product 1.2 (i.e. known coal and coal seam gas resources as well as current and potential resource developments). Describes the process for determining the coal resource development pathway (reported in product 2.3)	1.2 Coal and coal seam gas resource assessment 2.3 Conceptual modelling
M05	*Developing the conceptual model for causal pathways*	Describes the development of the conceptual model for causal pathways, which summarises how the 'system' operates and articulates the links between coal resource developments and impacts on receptors	2.3 Conceptual modelling
M06	*Surface water modelling*	Describes the approach taken for surface water modelling across all of the bioregions and subregions. It covers the model(s) used, as well as whether modelling will be quantitative or qualitative.	2.6.1 Surface water numerical modelling
M07	*Groundwater modelling*	Describes the approach taken for groundwater modelling across all of the bioregions and subregions. It covers the model(s) used, as well as whether modelling will be quantitative or qualitative. It also considers surface water – groundwater interactions, as well as how the groundwater modelling is constrained by geology.	2.6.2 Groundwater numerical modelling

Code	Proposed title	Summary of content	Associated technical product
M08	*Receptor impact modelling*	Describes how to develop the receptor impact models that are required to assess the potential impacts from coal seam gas and large coal mining on receptors. Conceptual, semi-quantitative and quantitative numerical models are described.	2.7 Receptor impact modelling
M09	*Propagating uncertainty through models*	Describes the approach to sensitivity analysis and quantifying uncertainty in the modelled hydrological response to coal and coal seam gas development	2.3 Conceptual modelling 2.6.1 Surface water numerical modelling 2.6.2 Groundwater numerical modelling 2.7 Receptor impact modelling
M10	*Risk and cumulative impacts on receptors*	Describes the process to identify and analyse risk	3 Impact analysis 4 Risk analysis
M11	*Hazard identification*	Describes the process to identify potential water-related hazards from coal and coal seam gas development	2 Model-data analysis 3 Impact analysis 4 Risk analysis
M12	*Fracture propagation and chemical concentrations*	Describes the likely extent of both vertical and horizontal fractures due to hydraulic stimulation and the likely concentration of chemicals after production of coal seam gas	2 Model-data analysis 3 Impact analysis 4 Risk analysis

Each submethodology is available online at http://www.bioregionalassessments.gov.au. Submethodologies might be added in the future.

Technical products

The outputs of the BAs include a suite of technical products variously presenting information about the ecology, hydrology, hydrogeology and geology of a bioregion and the potential direct, indirect and cumulative impacts of CSG and coal mining developments on water resources, both above and below ground. Importantly, these technical products are available to the public, providing the opportunity for all interested parties, including community, industry and government regulators, to draw from a single set of accessible information when considering CSG and large coal mining developments in a particular area.

The information included in the technical products is specified in the BA methodology. Figure 2 shows the information flow within a BA. Table 2 lists the content provided in the technical products, with cross-references to the part of the BA methodology that specifies it. The red rectangles in both Figure 2 and Table 2 indicate the information included in this technical product.

This technical product is delivered as a report (PDF). Additional material is also provided, as specified by the BA methodology:

- all unencumbered data syntheses and databases
- unencumbered tools, model code, procedures, routines and algorithms
- unencumbered forcing, boundary condition, parameter and initial condition datasets
- the workflow, comprising a record of all decision points along the pathway towards completion of the BA, gaps in data and modelling capability, and provenance of data.

The PDF of this technical product, and the additional material, are available online at http://www.bioregionalassessments.gov.au.

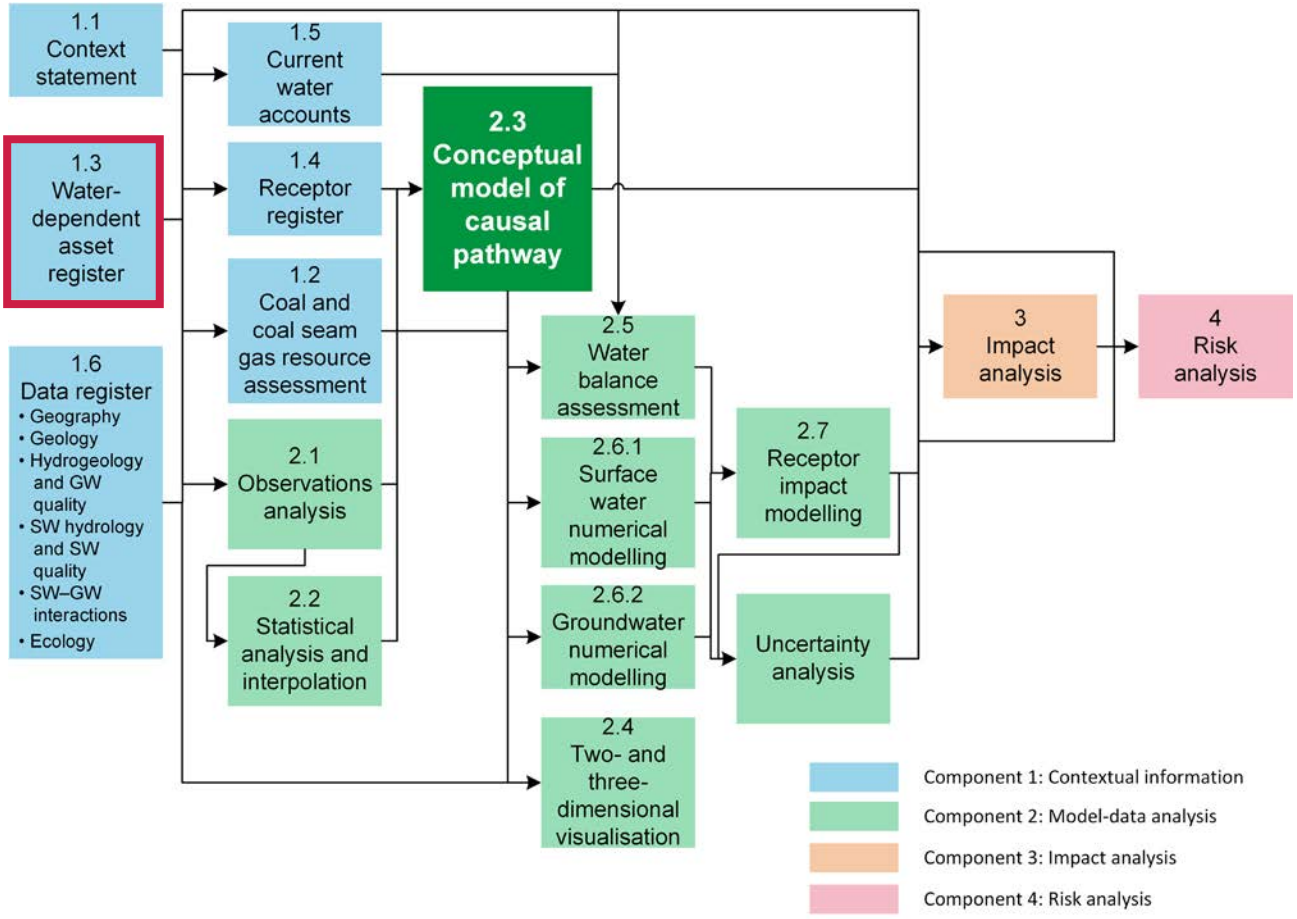


Figure 2 The simple decision tree indicates the flow of information through a bioregional assessment

The red rectangle indicates the information included in this technical product.

Table 2 Technical products delivered by the Lake Eyre Basin Bioregional Assessment

For each subregion in the Lake Eyre Basin Bioregional Assessment, technical products are delivered online at http://www.bioregionalassessments.gov.au, as indicated in the 'Type' column[a]. Other products – such as datasets, metadata, data visualisation and factsheets – are provided online.

Component	Product code	Title	Section in the BA methodology[b]	Type[a]
Component 1: Contextual information for the Pedirka subregion	1.1	Context statement	2.5.1.1, 3.2	PDF, HTML
	1.2	Coal and coal seam gas resource assessment	2.5.1.2, 3.3	Cross-reference
	1.3	Description of the water-dependent asset register	2.5.1.3, 3.4	PDF, HTML, register
	1.4	Description of the receptor register	2.5.1.4, 3.5	Cross-reference
	1.5	Current water accounts and water quality	2.5.1.5	Cross-reference
	1.6	Data register	2.5.1.6	Register
Component 2: Model-data analysis for the Pedirka subregion	2.1-2.2	Observations analysis, statistical analysis and interpolation	2.5.2.1, 2.5.2.2	Cross-reference
	2.3	Conceptual modelling	2.5.2.3, 4.3	PDF, HTML
	2.5	Water balance assessment	2.5.2.4	Cross-reference
	2.6.1	Surface water numerical modelling	4.4	Not produced
	2.6.2	Groundwater numerical modelling	4.4	Cross-reference
	2.7	Receptor impact modelling	2.5.2.6, 4.5	Not produced
Component 3: Impact analysis for the Pedirka subregion	3-4	Impact analysis	5.2.1	PDF, HTML
Component 4: Risk analysis for the Pedirka subregion		Risk analysis	2.5.4, 5.3	
Component 5: Outcome synthesis for the Lake Eyre Basin bioregion	5	Outcome synthesis	2.5.5	PDF, HTML

aThe types of products are as follows:
- 'PDF' indicates a PDF document that is developed by the Lake Eyre Basin Bioregional Assessment using the structure, standards, and look and feel specified by the programme.
- 'HTML' indicates the same content as in the PDF document, but delivered as webpages.
- 'Register' indicates controlled lists that are delivered using a variety of formats as appropriate.
- 'Cross-reference' indicates material that does not use the same structure, standards, and look and feel specified by the programme. This material is typically developed externally or through aligned research projects funded by the Department of the Environment. A webpage links to this material and explain how it fits into the Assessment.
- 'Not produced' indicates that the product was not developed. A webpage explains why and points to relevant submethodologies (Table 1).

bMethodology for bioregional assessments of the impacts of coal seam gas and coal mining development on water resources (Barrett et al., 2013)

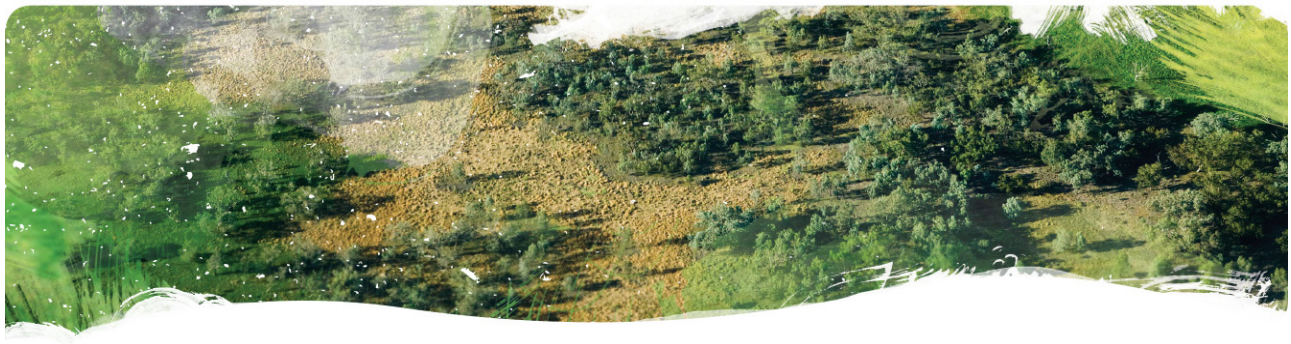
About this technical product

The following notes are relevant only for this technical product.

- All reasonable efforts were made to provide all material under a Creative Commons Attribution 3.0 Australia Licence.
- All maps created as part of this BA for inclusion in this product used the Albers equal area projection with a central meridian of 140.0° East for the Lake Eyre Basin bioregion and two standard parallels of –18.0° and –36.0°.
- Contact bioregionalassessments@bom.gov.au to access metadata (including copyright, attribution and licensing information) for all datasets cited or used to make figures in this product. At a later date, this information, as well as all unencumbered datasets, will be published online.
- The citation details of datasets are correct to the best of the knowledge of the Bioregional Assessment Programme at the publication date of this product. Readers should use the hyperlinks provided to access the most up-to-date information about these data; where there are discrepancies, the information provided online should be considered correct. The dates used to identify Bioregional Assessment Source Datasets are the dataset's published date. Where the published date is not available, the last updated date or created date is used. For Bioregional Assessment Derived Datasets, the created date is used.

References

Barrett DJ, Couch CA, Metcalfe DJ, Lytton L, Adhikary DP and Schmidt RK (2013) Methodology for bioregional assessments of the impacts of coal seam gas and coal mining development on water resources. A report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment. Department of the Environment, Australia. Viewed 19 January 2016, http://www.iesc.environment.gov.au/publications/methodology-bioregional-assessments-impacts-coal-seam-gas-and-coal-mining-development-water.



1.3 Description of the water-dependent asset register for the Pedirka subregion

A water-dependent asset has a particular meaning for bioregional assessments; it is an asset potentially impacted by changes in groundwater and/or surface water due to coal or coal seam gas development. Some ecological assets solely depend on incident rainfall and will not be considered as water dependent if evidence does not support a linkage to groundwater or surface water.

This product describes water-dependent assets that have been identified in the bioregional assessment and are listed in the water-dependent asset register (available at http://data.bioregionalassessments.gov.au/product/LEB/PED/1.3).

1.3.1 Methods

Summary

The water-dependent asset register described in this report is a list of water-dependent assets identified for the bioregional assessment (BA) of the Pedirka subregion. This section details the specific implementation to the Pedirka subregion of methods described in the companion submethodology M02 (as listed in Table 1) for compiling water-dependent assets (Mount et al., 2015).

The methods covered include: the process of nomination and collation of different groups of assets, the determination of the preliminary assessment extent (PAE) for the Pedirka subregion, the approach to determine water dependency based upon multiple lines of evidence (including literature, remote sensing data and available mapping), and the development and compilation of the water-dependent asset register.

The asset list for the Pedirka subregion, prior to assessment of water dependence, contains 1305 assets that intersect the Pedirka PAE, comprising 1239 ecological assets, 7 economic assets and 59 sociocultural assets.

1.3.1.1 Background and context

This product presents information about the water-dependent asset register for the Pedirka subregion. The name of the dated snapshot of the asset register this description refers to is 'Water-dependent asset register and asset list for Pedirka subregion on 27 August 2015' (available at Sparrow et al., 2015). The point-of-truth version of the asset register that this snapshot was extracted from resides in the asset database (Bioregional Assessment Programme, Dataset 1). The asset database and the water-dependent asset register can be updated so a more current version might be available at http://data.bioregionalassessments.gov.au/product/LEB/PED/1.3.

Development of the register used methods and processes defined and outlined in the companion submethodology M02 (as listed in Table 1) for compiling water-dependent assets (Mount et al., 2015); their specific application to the Pedirka subregion is described in the following sections.

An *asset* is an entity that has value to the community and, for BA purposes, is associated with a subregion or bioregion. Technically, an asset is a store of value and may be managed and/or used to maintain and/or produce further value. Each asset will have many values associated with it and they can be measured from a range of perspectives; for example, the values of a wetland can be measured from ecological, sociocultural and economic perspectives. A *bioregion* is a geographic land area within which coal seam gas (CSG) and/or coal mining developments are taking place, or could take place, and for which BAs are conducted. A *subregion* is an identified area wholly contained within a bioregion.

A *water-dependent asset* has a particular meaning for BAs; it is an asset potentially impacted, either positively or negatively, by changes in the groundwater and/or surface water regime due to coal resource development. Some assets are solely dependent on incident rainfall and will not be considered as water dependent if evidence does not support a linkage to groundwater or surface water.

The *water-dependent asset register* is a simple and authoritative listing of the assets within the *preliminary assessment extent* (PAE) (discussed in Section 1.3.1.3) that are potentially subject to water-related impacts. A PAE is the geographic area associated with a bioregion or subregion in which the potential water-related impact of coal resource development on assets is assessed. The compiling of the asset register is the first step to identifying and analysing potentially impacted assets, which is the goal of the overall BA.

The asset source data are compiled into an *asset database*, including the geographic location, which are designated as *elements* (individual spatial features – points, lines and polygons e.g. components of a larger system) and *assets* (combinations of one or more elements). During the compilation process, assets are assigned to one or more of three groups: (i) ecological, (ii) economic and (iii) sociocultural. Many assets are obtained from state and national databases and an important group of assets is provided by natural resource management organisations (NRMs) via the BA-purpose-built *Water Asset Information Tool* (WAIT) database.

The *asset list* is created through selection of assets in the asset database that occur within the PAE. The assets in the asset list that pass the BA water-dependency test are then 'registered' in the water-dependent asset register. A preliminary version of the asset register is presented to experts and organisations with local knowledge at organised workshops. Feedback is sought about whether the asset register is complete and correct; appropriate amendments are then made. It is at this stage – when assets have been selected using the PAE and the amended water-dependent assets have been recorded in the database – that the water-dependent asset register is complete for the purposes of producing product 1.3. Note, however, that the addition of new assets to the asset database, or a review of the status of existing assets in the database will mean that the asset register may be updated. As this has implications for other BA components, any updates must be documented and only be done with approval and tight version control. The product 1.3 will not be updated or republished as part of BAs but an updated version of the asset register (derived from the asset database) may be published at the same time as other products, for example, those associated with Component 3: Impact analysis (Figure 1 and Figure 2).

Following development of the asset register, the connection of the registered assets to coal resource development is assessed using ‘materiality’ tests and, if potentially subject to water-related impacts, assigned *receptors* (after Barrett et al., 2013). A receptor is a point in the landscape where water-related impacts on assets are measured and/or estimated. The approach to assigning receptors and impact variables to water-dependent assets is described in the companion submethodology M03 (as listed in Table 1) for assigning receptors to water-dependent assts (O’Grady et al., 2015).

1.3.1.2 Compiling assets and developing the water-dependent asset register

1.3.1.2.1 Ecological assets

Two natural resource management organisations (NRMs) nominated assets through contribution of data to the WAIT database (Australian Government Department of the Environment, Dataset 2, Dataset 3). These NRM-nominated assets were added to the asset database. Contributing organisations are listed in Table 3. There were no NRM-nominated assets in the NT.

Additional assets were nominated from analysis of data provided by national, state and regional databases (Data: Australian Government Department of the Environment (Dataset 2, Dataset 3) Table 4). These datasets included:

- areas with various designations of formal conservation at national or state level
- ecosystem types with a threatened status recognised by national legislation
- potential distributions of species with a threatened status recognised by national legislation
- previously identified water-dependent ecosystem types or water-related topographic features, nominated regardless of any designated conservation status.

Table 3 Natural resource management organisations which contributed data to the Water Asset Information Tool database for the Pedirka subregion

Organisation	Description in asset register	Elements	Assets (asset list)
Desert Channels Queensland	WAIT_Desert Channels	1969	8
SA Arid Lands Natural Resources Management Board	WAIT_SA	4709	93
Total		6678	101

Data: Australian Government Department of the Environment (Dataset 2, Dataset 3)

Table 4 Federal, state and regional data sources for ecological assets in the Pedirka subregion

Dataset[a]	Dataset citation	Elements	Assets asset list)
Australian Hydrological Geospatial Fabric version 2.1.1	Bureau of Meteorology (Dataset 4)	3,649	37
Collaborative Australian Protected Areas Database (CAPAD)	Australian Government Department of the Environment (Dataset 5)	10	10
Directory of Important Wetlands in Australia (DIWA) Spatial Database	Australian Government Department of the Environment (Dataset 6)	515	6
Great Artesian Basin Groundwater Recharge	Geoscience Australia (Dataset 7)	90	4
National Groundwater Dependent Ecosystems Atlas	Bureau of Meteorology (Dataset 8)	25,459	819
Birds Australia Important Bird Areas (IBA)	Birds Australia (Dataset 9)	3	3
National Groundwater Information System version 1.2 (NGIS)	Bureau of Meteorology (Dataset 10)	1,383	1
Lake Eyre Basin Rockholes and Waterholes in Queensland	Queensland Department of Environment and Resource Management (Dataset 11)	1	1
Threatened ecological communities listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)	Australian Government Department of the Environment (Dataset 12)	75	1

Dataset[a]	Dataset citation	Elements	Assets asset list)
Threatened species listed under the EPBC Act	Australian Government Department of the Environment (Dataset 13)	300	18
Threatened species listed under Queensland's *Nature Conservation Act 1992* (Nature Conservation Act)	Queensland Department of Science, Information Technology, Innovation and the Arts (Dataset 14)	11,451	5
QLD Wetland Data version 3: Streams	Queensland Department of Science, Information Technology, Innovation and the Arts (Dataset 15)	2,710	10
Northern Territory -Lake Eyre Basin - Wetlands Mapping	Northern Territory Department of Natural Resources, Environment, the Arts and Sport (NRETAS) (Dataset 16)	2,529	26
SA Lake Eyre Basin Aquatic Ecosystems Mapping and Classification	South Australian Department of Environment, Water and Natural Resources, (Dataset 17)	5,302	34
SA Wetland Groundwater Dependent Ecosystem Classification	South Australian Department of Environment, Water and Natural Resources, (Dataset 18)	2,468	163
Total		55,945	1,138

[a]The asset database (Bioregional Assessment Programme, Dataset 1) is a collation of all these source datasets. Some assets may be captured in multiple databases. These replicates are retained in the asset register as boundaries may differ between databases.

The asset database includes a wide range of information about each asset, including unique asset identifier (AID), name, type and geographic location. Geographic location is specified as 'shapes' in the sense of geographic information systems (GIS). A shape may be a polygon (for an area of land), a line (for a linear feature such as a watercourse) or a point (for a specific location whose area is smaller than the areal resolution of the geographic information (e.g. a spring). Many nominated assets are composed of several geographic parts. For example, a national park may comprise several blocks of land separated by road or railway reserves, the potential habitat of a threatened species of bird may include patches of remnant habitat separated by agricultural land, and the potential habitat of a threatened species of fish may be restricted to the artesian springs scattered widely across a landscape. To accommodate assets composed of many parts, the asset database specifies each shape as an 'element' and one or more elements are then grouped to create assets. A detailed description of the process for classifying and aggregating elements to assets is presented in the companion submethodology M02 (as listed in Table 1) for compiling water-dependent assets (Mount et al., 2015).

A preliminary version of the water-dependent asset list, along with associated maps and data, was presented to experts and organisations with local knowledge at workshops in Adelaide in March 2015, for comment and feedback. The meeting was attended by representatives from the South Australian Department of the Environment, Water and Natural Resources (DEWNR), Outback Communities Authority and South Australian Arid Lands Natural Resource Management Board. The attendees were given two weeks to review the asset list and preliminary assessments of water dependence, and to return comments and suggestions.

1.3.1.2.2 Economic assets

As described in the companion submethodology M02 (as listed in Table 1) for compiling water-dependent assets (Mount et al., 2015), economic assets are classed as either a 'basic water right' (stock and domestic) or a 'water access right':

- basic water right (stock and domestic) – this is the right to take water for domestic and stock purposes only. A basic right for 'take of groundwater' requires approval for any works that may be involved (e.g. a bore), but does not require a licence for the extraction of groundwater. A basic right for 'take of surface water' does not require approval for any works or for the extraction of surface water.
- water access right – this requires a licence both for the works and the extraction of the water. The extraction of the water can be for a range of purposes including irrigation, commercial, industrial, farming, dewatering, mining and intensive agriculture.

Licensing data were sourced from the Queensland Department of Natural Resources and Mines (DNRM), the DEWNR and the Northern Territory Department of Land Resource Management (DLRM).

Within the asset database, every 'water access right' and 'basic water right (stock and domestic)' is an element, and elements are grouped by type and spatial location (according to water management zones or areas) to create assets.

Table 5 Data sources for economic assets in the Pedirka subregion

Dataset[a]	Dataset citation	Elements	Assets (asset list)
QLD groundwater licensing from the water management system	Bioregional Assessment Programme (Dataset 19)	1	1
SA groundwater licensing from the water management system (bore locations)	South Australian Department of Environment, Water and Natural Resources (Dataset 20)	28	2
SA groundwater licensing from the water management system (areas around wells)	South Australian Department of Environment, Water and Natural Resources (Dataset 21)	1	1
NT groundwater licensing from the water management system	Northern Territory Department of Land Resource Management (Dataset 22)	2	1
NT groundwater management units in the Great Artesian Basin	Northern Territory Department of Land Resource Management (Dataset 23)	2	2
Total		34	7

[a]The asset database (Bioregional Assessment Programme, Dataset 1) is a collation of all these source datasets. Some assets may be captured in multiple databases. These replicates are retained in the asset register as boundaries may differ between databases.

1.3.1.2.3 Sociocultural assets

Sociocultural assets were sourced from the Australian Heritage Database (Australian Government Department of the Environment, Dataset 24, Dataset 25), National Heritage List and the Register of the National Estate.

In the Pedirka subregion, the Bioregional Assessment Programme has funded the South Australian Department of Environment, Water and Natural Resources to research cultural values associated with water assets, including Indigenous values. Reports from this study will be available at the Bioregional Assessment website (http://www.bioregionalassessments.gov.au) when finalised.

Table 6 Data sources from the Australian Heritage Database for sociocultural assets in the Pedirka subregion

Dataset[a]	Dataset citation	Elements	Assets (asset list)
National Heritage List (NHL)	Australian Government Department of the Environment (Dataset 24)	3	3
Register of the National Estate (RNE)	Bioregional Assessment Programme (Dataset 26)	56	56
Total		59	59

[a]The asset database (Bioregional Assessment Programme, Dataset 1) is a collation of all these source datasets. Some assets may be captured in multiple databases. These replicates are retained in the asset register as boundaries may differ between databases.

1.3.1.2.4 Duplicated or overlapping assets

Some specific areas within the Pedirka PAE were nominated several times, from different databases. For example, Dalhousie Springs and the immediate surrounding areas (north of Oodnadatta, in the western part of the PAE) were nominated as:

- a protected area (Collaborative Australian Protected Areas Database; CAPAD)
- an important wetland (*A directory of important wetlands in Australia*; DIWA)
- an area of heritage significance recognised within the Register of the National Estate (RNE)
- part of a national threatened ecological community (Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999;* EPBC Act)
- an NRM asset (WAIT database).

Likewise, some assets sourced from different datasets overlie each other, as they consider slightly different aspects of the same geographic area. For example, a national park may include springs, wetlands, and groundwater-dependent woodlands, and therefore the park may partially overlap assets describing:

- areas of heritage significance to the Register of the National Estate (RNE)
- groundwater-dependent ecosystems (GDEs)
- threatened ecological community distributions listed in the EPBC Act
- potential habitats of federal or state-listed threatened species.

Duplicate and overlapping assets were treated as entirely separate assets for the purposes of compiling the register of water-dependent assets for the Pedirka subregion. Such an approach meant that no judgment need be made of the priority of one asset or asset type over another asset or asset type, and thereby that equal respect and attention was paid to all stakeholders' asset nominations and contributed databases.

1.3.1.3 Determining the preliminary assessment extent

The development of the PAE for the Pedirka subregion was carried out by South Australian Department of Environment, Water and Natural Resources and only a summary of their work is provided in this section.

The following assumptions were applied to define the PAE for the Pedirka Basin:

- The extent of potential groundwater drawdown was derived from DEWNR groundwater Stage 1 preliminary modelling for the Pedirka Basin.
- Due to the absence of short-term (seven years) viable CSG or coal developments in SA, specific potential mining locations were not considered, other than known exploration activities occurring in the PAE.
- Exploration lease areas were included to determine known and potential mining activities, as these covered all mapped coal resources for the Pedirka Basin.
- Exploration lease areas do not specifically include potential mining-related infrastructure corridors, such as pipelines and access roads outside of the mining lease boundaries.
- As a result of dewatering activities, open-cut coal mining has the potential to draw down water in the Great Artesian Basin (GAB) where accessed coal deposits lie below the level of the aquifer.

- McDills Anticline was excluded from the modelling assessment due to poorly characterised geological structure. Further investigations are required to understand the influence on water availability and transmission extent.
- Northern boundary of the Perdirka PAE was based upon GAB boundary and extent of potential drawdown within the basin.
- Groundwater flows from recharge areas in the GAB towards critical spring supergroups, but drawdown would not be sufficient to impact the Mulligan River springs, near Boulia in Queensland, as these are outside of the GAB.
- There is no surface water connectivity to the isolated dune lake systems in the south and east of the Pedirka subregion in the Simpson Desert.
- Surface water features of the Finke River catchment within the Pedirka (PAE) boundary were included, but upstream connections of the tablelands were excluded as frequency of connectivity was considered too low for upstream refuge ecosystems to be reliant on lower reaches within the Pedirka Basin.
- The Neales River catchment was derived from the 1-second national digital elevation model and smoothed manually using heads-up digitising. Where possible it follows existing basin boundaries.

The following methodology was used to formulate the Pedirka PAE:

- The geological Pedirka Basin boundary and the mapped areas of economic coal beds and lodged exploration licences (obtained from SA Department of State Development (DSD)) were used as the starting point for calculations.
- A potentiometric surface was generated for the GAB aquifer (Cadna-owie Formation – Algebuckina Sandstone and equivalents) within SA and NT.
- DEWNR modelling of possible large-scale mining operations in the Pedirka subregion of the Eromanga Basin (based on exploration licences), with assumptions of 50-year life of mine and approximately around 400 ML withdrawal of groundwater per day, generated an inferred 210 km groundwater drawdown extent to 1 m drawdown.
- Western and southern boundaries were extended to follow the GAB and Arckaringa Basin boundaries to allow for any potential groundwater connectivity in these areas.
- A 10 km buffer was included where the calculated boundary intersects with fractured rock aquifer (FRA) extents.
- Paleogene and Neogene sediments were excluded from consideration as a buffer to the GAB where they intersect with coal deposits, as it was assumed that only direct impact to these Ceonzoic sediments would occur should open-cut mining activities occur.
- Phreatic surface information was utilised to identify connectivity to shallow groundwater potentially utilised by vegetation (defined as groundwater at up to 10 m depth).
- GAB discharge springs of the Lake Eyre supergroup were included, along with a 5 km buffer around the point location in order to accommodate the extensive wetland and terrestrial ecosystems that the springs support.
- Dalhousie Springs Complex is within the 210 km drawdown extent.

- Lower reaches of the Finke River are all within the 210 km buffer around the Pedirka coal beds, including the Snake Gully / Finke River floodout.
- All of the catchment of the Macumba River was incorporated into the PAE, including subcatchments that lie outside the Pedirka PAE boundary and those downstream to the confluence with the Kallakoopah.
- Upstream subcatchments of the Neales-Peake outside of the inferred 210 km drawdown zone were also included on the basis that some of the springs in those subcatchments support critical refuges for aquatic species that inhabit upstream reaches.
- A 20 km buffer boundary was used as a contingency around all known surface waters and groundwater drawdown extents, although all watercourse buffers were confined to within the groundwater drawdown extent.

The following data gaps were identified during definition of the Pedirka PAE:

- Exploration licences were not available for the NT.
- Further information and modelling are required to understand the zone of potential groundwater drawdown influence to 0.1 m. Such additional modelling might lead to extension of the zone of potential influence further south and east to encompass springs in the Lake Eyre and Mulligan River supergroups.
- Based on current level of knowledge, in the north-east portion of the Pedirka PAE, there is GAB flow towards the Mulligan River supergroup of springs, which are EPBC Act-listed discharge springs. These are currently assumed to be recharged from flow in rivers in this region. There is a possibility that a reduction in pressure of the GAB within the PAE could reverse the flow paths away from the Mulligan River springs or reduce pressure to them. For the current analysis, due to the depths of Paleogene and Neogene sediments and distance from the coal beds, these possibilities have been excluded due to the low likelihood of hydrological connectivity. Further research on hydrogeology in this region should inform future decision to include or exclude these springs.
- The influence of the Macumba River on Kati Thanda – Lake Eyre is unclear; further research is required.

Figure 3 Surface and groundwater preliminary assessment extents (PAE) for the Pedirka subregion

1.3.1.4 Assessing water dependence

1.3.1.4.1 Assessment principles

Once assets were compiled into the asset database and checked for inclusion in the PAE, they were assessed for water dependence. Although most nominated assets are, by definition of their database sources, 'water dependent' (e.g. groundwater bores, rivers, lakes and wetlands), there are a number of types of assets that are less clearly 'water dependent' (e.g. a national park with a varied landscape, the habitat of a non-aquatic species and historical places). Because of the diversity of asset types, the spectrum of degree to which assets might be water dependent, and

the need for all assessment decisions to be transparent and recorded, a highly structured, formal approach was developed for assessment of water dependency.

Six principles formed the foundation of the approach to assessment of water dependence of assets in the Pedirka PAE:

1. *Efficiency*. The methods were suitable for effective application to large numbers of assets.
2. *Transparency*. All decisions in assessments were tracked, including their rationale, any data sources and dates of assessments.
3. *Rigour*. Decision making was based on sound ecological, economic and sociocultural principles and clear logic, and able to withstand close peer and expert scrutiny.
4. *Multiple lines of evidence*. Wherever possible, assessment decisions are based on as many sources of information about water dependence as possible. Three broad groups of evidence were used: (i) asset naming conventions, (ii) documents describing asset management and (iii) GIS and remote sensing databases containing layers that directly or indirectly quantify surface water and groundwater availability.
5. *Precaution*. Where part of an asset is water dependent, the entire asset was assessed as water dependent. Where there is inconclusive evidence, assessment decisions consistently erred on the side of assuming potential water dependence (i.e. if one data source indicates water dependence, then the overall decision across the multiple lines of evidence is water dependence). On this basis, the maximum number of assets was retained within the database for subsequent analysis of potential development impacts.
6. *Separate tracking of assessment for dependence on groundwater and surface water*. Later stages of the BA impact analysis are likely to demonstrate separate causal pathways for potential impact of coal resource development via surface water and groundwater systems. If that proves to be the case, then potential for impact on an asset via the surface water or groundwater pathway will only be true if the asset depends on the corresponding above or below-ground water resource (Figure 4).

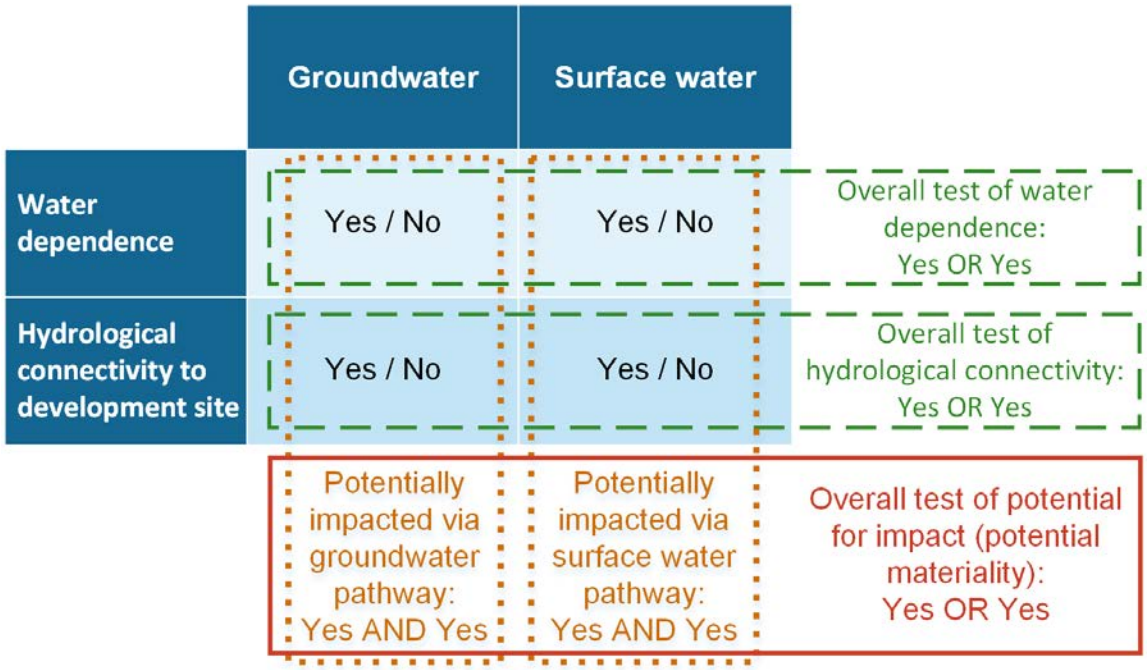


Figure 4 Logic for separate assessment and tracking of dependence on groundwater and surface water

This report focuses exclusively on assessment of water dependence i.e. the upper part of this logic. Future BAs for the Pedirka subregion will assess hydrological connectivity and response, and thus the potential for impact on assets.

1.3.1.4.2 Assessment criteria using asset naming conventions

For some asset sources, the only direct information available for assessing water dependence of each asset is its name. The Australian Hydrological Geospatial Fabric (AHGF), Great Artesian Basin Groundwater Recharge Beds database and National Groundwater Information System (NGIS) are databases in which little asset data other than name and geographic coordinates are available. The Queensland, SA and NT groundwater licensing from the water management system databases are also restricted in terms of information other than asset name and type.

Two simple naming criteria were used to assess water dependence for assets of these types:

- if asset name includes ‘spring’, ‘soakage’, ‘bore’, ‘groundwater’, etc., then the asset is groundwater dependent
- if asset name includes ‘river’, ‘stream’, ‘floodplain’, ‘waterhole’, ‘billabong’, ‘lake’, ‘wetland’, ‘marsh’, ‘surface water’, etc., then the asset is surface water dependent.

Although initially developed for specific, information-poor data sources, these rules were subsequently applied to all assets in the asset list, regardless of data source.

1.3.1.4.3 Assessment criteria using documents describing asset management

Most assets sourced from CAPAD, DIWA, and the EPBC Act list of threatened ecological communities are subject to legislatively required management plans that include some degree of ecosystem description. For these assets, management plans and/or asset descriptions were obtained from federal, state and territory agencies. The management plans and their constituent ecosystem descriptions were then subjected to text analysis, using the following simple criteria to assess water dependence:

- if ecosystem description includes 'spring', then asset is groundwater dependent
- if ecosystem description includes any ecosystem type, community type, habitat type or dominant species and has been identified in any published literature as accessing groundwater (e.g. river red gum, coolibah (*Eucalyptus coolabah*), fish species), then asset is groundwater dependent
- if ecosystem description includes 'riverine vegetation', 'floodplain', 'waterhole', 'billabong', 'lake', 'wetland', 'marsh', etc., then asset is surface water dependent
- if ecosystem description includes any ecosystem type, community type, habitat type or dominant species known to access surface water (e.g. river red gum, coolibah, lignum, most waterbird species, fish), then asset is surface water dependent.

According to these criteria, examination of documents about one asset may yield determination for both groundwater dependence and surface water dependence, in one ecosystem type or in different ecosystem types in different parts of the asset.

The water dependency of threatened species' habitats, including threatened species listed under the EPBC Act and under Queensland's *Nature Conservation Act 1992* (Nature Conservation Act), was assessed by a review of the habitat requirements for each species. It is important to emphasise that BAs consider the potential impact to the habitat of species, not to the population of the species *per se*. In most cases, profiles from the Species Profile and Threats Database (SPRAT) (Bioregional Assessment Programme, Dataset 26) and the Queensland Government's Wetland*Info* website (DEHP, 2015) were examined.

Any information suggesting that water dependence was 'certain', 'likely' or 'possible' was interpreted as 'water dependent' for the purposes of the asset register.

1.3.1.4.4 Assessment criteria using GIS and remote sensing databases

Criteria based upon asset naming and upon available, published asset descriptions and management plans proved to be inadequate for satisfactory assessment of water dependence in a large proportion of assets. Other sources of information were sought to expand the range of data available for assessment of asset water dependence.

Five mapped GIS and remote sensing data layers were identified as providing additional information relevant to assessing dependence on surface water or groundwater. GIS analyses were used to spatially intersect each asset with each of the five data layers. If any part of an asset was found to overlap with any one of these layers, then that observation was used as evidence for water dependence, according to the precautionary principle previously described in Section 1.3.1.4.1.

The five data layers were:

1. GDEs reliant on subsurface presence of groundwater, derived from the *National atlas of groundwater dependent ecosystems* (GDE Atlas; Bureau of Meteorology, 2012). Subsurface presence of groundwater is defined as groundwater that contributes to the soil water and near-surface aquifers accessible to plant roots without generating a flow of water at the soil surface. Only those GDEs derived from previous field work or possessing a high or moderate

potential for groundwater dependency were used in the intersection. Positive intersection of an asset with this layer indicates potential dependency on groundwater. A map of this data layer across the Pedirka PAE is shown in Figure 5.

2. GDEs reliant on surface expression of groundwater, derived from the GDE Atlas (Bureau of Meteorology, 2012). Surface expression of groundwater is defined as groundwater that flows at the soil surface in the form of a spring or seep, including those springs that lie under surface water bodies such as streams, waterholes, lakes or swamps, for which the primary source of water may be from surface flows. Only those GDEs derived from previous field work or possessing a high or moderate potential for groundwater dependency were used in the intersection. Positive intersection of an asset with this layer indicates potential dependency on groundwater and/or surface water. A map of this data layer across the Pedirka PAE is shown in Figure 6.
3. A combined multi-state and territory map of wetlands defined according to the Queensland Wetland Data Streams, SA Wetlands Groundwater Dependent Ecosystem Classification and Northern Territory - Lake Eyre Basin - Wetlands Mapping. Positive intersection of an asset with this layer indicates potential dependency on subsurface or surface expression of groundwater. A map of this data layer for the Pedirka PAE is shown in Figure 7.
4. Mean annual evapotranspiration in excess of incident rainfall across the Pedirka PAE (Reside et al., 2013). This layer is calculated as the difference between actual evapotranspiration assessed through remote sensing techniques during 1992 to 2011 and a predicted model of evapotranspiration if water were sourced only from incident rainfall. A positive difference means that long-term observation of the amount of water released into the atmosphere by plant evapotranspiration exceeds the inputs of water from rainfall, and the vegetation is accessing additional water from groundwater pools or contributions to soil water. These contributions to soil water result from surface water flowing from elsewhere in the catchment; however, the data were not able to be interpreted to indicate whether the additional water is from a groundwater pool or surface water flow. Thus, intersection of an asset with high excess evapotranspiration values (>100 mm per year) in this layer indicates potential dependency on groundwater and/or surface water. A map of this data layer across the Pedirka PAE is shown in Figure 8.
5. Percentage duration of flood inundation during 1987 to 2015, from the Water Observations from Space database (Bioregional Assessment Programme, Dataset 29). Positive intersection of an asset with higher percentage inundation classes (>1% of time) in this layer indicates potential dependency on surface water. A map of this data layer across the Pedirka PAE is shown in Figure 9.

Application of this approach is demonstrated for a single asset in the Pedirka PAE, Simpson Desert Conservation Park (Figure 10 and Figure 11). Simpson Desert Conservation Park sits in the Simpson Desert, immediately south of the border between SA and NT (see Figure 9). All five GIS and remote sensing layers provide clear evidence for dependence on groundwater and/or surface water in and around the swales, claypans and salt lakes that lie between the sand dunes in the central portion of the park and that are part of the overflow system for the Hale, Hay, Plenty and Todd rivers during years of unusually high and intense rainfall in central Australia. Therefore, this asset was assessed to be water dependent and is included in the register of water-dependent assets.

However, it is important to note that in the eastern and south-west portions of the park, each of the five layers provides evidence for different patterns of potential water dependence. Thus the five layers provide independent and complementary lines of evidence for the assessment of asset dependence on water.

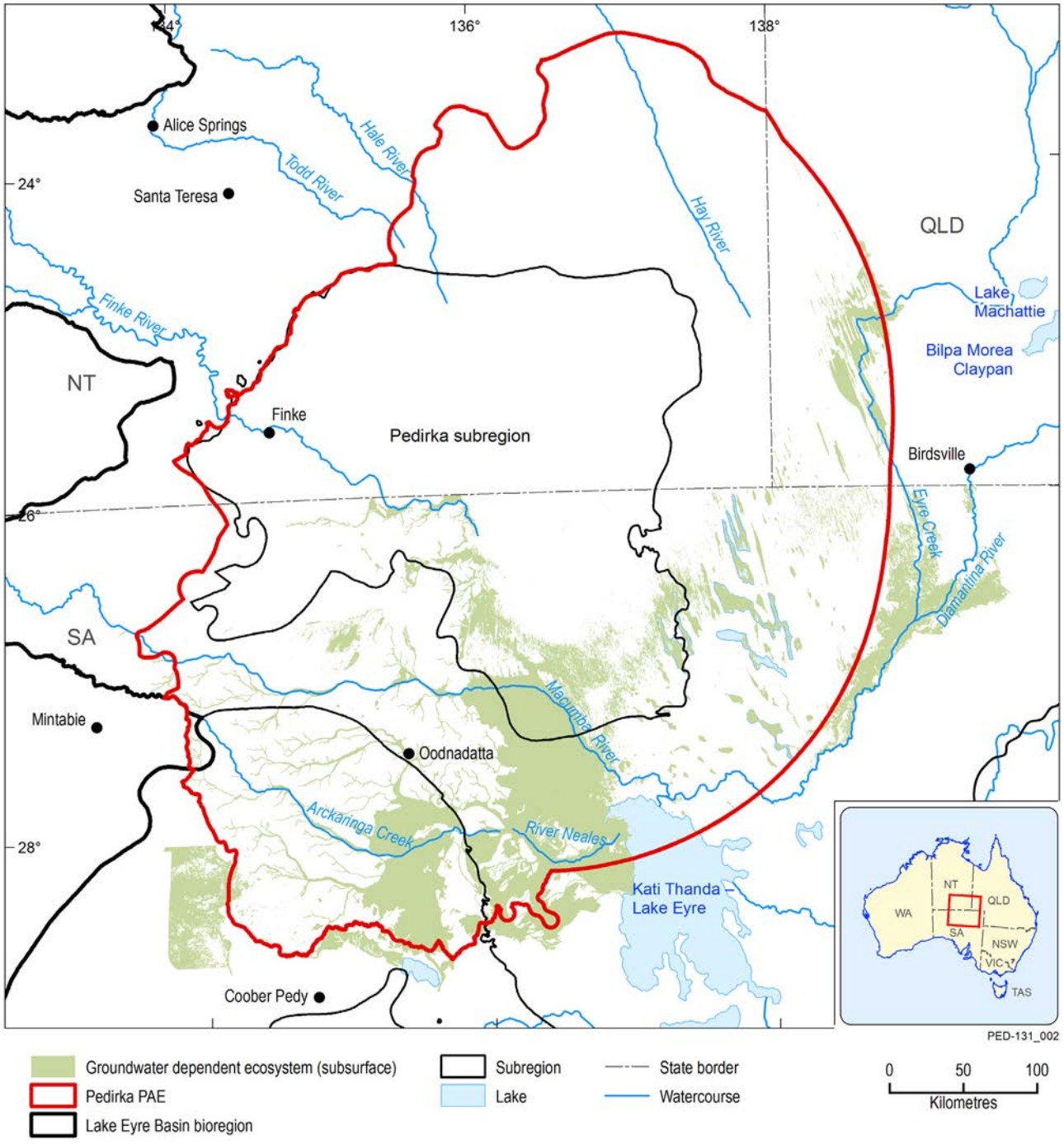


Figure 5 Groundwater-dependent ecosystems reliant on subsurface presence of groundwater in the Pedirka preliminary assessment extent (PAE)

Data: Bureau of Meteorology (Dataset 8)

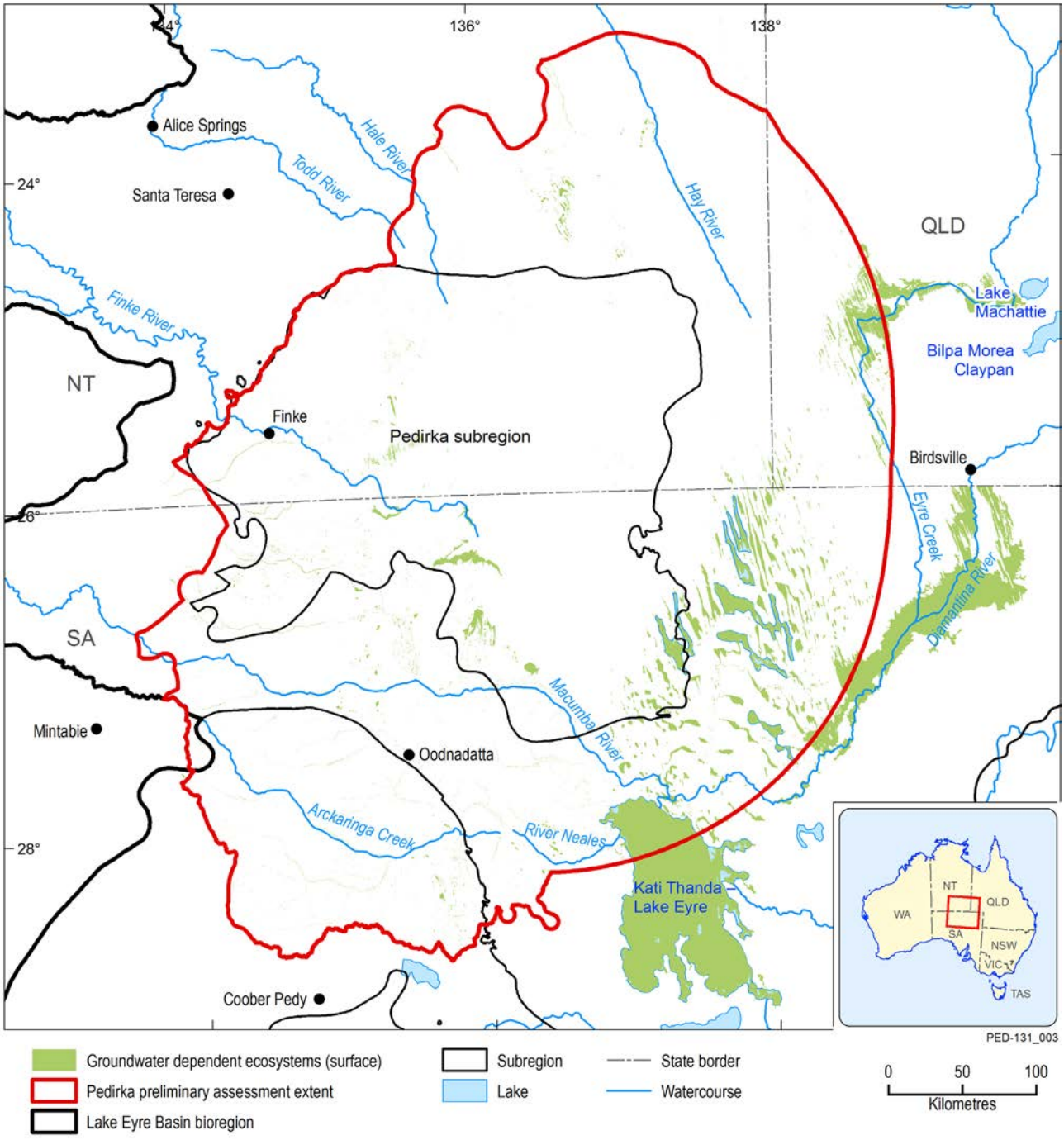


Figure 6 Groundwater-dependent ecosystems reliant on surface expression of groundwater in the Pedirka preliminary assessment extent (PAE)

Data: Bureau of Meteorology (Dataset 8)

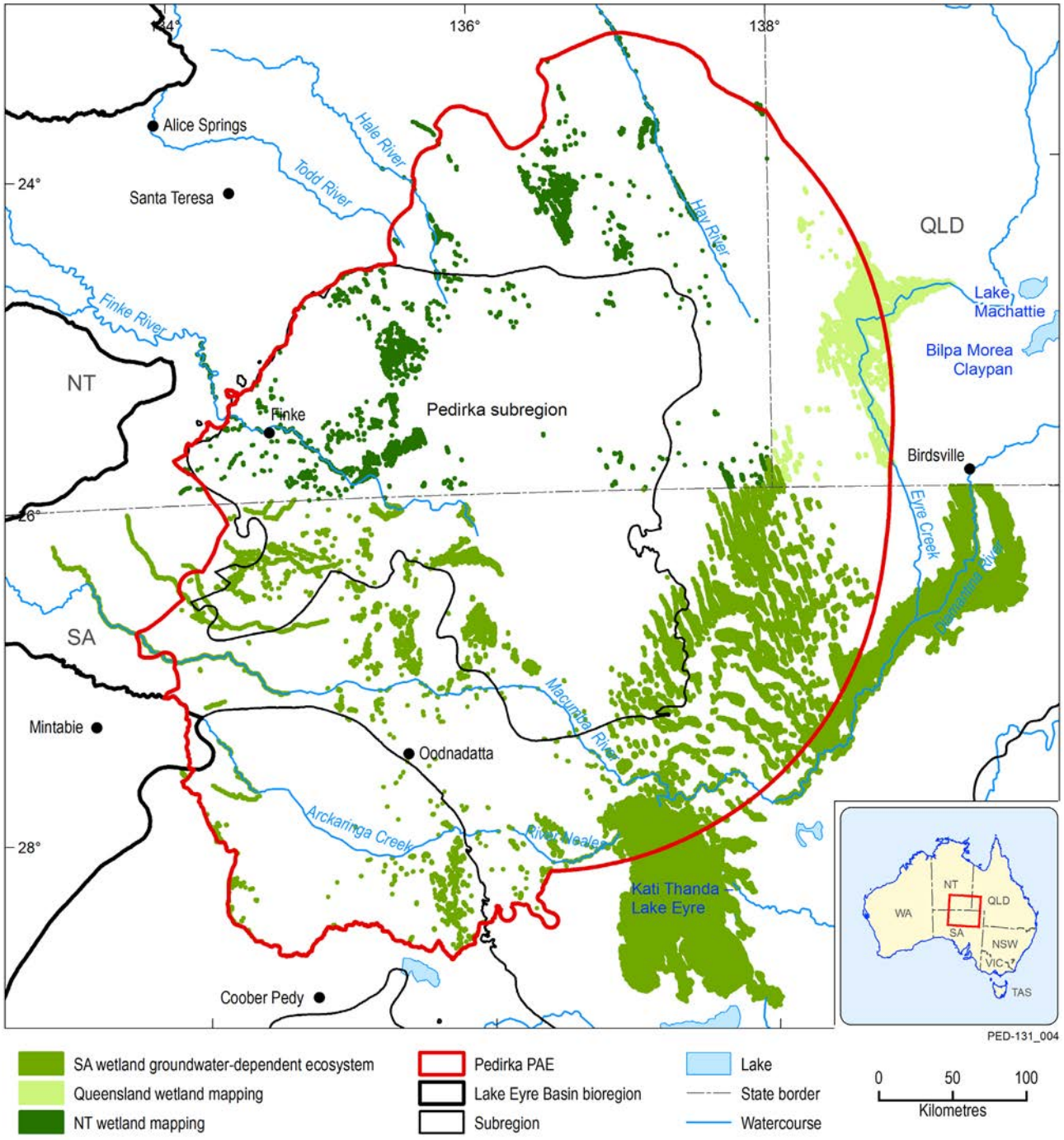


Figure 7 Distribution of wetland ecosystems types in the Pedirka preliminary assessment extent (PAE), according to the Queensland wetland mapping streams, South Australia wetland groundwater-dependent ecosystem mapping and Northern Territory wetland mapping

Data: Queensland Department of Science, Information Technology, Innovation and the Arts (Dataset 15), South Australian Department of Environment, Water and Natural Resources (Dataset 17) and Northern Territory Department of Natural Resources, Environment, the Arts and Sport (Dataset 16)

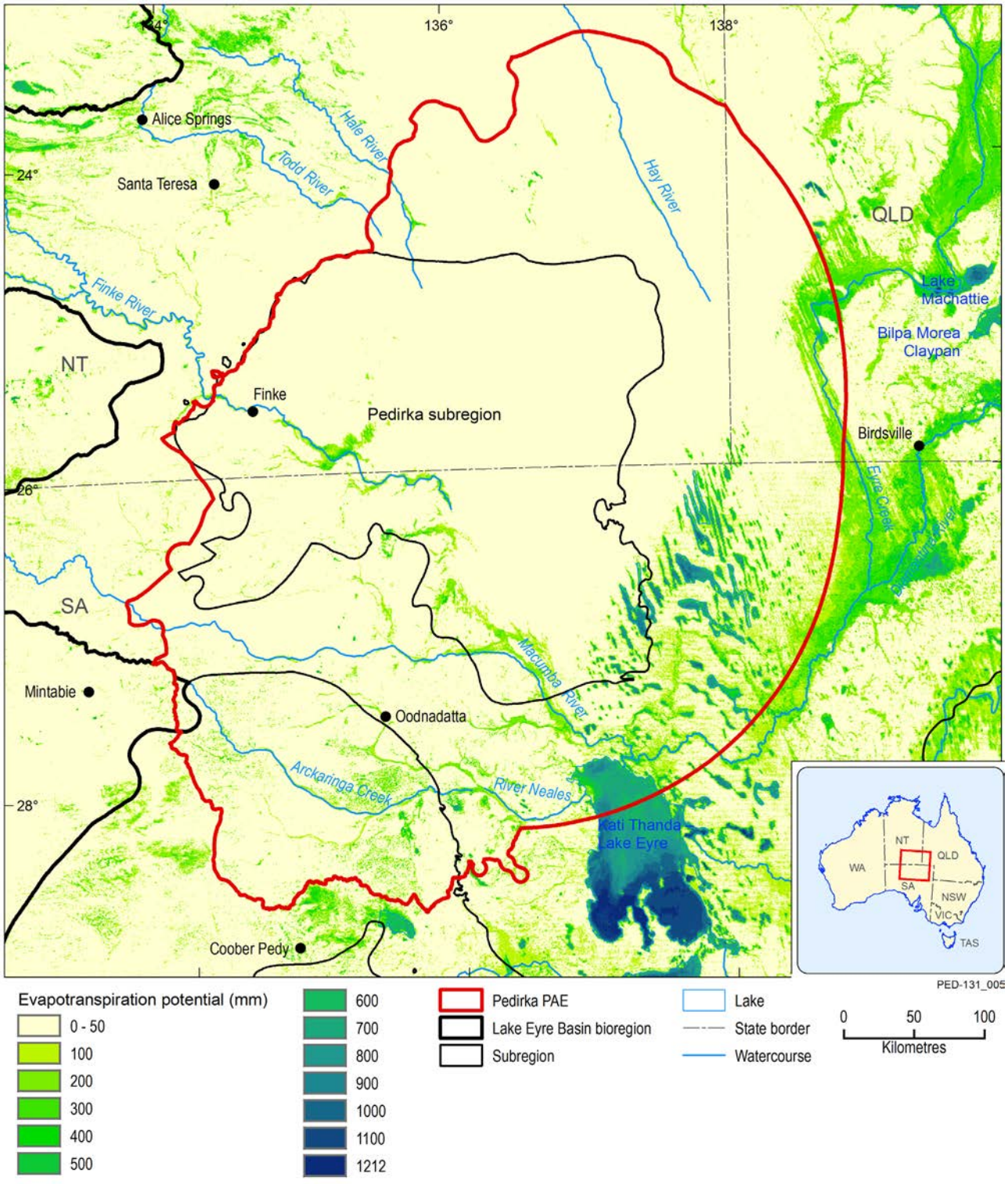


Figure 8 Mean annual evapotranspiration in excess of incident rainfall across the Pedirka preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 27)

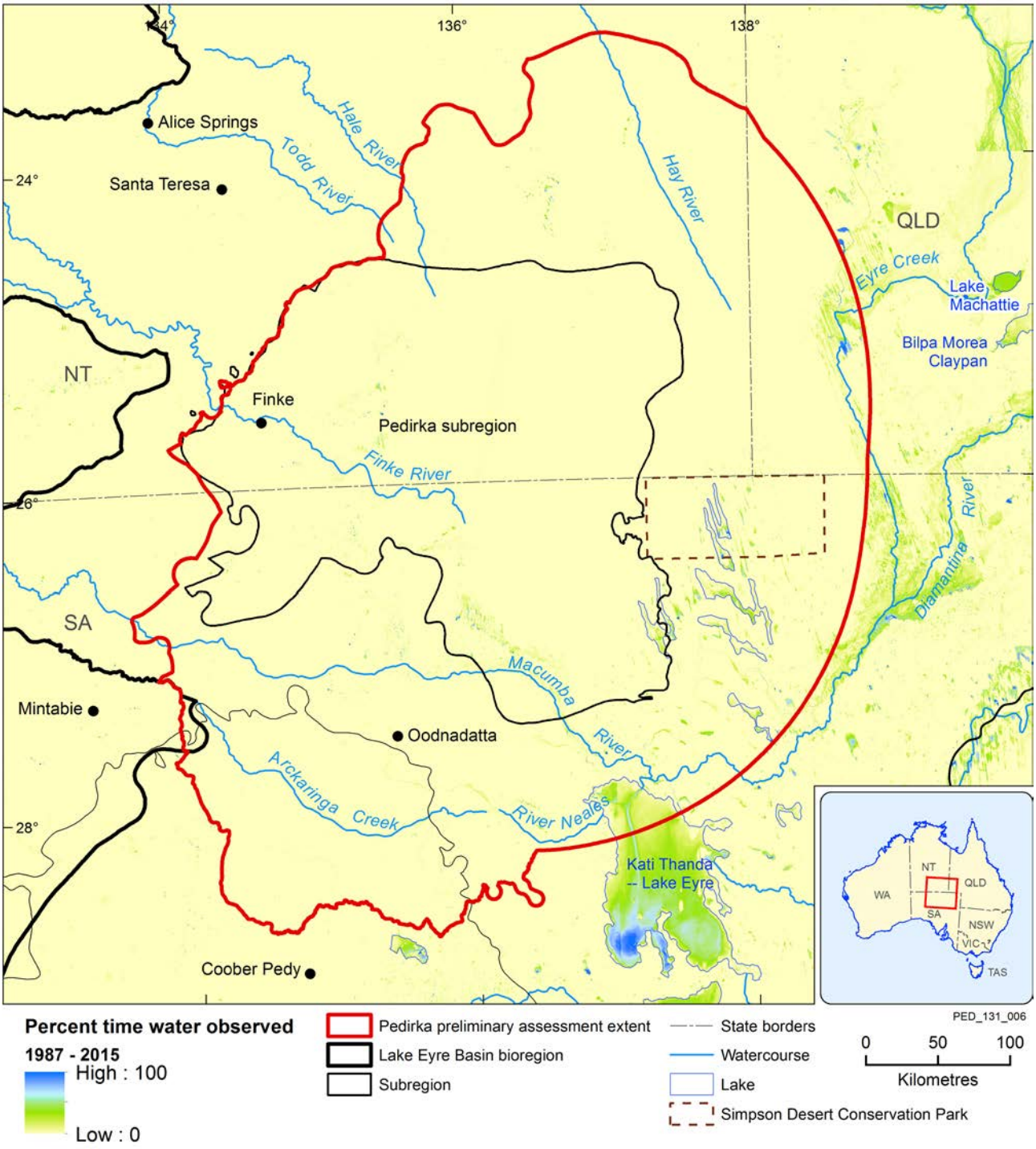


Figure 9 Percentage duration of flood inundation during 1987 to 2015 across the Pedirka preliminary assessment extent (PAE)

Data: Geoscience Australia (Dataset 28)

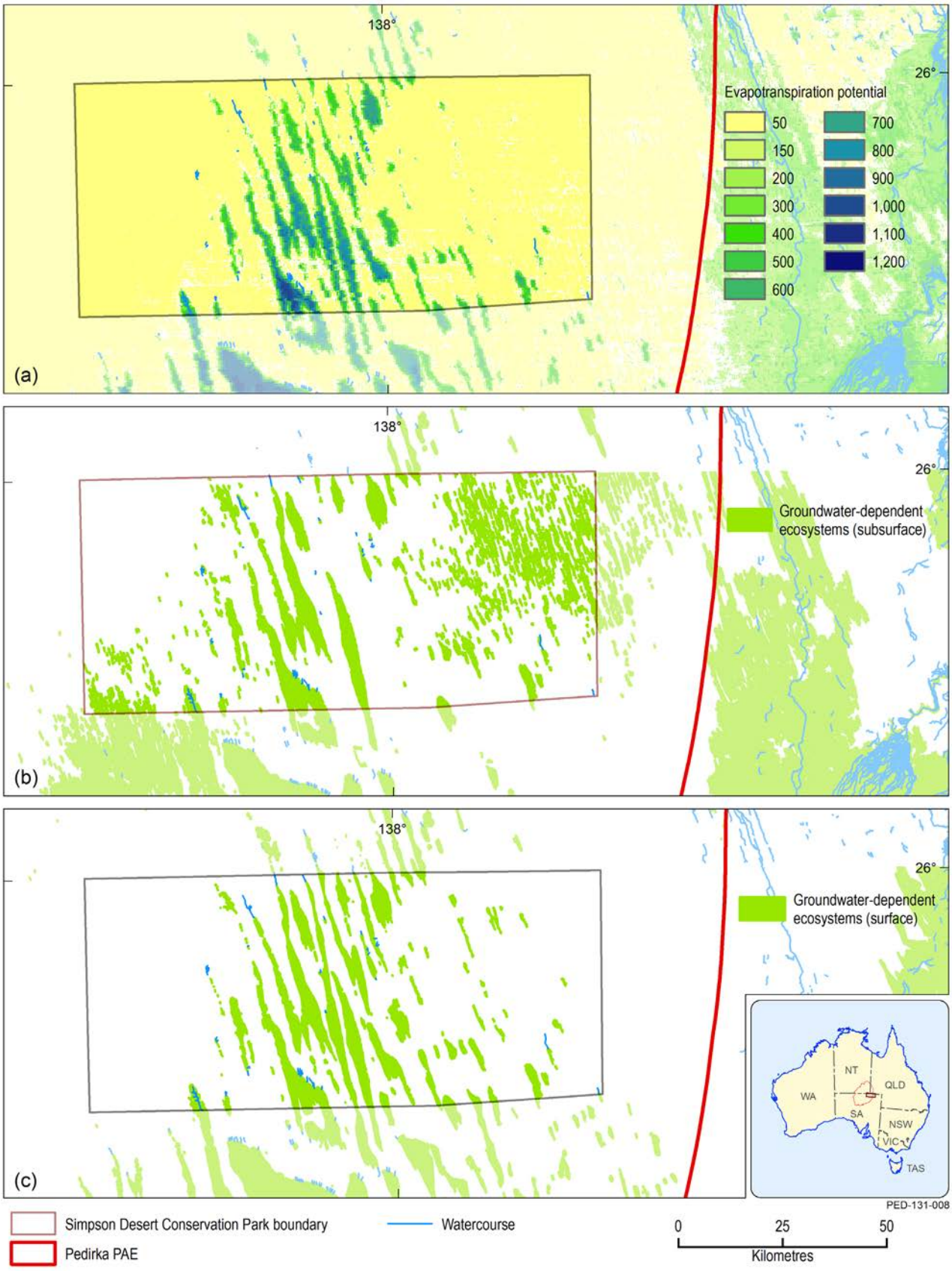


Figure 10 Spatial intersection of a specific asset, Simpson Desert Conservation Park, with layers of (a) mean annual evapotranspiration in excess of incident rainfall, (b) groundwater-dependent ecosystems reliant on subsurface presence of the water and (c) groundwater-dependent ecosystems reliant on surface expression of the water

Data: Bioregional Assessment Programme (Dataset 27), Bureau of Meteorology (Dataset 8)

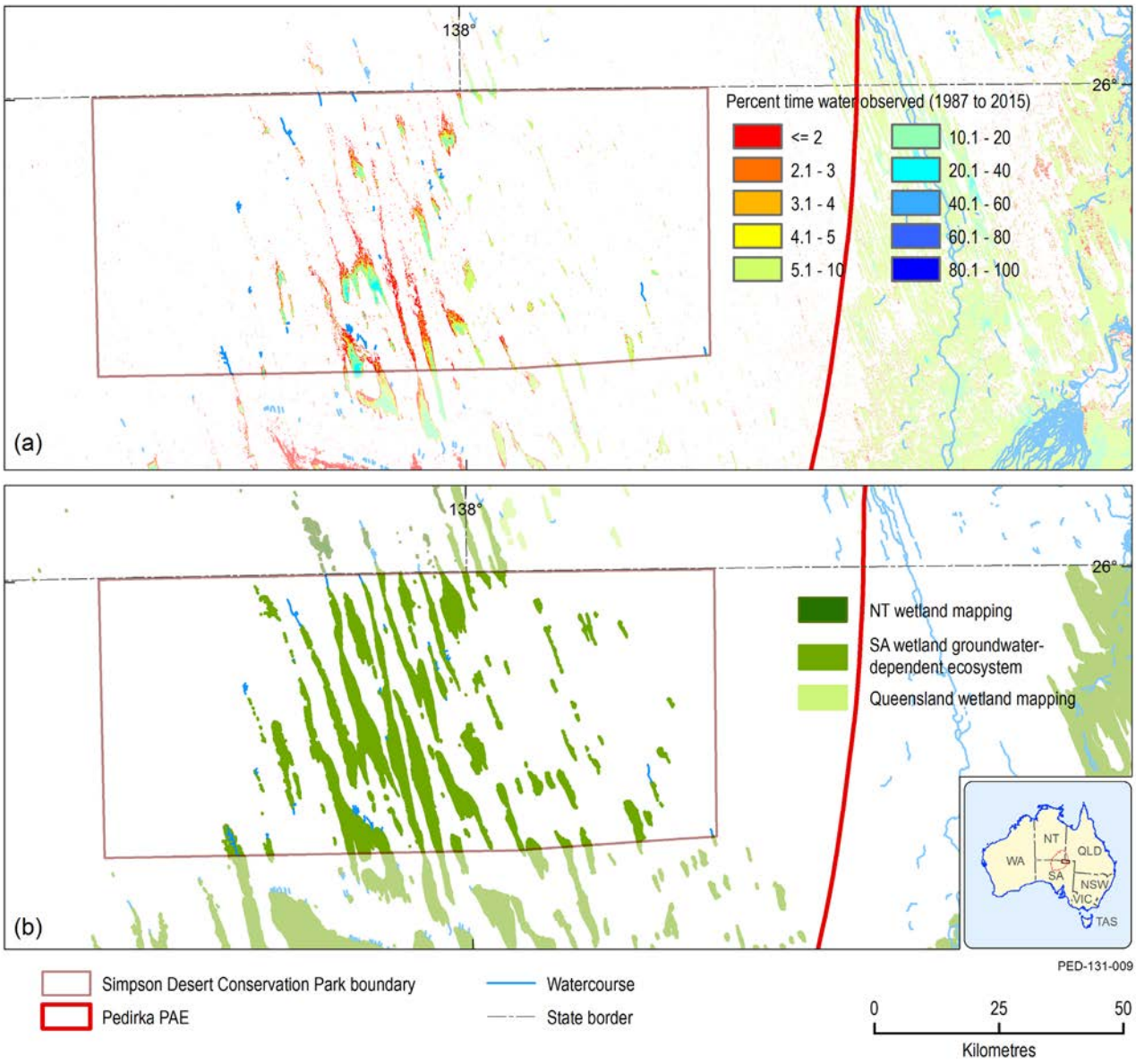


Figure 11 Spatial intersection of a specific asset, Simpson Desert Conservation Park, with layers of (a) percent duration of flood inundation and (b) the combination of Northern Territory's wetland mapping, South Australia's wetland groundwater-dependent ecosystems and wetlands according to Queensland Government's regional ecosystems classification

Data: Geoscience Australia (Dataset 28), Queensland Department of Science, Information Technology, Innovation and the Arts (Dataset 15), South Australian Department of Environment, Water and Natural Resources (Dataset 18) and Northern Territory Department of Natural Resources, Environment, the Arts and Sport (Dataset 16)

References

Barrett DJ, Couch CA, Metcalfe DJ, Lytton L, Adhikary DP and Schmidt RK (2013) Methodology for bioregional assessments of the impacts of coal seam gas and coal mining development on water resources. A report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment. Department of the Environment, Australia. Viewed 19 April 2015, http://iesc.environment.gov.au/publications/methodology-bioregional-assessments-impacts-coal-seam-gas-and-coal-mining-development-water.

Bureau of Meteorology (2012) Atlas of groundwater dependent ecosystems. Bureau of Meteorology, Canberra. Viewed 26 March 2015, http://www.bom.gov.au/water/groundwater/gde/.

DEHP (2015) Species information, Wetland*Info*. Queensland Department of Environment and Heritage Protection. Viewed 26 March 2015, http://wetlandinfo.ehp.qld.gov.au/wetlands/ecology/components/species/.

Mount RE, Mitchell PJ, Macfarlane C, Marston FM, McNamara JM, Raisbeck-Brown N, O'Grady AP, Moran BT and Wang J (2015) Compiling water-dependent assets. A submethodology from the Bioregional Assessment Technical Programme. Department of the Environment, Bureau of Meteorology, CSIRO and Geoscience Australia, Australia. Viewed 5 March 2015, http://data.bioregionalassessments.gov.au/submethodology/M02.

O'Grady AP, Crosbie R, Dambacher J, Hayes K, Henderson B, Holland K, Macfarlane C, Marston F, Mount R, Pollino C and Sparrow A (2015) Assigning receptors to water-dependent assets. A submethodology from the Bioregional Assessment Technical Programme. Department of the Environment, Bureau of Meteorology, CSIRO and Geoscience Australia, Australia. Viewed 14 July 2015, http://data.bioregionalassessments.gov.au/submethodology/M03.

Reside AE, Van Der Wal J, Phillips BL, Shoo LP, Rosauer DF, Anderson BJ, Welbergen JA, Moritz C, Ferrier S, Harwood TD, Williams KJ, Mackey B, Hugh S, Williams YM and Williams SE (2013) Climate change refugia for terrestrial biodiversity: defining areas that promote species persistence and ecosystem resilience in the face of global climate change. National Climate Change Adaptation Research Facility, Gold Coast.

Sparrow A, Raisbeck-Brown N, Johnstone G, Wang J, Carter R, Bell J, Perera W, Dillon R, Guo L, Moore B, Mount R and Evans T (2015) Water-dependent asset register and asset list for the Pedirka subregion on 27 August 2015. A spreadsheet associated with product 1.3 for the Pedirka subregion from the Lake Eyre Basin Bioregional Assessment. Department of the Environment, Bureau of Meteorology, CSIRO and Geoscience Australia, Australia. http://data.bioregionalassessments.gov.au/product/LEB/PED/1.3.

Datasets

Dataset 1 Bioregional Assessment Programme (2014) Asset database for the Pedirka subregion on 27 August 2015. Bioregional Assessment Derived Dataset. Viewed 10 November 2015, http://data.bioregionalassessments.gov.au/dataset/62dc178f-65ae-4e6a-b5d4-12895b37d04c.

Dataset 2 Australian Government Department of the Environment (2015) Queensland QLD - Regional - NRM - Water Asset Information Tool - WAIT - databases. Bioregional Assessment Source Dataset. Viewed 10 November 2015, http://data.bioregionalassessments.gov.au/dataset/675afffd-5f42-49f0-9e24-9d6cca41621e.

Dataset 3 Australian Government Department of the Environment (2015) South Australia SA - Regional - NRM Board - Water Asset Information Tool - WAIT - databases. Bioregional Assessment Source Dataset. Viewed 10 November 2015, http://data.bioregionalassessments.gov.au/dataset/bb5a044a-889c-40a0-bf65-e4826ae72e43.

Dataset 4 Bureau of Meteorology (2014) Geofabric Surface Network - V2.1.1. Bioregional Assessment Source Dataset. Viewed 10 November 2015, http://data.bioregionalassessments.gov.au/dataset/d84e51f0-c1c1-4cf9-a23c-591f66be0d40.

Dataset 5 Australian Government Department of the Environment (2014) Collaborative Australian Protected Areas Database (CAPAD) 2012 – external. Bioregional Assessment Source Dataset. Viewed 10 November 2015, http://data.bioregionalassessments.gov.au/dataset/ef93a2a2-6701-47ce-804d-12f8413bd09a.

Dataset 6 Australian Government Department of the Environment (2015) Directory of Important Wetlands in Australia (DIWA) Spatial Database (Public). Bioregional Assessment Source Dataset. Viewed 10 June 2015, http://data.bioregionalassessments.gov.au/dataset/6636846e-e330-4110-afbb-7b89491fe567.

Dataset 7 Geoscience Australia (2013) Great Artesian Basin and Laura Basin groundwater recharge areas. Bioregional Assessment Source Dataset. Viewed 10 November 2015, http://data.bioregionalassessments.gov.au/dataset/8c646031-9765-4d7b-97df-a0869d66eabe.

Dataset 8 Bureau of Meteorology (2012) National Groundwater Dependent Ecosystems (GDE) Atlas. Bioregional Assessment Source Dataset. Viewed 10 November 2015, http://data.bioregionalassessments.gov.au/dataset/e358e0c8-7b83-4179-b321-3b4b70df857d.

Dataset 9 Birds Australia (2009) Birds Australia – Important Bird Areas (IBA) 2009. Bioregional Assessment Source Dataset. Viewed 10 November 2015, http://data.bioregionalassessments.gov.au/dataset/5d488350-83b6-4e71-8d17-687ad8ff9941.

Dataset 10 Bureau of Meteorology (2013) National Groundwater Information System version 1.1. Bioregional Assessment Source Dataset. Viewed 10 November 2015, http://data.bioregionalassessments.gov.au/dataset/e157b1cd-3cb7-4cf9-a13c-a6bed576b8c7.

Dataset 11 Queensland Department of Environment and Resource Management (2009) Permanent and Semi-Permanent Waterbodies of the Lake Eyre Basin (Queensland and South Australia) (DRAFT). Bioregional Assessment Source Dataset. Viewed 10 June 2015, http://data.bioregionalassessments.gov.au/dataset/7d46c916-926f-41e8-b6ee-6a48b878d9d3.

Dataset 12 Australian Government Department of the Environment (2015) Communities of National Environmental Significance Database - RESTRICTED - Metadata only. Bioregional Assessment Source Dataset. Viewed 10 June 2015, http://data.bioregionalassessments.gov.au/dataset/c01c4693-0a51-4dbc-bbbd-7a07952aa5f6.

Dataset 13 Australian Government Department of the Environment (2014) Australia - Species of National Environmental Significance Database (BA subset). Bioregional Assessment Source Dataset. Viewed 10 June 2015, http://data.bioregionalassessments.gov.au/dataset/4eff885b-0d68-45e8-b4b1-e3e5448354eb.

Dataset 14 Queensland Department of Science, Information Technology, Innovation and the Arts (2014) QLD DSITIA Galilee LGA Species List. Bioregional Assessment Source Dataset. Viewed 10 November 2015, http://data.bioregionalassessments.gov.au/dataset/40902c5b-f9cd-473f-8a7e-37fb8850370a.

Dataset 15 Queensland Department of Science, Information Technology, Innovation and the Arts (2012) Queensland wetland data version 3 – wetland lines. Bioregional Assessment Source Dataset. Viewed 10 November 2015, http://data.bioregionalassessments.gov.au/dataset/53af31e0-c363-421d-a148-3808bf9c45ff.

Dataset 16 Northern Territory Department of Natural Resources, Environment, the Arts and Sport (NRETAS) (2009) Northern Territory - Lake Eyre Basin - Wetlands Mapping - METADATA ONLY. Bioregional Assessment Source Dataset. Viewed 17 September 2015, http://data.bioregionalassessments.gov.au/dataset/41d2ecc8-7700-4cc5-b80c-2092596d6f7e.

Dataset 17 South Australian Department of Environment, Water and Natural Resources (2014) Lake Eyre Basin (LEB) Aquatic Ecosystems Mapping and Classification. Bioregional Assessment Source Dataset. Viewed 22 June 2015, http://data.bioregionalassessments.gov.au/dataset/9be10819-0e71-4d8d-aae5-f179012b6906.

Dataset 18 South Australian Department of Environment, Water and Natural Resources (2010) South Australian Wetlands – Groundwater Dependent Ecosystems (GDE) Classification. Bioregional Assessment Source Dataset. Viewed 10 November 2015, http://data.bioregionalassessments.gov.au/dataset/fc35d75a-f12e-494b-a7d3-0f27e7159b05.

Dataset 19 Bioregional Assessment Programme (2014) QLD Dept of Natural Resources and Mines, Groundwater Entitlements linked to bores and NGIS v4 28072014. Bioregional Assessment Derived Dataset. Viewed 10 November 2015, http://data.bioregionalassessments.gov.au/dataset/b1ba5370-2c60-485f-9620-ddad39498999.

Dataset 20 South Australian Department of Environment, Water and Natural Resources (2014) SA Department of Environment, Water and Natural Resources (DEWNR) Groundwater Licence 141007. Bioregional Assessment Source Dataset. Viewed 13 November 2015, http://data.bioregionalassessments.gov.au/dataset/ce98b07d-1aea-44f6-8900-482ee49565b0.

Dataset 21 South Australian Department of Environment, Water and Natural Resources (2014) SA Department of Environment, Water and Natural Resourced (DEWNR) Water Management Areas 141007. Bioregional Assessment Source Dataset. Viewed 13 November 2015, http://data.bioregionalassessments.gov.au/dataset/d0730582-5225-4293-8da6-43ab3ec3b20d.

Dataset 22 Northern Territory Department of Land Resource Management (2014) Northern Territory Groundwater Licence Extract 20140130. Bioregional Assessment Source Dataset. Viewed 10 November 2015, http://data.bioregionalassessments.gov.au/dataset/80bd9912-5500-4f6f-a899-c299fb998518.

Dataset 23 Northern Territory Department of Land Resource Management (2014) Northern Territory Groundwater Management Units 20140630. Bioregional Assessment Source Dataset. Viewed 10 November 2015, http://data.bioregionalassessments.gov.au/dataset/01c48600-f9d3-42b6-8449-d2c5f40ef26f.

Dataset 24 Australian Government Department of the Environment (2004) National Heritage List Spatial Database (NHL) (v2.1). Bioregional Assessment Source Dataset. Viewed 10 November 2015, http://data.bioregionalassessments.gov.au/dataset/26daa8d7-a90e-47f3-982b-0df362414e65.

Dataset 25 Australian Government Department of the Environment (2004) Australia, Register of the National Estate (RNE) - Spatial Database (RNESDB) Internal. Bioregional Assessment Source Dataset. Viewed 10 November 2015, http://data.bioregionalassessments.gov.au/dataset/878f6780-be97-469b-8517-54bd12a407d0

Dataset 26 Bioregional Assessment Programme (2015) Species Profile and Threats Database (SPRAT) - Australia - Species of National Environmental Significance Database (BA subset - RESTRICTED - Metadata only). Bioregional Assessment Derived Dataset. Viewed 10 June 2015, http://data.bioregionalassessments.gov.au/dataset/7276dd93-cc8c-4c01-8df0-cef743c72112.

Dataset 27 Bioregional Assessment Programme (2015) Galilee Harwood Evapotranspiration v01. Bioregional Assessment Derived Dataset. Viewed 10 November 2015, http://data.bioregionalassessments.gov.au/dataset/11726ec2-89f4-4627-806f-6e9c119b92cb.

Dataset 28 Bioregional Assessment Programme (2015) Australian Water Observations from Space (WOfS) – Extracts and reclassification grids for the Lake Eyre Basin bioregion. Bioregional Assessment Derived Dataset. Viewed 10 November 2015, http://data.bioregionalassessments.gov.au/dataset/fc643926-cfe3-49b9-a0df-c07c0a85c10f.

1.3.2 Ecological assets

Summary

The water-dependent asset register for the preliminary assessment extent (PAE) of the Pedirka subregion contains 992 individual ecological assets. The water-dependent ecological assets encompass a large proportion of the area of the PAE. The asset register consists of 772 assets in the 'Vegetation' subgroup, 15 in the 'Groundwater feature' subgroup and 205 in the 'Surface water feature' subgroup. All nominated surface water and groundwater assets are assessed as water dependent. Of the nominated 'Vegetation' subgroup assets, 235 groundwater-dependent ecosystem (GDE) assets were excluded because of their low reliability status and a lack of evidence of water dependence using the datasets based on satellite imagery. Furthermore, 12 species habitat assets were excluded as the habitats could not be shown to fulfil the criteria for water dependence. The asset register includes one threatened ecological community and the potential spatial habitat distribution of three species listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The asset register also includes the potential habitat distributions of one additional species listed under Queensland's *Nature Conservation Act 1992* (Nature Conservation Act).

1.3.2.1 Description

1.3.2.1.1 Introduction to assets by subgroup, class and data source

The total number of ecological water-dependent assets in the PAE of the Pedirka subregion is 992 (from a total of 1239 ecological assets in the asset list). Of the water-dependent assets, 772 assets are vegetation features, 205 assets are surface water features and 15 assets are groundwater features (Table 7). Most of the vegetation features are groundwater-dependent ecosystems (GDEs) and most of the surface water features are wetlands, wetland complexes or swamps. Of the ecological assets, 938 assets were assessed as dependent on surface water and 646 assets were assessed as dependent on groundwater. Of these assets, 346 assets were assessed as dependent or possibly dependent on surface water alone, 54 assets were assessed as dependent or possibly dependent on groundwater alone, and 592 assets were assessed as dependent or possibly dependent on both surface water and groundwater.

Table 8 summarises the ecological assets and their water dependence according to database source. Maps of the distributions of the key data sources are shown in Figure 12, Figure 13, Figure 14, Figure 15, Figure 16 and Figure 17. Total assets cover a large proportion of the 219,000 km^2 area of the PAE, giving confidence that the asset register is a thorough basis for the assessment of potential impacts of coal resource developments during later stages of the BA. In some datasets, at least some large assets intersect with only a small part of the Pedirka PAE and extend far beyond the boundaries of the PAE. This is most strongly the case for the *National atlas of groundwater dependent ecosystems* (GDE Atlas) (subsurface) and the Water Asset Information Tool (WAIT) database, in which Great Artesian Basin (GAB) groundwater aquifers, recharge beds and dependent ecosystems extend far to the north, east and south of the Pedirka PAE.

Table 7 Summary of ecological assets within the preliminary assessment extent (PAE) of the Pedirka subregion, according to asset subgroup and class

Subgroup	Class	Number of water-dependent assets	Number of assets dependent on surface water	Number of assets dependent on groundwater
Groundwater feature	Aquifer, geological feature, alluvium or stratum	15	6	14
Surface water feature	Floodplain	13	13	0
	Lake, reservoir, lagoon or estuary	20	20	0
	Marsh, sedgeland, bog, spring or soak	66	26	65
	River or stream reach, tributary, anabranch or bend	51	51	0
	Waterhole, pool, rockpool or billabong	7	7	7
	Wetland, wetland complex or swamp	48	43	10
Vegetation	Groundwater-dependent ecosystem	747	747	535
	Habitat (potential species distribution)	25	25	15
Total		992	938	646

Data: Bioregional Assessment Programme (Dataset 1)

Table 8 Summary of ecological assets in the preliminary assessment extent (PAE) of the Pedirka subregion, according to asset data source

Dataset	Number of water-dependent assets	Number of assets dependent on surface water	Number of assets dependent on groundwater
Australian Hydrological Geospatial Fabric	37	37	5
Collaborative Australian Protected Areas Database (CAPAD)	10	10	7
A directory of important wetlands in Australia (DIWA)	6	6	5
Great Artesian Basin Groundwater Recharge	4	4	4
National atlas of groundwater dependent ecosystems (subsurface)	26	26	19
National atlas of groundwater dependent ecosystems (surface)	558	558	353
National Groundwater Information System	1	0	1
Birds Australia Important Bird Areas (IBA)	3	3	3
Northern Territory – Lake Eyre Basin – Wetlands Mapping	26	26	0
Queensland Lake Eyre Basin Rockholes and Waterholes in Queensland – Indigenous	1	1	1
Queensland Wetland Data Streams	10	10	0
SA Lake Eyre Basin Aquatic Ecosystems Mapping and Classification	34	34	0
SA Wetland Groundwater Dependent Ecosystem Classification	163	163	163
Threatened species listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)	8	8	3
Threatened species listed under *Queensland's Nature Conservation Act 1992*, excluding EPBC Act-listed species	3	3	1
Threatened ecological communities listed under the EPBC Act	1	1	1
WAIT Desert Channels	8	4	5
WAIT SA Arid Lands	93	44	75
Total	992	938	646

Data: Bioregional Assessment Programme (Dataset 1)

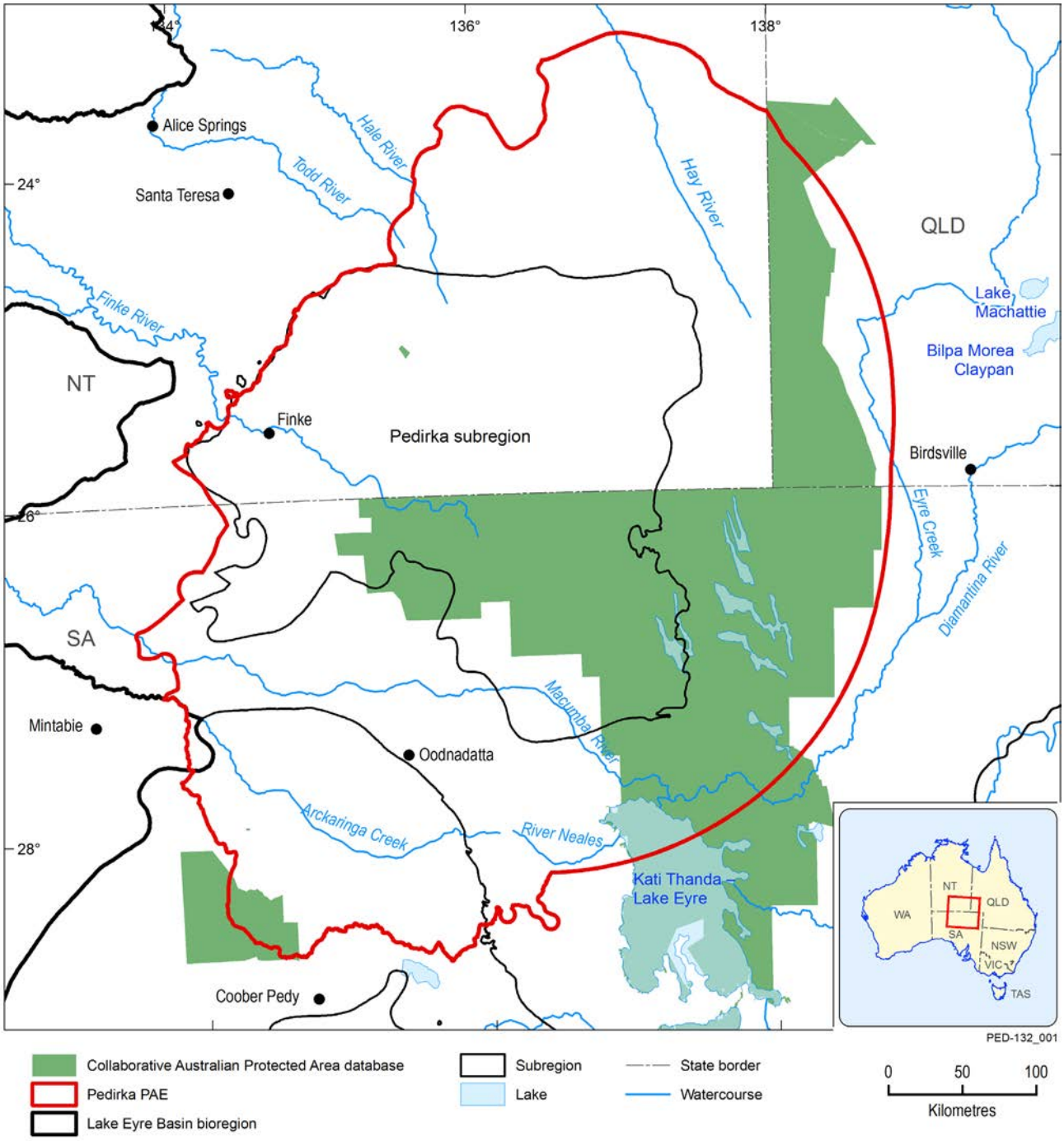


Figure 12 Collaborative Australian Protected Areas Database (CAPAD) assets in the Pedirka preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 1)

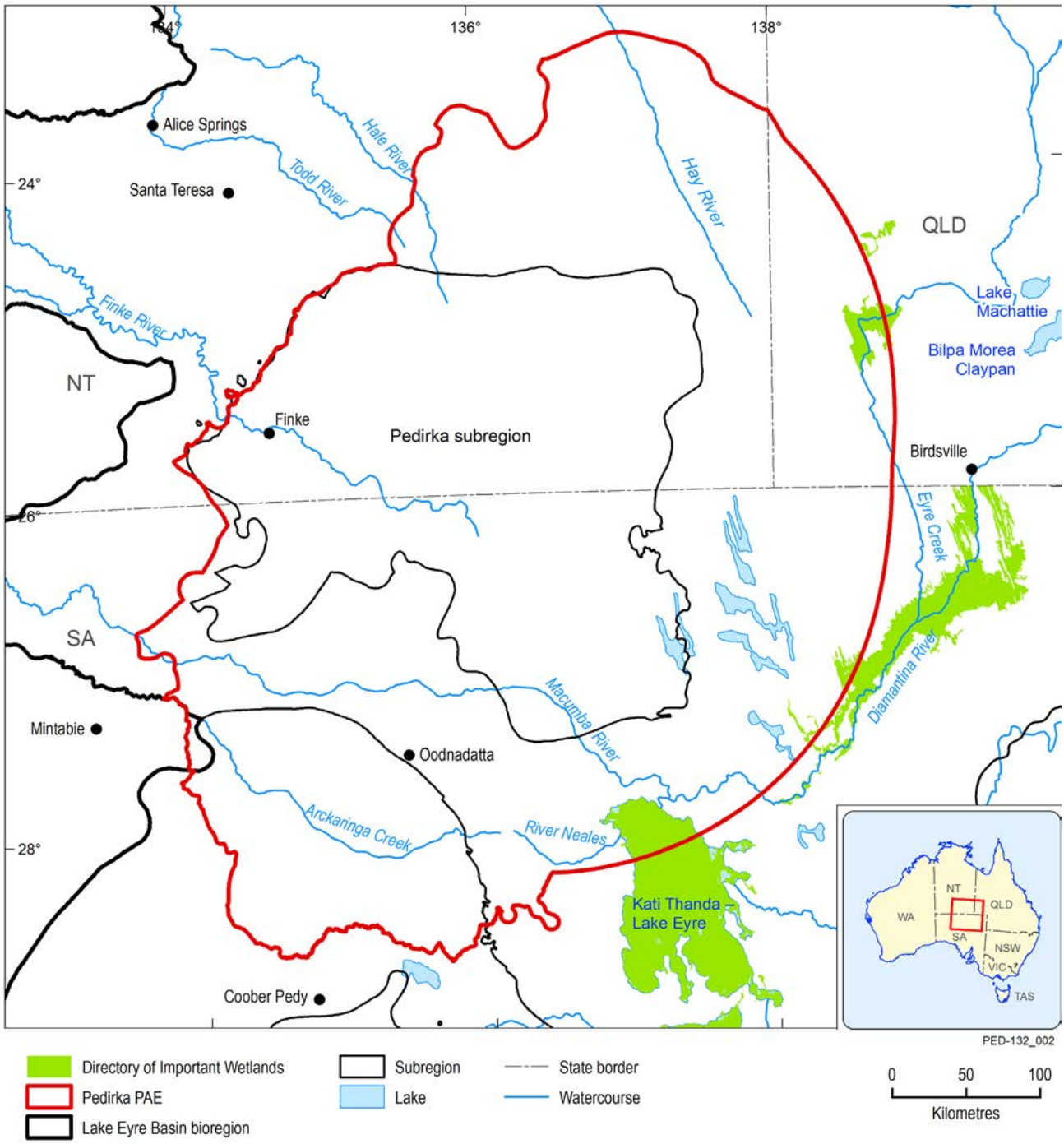


Figure 13 *A directory of important wetlands in Australia* (DIWA) assets in the Pedirka preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 1)

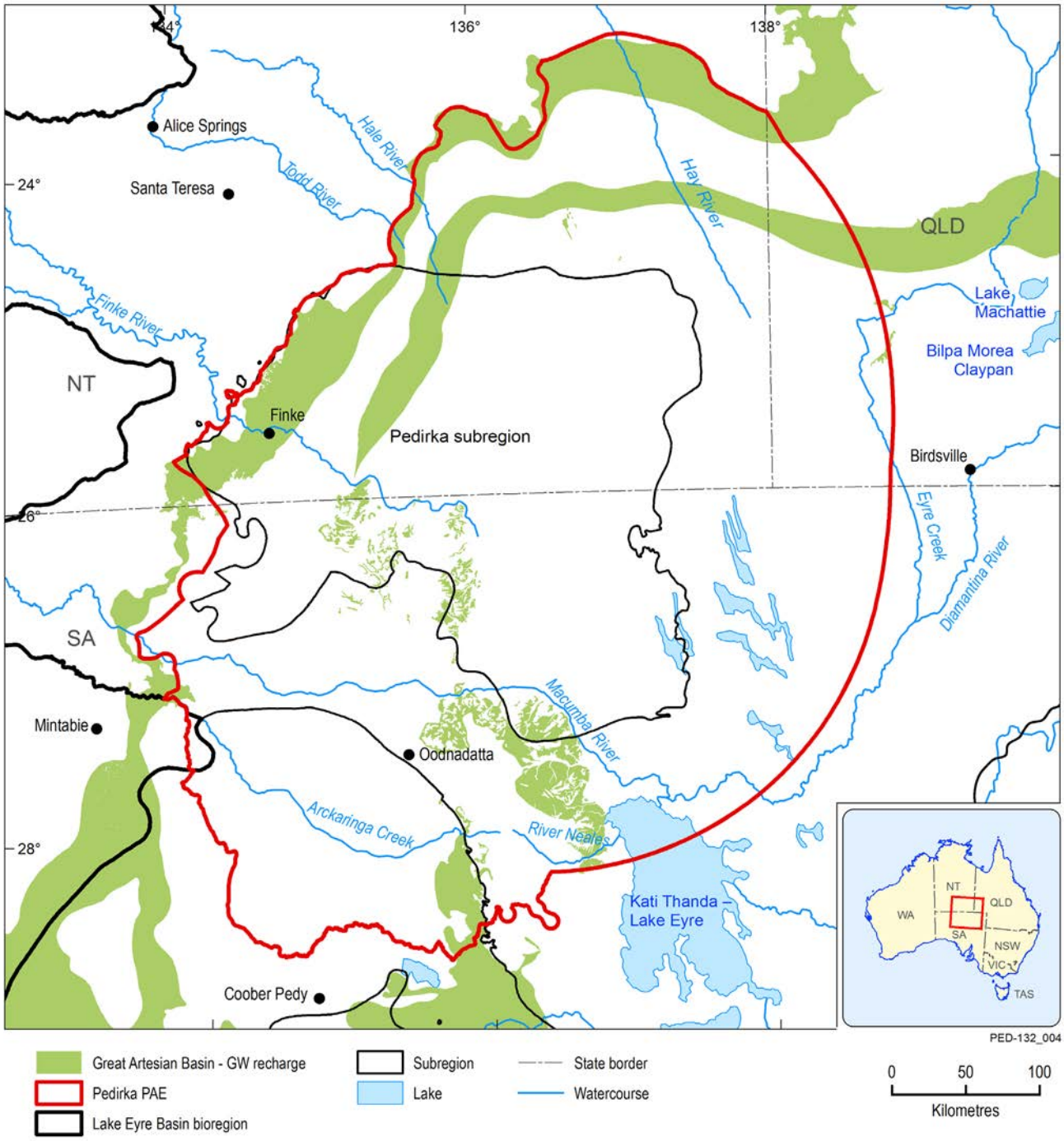


Figure 14 Great Artesian Basin Groundwater Recharge assets in the Pedirka preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 1)

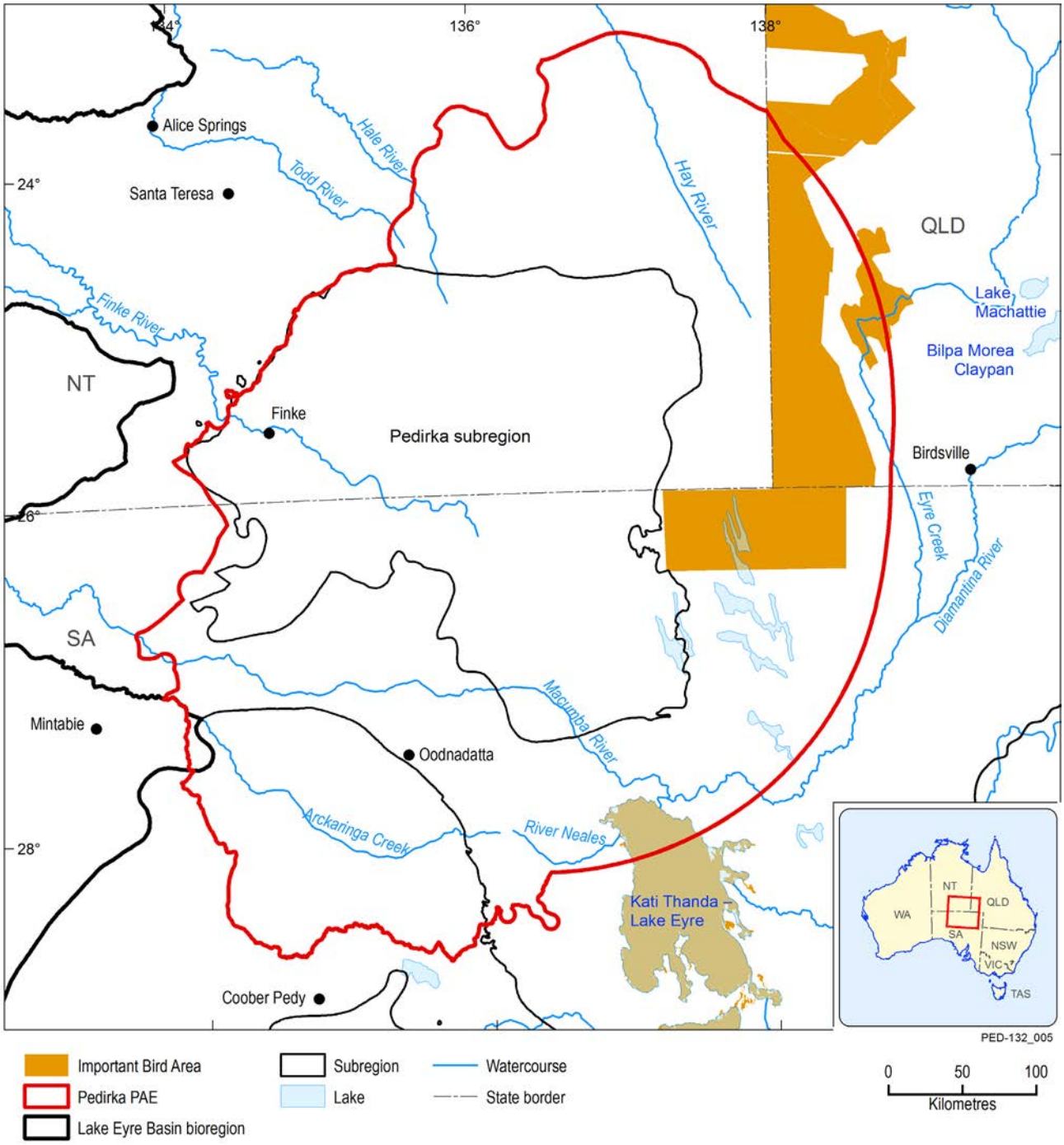


Figure 15 Map of Birds Australia Important Bird Areas (IBA) assets in the Pedirka preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 1)

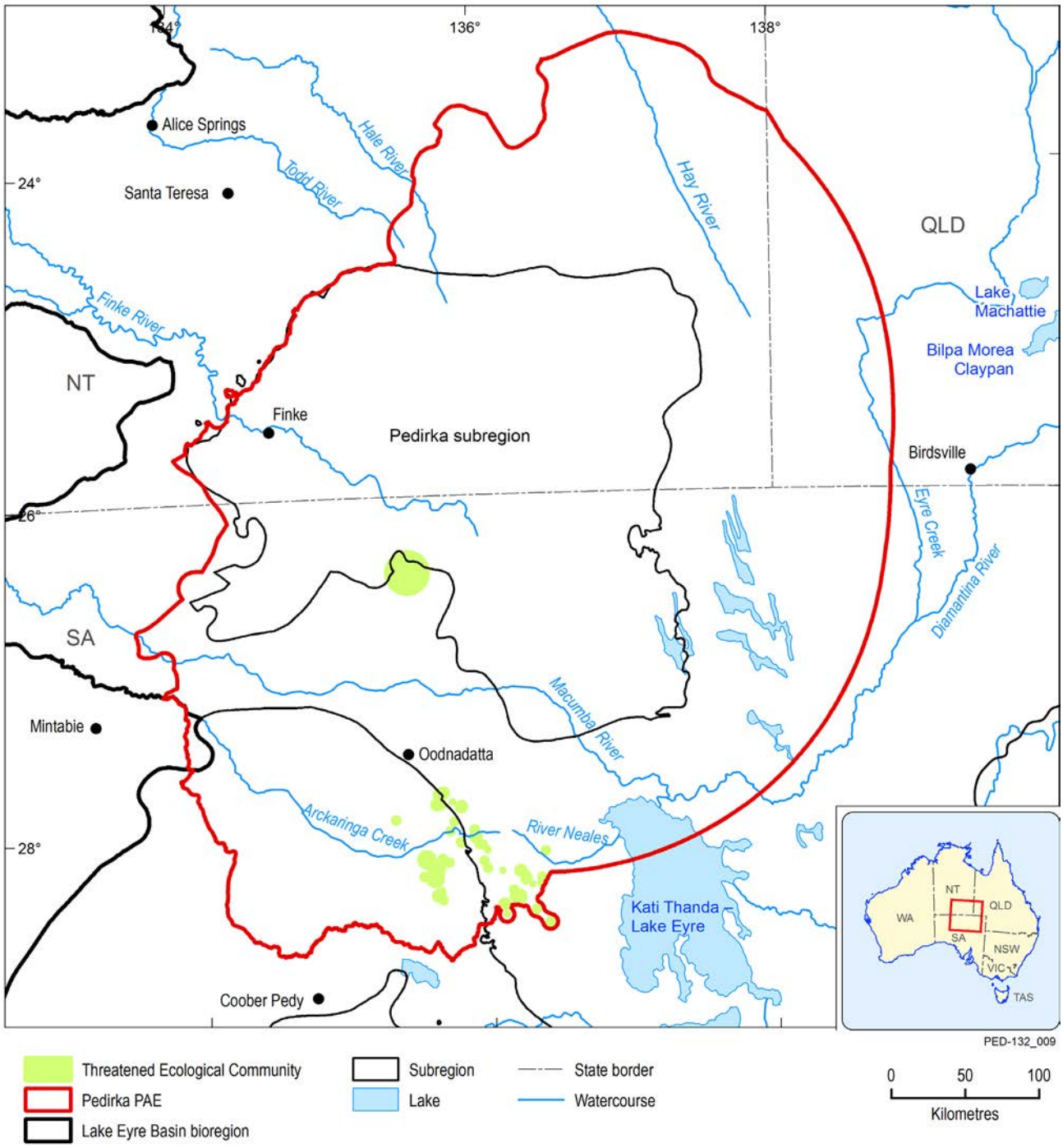


Figure 16 Threatened ecological communities listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* in the Pedirka preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 1)

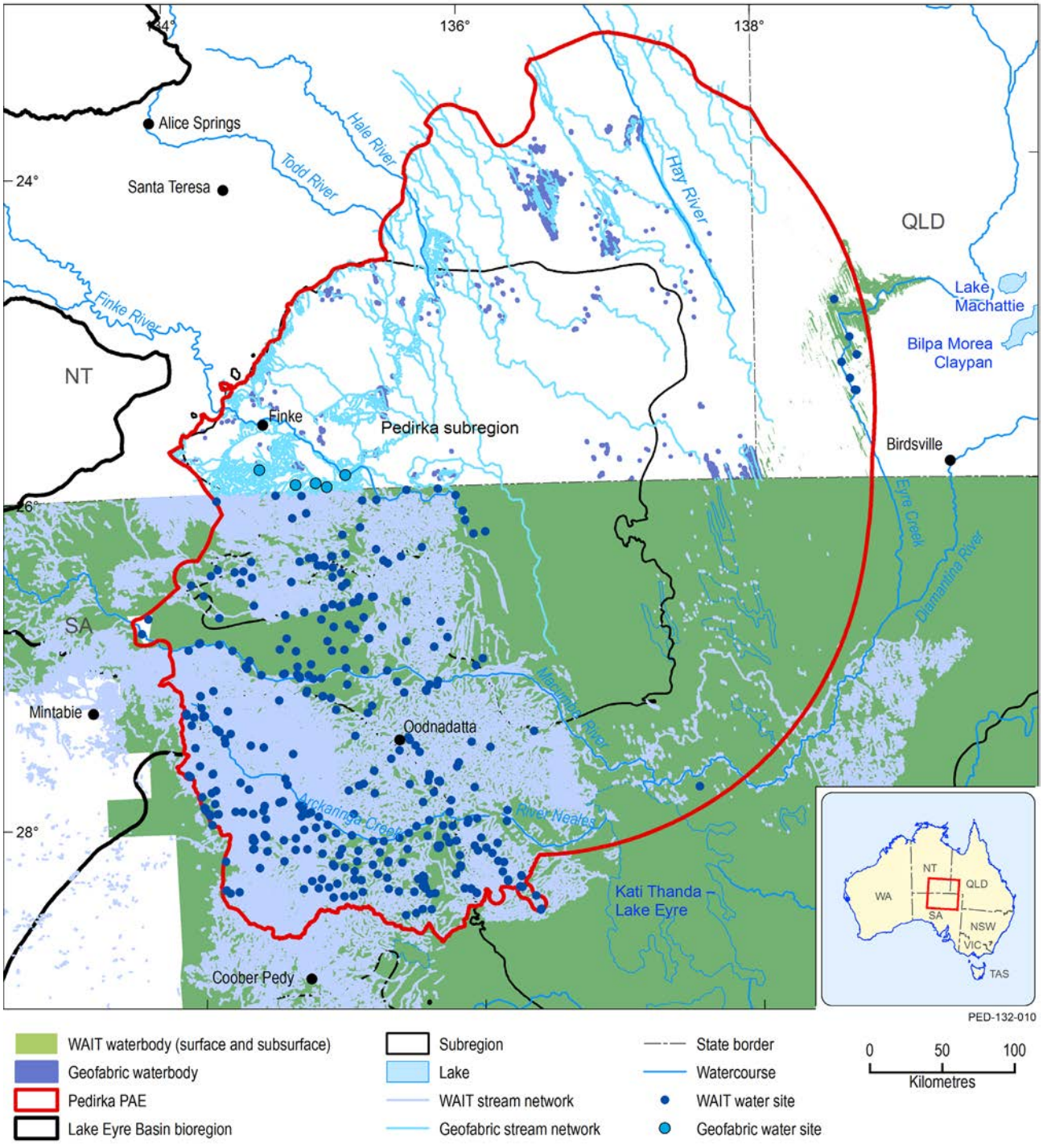


Figure 17 Water Asset Information Tool (WAIT) database assets for Queensland and South Australia, and equivalent Geofabric database assets for the Northern Territory, in the Pedirka preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 1)

1.3.2.1.2 Threatened ecological communities

Only one ecological community listed under the EPBC Act occurs in the Pedirka PAE. Management plans indicate that 'The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin threatened ecological community' depends eponymously on groundwater. Assessment data based on all satellite imagery data layers provide independent corroboration that this ecological community is water dependent. Most of these discharge springs occur to the west of Kati Thanda – Lake Eyre, with the Dalhousie Springs group lying further north, between Oodnadatta and Finke (Figure 16).

1.3.2.1.3 Habitats of threatened species

Of the 18 species listed as threatened under the EPBC Act, 8 species were assessed to rely upon water-dependent habitats, with 5 species dependent on surface water, and 3 species dependent on both surface water and groundwater (Table 9). Application of the precautionary principle means that any species that is 'possibly' dependent on water in excess of incident rainfall is determined to be water-dependent and its habitat is included in the register of water-dependent assets. None of the three EPBC Act-listed species that are dependent on groundwater is exclusively associated with 'The community of native species dependent on natural discharge of groundwater from the GAB threatened ecological community'. Instead, evidence for dependence on groundwater or surface water is much less clear cut. The species occur across a wide range of community types that are more commonly ephemeral rivers, creeks, swamps and floodplains than permanent waterbodies. Groundwater may contribute to the water supply in some of these community types, through contributions to subsurface baseflow in rivers and creeks, or to soil water in swamps and floodplains. In all these community types, determination of absolute dependence on water in excess of rainfall (i.e. flows down drainage lines and across floodplains) cannot be made with complete confidence, and in all cases the precautionary principle has been applied to assess these species' habitats.

Of the five species listed as threatened under the Nature Conservation Act, excluding those also listed under the EPBC Act, three species were assessed to rely upon water-dependent habitats, with two species likely or possibly dependent on surface water, and one species possibly dependent on both surface water and groundwater (Table 10). Evidence for dependence on surface water or groundwater is not clear cut for most of these species. As for some of the species listed under the EPBC Act, species listed under the Nature Conservation Act occur across a wide range of community types that are more commonly ephemeral than permanent waterbodies, and may involve some degree of input from groundwater sources. In such community types, determination of absolute dependence on water in excess of rainfall cannot be made with complete confidence, and again the precautionary principle has been applied to assess these species' habitats.

Table 9 Water-dependent threatened species listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* and within the preliminary assessment extent (PAE) of the Pedirka subregion

Although examples of individual species are listed, bioregional assessments consider the potential impact to the habitat of species not individual species per se.

Scientific name[a]	Common name	Dependence upon surface water	Dependence upon groundwater	Comments
Acacia latzii	Latz's Wattle	Possible	No	Occurs on shallow gravelly soils in small watercourses, gullies and rocky slopes
Ardea alba	Great Egret	Yes	Possible	Occurs in a wide range of wetland habitats, including freshwater and saline, permanent and ephemeral, open and vegetated
Calidris acuminata	Sharp-tailed Sandpiper	Yes	Unlikely	Occurs in lagoons, swamps, lakes, dams, waterholes, soaks, bore drains and bore swamps, saltpans and hyper-saline salt lakes
Eleocharis papillosa	Dwarf Desert Spike-rush	Yes	Possible	All records are from ephemeral wetlands, predominantly freshwater and semi-saline swamps
Erythrura gouldiae	Gouldian Finch	Yes	Possible	Associated with beds of grass around shallow waterholes, watercourses, soaks and springs
Macrotis lagotis	Greater Bilby	Possible	No	Historically associated with drainage systems, salt lake systems and other alluvial areas
Notoryctes typhlops	Itjaritjari	Possible	No	Few data on the habitat preferences of the Itjaritjari; may occupy sandy river flats where aeolian dunes occur nearby. River flats may be rich in food resources for the Itjaritjari
Rostratula australis	Australian Painted Snipe	Yes	No	Occurs in shallow freshwater (occasionally brackish) wetlands, both ephemeral and permanent, such as lakes, swamps, claypans, inundated or waterlogged grassland, saltmarsh, dams, and bore drains

Data: Bioregional Assessment Programme (Dataset 2)

[a]Typology and punctuation are given as they are used in the legislation.

Table 10 Water-dependent threatened species listed under Queensland's *Nature Conservation Act 1992* (but not listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999*) and within the preliminary assessment extent (PAE) of the Pedirka subregion

Although examples of individual species are listed, bioregional assessments consider the potential impact to the habitat of species not individual species per se.

Scientific name[a]	Common name	Dependence upon surface water	Dependence upon groundwater	Comments
Austrobryonia argillicola	Tobermorey Melon	Yes	Possible	Most abundant in seasonal swamps, clay pans and run-on areas, and riparian woodlands dominated by River Red Gum (*Eucalyptus camaldulensis*)
Epthianura crocea crocea	Yellow Chat	Yes	Unlikely	Birds feed within low vegetation in or near channels and basins, and are seen on the ground at the bases of sedges and on bare mud
Sclerolaena walkeri	A small shrub	Maybe	No	Occurs on saline river flats and floodplains

Data: Bioregional Assessment Programme (Dataset 2)
[a]Typology and punctuation are given as they are used in the legislation.

1.3.2.2 Gaps

The Pedirka subregion asset workshop in Adelaide in March 2015 confirmed two data gaps that had been identified previously during collation of the asset list:

- species listed as threatened under SA's *National Parks and Wildlife Act 1972*, including their threat status in the South Australian Outback region as assessed by Gillam and Urban (2013)
- species listed as threatened under the NT's *Territory Parks and Wildlife Conservation Act 2000*.

In each case, insufficient available spatial data meant that the habitats of these species could not be adequately geographically circumscribed as assets able to be nominated to the asset list, and thus it was not possible to determine the level of potential water dependence of these species during compilation of the register of water-dependent assets. Future assessments would be able to include the habitats of these species should suitable spatial data become available.

References

DEHP (2015) Aquatic Conservation Assessments (ACA) and AquaBAMM, Wetland*Info*. Queensland Department of Environment and Heritage Protection. Viewed 19 May 2015, http://wetlandinfo.ehp.qld.gov.au/wetlands/assessment/assessment-methods/aca/.

Gillam S and Urban R (2013) Regional Species Conservation Assessment Project, Phase 1 report: Regional Species Status Assessments, Outback region. South Australian Department of Environment, Water and Natural Resources, Adelaide.

Datasets

Dataset 1 Bioregional Assessment Programme (2014) Asset database for the Pedirka subregion on 27 August 2015. Bioregional Assessment Derived Dataset. Viewed 10 November 2015, http://data.bioregionalassessments.gov.au/dataset/62dc178f-65ae-4e6a-b5d4-12895b37d04c.

Dataset 2 Bioregional Assessment Programme (2015) Species Profile and Threats Database (SPRAT) - Australia - Species of National Environmental Significance Database (BA subset - RESTRICTED - Metadata only). Bioregional Assessment Derived Dataset. Viewed 22 May 2015, http://data.bioregionalassessments.gov.au/dataset/7276dd93-cc8c-4c01-8df0-cef743c72112.

1.3.3 Economic assets

Summary

The water-dependent asset register for the Pedirka subregion has seven economic water-dependent assets comprising 34 elements. There is only one asset within the subgroup 'Surface water management zone or area', comprising a single surface water access entitlement element, and six assets within the subgroup 'Groundwater management zone or area', comprising 31 groundwater access entitlement elements and two groundwater features used for water supply.

1.3.3.1 Description

The total number of economic water-dependent assets in the preliminary assessment extent (PAE) of the Pedirka subregion is seven (comprising 34 elements). These are:

- one asset comprising a single surface water access entitlement in SA
- four assets comprising 31 groundwater access entitlements grouped according to type and management zone or area in the NT, Queensland and SA
- two assets in NT that are groundwater features forming part of the Great Artesian Basin.

All assets are water dependent.

A *water access right* is defined as a perpetual or ongoing entitlement to exclusive access to a share of water from a specified consumptive pool as defined in the relevant water plan (Queensland *Water Act 2000*; Council of Australian Governments, 2004). Water access rights are tradeable with land in a bundled system, or may be tradeable without land in an unbundled system. The consumptive pool may be a body of groundwater or an interconnected set of surface water bodies. For a groundwater pool, access is by bores for domestic, stock, irrigation and/or other commercial uses, or for town water supplies. For surface waters, access is direct by pumping from a river or lake. Pool size and access right allocation of consumptive rights are subject to planning and management within zones, as used here to group the individual elements representing single bores and pumping locations into assets. Within the Pedirka subregion, two water access rights are for bores that supply the townships of Finke and Oodnadatta, and the remainder are bores that supply pastoral stations.

A *basic water right* (stock and domestic) is a water right held by a rural landowner for domestic, on-farm purposes (Department of the Environment, 2015). Stock purposes are watering stock of a number that would normally be depastured on the land on which the water is used, including pets. Domestic purposes include use within a house and for irrigation of a garden not exceeding 0.25 ha that is cultivated for domestic use rather than sale. Stock and domestic do not include use for dairies, piggeries, feed lots, poultry or any other intensive or commercial use. They may apply to domestic and farm bores, or to pumps in rivers and lakes. In the Pedirka subregion, all basic water rights are for bores on pastoral stations.

Table 11 shows the breakdown of water access entitlements (economic elements) for groundwater and surface water in the Pedirka preliminary assessment extent (PAE). The locations of the groundwater economic assets are shown in Figure 18.

Table 11 Summary of the water-dependent economic assets in the Pedirka preliminary assessment extent (PAE)

All assets are water dependent.

Subgroup	Asset class	State or territory	Number of assets	Number of elements
Groundwater management zone	Groundwater feature used for water supply	Northern Territory	2	2
	Water access right	Northern Territory	1	2
	Basic water right (stock and domestic)	Queensland	1	1
	Basic water right (stock and domestic)	South Australia	1	27
	Water access right	South Australia	1	1
Surface water management zone	Water access right	South Australia	1	1
Total			7	34

Data: Bioregional Assessment Programme (Dataset 1)

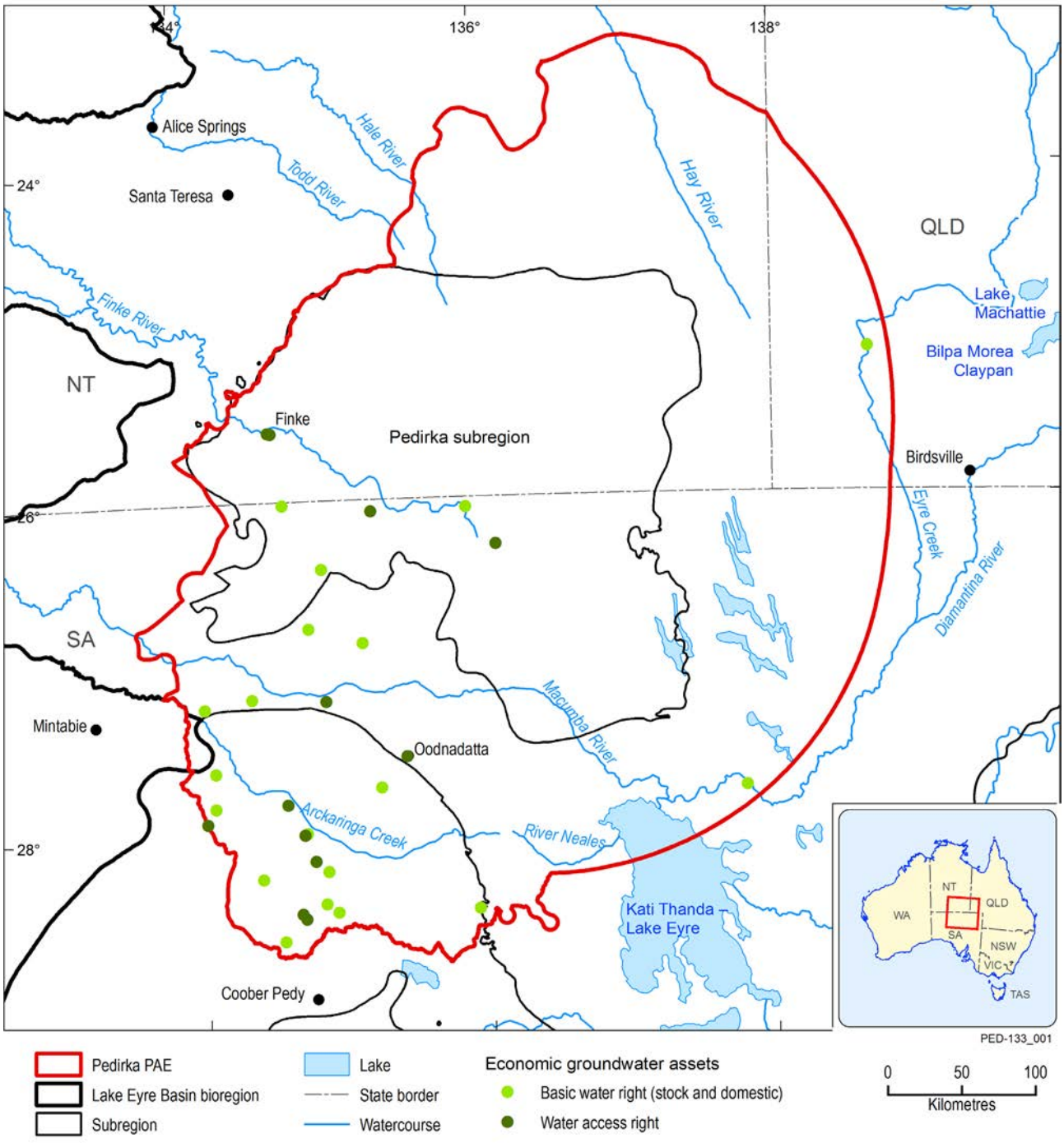


Figure 18 Groundwater economic assets in the preliminary assessment extent (PAE) of the Pedirka subregion

Data: Bioregional Assessment Programme (Dataset 1)

1.3.3.2 Gaps

No additional economic assets were nominated following the Pedirka subregion asset workshop in Adelaide in March 2015.

References

Council of Australian Governments (2004) Intergovernmental agreement on a National Water Initiative. Council of Australian Governments, Canberra. Viewed 22 May 2015, http://www.nwc.gov.au/__data/assets/pdf_file/0008/24749/Intergovernmental-Agreement-on-a-national-water-initiative.pdf.

Department of the Environment (2015) National water market: water rights. Department of the Environment, Australian Government. Viewed 19 August 2015, http://www.nationalwatermarket.gov.au/about/rights.html.

Datasets

Dataset 1 Bioregional Assessment Programme (2014) Asset database for the Pedirka subregion on 27 August 2015. Bioregional Assessment Derived Dataset. Viewed 10 November 2015, http://data.bioregionalassessments.gov.au/dataset/62dc178f-65ae-4e6a-b5d4-12895b37d04c.

1.3.4 Sociocultural assets

Summary

All 59 sociocultural assets were sourced from the Australian Heritage Database (Department of the Environment, 2015), of which 53 were considered to be water dependent (surface and/or groundwater). No additional sociocultural assets were nominated at the Pedirka subregion asset workshop in Adelaide in March 2015.

Some sociocultural assets with identified heritage values are also areas with natural values. Consequently they are partly or entirely protected under national and/or state conservation legislation, and thus were also nominated as ecological assets. These sociocultural assets are water dependent. Other sociocultural assets are historical places, including several places associated with the Overland Telegraph Line from Adelaide to Darwin. Most of the historical places are also water dependent because they are located near groundwater discharge springs or on floodplains.

Thirty-six Indigenous assets are listed in the Register of the National Estate (RNE) and in the absence of detailed location descriptions, all were considered to be potentially water dependent.

1.3.4.1 Description

The total of 59 sociocultural assets in the asset list were sourced from the Australian Heritage Database (Department of the Environment, 2015; Bioregional Assessment Programme, Dataset 1), comprising 56 assets from the RNE and 3 assets from the National Heritage List. A total of 53 were considered to be water dependent and were included in the water-dependent asset register. Of the water-dependent assets, 10 assets are assessed as dependent or possibly dependent on surface water alone, 4 assets are assessed as dependent or possibly dependent on groundwater alone and 39 assets are assessed as dependent or possibly dependent on both surface water and groundwater. No additional sociocultural assets were nominated at the Pedirka asset workshop in Adelaide in March 2015.

Table 12 shows the breakdown of water-dependent sociocultural assets by dataset, subgroup and class. The geographic locations of the assets are shown in Figure 19. There are 42 assets in the 'Cultural' subgroup and 11 assets in the 'Social' subgroup. Thirty-three of the assets from the RNE are classed as Indigenous sites. In the north, east and south of the Pedirka preliminary assessment extent (PAE), several large assets intersect with only a small part of the PAE and extend far beyond the boundaries of the PAE. During subsequent stages of the Bioregional Assessment Technical Programme, impact will only be assessed for those parts of such assets that lie within the PAE.

Table 12 Summary of the water-dependent sociocultural assets in the preliminary assessment extent (PAE) of the Pedirka subregion

Dataset	Subgroup	Asset class	Number of assets	Number of assets dependent on groundwater	Number of assets dependent on surface water
National Heritage List (NHL)	Cultural	Heritage site	3	2	2
Register of the National Estate (RNE)	Cultural	Heritage site	3	1	2
Register of the National Estate (RNE)	Cultural	Indigenous site	36	35	36
Register of the National Estate (RNE)	Social	Recreation area	11	5	9
Total			53	43	49

Data: Bioregional Assessment Programme (Dataset 1)

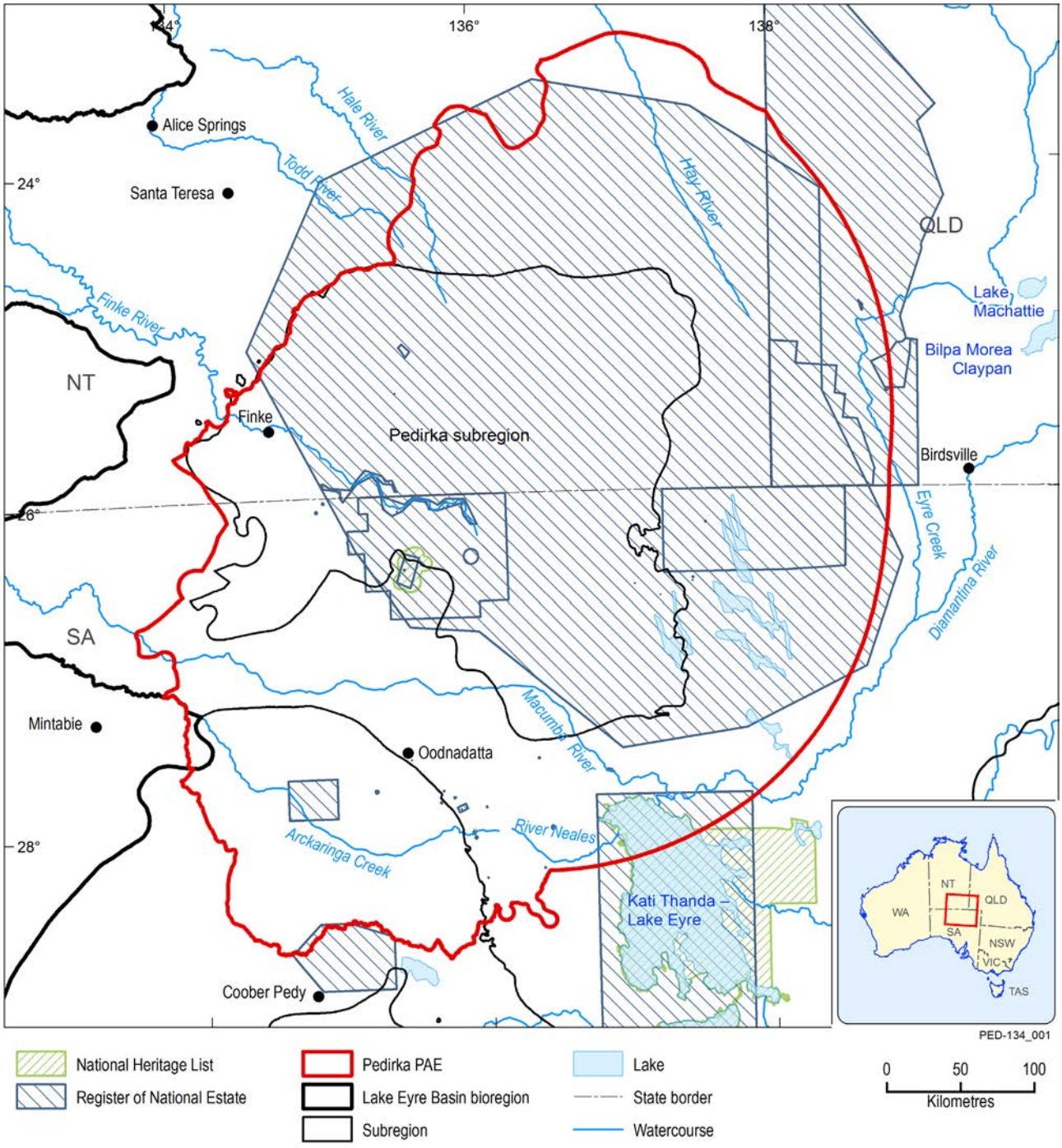


Figure 19 Water-dependent sociocultural assets in the Pedirka subregion

Data: Bioregional Assessment Programme (Dataset 1)

The three assets from the National Heritage List: Dalhousie Springs, Freeling Springs and Lake Eyre National Park (NHL) are all areas that have natural values and are partly or entirely protected under national and/or state conservation legislation. These sociocultural assets were also nominated as ecological assets. All examples of this type of asset depend on a combination of surface water and groundwater – at least in part.

Two of the three assets sourced from the RNE that are classed as heritage sites are also natural areas that have federal or state-level conservation designations (Kati Thanda – Lake Eyre and the

Simpson Desert). They are also nominated as assets from other databases that were classified as containing ecological assets and depend on surface water, at least in part.

The remaining asset (Charlotte Waters Telegraph Station) sourced from the RNE and classed as a heritage site is a historical place. This site was an active part of the Overland Telegraph Line from Adelaide to Darwin during the 19th century. It was assessed as water dependent because it is located on the floodplain of the Finke River.

The water-dependent asset register includes 36 Indigenous sites sourced from the RNE. Other than the name and location of the asset, very little information was available to assess water dependence. Hercus (2009) described locations with similar or related names in northern SA and associated many of those locations with waterholes and rockholes. On the basis of this naming information and the secondary analyses through intersections with remotely sensed data sources, and applying the precautionary principle in each case, all of these Indigenous sites are likely or possibly dependent on surface water, and all but one site may also be dependent on groundwater.

1.3.4.2 Gaps

No further sociocultural assets were nominated following the Pedirka asset workshop in Adelaide in March 2015.

In the Pedirka subregion, the Bioregional Assessment Programme is awaiting the outcomes of commissioned research into the cultural values associated with water assets, including Indigenous values. The Bioregional Assessment Programme will be able to incorporate this new information once it becomes available in the future..

For bioregional assessment purposes, no other specific gaps in the knowledge base related to sociocultural assets in the Pedirka subregion have been identified.

References

Department of the Environment (2015) Australian Heritage Database online. Viewed 22 May 2015, http://www.environment.gov.au/topics/heritage/publications-and-resources/australian-heritage-database.

Hercus L (2009) Murkarra, a landscape nearly forgotten: The Arabana country of the noxious insects, north and northwest of Lake Eyre. In: Hercus L and Koch H (eds) Aboriginal placenames: naming and re-naming the Australian landscape. ANU E Press and Aboriginal History Incorporated, Canberra, 257–272.

Datasets

Dataset 1 Bioregional Assessment Programme (2014) Asset database for the Pedirka subregion on 27 August 2015. Bioregional Assessment Derived0Dataset. Viewed 10 November 2015, http://data.bioregionalassessments.gov.au/dataset/62dc178f-65ae-4e6a-b5d4-12895b37d04c.

www.bioregionalassessments.gov.au

Australian Government
Department of the Environment
Bureau of Meteorology
Geoscience Australia

CSIRO