



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 Galilee subregion

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

25 September 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>.

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Artesian Spring Wetland at Doongmabulla Nature Refuge, Queensland, 2013

Credit: Jeremy Drimer, University of Queensland



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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.

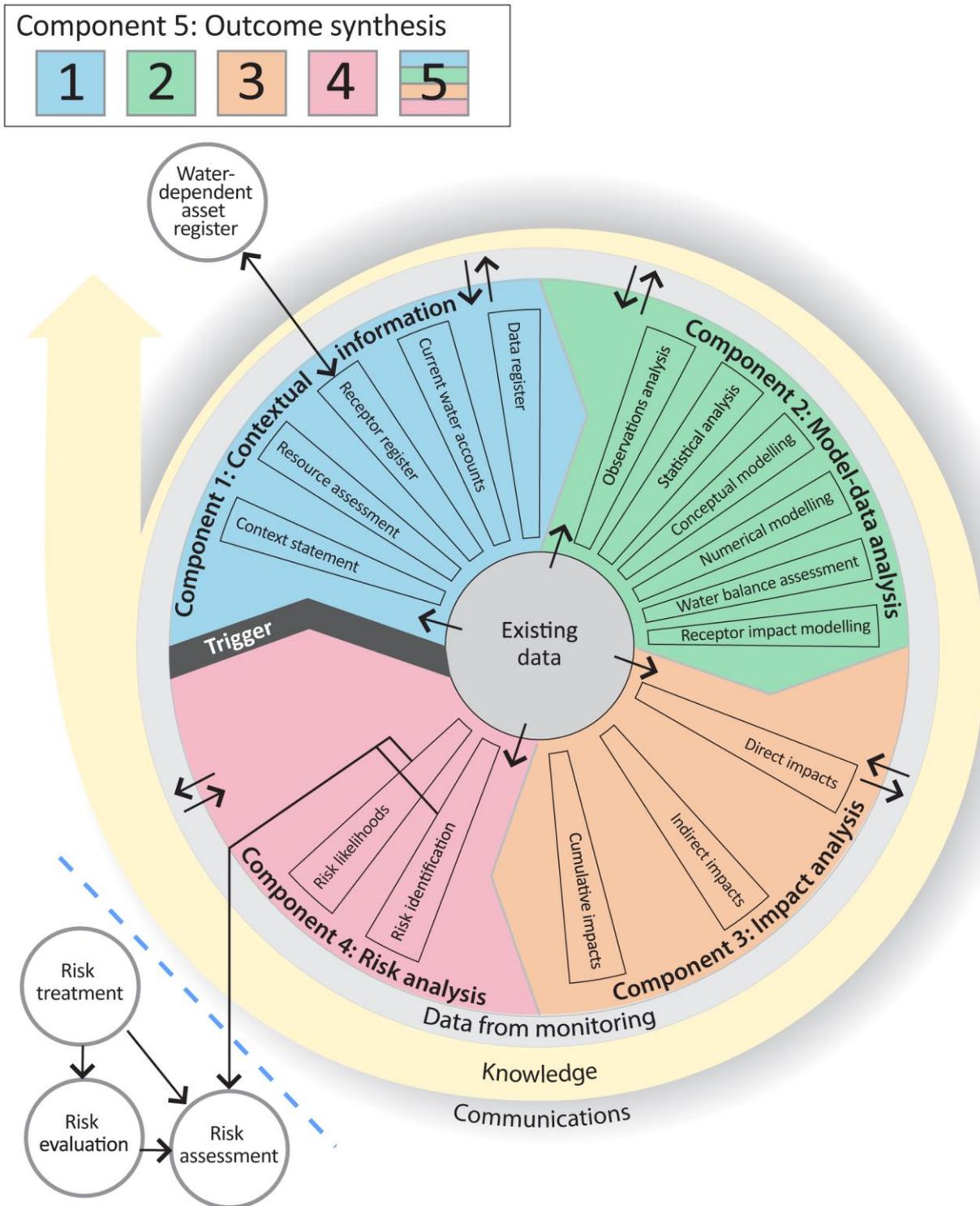


Figure 1 Schematic diagram of the bioregional assessment methodology

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	<i>Methodology for bioregional assessments of the impacts of coal seam gas and coal mining development on water resources</i>	A high-level description of the scientific and intellectual basis for a consistent approach to all bioregional assessments	All
M02	<i>Compiling water-dependent assets</i>	Describes the approach for determining water-dependent assets	1.3 Description of the water-dependent asset register
M03	<i>Assigning receptors and impact variables to water-dependent assets</i>	Describes the approach for determining receptors associated with water-dependent assets	1.4 Description of the receptor register
M04	<i>Developing a coal resource development pathway</i>	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	<i>Developing the conceptual model for causal pathways</i>	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	<i>Surface water modelling</i>	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	<i>Groundwater modelling</i>	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	<i>Receptor impact modelling</i>	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	<i>Propagating uncertainty through models</i>	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	<i>Risk and cumulative impacts on receptors</i>	Describes the process to identify and analyse risk	3 Impact analysis 4 Risk analysis
M11	<i>Hazard identification</i>	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	<i>Fracture propagation and chemical concentrations</i>	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>.

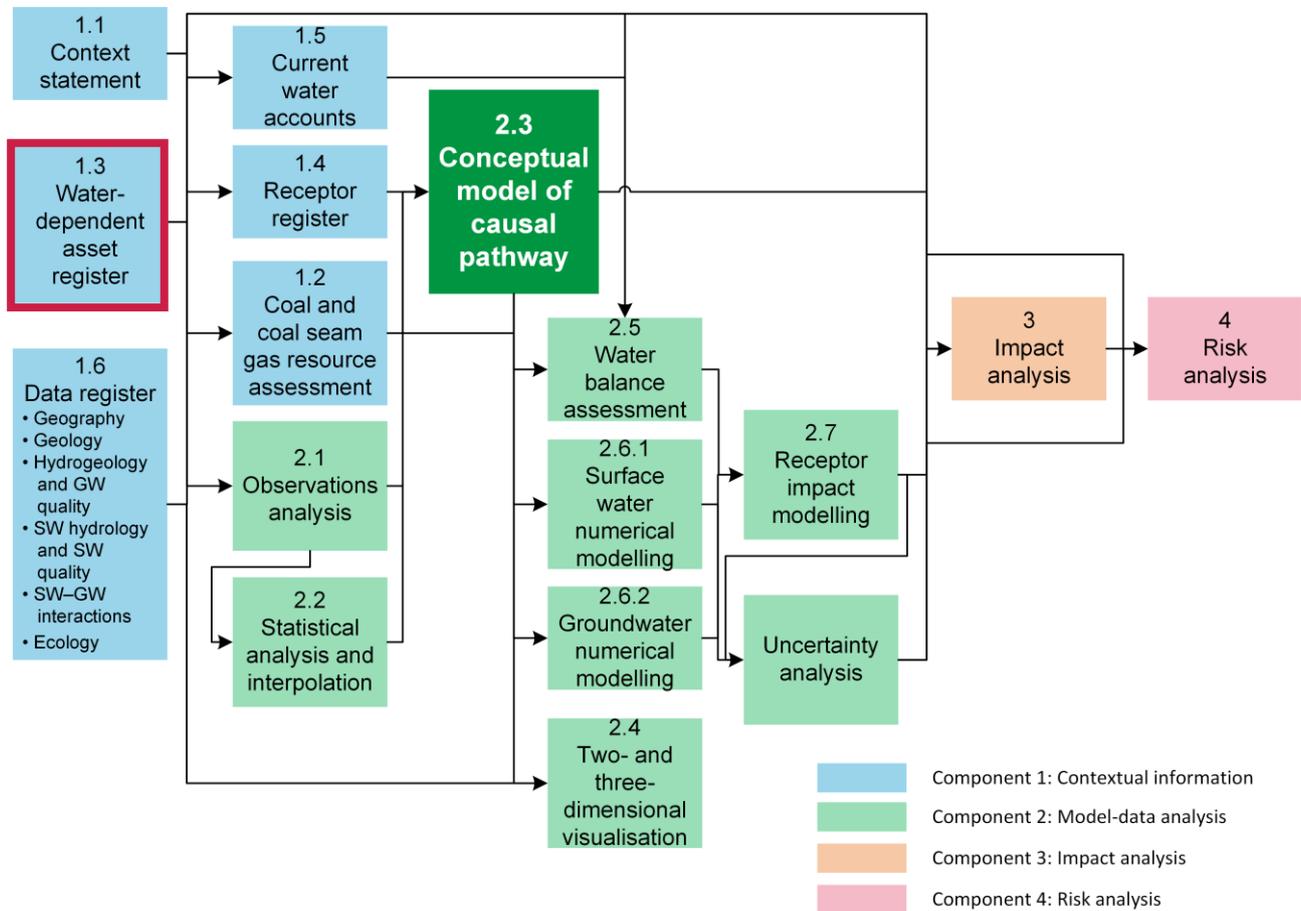


Figure 2 The simple decision tree indicates the flow of information through a bioregional assessment

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 Galilee 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	PDF, HTML
	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	PDF, HTML, register
	1.5	Current water accounts and water quality	2.5.1.5	PDF, HTML
	1.6	Data register	2.5.1.6	Register
Component 2: Model-data analysis for the Galilee subregion	2.1-2.2	Observations analysis, statistical analysis and interpolation	2.5.2.1, 2.5.2.2	PDF, HTML
	2.3	Conceptual modelling	2.5.2.3, 4.3	PDF, HTML
	2.5	Water balance assessment	2.5.2.4	PDF, HTML
	2.6.1	Surface water numerical modelling	4.4	PDF, HTML
	2.6.2	Groundwater numerical modelling	4.4	PDF, HTML
	2.7	Receptor impact modelling	2.5.2.6, 4.5	PDF, HTML
Component 3: Impact analysis for the Galilee subregion	3-4	Impact analysis	5.2.1	PDF, HTML
Component 4: Risk analysis for the Galilee 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.

^b*Methodology 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 4 July 2017, <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 Galilee 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/GAL/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 Galilee subregion. This section details the specific implementation to the Galilee subregion of methods described in the companion submethodology M02 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 Galilee 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.

1.3.1.1 Background and context

This product presents information about the water-dependent asset register developed for the Galilee subregion. The name of the dated snapshot of the asset register this description refers to is 'Water-dependent asset register and asset list for the Galilee subregion on 10 September 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/GAL/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 Galilee subregion is described in the following sections.

An *asset* is an entity having value to the community and, for bioregional assessment (BA) purposes, is associated with a bioregion or subregion. 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, 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 classified into 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 Office of Water Science liaised with Indigenous knowledge holders about Indigenous sociocultural water-dependent assets (further discussed in Section 1.3.4.1).

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. The product 1.3 will not be updated or republished as part of bioregional assessments 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 to water-dependent assets is described in the companion submethodology M03 (as listed in Table 1) for assigning receptors to water-dependent assets (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

Eight natural resource management organisations (NRMs) nominated assets through contribution of data to the Water Asset Information Tool (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.

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Additional assets were nominated from analysis of data provided by national, state and regional databases (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 or state legislation
- potential distributions of species with a threatened status recognised by national or state 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 Galilee subregion

Organisation	Description in asset register	Elements	Assets (asset list)
North Queensland Dry Tropics	WAIT_Burdekin	221	31
Desert Channels Queensland	WAIT_Desert Channels	25,635	214
Fitzroy Basin Association	WAIT_Fitzroy	7,532	36
Queensland Murray-Darling Committee	WAIT_QMDC	519	10
Queensland Murray-Darling Committee	WAIT_QMDC_ERIN	7	1
SA Arid Lands Natural Resources Management Board	WAIT_SA	1,471	35
Southern Gulf Catchments	WAIT_Southern Gulf	6,743	113
South West Natural Resource Management Ltd	WAIT_SWQLD_ERIN	8	8
Additional data contributed by ERIN	WAIT_ERIN	204	38
Total		42,340	486

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

Dataset ^{a,b}	Organisation	Dataset citation	Elements	Assets (asset list)
Collaborative Australian Protected Areas Database (CAPAD) 2012	Department of the Environment	Australian Government Department of the Environment (Dataset 4)	63	63
Directory of Important Wetlands in Australia (DIWA) Spatial Database	Department of the Environment	Australian Government Department of the Environment (Dataset 5)	52	39
Environmental Asset Database - Commonwealth Environmental Water Office	Department of the Environment (restricted access)	Australian Government Department of the Environment (Dataset 6)	3	3
Great Artesian Basin and Laura Basin groundwater recharge areas	Geoscience Australia	Geoscience Australia (Dataset 7)	520	10
National Groundwater Dependent Ecosystems (GDE) Atlas	Bureau of Meteorology	Bureau of Meteorology (Dataset 8)	110,320	2,265
Birds Australia - Important Bird Areas (IBA) 2009	Birds Australia	Birds Australia (Dataset 9)	13	13
Key Environmental Assets - KEA - of the Murray Darling Basin	Murray-Darling Basin Authority	Murray-Darling Basin Authority (Dataset 10)	7,724	149
Permanent and Semi-Permanent Waterbodies of the Lake Eyre Basin	Department of Science, Information, Technology, Innovation and the Arts, Queensland Government	Queensland Department of Environment and Resource Management (Dataset 11)	1,124	926
Communities of National Environmental Significance Database	Department of the Environment	Australian Government Department of the Environment (Dataset 12)	4,630	7
Australia - Species of National Environmental Significance Database	Department of the Environment	Australian Government Department of the Environment (Dataset 13)	641	39
QLD DSITIA Galilee LGA Species List	Department of Environment and Heritage Protection, Queensland Government	Queensland Department of Science, Information Technology, Innovation and the Arts (Dataset 14)	227,171	78
Biodiversity status of pre-clearing and remnant regional ecosystems - South East Qld	Department of Environment and Heritage Protection, Queensland Government	Queensland Herbarium, Department of Science, Information Technology, Innovation and the Arts (Dataset 15)	4,143	43

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Dataset ^{a,b}	Organisation	Dataset citation	Elements	Assets (asset list)
Ramsar Wetlands of Australia	Department of the Environment	Australian Government Department of Sustainability, Environment, Water, Population and Communities (Dataset 16)	1	1
Total			356,405	3,636

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

^bTypology and punctuation are given as provided in the metadata for these datasets.

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 register, along with associated maps and data, was presented to experts and organisations with local knowledge at workshops in Longreach and Richmond in September 2014, and in Brisbane in October 2014, for comment and feedback. The attendees were given two weeks to review the preliminary water-dependent asset register 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 in Queensland are classed either as 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 the water. A basic right for ‘take of surface water’ does not require approval for any works or for the extraction of the 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). Bores were also nominated by two NRM organisations (Desert Channels NRM and Southern Gulf NRM) through the WAIT database.

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 the nine water management zones or areas) to create assets.

Table 5 Data sources for economic assets in the Galilee subregion

Dataset ^{a,b}	Organisation	Dataset citation	Elements	Assets (asset list)
Groundwater Entitlements linked to bores and NGIS v4 28072014	Department of Natural Resources and Mines, Queensland Government	Bioregional Assessment Programme (Dataset 17)	4863	96
Surface Water Licences linked to Spatial Locations - v1 20140313	Department of Natural Resources and Mines, Queensland Government	Bioregional Assessment Programme (Dataset 18)	149	33
Total			5012	129

^aThe 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.

^bTypology and punctuation are given as provided in the metadata for these datasets.

1.3.1.2.3 Sociocultural assets

Sociocultural assets were sourced from the Australian Heritage Database which includes assets sourced from the World Heritage List, National Heritage List and the Register of the National Estate (Australian Government Department of the Environment, Dataset 19, Dataset 20, Dataset 21).

Meetings have been held with Indigenous knowledge holders in the Galilee subregion to gain further understanding of Indigenous cultural water-dependent assets. Where possible and appropriate, and with the agreement of Indigenous knowledge holders, these additional Indigenous sociocultural water-dependent assets will be published in a separate report. Identified assets will be incorporated into an updated water-dependent asset register and/or incorporated into later technical products.

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

Dataset ^{a,b}	Organisation	Dataset citation	Elements	Assets (asset list)
Australia World Heritage Areas	Department of the Environment	Australian Government Department of the Environment (Dataset 19)	1	1
National Heritage List Spatial Database (NHL) (v2.1)	Department of the Environment	Australian Government Department of the Environment (Dataset 20)	9	9
Australia, Register of the National Estate (RNE) - Spatial Database (RNESDB) Internal	Department of the Environment	Australian Government Department of the Environment (Dataset 21)	96	96
Total			106	106

^aThe 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.

^bTypology and punctuation are given as provided in the metadata for these datasets.

1.3.1.2.4 Duplicated or overlapping assets

Some specific areas within the Galilee PAE were nominated several times, from different databases. For example, Edgbaston Springs and the immediate surrounding areas (north-east of Aramac, in the north-eastern part of the PAE) were nominated as:

- a protected area (CAPAD)
- an important wetland (DIWA)
- an area of heritage significance to the National Estate (RNE)
- part of a national threatened ecological community (EPBC TEC)
- a Desert Channels NRM asset (WAIT).

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 Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- potential habitats of federal or state-listed threatened species.

Duplicate and overlapping assets are treated as entirely separate assets for the purposes of compiling the register of water-dependent assets for the Galilee subregion. Such an approach means 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 is paid to all stakeholders' asset nominations and contributed databases.

1.3.1.3 *Determining the preliminary assessment extent*

Defining the PAE allows the asset register to be compiled in parallel with the assessment of the coal and coal seam gas resources (Lewis et al., 2014) and the development of the coal resource development pathway (see pending companion product 2.3) for the subregion.

Because development of the Galilee PAE occurred prior to any modelling or significant data analysis taking place as part of the Galilee BA, the following principles guided the development of the PAE:

- The PAE had to encompass all conceivable, conceptualised scenarios, and be conservative and precautionary.
- The PAE had to encompass all potential coal resource developments within the Galilee subregion (see Lewis et al., 2014).
- There needed to be a buffer zone around the PAE area to avoid potential boundary effects during modelling and impact assessment (e.g. not having enough data outside the modelled area of interest to show the true edge of potential response and impact areas).

The Galilee PAE was constructed from two parts: a surface water PAE and groundwater PAE.

The surface water PAE was constructed according to the following steps:

1. Identify major catchments in the Galilee subregion and identify where the major drainage channels ended.
2. Identify major infrastructure in the catchments where surface water flow could be significantly impeded (e.g. dams).
3. If infrastructure such as a major dam exists, then the PAE was stopped at that point, as it was assumed any impacts would be captured rather than propagated further downstream. The exception was the surface water PAE in the Burdekin river basin. For the Burdekin River, the surface water PAE was extended beyond the Burdekin Falls dam to the coast. This was done to ensure that assets in the vicinity of the Burdekin River directly downstream of the dam were included in the asset register as all of the coal developments at an advanced approval stage in the Galilee subregion are located in the headwaters of the Burdekin river basin.
4. If there was no significant infrastructure, then the surface water PAE was extended along the main drainage to the outlet of the catchment. This was either at the sea or Kati Thanda – Lake Eyre.
5. A buffer of 5 km was placed around all drainage channels, to capture any near-stream assets and counter potential data errors in GIS datasets.

The groundwater PAE was constructed according to the following steps:

1. The whole of the Galilee subregion was included according to the precautionary principle. This approach was taken because, at the time of development of the PAE, there was limited information available about potential coal resource developments and potential hydrogeological connectivity.

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2. A buffer of 20 km was applied to the eastern margin of the subregion. Here, the reasoning was that the eastern margin of the Galilee subregion forms a major geological boundary and it is envisaged that drawdown of the watertable from developments would not extend far into adjoining geological regions. In addition, a 20 km buffer would include much of the Belyando River catchment, which is an area in which impacts could potentially occur as a result of its proximity to proposed coal resource developments.
3. At the time of development of the Galilee PAE, it was still uncertain how far any potential hydrological responses might extend into overlying aquifers associated with the Eromanga Basin. Thus a 200 km buffer was applied to the western and southern margins of the subregion. The reasoning here was that the overlying Eromanga Basin rock units extend to the west and south of the Galilee subregion.
4. The section of PAE boundary extending north-east from Cloncurry corresponds with the edge of the Eromanga Basin. This basin margin edge approximates a major groundwater divide in the Great Artesian Basin.

The Galilee PAE is a composite of this groundwater PAE and surface water PAE (Figure 3).

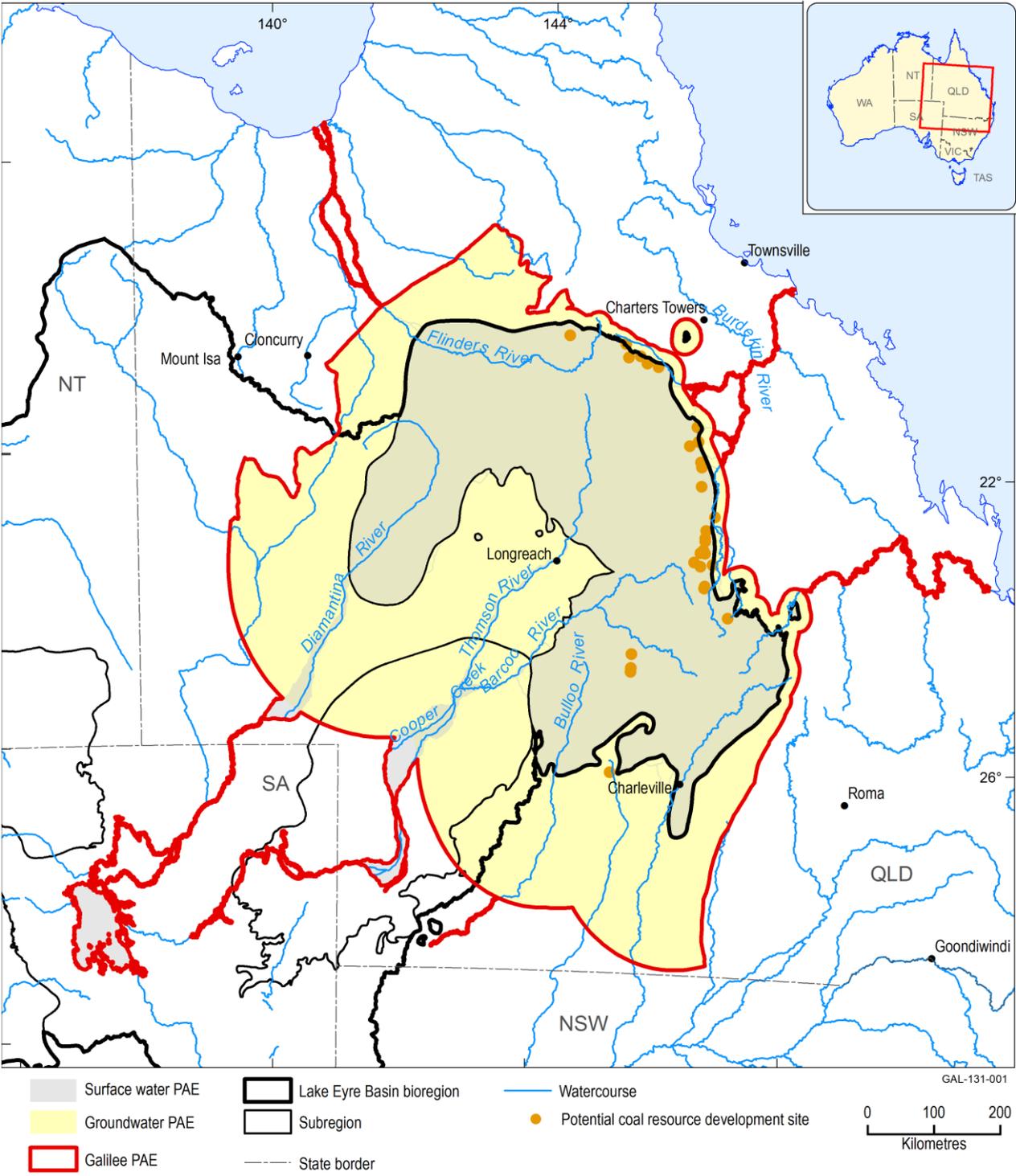


Figure 3 Potential coal resource development sites, and surface and groundwater preliminary assessment extents (PAE) for the Galilee subregion

Data: Geoscience Australia (Dataset 22), Bioregional Assessment Programme (Dataset 24)

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 degrees 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 form the foundation of the approach to assessment of water dependence of assets in the Galilee PAE:

- *Efficiency.* The methods are suitable for effective application to large numbers of assets.
- *Transparency.* All decisions in assessments are tracked, including their rationales, any data sources and dates of assessments.
- *Rigour.* Decision making is based on sound ecological, economic and sociocultural principles and clear logic, and able to withstand close peer and expert scrutiny.
- *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 are 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.
- *Precaution.* Where part of an asset is water dependent, the entire asset is assessed as water dependent. Where there is inconclusive evidence, assessment decisions consistently err 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 is retained within the database for subsequent analysis of potential development impacts.
- *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).

	Groundwater	Surface water	
Water dependence	Yes / No	Yes / No	Overall test of water dependence: Yes OR Yes
Hydrological connectivity to development site	Yes / No	Yes / No	Overall test of hydrological connectivity: Yes OR Yes
	Potentially impacted via groundwater pathway: Yes AND Yes	Potentially impacted via surface water pathway: Yes AND Yes	Overall test of potential for impact (potential materiality): Yes OR Yes

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 bioregional assessments for the Galilee 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 Environmental Assets Database (EAD), Great Artesian Basin Groundwater Recharge Beds database and the Key Environmental Assets (KEA) of the Murray-Darling Basin are databases in which little asset data other than name and geographic coordinates are available. The Queensland groundwater and surface water 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 the Collaborative Australian Protected Area Database (CAPAD), A *directory of important wetlands* in Australia (DIWA), the Ramsar List of Wetlands of International Importance and EPBC threatened ecological communities (EPBC TEC) 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 and Queensland 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 redgum, coolibah (*Eucalyptus coolabah*), black box (*Eucalyptus largiflorens*), 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 redgum, coolibah, black box, lignum, most waterbird species, fish), *then asset is surface water dependent.*

The water dependency of threatened species’ habitats, including threatened species listed under the Commonwealth’s *Environment Protection and Biodiversity Conservation Act 1999* (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) (Australian Government Department of the Environment, Dataset 23) and the Queensland Government’s *WetlandInfo* 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.

Six 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 six data layers. If any part of an asset was found to overlap with any one of these layers, that observation was used as evidence for water dependence, according to the precautionary principle previously described.

The six data layers were:

1. Groundwater-dependent ecosystems reliant on subsurface presence of groundwater, derived from the *National atlas of groundwater dependent ecosystems* (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 Galilee PAE is shown in Figure 5.
2. Groundwater-dependent ecosystems reliant on surface expression of groundwater, derived from the *National atlas of groundwater dependent ecosystems* (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 Galilee PAE is shown in Figure 6.
3. Wetlands defined according to the Queensland Government's regional ecosystems classification (Queensland Herbarium, 2014). Positive intersection of an asset with this layer indicates potential dependency on groundwater and/or surface water. These data are not available for the parts of the PAE that lie in SA. A map of this data layer for the Queensland parts of the Galilee PAE is shown in Figure 7.
4. Mean annual evapotranspiration in excess of incident rainfall across the Galilee 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 are 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 in this layer indicates potential dependency on groundwater and/or surface water. A map of this data layer across the Galilee PAE is shown in Figure 8.
5. The percentage of time water was observed during 1987 to 2015, from the Water Observations from Space database (Bioregional Assessment Programme, Dataset 27). Positive intersection of an asset with higher percentage inundation classes in this layer indicates potential dependency on surface water. A map of this data layer across the Galilee PAE is shown in Figure 9.

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6. The distribution of riparian vegetation potentially intersecting groundwater (Bioregional Assessment Programme, Dataset 28). This layer summarises the results of an analysis of remote sensing data to measure evapotranspiration rates towards the end of a prolonged period of below average rainfall. Positive intersection of an asset with this layer indicates potential dependency on groundwater. A map of this data layer across the Galilee PAE is shown in Figure 10.

Application of this approach is demonstrated for a single asset in the Galilee PAE, Lochern National Park, in Figure 11 and Figure 12. Lochern National Park sits immediately to the west of the Thomson River (see Figure 10). All six GIS and remote sensing layers provide clear evidence for dependence on groundwater and/or surface water along the main channels of the Thomson River. Therefore, this asset is assessed to be water dependent and is included in the register of water-dependent assets. However, it is important to note that away from the channels, each of the six layers provides evidence for different patterns of potential water dependence. Therefore the six 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 Galilee preliminary assessment extent (PAE)

Data: Bureau of Meteorology (Dataset 8)

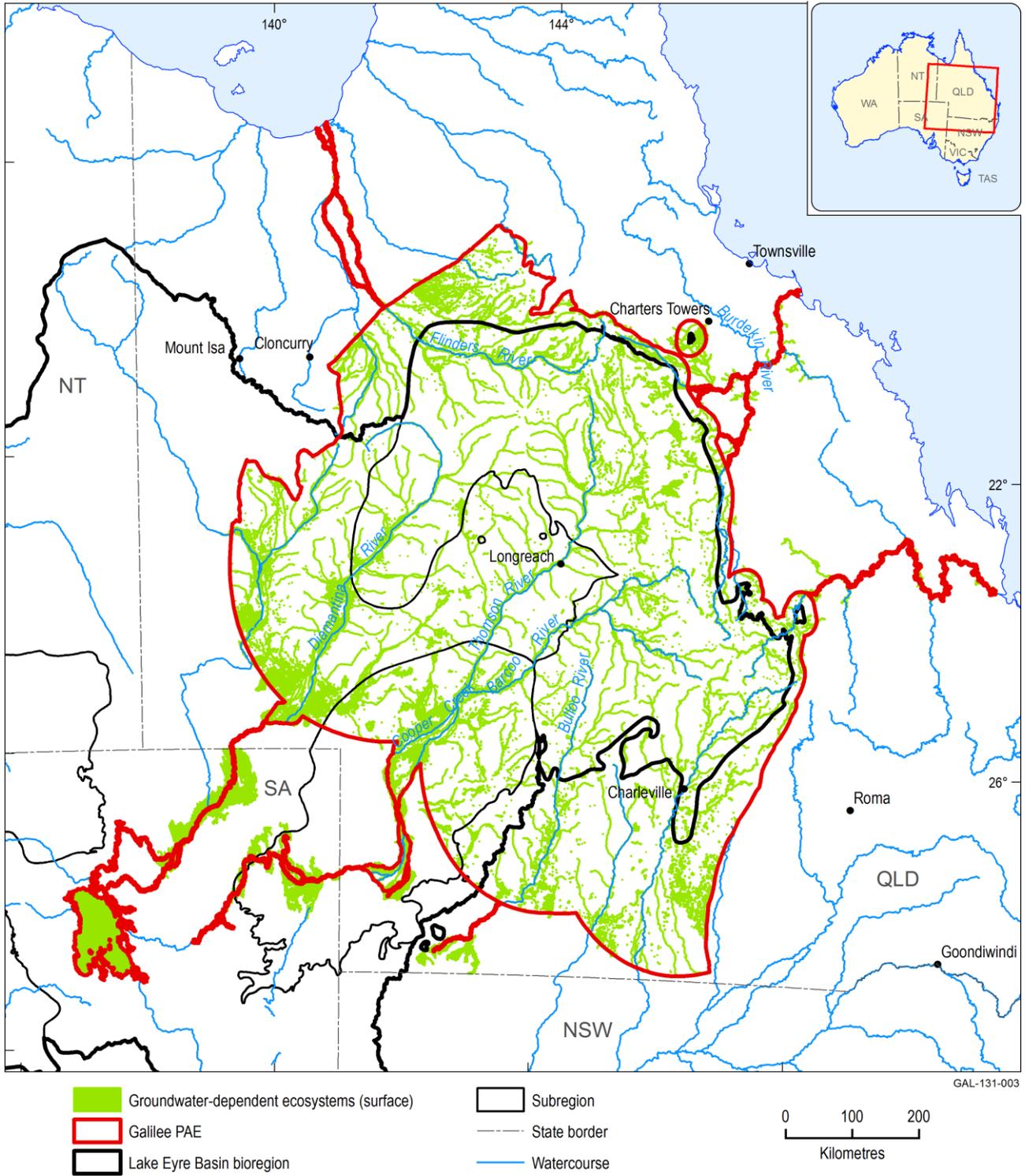


Figure 6 Groundwater-dependent ecosystems reliant on surface expression of groundwater in the Galilee preliminary assessment extent (PAE)

Data: Bureau of Meteorology (Dataset 8)

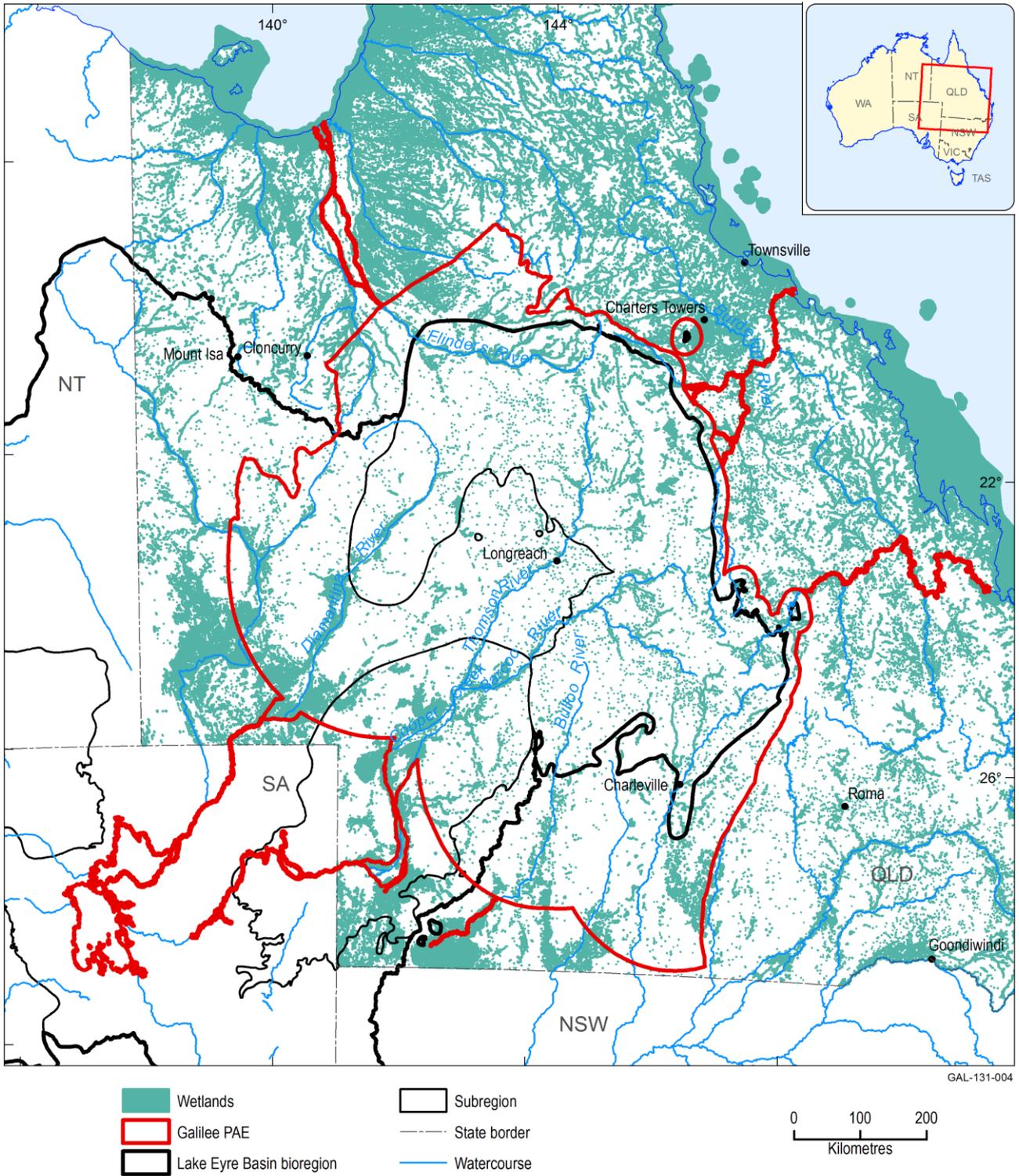


Figure 7 Distribution of wetland ecosystems types in the Galilee preliminary assessment extent (PAE), according to the Queensland Government’s regional ecosystems classification

Data: Bioregional Assessment Programme (Dataset 25)

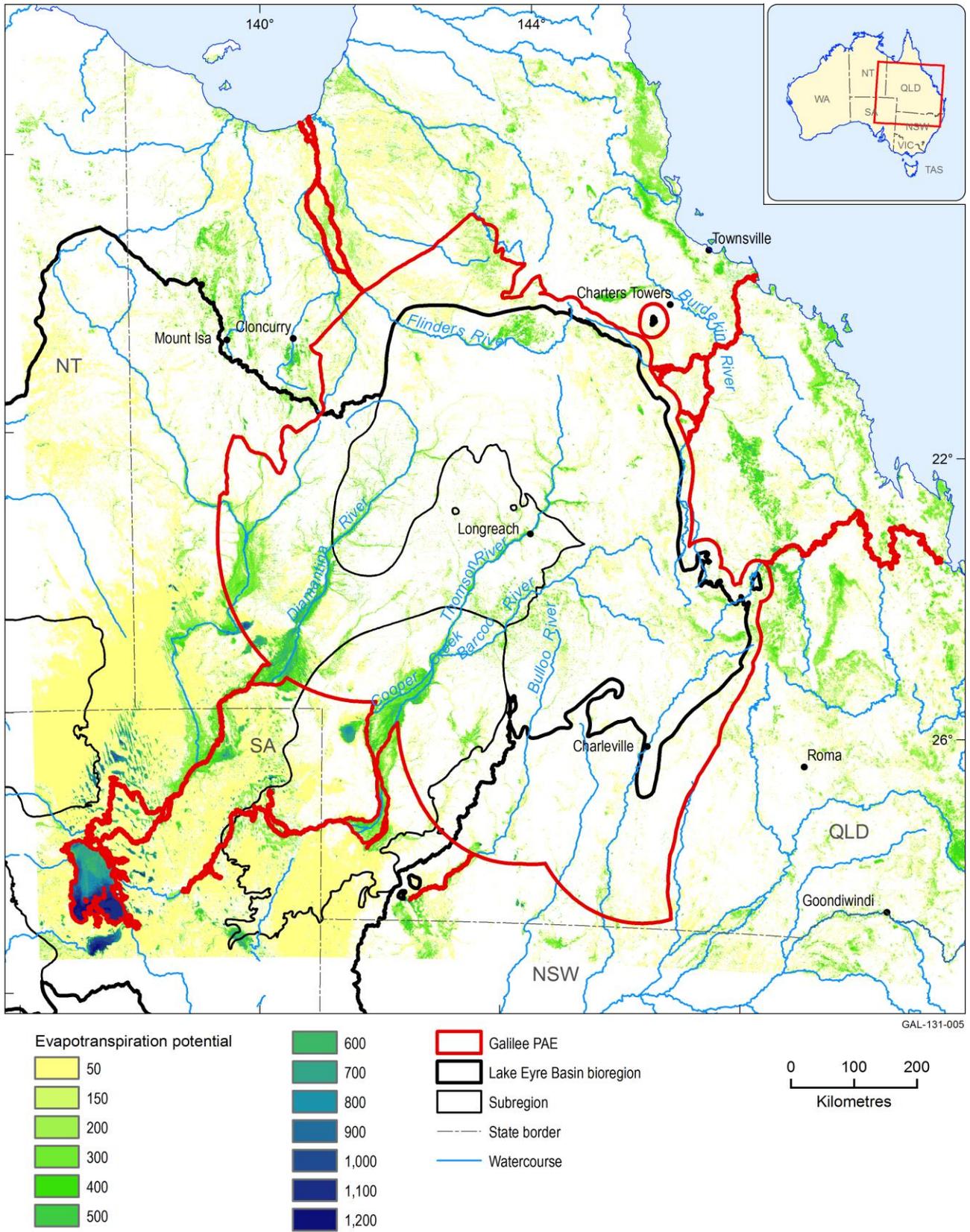


Figure 8 Mean annual evapotranspiration in excess of incident rainfall across the Galilee preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 26)

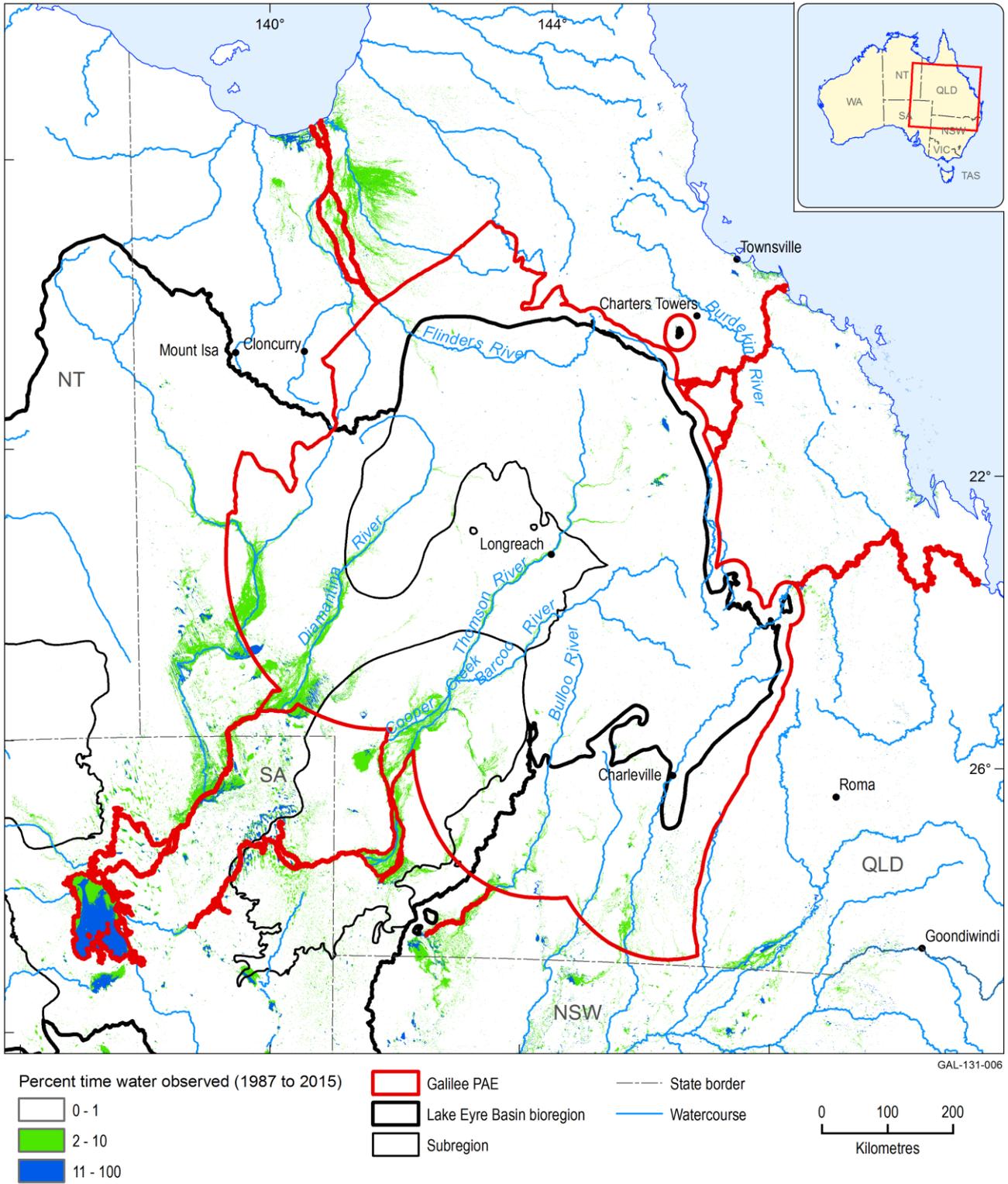


Figure 9 Percentage of time water was observed during 1987 to 2015 across the Galilee preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 27)

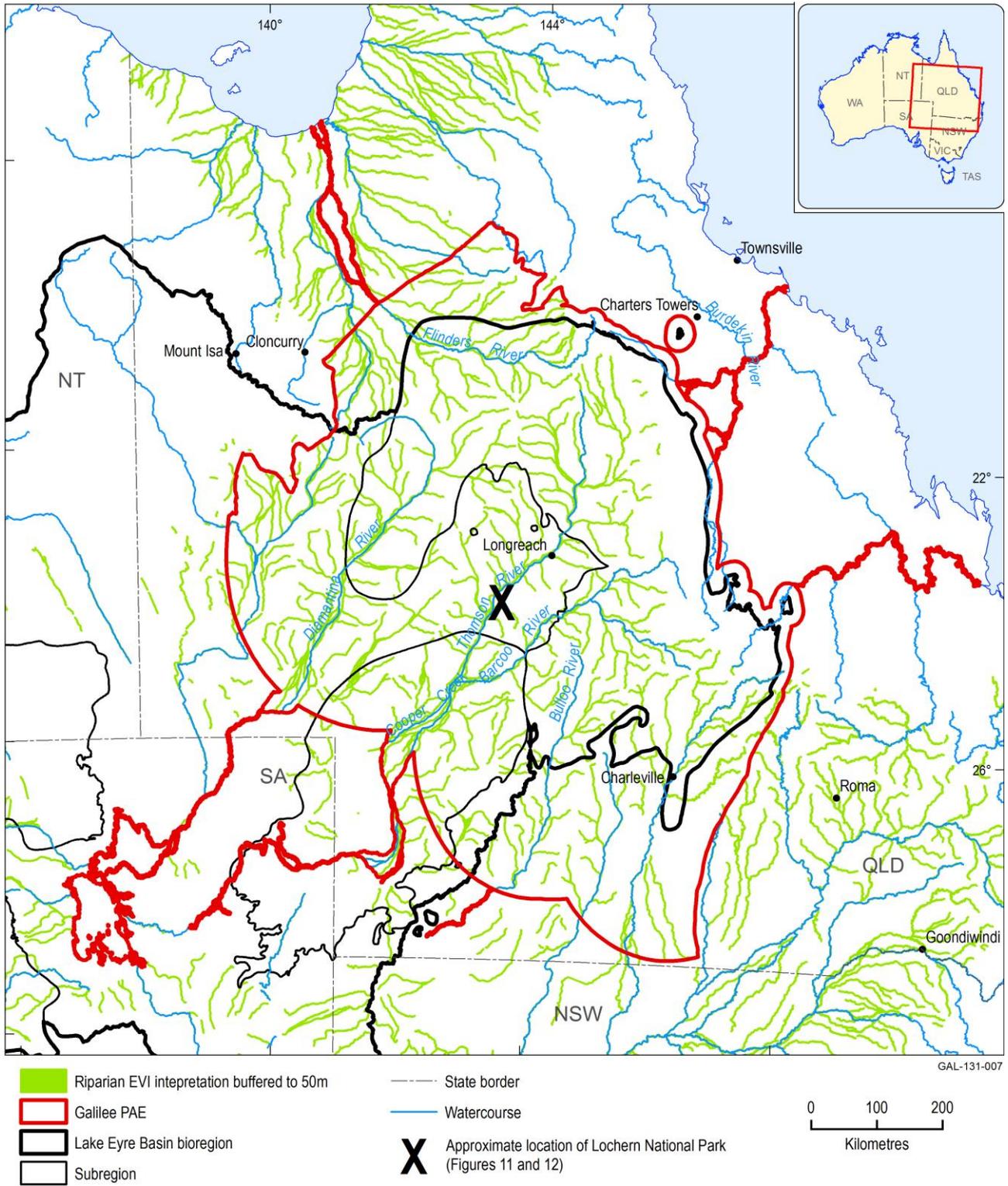


Figure 10 Distribution of riparian vegetation potentially intersecting shallow groundwater in the Galilee preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 28)

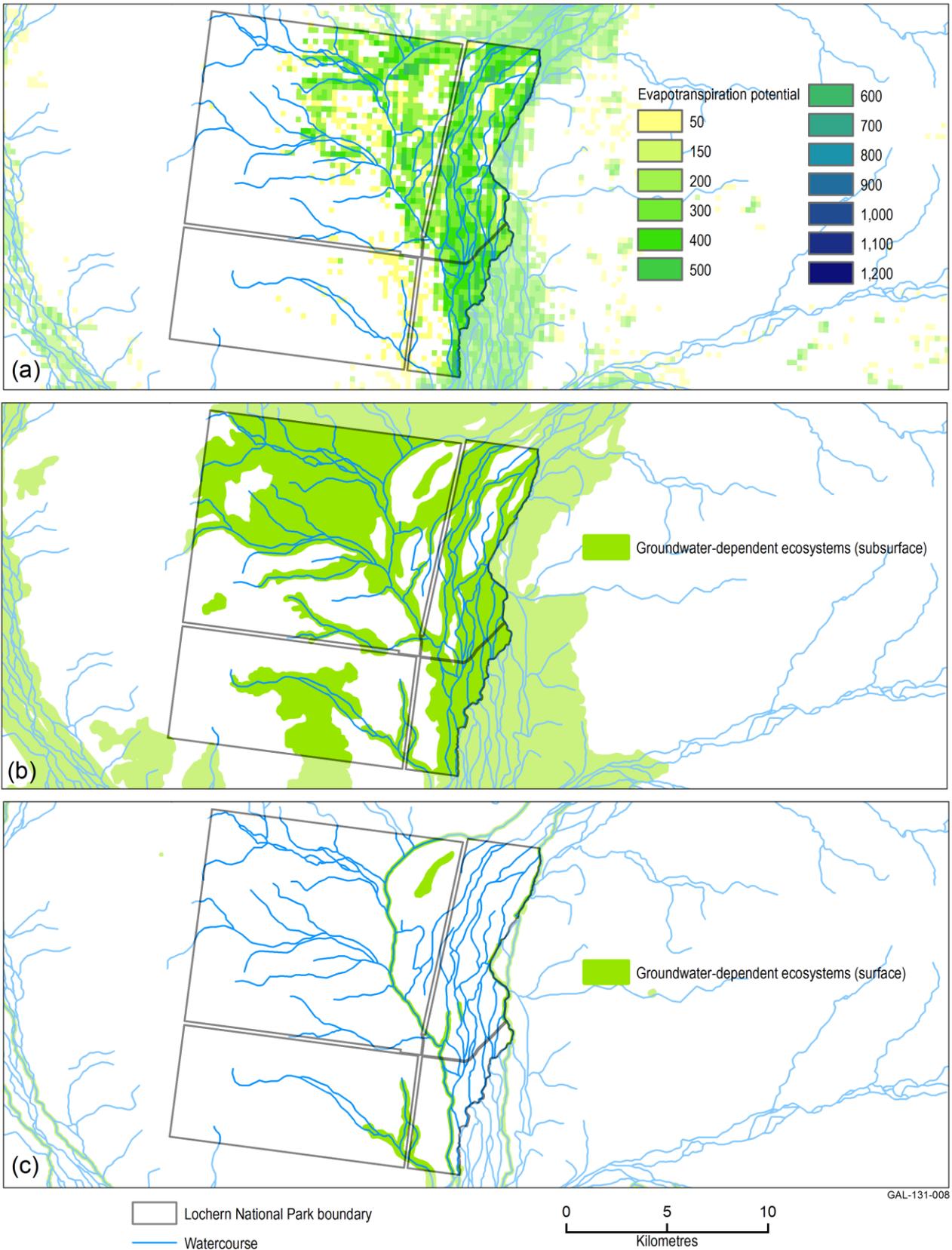


Figure 11 Spatial intersection of a specific asset, Lochern National Park, with layers of (a) mean annual evapotranspiration in excess of incident rainfall, (b) groundwater-dependent ecosystems reliant on subsurface presence of the water and (c) groundwater-dependent ecosystems reliant on surface expression of the water

Data: Bioregional Assessment Programme (Dataset 26), Bureau of Meteorology (Dataset 8)

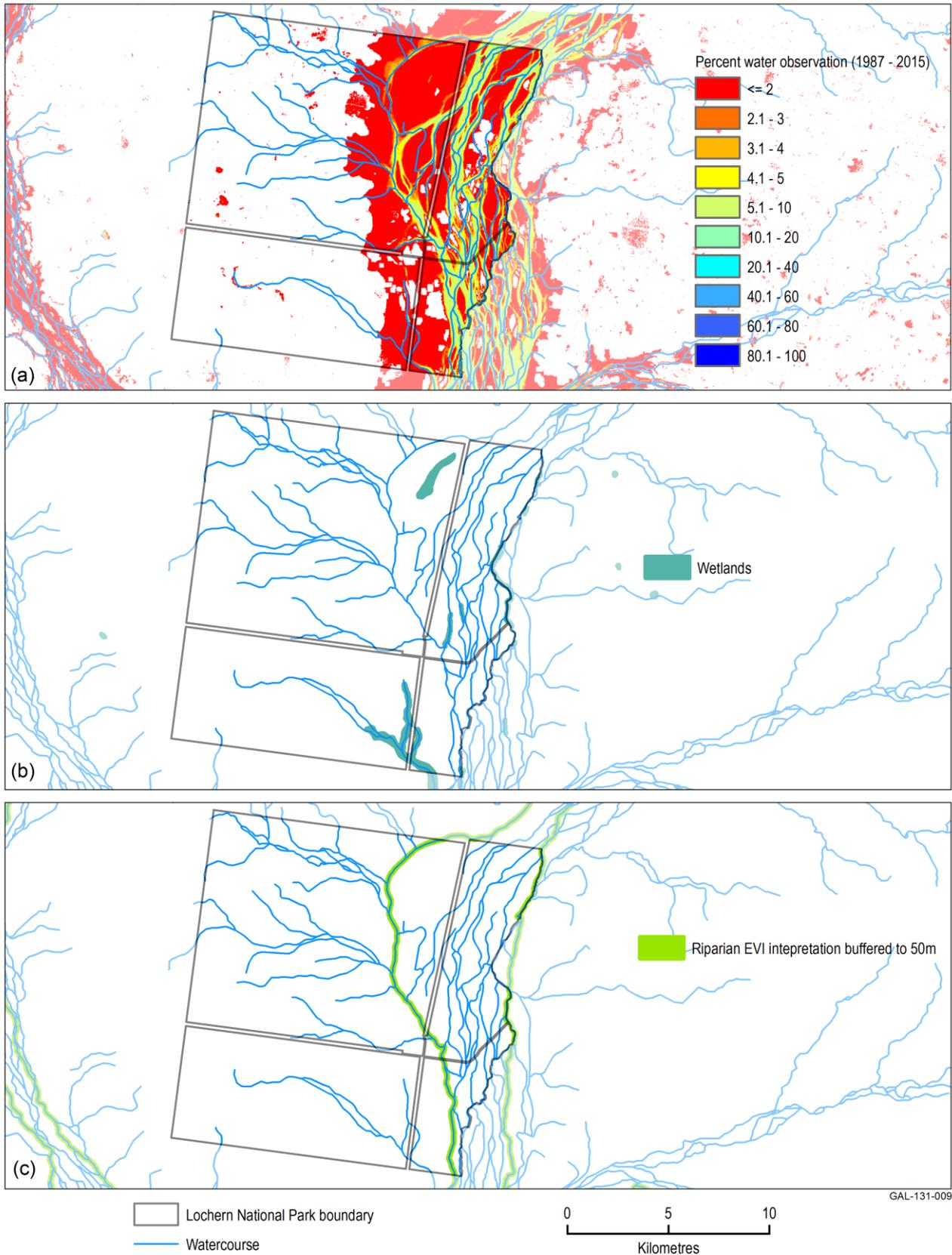


Figure 12 Spatial intersection of a specific asset, Lochern National Park, with layers of (a) percent duration of time water was observed, (b) wetlands according to the Queensland Government’s regional ecosystems classification and (c) riparian vegetation potential intercepting shallow groundwater

Data: Bioregional Assessment Programme (Dataset 27), Bioregional Assessment Programme (Dataset 25), Bioregional Assessment Programme (Dataset 28)

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, *WetlandInfo*. Queensland Department of Environment and Heritage Protection. Viewed 26 March 2015, <http://wetlandinfo.ehp.qld.gov.au/wetlands/ecology/components/species/>.
- Lewis S, Cassel R and Galinec V (2014) Coal and coal seam gas resource assessment for the Galilee subregion. Product 1.2 from the Lake Eyre Basin Bioregional Assessment. Department of the Environment, Bureau of Meteorology, CSIRO and Geoscience Australia, Australia. Viewed 19 April 2015, <http://data.bioregionalassessments.gov.au/product/LEB/GAL/1.2>.
- 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 19 April 2015, <http://data.bioregionalassessments.gov.au/submethodology/M03>.
- Queensland Herbarium (2014) Regional Ecosystem Description – Explanation of Fields. Department of Science, Information Technology, Innovation and the Arts, Brisbane. Viewed 14 October 2015, <http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/fields-explained/>.
- 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 Galilee subregion on 10 September 2015. A spreadsheet associated with product 1.3 for the Galilee subregion from the Lake Eyre Basin Bioregional Assessment. Department of the Environment, Bureau of Meteorology, CSIRO and Geoscience Australia, Australia. Viewed 24 September 2015, <http://data.bioregionalassessments.gov.au/product/LEB/GAL/1.3>.

Datasets

Dataset 1 Bioregional Assessment Programme (2013) Asset database for the Galilee subregion on 10 September 2015. Bioregional Assessment Derived Dataset. Viewed 14 September 2015, <http://data.bioregionalassessments.gov.au/dataset/c22a13bf-07ea-4eaa-960d-79d488a50496>.

Dataset 2 Australian Government Department of the Environment (2013) Queensland QLD - Regional - NRM - Water Asset Information Tool - WAIT - databases. Bioregional Assessment Source Dataset. Viewed 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/675afffd-5f42-49f0-9e24-9d6cca41621e>.

Dataset 3 Australian Government Department of the Environment (2013) South Australia SA - Regional - NRM Board - Water Asset Information Tool - WAIT - databases. Bioregional Assessment Source Dataset. Viewed 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/bb5a044a-889c-40a0-bf65-e4826ae72e43>.

Dataset 4 Australian Government Department of the Environment (2014) Collaborative Australian Protected Areas Database (CAPAD) 2012 - external. Bioregional Assessment Source Dataset. Viewed 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/ef93a2a2-6701-47ce-804d-12f8413bd09a>.

Dataset 5 Australian Government Department of the Environment (2001) Directory of Important Wetlands in Australia (DIWA) Spatial Database (Public). Bioregional Assessment Source Dataset. Viewed 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/6636846e-e330-4110-afbb-7b89491fe567>.

Dataset 6 Australian Government Department of the Environment (2011) Environmental Asset Database - Commonwealth Environmental Water Office - RESTRICTED (Metadata only). Bioregional Assessment Source Dataset. Viewed 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/29fd1654-8aa1-4cb3-b65e-0b37698ac9a6>.

Dataset 7 Geoscience Australia (2013) Great Artesian Basin and Laura Basin groundwater recharge areas. Bioregional Assessment Source Dataset. Viewed 09 September 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 09 September 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 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/5d488350-83b6-4e71-8d17-687ad8ff9941>.
- Dataset 10 Murray-Darling Basin Authority (2010) Key Environmental Assets - KEA - of the Murray Darling Basin RESTRICTED (Metadata only). Bioregional Assessment Source Dataset. Viewed 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/9948195e-3d3b-49dc-96d2-ea7765297308>.
- 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 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/7d46c916-926f-41e8-b6ee-6a48b878d9d3>.
- Dataset 12 Australian Government Department of the Environment (2000) Communities of National Environmental Significance Database - RESTRICTED - Metadata only. Bioregional Assessment Source Dataset. Viewed 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/c01c4693-0a51-4dbc-bbbd-7a07952aa5f6>.
- Dataset 13 Australian Government Department of the Environment (1998) Australia - Species of National Environmental Significance Database. Bioregional Assessment Source Dataset. Viewed 24 September 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 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/40902c5b-f9cd-473f-8a7e-37fb8850370a>.
- Dataset 15 Queensland Herbarium, Department of Science, Information Technology, Innovation and the Arts (2013) Biodiversity status of pre-clearing and remnant regional ecosystems - South East Qld. Bioregional Assessment Source Dataset. Viewed 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/9b7bcebf-8b7f-4fb4-bc91-d39f1bd960cb>.
- Dataset 16 Australian Government Department of the Environment (2002) Ramsar Wetlands of Australia. Bioregional Assessment Source Dataset. Viewed 24 September 2015, <http://data.bioregionalassessments.gov.au/dataset/d65cc156-944d-4961-bfba-eacfd61db63a>.

1.3.1 Methods

- Dataset 17 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 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/b1ba5370-2c60-485f-9620-ddad39498999>.
- Dataset 18 Bioregional Assessment Programme (2013) QLD DNRM Surface Water Licences linked to Spatial Locations - v1 20140313. Bioregional Assessment Derived Dataset. Viewed 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/caf51590-ad61-492d-87b6-89fc95ff842a>.
- Dataset 19 Australian Government Department of the Environment (2000) Australia World Heritage Areas. Bioregional Assessment Source Dataset. Viewed 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/4927789b-7ba7-4a77-b6fc-be1b29b6590c>.
- Dataset 20 Australian Government Department of the Environment (2004) National Heritage List Spatial Database (NHL) (v2.1). Bioregional Assessment Source Dataset. Viewed 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/26daa8d7-a90e-47f3-982b-0df362414e65>.
- Dataset 21 Australian Government Department of the Environment (2004) Australia, Register of the National Estate (RNE) - Spatial Database (RNESDB) Internal. Bioregional Assessment Source Dataset. Viewed 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/878f6780-be97-469b-8517-54bd12a407d0>.
- Dataset 22 Geoscience Australia (2013) OZMIN Mineral Deposits Database. Bioregional Assessment Source Dataset. Viewed 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/34247a24-d3cf-4a98-bb9d-81671ddb99de>.
- Dataset 23 Australian Government Department of the Environment (1998) Species Profile and Threats Database (SPRAT) - Australia - Species of National Environmental Significance Database (BA subset - RESTRICTED - Metadata only). Bioregional Assessment Source Dataset. Viewed 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/7276dd93-cc8c-4c01-8df0-cef743c72112>.
- Dataset 24 Bioregional Assessment Programme (2014) Coal deposits and projects in the Galilee Basin. Bioregional Assessment Derived Dataset. Viewed 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/784b7534-f2ae-426b-a60c-345d5dd08332>.
- Dataset 25 Bioregional Assessment Programme (2015) Queensland wetland data version 3 - wetland areas, QLD DSITIA - WETCLASS: E, L, M, P, R. Bioregional Assessment Derived Dataset. Viewed 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/421fa3ce-36c6-4932-8ec7-2b9bf78acf63>.

- Dataset 26 Bioregional Assessment Programme (2015) Galilee Harwood Evapotranspiration v01. Bioregional Assessment Derived Dataset. Viewed 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/11726ec2-89f4-4627-806f-6e9c119b92cb>.
- Dataset 27 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 15 October 2015, <http://data.bioregionalassessments.gov.au/dataset/fc643926-cfe3-49b9-a0df-c07c0a85c10f>.
- Dataset 28 Bioregional Assessment Programme (2015) Riparian Enhanced Vegetation Index (EVI) interpretation of major streams in the Great Artesian Basin, 50m Buffer for analysis, v01. Bioregional Assessment Derived Dataset. Viewed 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/cd9c7478-bbbe-4839-9c0e-546d751b445c>.

1.3.1 Methods

1.3.2 Ecological assets

Summary

The water-dependent asset register for the preliminary assessment extent (PAE) of the Galilee subregion contains 3973 individual ecological assets from the original asset list of 4122 nominated assets. The combined sets of water-dependent assets encompass a large proportion of the area of the PAE. The register consists of 2383 assets within the 'Vegetation' subgroup, 151 within the 'Groundwater' subgroup and 1439 within the 'Surface water' subgroup. All nominated 'Surface water' and 'Groundwater' assets are assessed as water dependent. Of nominated 'Vegetation' subgroup assets, 64 groundwater-dependent ecosystem assets were excluded because of their low reliability status and a lack of evidence of water dependence using the datasets based on satellite imagery, and 81 species habitat assets were excluded as the habitats could not be shown to fulfil the criteria for water dependence. The asset register includes six threatened ecological communities and the potential spatial habitat distribution of 19 species listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The asset register also includes 40 regional ecosystems classes and the potential habitat distributions of 24 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 Galilee subregion is 3973 (from a total of 4122 ecological assets on the asset list). Of the water-dependent assets, 2383 assets are vegetation features, with the remainder surface water features (1439) and groundwater features (151) (Table 7). Most of the vegetation features are groundwater-dependent ecosystems (GDEs). Most of the surface water features are waterholes, pools, rock pools or billabongs. Of the ecological assets, 3610 assets are assessed as dependent on surface water and 3178 assets are assessed as dependent on groundwater. Of these assets, 795 assets are assessed as dependent or possibly dependent on surface water alone, 363 assets are assessed as dependent or possibly dependent on groundwater alone, and 2815 assets are assessed as dependent or possibly dependent on both surface water and groundwater.

Table 8 summarises the assets and their water dependence according to database source. Maps of the distributions of the key data sources are shown in Figure 13 to Figure 22. Total assets cover a large proportion of the 611,000 km² 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 PAE and extend far beyond the boundaries of the PAE. This is most strongly the case for the World Heritage Areas dataset, in which the Great Barrier Reef World Heritage Area lies largely to the northeast of the PAE, and for the WAIT dataset, in which Great Artesian Basin groundwater aquifers and recharge beds extend far to the north, west and south of the PAE.

Table 7 Summary of ecological assets within the preliminary assessment extent (PAE) of the Galilee 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 features	Aquifer, geological feature, alluvium or stratum	151	19	151
Surface water features	Floodplain	5	5	1
	Lake, reservoir, lagoon or estuary	45	45	20
	Marsh, sedgeland, bog, spring or soak	109	109	0
	River or stream reach, tributary, anabranch or bend	152	152	8
	Waterhole, pool, rock pool or billabong	957	923	883
	Wetland, wetland complex or swamp	171	171	83
Vegetation	Groundwater-dependent ecosystem	2201	2032	1936
	Habitat (potential species distribution)	177	151	93
	Riparian vegetation	5	3	3
Total		3973	3610	3178

Data: Bioregional Assessment Programme (Dataset 1)

Table 8 Summary of ecological assets in the preliminary assessment extent (PAE) of the Galilee 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
Collaborative Australian Protected Areas Database (CAPAD)	62	55	35
<i>A directory of important wetlands in Australia (DIWA)</i>	39	39	30
Environmental Assets Database (EAD)	3	3	3
Great Artesian Basin Groundwater Recharge	10	10	10
<i>National atlas of groundwater dependent ecosystems (subsurface)</i>	137	134	117
<i>National atlas of groundwater dependent ecosystems (surface)</i>	2064	1898	1819
Birds Australia Important Bird Areas (IBA)	13	13	13
Key Environmental Assets of the Murray-Darling Basin (KEA) – streams	138	138	0
Key Environmental Assets of the Murray-Darling Basin (KEA) – waterbodies	11	11	11
Queensland DERM waterbodies	812	778	755
Queensland DERM waterbodies – Indigenous	114	114	114
Threatened species listed under the Commonwealth's <i>Environment Protection and Biodiversity Conservation Act 1999</i> (EPBC Act)	19	13	15
Threatened regional ecosystems listed under Queensland's <i>Nature Conservation Act 1992</i>	40	33	17
Threatened species listed under <i>Queensland's Nature Conservation Act 1992</i> , excluding EPBC Act-listed species	24	23	7
Ramsar List of Wetlands of International Importance	1	1	1
Threatened ecological communities listed under the EPBC Act	6	5	5
WAIT Burdekin	31	31	2
WAIT Desert Channels	214	145	112
WAIT ERIN	38	38	4
WAIT Fitzroy	34	30	5
WAIT Queensland Murray-Darling Committee	7	5	4
WAIT SA Arid Lands	35	34	24
WAIT Southern Gulf	113	51	73
WAIT Southwest Queensland	8	8	2
Total	3973	3610	3178

Data: Bioregional Assessment Programme (Dataset 1)

DERM = Queensland Department of Environment and Resource Management

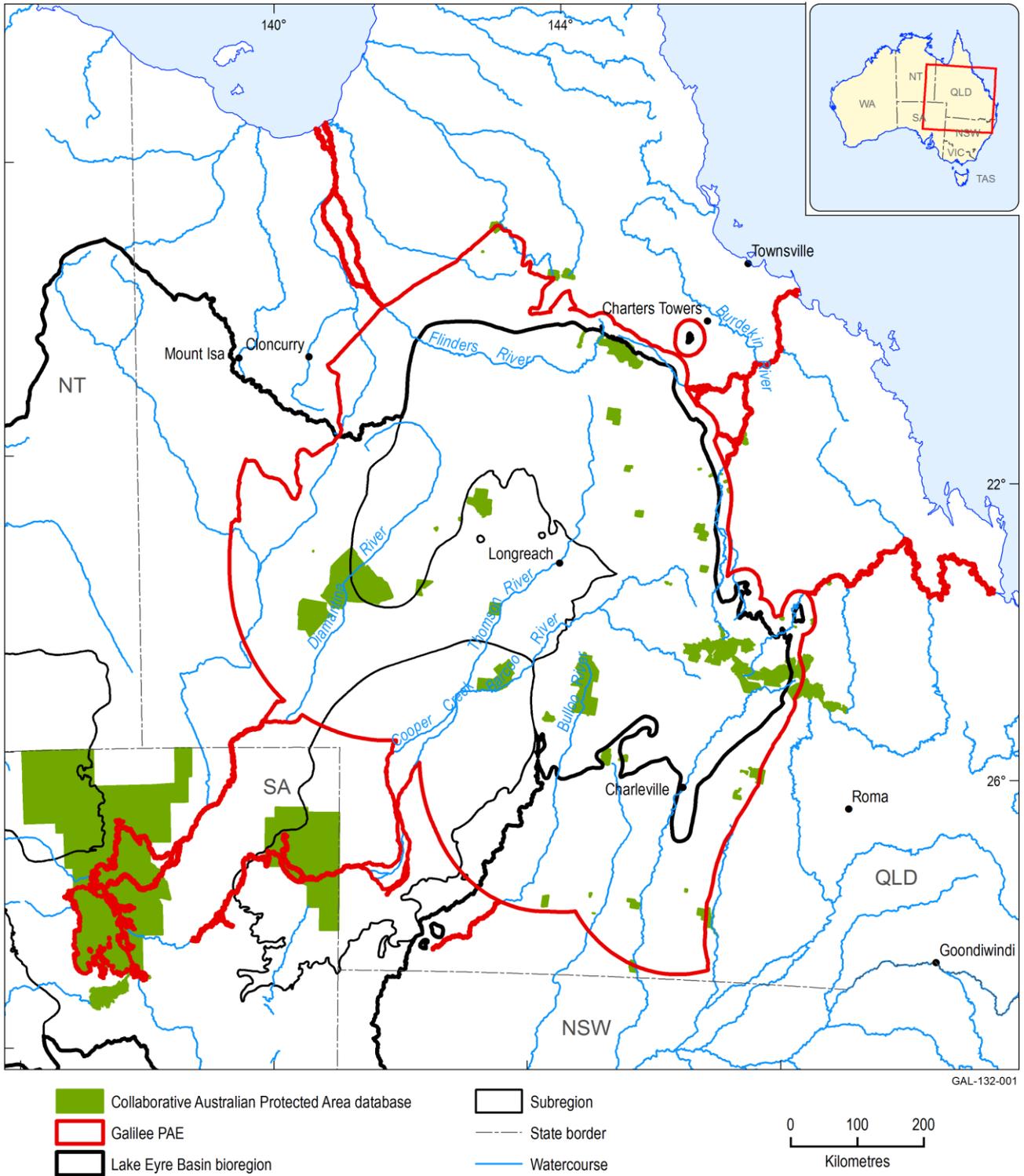


Figure 13 Map of Collaborative Australian Protected Areas Database (CAPAD) assets within the Galilee preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 1)

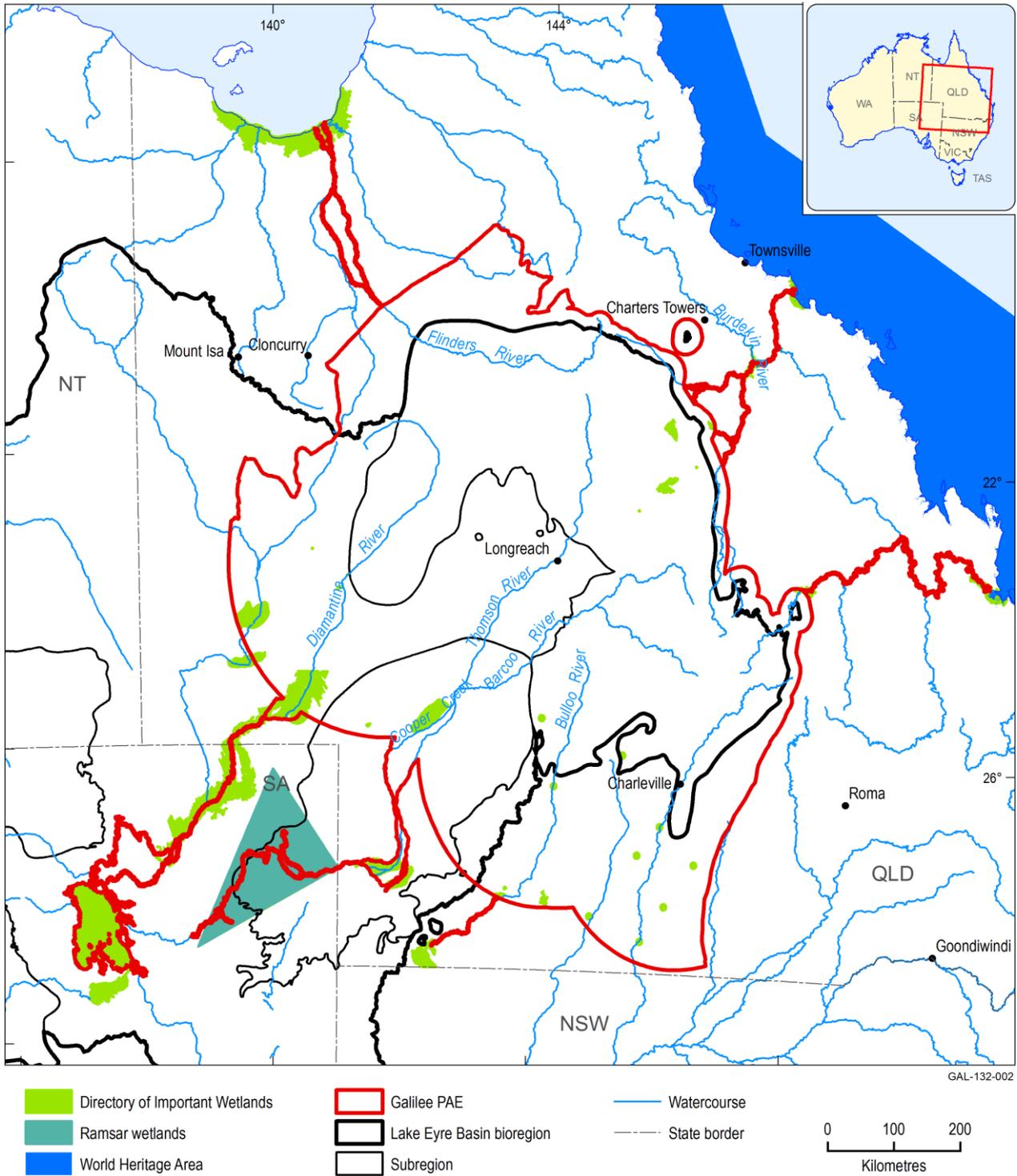


Figure 14 Map of *A directory of important wetlands in Australia (DIWA) assets within the Galilee preliminary assessment extent (PAE)*

Data: Bioregional Assessment Programme (Dataset 1)

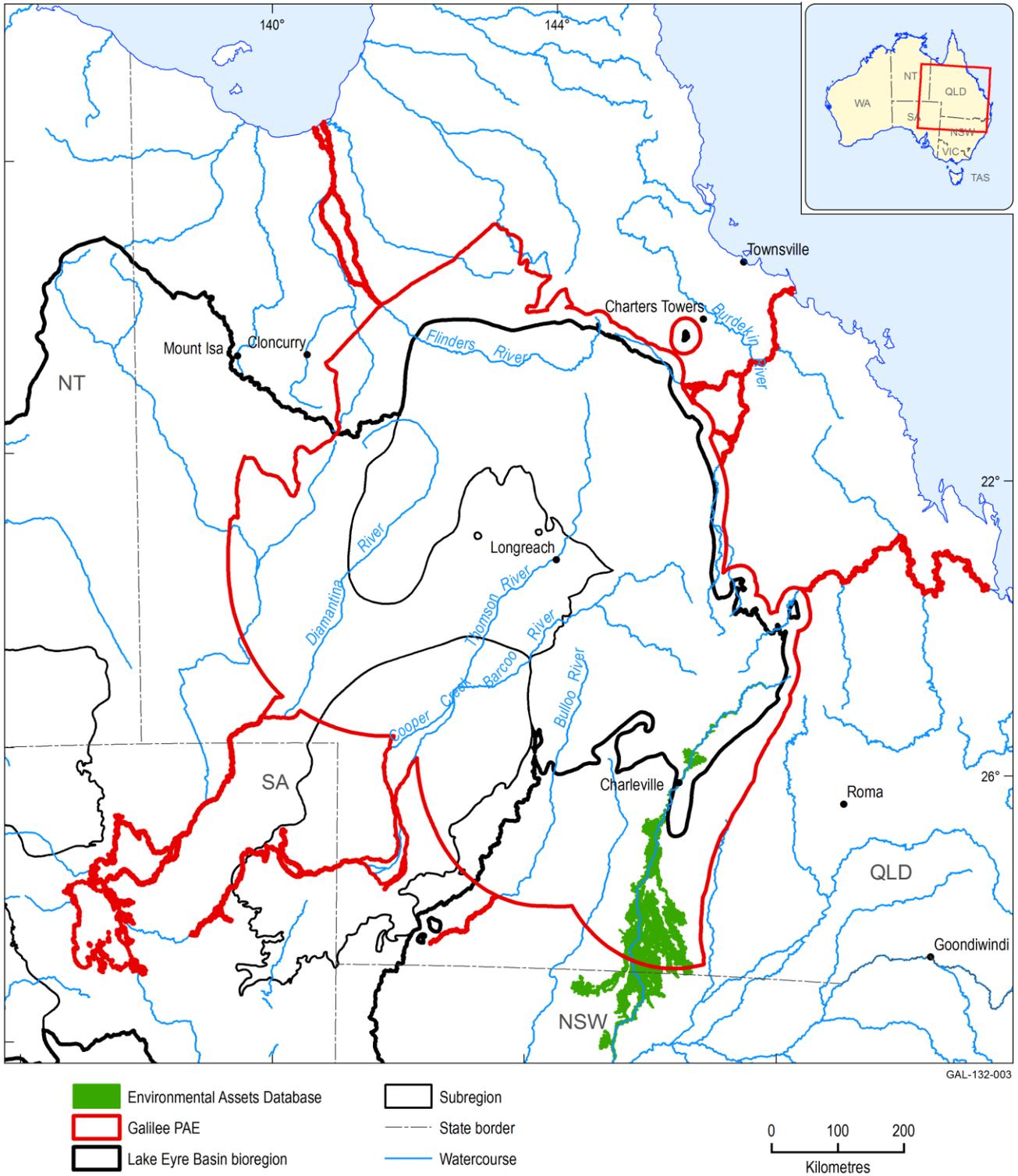


Figure 15 Map of Environmental Assets Database (EAD) assets within the Galilee preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 1)

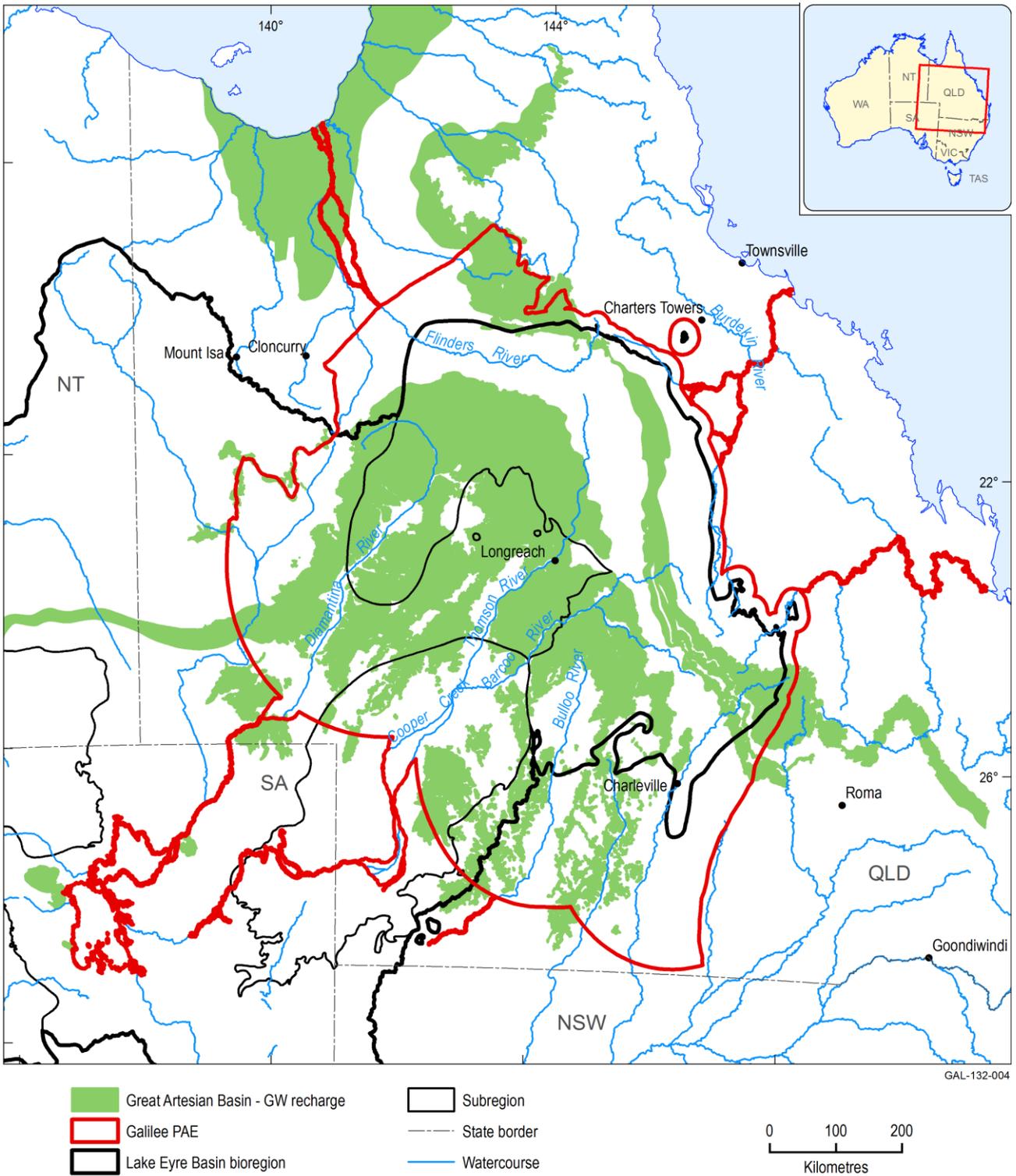


Figure 16 Map of Great Artesian Basin Groundwater Recharge assets within the Galilee preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 1)

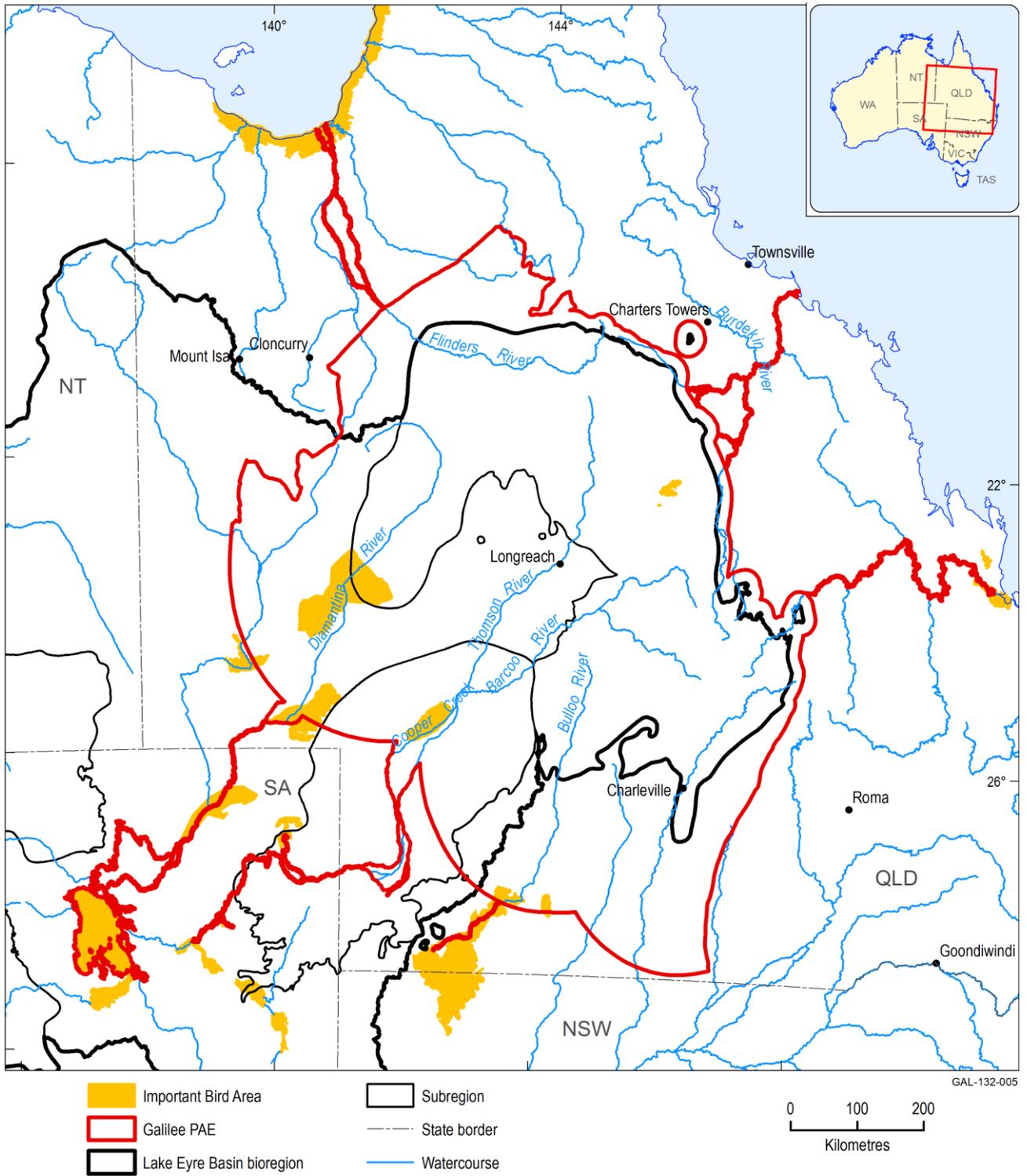


Figure 17 Map of Birds Australia Important Bird Areas (IBA) assets within the Galilee preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 1)

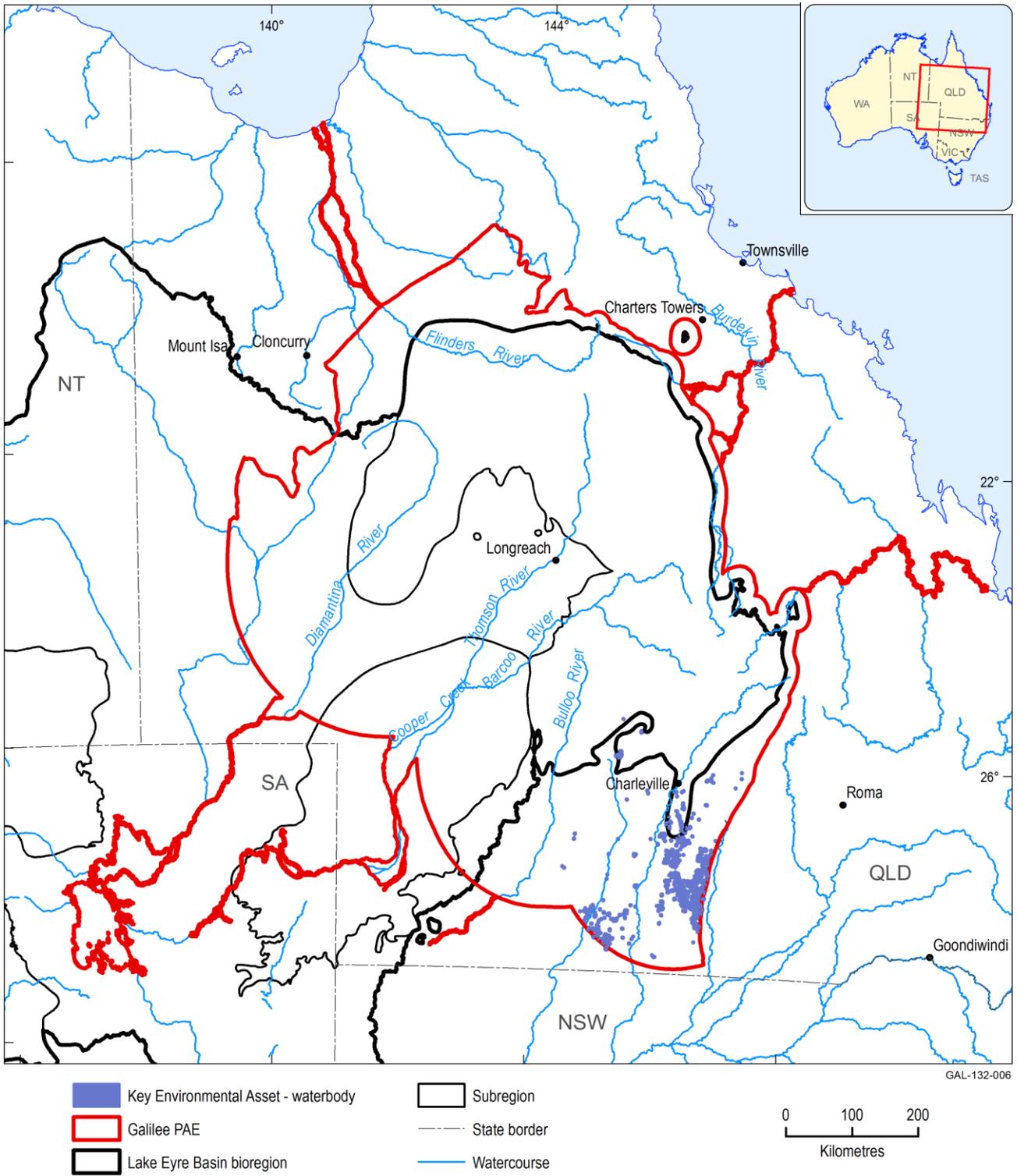


Figure 18 Map of key environmental assets (KEA) of the Murray-Darling Basin within the Galilee preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 1)

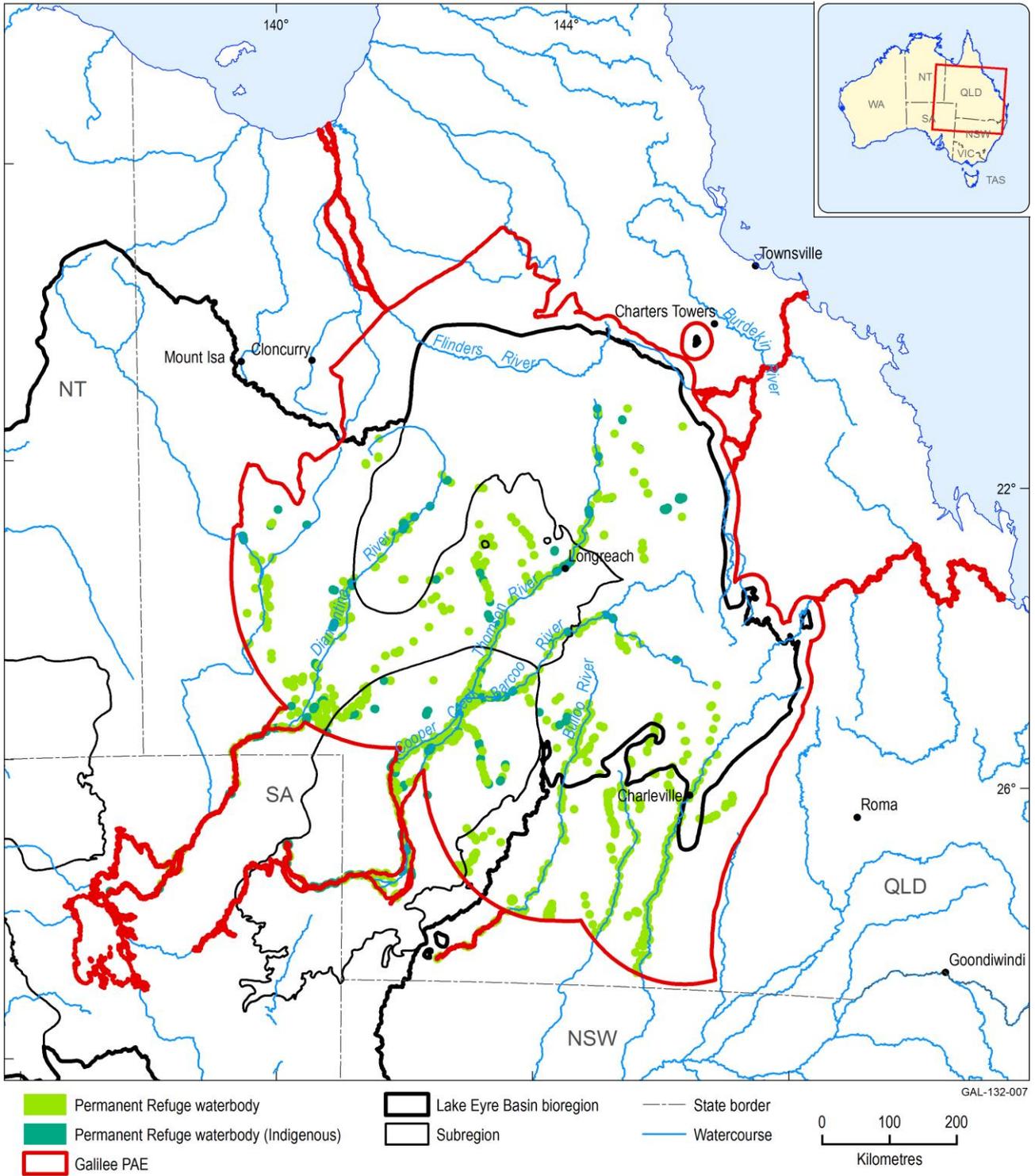


Figure 19 Map of Queensland Department of Environment and Resource Management Waterbodies Database assets within the Galilee preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 1)

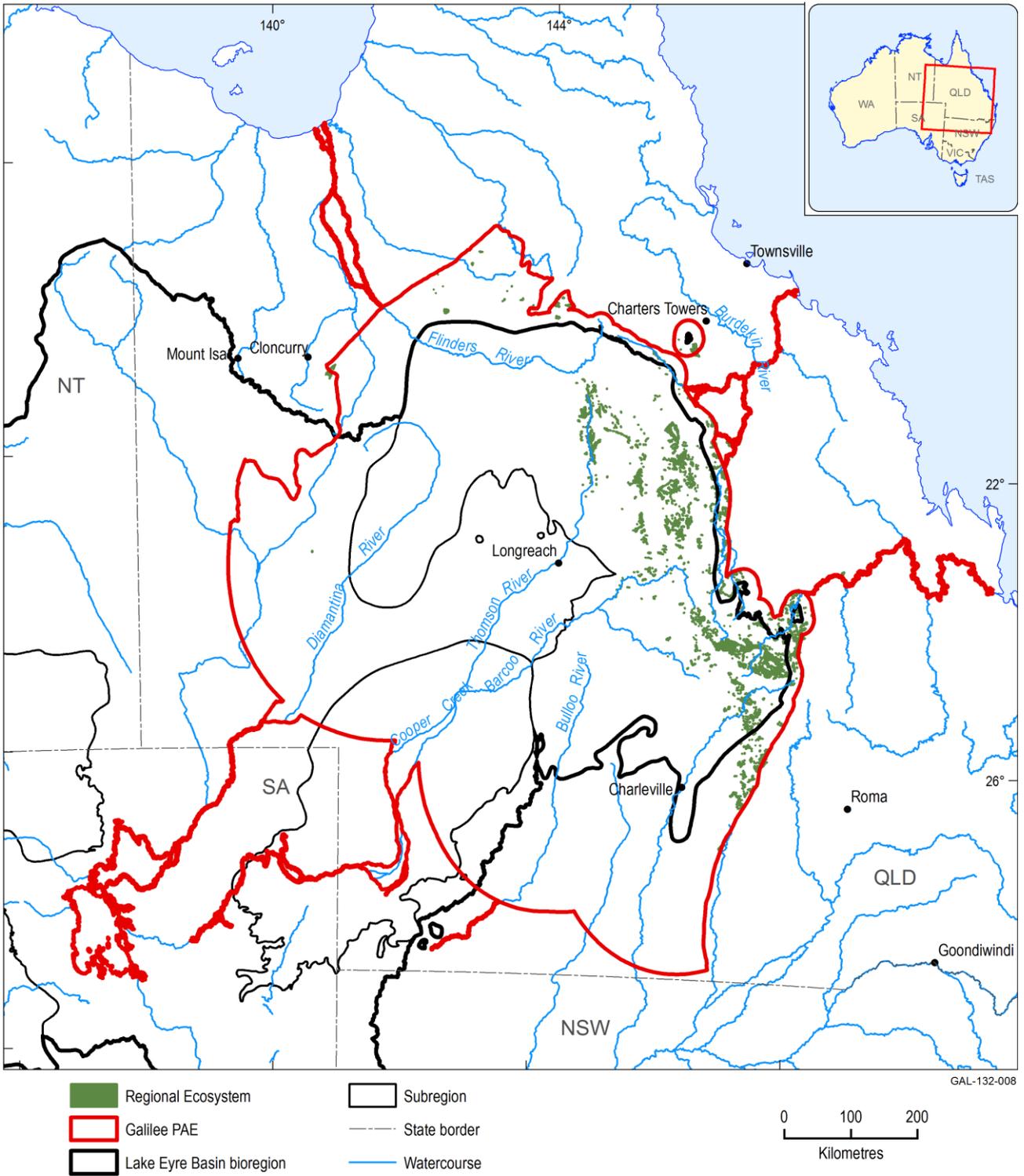


Figure 20 Map of threatened regional ecosystems listed under Queensland’s Nature Conservation Act 1992 within the Galilee preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 1)

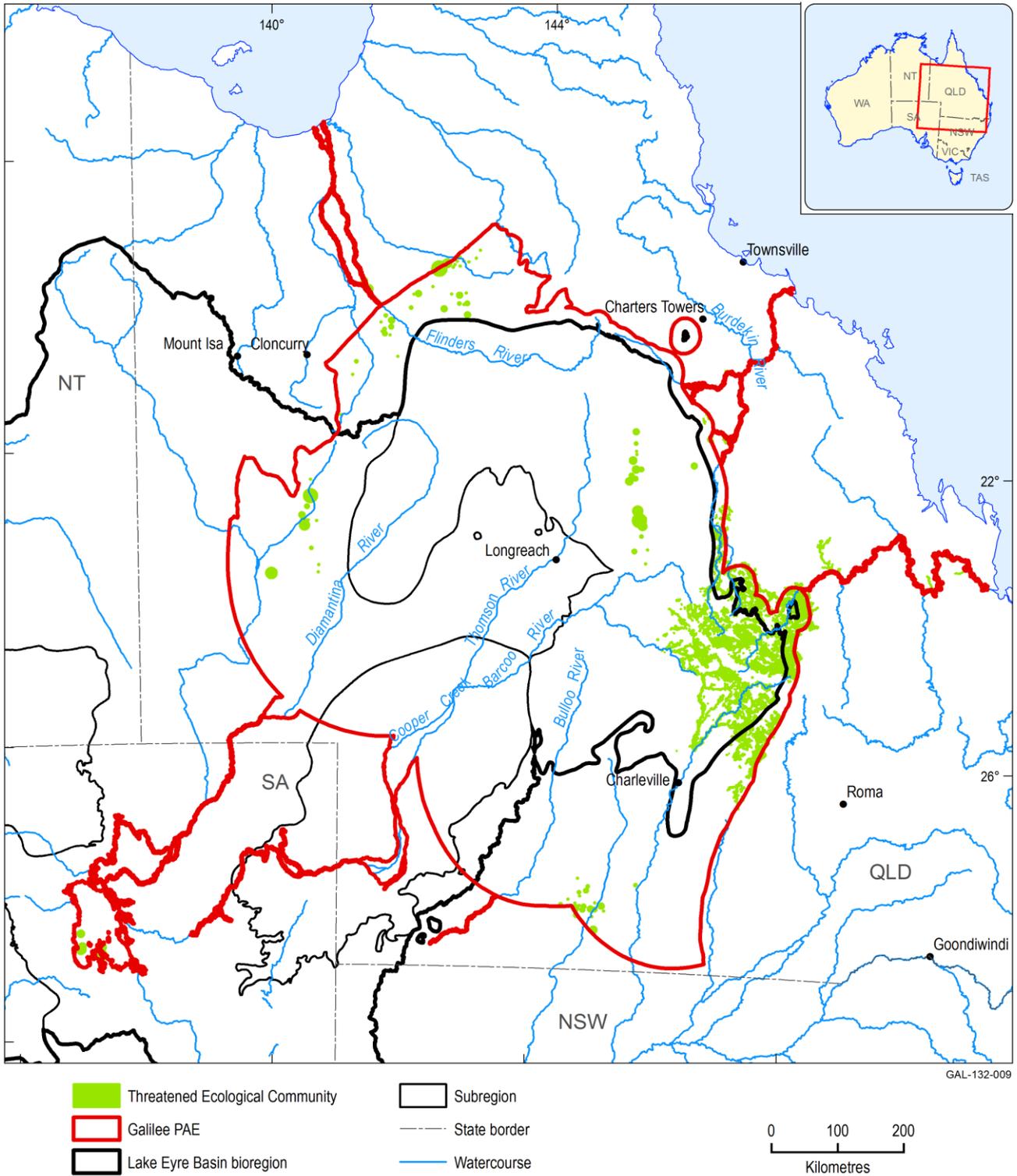


Figure 21 Map of threatened ecological communities listed under the Commonwealth’s *Environment Protection and Biodiversity Conservation Act 1999* within the Galilee preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 1)

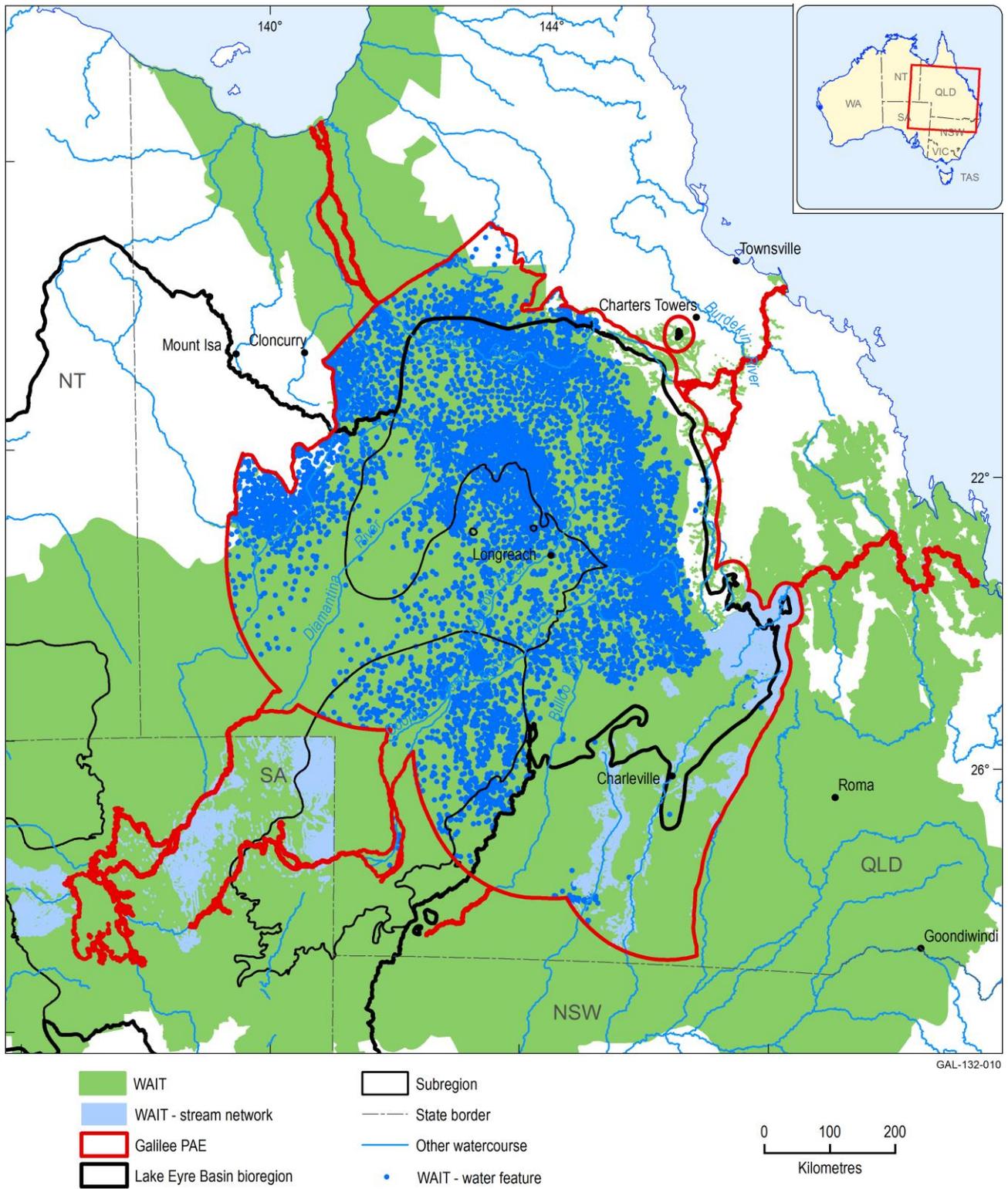


Figure 22 Map of Water Asset Information Tool (WAIT) database assets within the Galilee preliminary assessment extent (PAE), across all natural resource management regions

Data: Bioregional Assessment Programme (Dataset 1)

1.3.2 Ecological assets

1.3.2.1.2 Threatened ecological communities

Seven ecological communities listed under the EPBC Act occur in the Galilee subregion, and six are assessed as water dependent (Table 9). Management plans indicate only 'The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin threatened ecological community' depends on groundwater and the 'Coolibah – Black Box Woodlands of the Darling Riverine Plains' and the 'Brigalow Belt South Bioregions threatened ecological community' depend on surface water. However, the assessment data based on satellite imagery shows that at least parts of the other four ecological communities are likely to be water dependent, and so these assets are also assessed as water dependent on the basis of the precautionary principle.

Table 9 Water-dependent threatened ecological communities listed under the EPBC Act and within the preliminary assessment extent (PAE) of the Galilee subregion

Community ^a	Dependence upon surface water	Dependence upon groundwater	Rationale for inclusion in water-dependent asset register
Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant) threatened ecological community	Possible	Possible	Intersection with Queensland wetland mapping units; some riparian vegetation intercepting groundwater; and evapotranspiration greater than rainfall
Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions threatened ecological community	Yes	Possible	Associated with floodplains and drainage areas in which there is possible groundwater-surface water interaction
Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin threatened ecological community	Unlikely	Possible	Some riparian vegetation intercepting groundwater; and evapotranspiration greater than rainfall
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions threatened ecological community	Possible	Unlikely	Intersection with Queensland wetland mapping units
The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin threatened ecological community	Unlikely	Yes	Great Artesian Basin springs are the only habitat of this community.
Weeping Myall Woodlands threatened ecological community	Possible	Possible	Intersection with Queensland wetland mapping units; some riparian vegetation intercepting groundwater; and evapotranspiration greater than rainfall

Data: Australian Government Department of the Environment (Dataset 2), Bioregional Assessment Programme (Dataset 3, Dataset 4, Dataset 5)

^aTypology and punctuation are given as they are used in the legislation.

1.3.2.1.3 Habitats of threatened species

Of the 39 species listed as threatened under the EPBC Act, 19 species are assessed to rely upon water-dependent habitats, with four species dependent on surface water, six species dependent on groundwater, and nine species dependent on both surface water and groundwater (Table 10).

All six EPBC Act-listed species that are only dependent on groundwater are exclusively associated with the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin threatened ecological community (as listed under the EPBC Act). Evidence for dependence on surface water is often 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. In such 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 78 species listed as threatened under the Nature Conservation Act, excluding those also listed under the EPBC Act, 24 species are assessed to rely upon water-dependent habitats, with 17 species likely or possibly dependent on surface water, one species possibly dependent on groundwater, and six species possibly dependent on both surface water and groundwater (Table 11). 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. 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 10 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 Galilee 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
<i>Acacia ammophila</i>	A wattle	Unlikely	Possible	Distribution overlaps with the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin EPBC Act-listed threatened ecological community
<i>Amytornis barbatus barbatus</i>	Grey Grasswren (Bulloo)	Yes	Unlikely	Occurs in lignum and canegrass on swampy floodplains in the drainage basin of the Bulloo River
<i>Austrobryonia argillicola</i>	Tobermorey Melon	Yes	Possible	Grows along ephemeral creeks and in poorly drained areas on cracking clay plains. Most abundant in seasonal swamps, clay pans and run-on areas
<i>Chlamydogobius micropterus</i>	Elizabeth Springs Goby	Unlikely	Yes	Great Artesian Basin springs are the only habitat of this asset species.
<i>Chlamydogobius squamigenus</i>	Edgbaston Goby	Unlikely	Yes	Great Artesian Basin springs are the only habitat of this asset species.
<i>Denisonia maculata</i>	Ornamental Snake	Yes	Possible	Found on floodplains, undulating clay pans and along the margins of swamps, lakes and watercourses

Scientific name ^a	Common name	Dependence upon surface water	Dependence upon groundwater	Comments
<i>Eriocaulon carsonii</i>	Salt Pipewort	Unlikely	Yes	Great Artesian Basin springs are the only habitat of this asset species.
<i>Eryngium fontanum</i>	Blue Devil	Unlikely	Yes	Great Artesian Basin springs are the only habitat of this asset species.
<i>Geophaps scripta scripta</i>	Squatter Pigeon (southern)	Yes	Possible	Usually sighted close to permanent water bodies
<i>Lawrenzia buchananensis</i>	A shrub	Yes	Possible	Known from a single population in highly specific saline habitats along the shores of Lake Buchanan
<i>Livistona lanuginosa</i>	Waxy Cabbage Palm	Yes	Possible	Occurs only along sandy river and creek channels that flow only for part of the year, but with permanent pools or soaks
<i>Neochmia ruficauda ruficauda</i>	Star Finch (eastern)	Yes	Possible	Recorded from damp grasslands, sedgeland or grassy woodlands near permanent water or areas of regular inundation
<i>Pezoporus occidentalis</i>	Night Parrot	Possible	Possible	Likely on claypans, floodplains or the margins of salt lakes, and creeks or other water bodies
<i>Poephila cincta cincta</i>	Black-throated Finch (southern)	Yes	Possible	Prefers open grassy woodland habitats adjacent to water sources or riparian strips
<i>Pristis pristis (Pristis microdon)</i>	Large-tooth Sawfish	Yes	No	Spawns in estuaries and young fish live in freshwater riverine habitats up to 500 km inland
<i>Rostratula benghalensis (sensu lato)</i>	Australian Painted Snipe	Yes	Possible	Occurs in shallow freshwater (occasionally brackish) wetlands, both ephemeral and permanent
<i>Scaturiginichthys vermeilipinnis</i>	Redfin Blue Eye	Unlikely	Yes	Great Artesian Basin springs are the only habitat of this asset species.
<i>Sclerolaena blakei</i>	A small shrub	Possible	No	Only been collected in depressions and channels on gravelly downs
<i>Sclerolaena walkeri</i>	A small shrub	Possible	No	Occurs on saline river flats and floodplains

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

^aTypology and punctuation are given as they are used in the legislation.

Table 11 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 Galilee 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
<i>Adelotus brevis</i>	Tusked Frog	Yes	Possible	Found near creeks, ditches and ponds
<i>Arthraxon hispidus</i>	Hairy-joint Grass	Yes	Yes	In wet forest, often near creeks or swamps, and around freshwater springs and mound springs
<i>Botaurus poiciloptilus</i>	Australasian Bittern	Yes	Possible	Preferred habitat is wetlands with tall dense vegetation at the edges of pools or waterways
<i>Bursaria reevesii</i>	A shrub	Yes	Unlikely	Along drainage lines and in creek beds
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	Possible	No	Requires forest or woodland near watercourses
<i>Epthianura crocea crocea</i>	Yellow Chat	Yes	Unlikely	At Curtis Island, Torilla Plain and the Fitzroy Delta
<i>Epthianura crocea macgregori</i>	Yellow Chat (Dawson)	Yes	Unlikely	Habitat restricted to channels, basins and/or depressions with wetlands of sedges, rushes and grasses
<i>Erythrotriorchis radiatus</i>	Red Goshawk	Yes	No	Habitat must contain permanent water
<i>Eucalyptus raveretiana</i>	Black Ironbox	Yes	Possible	On the banks of watercourses
<i>Fontainea venosa</i>	Bahrs Scrub Fontainea	Possible	No	In vine forest along creeks
<i>Furina dunmalli</i>	Dunmall's Snake	Possible	No	In open forest on floodplains
<i>Grevillea hockingsii</i>	A shrub	No	Possible	Occasionally found on the edge of soaks containing <i>Melaleuca</i>
<i>Haloragis exalata subsp. velutina</i>	Tall Velvet Sea-berry	Possible	No	Formerly known from swamp vegetation
<i>Huperzia phlegmarioides</i>	Layered Tassel Fern	Yes	Unlikely	Occurs in lowland swamps and along watercourses
<i>Hypochrysops apollo apollo</i>	Apollo Jewel Butterfly	Yes	No	Dependent on water-dependent Ant Plant (<i>Myrmecodia beccarii</i>)
<i>Lophochroa leadbeateri</i>	Major Mitchell's Cockatoo	Yes	Possible	Inhabits habitats within easy reach of water
<i>Macrotis lagotis</i>	Greater Bilby	Possible	No	Favourable parts of range now include drainage systems, salt lake systems and other alluvial areas
<i>Malurus coronatus</i>	Purple-crowned Fairy Wren	Yes	Possible	Inhabits dense riparian vegetation with trees, shrubs, rushes and/or sedges

Scientific name ^a	Common name	Dependence upon surface water	Dependence upon groundwater	Comments
<i>Myrmecodia beccarii</i>	Ant Plant	Yes	No	In open woodlands of <i>Melaleuca viridiflora</i> or mangroves
<i>Neoroepa buxifolia</i>	A shrub	Yes	No	Occurs along creek banks or in creek beds with riparian vine thicket or vine forest
<i>Ninox rufa queenslandica</i>	Rufous Owl (southern subspecies)	Possible	No	Wet, forested gullies
<i>Picris barbarorum</i>	A daisy	Yes	No	A plant of river banks and floodplains
<i>Pimelea leptospermoides</i>	A small shrub	Possible	No	Partly found in woodlands where prolonged flooding occurs
<i>Samadera bidwillii</i>		Possible	No	Commonly found adjacent to temporary and permanent watercourses

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

^aTypology and punctuation are given as they are used in the legislation.

1.3.2.2 Gaps

No additional economic assets were nominated following the Galilee asset workshops in Longreach and Richmond in September 2014.

Two additional sets of potential assets were proposed at the workshop in Brisbane in October 2014, but they were considered of lower priority than other datasets already nominated by Queensland state agencies and thus these two datasets were not pursued to formal nomination for assets.

These sets of potential assets are from the Queensland Department of Environment and Heritage Protection, which holds the database for Aquatic Conservation Assessments (ACA) and for the Aquatic Biodiversity Assessment Mapping Method (AquaBAMM) (DEHP, 2015).

ACAs are non-social and non-economic assessments that are designed with the sole intent of identifying conservation values of wetlands at any user-defined scale. The ACA database contains a set of 'special features' that are places of hydrological, ecological and/or sociocultural locations that are not necessarily identified as wetlands or conservation places by other means. These features are a potential set of assets that are qualitatively different to any existing asset dataset contributed to the Galilee asset list during the current assessment of water dependence.

AquaBAMM identifies relative wetland conservation values within a specified area – usually a catchment – using criteria, indicators and measures that are based on a large body literature. The AquaBAMM process identified species of local significance which could be potential assets. Such species are not necessarily on national or state lists of threatened species, but are threatened in a specific catchment.

References

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

Datasets

Dataset 1 Bioregional Assessment Programme (2013) Asset database for the Galilee subregion on 10 September 2015. Bioregional Assessment Derived Dataset. Viewed 14 September 2015, <http://data.bioregionalassessments.gov.au/dataset/c22a13bf-07ea-4eaa-960d-79d488a50496>.

Dataset 2 Australian Government Department of the Environment (1998) Species Profile and Threats Database (SPRAT) - Australia - Species of National Environmental Significance Database (BA subset - RESTRICTED - Metadata only). Bioregional Assessment Source Dataset. Viewed 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/7276dd93-cc8c-4c01-8df0-cef743c72112>.

Dataset 3 Bioregional Assessment Programme (2015) Queensland wetland data version 3 - wetland areas, QLD DSITIA - WETCLASS: E, L, M, P, R. Bioregional Assessment Derived Dataset. Viewed 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/421fa3ce-36c6-4932-8ec7-2b9bf78acf63>.

Dataset 4 Bioregional Assessment Programme (2015) Galilee Harwood Evapotranspiration v01. Bioregional Assessment Derived Dataset. Viewed 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/11726ec2-89f4-4627-806f-6e9c119b92cb>.

Dataset 5 Bioregional Assessment Programme (2015) Riparian Enhanced Vegetation Index (EVI) interpretation of major streams in the Great Artesian Basin, 50m Buffer for analysis, v01. Bioregional Assessment Derived Dataset. Viewed 09 September 2015, <http://data.bioregionalassessments.gov.au/dataset/cd9c7478-bbbe-4839-9c0e-546d751b445c>.

1.3.2 Ecological assets

1.3.3 Economic assets

Summary

The water-dependent asset register for the Galilee subregion has 129 economic water-dependent assets comprising 5012 elements. There are 33 assets within the subgroup 'Surface water management zone or area', comprising 149 surface water access entitlement elements, and 96 assets within the subgroup 'Groundwater management zone or area', comprising 4863 groundwater access entitlement elements.

1.3.3.1 Description

The total number of economic water-dependent assets in the preliminary assessment extent (PAE) of the Galilee subregion is 129 (comprising 5012 elements). This includes 149 surface water access entitlements grouped into 33 assets according to type and management zones or areas, and 4863 groundwater access entitlements grouped into 96 assets according to type and management zone or area. 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 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.

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 irrigating a garden not exceeding 0.25 ha, cultivated for domestic use rather than sale. Stock and domestic does 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.

Table 12 shows the breakdown of water access entitlements (economic elements) for groundwater and surface water in the Galilee PAE. The locations of the economic assets are shown in Figure 23 (surface water) and Figure 24 (groundwater).

1.3.3 Economic assets

Table 12 Summary of economic assets in the Galilee asset database

All assets are water dependent.

	Class	Number of assets	Number of elements	Mean number of elements per asset	Maximum number of elements per asset
Groundwater management zone	Water access right	39	350	9	77
	Basic water right (stock and domestic)	57	4513	79.2	509
Surface water management zone	Water access right	25	123	4.9	21
	Basic water right (stock and domestic)	8	26	3.3	8
Total		129	5012	na	na

Data: Bioregional Assessment Programme (Dataset 1)
na=data not applicable

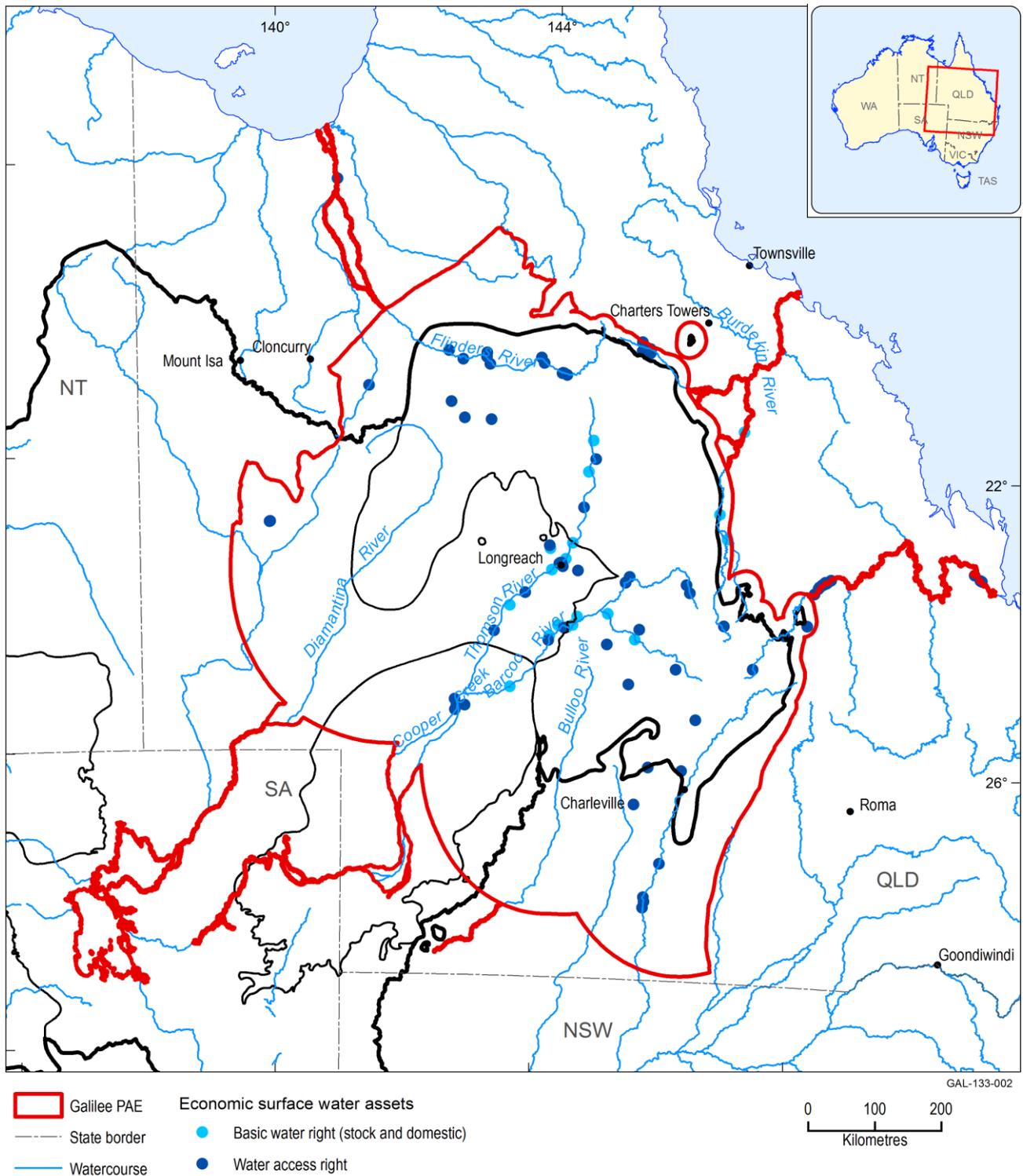


Figure 23 Location of surface water assets in the preliminary assessment extent (PAE) of the Galilee subregion

Data: Bioregional Assessment Programme (Dataset 1)

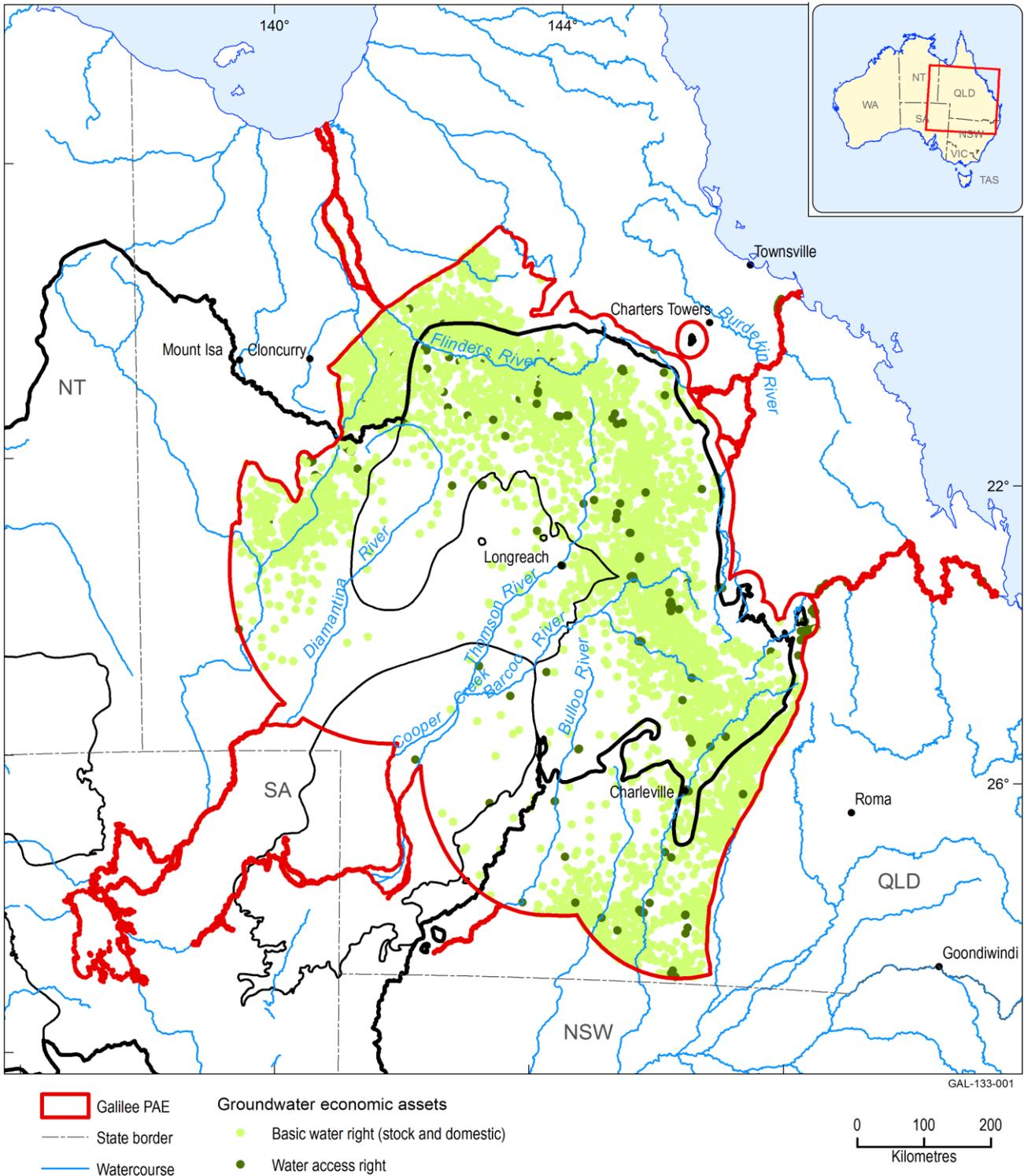


Figure 24 Location of groundwater assets in the preliminary assessment extent (PAE) of the Galilee subregion

Data: Bioregional Assessment Programme (Dataset 1)

1.3.3.2 Gaps

No additional economic assets were nominated following the Galilee asset workshops in Longreach and Richmond in September 2014, and in Brisbane in October 2014.

No water access rights or basic water rights (groundwater or surface water, in either case) were nominated for SA.

References

Council of Australian Governments (2004) Intergovernmental agreement on a National Water Initiative. Council of Australian Governments, Canberra. Viewed 15 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 (2013) Asset database for the Galilee subregion on 10 September 2015. Bioregional Assessment Derived Dataset. Viewed 14 September 2015, <http://data.bioregionalassessments.gov.au/dataset/c22a13bf-07ea-4eaa-960d-79d488a50496>.

1.3.3 Economic assets

1.3.4 Sociocultural assets

Summary

All 106 sociocultural assets were sourced from the Australian Heritage Database (Department of the Environment, 2015), of which 82 are considered to be water dependent (surface and/or groundwater). No additional sociocultural assets were nominated at the Galilee asset workshops in Longreach and Richmond in September 2014, and in Brisbane in October 2014.

Many 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 are also nominated as ecological assets. A high proportion of this type of sociocultural asset is water dependent. Other sociocultural assets are historical places, including several places associated with the ill-fated 19th century expedition of Burke and Wills. Most of the historical places are also water dependent, because they are located on floodplains.

Thirty-three Indigenous assets were listed in the Register of the National Estate within the Australian Heritage database, of which 16 are considered to be water dependent. Meetings have been held with Indigenous knowledge holders in the Galilee subregion to gain further understanding of Indigenous cultural water-dependent assets and possible additional nominations.

1.3.4.1 Description

The total of 106 sociocultural assets in the asset list are sourced from the Australian Heritage Database (Department of the Environment, 2015; Bioregional Assessment Programme Dataset 1), comprising 96 assets from the Register of the National Estate, nine assets from the National Heritage List and one asset from the World Heritage List. A total of 82 are considered to be water dependent and are included in the water-dependent asset register. Of the water-dependent assets, 29 assets are assessed as dependent or possibly dependent on surface water, 4 assets are assessed as dependent or possibly dependent on groundwater, and 49 assets are assessed as dependent or possibly dependent on both surface water and groundwater. No additional sociocultural assets were nominated at the Galilee asset workshops in Longreach and Richmond in September 2014, and in Brisbane in October 2014.

Table 13 shows the breakdown of sociocultural assets by dataset, subgroup and class, and the geographic locations of the assets are shown in Figure 25. All assets are in the 'Cultural' subgroup; no assets are in the 'Social' or 'Recreational' subgroup. Thirty-three of the assets from the Register of the National Estate are classed as Indigenous sites and 16 of them are water dependent. In the west and south of the Galilee 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 13 Summary of sociocultural assets in the preliminary assessment extent (PAE) of the Galilee subregion

Dataset	Subgroup	Class	Number of assets	Number of assets dependent on groundwater	Number of assets dependent on surface water
National Heritage List (NHL)	Cultural	Heritage site	9	9	9
Register of the National Estate (RNE)	Cultural	Heritage site	63	33	52
Register of the National Estate (RNE)	Cultural	Indigenous site	33	10	16
World Heritage List (WHL)	Cultural	Heritage site	1	1	1
Total			106	53	78

Data: Bioregional Assessment Programme (Dataset 1)

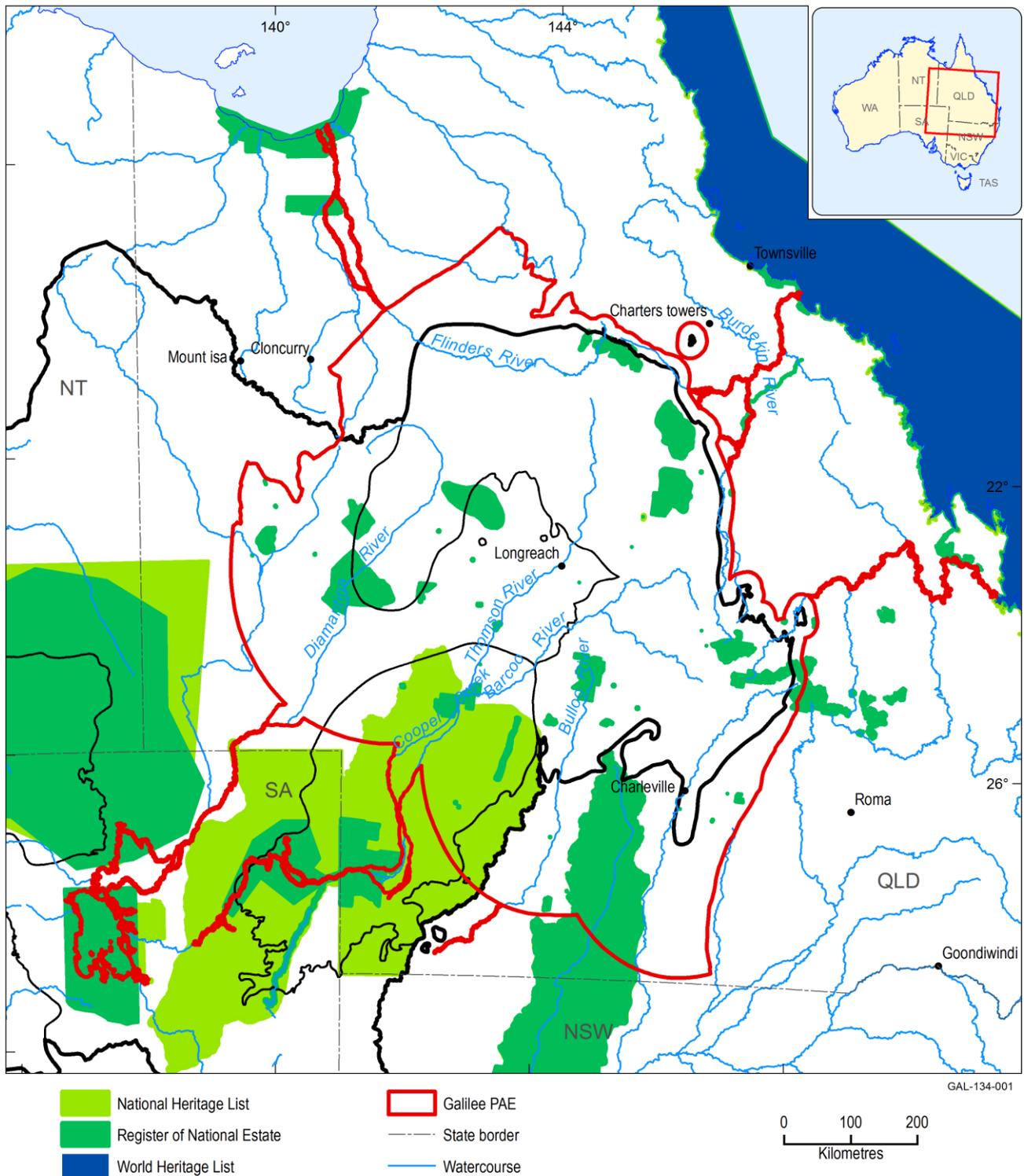


Figure 25 Location of sociocultural assets in the Galilee subregion

Data: Bioregional Assessment Programme (Dataset 1)

The assets from the National Heritage List include many areas that have natural values and are partly or entirely protected under national and/or state conservation legislation. Such sociocultural assets are also nominated as ecological assets (e.g. the Birdsville and Strzelecki Tracks Areas, the Cooper Creek subcatchment, Edgbaston Springs, Elizabeth Springs, the Great Barrier Reef, Lake Eyre National Park and Elliot Price Conservation Park, and the Simpson Desert).

1.3.4 Sociocultural assets

The Great Barrier Reef National Park is the single asset nominated from the World Heritage List. All of these two types of asset are dependent on surface water.

Many of the assets sourced from the Register of the National Estate and classed as heritage sites are also natural areas which have federal or state-level conservation designations. They are also nominated as assets from other databases. Examples include:

- Bladensburg National Park and surrounds
- Carnarvon Range area
- Cauckingburra Swamp
- Coongie Lake and adjacent area
- Cooper Creek floodplain
- Diamantina National Park
- Doongmabulla Springs
- Edgbaston Springs
- Elizabeth Springs
- Elliott Price Conservation Park
- Epping Forest National Park
- Hell Hole Gorge National Park
- Idalia National Park and adjacent areas
- the proposed Karandella National Park
- Lake Bindegolly National Park and Conservation Park
- Lake Buchanan and catchment
- Lake Eyre and environs
- Lake Galilee basin and wetlands
- Paroo catchment area
- Porcupine Gorge National Park
- Simpson Desert
- White Mountains National Park.

All examples of this type of asset also depend on surface water, at least in part, and many also depend on groundwater, most notably where Great Artesian Basin springs are present and are the defining heritage feature.

Other assets sourced from the Register of the National Estate and classed as heritage sites are historical places, including the Burke and Wills National Heritage Place, the Burke Memorial, the Wills Monument and Blazed Tree, the Dig Tree Reserve, the Alexandra Bridge, the Angellala Creek Rail Bridge, the Old Bowen Downs Road, and the Politic Sheds Historic Indicative Place. Many of these assets are also assessed as water dependent because they are located in floodplains.

The asset list includes 33 Indigenous sites sourced from the Register of the National Estate list within the Australian Heritage Database (Department of the Environment, 2015). Sixteen of these

sites are likely or possibly dependent on surface water, and ten sites may also be dependent on groundwater, including:

- Cunnavalla Creek Area Indigenous Registered
- Currawilla Area Indigenous Registered
- Innamincka Aboriginal Sites Indigenous Registered
- Innamincka Historic Reserve Indigenous Registered
- Marion Downs Middens Indigenous Registered
- Marion Downs Stone Huts Indigenous Registered
- Mucklandama Creek Area Indigenous Registered
- Nanyah Rock Wells Indigenous Registered
- Nappa Merrie Archaeological Area Indigenous Registered
- Nappamerry Area Natural Registered
- Nappapethera Waterhole Sites Indigenous Registered
- Payanta Indigenous Indicative Place
- Piastre Area Indigenous Registered
- Scarred Coolibah Trees Indigenous Indicative Place
- Scarred Tree Indigenous Registered
- The Weir Indigenous Indicative Place
- Vergemont Area Indigenous Registered
- Welsharp Area Indigenous Registered
- Westerton Area Indigenous Registered.

1.3.4.2 Gaps

No further sociocultural assets were nominated following the Galilee asset workshops in Longreach and Richmond in September 2014, and in Brisbane in October 2014.

Meetings have been held with Indigenous knowledge holders in the Galilee subregion to gain further understanding of Indigenous cultural water-dependent assets. Where possible and appropriate, and with the agreement of Indigenous knowledge holders, these additional Indigenous water-related values will be published in a separate report. Identified assets will be incorporated into an updated water-dependent asset register and/or incorporated into later technical products.

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

References

Department of the Environment (2015) Australian Heritage Database online. Viewed 26 March 2015, <http://www.environment.gov.au/topics/heritage/publications-and-resources/australian-heritage-database>.

Datasets

Dataset 1 Bioregional Assessment Programme (2013) Asset database for the Galilee subregion on 10 September 2015. Bioregional Assessment Derived Dataset. Viewed 14 September 2015, <http://data.bioregionalassessments.gov.au/dataset/c22a13bf-07ea-4eaa-960d-79d488a50496>

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