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 Hunter subregion

Product 1.3 for the Hunter subregion from the Northern Sydney Basin Bioregional Assessment

20 June 2016

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 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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Authorship is listed in relative order of contribution.

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Cover photograph

Oblique view west of Muswellbrook showing Bengalla coal storage (left foreground) with irrigated agriculture and riparian vegetation either side of the Hunter River and Mount Arthur coal mine in the distance (right background), NSW, 2014

© Google earth (2015), Sinclair Knight Merz Imagery date 16 December 2008. Position 32°17'58'' S, 150°48'51'' E, elevation 136 m, eye altitude 1.59 km

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Geoscience Australia

CSIRO

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Contributors to the Technical Programme

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

Role or team	Contributor(s)
Assistant Secretary	Department of the Environment: Matthew Whitfort
Programme Director	Department of the Environment: Anthony Swirepik
Technical Programme Director	Bureau of Meteorology: Julie Burke
Projects Director	CSIRO: David Post
Principal Science Advisor	Department of the Environment: Peter Baker
Science Directors	CSIRO: Brent Henderson Geoscience Australia: Steven Lewis
Integration	Bureau of Meteorology: Richard Mount (Integration Leader) CSIRO: Becky Schmidt
Programme management	Bureau of Meteorology: Louise Minty CSIRO: Paul Hardisty, Warwick McDonald Geoscience Australia: Stuart Minchin
Project Leaders	CSIRO: Alexander Herr, Kate Holland, Tim McVicar, David Rassam Geoscience Australia: Tim Evans, Kriton Glenn, Martin Smith Bureau of Meteorology: Natasha Herron
Assets and receptors	Bureau of Meteorology: Richard Mount (Discipline Leader) Department of the Environment: Glenn Johnstone, Wasantha Perera, Jin Wang
Bioregional Assessment Information Platform	Bureau of Meteorology: Lakshmi Devanathan (Team Leader), Derek Chen, Trevor Christie-Taylor, Melita Dahl, Angus MacAulay, Christine Panton, Paul Sheahan, Kellie Stuart, Carl Sudholz CSIRO: Peter Fitch, Ashley Sommer Geoscience Australia: Neal Evans
Communications	Bureau of Meteorology: Karen de Plater CSIRO: Helen Beringen, Chris Gerbing Department of the Environment: Lea Locke, Milica Milanja Geoscience Australia: Leane Regan
Coordination	Bureau of Meteorology: Julie Burke, Eliane Prideaux, Sarah van Rooyen CSIRO: Ruth Palmer Department of the Environment: Anisa Coric, James Hill, Bronwyn McMaster, Emily Turner Geoscience Australia: Tenai Luttrell
Ecology	CSIRO: Anthony O'Grady (Discipline Leader), Caroline Bruce, Tanya Doody, Brendan Ebner, Craig MacFarlane, Patrick Mitchell, Justine Murray, Chris Pavey, Jodie Pritchard, Nat Raisbeck-Brown, Ashley Sparrow
Geology	CSIRO: Deepak Adhikary, Emanuelle Frery, Mike Gresham, Jane Hodgkinson, Zhejun Pan, Matthias Raiber, Regina Sander, Paul Wilkes Geoscience Australia: Steven Lewis (Discipline Leader), Stephen Hostetler

Role or team	Contributor(s)
Geographic information systems	CSIRO: Jody Bruce, Debbie Crawford, Steve Marvanek, Arthur Read Geoscience Australia: Adrian Dehelean, Jo Bell
Groundwater modelling	CSIRO: Russell Crosbie (Discipline Leader), Tao Cui, Warrick Dawes, Lei Gao, Sreekanth Janardhanan, Luk Peeters, Praveen Kumar Rachakonda, Adam Ramage, Wolfgang Schmid, Saeed Torkzaban, Chris Turnadge, Andy Wilkins, Binzhong Zhou
Hydrogeology	Geoscience Australia: Tim Ransley (Discipline Leader), Hashim Carey, Chris Harris-Pascal, Karen Ivkovic, Jessica Northey, Emily Slatter
Information management	Bureau of Meteorology: , Belinda Allison (Team Leader) CSIRO: Qifeng Bai, Simon Cox, Phil Davies, Mick Hartcher, Geoff Hodgson, Brad Lane, Ben Leighton, David Lemon, Trevor Pickett, Shane Seaton, Ramneek Singh, Matt Stenson Geoscience Australia: Luke Caruana, Matti Peljo
Products	CSIRO: Becky Schmidt (Products Manager), Maryam Ahmad, Daniel Aramini, Clare Brandon, Heinz Buettikofer, Sonja Chandler, Anu Edirisuriya, Simon Gallant, Karin Hosking, Frances Marston, Linda Merrin, Sally Tetreault-Campbell, Catherine Ticehurst Geoscience Australia: Penny Kilgour, Kathryn Owen
Risk and uncertainty	CSIRO: Simon Barry (Discipline Leader), Jeffery Dambacher, Jess Ford, Keith Hayes, Geoff Hosack, Adrian Ickowicz, Warren Jin, Yang Liu, Dan Pagendam
Surface water hydrology	CSIRO: Neil Viney (Discipline Leader), Santosh Aryal, Mat Gilfedder, Fazlul Karim, Lingtao Li, Dave McJannet, Jorge Luis Peña-Arancibia, Xiaogang Shi, Tom Van Niel, Jai Vaze, Bill Wang, Ang Yang, Yongqiang Zhang

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- Discipline Leaders: Richard Mount (assets), Anthony O'Grady (ecology)
- Senior Science Leaders: David Post (Projects Director), Steve Lewis (Science Director, Geoscience Australia), Maryam Ahmad (Deputy Products Manager, CSIRO)
- Technical Assurance Reference Group: Chaired by Peter Baker (Principal Science Advisor, Department of the Environment), this group comprises officials from the NSW, Queensland, South Australian and Victorian governments.

Valuable contribution was also provided by Suzanne Slegers who clarified details of data processing steps, included in the Methods section.

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 (IESC, 2015).

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 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 (see http://www.bioregionalassessments.gov.au/assessments for a map and further information):

- 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.

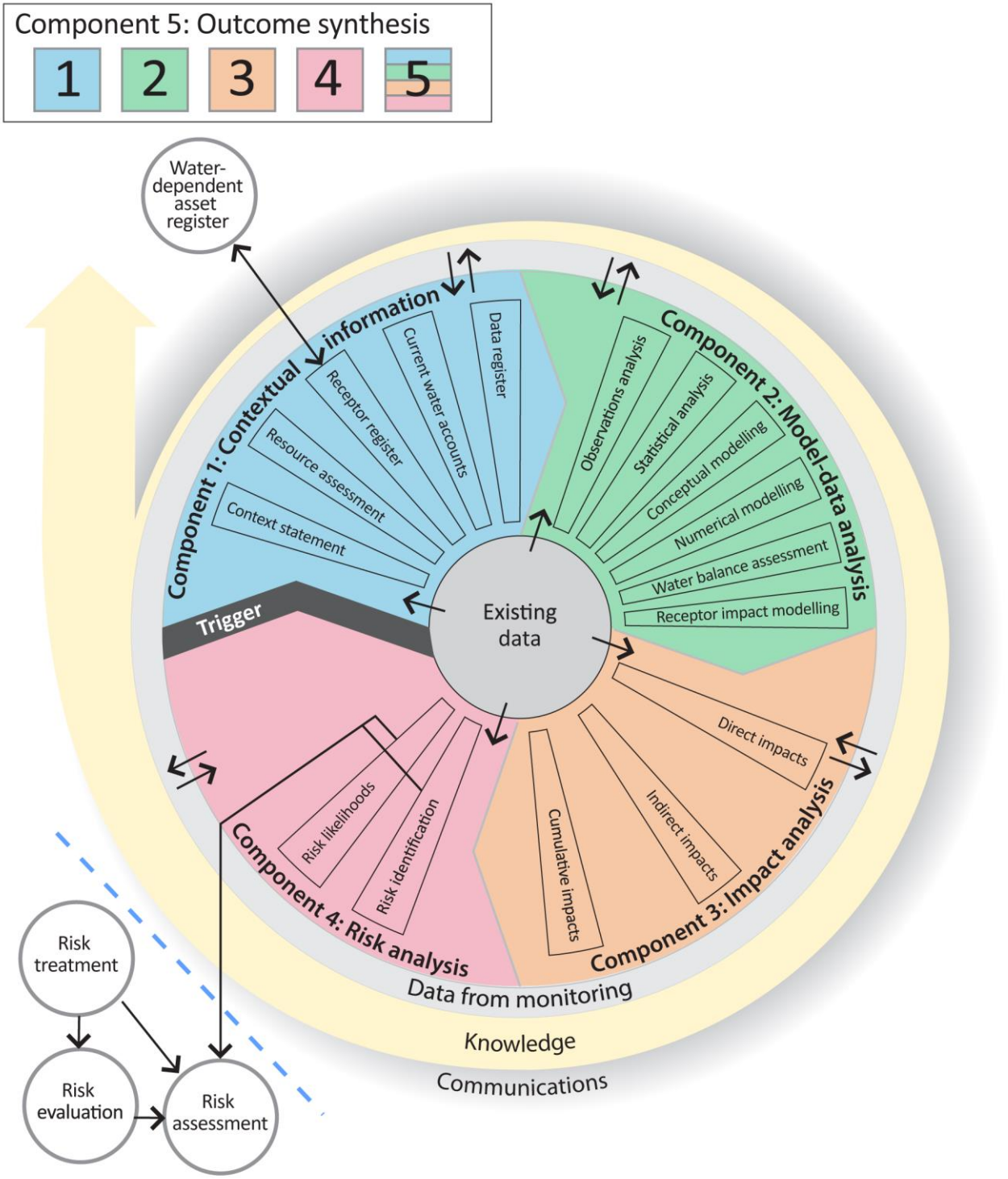

Figure 1 Schematic diagram of the bioregional assessment methodology

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

The overall scientific and intellectual basis of the BAs is provided in the BA methodology (Barrett et al., 2013). Additional guidance is required, however, about how to apply the BA methodology to a range of subregions and bioregions. To this end, the teams undertaking the BAs have developed and documented detailed scientific submethodologies (Table 1) to, in the first instance, support the consistency of their work across the BAs and, secondly, to open the approach to scrutiny, criticism and improvement through review and publication. In some instances, methodologies applied in a particular BA may differ from what is documented in the submethodologies – in this case an explanation will be supplied in the technical products of that BA. Ultimately the Programme anticipates publishing a consolidated 'operational BA methodology' with fully worked examples based on the experience and lessons learned through applying the methods to 13 bioregions and subregions.

The relationship of the submethodologies to BA components and technical products is illustrated in Figure 2. While much scientific attention is given to assembling and transforming information, particularly through the development of the numerical, conceptual and receptor impact models, integration of the overall assessment is critical to achieving the aim of the BAs. To this end, each submethodology explains how it is related to other submethodologies and what inputs and outputs are required. They also define the technical products and provide guidance on the content to be included. When this full suite of submethodologies is implemented, a BA will result in a substantial body of collated and integrated information for a subregion or bioregion, including new information about the potential impacts of coal resource development on water and water-dependent assets.

Table 1 Methodologies

Each submethodology is available online at http://data.bioregionalassessments.gov.au/submethodology/XXX, where 'XXX' is replaced by the code in the first column. For example, the BA methodology is available at http://data.bioregionalassessments.gov.au/submethodology/bioregional-assessment-methodology and submethodology M02 is available at http://data.bioregionalassessments.gov.au/submethodology/M02. Submethodologies might be added in the future.

Code	Proposed title	Summary of content
bioregional-assessment-methodology	*Methodology for bioregional assessments of the impacts of coal seam gas and coal mining development on water resources*	A high-level description of the scientific and intellectual basis for a consistent approach to all bioregional assessments
M02	*Compiling water-dependent assets*	Describes the approach for determining water-dependent assets
M03	*Assigning receptors to water-dependent assets*	Describes the approach for determining receptors associated with water-dependent assets
M04	*Developing a coal resource development pathway*	Specifies the information that needs to be collected and reported about known coal and coal seam gas resources as well as current and potential resource developments
M05	*Developing the conceptual model of causal pathways*	Describes the development of the conceptual model of causal pathways, which summarises how the 'system' operates and articulates the potential links between coal resource development and changes to surface water or groundwater
M06	*Surface water modelling*	Describes the approach taken for surface water modelling
M07	*Groundwater modelling*	Describes the approach taken for groundwater modelling
M08	*Receptor impact modelling*	Describes how to develop receptor impact models for assessing potential impact to assets due to hydrological changes that might arise from coal resource development
M09	*Propagating uncertainty through models*	Describes the approach to sensitivity analysis and quantification of uncertainty in the modelled hydrological changes that might occur in response to coal resource development
M10	*Impacts and risks*	Describes the logical basis for analysing impact and risk
M11	*Systematic analysis of water-related hazards associated with coal resource development*	Describes the process to identify potential water-related hazards from coal resource development

Technical products

The outputs of the BAs include a suite of technical products presenting information about the ecology, hydrology, hydrogeology and geology of a bioregion and the potential 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 relationship of the technical products to BA components and submethodologies. 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 outlines in both Figure 2 and Table 2 indicate the information included in this technical product.

Technical products are delivered as reports (PDFs). Additional material is also provided, as specified by the BA methodology:

- unencumbered data syntheses and databases
- unencumbered tools, model code, procedures, routines and algorithms
- unencumbered forcing, boundary condition, parameter and initial condition datasets
- lineage of datasets (the origin of datasets and how they are changed as the BA progresses)
- gaps in data and modelling capability.

In this context, unencumbered material is material that can be published according to conditions in the licences or any applicable legislation. All reasonable efforts were made to provide all material under a Creative Commons Attribution 3.0 Australia Licence.

Technical products, and the additional material, are available online at http://www.bioregionalassessments.gov.au.

The Bureau of Meteorology archives a copy of all datasets used in the BAs. This archive includes datasets that are too large to be stored online and datasets that are encumbered. The community can request a copy of these archived data at http://www.bioregionalassessments.gov.au.

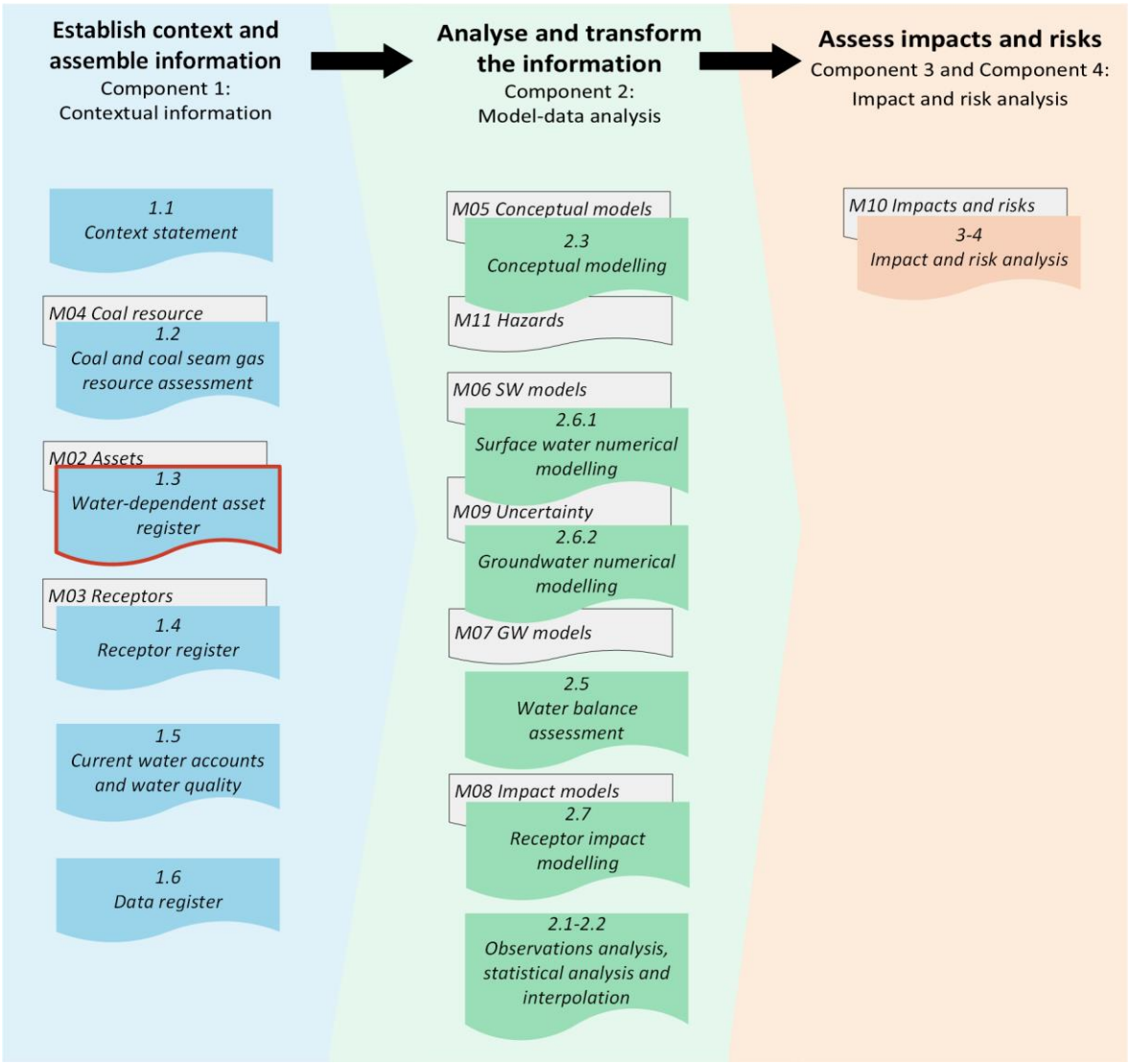

Figure 2 Technical products and submethodologies associated with each component of a bioregional assessment

In each component (Figure 1) of a bioregional assessment, a number of technical products (coloured boxes, see also Table 2) are potentially created, depending on the availability of data and models. The light grey boxes indicate submethodologies (Table 1) that specify the approach used for each technical product. The red outline indicates this technical product. The BA methodology (Barrett et al., 2013) specifies the overall approach.

Table 2 Technical products delivered by the Northern Sydney Basin Bioregional Assessment

For each subregion in the Northern Sydney 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. There is no product 2.4; originally this product was going to include two- and three-dimensional representations as per Section 4.2 of the BA methodology, but these are instead included in products such as product 2.3 (conceptual modelling), product 2.6.1 (surface water numerical modelling) and product 2.6.2 (groundwater numerical modelling).

Component	Product code	Title	Section in the BA methodology[b]	Type[a]
Component 1: Contextual information for the Hunter 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 Hunter 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 and Component 4: Impact and risk analysis for the Hunter subregion	3-4	Impact and risk analysis	5.2.1, 2.5.4, 5.3	PDF, HTML
Component 5: Outcome synthesis for the Northern Sydney Basin bioregion	5	Outcome synthesis	2.5.5	PDF, HTML

[a]The types of products are as follows:

- 'PDF' indicates a PDF document that is developed by the Northern Sydney Basin Bioregional Assessment using the structure, standards and format 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 151.0° East for the Northern Sydney 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 24 June 2016, http://data.bioregionalassessments.gov.au/submethodology/bioregional-assessment-methodology.

IESC (2015) Information guidelines for the Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals. Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development, Australia. Viewed 24 June 2016, http://www.iesc.environment.gov.au/publications/information-guidelines-independent-expert-scientific-committee-advice-coal-seam-gas.

1.3 Description of the water-dependent asset register for the Hunter 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/NSB/HUN/1.3).

1.3.1 Methods

Summary

The water-dependent asset register is a list of water-dependent assets identified for use in the bioregional assessment (BA) of the Hunter subregion. This section details the specific application to the Hunter subregion of methods described in the companion submethodology M02 for compiling water-dependent assets (Mount et al., 2015). Key concepts and terminology are also explained.

The methods covered include: defining the preliminary assessment extent (PAE) of the Hunter subregion and the processes for compiling assets, determining their water dependency, seeking and incorporating NSW state and local government feedback.

The asset list for the Hunter subregion contains 2545 assets that intersect the Hunter PAE, comprising 1836 ecological assets, 266 economic assets and 443 sociocultural assets.

Not all assets in the asset list make it into the water-dependent asset register. The reasons some ecological, economic and sociocultural assets in the asset list were not retained in the water-dependent asset register for the Hunter subregion are provided in Sections 1.3.2, 1.3.3 and 1.3.4, respectively.

The water-dependent asset register for the Hunter subregion contains 2207 assets, comprising 1651 ecological assets, 249 economic assets and 307 sociocultural assets.

1.3.1.1 Background and context

This product presents information about the water-dependent asset register developed for the Hunter 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 Hunter subregion on 20 November 2015' (Macfarlane 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/NSB/HUN/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 Hunter subregion is described in the following sections.

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

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

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

The asset source data are compiled into an asset database, including the geographic location, which are designated as elements (individual spatial features – points, lines and polygons e.g. components of a larger system) and assets (combinations of one or more elements). During the compilation process, assets are 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

Two natural resource management organisations (NRMs) contributed data to the WAIT database. These NRM-nominated assets were added to the asset database. When the Hunter subregion was defined in 2012, it largely fell within the Hunter Central Rivers Catchment Management Authority (CMA) area, with a small area within the Namoi CMA. From 1 January 2014, NSW CMAs transitioned into local land services (LLS) regions, however, the data continues to be attributed to the CMAs. Most of the assets from the Hunter Central River CMA data (348 out of 352) and all of the assets from the Namoi CMA (38) are classed as ecological assets.

Other data sources used to define ecological assets in the Hunter subregion are listed in Table 3. Some of the elements obtained from the State and Australian Government data sources duplicate elements provided by the Hunter Central Rivers CMA. This means that within the total asset number, the same asset could be counted multiple times, for example, the Avoca groundwater-dependent ecosystem is included in: the WAIT database as an NRM-nominated asset (Department of the Environment, Dataset 4); the Directory of Important Wetlands (Department of the Environment, Dataset 6); the Atlas of Groundwater Dependent Ecosystems (Bureau of Meteorology, Dataset 7); and the NSW Wetlands 2006 (NSW Office of Environment and Heritage, Dataset 13).

Table 3 includes assets that were identified by local and state government workshop participants during the Hunter assets workshop in April 2015 (see Section 1.3.1.4). Additional species were added to the database, based on spatial information from the *Atlas of Living Australia* (ALA) and NSW Threatened Species and Ecological Communities distributions. Not all assets suggested at the workshops made it into the asset list for the Hunter subregion because they either failed the 'fit-for-BA' test or were not in the PAE. The fit-for-BA test is intended to ensure that data included in the water-dependent asset register meets BA quality. The tests enable the exclusion of duplicate data, irrelevant data, superseded data and data with inadequate information content (e.g. lacking spatial coverage). Details are provided in Section 1.3.2.

Table 3 Data sources for ecological assets in the asset list for the Hunter subregion

Dataset[a]	Dataset citation	Elements	Assets (in asset list)
Water Asset Information Tool (WAIT) database	Australian Government Department of the Environment (Dataset 4)	20,433	386
Collaborative Australian Protected Areas Database (CAPAD)	Australian Government Department of the Environment (Dataset 5)	68	68
A directory of Important Wetlands in Australia (DIWA)	Australian Government Department of the Environment (Dataset 6)	550	17

Dataset[a]	Dataset citation	Elements	Assets (in asset list)
Atlas of Groundwater Dependent Ecosystems including: • subsurface presence of groundwater data • surface expression of groundwater	Bureau of Meteorology (Dataset 7)	 67,265 873	 160 74
Threatened ecological communities listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)	Australian Government Department of the Environment (Dataset 8)	2510	7
Threatened species listed under the EPBC Act	Bioregional Assessment Programme (Dataset 9)	15,766	146
Wetlands of International Importance (Ramsar wetlands)	Australian Government Department of the Environment (Dataset 10)	2	2
Birds Australia Important Bird Areas	Birds Australia (Dataset 11)	7	7
New South Wales High Probability Groundwater Dependent Vegetation with High Ecological Value	NSW DPI (Office of Water) (Dataset 12)	50,635	452
NSW State Wetlands 2006	NSW DECCW[b] (Dataset 13)	762	98
Estuarine Macrophytes	NSW DPI – Fisheries (Dataset 14)	10,782	28
Cameron's Gorge Grassy White Box Endangered Ecological Community EEC 3822	NSW OEH (Dataset 15)	1	1
Lower Hunter Spotted Gum Forest Endangered Ecological Community EEC 2319	NSW OEH (Dataset 16)	57	12
Gosford Council Endangered Ecological Communities (Umina woodlands) EEC 3906	NSW OEH (Dataset 17)	1	1
Climate Change Corridors Coastal - North East NSW	NSW DECCW[b] (Dataset 18)	7	6
Climate Change Corridors Dry - North East NSW	NSW DECCW[b] (Dataset 19)	42	33
Climate Change Corridors Moist - North East NSW	NSW DECCW[b] (Dataset 20)	8	8
Climate Change Corridors - Nandewar_NET	NSW DECCW[b] (Dataset 21)	1	1
Fauna Corridors North East NSW	NSW DECCW[b] (Dataset 22)	461	197
NSW Travelling Stock Reserve Conservation Values	NSW DECCW[b] (Dataset 23)	119	119
NSW Native Vegetation Management (NVM)	NSW OEH (Dataset 24)	815	5

Dataset[a]	Dataset citation	Elements	Assets (in asset list)
Atlas of Living Australia (ALA) • Platypus (*Ornithorhynchus anatinus*) • Beady Pipefish (*Hippichthys penicillus*) • Booroolong Frog (*Litoria booroolongensis*)	NSW OEH (Dataset 39)	275	4
NSW Fishing and Aquaculture – Listed threatened species, populations and ecological communities • Darling Hardyhead (*Craterocephalus amniculus*)	NSW DPI – Fisheries (Dataset 40)	30	1
NSW Threatened species and ecological communities • Wallum Froglet (*Crinia tinnula* • Green-thighed Frog (*Litoria brevipalmata*)) • Red-crowned Toadlet (*Pseudophryne australis*)	Office of Environment and Heritage, Department of Premier and Cabinet (Dataset 38)	20	3
Total		**171,490**	**1,836**

[a]The asset database (Bioregional Assessment Programme, Dataset 1) is a collation of all these source datasets. Some assets may be captured in multiple databases.
[b]NSW Office of Environment and Heritage (NSW OEH) is custodian of these datasets generated by the former NSW Department of Environment Climate Change and Water (NSW DECCW).
NSW OEH = New South Wales Office of Environment and Heritage; NSW DPI = New South Wales Department of Primary Industries; ALA = Atlas of Living Australia

1.3.1.2.2 Economic assets

All economic assets are types of *water access entitlements*, either *water access rights* or *basic water rights*. In NSW, water access entitlements are known as 'water access licences'. Within the asset database, every water access entitlement is an element. Elements are grouped by type and also spatially to create assets. *Basic landholder rights* (i.e. a type of basic water right), including riparian rights, maintain the right of those adjacent to rivers, estuaries, lakes or aquifers underlying the land to extract water for domestic and stock use without a water access licence. Basic landholder rights are defined by the jurisdiction based on the location of the water source and may include an estimated volume of use based on the number of landholders with adjacent water sources.

For the economic assets, the water access entitlements are divided into two classes:

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

Data sources used to create economic assets for the Hunter subregion are listed in Table 4. Both surface water and groundwater licensing data were sourced from the NSW Office of Water to determine economic assets (NSW Office of Water, Dataset 25, Dataset 26) and include all licensed entitlements under the NSW *Water Act 1912* and the NSW *Water Management Act 2000*. Water access licence data include whether the water source is groundwater or surface water, the entitlement volume and the corresponding works locations. These data are currently not publicly available and were obtained by special request. Consistent with how water licensing information is published under the Commonwealth's Water Act 2007, NSW Department of Primary Industries Water have consented to publication of these data in an aggregated form that protects the privacy of individual licence holders. Data about basic landholder rights, essentially non-licensed stock and domestic use permitted, were sourced from water sharing plans (NSW Department of Primary Industries, 2014).

In collating the economic elements, it was considered important to ensure no current or active water access entitlements were excluded, even where there was doubt about the current status of the entitlement, for example, 'sleeper' licences. For example, basic water rights (stock and domestic) do not have to be renewed on a frequent basis leading to some uncertainty about their current use status. This meant that only surface water and groundwater licences that were definitely 'abandoned' or 'cancelled' at the time of data extraction were marked as not 'current' or 'active' and therefore excluded for BA purposes.

Each licence can have one or multiple works associated with it, where the works is the location where the water is extracted through a bore or pump. Where works (locations) information was present it was linked to the particular surface water or groundwater licences, and a count added to show how many works were associated with each licence. It was assumed that each of the works associated with a water access right licence extracts an equal share of the volume. Thus, if a groundwater licence of 80 ML/year was associated with four works (bores), 20 ML/year was assigned to each work. It is not possible to validate this assumption within the resources of the BA. It is possible that the majority of extraction occurs at a single works location and is not evenly distributed across all works associated with the licence.

A digital spatial layer was generated using the spatial coordinates provided with the licensed datasets, or in the case of the groundwater licences linked to bores in the National Groundwater Information System (NGIS; Bureau of Meteorology, Dataset 27) database. This spatial layer was overlain with the PAE for the Hunter subregion. Thirty-five groundwater entitlement licences associated with Hunter subregion mines could not be linked to bores in the NGIS database. Instead OZMIN (Geoscience Australia, Dataset 28) was consulted to obtain mine location coordinates as a proxy for the actual bore locations. Water access licence records have been manually validated down to 200 ML to ensure all volumes above this amount were assigned a spatial location.

The class of asset was aggregated using the NSW Office of Water 'purpose' field which records the purpose that water is used for. Any purpose that was listed as 'Domestic' and/or 'Stock' was classed as a basic water right. Where the purpose is commercial, irrigation, farming, industrial or dewatering, the asset is classed as a water access right. Where a purpose included 'Stock' or 'Domestic' and another licensed purpose, it was classed as a water access right.

Groundwater works that were not classified as a basic water right or a water access right were classed as 'null'. These included test bores, bores installed for groundwater remediation, exploratory bores, exploratory research and monitoring bores. These elements are 'flagged' in the asset database and are not included in the water-dependent asset register. Once data checking and spatial attribution were completed, these pre-processed datasets were incorporated into the asset database (Bioregional Assessment Programme, Dataset 29, Dataset 30).

Spatial layers of NSW water sharing plan and groundwater macro plan areas were intersected with the Hunter PAE to identify the economic assets (Table 4). While 17 groundwater source areas and 52 surface water source areas intersected the Hunter PAE, some were excluded from the water-dependent asset register. This is because intersection with the PAE was a result of minor differences in their mapped boundaries which caused slivers of intersection rather than true intersection. In other words, some of the water sharing plans and macro groundwater plans selected in this way are not actually in the PAE (see Section 1.3.3).

Table 4 Data sources for economic assets in the Hunter subregion asset list

Dataset[a]	Dataset citation	Elements	Assets (in asset list)
Surface Water Entitlements Locations v1	NSW Office of Water (Dataset 25) Restricted access	In Bioregional Assessment Programme (Dataset 29)[b]	In Bioregional Assessment Programme (Dataset 29)[b]
Groundwater Entitlements Hunter	NSW Office of Water (Dataset 26) Restricted access	In Bioregional Assessment Programme (Dataset 30)[c]	In Bioregional Assessment Programme (Dataset 30)[c]
NSW Office of Water – National Groundwater Information System	Bureau of Meteorology (Dataset 27)	In Bioregional Assessment Programme (Dataset 30)[c]	In Bioregional Assessment Programme (Dataset 30)[c]
Operating Mines OZMIN	Geoscience Australia (Dataset 28)	In Bioregional Assessment Programme (Dataset 30)[c]	In Bioregional Assessment Programme (Dataset 30)[c]
Water Asset Information Tool database – water supply infrastructure	Australian Government Department of the Environment (Dataset 4)	2	2
Hunter surface water licences (water access rights and basic water rights)	Bioregional Assessment Programme (Dataset 29)[b]	4,818	62
Hunter groundwater bores (water access rights and basic water rights)	Bioregional Assessment Programme (Dataset 30)[c]	5,453	131
Regulated Rivers	NSW Office of Water (Dataset 31)	1	1
Groundwater Macro Plans (groundwater source areas)	NSW Office of Water (Dataset 32)	17	17
Water Sharing Plans (surface water source areas)	NSW Office of Water (Dataset 33)	53	53
Total		**10,344**	**266**

[a]The asset database (Bioregional Assessment Programme, Dataset 1) is a collation of all these source datasets. Some assets may be captured in multiple databases.
[b]Bioregional Assessment Programme (Dataset 30) is the derived dataset of NSW Office of Water (Dataset 26), Bureau of Meteorology (Dataset 27) and Geoscience Australia (Dataset 28).
[c]Bioregional Assessment Programme (Dataset 29) is the derived dataset of NSW Office of Water (Dataset 25).

1.3.1.2.3 Sociocultural assets

Indigenous sociocultural assets were sourced from existing Commonwealth heritage databases, (Table 5).

Meetings have been held with Indigenous knowledge holders in the Hunter subregion to gain further understanding of Indigenous cultural water-dependent assets. Should additional information on Indigenous water-related values become available to the Programme, it may might be incorporated into an updated water-dependent asset register and/or into later technical products. This will only be done if possible and approporiate, and with the agreement of Indigenous knowledge holders.

Sociocultural assets were primarily sourced from heritage and national estate lists within the Australian Heritage Database (Department of the Environment, 2013). A couple of assets were also obtained from the WAIT database.

Typically, sociocultural assets that are landscape water features are included within the ecological asset classes to avoid repetition of assets, but as noted earlier the asset list does contain some duplication of assets.

Table 5 Datasets in the Water Asset Information Tool database and Australian Heritage Database used to identify sociocultural assets in the Hunter subregion

Dataset[a]	Dataset citation	Elements	Assets (in asset list)
Water Asset Information Tool database – Avoca and Terrigal recreation areas	Australian Government Department of the Environment (Dataset 4)	2	2
World Heritage List (WHL)	Australian Government Department of the Environment (Dataset 34)	1	1
National Heritage List (NHL)	Australian Government Department of the Environment (Dataset 35)	9	9
Commonwealth Heritage List (CHL)	Australian Government Department of the Environment (Dataset 36)	12	12
Register of the National Estate (RNE)	Australian Government Department of the Environment (Dataset 37)	419	419
Total		**443**	**443**

[a]The asset database (Bioregional Assessment Programme, Dataset 1) is a collation of all these source datasets. Some assets may be captured in multiple databases.

1.3.1.3 Determining the preliminary assessment extent

Coal mines, both open-cut and underground, and coal deposits (which may become new coal mines) are widely distributed across the Hunter subregion, from the headwaters of the Goulburn River in the west to the cluster of mines along the Hunter valley floor between Muswellbrook and Singleton, to the various mines in the vicinity of the subregion's coastal lakes (Figure 3). Water connections between these and water-dependent assets are contained almost entirely within the subregion because surface water drainage from 99.5% of the subregion is to its coastal lakes and/or the sea. Since there are no plans for coal resource development in the small area of the subregion that drains into the Namoi river basin (pink circle in Figure 3), there is no need to extend the PAE any further downstream of its current extent within the Namoi river basin. This small extension of the subregion into the Namoi river basin reflects a geological, rather than hydrological, basis for defining the subregion in this area (see Section 1.1.1 in McVicar et al., 2015). Thus the PAE for the Hunter subregion has been defined as the subregion itself.

Figure 3 Location of the Hunter preliminary assessment extent (PAE)

The PAE coincides completely with the subregion boundary. The small area contained within the pink circle flows into the Namoi river basin and has no current or proposed coal resource development.
Data: Bioregional Assessment Programme (Dataset 2, Dataset 3)

1.3.1.4 Assessing water dependence

Assets in the asset database that intersect the Hunter PAE form the asset list for the Hunter subregion. The water dependency of each asset in the asset list must then be assessed. Only assets that have a water dependency qualify for inclusion in the water-dependent asset register. Thus any asset that might potentially be impacted by changes in the groundwater and/or surface water regime due to coal resource development is added to the water-dependent asset register. Many assets are clearly 'water dependent', including all economic assets (i.e. water access entitlements and reservoirs).

In the case of ecological assets, features such as rivers, wetlands, lakes, lagoons and groundwater dependent ecosystems are clearly water dependent, however the water dependency of other assets, such as nature reserves and conservation areas, is less certain. The water dependency of nature reserves and conservation areas was determined based on their intersection with obvious surface water and groundwater features. Assets that do not overlap with obvious water features were judged not to be water dependent. The water dependency of threatened species and communities were assessed on a case-by-case basis, based on their profiles on the Species Profiles and Threats database (SPRAT) (Australian Government Department of the Environment, Dataset 8; Bioregional Assessment Programme, Dataset 9) and the NSW BioNet website (NSW Office of Heritage and Environment, 2015).

A similar approach was taken to judge the water dependency of sociocultural assets. A 500 m buffer was put around all rivers and wetlands and this was intersected with the sociocultural assets to identify those potentially having a water dependency.

Water dependence was determined for a preliminary list of assets to produce a preliminary version of the water-dependent asset register. For transparency, decisions about water dependency are recorded in the asset database. The preliminary version of the water-dependent asset register, with associated maps and data, was presented to experts and organisations with local knowledge at the Hunter asset workshop in Thornton (NSW) in April 2015 for comment and feedback. There were 18 participants from state and local governments (Table 6) and 8 members from the BA team. The participants demonstrated an enormous willingness to provide additional or better data to improve the asset register for the subregion.

Some data gaps were identified and issues were raised. They are summarised in Table 7, together with the BA response to these issues. The main issues concerned some of the datasets used and that particular species were missing from the list.

Following the workshop, a period of three weeks was allowed to follow up additional asset datasets from the local government and state agencies. Where datasets were deemed fit for BA purpose and the assets were within the PAE, they were added to the asset register.

More details about the ecological, economic and sociocultural water-dependent assets identified in the Hunter subregion, and the reasons for their inclusion or exclusion from the water-dependent asset register, are described in Section 1.3.2, Section 1.3.3 and Section 1.3.4 respectively.

The water-dependent asset register is an authoritative listing of the assets that will be included in other components of the BA; all spatial and other data associated with each asset are stored in the asset database.

Table 6 Organisations represented at the Hunter subregion asset workshop held in Thornton on Thursday 30 April 2015

Organisation	Number of participants
CSIRO	4
Department of the Environment – Environmental Resources Information Network	1
Department of the Environment – Office of Water Science	3
Hunter Councils	2
Hunter Local Land Services	1
Hunter Water Corporation	1
NSW Environment Protection Authority	1
NSW Office of Environment and Heritage	6
NSW Planning and Environment	1
NSW Primary Industries - Office of Water	4
NSW Primary Industries – Aquatic Ecosystems	1
NSW Trade and Investment	1
Total	**26**

Table 7 Summary of issues raised at the Hunter subregion asset workshop and actions for the Assessment team

Description of issue	Action / Response
Economic assets	
Suggestion from NSW Office of Water that water rights assets could be differentiated on the basis of licence security.	Entitlements have now been classed as high security and general security licences. They probably do not need to be treated differently in the impact modelling, except to note that any changes in inflows and water held in storages would more likely impact general security allocations than high security allocations.
Close to 1300 groundwater bores do not have water rights information – tagged as unknown.	Post workshop, NSW Office of Water provided 'purpose' classes for 1157 bores, which left only 67 bores undefined. These 67 bores were assigned a 'null' class and were not included in the asset register.
Recommended the Hunter regulated river be split into two assets, reflecting river operations from two different dams.	The Hunter regulated river is represented as a single asset, but receptors will be located along the different reaches, so impacts can be assessed at more local scale.
Ecological assets	
NSW Office of Environment and Heritage noted that the surface water catchments provided through Water Assets Information Tool do not represent all river assets. Want the entire river system to be in the asset list. Thought that assets in small tributary streams might be missed.	The catchments are from Australian Hydrological Geospatial Fabric (Geofabric) (Dataset 41) – have been derived from blue line network of named rivers and cover the whole Hunter preliminary assessment extent (PAE). River network was sourced from the WAIT database (Dataset 4) for the Hunter PAE. Assets encompass a range of scales, as determined by the source data. Receptors will be located across the preliminary assessment area to ensure that impacts at assets throughout the PAE can be assessed.
Concerns were raised that the NSW threatened species list was not used when developing the asset database. It was noted that there are a number of NSW threatened frog species that are not on the EPBC[a] list that should be included.	NSW threatened species list has been generated for the PAE based on NSW Office of Environment and Heritage (OEH) sub-Catchment Management Authority (CMA) areas and is now included in the Hunter asset list. The Wallum Froglet (*Crinia tinnula*), Booroolong Frog (*Litoria booroolongensis*) and Red-crowned Toadlet (*Pseudophryne australis*) have been added to the asset register (Dataset 38, Dataset 39). Other species will fail the 'fit for BA use' test for inclusion in the asset register. They will be identified in the data gaps section (Section 1.3.2.2) as having uncertain distribution. Where possible, they will be mapped to a landscape class, such that qualitative assessments of impact from coal resource development can be made.

Description of issue	Action / Response
Coastal lakes and coastal lake species missing from the asset list • Syngnathiformes – seahorses, seadragons, pipefish, pipehorses and seamoths	Five different datasets in the Hunter assets list (Dataset 6, Dataset 7, Dataset 8, Dataset 12, Dataset 13) contain coastal lakes. These were cross-checked against OEH datasets and experts in OEH and found to be comprehensive. All Syngnathiformes are protected under the NSW *Fisheries Management Act 1994* and are also protected under s248 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. There are 16 species of pipefish, 2 species of seahorse, 2 species of pipehorse and 1 seadragon which 'may' occur within or near the Hunter PAE. EPBC[a]-listed species that 'may' occur (i.e. not 'known' or 'likely' to occur) are not included in the asset register, unless more specific distribution data can be found. A review of *Atlas of living Australia* (ALA, 2015) observations shows that very few of these have been sighted in Hunter PAE coastal waters. The Beady Pipefish (*Hippichthys penicillus*) (Dataset 39) was added to the register based on ALA observation data. Distribution data were sought from NSW OEH and NSW Department of Primary Industries but were not available. OEH suggested that habitat for many syngnathids are seagrass beds. The project team deemed that this information was not sufficient to change 'may' occur to 'likely' or 'known' to occur.
Review of water-dependency assessment was requested for the following: • Latham's snipe • Littoral rainforest • Weeping Myall-Coobah-Scrub Wilga Shrubland of the Hunter Valley.	Based on expert advice received during and post the workshop, the following were classed as water dependent: • Latham's snipe • Littoral rainforest • Weeping Myall-Coobah-Scrub Wilga Shrubland of the Hunter Valley.
Purple spotted gudgeon (*Mogurnda adspersa*) is missing	NSW *Fisheries Management Act 1994* as an endangered species. A small population is known to occur in Goorangoola Creek in the Hunter region. Goorangoola Creek is outside the Hunter PAE. This species is not included in the Hunter Assets Register.
Platypus is missing	The platypus is not a threatened or endangered species, but is protected under NSW *National Parks and Wildlife Act 1974*. It has been added to the asset list as an ecological asset (Dataset 39).
NSW OEH recommended including the NSW OEH wetlands database.	NSW OEH wetlands database has been included (Dataset 13). There is substantial overlap between it and the National GDE Atlas mapping (Dataset 7) and Department of Primary Industries, Fisheries mapping of estuarine macrophytes (Dataset 14).

[a]Threatened ecological communities listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999*

GDE = groundwater-dependent ecosystem; NSW OEH = New South Wales Office of Environment and Heritage; ALA = *Atlas of living Australia*

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Dataset 15 Office of Environment and Heritage (OEH) (2008) Camerons Gorge Grassy White Box Endangered Ecological Community (EEC) 2008. Bioregional Assessment Source Dataset. Viewed 26 June 2015, http://data.bioregionalassessments.gov.au/dataset/cc77d836-86d3-429d-b0ab-1599cff00414.

Dataset 16 Office of Environment and Heritage (OEH) (2013) Lower Hunter Spotted Gum Forest EEC 2010. Bioregional Assessment Source Dataset. Viewed 26 June 2015, http://data.bioregionalassessments.gov.au/dataset/5a8f525b-d602-4120-99a3-900fc05180e7.

Dataset 17 Office of Environment and Heritage (OEH) (2013) Gosford Council Endangered Ecological Communities (Umina woodlands) EEC3906. Bioregional Assessment Source Dataset. Viewed 26 June 2015, http://data.bioregionalassessments.gov.au/dataset/485b84ef-7f56-40b3-bf25-5ba359dd4623.

Dataset 18 NSW Department of Environment Climate Change and Water (DECCW) (2007) Climate Change Corridors Coastal North East NSW. Bioregional Assessment Source Dataset. Viewed 26 June 2015, http://data.bioregionalassessments.gov.au/dataset/0a1b4dc6-07a4-4f2b-acc2-000eed75db22.

Dataset 19 Office of Environment and Heritage (OEH) NSW (2003) Climate Change Corridors (Dry Habitat) for North East NSW. Bioregional Assessment Source Dataset. Viewed 23 June 2015, http://data.bioregionalassessments.gov.au/dataset/8871574a-62ac-4b59-9cc3-bc991a6abd57.

Dataset 20 NSW Department of Environment Climate Change and Water (DECCW) (2003) Climate Change Corridors (Moist Habitat) for North East NSW. Bioregional Assessment Source Dataset. Viewed 26 June 2015, http://data.bioregionalassessments.gov.au/dataset/f8445d2e-ec1f-4f5a-99cc-7f90d1f96103.

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Dataset 22 NSW Department of Environment Climate Change and Water (DECCW) (2001) Fauna Corridors for North East NSW. Bioregional Assessment Source Dataset. Viewed 26 June 2015, http://data.bioregionalassessments.gov.au/dataset/c8b21575-8003-41ba-bb7e-378c2eb3486d.

Dataset 23 NSW Department of Environment Climate Change and Water (DECCW) (2009) Travelling Stock Route Conservation Values. Bioregional Assessment Source Dataset. Viewed 26 June 2015, http://data.bioregionalassessments.gov.au/dataset/198900d5-0d06-4bd0-832b-e30a7c4e8873.

Dataset 24 NSW Department of Environment Climate Change and Water (DECCW) (2012) Native Vegetation Management (NVM) - Manage Benefits. Bioregional Assessment Source Dataset. Viewed 23 June 2015, http://data.bioregionalassessments.gov.au/dataset/b299e256-1d37-4f89-8c51-93567ebf3753.

Dataset 25 NSW Office of Water (2013) NSW Office of Water Surface Water Entitlements Locations v1_Oct2013. Bioregional Assessment Source Dataset. Viewed 16 June 2015, http://data.bioregionalassessments.gov.au/dataset/fc872710-998e-4c76-8b98-1df383c53de6.

Dataset 26 NSW Office of Water (2015) Groundwater Entitlement Hunter NSW Office of Water 20150324 Restricted. Bioregional Assessment Source Dataset. Viewed 16 June 2015, http://data.bioregionalassessments.gov.au/dataset/19697f0a-4513-42a4-a7ce-4e00f48a715a.

Dataset 27 Bureau of Meteorology (2014) NSW Office of Water - National Groundwater Information System 20141101v02. Bioregional Assessment Source Dataset. Viewed 16 June 2015, http://data.bioregionalassessments.gov.au/dataset/6c364d09-fc3b-47c3-aa98-6c702d3d8137.

Dataset 28 Geoscience Australia (2014) Operating Mines OZMIN GeoScience Australia National 20150201. Bioregional Assessment Source Dataset. Viewed 16 June 2015 http://data.bioregionalassessments.gov.au/dataset/65c0c042-1ba8-47a8-9793-4363672500b9.

Dataset 29 Bioregional Assessment Programme (2014) NSW Office of Water_SWLicencesProcessed_Hunter v1 16052014. Bioregional Assessment Derived Dataset. Viewed 16 June 2015, http://data.bioregionalassessments.gov.au/dataset/25d233eb-dbc4-4ca3-b200-1d1df2b5126c.

Dataset 30 Bioregional Assessment Programme (2015) Groundwater Economic Elements Hunter NSW 20150520 PersRem v02. Bioregional Assessment Derived Dataset. Viewed 16 June 2015, http://data.bioregionalassessments.gov.au/datastore/dataset/7174b44f-7146-4b70-a77f-b55c989a3278.

Dataset 31 NSW Office of Water (2013) NSW Office of Water combined geodatabase of regulated rivers and water sharing plan regions. Bioregional Assessment Source Dataset. Viewed 23 June 2015, http://data.bioregionalassessments.gov.au/dataset/24157c41-c42f-4e1f-a791-a1ad18c8215d.

Dataset 32 NSW Office of Water (2013) NSW Office of Water - Groundwater Management Areas. Bioregional Assessment Source Dataset. Viewed 19 June 2015, http://data.bioregionalassessments.gov.au/dataset/41c28791-77d0-4d1d-b06b-8c9b579b9ab6.

Dataset 33 NSW Office of Water (2013) NSW Office of Water combined geodatabase of regulated rivers and water sharing plan regions. Bioregional Assessment Source Dataset. Viewed 19 June 2015, http://data.bioregionalassessments.gov.au/dataset/24157c41-c42f-4e1f-a791-a1ad18c8215d.

Dataset 34 Australian Government Department of the Environment (2013) Australia World Heritage Areas. Bioregional Assessment Source Dataset. Viewed 19 June 2015, http://data.bioregionalassessments.gov.au/dataset/4927789b-7ba7-4a77-b6fc-be1b29b6590c.

Dataset 35 Australian Government Department of the Environment (2014) National Heritage List Spatial Database (NHL) (v2.1). Bioregional Assessment Source Dataset. Viewed 17 April 2015, http://data.bioregionalassessments.gov.au/dataset/26daa8d7-a90e-47f3-982b-0df362414e65.

Dataset 36 Australian Government Department of the Environment (2014) Commonwealth Heritage List Spatial Database (CHL). Bioregional Assessment Source Dataset. Viewed 19 June 2015, http://data.bioregionalassessments.gov.au/dataset/57720684-4948-45db-a2c8-37259d531d87.

Dataset 37 Australian Government Department of the Environment (2014) Australia, Register of the National Estate (RNE) - Spatial Database (RNESDB) Internal. Bioregional Assessment Source Dataset. Viewed 19 June 2015, http://data.bioregionalassessments.gov.au/dataset/878f6780-be97-469b-8517-54bd12a407d0.

Dataset 38 Office of Environment and Heritage, Department of Premier and Cabinet (2013) Spatial Threatened Species and Communities (TESC) NSW 20131129. Bioregional Assessment Source Dataset. Viewed 26 June 2015, http://data.bioregionalassessments.gov.au/dataset/a6664894-1489-46d1-a6ca-16f9ab519a28.

Dataset 39 Office of Environment and Heritage (OEH) (2014) Atlas of Living Australia NSW ALA Portal 20140613. Bioregional Assessment Source Dataset. Viewed 26 June 2015, http://data.bioregionalassessments.gov.au/dataset/cb420b33-b828-40fe-a844-7fdbe828d4d6.

Dataset 40 NSW Department of Primary Industries, Fisheries and Aquaculture (2015) Darling River Hardyhead Predicted Distribution in Hunter River Catchment NSW 2015. Bioregional Assessment Source Dataset. Viewed 29 June 2015, http://data.bioregionalassessments.gov.au/dataset/643c6228-6435-4f5a-9f09-5f53efe234d2.

Dataset 41 Bureau of Meteorology, Water Division, Water Data Services (2011) Geofabric Surface Catchments - V2.1. Bioregional Assessment Source Dataset. Viewed 26 June 2015, http://data.bioregionalassessments.gov.au/dataset/ea1b6f6c-e8a3-4c78-a463-044c89857fc0.

1.3.2 Ecological assets

Summary

The total number of ecological assets in the asset list for the preliminary assessment extent (PAE) of the Hunter subregion is 1836. Of those, 205 are in the 'Surface water feature' subgroup, 24 are in the 'Groundwater feature (subsurface)' subgroup and the remainder are in the 'Vegetation' subgroup.

The majority of ecological assets (1651), including all surface and groundwater features, passed the test for water dependency, and are included in the water-dependent asset register.

A small number of potential species habitat distributions, potential groundwater-dependent ecosystems and nature reserves and conservation areas were judged not to be water dependent owing to the lack of any clear water dependence in either their description or geographic location.

1.3.2.1 Description

The total number of assets listed under the heading 'Ecological' in the asset database for the PAE of the Hunter subregion on 20 November 2015 is 1836 (Table 8). Assets fall within three subgroups and seven classes. As described in Section 1.3.1.4, all landscape features such as aquifers, rivers, lagoons, lakes, springs and wetlands, and the habitats dependent on them, are inherently water dependent; hence, all assets in the subgroups 'Surface water feature' and 'Groundwater feature (subsurface)' are included in the water-dependent asset register. Selected 'Surface water feature' assets are illustrated in Figure 4 and Figure 5.

Of assets in the 'Vegetation' subgroup, 234 assets are groundwater-dependent ecosystems (GDE) derived from the *National atlas of groundwater dependent ecosystems* (GDE Atlas; Bureau of Meteorology, Dataset 1). Of these, 34 are wetlands, 36 are rivers and 4 are springs and are classified as surface GDEs. All springs, wetlands and rivers are water dependent and many of these are replicated in other classes (for example 'Ginger Beer Springs'). Four assets named as 'ecosystems' and 156 assets named as 'vegetation types' are classified as subsurface GDEs. Vegetation types that are identified within the database as 'known GDEs' or having a moderate-to-high or high probability of being a GDE have been classified as water dependent. Only 99 assets from the GDE Atlas had a less than moderate-to-high probability of being water dependent and were excluded. A further 452 vegetation communities and wetlands were supplied as assets by the NSW Office of Water (Figure 7) based on mapping of vegetation with a high probability of groundwater interaction (NSW Department of Primary Industries, Dataset 2). All are assumed to be water dependent having already passed a test for high probability of groundwater interaction prior to their inclusion in the NSW GDE Atlas.

The 'Habitat (potential species distribution)' asset class contains 921 assets from various sources (Table 8), most of which (835) are water dependent based on the criteria given in Section 1.3.1.4. Within the 'Habitat (potential species distribution)' asset class are 258 Geofabric (the Australian

Hydrological Geospatial Fabric) river basins containing habitat and streams that were supplied from the former Hunter-Central Rivers Catchment Management Authority (CMA), and a further 16 river basins from the Namoi CMA (Dataset 3). All catchments are water dependent, along with all assets from Department of Primary Industries (Dataset 4), Australian Government Department of the Environment (Dataset 5, Dataset 6) and NSW Department of Environment Climate Change and Water (DECCW) (Dataset 7, Dataset 8). Most of the assets from Birds Australia (Dataset 9), Australian Government Department of the Environment (Dataset 10), DECCW (Dataset 11, Dataset 13, Dataset 15, Dataset 16, Dataset 17) and Office of Environment and Heritage (Dataset 12, Dataset 14) are also judged to be water dependent.

Only two threatened or endangered ecological communities (Office of Environment and Heritage Dataset 18, Dataset 19, Dataset 20; Australian Government Department of the Environment, Dataset 21) are not water dependent: 'Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion Threatened Ecological Community' and 'Lower Hunter Spotted Gum Forest Endangered Ecological Community EEC 2319'. Assets sourced from Birds Australia Important Bird Areas (IBA), CAPAD and Threatened Ecological Communities (TEC) are illustrated in Figure 8. Assets from DECCW (Dataset 11, Dataset 12, Dataset 13, Dataset 14, Dataset 15, Dataset 16, Dataset 17) and Office of Environment and Heritage (Dataset 18, Dataset 19, Dataset 20) are not presented.

Of the 146 potential habitat distributions for EPBC-listed species (i.e. under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999*) identified within the Hunter PAE, 105 are water dependent based on descriptions of their habitat and only 41 are judged to not be water dependent because their habitats lacked demonstrated water dependency. All fish (including sharks) and frogs were judged to be water dependent. Fifty-seven of 59 birds, 7 of 9 mammals, 5 of 8 reptiles and 29 of 63 plants were judged to be water dependent. Owing to the large number of these assets and their overlap, they are not presented in map form.

Table 8 Total ecological assets and water-dependent ecological assets in the preliminary assessment extent (PAE) of the Hunter subregion

Group	Subgroup	Asset class	Total assets (in assets list)	Water-dependent assets
Ecological	Surface water feature	Floodplain	9	9
		Lake, reservoir, lagoon or estuary	100	100
		River or stream reach, tributary, anabranch or bend	66	66
		Wetland, wetland complex or swamp	30	30
	Groundwater feature (subsurface)	Aquifer, geological feature, alluvium or stratum	24	24
	Vegetation	Groundwater-dependent ecosystems	686	587
		Habitat (potential species distribution)	921	835
Total			**1836**	**1651**

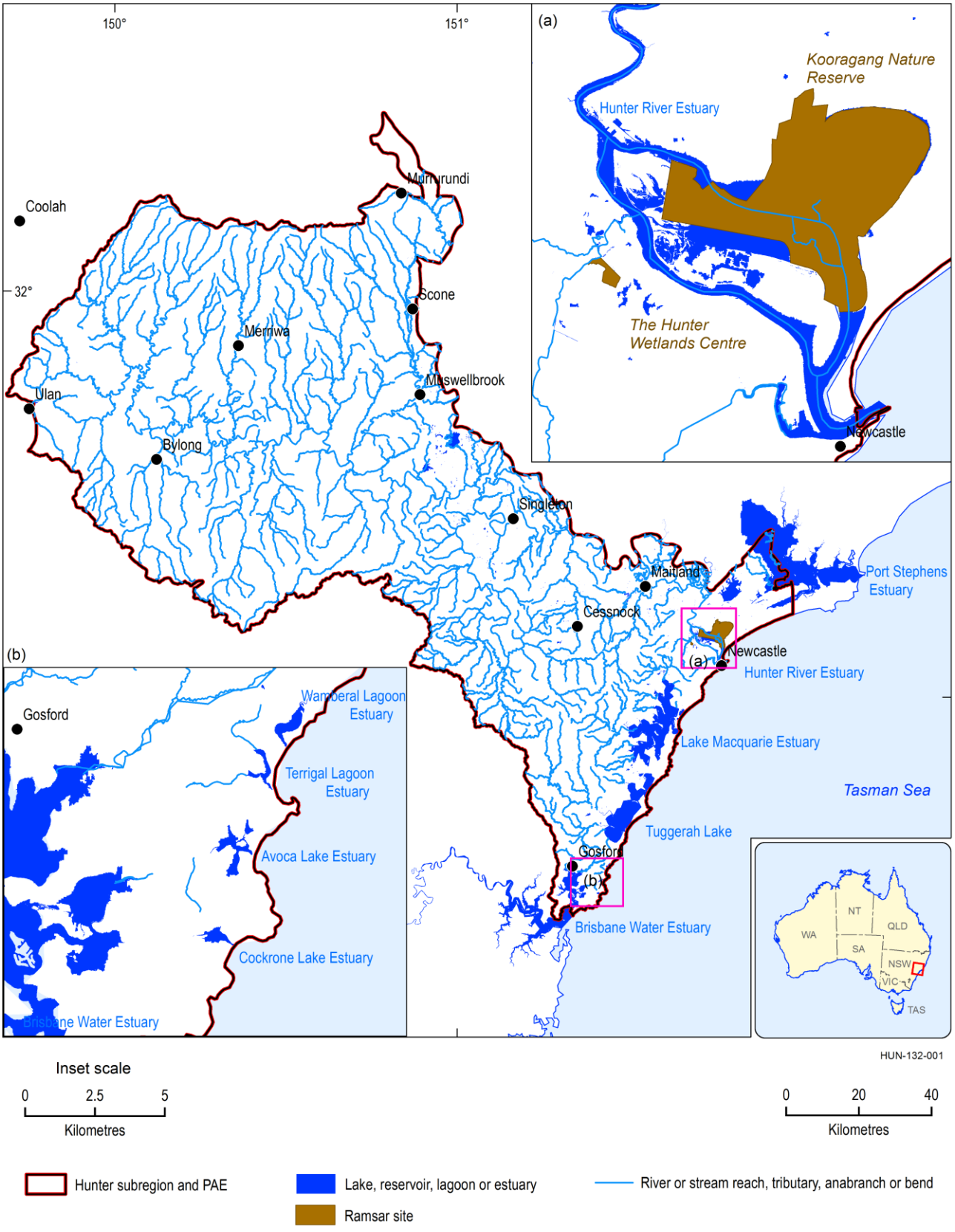

Figure 4 Location of selected 'Surface water feature' assets in the 'Lake, reservoir, lagoon or estuary' class and 'River or stream reach, tributary, anabranch or bend' class of the Hunter subregion

Includes the Ramsar-listed Kooragang Nature Reserve and Hunter Wetlands Centre which together comprise the Hunter Estuary Wetlands Ramsar site.
Data: Australian Government Department of Environment (Dataset 3, Dataset 5); NSW Department of Environment Climate Change and Water (DECCW) (Dataset 7)

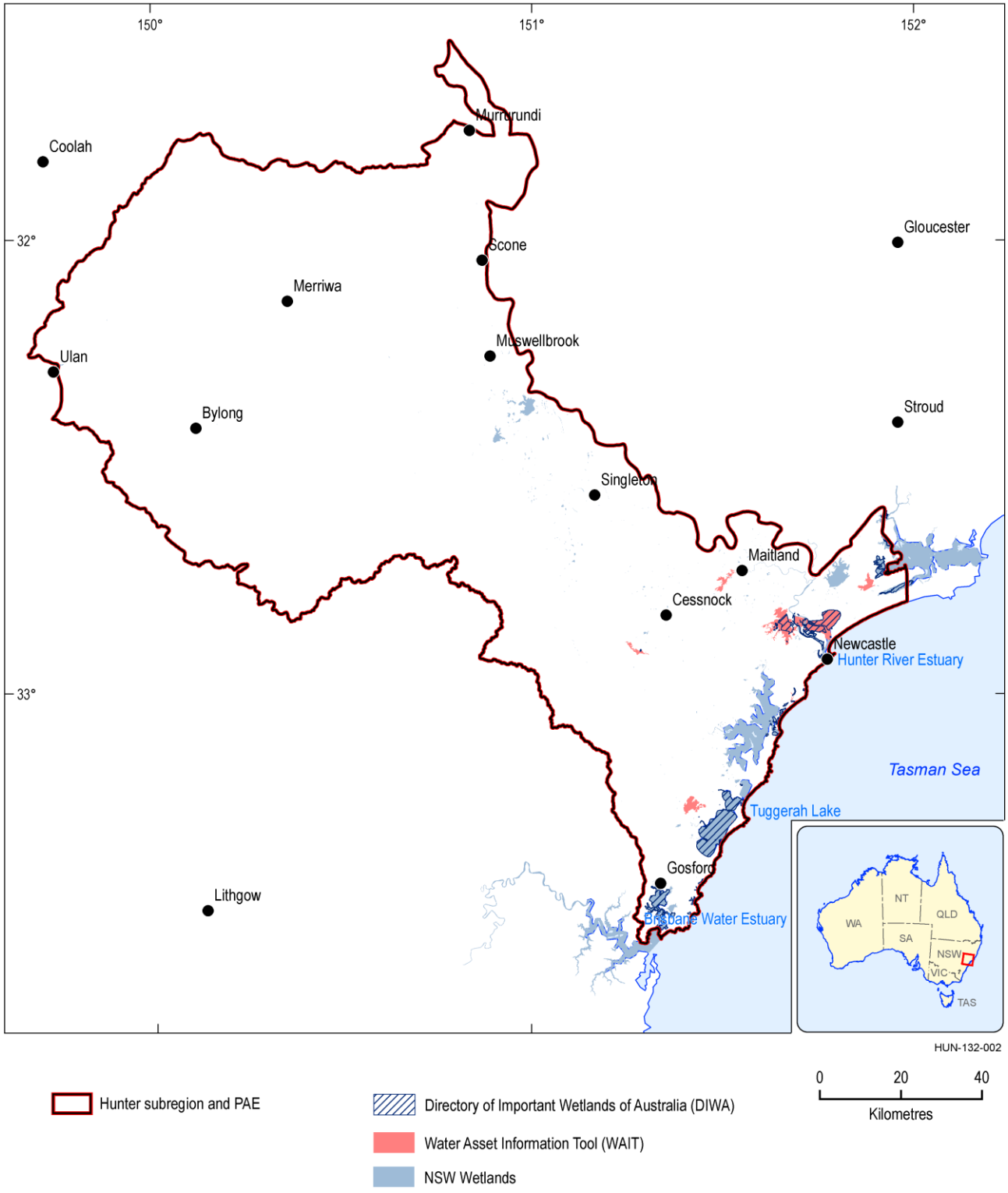

Figure 5 Location of selected assets in the 'Surface water feature' subgroup in the 'Wetland, wetland complex or swamp' and 'Floodplain' asset classes of the Hunter subregion

Data: Australian Government Department of the Environment (Dataset 3, Dataset 6); NSW Department of Environment Climate Change and Water (DECCW) (Dataset 7). Note that there is substantial overlap between the three data sources.

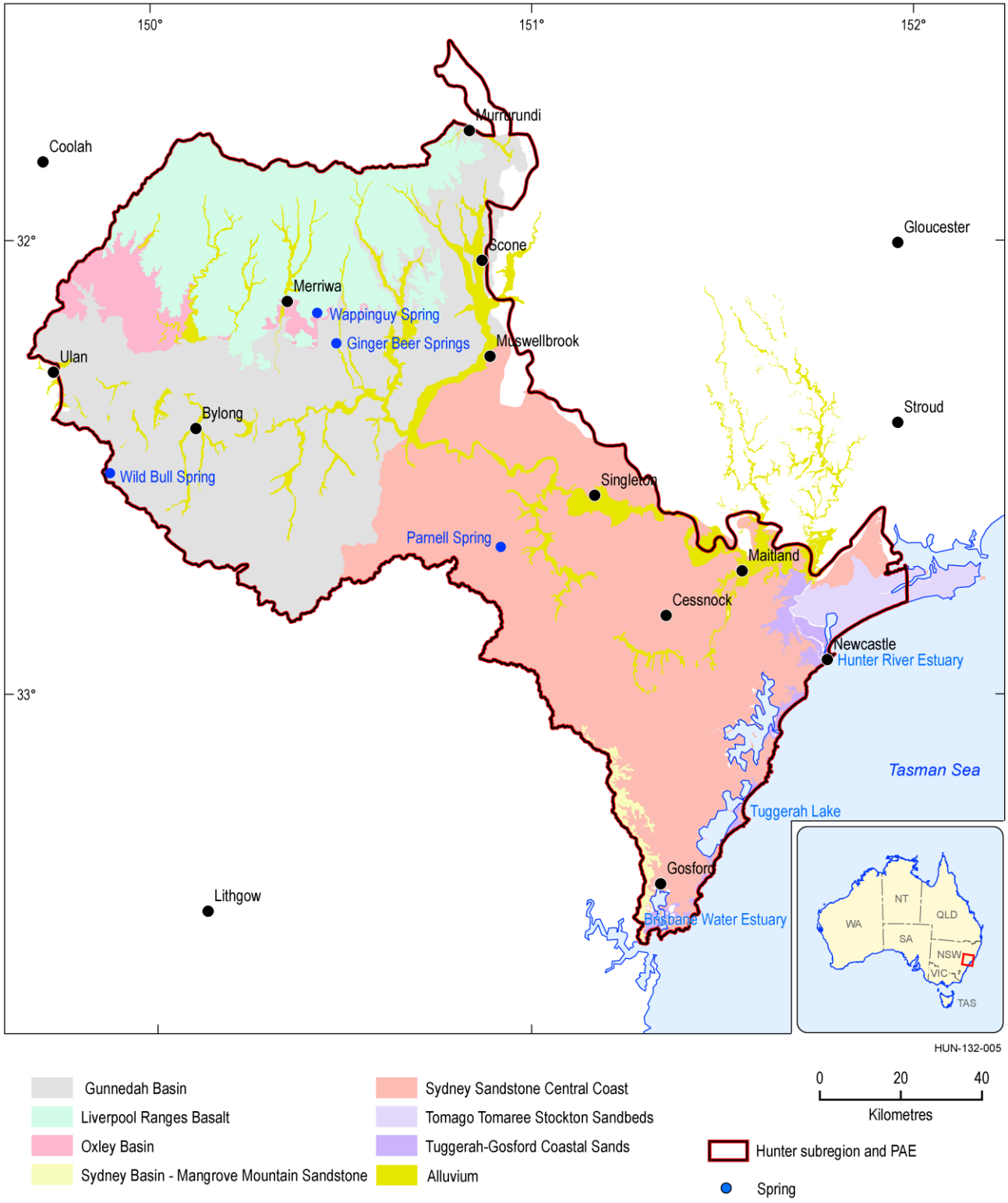

Figure 6 Location of selected assets in the 'Aquifer, geological feature, alluvium or stratum' asset class of the Hunter subregion

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

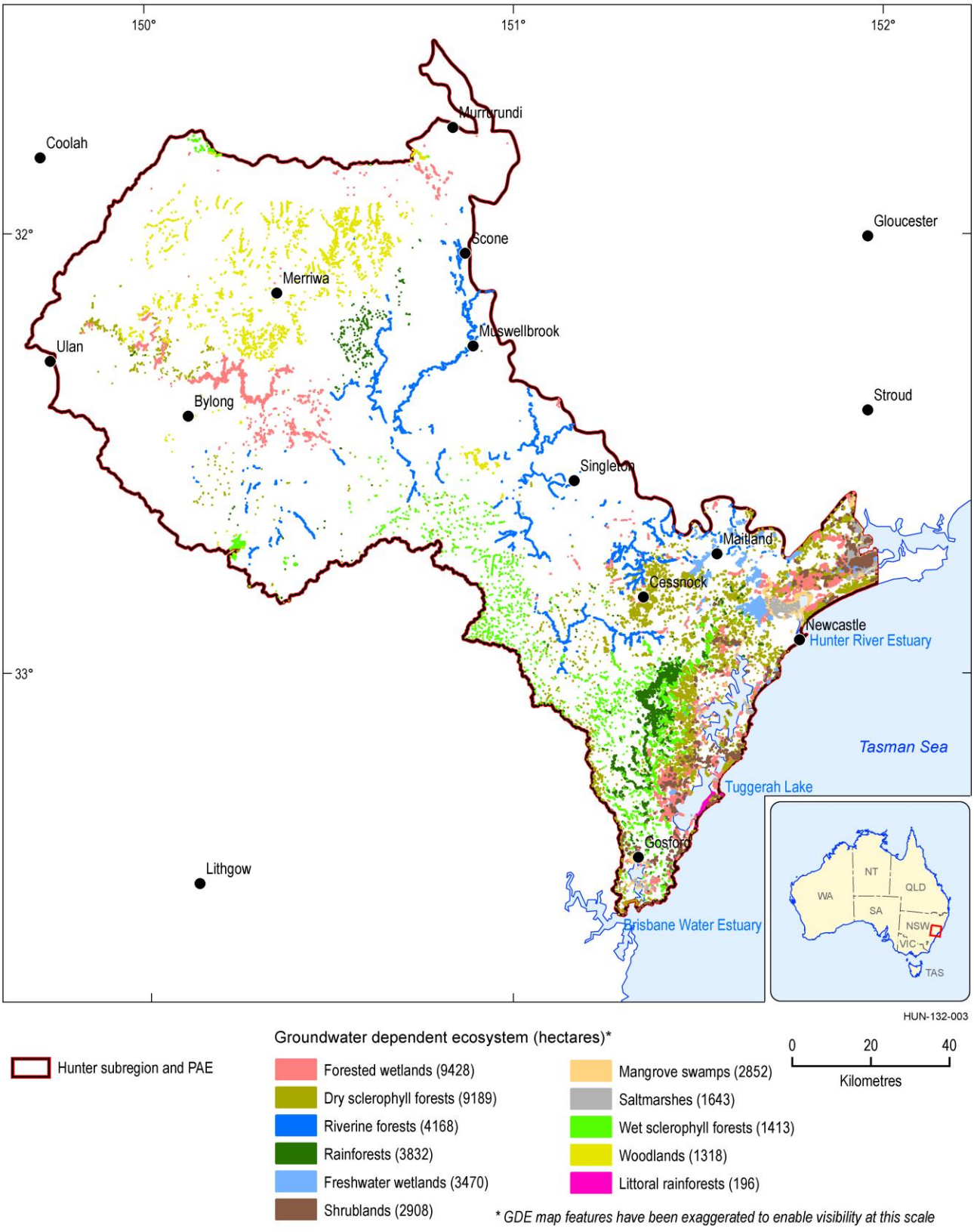

Figure 7 Location of assets in the 'Vegetation' subgroup in the 'Groundwater-dependent ecosystems' asset class of the Hunter subregion

Vegetation types are grouped according to vegetation formation (Keith 2006). Note that within this classification the formation 'Forested wetlands' includes Eastern riverine forests.
Data: NSW Department of Primary Industries (Office of Water) (Dataset 2)

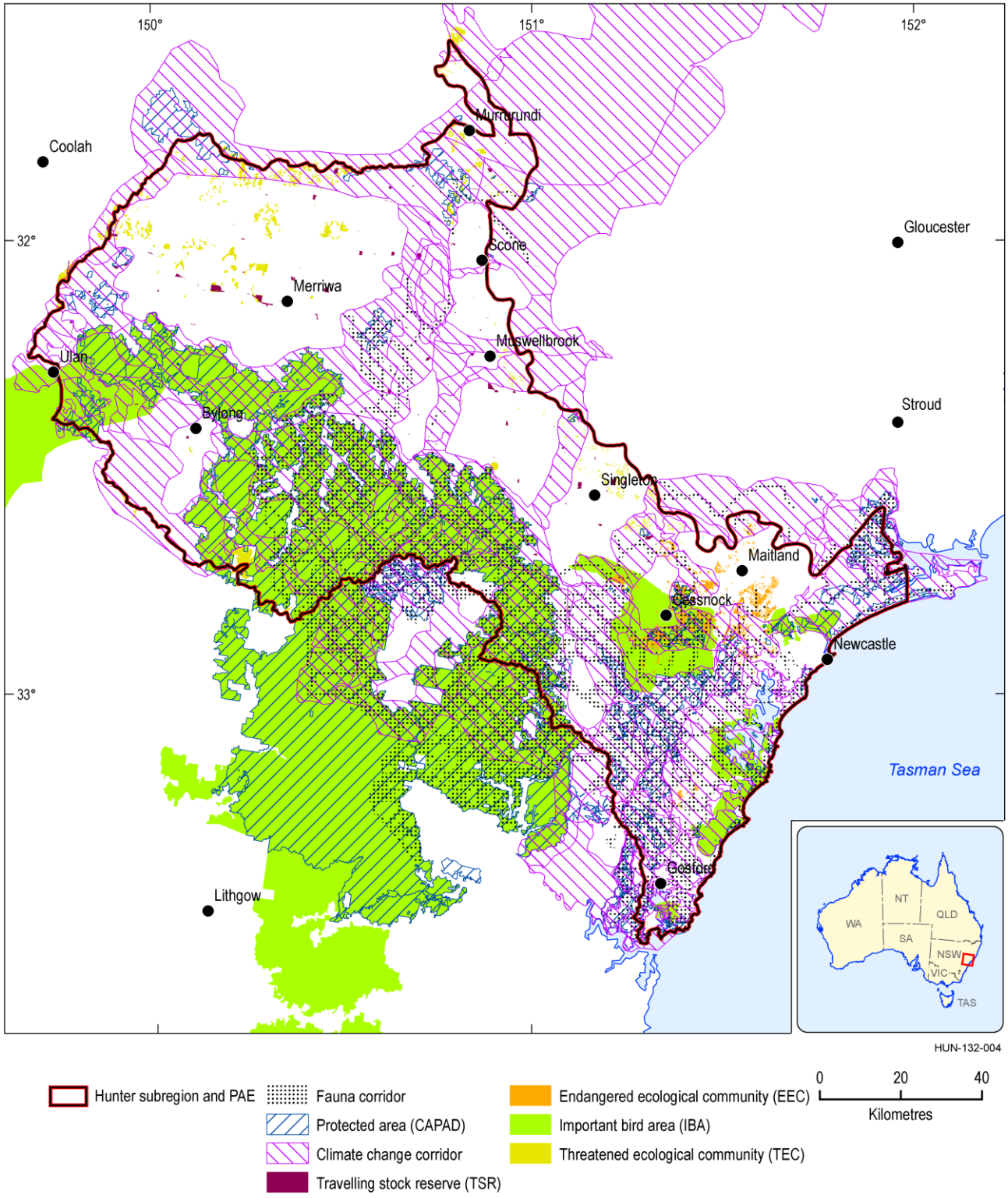

Figure 8 Location of selected assets in the 'Vegetation' subgroup in the 'Habitat (potential species distribution)' asset class of the Hunter subregion

Data: Birds Australia (Dataset 9); Australian Government Department of the Environment (Dataset 10); NSW Department of Environment Climate Change and Water (DECCW) (Dataset 11, Dataset 13, Dataset 15, Dataset 16); Office of Environment and Heritage (OEH) (Dataset 12, Dataset 14, Dataset 18, Dataset 19, Dataset 20)

1.3.2.2 Gaps

The habitats of species listed under the NSW *Threatened Species Conservation Act 1995*, but not under the EPBC Act, are not included as ecological assets in the Hunter asset list, owing to the lack of detailed modelling of individual species potential habitats. Similarly, endangered ecological communities are also not included in the asset list. Several species and endangered ecological communities of importance were identified during the assets workshop (see Section 1.3.1.4) and have been added as ecological assets (see Section 1.3.4) using spatial layers generated by the BA teams based on the best available knowledge of their habitat requirements or provided by third parties.

Datasets

Dataset 1 Bureau of Meteorology (2012) National Groundwater Dependent Ecosystems Atlas. Bioregional Assessment Source Dataset. Viewed 19 June 2015, https://data.bioregionalassessments.gov.au/dataset/68b3aa8b-1f19-4147-88dd-bfc1e052d3f5.

Dataset 2 NSW Department of Primary Industries (Office of Water) (2015) Hunter CMA GDEs (DRAFT DPI pre-release). Bioregional Assessment Source Dataset. Viewed 23 June 2015, http://data.bioregionalassessments.gov.au/dataset/469d6d2e-900f-47a7-a137-946b89b3d188.

Dataset 3 Australian Government Department of the Environment (2013) New South Wales NSW - Regional - CMA - Water Asset Information Tool - WAIT - databases. Bioregional Assessment Source Dataset. Viewed 19 June 2015, https://data.bioregionalassessments.gov.au/dataset/330532aa-66ba-44f5-984b-8a21a99661a0.

Dataset 4 Department of Primary Industries (2004) Estuarine Macrophytes of Hunter Subregion NSW DPI Hunter 2004. Bioregional Assessment Source Dataset. Viewed 23 June 2015, http://data.bioregionalassessments.gov.au/dataset/fb7bf5a0-f0e3-429b-9b54-0d4b58fb49c2.

Dataset 5 Australian Government Department of the Environment (2011) Ramsar Wetlands of Australia. Bioregional Assessment Source Dataset. Viewed 1 November 2014, http://data.bioregionalassessments.gov.au/datastore/dataset/d65cc156-944d-4961-bfba-eacfd61db63a.

Dataset 6 Australian Government Department of the Environment (2010) Directory of Important Wetlands in Australia (DIWA) Spatial Database (Public). Bioregional Assessment Source Dataset. Viewed 19 June 2015, https://data.bioregionalassessments.gov.au/dataset/6636846e-e330-4110-afbb-7b89491fe567.

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Dataset 8 NSW Department of Environment Climate Change and Water (DECCW) (2006) Threatened Migratory Shorebird Mapping NSW DECCW 2006. Bioregional Assessment Source Dataset. Viewed 23 June 2015, http://data.bioregionalassessments.gov.au/dataset/92a85a3e-11e9-43cf-96d6-f8cd4fb65d03.

Dataset 9 Birds Australia (2009) Birds Australia – Important Bird Areas (IBA) 2009. Bioregional Assessment Source Dataset. Viewed 1 November 2014, http://data.bioregionalassessments.gov.au/dataset/5d488350-83b6-4e71-8d17-687ad8ff9941.

Dataset 10 Australian Government Department of the Environment (2012) Collaborative Australian Protected Areas Database (CAPAD) 2012 – external. Bioregional Assessment Source Dataset. Viewed 19 June 2015, http://data.bioregionalassessments.gov.au/dataset/ef93a2a2-6701-47ce-804d-12f8413bd09a.

Dataset 11 NSW Department of Environment Climate Change and Water (DECCW) (2007) Climate Change Corridors Coastal North East NSW. Bioregional Assessment Source Dataset. Viewed 26 June 2015, http://data.bioregionalassessments.gov.au/dataset/0a1b4dc6-07a4-4f2b-acc2-000eed75db22.

Dataset 12 Office of Environment and Heritage (OEH) NSW (2003) Climate Change Corridors (Dry Habitat) for North East NSW. Bioregional Assessment Source Dataset. Viewed 23 June 2015, http://data.bioregionalassessments.gov.au/dataset/8871574a-62ac-4b59-9cc3-bc991a6abd57.

Dataset 13 NSW Department of Environment Climate Change and Water (DECCW) (2003) Climate Change Corridors (Moist Habitat) for North East NSW. Bioregional Assessment Source Dataset. Viewed 26 June 2015, http://data.bioregionalassessments.gov.au/dataset/f8445d2e-ec1f-4f5a-99cc-7f90d1f96103.

Dataset 14 Office of Environment and Heritage (OEH) NSW (2003) Climate Change Corridors for Nandewar and New England Tablelands. Bioregional Assessment Source Dataset. Viewed 23 June 2015, http://data.bioregionalassessments.gov.au/dataset/d480bd52-c46a-41ae-bab8-0e8d7620160b.

Dataset 15 NSW Department of Environment Climate Change and Water (DECCW) (2001) Fauna Corridors for North East NSW. Bioregional Assessment Source Dataset. Viewed 26 June 2015, http://data.bioregionalassessments.gov.au/dataset/c8b21575-8003-41ba-bb7e-378c2eb3486d.

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Dataset 17 NSW Department of Environment Climate Change and Water (DECCW) (2012) Native Vegetation Management (NVM) - Manage Benefits. Bioregional Assessment Source Dataset. Viewed 23 June 2015, http://data.bioregionalassessments.gov.au/dataset/b299e256-1d37-4f89-8c51-93567ebf3753.

Dataset 18 Office of Environment and Heritage (OEH) (2008) Camerons Gorge Grassy White Box Endangered Ecological Community (EEC) 2008. Bioregional Assessment Source Dataset. Viewed 26 June 2015, http://data.bioregionalassessments.gov.au/dataset/cc77d836-86d3-429d-b0ab-1599cff00414.

Dataset 19 Office of Environment and Heritage (OEH) (2013) Lower Hunter Spotted Gum Forest EEC 2010. Bioregional Assessment Source Dataset. Viewed 26 June 2015, http://data.bioregionalassessments.gov.au/dataset/5a8f525b-d602-4120-99a3-900fc05180e7.

Dataset 20 Office of Environment and Heritage (OEH) (2013) Gosford Council Endangered Ecological Communities (Umina woodlands) EEC3906. Bioregional Assessment Source Dataset. Viewed 26 June 2015, http://data.bioregionalassessments.gov.au/dataset/485b84ef-7f56-40b3-bf25-5ba359dd4623.

Dataset 21 Australian Government Department of the Environment (2014) Communities of National Environmental Significance Database - RESTRICTED - Metadata only. Bioregional Assessment Source Dataset. Viewed 20 May 2015, http://data.bioregionalassessments.gov.au/dataset/c01c4693-0a51-4dbc-bbbd-7a07952aa5f6.

1.3.3 Economic assets

Summary

The total number of economic assets in the asset list for the preliminary assessment extent (PAE) of the Hunter subregion is 266. Of these, 148 are groundwater assets and 118 are surface water assets.

All economic assets in the asset list are by their very nature water dependent, but 17 assets (entailing 17 elements) in the list were excluded from the water-dependent asset register for the Hunter subregion because their intersection with the PAE was negligible. Thus the Hunter water-dependent asset register has 249 economic assets, of which 108 are classed as surface water economic assets and 141 as groundwater economic assets.

These assets represent groupings of surface and groundwater economic elements, including water access licences, basic water rights, water source areas, water supply infrastructure and the regulated river. In all, there are 10,327 elements, of which 5,463 pertain to groundwater management areas and 4,864 to surface water management areas.

1.3.3.1 Description

The total number of economic assets in the water-dependent asset register for the Hunter subregion is 249, of which 108 are surface water assets and 141 groundwater assets. All of these are, by their very nature, water dependent.

The economic assets represent groupings of economic elements. Economic elements include water access licences and basic rights to take water (both referred to as water access entitlements), represented spatially by:

- location of surface water offtake points and groundwater bores (i.e. represented as point features)
- water source areas identified within water sharing plans which intersect the PAE (represented as polygon features)
- water supply and monitoring infrastructure (represented as point features)
- river segments (represented as line features).

All economic elements, assets and total share component data were sourced from NSW Office of Water including:

- an extract from the Water Licensing System and Surface and Groundwater Approved Work Locations database (NSW Department of Primary Industries, 2013a)
- NSW Water Sharing Plans (NSW Department of Primary Industries, 2015).

Every water access right (licensed entitlement) and basic water right (statutory entitlement) is an element. The NSW Office of Water classifies water access entitlements by 'purpose', which records the intended use of that water. Bores that are classified as exploratory or monitoring bores and which generally do not have water access rights associated with them are not included in the asset

register. In all, 1924 monitoring and exploration groundwater bores were excluded from the water-dependent asset register (Bioregional Assessment Programme, Dataset 1). A number of bores have high security licences, reflecting their importance for meeting basic community needs; 57 bores are classified as being for town water supply and 6 bores for power generation. Most other entitlements have a general security classification, which means they are at greater risk of allocation cuts when resource availability is low, such as in times of drought.

In the Hunter subregion, there are 10,327 economic elements, of which 4,864 pertain to surface water resources and 5,463 to groundwater resources. Most of these are water access entitlements; 10 are groundwater source areas and 43 are surface water source areas, which are contained within or intersect the PAE; two water supply dams, Grahamstown Dam and Mardi Dam; the regulated part of the Hunter River (i.e. downstream of Glenbawn Dam and Glennies Creek Dam), represented as a single asset. Table 9 summarises the breakdown of assets within the Hunter water-dependent asset register. Elements have been grouped by type (purpose) and spatial location (water source area) to create assets.

Table 10 shows the share components for the surface water and groundwater resources. Share components are a specified share or volume of water that can be extracted within a specified water management area within a water year. Total share components include basic landholder rights described in water sharing plans (WSPs) (NSW Department of Primary Industries, 2015). In the Hunter PAE the share component for surface water sources is 384,455 ML/year and for groundwater sources 212,841 ML/year. While these data suggest greater reliance on surface water than on groundwater in the Hunter subregion, actual annual use patterns may tell a different story, depending on water resource availability and climate conditions.

Table 9 Assets within each category of economic asset in the Hunter subregion water-dependent asset register

Subgroup	Asset class	Assets in asset list	Assets in water-dependent asset register
Groundwater management zone or area (surface area)	A groundwater feature used for water supply (groundwater source)	17	10
	Water supply and monitoring infrastructure	0	0
	Water access right	86	86
	Basic water right (stock and domestic)	45	45
	Groundwater total	**148**	**141**
Surface water management zone or area (surface area)	A surface water feature used for water supply	53 (water sources) 1 (regulated river)	43 1
	Water supply and monitoring infrastructure	2	2
	Water access right	39	39
	Basic water right (stock and domestic)	23	23
	Surface water total	**118**	**108**
Total		**266**	**249**

Data[a]: NSW Department of Primary Industries, NSW Office of Water (Dataset 2), Bureau of Meteorology (Dataset 3), NSW Office of Water (Dataset 4, Dataset 5)
[a]The asset database (Bioregional Assessment Programme, Dataset 1) is a collation of all these source datasets.

Table 10 Total share components for surface water and groundwater access entitlements for the Hunter subregion

Subgroup	Class	Total share component (ML/y)
Groundwater management zone or area (surface area)	Water access right	127,395
	Basic water right	85,446
	Groundwater total	**212,841**
Surface water management zone or area (surface area)	Water access right	368,669
	Basic water right	15,786
	Surface water total	**384,455**
Total		**597,296**

Data[a]: Bureau of Meteorology (Dataset 3), NSW Office of Water (Dataset 4, Dataset 5)
[a]The asset database (Bioregional Assessment Programme, Dataset 1) is a collation of all these source datasets.

The Hunter PAE contains seven water sharing plan areas. The distribution of surface water elements across the water sharing plan areas is shown in Figure 9. WSPs define the water sources to which they pertain and can include rivers, aquifers and lakes. These water source areas are used to group economic elements within the PAE into assets.

Not all the water source areas within the water sharing plan areas are contained within the Hunter PAE. Those that intersect the PAE are included in the asset list for the Hunter subregion (Bioregional Assessment Programme, Dataset 1). Of the 53 water source areas in the asset list, 10

water source areas were not included in the water-dependent asset register because the area of intersection with the PAE was negligible, a consequence of small boundary differences in their mapped extents. The Hunter Unregulated and Alluvial Water Sources plan area is the largest planning area and contains 35 water source areas that intersect the PAE.

The groundwater elements within the Hunter PAE span five water sharing plan areas (Figure 9). Most of the alluvial groundwater in the Hunter subregion is managed under the NSW *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009* (NSW Department of Primary Industries, 2009b). The coastal sand aquifers which comprise the Tomago Tomaree Stockton groundwater sources are covered by the Tomago Tomaree Stockton WSP (DIPNR, 2003b). The boundaries of the Hunter subregion intersect with the outer boundaries of management areas within the Greater Metropolitan Region Groundwater Sources (NSW Department of Primary Industries, 2011a) and NSW Murray–Darling Basin Fractured Rock Groundwater Sources (NSW Department of Primary Industries, 2011b) water sharing plan areas. The Kulnura Mangrove Mountain Groundwater Sources are managed under the Kulnura Mangrove Mountain Groundwater Sources WSP, which was amended in May 2013 (NSW Department of Primary Industries, 2013b) and a small area of the Hunter subregion lies within this WSP area. The draft WSP for the North Coast Fractured and Porous Rock Groundwater Sources, which is currently under development (NSW Department of Primary Industries, 2014), will manage groundwater extracted from the hard rock groundwater sources which fall within the Hunter subregion. It is not shown in Figure 9.

Groundwater water access rights have been grouped into assets on the basis of water source areas and use. Of the 17 water source areas in the asset list for the Hunter subregion, 7 were excluded because the area of intersection with the PAE was negligible. Ten groundwater sources have been retained in the water-dependent asset register (Bioregional Assessment Programme, Dataset 1).

The WSPs for the Central Coast Unregulated Water Sources (NSW Department of Primary Industries, 2009a), Jilliby Jilliby Creek Water Source (DIPNR, 2004a), Karuah River Water Source (DIPNR, 2004b) and Ourimbah Creek Water Source (DIPNR, 2003a) do not cover groundwater extraction. There are small portions of other WSP areas that fall within the Hunter subregion, however groundwater entitlement in these areas is relatively minor.

The Hunter subregion water sharing plans are discussed more in Section 1.1.4.1 and Section 1.1.5.4 of the companion product 1.1 for the Hunter subregion (McVicar et al., 2015). An account of groundwater availability and use, in the context of how groundwater resources are managed, as well as groundwater quality, are discussed in companion product 1.5 for the Hunter subregion (Zhang et al., 2015).

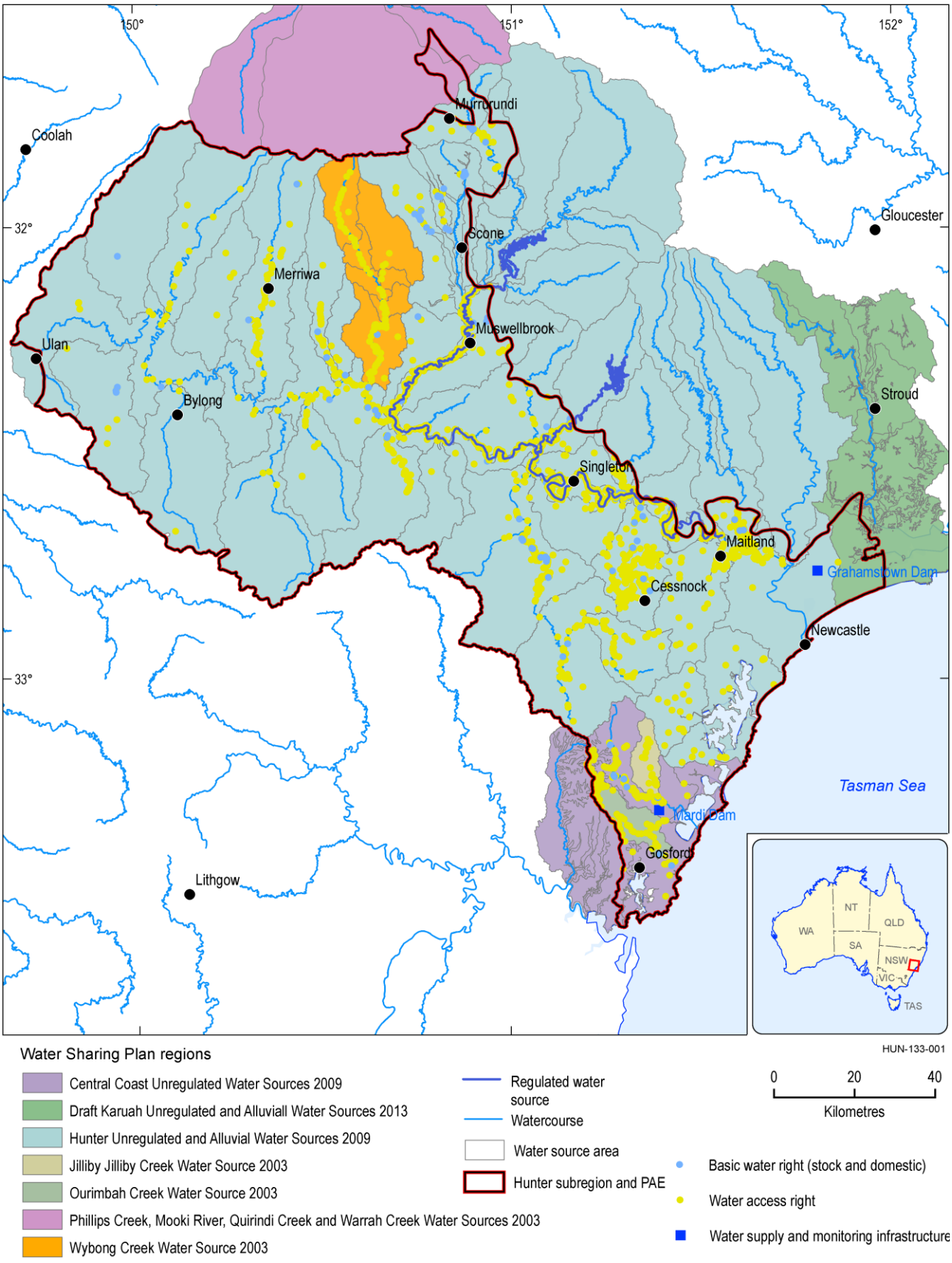

Figure 9 Location of surface water elements relative to water sharing plan areas within the Hunter preliminary assessment extent (PAE)

Data: Bureau of Meteorology (Dataset 3), NSW Office of Water (Dataset 5)

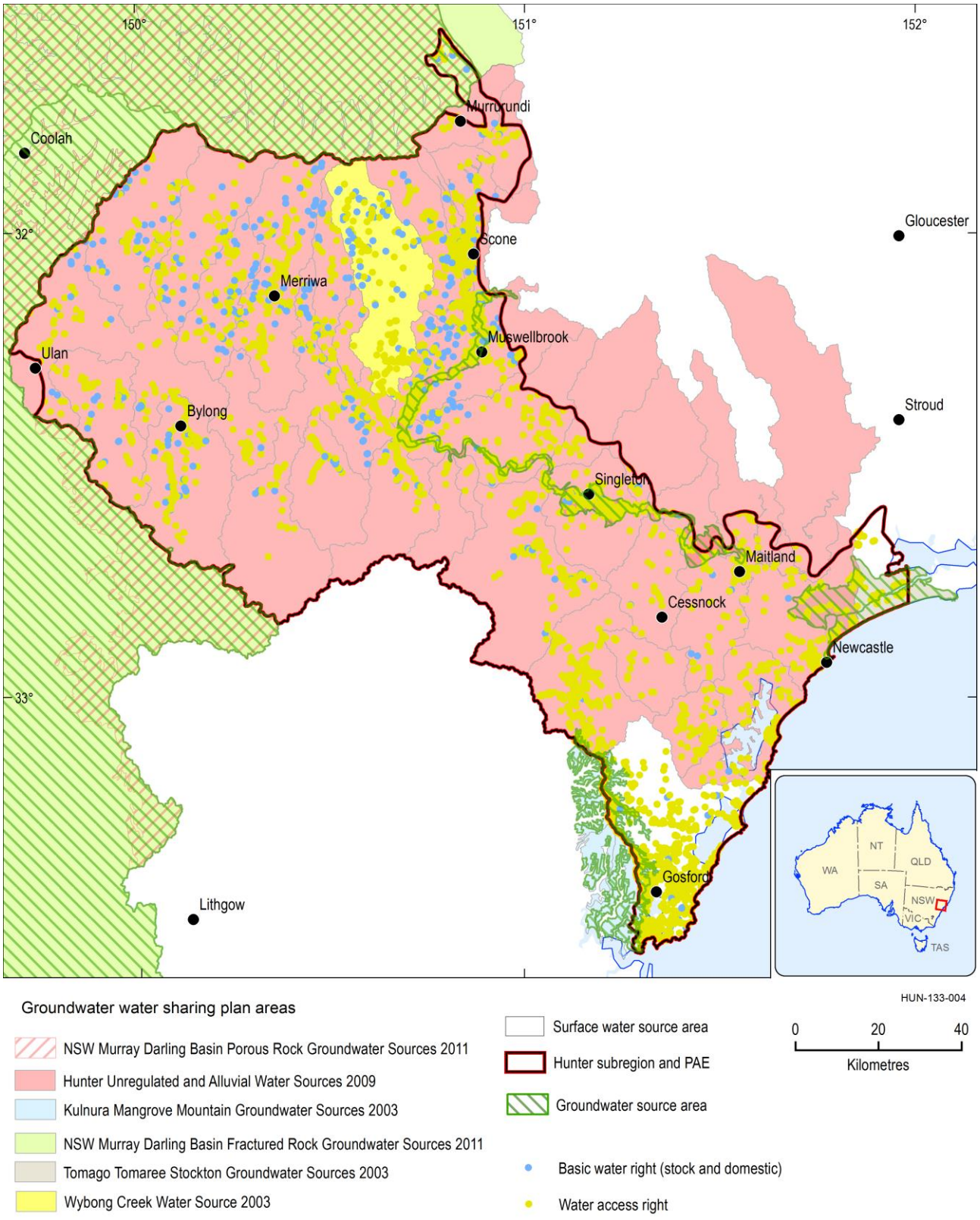

Figure 10 Location of groundwater elements within the preliminary assessment extent (PAE) of the Hunter subregion

Data: NSW Department of Primary Industries, NSW Office of Water (Dataset 2), NSW Office of Water (Dataset 4)

1.3.3.2 Gaps

Groundwater and surface water entitlement volumes may not represent total extraction due to the exclusions that exist under NSW's Water Management Act 2000, where entitlements are not required for stock/domestic and other low risk activities for surface water and groundwater (NSW Government, 2015).

Basic landholder rights (i.e. basic water rights) for surface water were extracted from the NSW Office of Water, Water Sharing Planning website in June 2014 (Bureau of Meteorology, Dataset) and for groundwater in October 2013 (NSW Office of Water, Dataset 4). The total basic water right entitlements are expected not to change significantly on a yearly basis, therefore the difference in timing is considered immaterial.

The water sharing plan dataset was reduced to include only water sources which are part of a finalised WSP (i.e. those having a formally identified volume and/or take). Water sources that do not have an identified volume under a plan were not included in the asset database. Therefore, the total number and/or volume of groundwater entitlements is expected to vary when the water source areas are excluded.

The surface water access entitlement data received from NSW Office of Water do not include details of the river reaches where the offtakes are located; instead they include the water source and water management zone associated with the WSP. A water source can be any set of rivers, aquifers or lakes and the like, which are defined by a gazetted WSP to be a water source. Therefore when the elements are aggregated into the asset, water access entitlements are grouped together across the water source area (a large polygon). This will need to be taken into account when assigning receptor locations as the water source may include multiple river reaches and potentially multiple river branches.

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1.3.4 Sociocultural assets

Summary

Four hundred and forty-three sociocultural assets are contained within the Hunter subregion asset list, of which 408 are in the 'Cultural' subgroup and 35 in the 'Social' subgroup.

Of these, 307 were judged to be water dependent on the basis that they are located in the same area as other surface water or groundwater features. These are included within the water-dependent asset register for the Hunter subregion.

Where possible and appropriate, and with the agreement of Indigenous knowledge holders, any additional Indigenous water-related values will be published in a separate report.

1.3.4.1 Description

Four hundred and forty-three sociocultural assets are identified within the preliminary assessment extent (PAE) for the Hunter subregion, of which 408 are grouped into the cultural subgroup and 35 into the social subgroup. Thirteen Indigenous sociocultural assets sourced from existing Commonwealth heritage databases are included for assessment. Sources of data are summarised in Table 5. Most assets (419) are derived from the Register of the National Estate (RNE, Australian Government Department of the Environment (Dataset 1). Twelve assets are Commonwealth heritage-listed (CHL; Department of the Environment (Dataset 2), nine are National heritage-listed (NHL; Australian Government Department of the Environment (Dataset 3) and there is one World Heritage Area (WHA; Australian Government Department of the Environment (Dataset 4), the Greater Blue Mountains Area World Heritage Area. Two assets are sourced from the Water Asset Information Tool (WAIT) database (Australian Government Department of the Environment, Dataset 5).

Three hundred and seven are judged to be water dependent (Table 11), based on their proximity to surface water and/or groundwater features (Section 1.3.1.4). Details can be found in the register.

Table 11 Total sociocultural assets and water-dependent sociocultural assets in the preliminary assessment extent (PAE) of the Hunter subregion

Group	Subgroup	Asset class	Total assets (in assets list)	Water-dependent assets
Sociocultural	Cultural	Heritage site	395	275
		Indigenous site	13	9
	Social	Recreation area	35	23
Total			**443**	**307**

1.3.4.2 Gaps

Meetings have been held with Indigenous knowledge holders in the Hunter subregion to gain further understanding of indigenous cultural water-dependent assets. Should additional information on Indigenous water-related values become available to the Programme, it may might be incorporated into an updated water-dependent asset register and/or into later technical products. This will only be done if possible and approporiate, and with the agreement of Indigenous knowledge holders.

Datasets

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