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 Namoi subregion

Product 1.3 for the Namoi subregion from the Northern Inland Catchments Bioregional Assessment

7 August 2015

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

The Bioregional Assessment Programme

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

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

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Cover photograph

Gulligal Lagoon, which is located about halfway between Gunnedah and Boggabri on the western side of the Namoi River, NSW, 2005

Credit: Neal Foster, NSW Office of Water

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Contents

Figures

Tables

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Introduction

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

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

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

The Bioregional Assessment Programme

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

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

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

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

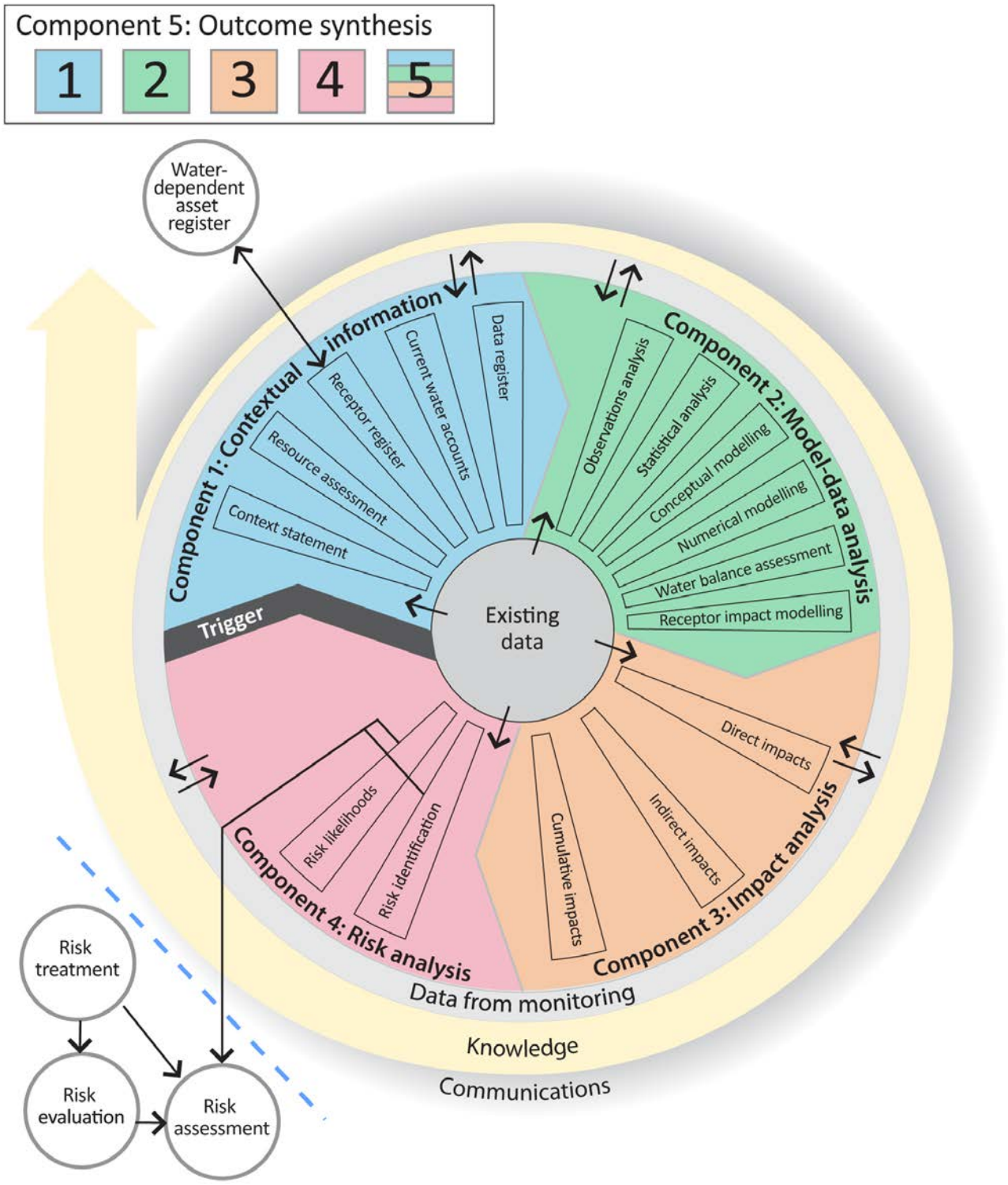


Figure 1 Schematic diagram of the bioregional assessment methodology

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

Methodologies

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

Table 1 Methodologies and associated technical products listed in Table 2

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

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

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

Technical products

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

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

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

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

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

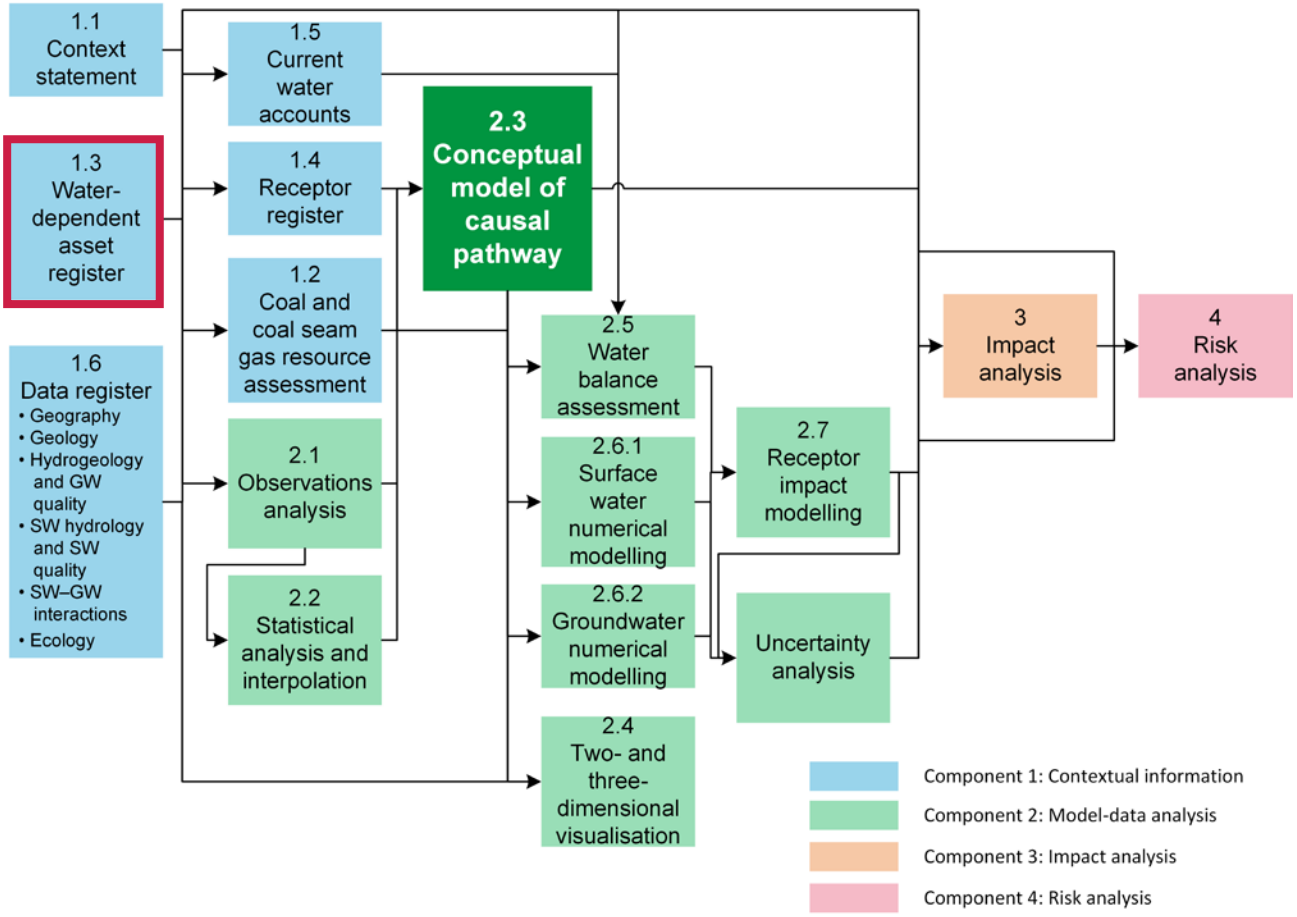


Figure 2 The simple decision tree indicates the flow of information through a bioregional assessment

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

Table 2 Technical products delivered by the Northern Inland Catchments Bioregional Assessment

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

Component	Product code	Title	Section in the BA methodology[b]	Type[a]
Component 1: Contextual information for the Namoi 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 Namoi subregion	2.1-2.2	Observations analysis, statistical analysis and interpolation	2.5.2.1, 2.5.2.2	PDF, HTML
	2.3	Conceptual modelling	2.5.2.3, 4.3	PDF, HTML
	2.5	Water balance assessment	2.5.2.4	PDF, HTML
	2.6.1	Surface water numerical modelling	4.4	PDF, HTML
	2.6.2	Groundwater numerical modelling	4.4	PDF, HTML
	2.7	Receptor impact modelling	2.5.2.6, 4.5	PDF, HTML
Component 3: Impact analysis for the Namoi subregion	3-4	Impact analysis	5.2.1	PDF, HTML
Component 4: Risk analysis for the Namoi subregion		Risk analysis	2.5.4, 5.3	
Component 5: Outcome synthesis for the Northern Inland Catchments 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 Inland Catchments Bioregional Assessment using the structure, standards, and look and feel specified by the programme.
- 'HTML' indicates the same content as in the PDF document, but delivered as webpages.
- 'Register' indicates controlled lists that are delivered using a variety of formats as appropriate.
- 'Cross-reference' indicates material that does not use the same structure, standards, and look and feel specified by the programme. This material is typically developed externally or through aligned research projects funded by the Department of the Environment. A webpage links to this material and explain how it fits into the Assessment.
- 'Not produced' indicates that the product was not developed. A webpage explains why and points to relevant submethodologies (Table 1).

[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

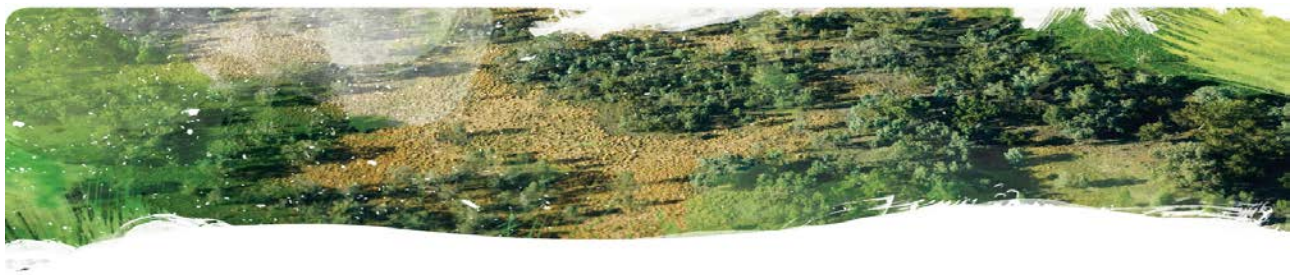
The following notes are relevant only for this technical product.

- All reasonable efforts were made to provide all material under a Creative Commons Attribution 3.0 Australia Licence. The copyright owners of the following figure, however, did not grant permission to do so: Figure 4. It should be assumed that third parties are not entitled to use this material without permission from the copyright owner.
- 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 Inland Catchments bioregion and two standard parallels of –18.0° and –36.0°.
- This report presents information about the water-dependent asset register developed for the Namoi subregion. Development of the register used methods and processes defined and outlined in the companion submethodology M02 for compiling water-dependent assets (the Assets methodology; Mount et al., 2015). The BA methodology (Barrett et al., 2013) is the foundation reference that describes, at a high level, how bioregional assessments should be undertaken.
- 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 7 August 2015, http://www.iesc.environment.gov.au/publications/methodology-bioregional-assessments-impacts-coal-seam-gas-and-coal-mining-development-water.

Mount RE, Mitchell PJ, Macfarlane C, Marston FM, McNamara JM, Raisbeck-Brown N, O'Grady AP, Moran BT and Wang J (2015) Compiling water-dependent assets. A submethodology from the Bioregional Assessment Technical Programme. Department of the Environment, Bureau of Meteorology, CSIRO and Geoscience Australia, Australia. Viewed 4 June 2015, http://data.bioregionalassessments.gov.au/submethodology/M02.



1.3 Description of the water-dependent asset register for the Namoi 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://www.bioregionalassessments.gov.au).

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 Namoi subregion. This section details the specific application to the Namoi subregion of methods described in the companion submethodology M02 (as listed in Table 1) for compiling water-dependent assets (Mount et al., 2015), outlining how the register was compiled. Key concepts and terminology are also explained.

The methods covered include: the process of collecting different groups of assets and determining their water dependency, the development and compilation of the water-dependent asset register, and the determination of the preliminary assessment extent (PAE) of the Namoi subregion.

The extent of the Namoi subregion is defined by the Namoi river basin, but terminates in the east against the Hunter-Mooki Thrust fault, which marks the furthest extent of the coal-bearing geological Gunnedah Basin. This boundary determines the extent of the coal resource under consideration. However, the impacts from developing this resource could extend beyond the subregion boundary, and in other places might be unlikely to extend as far as the subregion boundary. The PAE incorporates findings from the *Namoi Catchment water study* (Schlumberger Water Services, 2012). The assets listed in the water-dependent asset register occur within this PAE.

1.3.1.1 Background and context

This product presents information about the water-dependent asset register developed for the Namoi 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 Namoi subregion on 15 January 2015'. 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 Namoi subregion is described in the following sections.

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

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

considered as water dependent if evidence does not support a linkage to groundwater or surface water.

The *water-dependent asset register* is a simple and authoritative listing of the assets within the 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 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.

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

Asset information was provided by the former Namoi Catchment Management Authority – note that from 1 January 2014, in NSW CMAs transitioned into local land services (LLS) regions. However, as this CMA operated within the Namoi subregion when it was defined in 2012, these data have continued to be used. The data were delivered for compilation into the asset database via the BA-purpose-built Water Asset Information Tool (WAIT) database prepared by natural resource management organisations (NRMs) and contributions from those with expert local knowledge (Table 3). These NRM-nominated assets were added to the asset database. Data were also obtained from other national, state and regional authorities to complement the coverage of assets provided by the WAIT for the subregion.

An overview of the datasets used to determine the ecological assets for the Namoi subregion is shown in Table 4.

Table 3 Natural resource management organisations that contributed data to the Water Asset Information Tool database

Organisation	Description in asset register
Namoi Catchment Management Authority	WAIT_Namoi
Border Rivers-Gwydir Catchment Management Authority	WAIT_Border Rivers-Gwydir

Table 4 Data sources for ecological assets in the Namoi subregion

Dataset[a]	Organisation	Dataset citation	Elements	Assets (asset lists)
Water Asset Information Tool database	NSW Regional Catchment Management Authority	Australian Government Department of the Environment (Dataset 2)	1,586	1,176
Collaborative Australian Protected Areas Database (CAPAD)	Department of the Environment	Australian Government Department of the Environment (Dataset 3)	43	43
A directory of important wetlands in Australia (DIWA)	Department of the Environment	Australian Government Department of the Environment (Dataset 4)	50	1
Environmental Assets Database (EAD; Commonwealth Environmental Water Holder)	Department of the Environment (restricted access)	Australian Government Department of the Environment (Dataset 5)	4	4
Great Artesian Basin Groundwater Recharge	Geoscience Australia	Geoscience Australia (Dataset 6)	2	1
National atlas of groundwater dependent ecosystems (GDE Atlas)	Bureau of Meteorology	Bureau of Meteorology (Dataset 7)	*Surface:* 1,012 Subsurface: 17,778	*Surface:* 64 Subsurface: 618

Dataset[a]	Organisation	Dataset citation	Elements	Assets (asset lists)
Important Bird Areas (IBA)	Birdlife Australia	Birds Australia (Dataset 8)	2	2
Key Environmental Assets of the Murray-Darling Basin (KEA)	Murray-Darling Basin Authority	Murray-Darling Basin Authority (Dataset 9)	89	7
Threatened ecological species listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)	Department of the Environment	Australian Government Department of the Environment (Dataset 10)	3,000	41
Threatened communities listed under the EPBC Act	Department of the Environment	Australian Government Department of the Environment (Dataset 11)	10,617	7
Ramsar wetlands of Australia	Department of the Environment	Australian Government of the Environment (Dataset 12)	0	0
Total			**34,183**	**1,964**

[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

Within the asset database, each surface water, groundwater and vegetation polygon, line or point is an element and elements are grouped by class and by spatial location to create assets; each asset has a unique identifier (AID). For example, the Lake Goran ecological asset from the Directory of Important Wetlands (AID 3659) comprises 50 polygon elements, which is classed as a surface water feature in the wetland, wetland complex or swamp class. The Namoi River (AID 5070) ecological asset (as outlined in the key environmental assets data of the Commonwealth's *Basin Plan 2012*) comprises 76 line elements and is classed as a surface water feature, in the river or stream reach, tributary, anabranch or bend class. In the groundwater features, the Narrabri Water Table Aquifer asset (AID 2988) comprises one polygon, which is in the aquifer, geological feature, alluvium or stratum class.

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 include an estimated volume of use based on the number of landholders with adjacent water sources. A fuller description of the process is given in the companion submethodology M02 (as listed in Table 1) for compiling water-dependent assets (Mount et al., 2015).

Catchment areas were provided via the WAIT database and categorised as 'A surface water feature used for water supply'. As the catchment area includes all water in the catchment, not just water used for supply, these elements and assets double count the detailed licensing data included under the water access rights and basic water rights. As detailed water access rights and basic water rights are already included in the assessment, catchment areas were not included as assets and are not registered for inclusion in any other BA component undertaken for the Namoi subregion and are not considered further.

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

- Basic water right (stock and domestic) – this is the right to take water for domestic and stock purposes only. A basic right for 'take of groundwater' requires approval for 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 requires a licence both for the works and the extraction of the water. The extraction of the water can be for a range of purposes including irrigation, commercial, industrial, farming, dewatering, mining, intensive agriculture etc.

Licensing data were sourced from the NSW Office of Water to determine economic assets (NSW Office of Water, 2013). These data are currently not publically available and were obtained by special request. Consistent with how water licensing information is published under the Commonwealth's *Water Act 2007*, this data will be published in an aggregated form. Data covered groundwater and surface water access licences, and their corresponding works locations. Data about basic landholder rights were sourced online from the publically available water sharing plans (NSW Department of Primary Industries, 2014). Data sources for economic assets for the Namoi subregion are listed in Table 5.

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', 'cancelled' or 'suspended' as at 20 November 2013 were marked as not 'current' or 'active' and therefore excluded for BA purposes. This also applied to any water access licences that did not have a corresponding works approval with location information. 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. The volume of the licence was then equally split among the works to ensure that the licence volumes were not double-counted. A geographic information system (GIS) layer was derived using the spatial coordinates provided with the licensed work approvals. This spatial layer was overlain with the PAE for the Namoi subregion. The intersection of the two layers combined with the related attribute data gave a spatially explicit view of the active entitlements within the PAE, with a volume of surface water or groundwater attributed to each works.

The class of asset (as described in the asset submethodology (Mount et al., 2015)) 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 included in the class 'Basic water right'. Where 'Stock' and/or 'Domestic' was listed with another licensed purpose, it was listed as a 'Water access right'. 'Water access right' was based on anything that had an extractive use purpose such as, for example, commercial, irrigation, farming, industrial, or dewatering.

Each water access right 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. The process assumed that each of the works associated with a licence extracts an equal share of the volume. Therefore if there is one groundwater licence of 80 ML/year that has four works (bores) associated with it, then 20 ML/year is assigned to each of those works. 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. Only 2% of entitlements are split across multiple works for surface water and groundwater. The overall impact is very negligible, if at all.

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, monitoring bores and waste disposal bores. These elements are 'flagged' in the asset database and are not included in the water-dependent asset register.

Table 5 Data sources for economic assets in the Namoi subregion

Dataset[a]	Organisation	Dataset citation	Elements	Assets (asset list)
Ground water points (+ additional polygons x1) Economic_GW	NSW Office of Water; Bureau of Meteorology	Bioregional Assessment Programme (Dataset 13), Bureau of Meteorology (Dataset 14)	8,954	53
Surface water points (+ additional polygons x2) Economic_SW	NSW Office of Water; Bureau of Meteorology	Bioregional Assessment Programme (Dataset 15), NSW Office of Water (Dataset 16)	1,467	39
Regulated Rivers Economic_RegRiv	NSW Office of Water; Bureau of Meteorology	NSW Office of Water (Dataset 17)	3	3
Groundwater Macro Plans Economic_GWMP	NSW Office of Water; Bureau of Meteorology	NSW Office of Water (Dataset 17)	26	26
Water Sharing Plans (GW+SW) Economic_WSP	NSW Office of Water; Bureau of Meteorology	NSW Office of Water (Dataset 17)	47	47
Total			**10,497**	**168**

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

1.3.1.2.3 Sociocultural assets

Some sociocultural data were provided by the former Namoi Catchment Management Authority, some have been sourced from the Australian Heritage Database (Department of the Environment, 2013) (Table 6) and some information about Indigenous heritage sites have been sourced from the NSW Aboriginal Heritage Information Management System (Environment and Heritage, 2013).

Table 6 Data sources for sociocultural assets in the Namoi subregion

Dataset[a]	Organisation	Dataset citation	Elements	Assets (asset list)
Register of the National Estate (RNE)	Department of the Environment	Australian Government Department of the Environment (Dataset 18)	40	40
National Heritage List	Department of the Environment	Australian Government Department of the Environment (Dataset 19)	1	1
Commonwealth Heritage List	Department of the Environment	Australian Government Department of the Environment (Dataset 20)	0	0
World Heritage List	Department of the Environment	Australian Government Department of the Environment (Dataset 21)	0	0
Total			**41**	**41**

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

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

1.3.1.3 Determining the preliminary assessment extent

The extent of the Namoi subregion is defined by the Namoi river basin, but terminates in the east against the Hunter-Mooki Thrust fault, which marks the furthest extent of the coal-bearing geological Gunnedah Basin. This determines the eastern extent of the coal resources under consideration. However, the impacts from developing this resource could extend beyond the subregion boundary, or might not extend as far as the subregion boundary due to its remoteness from development or lack of hydrological connectivity.

The 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. It is the first step to identify the potentially impacted assets.

Development of the PAE for the Namoi subregion (Figure 3) considered the location of CSG and coal resource development, results from the *Namoi Catchment water study* (Schlumberger Water Services, 2012), groundwater flow directions and the surface water flood extent.

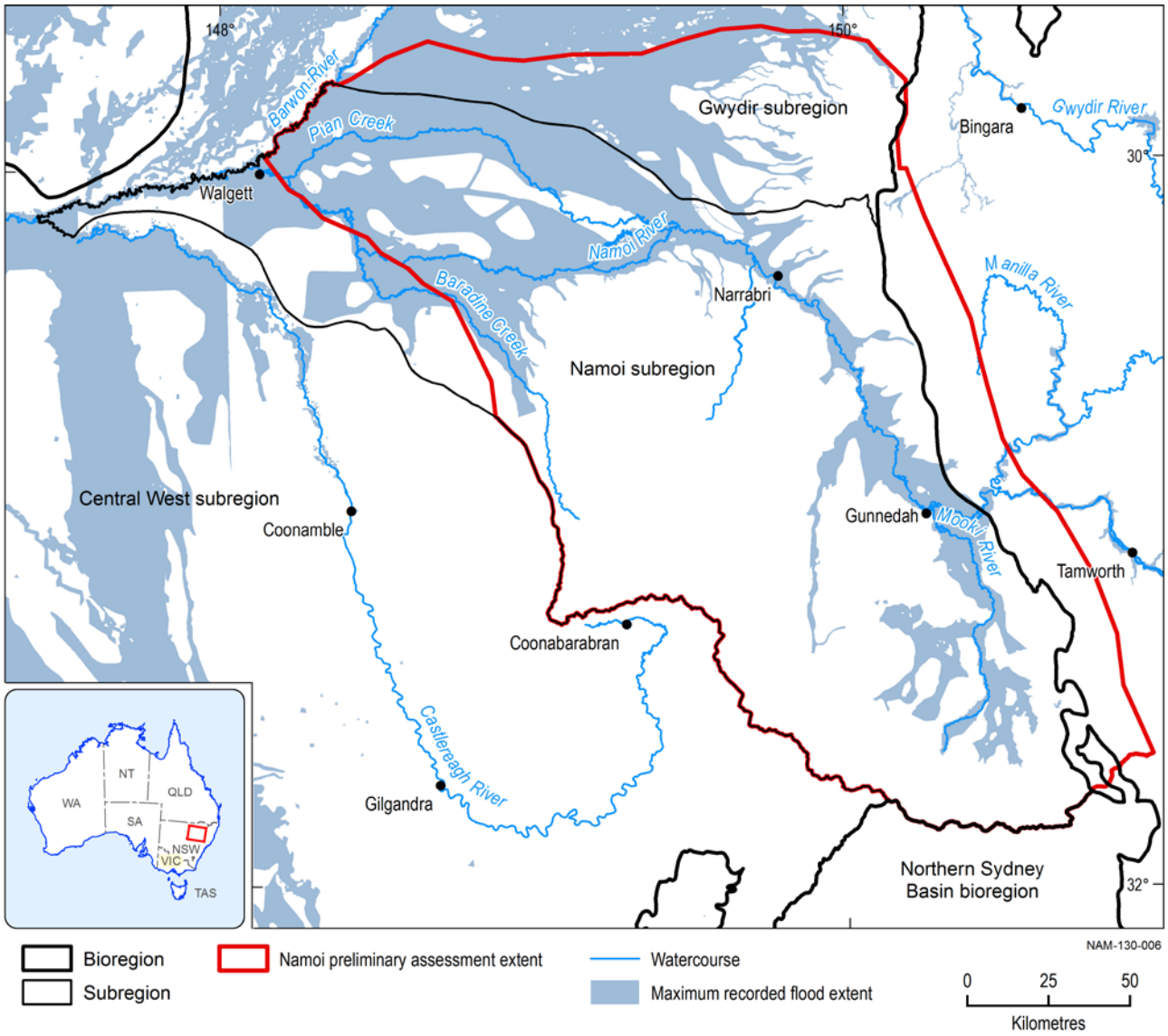


Figure 3 Preliminary assessment extent (PAE) of the Namoi subregion

Data: CSIRO (Dataset 22), Chen et al. (2012)

The locations of current and future coal and CSG development are shown in Figure 9 (coal) and Figure 11 (CSG) in companion product 1.2 for the Namoi subregion (Northey et al., 2014).

At the time of the *Namoi Catchment water study* (Schlumberger Water Services, 2012), their model scenario 3 (Figure 4) was taken to be the most-likely-development scenario. The estimate of the impact from model scenario 3 was an input to determining the extent of the PAE of the Namoi subregion.

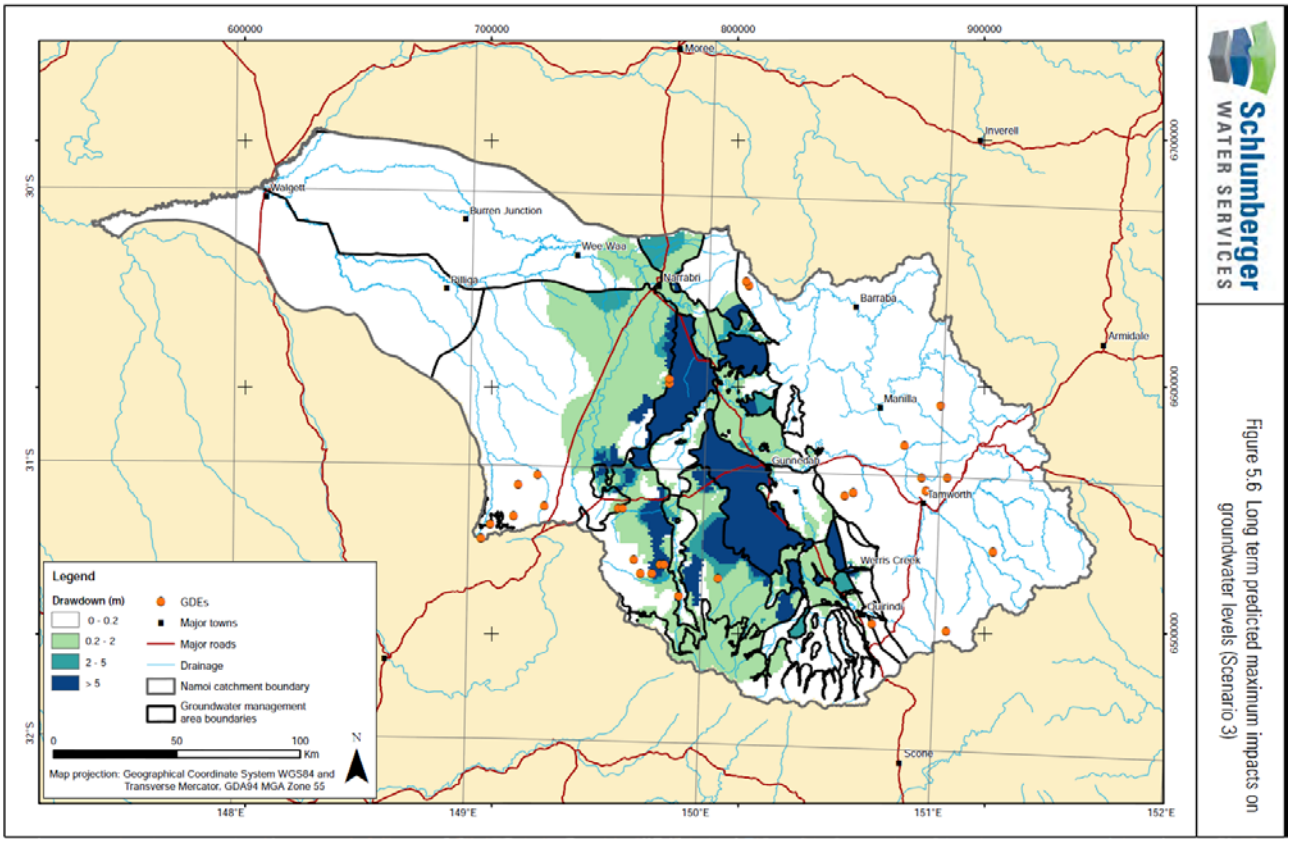


Figure 4 Development scenario 3 from the *Namoi Catchment water study*

Source: Figure 5.6 from Schlumberger Water Services (2012). This figure is not covered by a Creative Commons Attribution licence. It has been reproduced with the permission of NSW Trade & Investment.

The Hunter-Mooki Thrust fault, which forms the eastern boundary of the Namoi subregion (Figure 3), is likely to be a barrier to groundwater flow because the coal seams, aquifers and aquitards of the Gunnedah and Surat basins abut against much older Paleozoic formations. As a precaution, the PAE of the Namoi subregion extends about 20 km east of the fault line (Figure 3).

For the Cenozoic sediments in the lower Namoi river basin, the impacts could potentially extend across the entire area of occurrence of the Namoi alluvium defined by the Lower Namoi Water Sharing Plan boundary (Smithson, 2009). The same boundary would also be appropriate for the underlying Surat Basin. This is because in both hydrogeological systems, there is some flow into the area, but no groundwater flow radially outwards from the area (see Figure 26 and Figure 27 in companion product 1.1 for the Namoi subregion (Welsh, et al., 2014)).

The maximum surface water impact is taken to be the extent of the largest recorded flood event. This occurred in 1956. Although 1956 was not the wettest year, it followed a very wet 1955, so less rain was able to be absorbed, and the flooding was extensive (see Figure 43 in companion product 1.1 for the Namoi subregion (Welsh et al., 2014)).

1.3.1.4 Assessing water dependence

Once the assets were compiled into the asset database and checked for inclusion in the PAE, they were assessed for water dependence. All assets in the asset list that may be potentially impacted by changes in the groundwater or surface water regime due to coal resource development were identified. While the vast majority of the assets will be clearly 'water dependent' in the general

sense of the phrase (e.g. groundwater bores, rivers and wetlands), there is a small group of assets that could be affected but are not as readily identified as being 'water dependent'. Examples of these assets include historic buildings that may be potentially subject to added inundation or salinity impacts, or Indigenous assets that may be more difficult to access due to changes in the water regime.

It is important to emphasise that BAs consider the potential impact to the habitat of species not the individual species per se. However, it is necessary to present species-based information to best reflect the available data; but implicit in this is the focus on habitat.

The water dependency of threatened species assets or habitats was assessed by a review of the habitat requirements for each species. In most cases profiles from the *Species Profile and Threats Database* (SPRAT; Department of the Environment, 2012; Australian Government Department of the Environment, Dataset 10) were examined. The water dependence of each species-related asset was ranked as being 'likely', 'possible', 'unlikely' or 'unsure'. Assets listed as 'likely' are those with a clear and demonstrated link to aquatic ecosystems, (e.g. aquatic species). Assets listed as 'possible' may have some overlap with habitats that may be water dependent (e.g. species that may visit riparian areas). Assets listed as 'unlikely' show no water dependence in habitat requirements.

Species listed under NSW's *Threatened Species and Conservation Act 1995* for areas covering the former Namoi and Border Rivers-Gwydir CMAs were considered for inclusion in the asset database. However, there is currently insufficient habitat modelling information to make definitive determinations of:

- their occurrence within the PAE
- habitat requirements occurring within the PAE.

Similarly, listed aquatic species from Table 17 of Welsh et al. (2014) are included in the asset database.

As there was no available spatial information related to the distribution of assets associated with species and their associated habitats, they are recognised as being 'potential' assets but require further investigations before they can be included in the water-dependent asset register.

A preliminary assessment of the water dependency of vegetation assets was made using the following rules:

- Riparian vegetation was assumed to be water dependent (attributed as 'likely').
- Vegetation assets that intersect with the maximum floodplain extent were assumed to be water dependent (attributed as 'likely').
- Vegetation assets outside the maximum floodplain extent mapping, where groundwater was less than 10 m from the surface were assumed to be water dependent (attributed as 'likely').
- Vegetation assets derived from the 'Groundwater-dependent ecosystem' class with a known groundwater dependency derived from previous field work or a high potential for groundwater dependency were assumed to be groundwater dependent (attributed as 'likely'). Assets with a moderate potential for groundwater dependency were attributed as

possible. Vegetation assets sourced from the *Atlas of groundwater dependent ecosystems* (Bureau of Meteorology, 2012) with a low probability for groundwater dependence were given an attribution of 'unlikely'.

All assets in the 'Surface water feature' and 'Groundwater feature (subsurface)' classes of the asset database were assumed to be water-dependent assets and attributed as 'likely'.

Assets attributed as 'likely' or 'possible' are considered further in the bioregional assessment and flagged as 'yes' with respect to water dependency in the asset database; assets attributed as 'unlikely' are flagged as 'no' in the asset database and are not considered further in the bioregional assessment.

Once water dependence was determined, and the decisions recorded in the asset database, a preliminary version of the water-dependent asset register was generated from 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 a workshop in Gunnedah in July 2014 for comment and feedback. Further economic assets were identified: water licences that do not require a works approval and therefore do not include a specific location and surface water storages used for flood plain harvesting. These additional economic assets are further discussed in Section 1.3.3.1. No additional ecological or sociocultural assets were suggested by the attendees.

The characteristics of the groups of water-dependent assets identified in the Namoi 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.

The water-dependent asset register is a simple and authoritative listing of the names of the assets that will be included in other components of the BA; all the spatial and other data associated with each asset (including for each element) is stored in the asset database. Other BA components are described in the BA methodology (Barrett et al., 2013) and the pending companion submethodologies including M03 (as listed in Table 1) for assigning receptors to water-dependent assets.

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1.3.2 Ecological assets

Summary

The asset list for the Namoi subregion contains 1964 ecological assets, of which 1684 were considered water dependent. The vegetation subgroup was predominantly sourced from the *National atlas of groundwater dependent ecosystems* (Bureau of Meteorology, 2012). Most (442 assets) of the groundwater dependent ecosystems were considered water dependent, including 44 river reaches, 22 groundwater fed springs and six wetlands. The water-dependent asset register includes the potential spatial habitat distribution of 18 species listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), one wetland (Lake Goran) listed in *A directory of important wetlands in Australia* (DIWA; Environment Australia, 2001), two important bird areas (IBAs) and 43 protected areas that were assumed to contain water dependent assets. Four threatened ecological communities that occur within the maximum flood extent of the Namoi subregion were also included in the water-dependent asset register. All of the 1142 surface water features and all but eight of the 41 groundwater features, were assumed to be water dependent. A number of important alluvial aquifers, groundwater management zones and groundwater-fed springs were included in the water-dependent asset register.

1.3.2.1 Description

The total number of ecological assets identified in the preliminary assessment extent (PAE) of the Namoi subregion is 1964 as outlined in the final column of Table 7. All 1142 surface water features (including assets classed as 'River or stream reach, tributary, anabranch or bend', 'Lake, reservoir, lagoon or estuary', 'Waterhole, pool, rock pool or billabong', 'Wetland, wetland complex or swamp', 'Marsh, sedgeland, bog, spring or soak' or 'Floodplain') were assumed to be water dependent and were included in the water-dependent asset register. Most of the 41 groundwater features (subsurface) were assumed to be water dependent, with the exception of the eight geological formations that were not assumed to be water-dependent ecological assets. Most (682 of 781) ecological assets in the vegetation subgroup were sourced from the *National atlas of groundwater dependent ecosystems* (Bureau of Meteorology, 2012). Two thirds (531) of the 688 groundwater dependent ecosystems included in the asset list were assumed to be water dependent based on previous studies or their moderate or high potential for groundwater interaction. Most (67) of the remaining 93 ecological assets in the vegetation subgroup, were assumed to be water dependent habitat, contain water dependent features, be associated with water dependent features or have water-dependent lifecycle requirements.

The total number of water-dependent ecological assets identified in the Namoi subregion PAE is 1684, including 1142 in the surface water feature subgroup, 33 in the groundwater feature subgroup and 509 in the vegetation subgroup, as outlined in the fourth column of Table 7.

Table 7 Summary of ecological assets within the preliminary assessment extent of the Namoi subregion

Subgroup	Class	Not in water-dependent asset register	In water-dependent asset register	Total assets (asset list)
Groundwater feature (subsurface)	Aquifer, geological feature, alluvium or stratum	8	33	41
	Groundwater total	**8**	**33**	**41**
Surface water feature	River or stream reach, tributary, anabranch or bend	0	767	767
	Lake, reservoir, lagoon or estuary	0	31	31
	Waterhole, pool, rock pool or billabong	0	10	10
	Wetland, wetland complex or swamp	0	279	279
	Marsh, sedgeland, bog, spring or soak	0	21	21
	Floodplain	0	34	34
	Surface water total	**0**	**1142**	**1142**
Vegetation	Groundwater-dependent ecosystem	246	442	688
	Habitat (potential species distribution)	26	67	93
	Vegetation total	**272**	**509**	**781**
Total		**280**	**1684**	**1964**

Data: Bioregional Assessment Programme (Dataset 1)

1.3.2.1.1 Groundwater features

A range of groundwater-dependent ecosystems are present in the PAE of the Namoi subregion including groundwater-dependent vegetation, baseflow systems and associated riverine vegetation and wetlands and springs and aquifers (Welsh et al., 2014). Forty one ecological assets within the 'Groundwater feature (subsurface)' subgroup were included in the Namoi asset list. The 22 groundwater management zones in the asset list were considered water dependent, including the 13 Upper and Lower Namoi alluvium groundwater management zones shown in Figure 5 and the nine groundwater management zones shown in Figure 6. Nine groundwater flow systems (including the Pilliga Sandstone, Tertiary Volcanics and Riverine Plain Alluvium, the Cadna-owie Hooray Equivalent GAB recharge and Narrabri Water Table Aquifer) were also assumed to be water dependent. However, eight groundwater formations (e.g. the Allaru formation) were not assumed to be water dependent as they are geological formations.

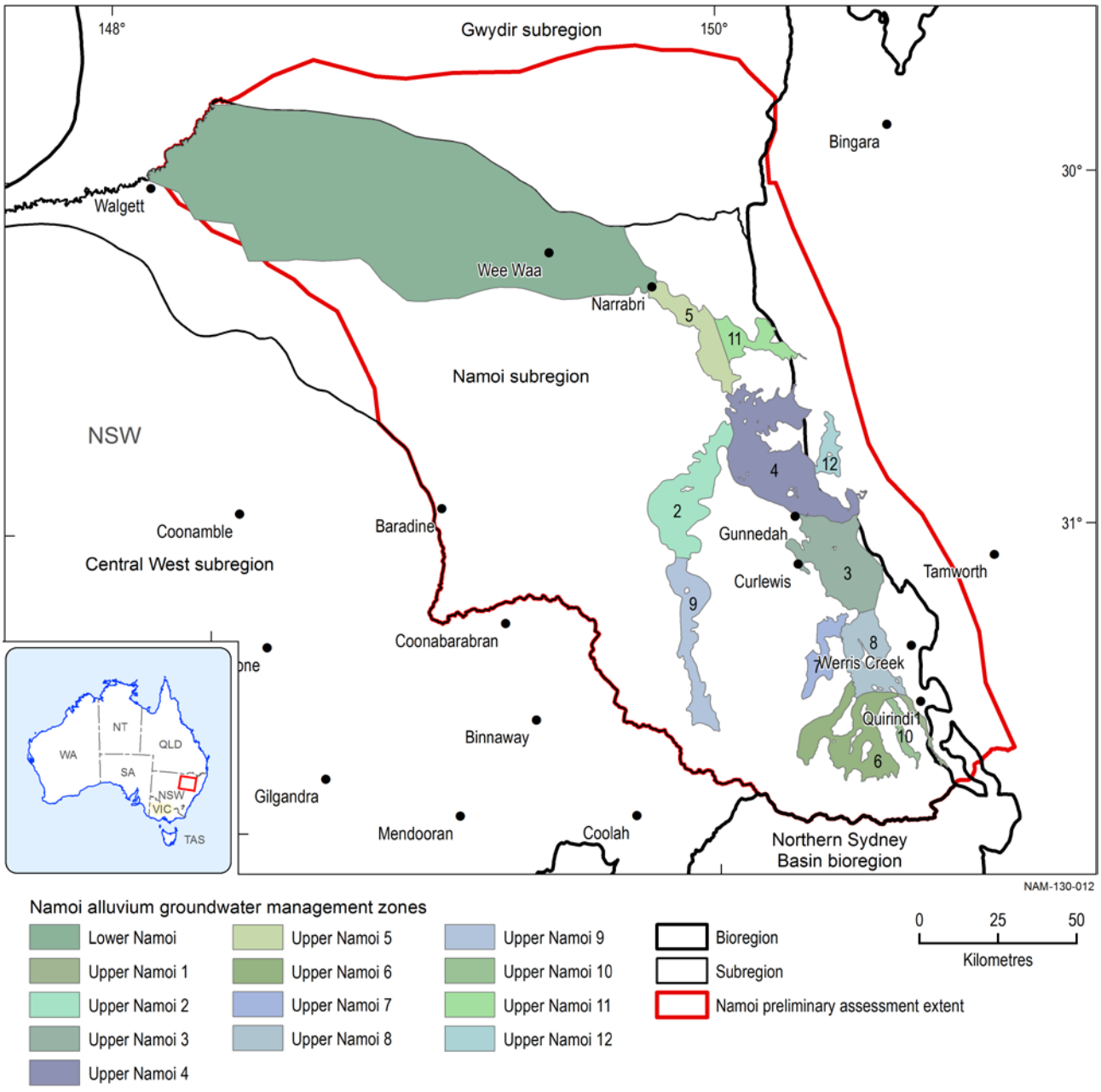

Figure 5 Groundwater management zones of the Upper and Lower Namoi alluvium within the 'Groundwater features (subsurface)' subgroup within the preliminary assessment extent of the Namoi subregion

Data: Bioregional Assessment Programme (Dataset 1), Australian Government Department of the Environment (Dataset 2)

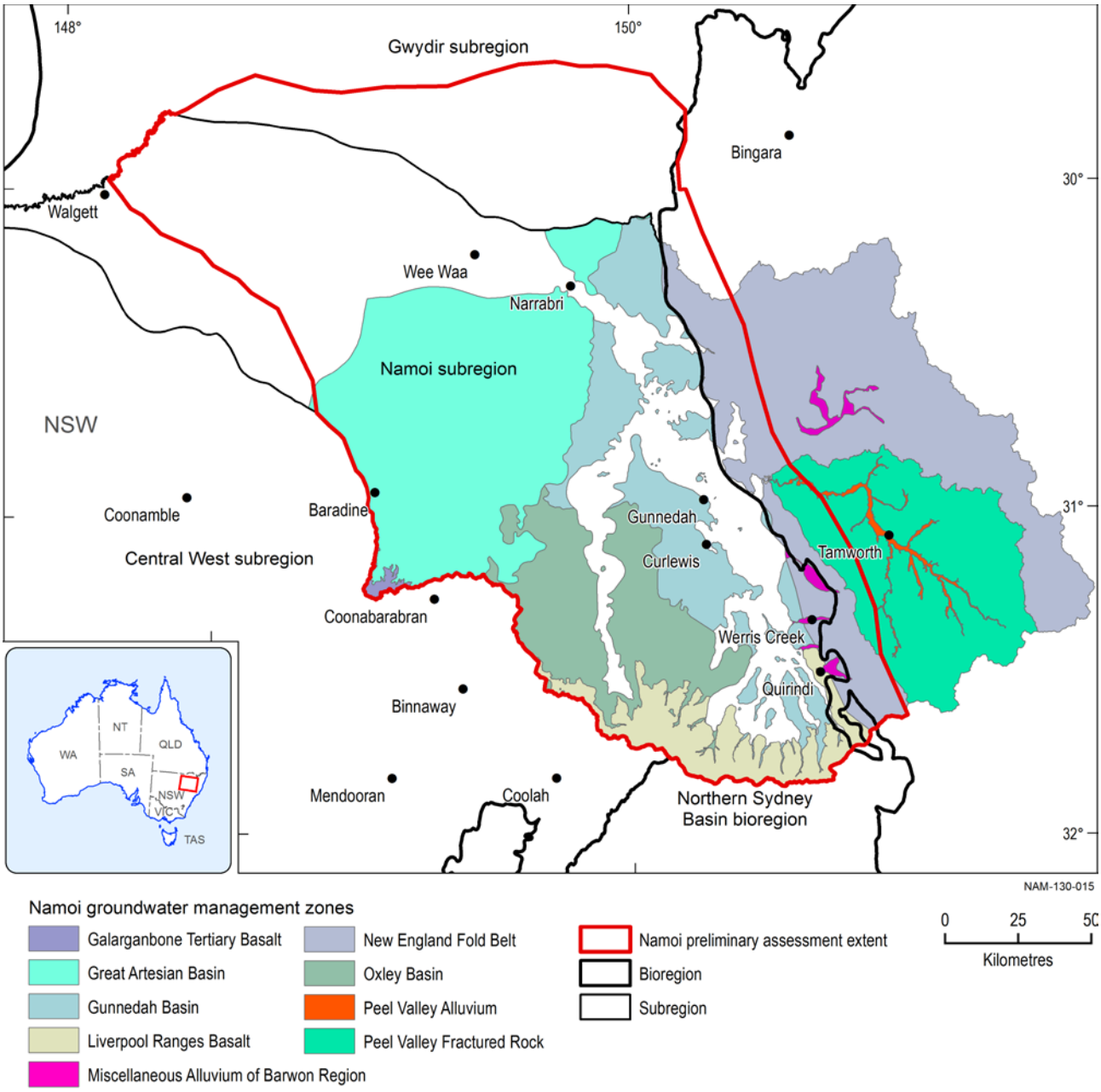

Figure 6 Groundwater management zones of the Namoi subregion within the 'Groundwater features (subsurface)' subgroup within the preliminary assessment extent of the Namoi subregion

Data: Bioregional Assessment Programme (Dataset 1), Australian Government Department of the Environment (Dataset 2)

The PAE of the Namoi subregion contains 21 springs fed by groundwater that are classed as 'Marsh, sedgeland, bog, spring or soak' in the surface water feature subgroup of the asset list. These are predominantly in the upper Namoi river basin associated with the Pilliga, Liverpool Range, Peel and Kaputar IBRA subregions (Figure 7).

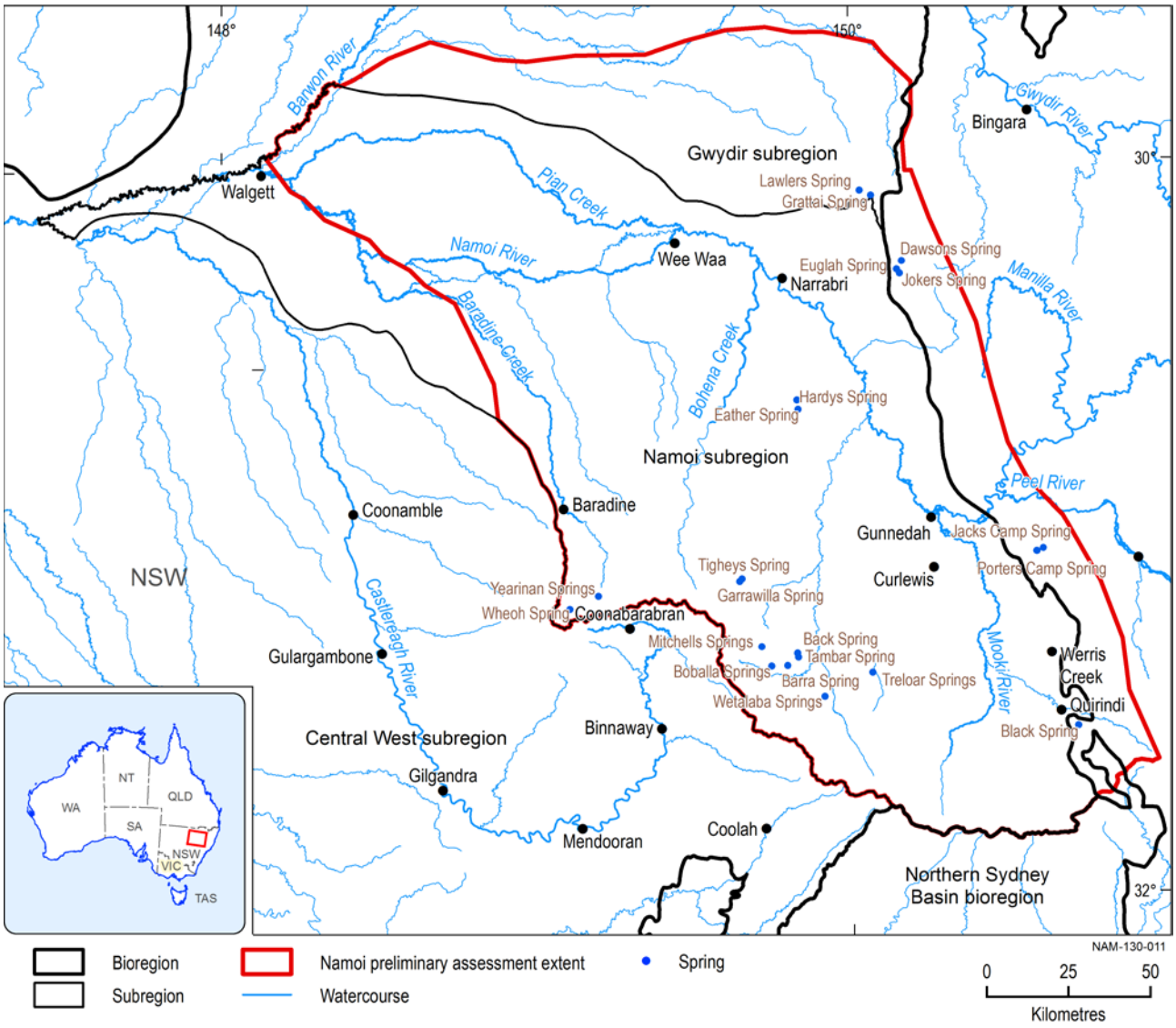

Figure 7 Groundwater springs within the preliminary assessment extent of the Namoi subregion

Data: Bioregional Assessment Programme (Dataset 1), Australian Government Department of the Environment (Dataset 2)

1.3.2.1.2 Surface water features

The asset list contains 1142 ecological assets classed in the 'Surface water features' subgroup that occur in the PAE of the Namoi subregion and are listed in Table 7. These assets include: rivers, creeks and tributaries, riparian vegetation, wetland complexes, springs and lakes. The Namoi River itself forms part of the endangered 'aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River' (Green et al., 2011). All 1142 ecological assets within this subgroup are assumed to be water dependent.

1.3.2.1.3 Vegetation

The PAE of the Namoi subregion contains one wetland listed in DIWA (Environment Australia, 2001): Lake Goran within the Liverpool Plains subregion of the Interim Biogeographic Regionalisation of Australia (IBRA; SEWPaC, 2012). Two IBRA bioregions occur within the PAE: (i) the Bundarra-Barraba bioregion and (ii) the Pilliga bioregion. The Pilliga IBRA bioregion is predominantly associated with the Liverpool Plains, Pilliga and Pilliga Outwash IBRA subregions.

Less than 0.25% of the Bundarra-Barraba IBRA bioregion that is associated with the Peel IBRA subregion occurs within the PAE. Forty-three Collaborative Australian Protected Area Database (CAPAD) areas occur in the PAE. CAPAD areas include: national parks (e.g. Mount Kaputar National Park), conservation reserves (e.g. Bullawa Creek state conservation area) and Indigenous Protected Areas. These areas largely represent terrestrial nature reserves and were all assumed to contain water dependent features.

Seven threatened ecological communities listed under the EPBC Act are represented within the PAE of the Namoi subregion (Table 8). Four of these threatened ecological communities are included in the water-dependent asset register where the community was known to occur within the maximum flood extent of the Namoi subregion or was a dominant floodplain vegetation community.

Table 8 Threatened ecological communities listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* within the preliminary assessment extent of the Namoi subregion

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

Name	Status	Water-dependent asset register decision
Brigalow (*Acacia harpophylla* dominant and co-dominant)	Endangered	Community does not demonstrate water dependency, occurs in dry woodlands and open forest
Coolibah-black box woodlands of the Darling riverine plains and Brigalow belt South Bioregions	Endangered	Community demonstrates water dependency, intersects with maximum flood extent and is a dominant floodplain vegetation community
Grey box grassy woodlands and derived native grasslands of south-eastern Australia	Endangered	Community demonstrates water dependency, intersects with maximum flood extent
Natural grasslands on basalt and fine textured alluvial plains of northern New South Wales and southern Queensland	Critically endangered	Community demonstrates water dependency, intersects with maximum flood extent
Semi-evergreen vine thickets of the Brigalow Belt (north and South) and Nandewar ranges	Endangered	Community does not demonstrate water dependency, occurs outside maximum flood extent
Weeping Myall Woodlands	Endangered	Community demonstrates water dependency, intersects with maximum flood extent
White box-Yellow box-Blakely's red gum grassy woodland and derived native grassland	Critically endangered	Community does not demonstrate water dependency, not associated with active drainage channels, rarely if ever flooded

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

The PAE for the Namoi subregion includes the potential spatial habitat distribution of 41 species listed under the EPBC Act. This includes 19 plant, one frog, three reptile, 12 bird and six mammal species (Table 9). Note that the asset under consideration is the habitat of these species rather than the species per se, hence these assets are listed under the subgroup, vegetation. The habitat of 18 of the 41 species was considered water dependent for the following reasons: associated with drainage or soakage areas, wetland or permanent open water dependent or associated with floodplain or riparian vegetation communities. Most of (23 of 41) the remaining species were not considered to be water dependent because they were associated with grassland, woodland, dry scrub, open forest, heathlands or rainforest vegetation communities, rocky outcrops, upstream of

potential development activities, insufficient habitat information or it was a wide-spread migratory species.

Table 9 Species listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* within the preliminary assessment extent of the Namoi subregion

Water dependency represents a preliminary assessment based on a literature review of habitat requirements.

Functional group	Asset name[a]	Status	In water-dependent asset register
Birds	Australasian Bittern (Botaurus poiciloptilus)	Endangered	Habitat features consistent with water dependency, species is wetland dependent
	Australian Painted Snipe (Rostratula australis)	Endangered	Habitat features consistent with water dependency, species is wetland dependent
	Black-faced Monarch (Monarcha melanopsis)	Migratory	Habitat predominantly outside of PAE
	Cattle Egret (Ardea ibis)	Migratory	Habitat features consistent with water dependency, species requires permanent water for roosting
	Great Egret, White Egret (Ardea alba)	Migratory	Habitat features consistent with water dependency, species is wetland dependent
	Malleefowl (Leipoa ocellata)	Vulnerable	Habitat features not consistent with demonstrated water dependency, occurs in dry shrublands and low woodlands
	Red Goshawk (Erythrotriorchis radiatus)	Vulnerable	Habitat features consistent with water dependency, associated with groundwater dependent riparian trees
	Regent Honeyeater (Anthochaera phrygia)	Endangered	Habitat features consistent with water dependency, associated with groundwater dependent riparian trees
	Rufous Fantail (Rhipidura rufifrons)	Migratory	Habitat features not consistent with demonstrated water dependency, occurs in wet schlerophyll and coastal rainforest
	Satin Flycatcher (Myiagra cyanoleuca)	Migratory	Habitat features not consistent with demonstrated water dependency, widespread migratory bird
	Swift Parrot (Lathamus discolor)	Endangered	Habitat features consistent with water dependency, box ironbark habitat in drainage lines is critical refugia
	White-bellied Sea-Eagle (Haliaeetus leucogaster)	Migratory	Habitat features consistent with demonstrated water dependency and are characterised by the presence of large areas of open water (larger rivers, swamps, lakes, the sea)
Frogs	Booroolong Frog (Litoria booroolongensis)	Endangered	Habitat upstream from any developments
Mammals	Brush-tailed Rock-wallaby (Petrogale penicillata)	Vulnerable	Habitat features not consistent with demonstrated water dependency, prefers rocky outcrops

Functional group	Asset name[a]	Status	In water-dependent asset register
	Koala (Phascolarctos cinereus)	Vulnerable	Habitat features consistent with water dependency, associated with groundwater dependent riparian trees
	New Holland Mouse, Pookila (Pseudomys novaehollandiae)	Vulnerable	Habitat features not consistent with demonstrated water dependency, occurs in open heathlands, woodlands and forests
	Pilliga Mouse, Poolkoo (Pseudomys pilligaensis)	Vulnerable	Habitat features not consistent with demonstrated water dependency, occurs in dry scrub and open forest. Note that while coal seam gas activity is an EPBC Act listed threat, the Pilliga Mouse does not demonstrate water dependency for the purposes of a BA.
	Potential distribution of South-eastern Long-eared Bat (Nyctophilus corbeni)	Vulnerable	Habitat features consistent with water dependency, species roost in river red gums
	Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (Dasyurus maculatus maculatus)	Endangered	Habitat features consistent with water dependency, associated with groundwater dependent riparian trees
Reptiles	Border Thick-tailed Gecko, Granite Belt Thick-tailed Gecko (Uvidicolus sphyrurus)	Vulnerable	Habitat features not consistent with demonstrated water dependency, occurs in dry scrub and open forest
	Five-clawed Worm-skink, Long-legged Worm-skink (Anomalopus mackayi)	Vulnerable	Habitat features consistent with demonstrated water dependency, associated with floodplain coolibah/blackbox vegetation
	Pink-tailed Worm-lizard, Pink-tailed Legless Lizard (Aprasia parapulchella)	Vulnerable	Habitat features not consistent with demonstrated water dependency, occurs in grasslands, woodlands and open forest
Plants	(Bertya opponens)	Vulnerable	Habitat features not consistent with demonstrated water dependency, occurs in dry scrub and open forest
	(Hakea pulvinifera)	Endangered	Habitat features not consistent with demonstrated water dependency, occurs in dry scrub and open forest
	(Macrozamia machinii)	Vulnerable	Habitat features not consistent with demonstrated water dependency, occurs in dry scrub and open forest
	(Philotheca ericifolia)	Vulnerable	Habitat features consistent with water dependency, prefers drainage and soakage areas
	(Pultenaea setulosa)	Vulnerable	Not enough habitat information to assess
	(Rulingia procumbens)	Vulnerable	Habitat features not consistent with demonstrated water dependency, occurs in dry scrub and open forest
	(Tylophora linearis)	Endangered	Habitat features not consistent with demonstrated water dependency, occurs in dry scrub and open forest

Functional group	Asset name[a]	Status	In water-dependent asset register
	A leek-orchid (Prasophyllum sp. Wybong)	Critically Endangered	Habitat features consistent with water dependency, prefers dry to wet soils
	Austral Toadflax, Toadflax (Thesium australe)	Vulnerable	Habitat features not consistent with demonstrated water dependency, occurs in dry scrub and open forest
	Belson's Panic (Homopholis belsonii)	Vulnerable	Habitat features consistent with water dependency, prefers drainage and soakage areas
	bluegrass (Dichanthium setosum)	Vulnerable	Habitat features not consistent with demonstrated water dependency, occurs in dry scrub and open forest
	Cobar Greenhood Orchid (Pterostylis cobarensis)	Vulnerable	Habitat features not consistent with demonstrated water dependency, occurs in dry scrub and open forest
	Finger Panic Grass (Digitaria porrecta)	Endangered	Habitat features not consistent with demonstrated water dependency, occurs in grasslands, woodlands and open forest
	Hawkweed (Picris evae)	Vulnerable	Habitat features not consistent with demonstrated water dependency, occurs in dry woodlands and open forest
	Lobed Blue-grass (Bothriochloa biloba)	Vulnerable	Habitat features not consistent with demonstrated water dependency, occurs in grasslands, woodlands and open forest
	Ooline (Cadellia pentastylis)	Vulnerable	Habitat features not consistent with demonstrated water dependency, occurs in semi-evergreen rainforest vine thickets
	Slender Darling-pea, Slender Swainson, Murray Swainson-pea (Swainsona murrayana)	Vulnerable	Habitat features consistent with water dependency, prefers seasonally inundated, heavy textured floodplain soils, associated with blackbox
	Spiny Pepper-cress (Lepidium aschersonii)	Vulnerable	Habitat features consistent with water dependency, prefers seasonally inundated, heavy textured floodplain soils
	Tarengo Leek Orchid (Prasophyllum petilum)	Endangered	Habitat features consistent with water dependency, genus is often associated with moist, poorly drained sites

[a]Although examples of individual species are listed, bioregional assessments consider the potential impact to the habitat of species not individual species per se. Punctuation and typography appear as used in the asset database.
Data: Australian Government Department of the Environment (Dataset 3)

The asset list contains 682 assets derived from the *National atlas of groundwater dependent ecosystems* (Bureau of Meteorology, 2012) that are classed as 'Groundwater-dependent ecosystems' in the vegetation subgroup of the asset database. These comprise mostly vegetation areas or surface water areas identified as being potentially groundwater dependent. Water dependency of these assets was assumed if the asset had been classified in the *National atlas of groundwater dependent ecosystems* (Bureau of Meteorology, 2012) as: identified in a previous study (27 assets), high (35 assets), moderate to high (66 assets), moderate (242 assets) or low to

moderate (155 assets) probability of groundwater interaction. This included groundwater dependent vegetation, and rivers, streams, springs and wetlands identified as connected and gaining systems – where gaining systems receive water from the groundwater system and losing systems lose water to the groundwater system. A connected system has a continuous saturated zone, whereas surface water – groundwater interactions are disconnected by an unsaturated zone in disconnected systems. Assets classed in the *National atlas of groundwater dependent ecosystems* (Bureau of Meteorology, 2012) with a low potential for groundwater interaction or connected, losing systems (246) are not considered to be water dependent. A further six assets were identified by the community as groundwater dependent ecosystems and are considered water dependent.

1.3.2.2 Gaps

Sixteen species listed in the EPBC Act were not included in the water-dependent asset register for the Namoi subregion as there was insufficient spatial habitat modelling information available to confirm the presence of their habitats within the PAE of the Namoi subregion (Table 10).

Table 10 Species listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* but excluded from the water-dependent asset register

Decisions to 'exclude' were based on lack of available spatial habitat modelling to confirm presence in the preliminary assessment extent or there was low confidence associated with the data. However, some species may be considered further in development of conceptual models for water dependent habitats.

Functional group	Species[a]	Status	Decision
Birds	Fork-tailed Swift	Marine migratory	Insignificant proportion of its extensive distribution in PAE
	Latham's Snipe, Japanese Snipe	Marine migratory	No known, likely distribution within PAE ('May occur' only)
	Osprey	Marine migratory	No known, likely distribution within PAE ('May occur' only)
	Rainbow Bee-eater	Marine migratory	No known, likely distribution within PAE ('May occur' only)
	Squatter Pigeon (southern)	Vulnerable	No known, likely distribution within PAE ('May occur' only)
	Superb Parrot	Vulnerable	Insignificant proportion of its extensive distribution in PAE
	White-throated Needle tail	Marine migratory	Insignificant proportion of its extensive distribution in PAE
Fish	Murray Cod	Vulnerable	No known, likely distribution within PAE ('May occur' only)
	Silver Perch, Bidyan	Critically endangered	Insignificant proportion of its extensive distribution in PAE
	Murray Hardyhead	Endangered	No known, likely distribution within PAE ('May occur' only)

Functional group	Species[a]	Status	Decision
Mammals	Large-eared Pied Bat	Vulnerable	No known, likely distribution within PAE ('May occur' only)
	Grey-headed Flying-fox	Vulnerable	Insignificant proportion of its extensive distribution in PAE
Reptile	Bell's Turtle	Vulnerable	No known, likely distribution within PAE ('May occur' only)
Plants	*Euphrasia arguta*	Critically endangered	No known, likely distribution within PAE ('May occur' only)
	Haloragis exalata subsp. velutina	Vulnerable	No known, likely distribution within PAE ('May occur' only)
	Streblus pendulinus	Endangered	No known, likely distribution within PAE ('May occur' only)

[a]Although examples of individual species are listed, bioregional assessments consider the potential impact to the habitat of species not individual species per se. Punctuation and typography appear as used in the asset database.
Data: Australian Government Department of the Environment (Dataset 3)

Species listed in the *Threatened Species Conservation Act 1995* (NSW) (the TSC Act) were not included in the water-dependent asset register for the Namoi subregion as there was insufficient spatial habitat modelling information available to confirm the presence of their habitats within the PAE of the Namoi subregion. The TSC Act lists 123 faunal species (17 bat, 56 bird, five fish, eight frog, three invertebrate, 19 marsupial, six reptile and nine rodent species) within the former Namoi and Border Rivers-Gwydir catchment management authorities (CMAs) (Table 11). Table 9 and Table 10 also present 21 of these faunal species. The TSC Act lists 13 faunal species within the former Namoi and Border Rivers-Gwydir CMAs as presumed extinct, five as critically endangered, 28 as endangered, three as endangered populations and 74 as vulnerable. Table 12 presents 80 threatened flora species listed under the TSC Act within the former Namoi and the Border Rivers-Gwydir CMAs, including 14 that were presented in Table 9 or Table 10. Two TSC Act flora species are listed as presumed extinct, two as critically endangered, 43 as endangered and 33 as vulnerable. Table 13 presents 18 threatened ecological communities listed under the TSC Act within the former Namoi and the Border Rivers-Gwydir CMAs, including three that were presented in Table 8. Two of these threatened ecological communities are listed as critically endangered, the remainder are endangered.

The number of wetlands listed in the water-dependent asset register is less than has been previously reported by other authors (Eco Logical, 2008). There is some difficulty in attributing these differences as typologies and assessment extent vary between previous studies and the current PAE of the Namoi subregion. Similarly the number of watercourses in the current asset register is less than is reported in data sources such as the Geofabric. To address these issues it is proposed to use the Australian National Aquatic Ecosystem (ANAE) classification framework (Brooks et al., 2014) to develop the landscape classification component of the BA to attribute both wetlands and watercourses using a typology that is consistent with national initiatives.

Table 11 Threatened faunal species of the Namoi and Border Rivers-Gwydir catchment management authorities listed under NSW *Threatened Species Conservation Act 1995* and NSW *Fisheries Management Act 1994*

Functional group	Species[a]	Status
Bats	*Mormopterus eleryi*	Endangered
	Chalinolobus dwyeri	Vulnerable
	Chalinolobus nigrogriseus	Vulnerable
	Chalinolobus picatus	Vulnerable
	Falsistrellus tasmaniensis	Vulnerable
	Kerivoula papuensis	Vulnerable
	Miniopterus australis	Vulnerable
	Miniopterus schreibersii oceanensis	Vulnerable
	Mormopterus beccarii	Vulnerable
	Mormopterus norfolkensis	Vulnerable
	Myotis macropus	Vulnerable
	Nyctophilus corbeni	Vulnerable
	Pteropus poliocephalus	Vulnerable
	Saccolaimus flaviventris	Vulnerable
	Scoteanax rueppellii	Vulnerable
	Vespadelus baverstocki	Vulnerable
	Vespadelus troughtoni	Vulnerable
Birds	*Anthochaera phrygia*	Critically endangered
	Erythrotriorchis radiatus	Critically endangered
	Ardeotis australis	Endangered
	Botaurus poiciloptilus	Endangered
	Burhinus grallarius	Endangered
	Calidris ferruginea	Endangered
	Ephippiorhynchus asiaticus	Endangered
	Falco hypoleucos	Endangered
	Geophaps scripta	Endangered
	Lathamus discolor	Endangered
	Leipoa ocellata	Endangered
	Nettapus coromandelianus	Endangered
	Phaps histrionica	Endangered
	Poephila cincta cincta	Endangered
	Rostratula australis	Endangered

Functional group	Species[a]	Status
	Alectura lathami – endangered population	Endangered population
	Anseranas semipalmata	Vulnerable
	Callocephalon fimbriatum	Vulnerable
	Calyptorhynchus banksii samueli	Vulnerable
	Calyptorhynchus lathami	Vulnerable
	Certhionyx variegatus	Vulnerable
	Chthonicola sagittata	Vulnerable
	Circus assimilis	Vulnerable
	Climacteris picumnus victoriae	Vulnerable
	Daphoenositta chrysoptera	Vulnerable
	Epthianura albifrons	Vulnerable
	Falco subniger	Vulnerable
	Glossopsitta pusilla	Vulnerable
	Grantiella picta	Vulnerable
	Grus rubicunda	Vulnerable
	Hamirostra melanosternon	Vulnerable
	Hieraaetus morphnoides	Vulnerable
	Irediparra gallinacea	Vulnerable
	Limosa limosa	Vulnerable
	Lophochroa leadbeateri	Vulnerable
	Lophoictinia isura	Vulnerable
	Melanodryas cucullata cucullata	Vulnerable
	Melithreptus gularis gularis	Vulnerable
	Neophema pulchella	Vulnerable
	Ninox connivens	Vulnerable
	Ninox strenua	Vulnerable
	Oxyura australis	Vulnerable
	Pachycephala inornata	Vulnerable
	Pachycephala olivacea	Vulnerable
	Pandion cristatus	Vulnerable
	Petroica boodang	Vulnerable
	Petroica phoenicea	Vulnerable
	Phaethon rubricauda	Vulnerable
	Polytelis swainsonii	Vulnerable

Functional group	Species[a]	Status
	Pomatostomus temporalis temporalis	Vulnerable
	Ptilinopus magnificus	Vulnerable
	Stagonopleura guttata	Vulnerable
	Stictonetta naevosa	Vulnerable
	Tyto longimembris	Vulnerable
	Tyto novaehollandiae	Vulnerable
	Tyto tenebricosa	Vulnerable
Fish	*Ambassis agassizii*	Endangered
	Craterocephalus fluviatilis	Critically endangered
	Tandanus tandanus	Endangered population
	Mogurnda adspersa	Endangered
	Bidyanus bidyanus	Vulnerable
Frogs	*Litoria castanea*	Critically endangered
	Litoria aurea	Endangered
	Litoria booroolongensis	Endangered
	Mixophyes balbus	Endangered
	Adelotus brevis – endangered population	Endangered population
	Crinia sloanei	Vulnerable
	Litoria daviesae	Vulnerable
	Litoria subglandulosa	Vulnerable
Invertebrates	*Jalmenus eubulus*	Critically endangered
	Notopala sublineata	Endangered
	Petalura gigantea	Endangered
Marsupials	*Macropus dorsalis*	Endangered
	Petrogale penicillata	Endangered
	Bettongia lesueur graii	Presumed extinct
	Bettongia penicillata penicillata	Presumed extinct
	Bettongia tropica	Presumed extinct
	Dasyurus geoffroii	Presumed extinct
	Isoodon auratus auratus	Presumed extinct
	Lagorchestes leporides	Presumed extinct
	Macrotis lagotis	Presumed extinct
	Onychogalea fraenata	Presumed extinct
	Perameles bougainville fasciata	Presumed extinct

Functional group	Species[a]	Status
	Aepyprymnus rufescens	Vulnerable
	Cercartetus nanus	Vulnerable
	Dasyurus maculatus	Vulnerable
	Petaurus australis	Vulnerable
	Petaurus norfolcensis	Vulnerable
	Phascogale tapoatafa	Vulnerable
	Phascolarctos cinereus	Vulnerable
	Sminthopsis macroura	Vulnerable
Reptiles	*Anomalopus mackayi*	Endangered
	Oedura rhombifer	Endangered
	Aprasia parapulchella	Vulnerable
	Elseya belli	Vulnerable
	Hoplocephalus bitorquatus	Vulnerable
	Underwoodisaurus sphyrurus	Vulnerable
Rodents	*Pseudomys apodemoides*	Endangered
	Pseudomys delicatulus	Endangered
	Pseudomys oralis	Endangered
	Conilurus albipes	Presumed extinct
	Leporillus apicalis	Presumed extinct
	Pseudomys australis	Presumed extinct
	Pseudomys gouldii	Presumed extinct
	Pseudomys pilligaensis	Vulnerable
	Rattus villosissimus	Vulnerable

[a]Although examples of individual species are listed, bioregional assessments consider the potential impact to the habitat of species not individual species per se.
Data: NSW *Threatened Species Conservation Act 1995* and NSW *Fisheries Management Act 1994*

Table 12 Threatened flora of the Namoi and Border Rivers-Gwydir catchment management authorities listed under NSW *Threatened Species Conservation Act 1995*

Species[a]	Status
Muehlenbeckia costata	Vulnerable
Tylophora linearis	Vulnerable
Macrozamia humilis	Endangered
Platyzoma microphyllum	Endangered
Euphrasia arguta	Critically endangered
Myriophyllum implicatum	Critically endangered

Species[a]	Status
Cyperus conicus	Endangered
Desmodium campylocaulon	Endangered
Digitaria porrecta	Endangered
Euphrasia orthocheila subsp. peraspera	Endangered
Homopholis belsonii	Endangered
Indigofera baileyi	Endangered
Ipomoea diamantinensis	Endangered
Lepidium monoplocoides	Endangered
Lepidium peregrinum	Endangered
Monotaxis macrophylla	Endangered
Polygala linariifolia	Endangered
Sida rohlenae	Endangered
Stenopetalum velutinum	Presumed extinct
Arthraxon hispidus	Vulnerable
Dichanthium setosum	Vulnerable
Euphrasia ciliolata	Vulnerable
Lepidium aschersonii	Vulnerable
Picris evae	Vulnerable
Rutidosis heterogama	Vulnerable
Swainsona murrayana	Vulnerable
Swainsona sericea	Vulnerable
Thesium australe	Vulnerable
Diuris pedunculata	Endangered
Chiloglottis platyptera	Vulnerable
Diuris tricolor	Vulnerable
Pterostylis cobarensis	Vulnerable
Acacia acrionastes	Endangered
Acacia atrox	Endangered
Acacia jucunda	Endangered
Acacia pubifolia	Endangered
Acalypha eremorum	Endangered
Almaleea cambagei	Endangered
Asterolasia sp. 'Dungowan Creek'	Endangered
Astrotricha roddii	Endangered

Species[a]	Status
Boronia boliviensis	Endangered
Boronia ruppii	Endangered
Capparis canescens	Endangered
Grevillea beadleana	Endangered
Hakea pulvinifera	Endangered
Hibbertia tenuifolia	Endangered
Homoranthus binghiensis	Endangered
Homoranthus croftianus	Endangered
Leucopogon confertus	Endangered
Micromyrtus grandis	Endangered
Phebalium glandulosum subsp. eglandulosum	Endangered
Pimelea venosa	Endangered
Pomaderris queenslandica	Endangered
Prostanthera staurophylla sensu stricto	Endangered
Zieria ingramii	Endangered
Euphrasia ruptura	Presumed extinct
Acacia macnuttiana	Vulnerable
Acacia pycnostachya	Vulnerable
Bertya opponens	Vulnerable
Boronia granitica	Vulnerable
Grevillea scortechinii subsp. sarmentosa	Vulnerable
Haloragis exalata subsp. velutina	Vulnerable
Homoranthus lunatus	Vulnerable
Homoranthus prolixus	Vulnerable
Melaleuca groveana	Vulnerable
Prostanthera cryptandroides subsp. cryptandroides	Vulnerable
Rulingia procumbens	Vulnerable
Tasmannia purpurascens	Vulnerable
Angophora exul	Endangered
Eucalyptus camphora subsp. relicta	Endangered
Eucalyptus magnificata	Endangered
Eucalyptus scoparia	Endangered
Syzygium paniculatum	Endangered
Cadellia pentastylis	Vulnerable

Species[a]	Status
Eucalyptus boliviana	Vulnerable
Eucalyptus caleyi subsp. ovendenii	Vulnerable
Eucalyptus mckieana	Vulnerable
Eucalyptus nicholii	Vulnerable
Eucalyptus oresbia	Vulnerable
Eucalyptus rubida subsp. barbigerorum	Vulnerable

[a]Although examples of individual species are listed, bioregional assessments consider the potential impact to the habitat of species not individual species per se.
Data: NSW *Threatened Species Conservation Act 1995*

Table 13 Threatened ecological communities of the Namoi and Border Rivers-Gwydir catchment management authorities listed under NSW *Threatened Species Conservation Act 1995*

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

Community	Status
Marsh Club-rush sedgeland in the Darling Riverine Plains Bioregion	Critically endangered ecological community
New England Peppermint (*Eucalyptus nova-anglica*) Woodland on Basalts and Sediments in the New England Tableland Bioregion	Critically endangered ecological community
Artesian Springs Ecological Community	Endangered ecological community
Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions	Endangered ecological community
Cadellia pentastylis (Ooline) community in the Nandewar and Brigalow Belt South Bioregions	Endangered ecological community
Carbeen Open Forest Community in the Darling Riverine Plains and Brigalow Belt South Bioregions	Endangered ecological community
Carex Sedgeland of the New England Tableland, Nandewar, Brigalow Belt South and NSW North Coast Bioregions	Endangered ecological community
Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregion	Endangered ecological community
Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions	Endangered ecological community
Howell Shrublands in the New England Tableland and Nandewar Bioregions	Endangered ecological community
Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions	Endangered ecological community
McKies Stringybark/Blackbutt Open Forest in the Nandewar and New England Tableland Bioregions	Endangered ecological community
Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions	Endangered ecological community
Native Vegetation on Cracking Clay Soils of the Liverpool Plains	Endangered ecological community

Community	Status
Ribbon Gum-Mountain Gum-Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion	Endangered ecological community
Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions	Endangered ecological community
Upland Wetlands of the Drainage Divide of the New England Tableland Bioregion	Endangered ecological community
White Box Yellow Box Blakely's Red Gum Woodland	Endangered ecological community

Data: NSW *Threatened Species Conservation Act 1995*

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1.3.3 Economic assets

Summary

The water-dependent asset register for the Namoi subregion has 168 economic water-dependent assets comprising 10,497 elements. There are 88 economic assets in the 'Surface water management zone or area' economic asset subgroup comprised of 1516 surface water access entitlements and 80 economic assets in the 'Groundwater management zone or area' economic asset subgroup comprised of 8981 groundwater access entitlements.

1.3.3.1 Description

The total number of economic water-dependent assets in the preliminary assessment extent (PAE) of the Namoi subregion is 168 (comprising 10,497 elements). This includes 1516 surface water access entitlements and 8981 groundwater access entitlements with total share components of 632,077 and 420,690 ML/year respectively. Share components are a specified share or volume of water that can be extracted within a specified water management area. Total share components include basic landholder rights described in water sharing plans (WSPs) (NSW Department of Primary Industries, 2014). These data indicate a much stronger reliance on surface water than on groundwater in the PAE of the Namoi subregion.

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 Office of Water, 2013)
- NSW Water Sharing Plans (NSW Department of Primary Industries, 2014).

Within the asset database, every water access right and basic water right (stock and domestic) is an element and elements are grouped by type and spatial location to create assets (see Section 1.3.1.2).

Water access entitlements for surface water and groundwater include basic landholder rights described in the WSPs which are also classed as 'Basic water right (stock and domestic)'. Table 14 and Table 15 show the breakdown of water access entitlements (economic elements) for surface water and groundwater in the PAE of the Namoi subregion.

Further economic assets were identified during the Gunnedah workshop, these included (i) water access rights that do not require a works approval and therefore do not include a specific location and (ii) surface water storages used for floodplain harvesting. Water access rights that do not require a works approval have been included in the water-dependent asset register by assigning the water access right to the water source polygon. Water access rights without corresponding work approvals were identified as follows:

- one water access right (166 ML/year) without a corresponding work approval located in the Upper Namoi Zone 4 Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source

- sixty-eight water access rights (93,450 ML/year) without corresponding work approvals located in the Gwydir Regulated River Water Source (93,450 ML/year). These sixty-eight water access rights have been amalgamated to one element and one asset
- thirty-five water access rights (6,409 ML/year) without corresponding work approvals located in the Lower Namoi Regulated River Water Source. These thirty-five water access rights have been amalgamated to one element and one asset.

Floodplain harvesting water storages are in the process of being digitised by the NSW Office of Water and were not available for inclusion in the water-dependent asset register at this time. There are 88 economic surface water assets and 80 economic groundwater assets within the PAE of the Namoi subregion. Table 14 shows the number of elements and assets for each category of economic asset within the Namoi water-dependent asset register. The locations of the elements are shown in Figure 8 and Figure 9 and the locations of the assets (i.e. the grouped elements) are shown in Figure 10 and Figure 11. Where known, groundwater bore depth is recorded in the asset database. The median bore depth is 36 m, with a maximum of 1200 m, so most water bores tap shallow alluvial groundwater systems (less than 150 m). The PAE of the Namoi subregion is covered by eight groundwater management units (hydraulically connected groundwater systems defined and recognised by state and territory agencies; often included in legislation). These groundwater management units and their water sharing plans are discussed in Section 1.1.4.3 (Groundwater regulation and management) in companion product 1.1 for the Namoi subregion (Welsh et al., 2014).

Table 14 Classification of economic elements to create economic assets in the Namoi asset database

Subgroup	Class	Number of elements	Number of assets
Groundwater management zone or area (surface area)	A groundwater feature used for water supply	0	0
	Water supply and monitoring infrastructure	0	0
	Water access right	1,937	26
	Basic water right (stock and domestic)	7,044	54
	Groundwater total	**8,981**	**80**
Surface water management zone or area (surface area)	A surface water feature used for water supply	0	0
	Water supply and monitoring infrastructure	0	0
	Water access right	1,459	35
	Basic water right (stock and domestic)	57	53
	Surface water total	**1,516**	**88**
Total		**10,497**	**168**

Data[a]: Bioregional Assessment Programme (Dataset 2, Dataset 5), NSW Office of Water (Dataset 4, Dataset 3), Bureau of Meteorology (Dataset 6)

[a]The asset database (Bioregional Assessment Programme, Dataset 1) is a collation of all these source datasets.

Table 15 Total share components for groundwater and surface water access entitlements

Subgroup	Total share component (ML/y)	Total share component (ML/y)
Groundwater management zone or area (surface area)	420,690	420,690
Surface water management zone or area (surface area)	632,077	632,077
Total	**1,052,767**	**1,052,767**

Data[a]: Bioregional Assessment Programme (Dataset 2, Dataset 5), NSW Office of Water (Dataset 4, Dataset 3), Bureau of Meteorology (Dataset 6)

[a]The asset database (Bioregional Assessment Programme, Dataset 1) is a collation of all these source datasets.

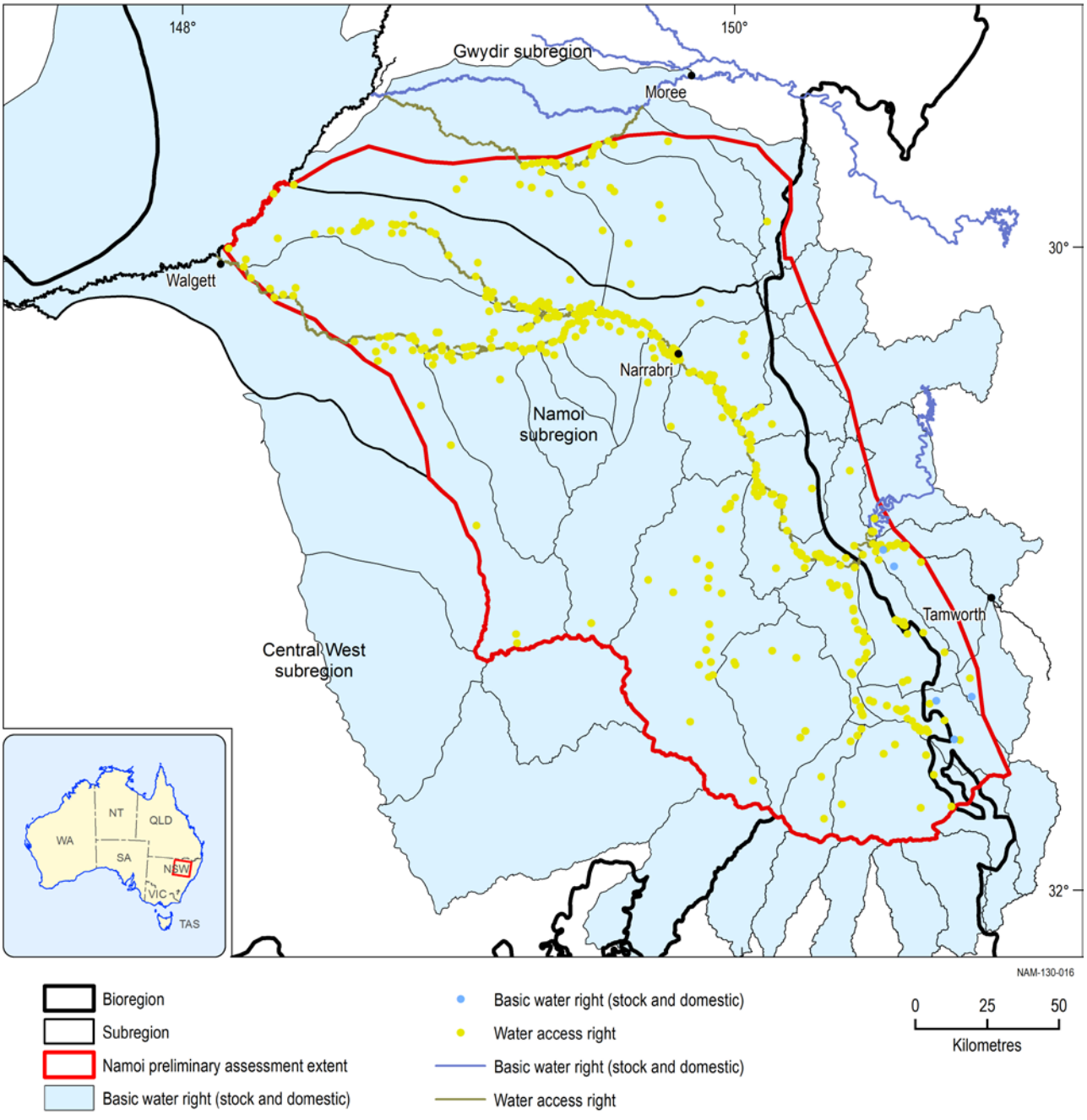

Figure 8 Location of surface water elements in the preliminary assessment extent of the Namoi subregion

Data: Bioregional Assessment Programme (Dataset 1, Dataset 2), NSW Office of Water (Dataset 3, Dataset 4)

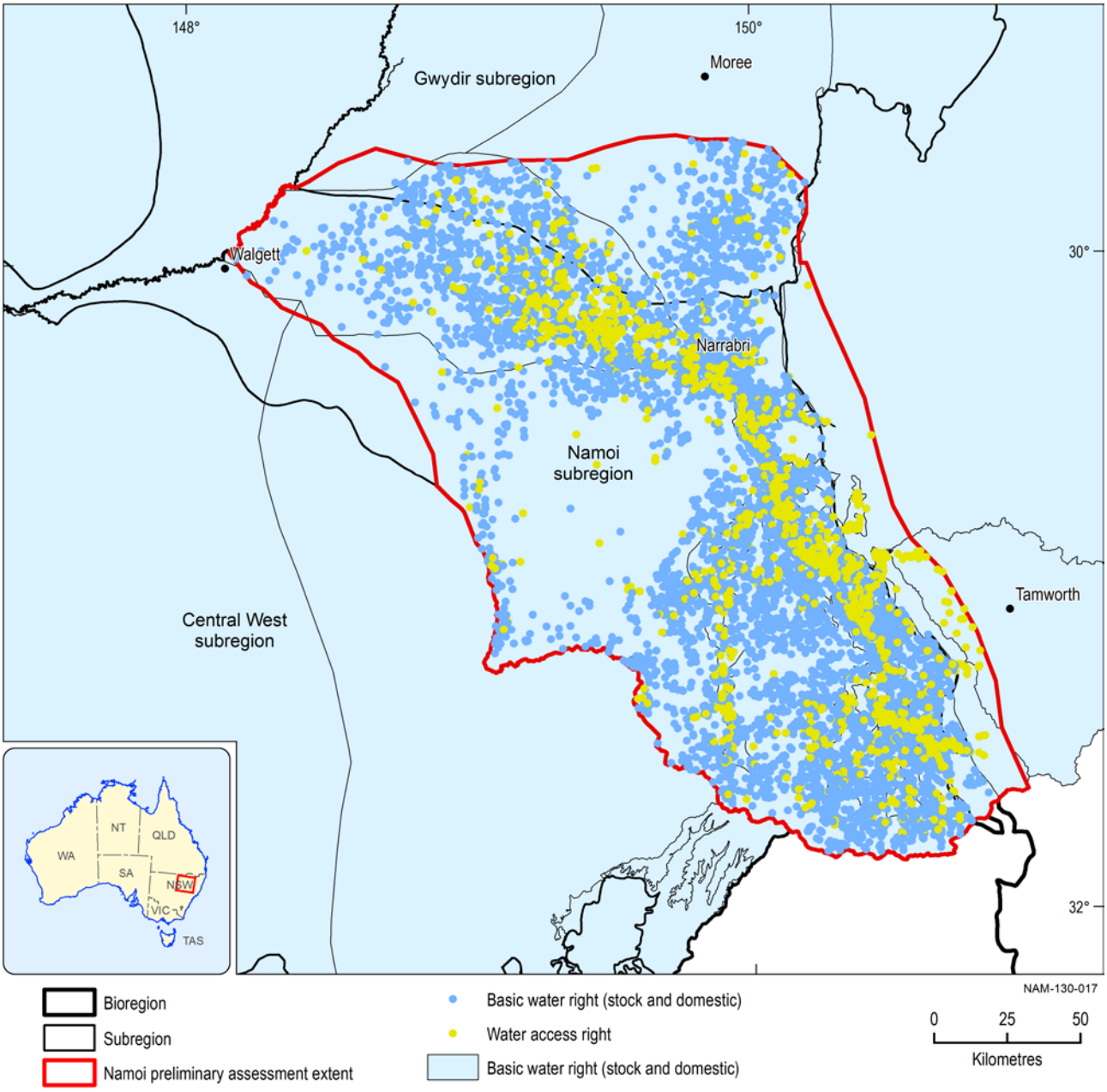

Figure 9 Location of groundwater elements in the preliminary assessment extent of the Namoi subregion

Data: Bioregional Assessment Programme (Dataset 1, Dataset 5), NSW Office of Water (Dataset 4), Bureau of Meteorology (Dataset 6)

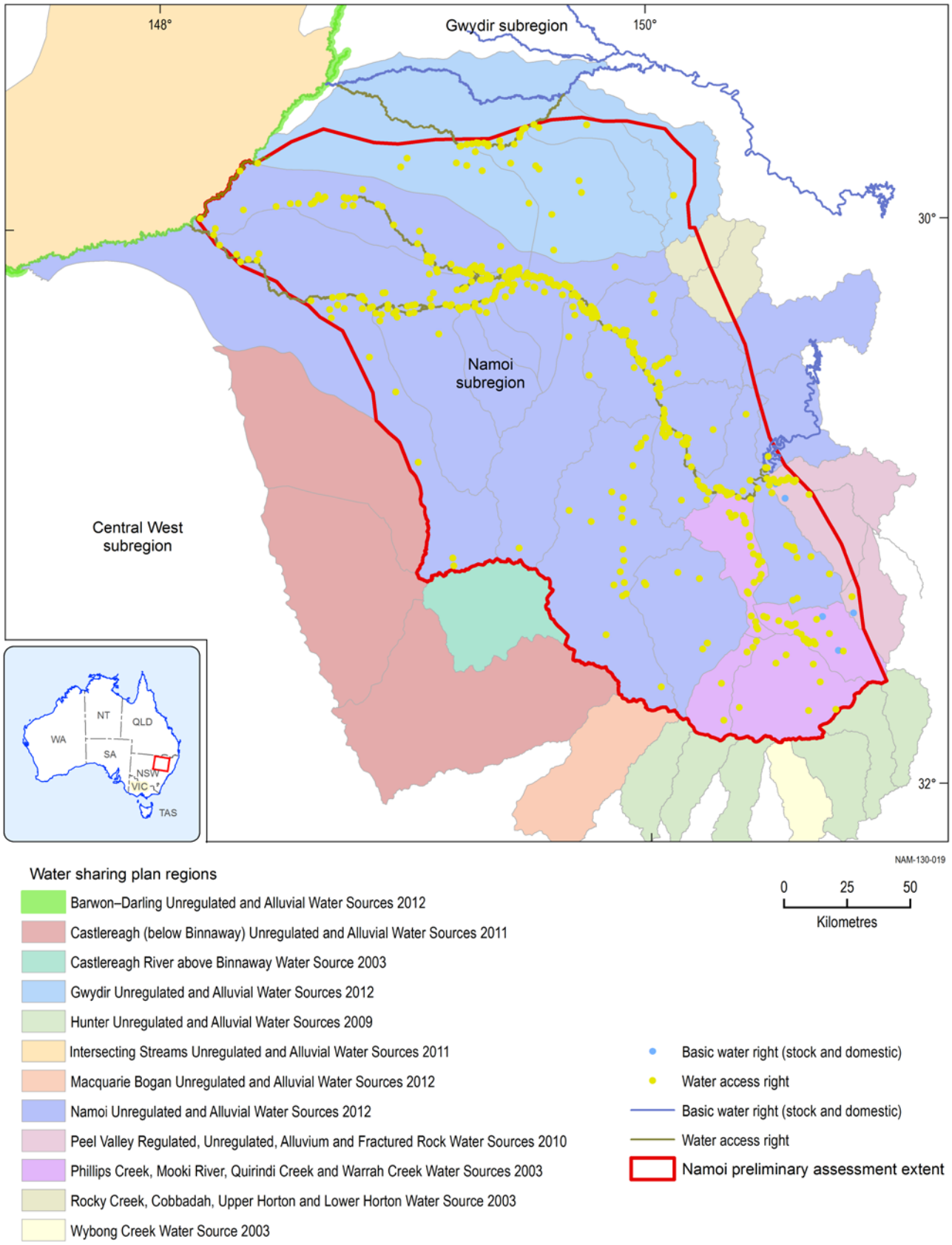

Figure 10 Location of surface water access right and basic water right assets in the preliminary assessment extent of the Namoi subregion

Data: Bioregional Assessment Programme (Dataset 1, Dataset 2, Dataset 5), NSW Office of Water (Dataset 3, Dataset 4)

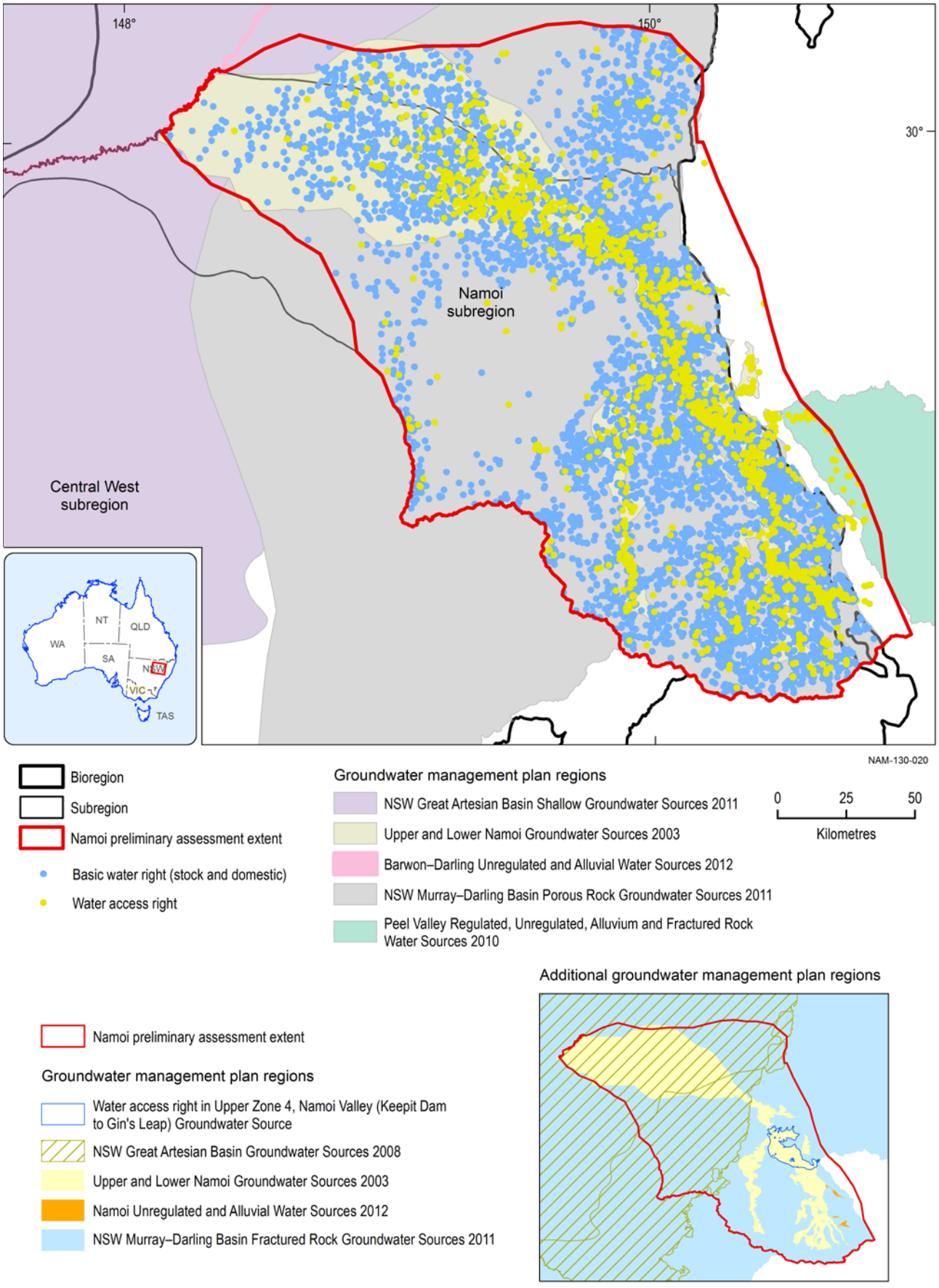

Figure 11 Location of groundwater water access right and basic water right assets in the preliminary assessment extent of the Namoi subregion

Data: Bioregional Assessment Programme (Dataset 1, Dataset 5), NSW Office of Water (Dataset 4), Bureau of Meteorology (Dataset 6)

1.3.3.2 Gaps

Data for surface water and groundwater entitlements in the far east of the PAE (outside the bioregion assessment boundary, but within the PAE) was extracted from NSW Office of Water at a later time. This is because the original dataset did not include this area. Groundwater entitlements were extracted from the NSW Office of Water licensing system in May 2014. Surface water entitlements were extracted from the NSW Office of Water licensing system in November 2014. Original extracts from NSW Office of Water licensing system were obtained in November 2013. The Namoi region is a fully capped groundwater and surface water system so therefore the total number/ volume of entitlements is not expected to be significantly different, with the changes immaterial. Therefore, it is not expected to be an issue that extracts from the Water licensing system have been taken at different dates.

Further economic assets were identified during the Gunnedah workshop including surface water storages used for floodplain harvesting. Floodplain harvesting water storages are in the process of being digitised by the NSW Office of Water and were not available for inclusion in the water-dependent asset register at this time. The data in the *Surface Water Access Entitlements* received from the NSW Office of Water do not include details of the river reach where the offtake was located; instead data included the Water Source and Water Management Zone that are 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 licences are grouped together across the water source which is 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

Forty-one sociocultural assets were sourced from the Australian Heritage Database, including 31 classed as heritage sites and ten classed as Indigenous sites. Twenty two of the heritage site assets and eight of the indigenous site assets are considered to be water dependent based on the presence of floodplain and wetland areas within their spatial extent. None of the assets provided by the former Namoi Catchment Management Authority are classified as sociocultural. The Namoi Asset workshop held in July 2014 did not identify additional sociocultural assets.

Meetings have been held with Indigenous knowledge holders in the Namoi subregion to gain further understanding of Indigenous cultural water-dependent assets.

1.3.4.1 Description

Forty-one sociocultural assets were sourced from the Australian Heritage Database (Department of the Environment, 2013): 40 from the Register of the National Estate (Australian Government of the Environment, Dataset 1) and one from the National Heritage List (Australian Government of the Environment, Dataset 2). There were no sociocultural assets in the Namoi subregion that were sourced from the NSW Aboriginal Heritage Information Management System (Environment and Heritage, 2013). Thirty-one heritage and ten Indigenous assets were included in the asset database. Of the 31 heritage assets, 22 are considered water dependent, including 14 that are located within the maximum flood extent and eight assets that are assumed to contain water-dependent features.

Ten Indigenous sociocultural assets were sourced from existing Commonwealth heritage databases (Australian Government Department of the Environment, Dataset 1) and are included in the asset list. Eight of the Indigenous assets are considered to be water dependent based on the presence of floodplain and wetland areas within their spatial extent.

1.3.4.2 Gaps

The Namoi Asset workshop held in July 2014 did not identify additional sociocultural assets. For bioregional assessment purposes, no specific gaps in the knowledge base related to sociocultural assets in the Namoi subregion have been identified.

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

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