



Australian Government



BIOREGIONAL
ASSESSMENTS

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

Coal and coal seam gas resource assessment for the Central West subregion

Product 1.2 for the Central West subregion from the
Northern Inland Catchments Bioregional Assessment

30 October 2014



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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Authorship is listed in relative order of contribution.

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Cover photograph

Macquarie Marshes, on the north-western end, between Carinda and Warren, NSW, 2009

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Bureau of Meteorology
Geoscience Australia



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Contributors to the Technical Programme

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

Assistant Secretary	Department of the Environment: Gayle Milnes
Programme Director	Department of the Environment: Edwina Johnson
Technical Programme Director	Bureau of Meteorology: Bronwyn Ray
Projects Director	CSIRO: David Post
Principal Science Advisor	Department of the Environment: Peter Baker
Science Directors	CSIRO: Brent Henderson Geoscience Australia: Trevor Dhu
Integration Lead	Bureau of Meteorology: Richard Mount
Programme management	Bureau of Meteorology: Graham Hawke, Louise Minty CSIRO: Paul Hardisty, Warwick McDonald Geoscience Australia: Stuart Minchin
Project Leaders	CSIRO: Tim McVicar, David Rassam, Wendy Welsh Geoscience Australia: Hashim Carey, Kriton Glenn
Assets and receptors	Bureau of Meteorology: <u>Richard Mount</u> Department of the Environment: Rachel Carter, Larry Guo, Brad Moore, Jin Wang Geoscience Australia: Joe Bell
Bioregional Assessment Information Platform	Bureau of Meteorology: <u>Brian Cannell</u> , Trevor Christie-Taylor, Mark Hatcher CSIRO: <u>David Lemon</u> Department of the Environment: Geraldine Cusack Geoscience Australia: <u>Neal Evans</u>
Communications	Bureau of Meteorology: Mel Martin CSIRO: Tsuey Cham, Leane Regan Department of the Environment: Sophie Alexander, Milica Milanja, Kirsty Rolls Geoscience Australia: David Beard, Chris Thompson

Coordination	<p>Bureau of Meteorology: Julie Burke, Sarah van Rooyen</p> <p>CSIRO: Ruth Palmer</p> <p>Department of the Environment: James Hill, Sunita Johar, Broni McMaster, Carolyn Paris, Craig Watson</p> <p>Geoscience Australia: Tenai Luttrell</p>
Ecology	<p>CSIRO: Tanya Doody, Brendan Ebner, <u>Alexander Herr</u>, Kate Holland, Craig MacFarlane, Tracey May, Patrick Mitchell, Justine Murray, Anthony O'Grady, Chris Pavey, Jodie Pritchard, Nat Raisbeck-Brown, Ashley Sparrow, Georg Wiehl</p>
Geology	<p>CSIRO: Deepak Adhikary, Luke Connell, Emanuelle Frery, Jane Hodgkinson, James Kear, Zhejun Pan, Kaydy Pinetown, Matthias Raiber, Hayley Rohead-O'Brien, Regina Sander, Peter Schaub, Garth Warren, Paul Wilkes, Andrew Wilkins, Yanhua Zhang</p> <p>Geoscience Australia: Tim Evans, <u>Steven Lewis</u>, John Magee, Martin Smith</p>
Geography	<p>Bureau of Meteorology: Natasha Herron</p>
Geographic information systems	<p>CSIRO: Caroline Bruce, Jody Bruce, Malcolm Hodgen, Steve Marvanek</p> <p>Geoscience Australia: Gerard Stewart, Kirsten Walker</p>
Groundwater modelling	<p>CSIRO: Olga Barron, <u>Russell Crosbie</u>, Tao Cui, Warrick Dawes, Lei Gao, Sreekanth Janardhanan, Luk Peeters, Praveen Kumar Rachakonda, Wolfgang Schmid, Saeed Torkzaban, Chris Turnadge, Binzhong Zhou</p> <p>Geoscience Australia: Wenping Jiang</p>
Hydrogeology	<p>CSIRO: Konrad Miotlinski</p> <p>Geoscience Australia: Rebecca Cassel, <u>Jim Kellett</u>, Sarah Marshall, Rebecca Norman, Jessica Northey, Tim Ransley, Martin Smith, Baskaran Sundaram, KokPiang Tan, Luke Wallace, Gabrielle Yates</p>
Information management	<p>Bureau of Meteorology: Belinda Allison, Jill McNamara, <u>Brendan Moran</u></p> <p>CSIRO: Nick Car, Phil Davies, Andrew Freebairn, Mick Hartcher, Geoff Hodgson, Brad Lane, Ben Leighton, Trevor Pickett, Ramneek Singh, Matt Stenson, Garry Swan</p> <p>Geoscience Australia: Luke Caruana, Penny Kilgour, Matti Peljo</p>
Products	<p>CSIRO: Maryam Ahmad, Daniel Aramini, Heinz Buettikofer, Simon Gallant, Karin Hosking, Frances Marston, Linda Merrin, <u>Becky Schmidt</u>, Sally Tetreault-Campbell, Catherine Ticehurst</p> <p>Geoscience Australia: Veronika Galinec, Daniel Rawson</p>
Risk and uncertainty	<p>CSIRO: <u>Simon Barry</u>, Jeffery Dambacher, Jess Ford, Keith Hayes, Geoff Hosack, Yang Liu, Warren Jin, Dan Pagendam, Carmel Pollino</p>
Surface water hydrology	<p>CSIRO: Santosh Aryal, Mat Gilfedder, Fazlul Karim, Lingtao Li, Dave McJannet, Jorge Pena Arancibia, Xiaogang Shi, Tom Van Niel, <u>Neil Viney</u>, Bill Wang, Ang Yang, Yongqiang Zhang</p>

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This technical product was reviewed by several groups:

- Discipline Leaders: Steven Lewis (geology, Geoscience Australia), Becky Schmidt (Products Manager, CSIRO)
- Senior Science Leaders: David Post (Projects Director, CSIRO), Trevor Dhu (Science Director, Geoscience Australia), Brent Henderson (Science Director, CSIRO)
- Technical Assurance Reference Group: Chaired by Peter Baker (Principal Science Advisor, Department of the Environment), this group comprises officials from the NSW, Queensland, South Australian and Victorian governments
- Additional reviewers: Maryam Ahmad (products, CSIRO), Heinz Buettikofer (products, CSIRO). Glencore provided feedback when contacted to check the accuracy of our descriptions of their operations.

Introduction

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

Bioregional assessments (BAs) are one of the key mechanisms to assist the IESC in developing this advice so that it is based on best available science and independent expert knowledge.

Importantly, technical products from BAs are also expected to be made available to the public, providing the opportunity for all other interested parties, including government regulators, industry, community and the general public, to draw from a single set of accessible information. A BA is a scientific analysis, providing a baseline level of information on the ecology, hydrology, geology and hydrogeology of a bioregion with explicit assessment of the potential direct, indirect and cumulative impacts of CSG and coal mining development on water resources.

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

The Bioregional Assessment Programme

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

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

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

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

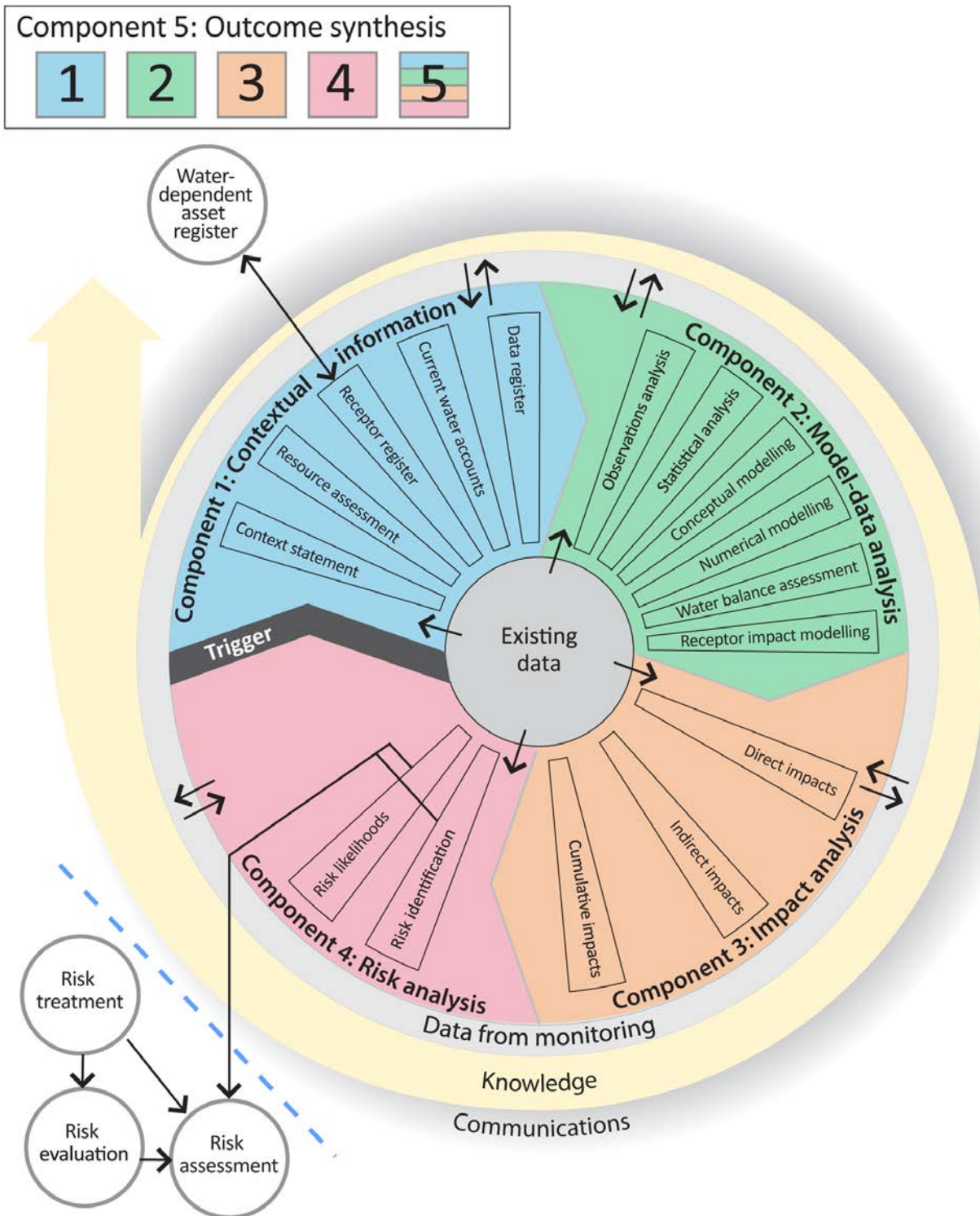


Figure 1 Schematic diagram of the bioregional assessment methodology

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

Methodologies

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

Table 1 Methodologies and associated technical products listed in Table 2

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

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

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

Technical products

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

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

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

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

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

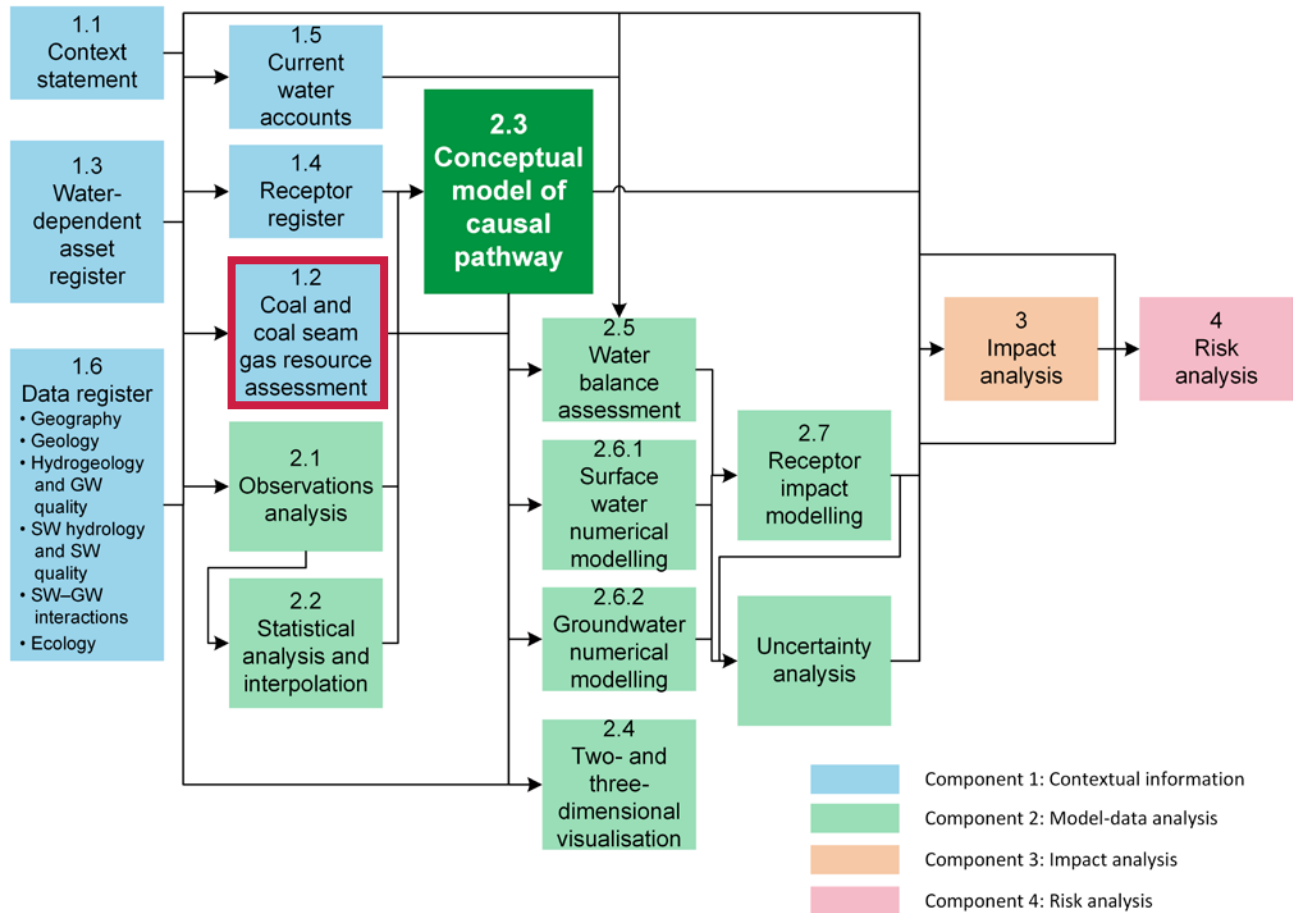


Figure 2 The simple decision tree indicates the flow of information through a bioregional assessment

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

About this technical product

The following notes are relevant only for this technical product.

- All reasonable efforts were made to provide all material under a Creative Commons Attribution 3.0 Australia Licence.
- All maps created as part of this BA for inclusion in this product used the Albers equal area projection with a central meridian of 151.0° East for the Northern Inland Catchments bioregion and two standard parallels of -18.0° and -36.0°.

Table 2 Technical products being delivered as part of the Northern Inland Catchments Bioregional Assessment

For each subregion in the Northern Inland Catchments Bioregional Assessment, technical products will be delivered as data, summaries and reports (PDFs) as indicated by ■ in the last column of Table 2. The red rectangle indicates the information covered in this technical product. A suite of other technical and communication products – such as maps, registers and factsheets – will also be developed through the bioregional assessments.

Component	Product code	Information	Section in the BA methodology ^a	Report
Component 1: Contextual information for the Central West subregion	1.1	Context statement	2.5.1.1, 3.2	■
	1.2	Coal and coal seam gas resource assessment	2.5.1.2, 3.3	■
	1.3	Description of the water-dependent asset register	2.5.1.3, 3.4	■
	1.4	Description of the receptor register	2.5.1.4, 3.5	■
	1.5	Current water accounts and water quality	2.5.1.5	■
	1.6	Data register	2.5.1.6	
Component 2: Model-data analysis for the Central West subregion	2.1-2.2	Observations analysis, statistical analysis and interpolation	2.5.2.1, 2.5.2.2	■
	2.3	Conceptual modelling	2.5.2.3, 4.3	■
	2.4	Two- and three-dimensional representations	4.2	b
	2.5	Water balance assessment	2.5.2.4	■
	2.6.1	Surface water numerical modelling	4.4	■
	2.6.2	Groundwater numerical modelling	4.4	■
	2.7	Receptor impact modelling	2.5.2.6, 4.5	■
Component 3: Impact analysis for the Central West subregion	3	Impact analysis	5.2.1	■
Component 4: Risk analysis for the Central West subregion	4	Risk analysis	2.5.4, 5.3	■
Component 5: Outcome synthesis for the Northern Inland Catchments bioregion	5	Outcome synthesis	2.5.5	■

^aBarrett et al. (2013)

^bThe two- and three-dimensional representations will be delivered in products such as 2.3, 2.6.1 and 2.6.2.

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 30 October 2014, <<http://www.environment.gov.au/coal-seam-gas-mining/pubs/methodology-bioregional-assessments.pdf>>.



1.2 Coal and coal seam gas resource assessment for the Central West subregion

The coal and coal seam gas resource assessment summarises the known coal and coal seam gas resources, and developments both now and potentially in the future. The following data and information are presented:

- the geology and spatial distribution of known coal resources
- the baseline of current coal and coal seam gas extraction
- exploration and mining tenements
- proposed future developments (both new developments and expansion or closure of existing developments), including details of location, timing, methods and extraction volumes as determined from proposed development plans.

This information will be used to develop the coal resource development pathway (as reported in product 2.3), which articulates the most likely combination of developments at a subregion or bioregion scale, including all individual coal and coal seam gas resource projects that are expected.



1.2.1 Available coal and coal seam gas resources

Summary

Coals of the Sydney, Gunnedah and Surat geological basins occur within the Central West subregion, although coal is currently only mined in the northernmost extent of the Western Coalfield of the Sydney Basin. Multiple coal seams occur within the Illawarra Coal Measures and at the Ulan Coal site where there are ten seams. The Ulan Coal is one of the main coal sequences mined in the northern area of the Sydney Basin and has a total thickness of up to 14 m.

Areas west of the Rocky Glen Ridge are largely unexplored for coal. The structural units of the Gunnedah Basin in the subregion include the Oxley sub-basin, the Gilgandra Trough and the western edge of the Mullaley sub-basin. The Cobbora coal deposit is primarily in a sinuous syncline that has proven challenging to correlate between the Western Coalfield of the Sydney Basin and the Gunnedah Basin. In the Cobbora area the Upper Permian strata contain five potentially mineable coal seams.

Exploration for coal seam gas (CSG) in the Gunnedah Basin in the Central West subregion identified the Late Permian coals of the Black Jack Group as a potential resource, particularly the Hoskissons Coal. However, the coal seams were found to be either severely undersaturated with total gas content generally below 1 m³/t, or with maximum gas content of 4 to 5 m³/t but with high levels of CO₂ making them unattractive for commercial CSG extraction. The Early Permian Maules Creek Formation, which is the primary target for CSG recovery in the Namoi subregion, is either not present in this part of the Gunnedah Basin or only poorly developed.

Limited coal development in the Coonamble Embayment of the Surat Basin means this area has not been extensively explored for CSG. A single exploration well has been drilled to assess the CSG potential of the Cretaceous Rolling Downs Group of the southern Surat Basin in the north-western part of the Central West subregion. Individual coal seams were up to 1.58 m thick (net thickness 6.92 m), but the gas content was not measured.

The Sydney Basin has not been a target for CSG exploration in the subregion to date.

1.2.1.1 Coal

1.2.1.1.1 Sydney Basin

Only coals of the northernmost extent of the Western Coalfield of the Sydney Basin are currently being mined in the Central West subregion, as discussed in Sections 1.2.2 to 1.2.4. The main mined coal horizons in the Western Coalfield are within the Cullen Bullen and the Charbon subgroups of the Illawarra Coal Measures (Bayly, 2012, p. 3), which are of Permian age (see Figure 21 in companion product 1.1 for the Central West subregion (Welsh et al., 2014)). These are overlain by sedimentary formations of varying thickness, age and type including sandstone, shale and alluvium (Ulan Coal, 2014a). Other important coal seams, such as the Moolarben Coal Member, and Middle

River Coal Member and Katoomba Coal Member, are within overlying units such as the Farmers Creek Formation.

In the Bylong (Figure 3) area the Lithgow Coal comprises mainly dull coal with a raw ash yield of 20%. The seam rapidly thins west of Bylong (Yoo et al., 1995, p. 241). Similar to the rest of the coalfield the Lidsdale Coal persists in the Ulan (Figure 3) area, where it makes up the lower section of the Ulan Coal. It is around 7 m thick, and has a low ash yield (11 to 13%, air-dried) (Yoo et al., 2001, p. 89). In the north of the Western Coalfield the upper half of the Cullen Bullen Subgroup and the lower half of the Charbon Subgroup are referred to as the Ulan Coal (Yoo et al., 2001, p. 89). The upper section of the Ulan Coal in the same area has raw ash yields ranging from 11 to 45% (Yoo et al., 1995, p. 243) and is typically layered (Yoo et al., 2001, p. 89). The total thickness of the Ulan Coal is around 14 m in the Ulan area (Yoo et al., 2001, p. 89). Multiple coal seams occur within the Illawarra Coal Measures and ten are referred to by Ulan Coal Mines Limited at the Ulan coal site (Ulan Coal, 2014a). Of these, nine are situated in the west, the bottom-most of which is the seam commonly referred to by Ulan Coal Mines Limited as the 'Ulan Seam' (Ulan Coal, 2014a). The seams range in thickness from 0.4 to 10 m, with the Ulan Seam being the thickest (Ulan Coal, 2012, p. 23). The Ulan Seam thickness averages 5 to 7 m and dips towards the north-east at 1 to 2° (Ulan Coal, 2014b). The dip of the coal and changes in topography generally increase the depth of cover towards the north-east (Ulan Coal, 2014b), from 40 to 50 m at the Open-Cut extension area to 320 m at Ulan No. 3 underground mine (Ulan Coal, 2012, p. 24). Apart from the Ulan Seam, all seams within the Ulan mining leases are discussed in Sections 1.2.2 and 1.2.3 (Ulan Coal, 2014a). At the northernmost extent of the coalfield, in the Coolah-Turill area, the Lidsdale Coal, which has raw ash yield from 20 to 34%, is up to approximately 4 m thick and increases in depth and thickness towards the Liverpool Range (Figure 3) (Yoo et al., 1995, p. 243).

The Irondale Coal has economic potential in the Wolgan (Figure 3) area, where it is up to 2.4 m thick. It is a high-volatile, vitrain-rich, coking coal, although most of the resources are within the Wollemi National Park (Figure 3) (Yoo et al., 1995, p. 243). According to Yoo et al. (1995, p. 243) the Turill Coal Member is potentially mineable in the Turill-Cassilis area (Figure 3) (northern part of the coalfield) where it is up to 4 m thick at Cassilis. It commonly consists of bright bands and some stone bands and has raw ash of 23 to 45%. The Middle River and Katoomba coal members are economic towards the south of the coalfield, although outside of the Central West subregion (Yoo et al., 1995, p. 243).

The main coal horizons include the Lithgow Coal and the Lidsdale Coal within the Cullen Bullen Subgroup (southern area), the Ulan Coal (northern area), and the Irondale Coal stated by Yoo et al. (1995, p. 235) as being within the Charbon Subgroup, although the Australian Stratigraphic Units Database (ASUD, n.d.) does not formally deem this to be part of the Charbon Subgroup.

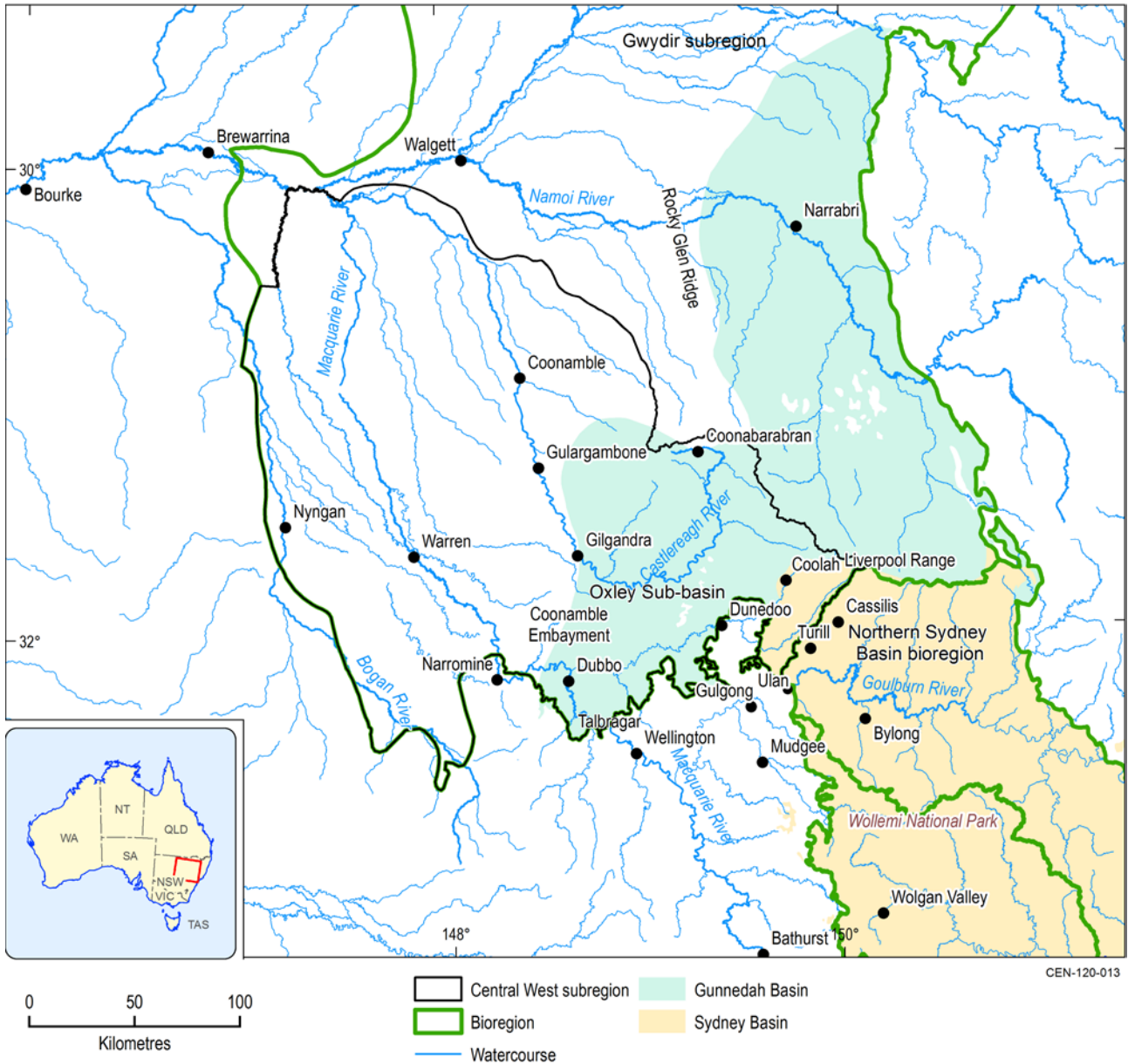


Figure 3 Geological features and geographic locations of and around the Central West subregion

1.2.1.1.2 Gunnedah Basin

The southernmost areas of the Gunnedah Basin (Figure 3), which fall within the Central West subregion, include the Oxley sub-basin (Figure 3), (O’Neill and Danis, 2013, p. 32), which is possibly synonymous with the Gilgandra sub-basin referred to by Yoo et al. (1995, p. 251), the Gilgandra Trough, referred to in EMM (2012, p. 4) and the western edge of the Mullaley sub-basin (see Figure 17 in companion product 1.1 for the Central West subregion (Welsh et al., 2014)). The Gilgandra Trough is separated from the Western Coalfield by Paleozoic rocks of the Rocky Glen Ridge (Figure 3), and the Dunedoo High to the north (EMM, 2012, p. 4). According to Yoo et al. (1995, p. 251) areas west of the Rocky Glen Ridge are largely unexplored for coal, although Permian rocks have been intersected in exploration drilling.

Apart from the Ulan Seam, the remaining strata of the Cobbora coal deposit has proven challenging to correlate between the Western Coalfield of the Sydney Basin and the Gunnedah Basin (Figure 3) (EMM, 2012, p. 22). The region contains pre-Permian metamorphic basement

rocks overlain by coal-bearing strata of Permian, Triassic and Jurassic age (AMM, 2012, p. 22). Over 500 holes have been drilled in the area since the late 1970s and recent exploration has identified that the Cobbora coal deposit is primarily in a sinuous syncline where the regional dip increases on its flanks and where sedimentary rocks lap unconformably onto underlying basement to the west (EMM, 2012, p. 23). The Upper Permian strata contain five potentially mineable coal seams, which in stratigraphic descending order are the Trinkey Formation (2 to 5 m thick), Whaka Coal Member (2 to 14 m thick), Flyblowers Creek Coal (3 to 5 m thick) and two split seams of the Ulan Coal (each 2 to 5 m thick), of which the main mining targets are the two Ulan seams and the Flyblowers Creek Coal, which have consistent distribution with shallow overburden (EMM, 2012, p. 24–25). The seams in the Trinkey Formation and Whaka Coal Member have higher ash content than the other seams (EMM, 2012, p. 23). Coal seams subcrop continuously in a north-west line to the west of Laheys Creek and crop out at several locations (EMM, 2012, p. 25).

1.2.1.1.3 Surat Basin

Overlying the western Gunnedah Basin in the Central West subregion are sedimentary deposits of the Coonamble Embayment (Figure 3), part of the southern Surat Basin. Little is known about the coal-bearing formations in the Coonamble Embayment, but Radke et al. (2012, p. 66, 122) mentioned that coal seams are rare, with only thin, uneconomic coals present in the Purlawaugh Formation (see Figure 20 in companion product 1.1 for the Central West subregion (Welsh et al., 2014)) and the Drilool beds.

1.2.1.2 Coal seam gas

CSG resources in the Gunnedah Basin in the Central West subregion are contained within the coal-bearing formations of the Oxley sub-basin (see Figure 3). Exploration for CSG has identified the Late Permian coals of the Black Jack Group, in particular the Hoskissons Coal, as a potential CSG target (see Figure 20 in companion product 1.1 for the Central West subregion (Welsh et al., 2014) for the stratigraphy of the Gunnedah Basin). The Early Permian Maules Creek Formation (see Figure 20 in companion product 1.1 for the Central West subregion (Welsh et al., 2014)), which is the primary target for Santos Ltd's Narrabri Gas Project in the Namoi subregion (see companion product 1.2 for the Namoi subregion (Northey et al., 2014)), is either not present in this part of the Gunnedah Basin or its geology is only poorly developed. Results from core wells indicate that the explored area of the Gunnedah Basin in the subregion is not currently prospective for commercial CSG extraction. The coal seams of the Black Jack Group were found to be either severely undersaturated with total gas content generally below 1 m³/t, or with maximum gas content of 4 to 5 m³/t but with high levels of CO₂ (ESG, 2007a, 2007b, 2010a, 2010b; Santos, 2008, 2009a, 2009b, 2009c, 2009d; Strike Oil, 2003a, 2003b).

Limited coal development in the Coonamble Embayment of the Surat Basin (see Figure 3) means that this area has not been extensively explored for CSG in the Central West subregion. Stewart and Alder (1995, p. 160) considered commercial oil or gas discoveries in the NSW part of the Surat Basin to be more prospective in northern NSW, and Ransley et al. (2012) noted that no commercial oil or gas discoveries have been made in the NSW part of the Surat Basin. A single exploration well has been drilled to assess the CSG potential of the Cretaceous Rolling Downs Group of the southern Surat Basin in the north-western part of the Central West subregion. It intersected a net coal thickness of 6.92 m (including inferior coals) with individual seam

thicknesses of 0.25 to 1.58 m. Coal was encountered to depths of 270 m. The gas content of the coals was not measured (Cydonia Resources, 2011).

The Sydney Basin, a small part of which occurs in the south-east of the Central West subregion (see Figure 3), has not been a target for CSG exploration in the subregion to date (as of October 2014). Four distinct zones of gas layering with depth have been identified in the Sydney Basin coal seams including: a CO₂ dominated zone; a biogenic, methane-rich zone; a CO₂ and methane (mixed) zone; and a methane-rich zone that is likely to be of thermogenic origin (Thomson et al., 2014). Although the shallower biogenic methane may prove a target for CSG production due to enhanced permeability in the coals, the highly variable CO₂ content (ranging from less than 10% to 90%) of the mixed gas zones may be problematic for commercial CSG recovery (Thomson et al., 2014). The deeper, thermogenic methane zone may have economic gas content and composition, but coal permeability may be very low in those areas (Thomson et al., 2014).

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1.2.2 Current activity and tenements

Summary

In the Central West subregion there is one mining operation currently extracting coal. Owned by Glencore plc, the Ulan Mine Complex is 1.5 km north of Ulan Village in the Western Coalfields of NSW. Mining has taken place in the Ulan area since the 1920s. Ulan Coal Mines Limited (UCML) currently holds several mining leases that intersect the Central West subregion. The Ulan Mine Complex has two approved underground mining operations (Ulan No. 3 and Ulan West) and one open-cut operation. The mining complex is at the western limit of the geological Sydney Basin at the southern end of the geological Gunnedah Basin. The complex currently operates 24 hours per day, seven days a week. Approximately 7.2 Mt of coal was extracted from the Ulan Mine Complex in 2013. Coal is of high quality with low sulfur, and most coal is sold as thermal coal in the export market with some also supplied to the domestic market for power generation.

No commercial coal seam gas (CSG) extraction is currently occurring in the Central West subregion. Any past or present CSG exploration activities are described in Section 1.2.3 – Proposals and exploration.

1.2.2.1 Coal

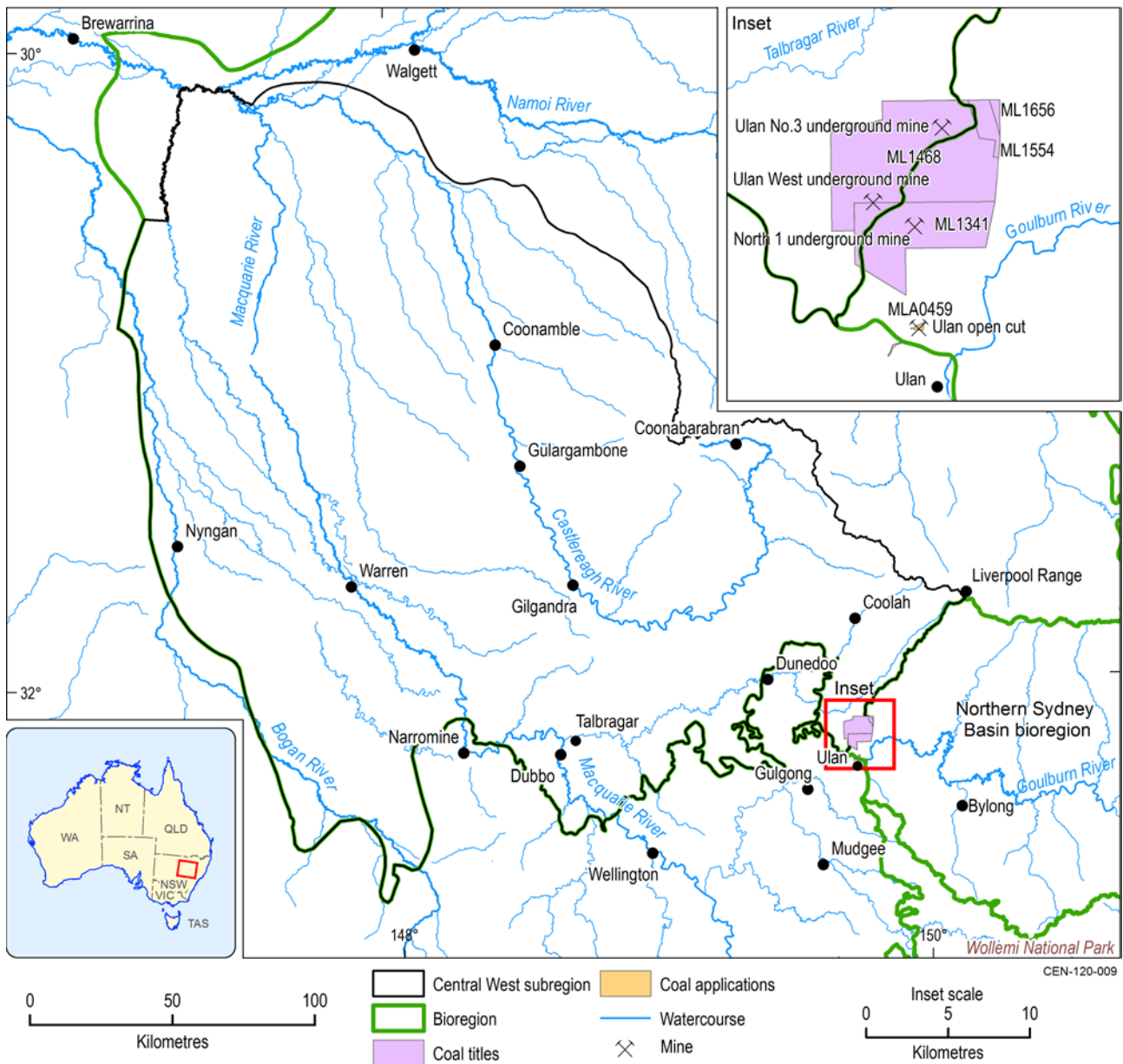


Figure 4 Central West subregion mining leases

Source data: MinView (NSW Department of Trade and Investment, 2013)
ML = mining lease

Ulan Coal Mines Limited

Part of the Ulan No. 3 mine site is outside of the Central West subregion, including the currently mined area. However, for the purposes of this report all of the Ulan Mining Complex is discussed, even though the subregion boundary runs through the mine complex (Figure 4).

UCML is a joint venture between Xstrata Coal Pty Limited (90%) and Mitsubishi Development (10%) (Umwelt, 2011). Xstrata Coal is wholly owned by Glencore. UCML operates the Ulan Mine Complex, in the Western Coalfields of NSW, approximately 38 km north-north-east of Mudgee (Figure 4) and 19 km north-east of Gulgong (Figure 4) (Umwelt, 2011, p. 1). Mining in the Ulan area

has taken place since the 1920s (Umwelt, 2011, p. 1) when Ulan No. 1 Colliery supplied coal to local markets for a short period and then from 1942 to 1950, supplying coal to a power station north of Ulan Village and to other local markets (Ulan Coal, 2013). The power station closed in 1969. Ulan No. 2 continued to supply coal from the underground mine to local markets and additional coal was extracted from an open-cut mine established in the 1980s. Ulan No. 3 commenced in 1986 both as underground and open pit mining (Ulan Coal, 2013).

The current lease areas are approximately 4 to 5 km north of Ulan Village although the mine's colliery holding boundary is approximately 1.5 km north of the village. Ulan Mine Complex covers approximately 17,959 ha and is at the headwaters of the Talbragar and Goulburn river catchments (Umwelt, 2011, p. 1; Ulan Coal, 2013). The NSW Department of Planning provided project approval (08_0184) in 2010 for coal production of up to 20 Mt/year over the next 21 years (Ulan Coal, 2013, Overview of operations). Production across the various pits at the Ulan Mine Complex equated to 7 Mt run-of-mine (ROM) coal (equating to 5.9 Mt of product coal) in 2012, 7.26 Mt ROM (6.24 Mt product coal) in 2013 and a projected 10.8 Mt ROM (10.6 Mt product coal) in 2014 (Glencore, 2014, p. 24). The majority of coal from the Ulan Mine Complex is sold to the thermal export market and some higher ash content coal is sold to the domestic market for power generation (Umwelt, 2011, p. 2.1).

UCML currently hold 13 mining and exploration leases for the Ulan Mine Complex situated partially within the Central West subregion (Umwelt, 2011, p. 4.1): four of the leases cover existing activity. Ulan Mine Complex has two approved underground mining operations (Ulan No. 3, currently in operation, and Ulan West, which commenced production of longwall coal in May 2014) and an open-cut operation (Umwelt, 2011, p. 2.1). The Ulan Mine Complex is at the western limit of the Sydney Basin (Figure 3) and the southern end of the Gunnedah Basin (Figure 3). At the complex, ten coal seams occur within the Permian Illawarra Coal Measures (see Figure 21 in companion product 1.1 for the Central West subregion (Welsh et al., 2014)), eight above the Ulan coal seam and one below. The seams range in thickness from 0.4 to 10 m, with Ulan coal seam being the thickest (Umwelt, 2011, p. 1.4). Only the lowest 3 m of the Ulan coal seam are removed from the underground mine due to its high quality and as a result, only approximately 30% of the coal requires washing (Ulan Coal, 2013). The water balance for the Ulan Mine Complex for 2012 reported that intercepted water sources including rainfall on dams and ponds was 384 ML and runoff from catchments was 1615 ML, although detail per mine/pit was not available (Xstrata Coal, 2013).

Ulan No. 3 underground mine

Mining at Ulan No. 3 is performed through longwall mining methods using continuous miners and shuttle car operation (Ulan Coal, 2013). Coal is moved by conveyor to the surface where the higher-ash coal is moved by truck and conveyor to the wash plant. Coal that does not require washing is crushed and prepared for transport offsite (Ulan Coal, 2013). When coal is ready for transport it is loaded at a dedicated loading facility for rail to both domestic markets and for export via the Port of Newcastle (Umwelt, 2011, p. 2.1). The complex currently operates 24 hours per day, seven days a week (Umwelt, 2011, p. 2.1), with onsite facilities including mine ventilation and power supply infrastructure, fuel storage and workshops, administration buildings, tailings emplacement areas, overland and underground conveyors, stockpiles, processing and sizing

stations, mine access, service boreholes, water management infrastructure, communications infrastructure, access roads and monitoring equipment (Umwelt, 2011, p. 2.1–2.2).

Coal is of high quality with low sulfur, nitrogen and phosphorous providing good handling and combustion properties (Ulan Coal, 2013). Most coal is sold as thermal coal in the export market but some higher-ash content coal is supplied to the domestic market for power generation (Umwelt, 2011, p. 1.6).

North 1 underground mine

The North 1 underground mine was identified in Ulan Coal Mines Continued Operations Project as a separate underground operation with longwall panels in an area that had not been previously mined, adjacent to (on the western edge of) an area that was mined in the early 1990s (Umwelt, 2011, p. 3.1). Since that time, this has now been largely mined and is considered to be part of the Ulan No. 3 underground mine area, and not a separate entity (B Anderson (Glencore), 2014, pers. comm.).

Ulan Open Cut operation

In December 2010, open-cut mining recommenced at the Ulan Mine Complex across 239 ha adjoining the previous open-cut mining area approved for highwall mining (Umwelt, 2013, p. 2.2). Access to the Ulan Open Cut extension is via an existing road off Ulan Road approximately 1 km north of the Cope Road junction (NSW Department of Planning, 2010, p. 9). Coal from the open-cut area is hauled by truck from the pit to a crushing facility onsite and then moved by conveyor to the coal handling and preparation plant (Ulan Coal, 2012, p. 57) before stockpiling and transporting offsite. Coal rejects are stockpiled onsite and used for backfilling (Ulan Coal, 2012, p. 59). Approximately 158 ha of vegetation may be disturbed during construction and mining of the Ulan Open Cut extension (Ulan Coal, 2012, p. 34). Topsoil will be used for other areas undergoing rehabilitation or will be stockpiled for future rehabilitation. Minimal soil handling will be performed to reduce soil structure degradation (Ulan Coal, 2013). Overburden is blasted to fracture and aid its removal by dragline or excavator and truck to expose the Ulan Seam (Ulan Coal, 2013). The coal is crushed and then transported by overland conveyor, stockpiled and then further transported by conveyor to the coal handling and preparation plant, which has been upgraded to allow 20 Mt/year of coal to be processed (NSW Department of Planning, 2010, p. 9). Coal is stockpiled before being transported by rail to the Port of Newcastle or to domestic customers as required (Ulan Coal, 2013).

Ulan West underground mine

Ulan West underground mine is expected to continue for another 21 years (NSW Department of Planning, 2010, p. 9). Approximately 126 Mt of coal from the Ulan Seam will be mined at Ulan West at depths of 80 to 225 m below surface (NSW Department of Planning, 2010, p. 9). Ulan West underground mine surface water management infrastructure includes water treatment facilities and piped services. Storage for potable water, mine wastewater, processing and fire water supply and other storage such as air, nitrogen and diesel have been developed along with a rail refuelling facility (Umwelt, 2011, p. 2.3, Ulan Coal, 2013).

1.2.2.2 Coal seam gas

As of August 2014 no commercial CSG extraction has occurred or is currently occurring in the Central West subregion. Any past or present CSG exploration activities are described in Section 1.2.3 – Proposals and exploration.

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1.2.2 Current activity and tenements

1.2.3 Proposals and exploration

Summary

In the Central West subregion, there are two mine plans and one potential exploration project, which are outlined below.

Ulan Coal Mines Limited (UCML) is owned by Glencore plc and the mining area overlies parts of several surface water catchments (detailed in Ulan Coal, 2012, p. 37). UCML has recently extended its mining activities within this complex as part of a 21-year conceptual development plan for the Ulan Mine Complex. Multiple mining operations exist within the site and at present, Ulan No.3 is planned to progress northwards for up to 18 years (NSW Department of Planning, 2010, p. 9). In addition to mining leases, Glencore owns Exploration Licences (ELs) 5573 and 7542 which are situated at Ulan No. 3 underground and Ulan West respectively.

The Cobbora Coal Project is a proposed open-cut coal mine that will supply thermal coal to NSW power stations in the Upper Hunter Valley and the Central Coast, in addition to coal being sold on the open market. The project application area covers about 27,400 ha (which was mostly previously cleared for agriculture) of which a potential disturbance area of up to 4,700 ha is expected (EMGA Mitchell McLennan, 2012, p. ES.5–6). Although it is not clear when construction is likely to commence, the mine is expected to take 2.5 years to construct and the projected life of the mine, following construction, is 21 years (EMGA Mitchell McLennan, 2012, p. ES.1, ES.6). The mine will produce up to 12 Mt/year of product coal with ash content varying between 25 and 45%. Coal blending will be performed to achieve suitable qualities for end users (EMGA Mitchell McLennan, 2012, p. 35).

Phoenix Vision Coal Pty Ltd own EL 7115 in the subregion (Southern Cross Exploration N.L., 2012, p. 4) but activities and intentions for this EL are presently unclear.

Exploration for coal seam gas (CSG) has predominantly occurred in the eastern part of the Central West subregion focusing on the geological Gunnedah Basin. Target coals are the Late Permian aged coals of the Black Jack Group, with the primary target the Hoskissons Coal. The Early Permian Maules Creek Formation is either not present in the eastern part of the Central West subregion or only poorly developed. Results from exploration core wells indicate that the explored area is not currently prospective for commercial CSG. A single exploration well has been drilled to assess the CSG potential of the Cretaceous Rolling Downs Group of the southern geological Surat Basin. The gas content of the coals was not measured.

Currently, Santos Ltd is the only holder of CSG exploration licences in the Central West subregion after acquiring Eastern Star Gas Limited in 2011.

Further CSG exploration and commercialisation in the Central West subregion needs to be consistent with NSW coal seam gas regulations and CSG exclusion zones that prohibit new CSG exploration and development in and around (within a 2 km buffer) existing residential areas.

1.2.3.1 Coal

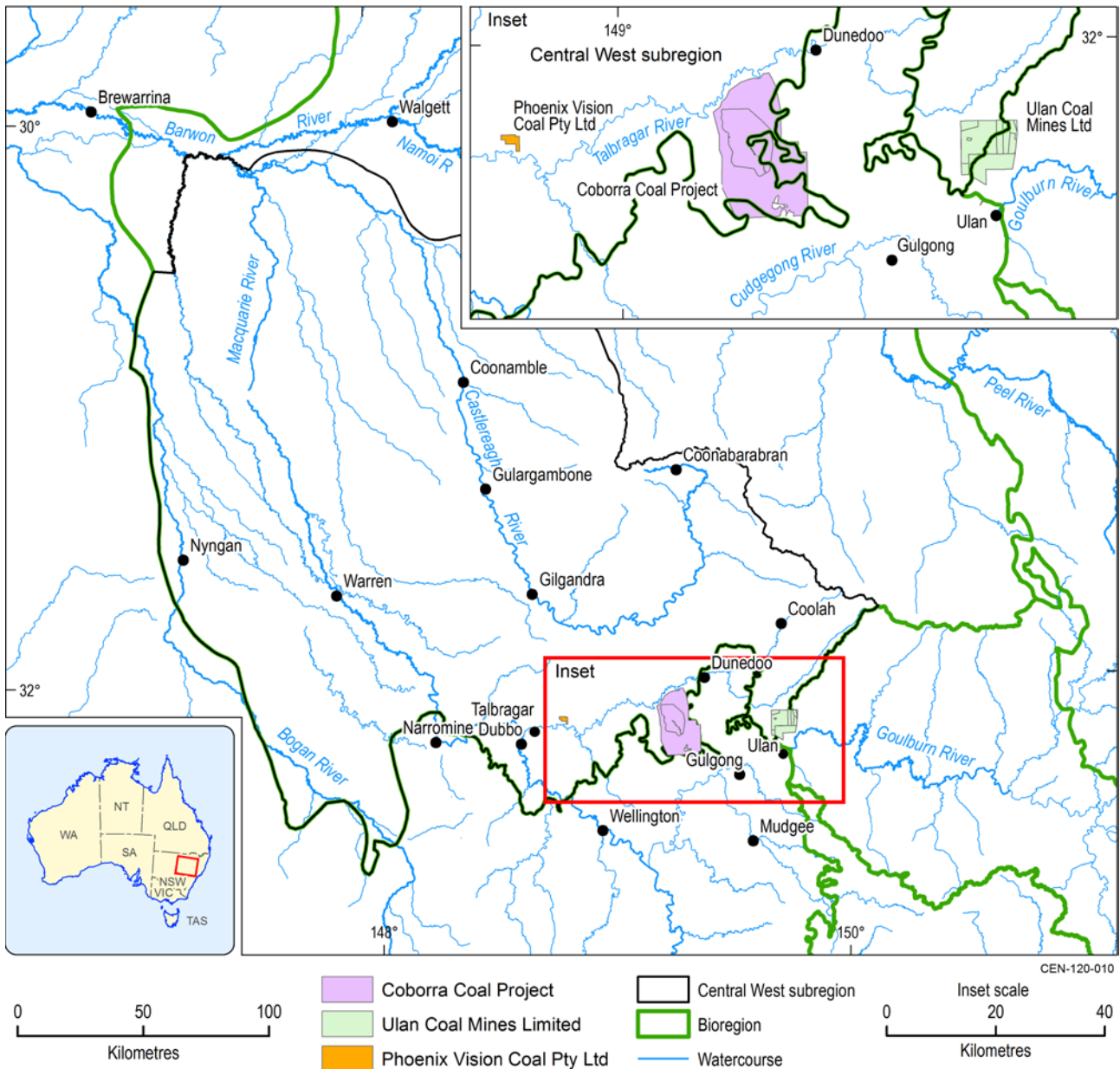


Figure 5 Central West subregion showing company exploration and mining leases and mining lease applications

Source data: NSW Department of Trade and Investment (2013)

1.2.3.1.1 Ulan Coal Mines Continued Operations Project

UCML, owned by Glencore, straddles the Great Dividing Range and includes parts of several catchments (detailed in Ulan Coal, 2012, p. 37) (Figure 5). UCML has extended its mining activities within this complex recently as part of a 21-year conceptual plan for the Ulan Mine Complex (Project Approval 08_0184 under Part 3A of the *Environmental Planning and Assessment Act 1979*) known as the Ulan Continued Operations Project (NSW Department of Planning, 2010, p. 2; Umwelt, 2011, p. 1). In addition to its mining leases, Glencore owns ELs 5573 and 7542 which are situated at Ulan No. 3 underground and Ulan West respectively. The mining complex has multiple operations all existing within the site and the recent ‘Continued Operations Project’ is now largely

operational. Previously a concrete batching plant was proposed and approved but construction is not presently planned (B Anderson (Glencore), 2014, pers. comm.).

Ulan No.3 underground

Ulan No.3 is expected to progress northwards for up to 18 years (NSW Department of Planning, 2010, p. 9). Approximately 19 Mt of coal will be mined underground from the Ulan Seam using longwall methods, at depths of 30 to 110 m below ground (NSW Department of Planning, 2010, p. 9). Access to Ulan No. 3 underground mine will be via an existing road off Ulan Road, about 6.6 km north of the Cope Road junction (NSW Department of Planning, 2010, p. 9). Modifications will allow continuation of mining at Ulan No. 3. No additional water sources will be sought at the mine for the progression of Ulan No. 3 as UCML currently generates water in excess of its operational requirements, predominantly sourced from underground dewatering and surface collection from disturbed ground (Umwelt, 2009, p. 2.16).

1.2.3.1.2 Cobbora Coal Project

The Cobbora Coal Project is a proposed open-cut coal mine that will primarily supply thermal coal to NSW power stations including Bayswater and Liddell in the Upper Hunter Valley and Eraring and Vales Point on the Central Coast, with remaining coal being sold on the open market (EMGA Mitchell McLennan, 2011, p. 1). The Cobbora Coal Project is owned by the State of NSW (Cobbora Holding Company Pty Limited, 2014). The Cobbora Coal Project is approximately 5 km south of Cobbora and 22 km south-east of Dunedoo (Figure 3) (EMGA Mitchell McLennan, 2011, p. 1), within EL 7394 (EMGA Mitchell McLennan, 2012, p. ES.5) and Mining Lease Application (MLA) 0442. The project application area covers about 27,400 ha (EMGA Mitchell McLennan, 2012, p. ES.5), which has been mostly cleared for agriculture (EMGA Mitchell McLennan, 2012, p. ES.6). The potential disturbance area of the mine will be up to 4,700 ha (EMGA Mitchell McLennan, 2012, p. ES.5).

The project will include an open-cut mine, coal handling and preparation plant, rail spur and loading facility, access roads, water and power supply, and mine infrastructure (EMGA Mitchell McLennan, 2012, p. ES.1). The coal will be extracted simultaneously from three locations in the mining project area using open-cut truck and excavator operations (EMGA Mitchell McLennan, 2012, p. 37). Although it is unclear when the project will commence, the mine is expected to take 2.5 years to construct (EMGA Mitchell McLennan, 2012, p. ES.6), and the projected life of the mine, following construction, is 21 years (EMGA Mitchell McLennan, 2012, p. ES.1, ES.6). About 20 Mt/year of run-of-mine (ROM) coal is planned to be extracted (EMGA Mitchell McLennan, 2012, p. ES.1), which will be processed to produce up to 12 Mt/year of product coal (EMGA Mitchell McLennan, 2012, p. ES.1, ES.6). Coal quality is variable with ash content between 25 and 45%. Coal blending will be performed to achieve suitable qualities for end users (EMGA Mitchell McLennan, 2012, p. 35).

The coal target for the Cobbora Coal Project (CCP) is from the Gunnedah Basin, specifically the Dunedoo Formation. The main target seams are the Flyblowers Creek Coal and Ulan Upper and Ulan Lower seams (EMGA Mitchell McLennan, 2012, p. ES.5, 35).

Coal will be loaded onto trains at a dedicated 28 km rail spur and balloon loop that will link to the Dunedoo-Gulong railway at Tallawang (EMGA Mitchell McLennan, 2012, p. ES.6). The disturbed area of the project application area will potentially include up to 1,876 ha of woodland vegetation, 976 ha of native pasture grasslands and 1,796 ha of exotic grassland (EMGA Mitchell McLennan, 2012, p. ES.12). A small area of high quality agricultural land situated close to the mining area will be avoided (EMGA Mitchell McLennan, 2012, p. ES.7, ES.11). Habitat for 39 threatened species may be directly or indirectly affected by the project and of those species, 20 have already been observed in the project area, including the powerful owl, glossy black cockatoo, freshwater catfish and microbats (for full list see EMGA Mitchell McLennan, 2012, p. ES.12, 267).

It is reported that waste rock will be used to back-fill mined voids where possible or will be placed in out-of-pit areas by trucks (EMGA Mitchell McLennan, 2012, p. 37). Trucks will move coal to the coal handling and preparation plant where it will be crushed and moved to stockpiles for further handling (EMGA Mitchell McLennan, 2012, p. 37). The mine will be progressively rehabilitated (EMGA Mitchell McLennan, 2012, p. ES.7).

Water demand will be up to 3700 ML per year both for dust suppression and for processing coal at the coal handling and preparation plant (EMGA Mitchell McLennan, 2012, p. ES.7). Most water used will be surface water and water from within the mine in line with condition 29 of the Project Approval (NSW Government DPE, 2014, p. 14). Up to 3310 ML of water per year may be used, if required, allocated under the project's high security water access licences from the Cudgegong River, but without affecting town or domestic and stock supplies (EMGA Mitchell McLennan, 2012, p. ES.7).

In May 2014, NSW Government approved the Cobbora Coal Project plan (NSW Planning Assessment Commission, 2014; Cobbora Holding Company Pty Limited, 2014). Commonwealth approval for the project was given on 10 July 2014 (Department of the Environment, 2014). Detailed conditions, including environmental conditions for approval have been identified (NSW Government DPE, 2014; Department of the Environment, 2014). Conditions include that: the proponent shall not extract more than 20 Mt of ROM coal from the site in any calendar year; operations will not transport more than 12 Mt of coal from the site in any calendar year; and operations may be carried out on the site for a period of 24 years from the commencement of site construction. On 6 August 2014, NSW Government called for expressions of interest (EOI) for purchase of Cobbora Coal Mine, and the EOI remains open to prospective bidders until early September 2014 (NSW Government, 2014).

1.2.3.1.3 Phoenix Vision Coal Pty Ltd

EL 7115 is owned by Phoenix Vision Coal Pty Ltd. In 2012, Southern Cross Exploration N L stated it wished to acquire a 65% interest in this EL (Southern Cross Exploration N L, 2012, p. 4) but activities and intentions for this EL are presently unclear and in July 2014, EL 7115 was listed as 'Renewal Sought' by the owner (NSW Department of Trade and Investment, 2014a, p. 12).

1.2.3.2 Coal seam gas

Targeted exploration for CSG has predominantly occurred in the eastern part of the Central West subregion focusing on the Gunnedah Basin (Figure 3). Current petroleum exploration licences

(PELs) completely or partially in the Central West subregion are shown in Figure 6 and summarised in Table 3. These are PEL 12, PEL 238, PEL 428, PEL 433, PEL 434, PEL 450, PEL 456, and PEL 462. However, only small portions of PEL 12 and PEL 238 are in the Central West subregion with most in the Namoi subregion. No exploration has occurred on these tenements in the Central West subregion. Similarly, most of PEL 456 is outside the Central West subregion. Currently, Santos is the (joint) holder of all PELs in the Central West subregion, after acquiring Eastern Star Gas in 2011.

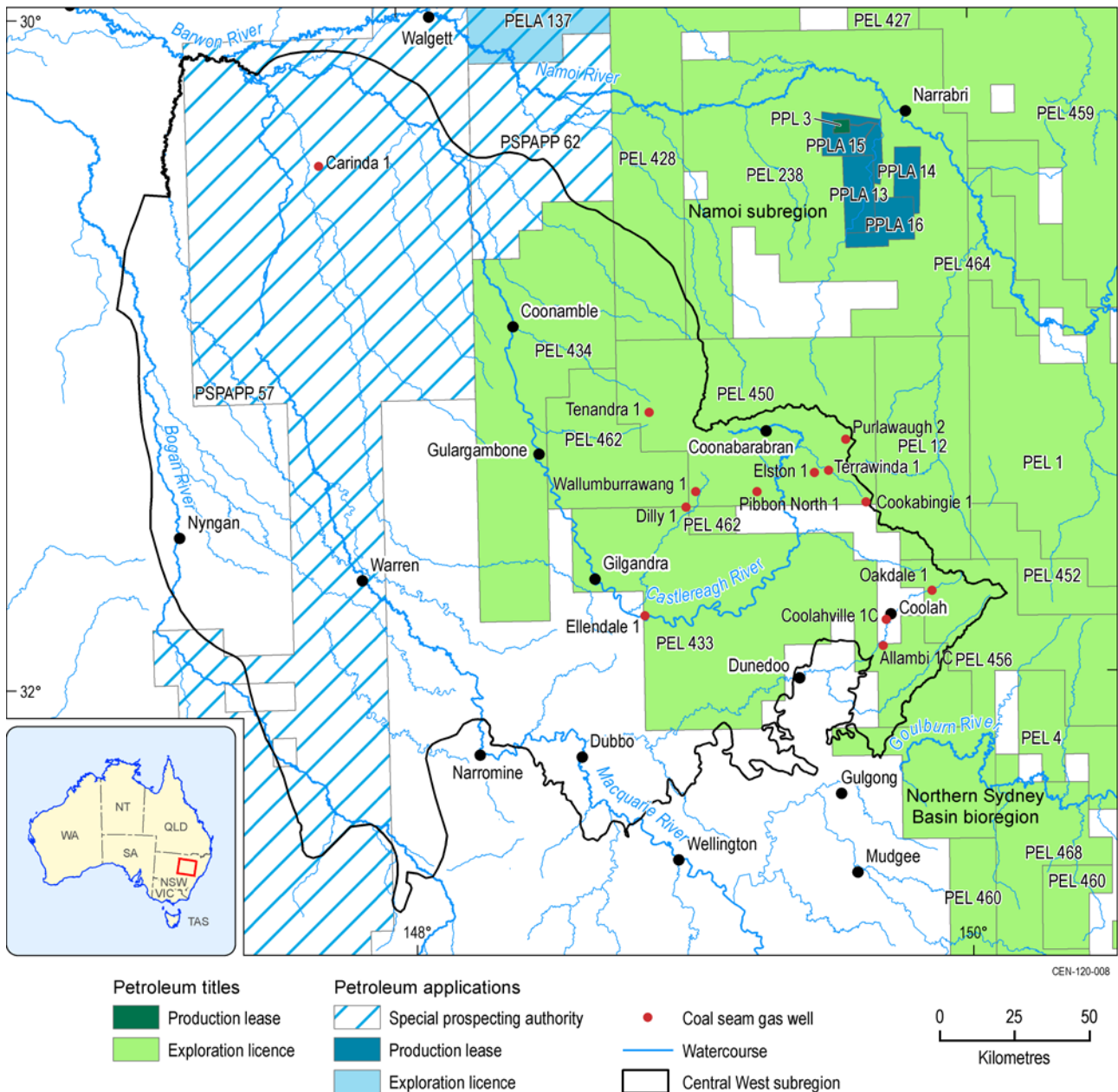


Figure 6 Petroleum titles and applications and coal seam gas wells in the Central West subregion

Source data: NSW Department of Trade and Investment (2014c), viewed 21 August 2014

PEL = petroleum exploration licence; PELA = petroleum exploration licence application; PPL = petroleum production lease; PPLA = petroleum production lease application; PSPAPP = petroleum special prospecting authority application

A large part of the subregion is currently covered by Petroleum Special Prospecting Authority Application (PSPAPP) 57 (applicant: NSW Aboriginal Land Council) (see Figure 6). Another PSPAPP

partially in the subregion is PSPAPP 62 (applicant Ison Energy Pty Ltd) (see Figure 6). These PSPAPPs are currently (as of August 2014) under consideration by the NSW Government (NSW Department of Trade and Investment, 2014b).

CSG exploration in the Gunnedah Basin in the Central West subregion has occurred in the southern part of PEL 450 (seven exploration wells in the subregion, see Figure 6 for well location and names), PEL 433 (three exploration wells), and the far western part of PEL 456 (one exploration well – Oakdale 1) (see Figure 6). Another exploration well (Coolahville-1C) is located south of PEL 450 and PEL 12 in a block that is not currently covered by a PEL or a PELA (as of August 2014 (NSW Department of Trade and Investment, 2014d)).

Table 3 Petroleum exploration licences completely or partially in the Central West subregion

Licence	Licence holder	Area (km ²)	Number of exploration wells in subregion	Notes
PEL 12	Santos Ltd	2,275	0	Only very small fraction in subregion (see Figure 6)
PEL 238	Santos Ltd	7,920	0	Only very small fraction in subregion (see Figure 6)
PEL 428	Santos Ltd	6,021	0	Only fraction in subregion (see Figure 6)
PEL 433	Santos Ltd	5,764	3	
PEL 434	Santos Ltd	4,338	0	
PEL 450	Santos Ltd	4,330	7	Only about two-thirds of licence area in subregion (see Figure 6)
PEL 456	Macquarie Energy Pty Ltd (wholly-owned subsidiary of Dart Energy Limited), Santos Ltd	5,019	1	Only very small fraction in subregion (see Figure 6)
PEL 462	Santos Ltd	1,688	0	

Source data: pbEncom (2014)

PEL = petroleum exploration licence

The wells were drilled to determine parameters relevant to CSG operations, such as coal seam depth and thickness, coal quality, rank, gas content, gas composition, sorptive capacity, and in situ permeability. Target coals for CSG in the western Gunnedah Basin in the Central West subregion are the Late Permian coals of the Black Jack Group, with the primary target being the Hoskissons Coal. The Early Permian Maules Creek Formation is either not present in the eastern part of the Central West subregion or only poorly developed. Results from the core wells indicate that the explored area of the Central West subregion is not currently prospective for commercial CSG extraction. The coal seams of the Black Jack Group were found to be either severely undersaturated, with total gas content generally below 1 m³/t, or with maximum gas content of 4 to 5 m³/t but with high levels of CO₂ (ESG, 2007a, 2007b, 2010a, 2010b; Santos, 2008a, 2009a, 2009b, 2009c, 2009d; Strike Oil, 2003a, 2003b).

Regional coal seam gas assessment to evaluate the CSG potential in the Gunnedah Basin was undertaken by Santos which included the licence areas PEL 450, PEL 456, and PEL 462 (Santos, 2009c). In 2008 Santos proposed to drill up to 11 new core wells in PEL 450 (Santos, 2008b) of which eight were to be located in the Central West subregion. However, only two of the proposed wells have since been drilled in the subregion (Tenandra 1 and Wallumburrawang 1 – see Figure 6) and the approval for the core well drilling programme has now expired. The results of the Tenandra 1 and Wallumburrawang 1 wells are included in the summary of exploration results presented above. In 2010 Santos gained approval from the NSW Government to conduct the Windurong Seismic Survey to assist in identifying hydrocarbon potential in PEL 450 and PEL 462 (NSW Department of Primary Industries, 2010; Santos, 2010).

A single exploration well has been drilled to assess the CSG potential of the Cretaceous Rolling Downs Group of the southern Surat Basin. The exploration well Carinda 1, in the north-western part of the Central West subregion currently covered by PSPAPP 57 (see Figure 6), intersected a net coal thickness of 6.92 m (including inferior coals) with individual seam thickness of 0.25 to 1.58 m. Coal was encountered to depths of 270 m. The gas content of the coals was not measured (Cydonia Resources, 2011). Gas content measurements require one or several coal cores to be taken from the seam and analysed in a laboratory. This is an additional expense and thus such analysis is not always undertaken during exploration for coal seam gas.

CSG exploration and commercialisation in the Central West subregion needs to be consistent with the CSG regulations and CSG exclusion zones that apply in NSW. These laws prohibit new CSG exploration and development in and around (within a 2 km buffer) existing residential areas (NSW DPI, 2013a, 2013b). See Figure 10 in companion product 1.1 for exclusion zones in the Central West subregion (Welsh et al., 2014).

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1.2.4 Catalogue of potential resource developments

Summary

In the Central West subregion, there are two proposed coal mine plans and one potential coal exploration project. The Ulan Coal Mines Continued Operations Project has an approved extension of operations which will progress northwards in the complex for up to 18 years. The Cobbora Coal Project has been approved and is a proposed open-cut coal mine that will take approximately 2.5 years to construct and will operate for 21 years. Phoenix Vision Coal Pty Ltd owns an exploration licence in the subregion, although there are no details available for this potential project.

As of October 2014 there are no coal seam gas (CSG) developments planned or proposed in the Central West subregion.

1.2.4.1 Potential coal developments

All known potential coal developments in the Central West subregion to date are catalogued in Table 4. All those listed here are discussed in Section 1.2.3 and their locations shown in Figure 5 in Section 1.2.3. The Ulan Coal Mines Continued Operations Project and the Cobbora Coal Project have approved environmental impact statements (EIS) and published Joint Ore Reserves Committee (JORC) Code compliant resource figures. The Phoenix Vision Coal Pty Ltd project is presently at the exploration stage and actual activity, quality of coal and potential tonnage or reserves are not reported.

Table 4 Catalogue of potential coal resource developments in the Central West subregion

Project name	Company	Longitude	Latitude	Record date ^a	Material ^b	Total coal resources ^c (Mt)	Status of EIS ^d	Notes
Cobbora Coal Project	Cobbora Holding Company Pty Ltd	149.2507°	-32.2203°	11 May 2010	Thermal Coal	630 (Reserves) 1050 (Total)	EIS approved	EMGA Mitchell McLennan (2011)
Phoenix Vision Coal Pty Ltd	Phoenix Vision Coal Pty Ltd	148.785°	-32.156°	No resources reported	Not reported	Not reported	Pre-EIS	Activity, quality and tonnage uncertain
Ulan Coal Mines Continued Operations Project	Ulan Coal Mines Limited (Glencore plc)	149.7499°	-32.2468°	31 Dec 2012	Thermal Coal	193.4 (Reserves) 1940 (Total)	EIS approved	NSW Department of Planning (2010) Umwelt (2011)

^aThe record date is the most recent date for updated coal resource numbers.

^bMaterials fall into one of the following four classes: thermal coal, coking coal, pulverised coal injection (PCI) and unspecified.

^cThis is calculated by summing the resources with Joint Ore Reserves Committee (JORC) codes of measured, indicated and inferred.

^dThe status of the project within an environmental impact statement (EIS): pre-EIS, EIS in preparation, EIS submitted, EIS closed, supplementary EIS and EIS approved.

1.2.4.2 Potential coal seam gas developments

As of October 2014 there are no CSG developments planned or proposed in the Central West subregion.

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