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 Maranoa-Balonne-Condamine subregion

Product 1.2 for the Maranoa-Balonne-Condamine subregion from the Northern Inland Catchments Bioregional Assessment

28 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>.

Department of the Environment

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

Bureau of Meteorology

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

CSIRO

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

Geoscience Australia

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

ISBN-PDF 978-1-4863-0367-0

Citation

Sander R, Hodgkinson J and Pinetown K (2014) Coal and coal seam gas resource assessment for the Maranoa-Balonne-Condamine subregion. Product 1.2 for the Maranoa-Balonne-Condamine subregion from the Northern Inland Catchments Bioregional Assessment. Department of the Environment, Bureau of Meteorology, CSIRO and Geoscience Australia, Australia.

Authorship is listed in relative order of contribution.

Copyright

Disclaimer

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

Cover photograph

Condamine river weir on Darling Downs in Queensland, 2005

Credit: © Commonwealth of Australia (Murray–Darling Basin Authority), Arthur Mostead

Australian Government
Department of the Environment
Bureau of Meteorology
Geoscience Australia

CSIRO

v20141028

Contents

Figures

Tables

Contributors to the Technical Programme

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

Acknowledgements

This technical product was reviewed by several groups:

- Discipline Leaders: Steven Lewis (geology, Geoscience Australia), Richard Mount (assets, Bureau of Meteorology)
- 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). Companies developing coal and coal seam gas resources in the Maranoa-Balonne-Condamine subregion checked the accuracy of our descriptions of their operations: Allegiance Coal Limited, Aquila Resources Ltd, Arrow Energy Pty Ltd, Blue Energy Limited, Carbon Energy Limited, InterGen Australia, Cockatoo Coal Limited, MetroCoal Limited and SinoCoal Resources Pty Ltd, New Hope Group, Origin Energy Limited, Peabody Energy, QGC Pty Limited, Santos Ltd, Senex Energy Limited.

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.

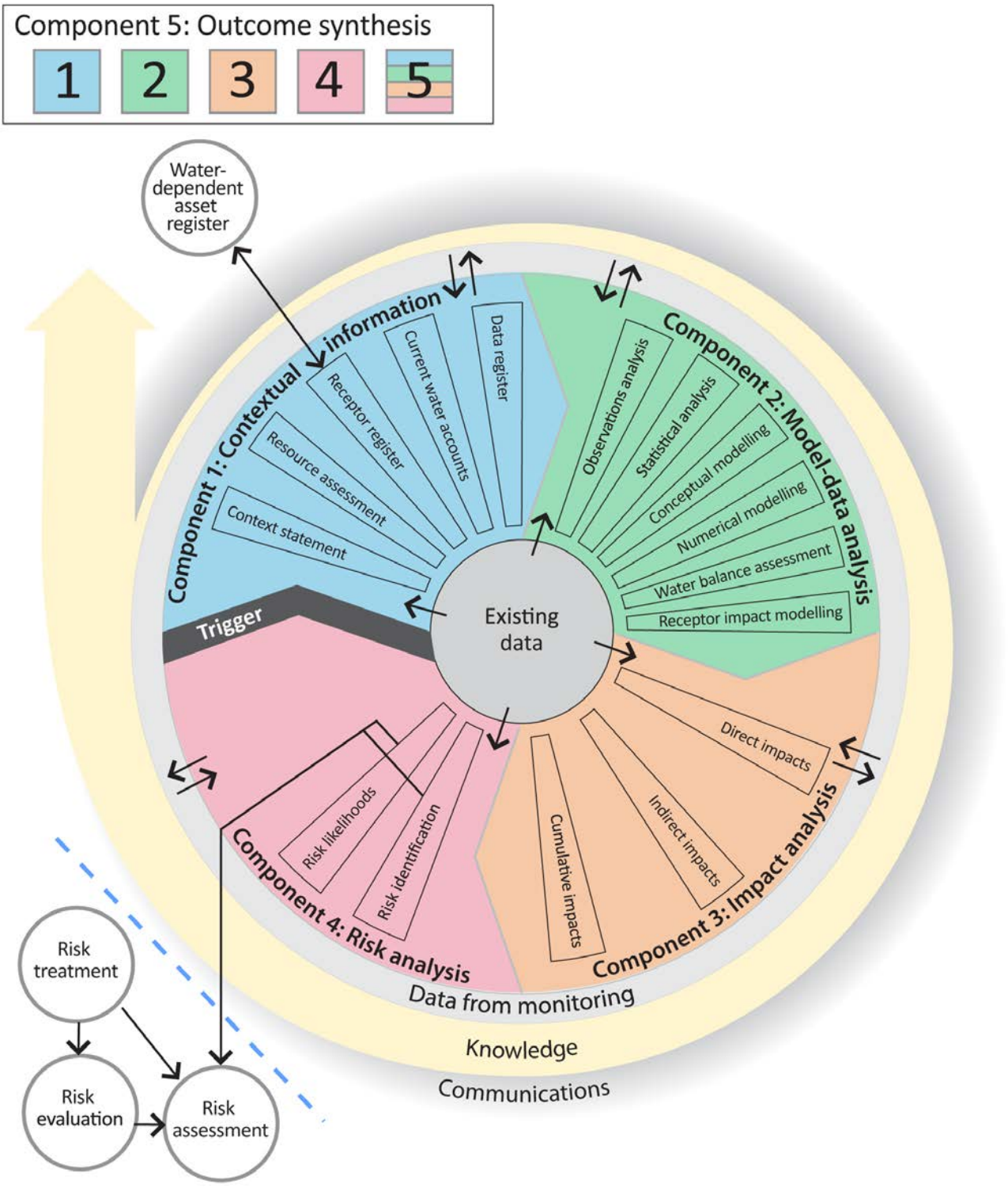

Figure 1 Schematic diagram of the bioregional assessment methodology

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>.

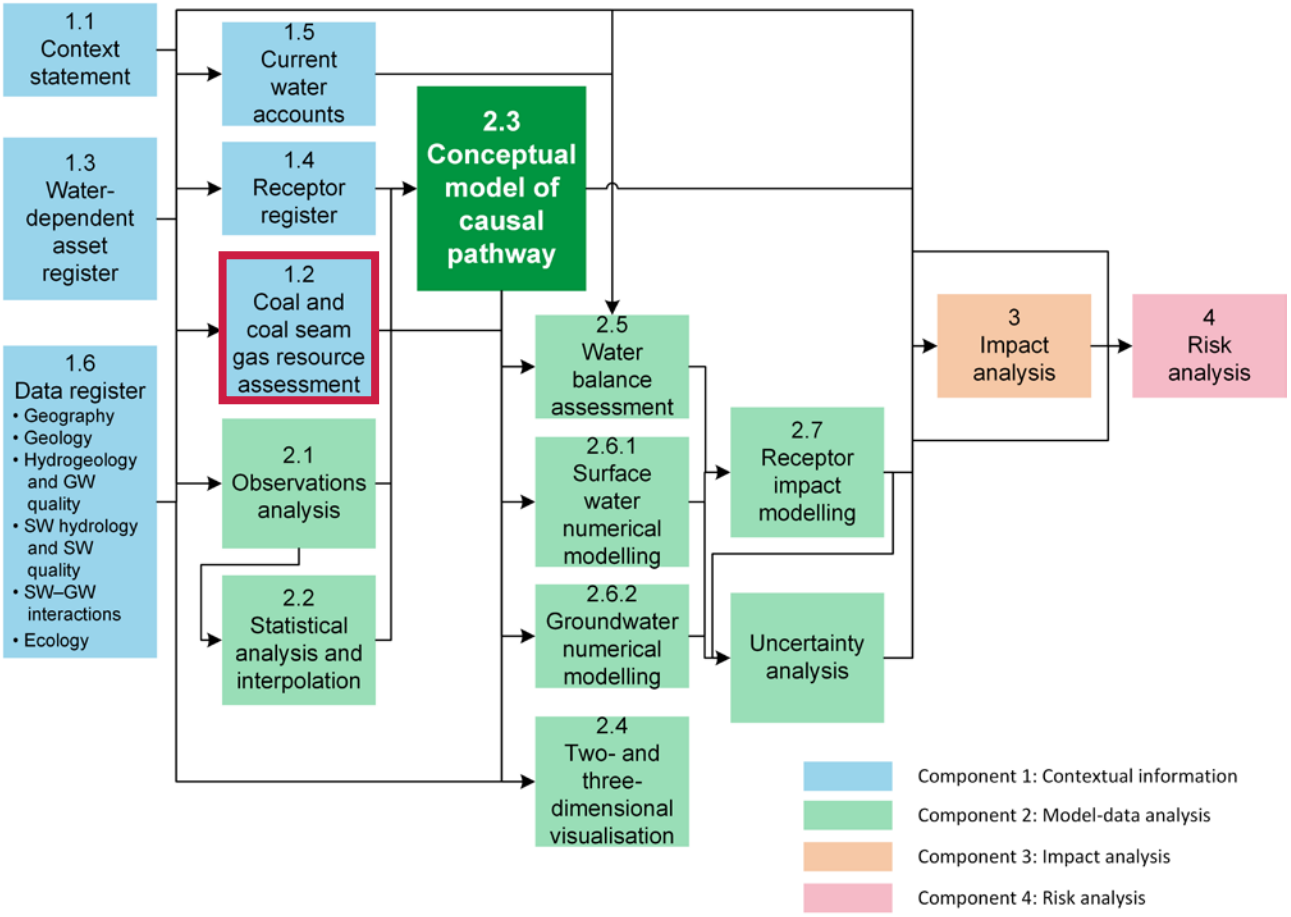

Figure 2 The simple decision tree indicates the flow of information through a bioregional assessment

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

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 16. 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°.

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 Maranoa-Balonne-Condamine 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 Maranoa-Balonne-Condamine 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 Maranoa-Balonne-Condamine subregion	3	Impact analysis	5.2.1	■
Component 4: Risk analysis for the Maranoa-Balonne-Condamine 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	■

[a]Barrett et al. (2013)
[b]The 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 28 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 Maranoa-Balonne-Condamine 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

Coal is currently mined from four mines in the geological Clarence-Moreton and Surat basins in the Maranoa-Balonne-Condamine subregion. Although the southern part of the Bowen Basin is also in the subregion, its known economic coal deposits are north of the subregion boundary, so are not assessed in this bioregional assessment.

The Clarence-Moreton and Surat basins merge across the Kumbarilla Ridge. Their economic coal deposits occur in the Middle to Upper Jurassic Walloon Coal Measures. Coal seams in the Walloon Coal Measures of the Clarence-Moreton Basin are generally interbanded with mudstone and siltstone, and individual coal plies (layers within the coal) are generally less than 1 m thick. The major coal deposits in the Surat Basin Walloon Coal Measures occur in the geographic areas of Macalister, Brigalow and Chinchilla. Targets for coal seam gas (CSG) in the Maranoa-Balonne-Condamine subregion are the seams of the Walloon Coal Measures of the Surat Basin in the central-northern and central-eastern part of the subregion. CSG production occurs from the Taroom and the Juandah coal measures. No significant volumes of CSG are expected to be present in the Surat Basin in the most north-western part and the eastern part of the subregion due to the proximity to the basin margins. The coals here are shallow and gas is expected to have been desorbed over time.

The Bandanna Formation of the Bowen Basin has been targeted for CSG exploration in the north-western tip of the subregion. However, the coals were not found to have potential for CSG recovery. The coal seams of the Clarence-Moreton Basin, in the eastern part of the Maranoa-Balonne-Condamine subregion, have not been explored for CSG as of yet.

1.2.1.1 Coal

Coal is currently mined from four mines in the geological Clarence-Moreton and Surat basins within the Maranoa-Balonne-Condamine subregion boundary. Known economic coal deposits in the Bowen Basin are north of the bioregion boundary. The basins are shown in Figure 3.

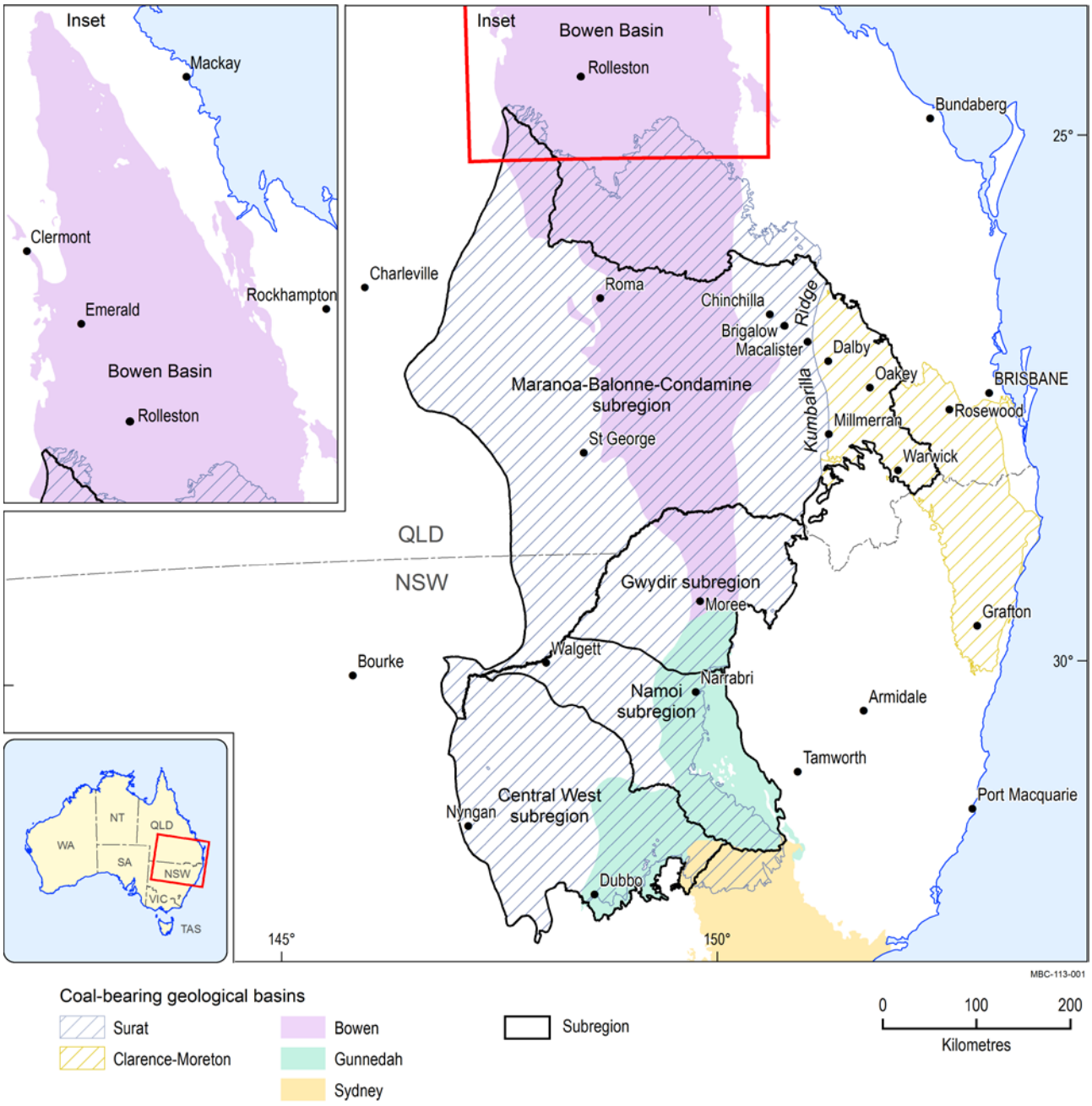

Figure 3 Geological basins in the Northern Inland Catchments bioregion

1.2.1.1.1 Bowen Basin

The structural units of the Bowen Basin within the subregion boundary include the south-east Taroom Trough, up to the Roma Shelf. Coal seams of the Bowen Basin are classified into four distinct groups (numbered I through IV) (Mallett et al., 1995, p. 305). Group I is the oldest and is highly variable in thickness and lithology with some good quality coking and non-coking coal towards the northern part of the basin. Group II consists of several unconnected deposits of coal with variable properties, some of which are of economic interest. Group III contains high grade coking coal that is laterally extensive and consists of multiple seams. Group IV has the most diverse quality coal and is most widely distributed having formed in river, lake and marshy environments and although quality and rank can vary, contains coking and non-coking coal of major economic importance. The coal-bearing formations are better developed and thicker in the

central and northern Bowen Basin, compared to the southern basin, which is included in the Maranoa-Balonne-Condamine subregion boundary. The coal deposits north of the subregion boundary are not assessed in this bioregional assessment.

In the south-west of the basin, although north of the subregion boundary, the economic coal deposits of the Bandanna Formation are locally developed with up to four coal seams present in an area that outcrops 15 km west of Rolleston (Mallett et al., 1995, p. 325). The coal seams are up to 6 m thick and have vitrinite reflectance values of 0.56 to 0.61%, and volatile matter contents between 27 and 32% (Mallett et al., 1995, p. 325).

1.2.1.1.2 Clarence-Moreton Basin

The Clarence-Moreton Basin merges with the Surat Basin across the Kumbarilla Ridge, a basement high consisting of Carboniferous Texas beds that separate the Cecil Plains sub-basin within the Clarence-Moreton Basin (New Hope Group, 2014, p. 4-19). The economic coal-bearing strata of the Surat and Clarence-Moreton basins are in the Walloon Coal Measures, which are Middle to Upper Jurassic in age, and part of the Injune Creek Group (see Figure 9 (stratigraphic column) in companion product 1.1 for the Maranoa-Balonne-Condamine subregion (Welsh et al., 2014)). The Walloon Coal Measures occur on both sides of the Kumbarilla Ridge, and are laterally continuous (New Hope Group, 2014, p. 4-19). In the Clarence-Moreton Basin, the Injune Creek Group is divided into a productive, coal-bearing lower unit, the Walloon Coal Measures, and a coal resource-barren upper unit, the Kumbarilla beds (New Hope Group 2014, p. 4-20).

The coal seams of the Walloon Coal Measures in the Clarence-Moreton Basin are generally interbanded with mudstone and siltstone, and minor thin shale bands. Individual coal plies are mostly less than 1 m thick (Goscombe and Coxhead, 1995, p. 501). The coals are generally vitrinite-rich and contain up to 20% liptinite in some cases (Goscombe and Coxhead, 1995, p. 502).

Major coal deposits of the Clarence-Moreton Basin occur in the Rosewood, Oakey and Millmerran areas. Washed ash yields are around 16 and 17% and volatile matter contents vary between 38 and 42% (Goscombe and Coxhead, 1995, p. 504). Working sections of coal are reported to be 10 to 20 m in the Oakey area, whereas banded seams range from 2 to 15 m in thickness in the Millmerran area (Goscombe and Coxhead, 1995, p. 505).

New Hope Coal (2014, p. 4-21) state that at their project site, New Acland Coal Mine Stage 3, the Walloon Coal Measures are about 120 to 130 m thick, with economically recoverable coal reserves less than 75 m below ground level at their deepest point (New Hope Coal, 2014, p. 4-21). Within the lower Walloon Coal Measures both at the New Acland Coal Mine Stage 3 site and beyond, there are three major coal intervals: the Waipanna, Acland-Sabine and Balgowan.

The Acland-Sabine Sequence (New Hope Coal, 2014, p. 4-20) is a major coal-bearing unit of the Walloon Coal Measures and occurs in the lower coal-bearing unit, equivalent to the Taroom Coal Measures. The Walloon Coal Measures are unconformably overlain by Cenozoic basalts in some areas, whereas other areas are covered with Quaternary alluvium deposited by creeks and rivers (New Hope Coal, 2014, p. 4-21). The coal measure sequences dip 1 to 3 degrees towards the south-south-west, although local faulting and folding causes local variation (New Hope Coal, 2014, p. 4-21). Faulting typically occurs along two main trends striking north-east and north-west.

The Acland-Sabine interval contains six groups of seams, each containing up to 10 plies, with a total of 47 plies and a mean ply thickness of 0.23 m. These groups of seams are unlikely to extend laterally, but instead form isolated pods of coal (New Hope Coal, 2014, p. 4-21). The Waipanna interval overlies the Acland-Sabine interval and contains six seams that contain a total of 53 plies. The Balgowan interval, which underlies the Acland-Sabine interval, contains seven seam groups with a total of 21 plies (New Hope Coal, 2014, p. 4-21). Coal seams in the Waipanna interval, within the lower part of a 75 m unit of thinly bedded fine-grained sandstone, exhibit rapid, lateral facies changes, and one seam reaches 6 m in thickness but is of poor quality and banded (New Hope Coal, 2014, p. 4-52). Within the Acland-Sabine interval a banded coal 18 m thick has been identified in a 30 to 60 m unit of predominantly thinly bedded fine-grained sandstone and mudstone (New Hope Coal, 2014, p. 4-52). In the Balgowan interval numerous thin coal seams extend though a 30 m unit of medium- to fine-grained sandstone (New Hope Coal, 2014, p. 4-52).

At the Commodore Mine the Walloon Coal Measures are gently folded with coal dipping at less than 3 degrees to the west. The seams mined are the Kooroongarra seam, which is up to 3 m thick, the Commodore seam, which averages 5.2 m in thickness and the Bottom Rider seam, which is 1.5 to 0.9 m thick. The Top Rider and Bottom Rider seams are considered to be minor seams and the typical in situ ash of coals at the Commodore deposit is about 36% (Goscombe and Coxhead, 1995, p. 505).

1.2.1.1.3 Surat Basin

In the Surat Basin, the Middle to Upper Jurassic Injune Creek Group, which consists of lithic sandstone, siltstone, mudstone and coal contiguous with the Clarence-Moreton Basin across the Kumbarilla Ridge, provides a major coal sequence in the Maranoa-Balonne-Condamine subregion. The thick sequence of interbedded coal and sedimentary rocks comprises of two coal groups: the Juandah Coal Measures and the Taroom Coal Measures (Queensland Government EHP, 2013, p. 32), both part of the Walloon Coal Measures.

In a study by Scott et al. (2007, p. 7) the Jurassic coals of the Surat Basin were described as dull, and rich in carbon (>80% dry, ash-free (daf)), with high volatile matter content (>30% as received (ar)) and moderate to high ash yield (~ 30% ar). Coal rank ranges from sub-bituminous to high-volatile bituminous (Scott et al., 2007, p. 7).

The major coal deposits of the Walloon Coal Measures occur in the Macalister, Brigalow and Chinchilla areas in the subregion (Goscombe and Coxhead, 1995, p. 505). The Juandah Coal Measures in the Macalister area contain six coal seams with a mean aggregate thickness of 8 m. At the Brigalow deposit on the western flank of the Kumbarilla Ridge, the coals of the Juandah Coal Measures contain two economic seams of interest, the uppermost of which has a maximum and mean thickness of 16 m and 10 m, respectively, and mean in situ ash of 28% (Goscombe and Coxhead, 1995, p. 506). Several deposits of the Juandah Coal Measures occur in the Chinchilla area, where washed ash yields are about 12% and volatile matter contents are about 42%. At Sefton Park and Rywung, the coal measure sequences contain two banded seams 1.5 to 5.8 m thick, and economic coal resources are also present at Glen Wilga, Haystack Road and Horse Creek (Goscombe and Coxhead, 1995, p. 506). In the Wandoan area, three seams are typically present in the Juandah Coal Measures, with individual seams 1 to 6 m thick (Goscombe and Coxhead, 1995, p. 506). These occur at about 80 m depth. Washed ash yields in the Wandoan area are about 9%

and volatile matter contents are about 44%. Approximately 70 km north of the subregion in Taroom, the Taroom Coal Measures have two coal seams of economic interest: an upper and a lower seam with mean thicknesses of about 5 m, and 2 to 3 m, respectively. Some of the coal resources in this area occur within 60 m of the surface (Goscombe and Coxhead, 1995, p. 506) and extend south into the subregion past Chinchilla.

At a proposed mine site called 'The Range' (see Section 1.2.3.1.2), coal is typically situated at shallow depths, and coal mining will require only open-cut methods for extraction of coal from seams located from 20 to 120 m below the surface (Queensland Government EHP, 2013, p. 2). Further south at Kogan Creek, coal has minimum depths of 12 to 15 m below the surface (CS Energy, 2013, p. 2). The three main seams at Kogan Creek have a total thickness of 12 m, and dip gently towards the south-west in seams of 0.1 to 3 m thickness (CS Energy, 2013, p. 2).

1.2.1.2 Coal seam gas

Targets for CSG in the Maranoa-Balonne-Condamine subregion are primarily the seams of the Walloon Coal Measures of the Surat Basin. However, in the most north-western part and the eastern part of the subregion no significant volumes of CSG are expected to be present in the Surat Basin. Due to the proximity to the basin margins the coals are very shallow and the unconfined pressure within the seams allows gas to desorb and be lost from the system (Queensland Government EHP, 2013, p. 32; Scott et al., 2007). This is supported by observations of Scott et al. (2007, p. 11), who found that loss of gas from the Walloon Coal Measures is apparent in the north-east Surat Basin as a result of a reduction in confining pressure through tectonic movement and/or water movement.

In the central-northern and central-eastern part of the Maranoa-Balonne-Condamine subregion, CSG recovery occurs from the Walloon Coal Measures generally at depths of 200 to 600 m below the surface (Papendick et al., 2011, p. 123). Production targets of the Walloon Coal Measures are the seams of the Taroom and the Juandah coal measures (Papendick et al., 2011, p. 123; DNRM, 2014a); three coal seams have been identified for the Taroom Coal Measures and seven for the Juandah Coal Measures (QGC, 2009). Mean net thickness has been reported as 30 m (the Taroom Coal Measures contributing 8 m and the Juandah Coal Measures 22 m) (QGC, 2009), though it varies locally. Studies of the Dalby and Roma fields by Papendick et al. (2011, p. 123) reported that an average Dalby well contains 20 to 30 m of net coal and an average Roma well contains about 15 m. Gas production may also occur from other facies interspersed between the coal seams, such as shale and tight gas reservoirs. The extent of this contribution is unknown and has not been further investigated.

Individual seams of the Walloon Coal Measures can be thin and commonly contain lateral discontinuities disrupting the seams. However, they typically have high seam permeabilities (DNRM, 2014a); in the Roma field permeabilities can be as high as 200 mD, whereas permeabilities for a well sampled in the Dalby field ranged from 0.07 to 42.38 mD. High permeabilities decrease the need for well stimulation (such as hydraulic fracturing) to enable gas production at economic quantities.

Gas contents in the Walloon Coal Measures range from 1 to 15 m^3/t (daf), with a mean of about 5 m^3/t (daf) (Scott et al., 2007, p. 10). Similar ranges were also reported by Hamilton et al. (2012, p. 26). Gas contents within the upper coal seams of the Juandah Coal Measures (Kogan, Macalister Upper and Macalister Lower) appear to be lower and more variable compared to the lower seams (Scott et al., 2007, p. 10). Coals of the Taroom Coal Measures have lower gas contents than those of the Juandah Coal Measures (Scott et al., 2007, p. 10). Hamilton et al. (2012, p. 26) observed varying trends for gas content and depth, where it either increases; increases then decreases; or decreases with depth. The mean gas saturation of the Walloon Coal Measures is estimated as 80% (QGC, 2009).

Hamilton et al. (2012, p. 29) reported Walloon Coal Measures CSG as consisting almost entirely of methane (>98%; air-free basis), with only minor carbon dioxide and nitrogen, and very low levels of ethane (<1%). This is in agreement with average coal properties reported by QGC Pty Limited who stated that the gas is composed of more than 97% methane with only small amounts of nitrogen and carbon dioxide (QGC, 2009). The methane is mainly of biogenic origin (Papendick et al., 2011, p. 124).

The Bandanna Formation of the Bowen Basin has been targeted for CSG in the north-western tip of the subregion. However, the coals were not found to have potential for CSG recovery (Blue Energy, 2010). The coal seams of the Clarence-Moreton Basin, in the eastern part of the Maranoa-Balonne-Condamine subregion, have not been explored for CSG as of yet (as of October 2014).

Total proved and probable (2P) CSG reserves as per the Petroleum Resource Management System (World Petroleum Council, 2011) in the Maranoa-Balonne-Condamine subregion are in excess of 28,000 petajoule (PJ) as of 31 December 2013 (DNRM, 2014b). In comparison, Queensland's total 2P reserves for the same period are 41,124 PJ (DNRM, 2014b). This indicates that the majority of Queensland's current CSG reserves are in the Maranoa-Balonne-Condamine subregion.

References

CS Energy (2013) Kogan Creek Fact Sheet, 2pp. Viewed 22 April 2014, <http://www.csenergy.com.au/userfiles/file/Kogan%20Creek%20Mine%20fact%20sheet%20-%20April%202013.pdf>.

Blue Energy (2010) Annual Report 2010. Blue Energy Limited, Brisbane. Viewed 2 July 2014, <http://www.theroom.com.au/clients/blueenergy/flipbook/index.html>.

DNRM (2014a) Queensland's coal seam gas overview. Queensland Government, Department of Natural Resources and Mines, Brisbane.

DNRM (2014b) Coal seam gas reserves 1 January 2005 to 31 December 2013. Queensland Government Department of Natural Resources and Mines, Brisbane. Viewed 29 August 2014, <http://mines.industry.qld.gov.au/mining/production-reserves-statistics.htm>.

Goscombe PW and Coxhead BA (1995) Clarence-Moreton, Surat, Eromanga, Nambour and Mulgildie basins. In: Ward CR, Harrington HJ, Mallett CW, and Beeston JW (eds) Geology of Australian coal basins. Incorporated Coal Group Special Publication No. 1. Geological Society of Australia, Sydney, 489–511.

Hamilton SK, Esterle JS and Golding SD (2012) Geological interpretation of gas content trends, Walloon Subgroup, eastern Surat Basin, Queensland, Australia. International Journal of Coal Geology 101, 21–35.

Mallett CW, Pattison C, McLennan T, Balfe P and Sullivan D (1995) Bowen Basin. In: CR Ward, HJ Harrington, CW Mallett and JW Beeston (eds) Geology of Australian Coal Basins, Special Publication No. 1. Geological Society of Australia Incorporated Coal Group, Australia, 299–340.

New Hope Group (2014) New Acland Coal Mine Stage 3 Project, Environmental Impact Statement, Full Report. Queensland Government, Brisbane.

Papendick SL, Downs KR, Vo KD, Hamilton SK, Dawson GKW, Golding SD and Gilcrease PC (2011) Biogenic methane potential for Surat Basin, Queensland coal seams. International Journal of Coal Geology 88, 123–134.

QGC (2009) Queensland Curtis LNG – environmental impact statement. QGC Limited, Brisbane.

Queensland Government EHP (2013) The Range Project Environmental Impact Statement, Brisbane, Queensland. Queensland Government Department of Environment and Heritage Protection. Viewed 22 April 2014, <http://www.ehp.qld.gov.au/management/impact-assessment/eis-processes/the-range.html>.

Scott S, Anderson B, Crosdale P, Dingwall J and Leblang G (2007) Coal petrology and coal seam gas contents of the Walloon Subgroup – Surat Basin, Queensland, Australia. International Journal of Coal Geology 70, 209–222.

Welsh W, Herron N, Rohead-O'Brien H, Ransley T, Aryal S, Mitchell P, Buckerfield S and Marshall S (2014) Context statement for the Maranoa-Balonne-Condamine subregion. Product 1.1 for the Maranoa-Balonne-Condamine subregion from the Northern Inland Catchments Bioregional Assessment. Department of the Environment, Bureau of Meteorology, CSIRO and Geoscience Australia, Australia. Viewed 17 September 2014, <http://www.bioregionalassessments.gov.au/documents/context-statements/BA-NIC-MBC-110-ContextStatement.pdf>.

World Petroleum Council (2011) Guidelines for the Application of the Petroleum Resource Management System. Viewed 14 July 2014, <http://www.spe.org/industry/docs/PRMS_Guidelines_Nov2011.pdf>.

1.2.2 Current activity and tenements

Summary

At present, four open-cut coal mines are in operation in the Maranoa-Balonne-Condamine subregion: Commodore, New Acland, Kogan Creek and Cameby Downs. All operating mines are in the east of the subregion. Commodore Mine is an open-cut mine majority owned by InterGen Australia and co-owned by Marubeni Corporation and four other organisations. It is the sole supplier of thermal coal to InterGen's adjacent 850 megawatt Millmerran Power Station, approximately 200 km west of Brisbane. Coal at Commodore Mine is extracted from the Walloon Coal Measures. New Acland Coal Mine is 177 km west of Brisbane, is currently operated by the New Hope Group as 'Stage 2' of its three stage mine development plan and produces thermal coal for both domestic and international customers. Kogan Creek Mine near Chinchilla, is owned by Aberdare Collieries Pty Ltd (a subsidiary of CS Energy Ltd, which is owned by the Queensland Government). The mine provides thermal coal to CS Energy's adjacent Kogan Creek Power Station. Cameby Downs is owned by Yancoal Australia Ltd. It is an open-cut mining operation about 30 km north-west of Chinchilla producing low ash, export quality thermal coal. Stage 1 of the project currently produces about 1.4 Mt/year of thermal coal. Additionally, there are two underground coal gasification projects (UCG, which is a process that converts coal into gas and liquids) in the subregion: Bloodwood Creek and Linc Energy Limited's Hopeland No 1. They are discussed briefly here as the Queensland Government considers UCG to be a coal mining activity, although UCG is not being considered in this bioregional assessment.

Established coal seam gas (CSG) operations in the Maranoa-Balonne-Condamine subregion include Arrow Energy Pty Ltd's Daandine, Kogan North, and Tipton West gas fields; Origin Energy Limited's Talinga gas field; and QGC Pty Limited's Argyle-Kenya, Lauren, Bellevue, Berwyndale, and Berwyndale South gas fields. Production typically occurs from the Walloon Coal Measures of the Surat Basin.

CSG field development has escalated considerably in the recent past as a result of the construction of three large scale liquefied natural gas (LNG) projects on Curtis Island near Gladstone. A large portion of the gas to be supplied to the LNG projects will be extracted from the Walloon Coal Measures located in the Maranoa-Balonne-Condamine subregion. QGC Pty Limited, Origin Energy Limited, and Santos Ltd are the respective operators of these LNG projects and the associated gas field developments. Part of the gas produced during the ramp-up phase is sold to the domestic market and gas fired power stations before commercial production of the LNG facilities commences.

1.2.2.1 Coal

Section 1.2.2.1 includes all the currently operating coal mines. For a development to be considered current, commercial production for that particular mine needs to have commenced prior to December 2012.

Table 3 Active mines in the Maranoa-Balonne-Condamine subregion showing mine name, mine ownership and coal production (million tonnes per annum (Mt/year))

Mine name	Company	Annual production (Mt/year)
Commodore	InterGen Australia and Marubeni Corporation	3.6
New Acland	New Hope Group	7.4
Kogan Creek	Abadare Collieries Pty Ltd	2.8
Cameby Downs	Yancoal Australia Ltd	1.4

At present, four coal open-cut mines are in operation in the Maranoa-Balonne-Condamine subregion (Table 3, Figure 4): Commodore, New Acland, Kogan Creek and Cameby Downs. All operating mines are in the east of the subregion. Wilkie Creek Coal Mine (owned by the American corporation Peabody Energy, Inc), is listed as an operating mine in the Queensland Government Interactive Resource and Tenure Maps (IRTM) system at the time data were gathered, but ceased coal production in December 2013 (Peabody Energy, 2013) and IRTM are not updated frequently, so provided a slightly out-of-date dataset. Activities only for closure of the mine are now taking place at the Wilkie Creek Coal Mine. For this reason Wilkie Creek Coal Mine has not been discussed further here. The IRTM does not report Cameby Downs Mine as being active. Cameby Downs has multiple leases listed as future plans in the IRTM, but at Mining Lease (ML) 50233 mining operations are current. Cameby Downs (ML 50233) is discussed as an active mine.

Underground coal gasification (UCG) is a process that converts coal into gas and liquids in situ via controlled partial combustion. UCG is considered to be coal mining by the Queensland Government, and although it is out of scope for the bioregional assessments, it is discussed briefly for the sake of completeness. There are two UCG projects in the subregion:

1. Bloodwood Creek is the pilot site for Carbon Energy's first trial to commercialise its proprietary UCG 'keyseam®' technology. The Bloodwood Creek pilot project has operated since October 2008 in Mining Lease Application (MLA) 50253. Bloodwood Creek is currently in its decommissioning phase, and the technology is being assessed for environmental sustainability. In July 2013, an independent scientific panel concluded that UCG could, in principle, be conducted in a manner that is socially and environmentally acceptable and safe, but that there must first be a demonstration that acceptable decommissioning (DNRM, 2013) and effective risk based planning for rehabilitation of underground facilities can be achieved before commercial UCG operations in Queensland could be approved.

2. Linc Energy has operated an UCG demonstration project at their Hopeland No 1 (MLA 50242 and Mineral Development Licence (MDL) 309) site 20 km south-west of Chinchilla since 1999 (Linc Energy, 2007). In 1999, Linc Energy commenced five generations of UCG design tests that continued over 14 years, where coal seams at depths of 120 m below the surface were gasified. In November 2013, Linc Energy announced that the successful completion of testing marked the conclusion of the development at Chinchilla, and that the site will move into its final phase of site decommissioning and remediation, during which time further studies would be undertaken to enhance knowledge in that phase (Linc Energy, 2013). The operation ceased in 2013 (Linc Energy, 2013, p. 2).

1.2.2.1.1 Commodore Mine

Commodore is an open-cut mine mainly owned by InterGen and Marubeni, situated approximately 200 km west of Brisbane. The Commodore Mine is the sole supplier of thermal coal to InterGen's adjacent 850 megawatt Millmerran Power Station (InterGen, 2014). The mine has approximately 3.6 Mt/year production capacity (Downer EDI, 2007). Mining is performed by the contractor, Downer EDI Mining, on behalf of its majority owner, InterGen. No surface or groundwater resources are accessed for water needs: catchment water is collected and stored in sediment dams and recycled water is available from the power station if insufficient overland flow is available (Psi-Delta, 2010, p. 120). Approximately 150 ML of overland flow is used at the mine per year and as coal is not washed, water is only used for dust suppression and irrigation (Psi-Delta, 2010, p. 127). Conveyors across creeks are fully enclosed to prevent dust emissions and spillage into the creek (InterGen, 2014). The coal is mined from the Walloon Coal Measures, typically the Kooroongarra seam which is up to 3 m thick, the Commodore Seam which averages 5.2 m thickness and the Bottom Rider seam which is up to 0.9 m thick. Overburden and waste are stored for later use to backfill pits and to develop the final landform. Progressive rehabilitation is underway (InterGen, 2014). The mine started production in 2002 with an expected lifespan of more than 30 years.

1.2.2.1.2 New Acland Coal Mine Stage 2

New Acland Coal Mine is 14 km north-north-west of Oakey, 40 km north-west of Toowoomba and 177 km west of Brisbane. New Acland Coal Mine is currently operated by the New Hope Group. The mine is currently operating 'Stage 2' of its three stage plan. New Acland Coal Mine Stage 2 consists of a 64 million tonne (Mt) product coal resource within the Acland-Sabine, Waipanna and Balgowan sequences of the Walloon Coal Measures (Queensland Government EPA, 2006, p. 5). The mine currently produces approximately 5 Mt/year of thermal product coal (New Hope Group, 2012a, p. 8) using conventional truck and excavator strip mining operations (Queensland Government EPA, 2006, p. 6). Mining commenced in 2002 and reserves are forecast to be depleted by 2017 (New Hope Group, 2012a, p. 8). Approximately 10% of the New Acland mining lease area is mined at any one time while agricultural activities continue on remaining land. Land rehabilitation is continual and is assisted by the Acland Pastoral Company to ensure the former disturbed land is returned to a commercially viable agricultural state (Queensland Government EPA, 2006, p. 13; New Hope Group, 2013). New Acland Coal Mine purchases approximately 5500 ML of recycled water per year from Toowoomba's Wetella Wastewater Reclamation Facility and Oakey's Reverse-osmosis Water Treatment Plant (Queensland Government EPA, 2006; Psi-Delta, 2010, p. 127). Additionally the mine uses 1370 ML of groundwater per year (Psi-Delta, 2010, p. 127). This non-potable water is used for coal preparation and dust suppression purposes (Queensland Government EPA, 2006, p. 6). There are two coal handling and preparation plants at the mine site where thermal coal of different qualities is blended to meet product specifications. Currently, a train loading facility near Jondaryan provides the mine with access to transportation of coal to both domestic and international customers (New Hope Group, 2012b).

1.2.2.1.3 Kogan Creek Mine

Kogan Creek Mine near Chinchilla, is owned by Aberdare Collieries, a subsidiary of CS Energy which is owned by the Queensland Government. The mine provides approximately 2.8 Mt/year of thermal coal to CS Energy's adjacent Kogan Creek Power Station (CS Energy, 2012, p. 10). The mine commenced operations in 2007 and although the life of mine is not clear, the present contract for operation is with Golding Contractors until 2018. Kogan Creek is an open-cut mine where three main seams of coal have a combined thickness of 12 m, dipping gently to the south-west. It is mined using front-end loaders and haul trucks (CS Energy, 2013). Coal is transported to the power station by a 4 km overland conveyor (CS Energy, 2013). The coal from Kogan Creek Mine is very high quality and does not require washing prior to use, complementing the power station's dry-cooled operation that uses 90% less water than a wet-cooled power station of equivalent size. Spoil dumps are used to backfill the voids after coal has been mined in preparation for land rehabilitation, and remaining spoil dumps are formed into hills approximately 30 m high which are landscaped and revegetated (CS Energy, 2013). Water usage for the mine is 0.5 ML/day, and as coal is not washed, this is used mainly for dust suppression (Psi-Delta, 2010, p. 127; Western Downs Regional Council, 2012). The water is sourced through the use of groundwater bores and harvesting of overland flow (Psi-Delta, 2010, p. 120). Waste ash from the power station is mixed with a small amount of water and pumped back into mine voids for permanent storage. The total coal resource (measured and indicated) reported at the mine is 400 Mt (CS Energy, 2013).

1.2.2.1.4 Cameby Downs Mine

Cameby Downs Mine is an open-cut mining operation at ML 50233 about 30 km north-west of Chinchilla producing low ash, export quality thermal coal. Coal production at Cameby Downs Mine commenced in late 2010. The mine is owned by Yancoal which acquired the lease from the previous owners, Syntech Resources Pty Ltd, in 2011 (Yancoal Australia, 2012). Stage 1 of the project, currently in operation, is producing about 1.4 Mt/year of thermal coal (Clifford Chance, 2011) and onsite facilities include coal handling and preparation plants.

Resources at the mine comprise of 208 Mt measured, 247 Mt indicated and 233 Mt inferred and proved plus probable (2P) reserves of 440 Mt (proved 189 Mt and probable 251 Mt). Coal deposits are in the Juandah Coal Measures where a mineable (extractable using current procedures) coal unit of individual coal seams is up to 20 m thick. Conventional truck and shovel mining techniques are used at the mine. Some very low ash coal is taken straight to the stockpile, whereas other coal is processed onsite at the coal handling and preparation plant. The mine has a contract for using CSG water, which is used for dust suppression and washing coal at a rate of 1500 ML per year (Psi-Delta, 2010, p. 134).

The initial concept for the mine was a two stage development. The first stage is now complete and running at capacity. Subject to additional approvals and infrastructure becoming available, the capacity could be increased in the longer term to over 20 Mt/year of coal product during the second stage (Queensland Government, 2010; Yancoal Australia, 2012). As timing of infrastructure upgrades is unclear, expansion plan timing also remains uncertain (Yancoal Australia, 2012). Current water usage at the site is not reported.

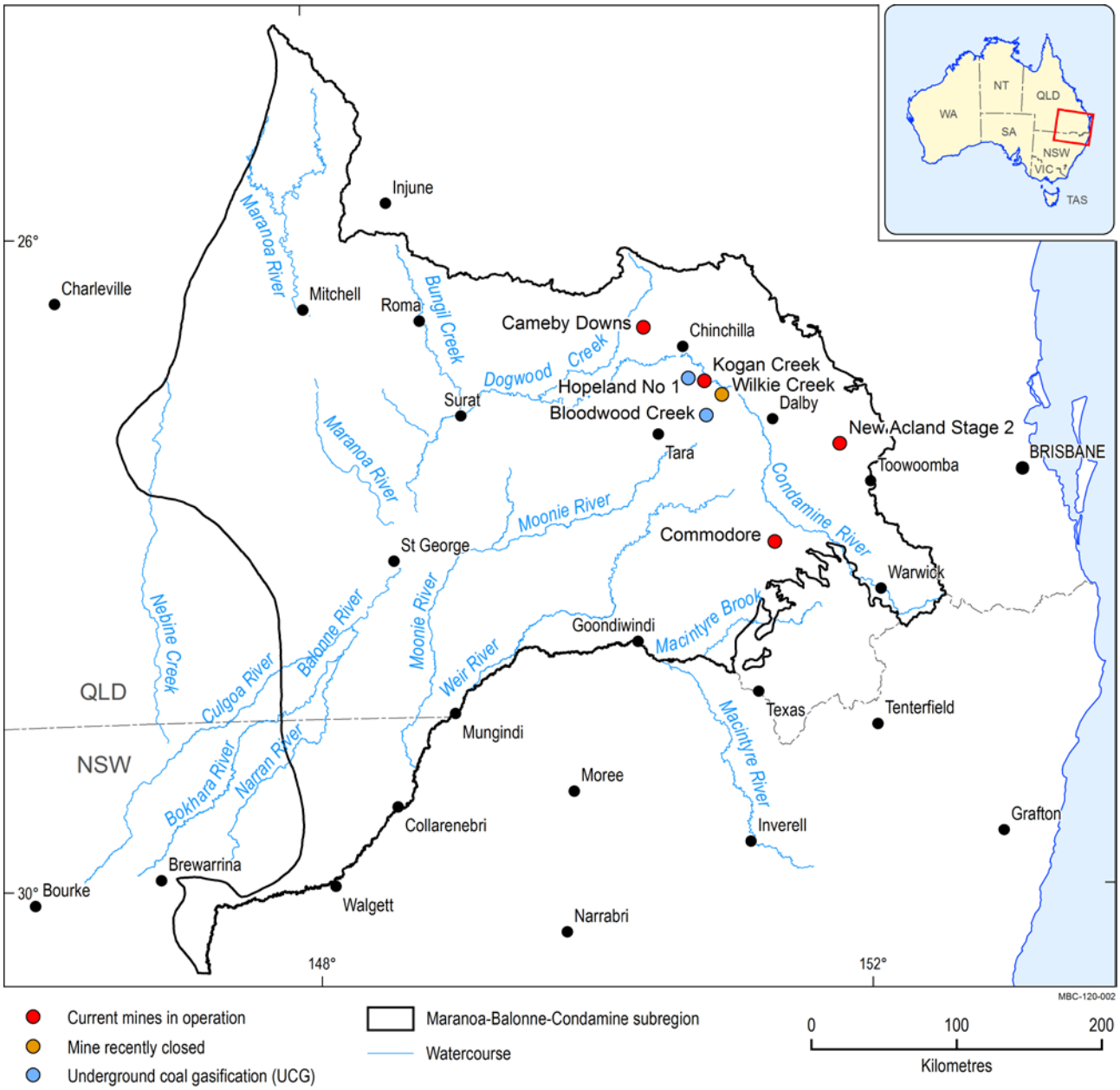

Figure 4 Location of current mines in the Maranoa-Balonne-Condamine subregion

Source data: DNRM (2014a), viewed 5 March 2014

1.2.2.2 Coal seam gas

This section includes all the currently operating CSG operations. For a development to be considered current, commercial production for that particular development needs to have commenced prior to December 2012.

Exploration and production testing for CSG from the Walloon Coal Measures of the Surat Basin began in 2000 with QGC's Argyle 1 well (approximately 25 km south-west of the town of Chinchilla) confirming the CSG potential (DNRM, 2014b). Further exploration revealed the extent of the resource and resulted in considerable exploration and production activity in the Maranoa-Balonne-Condamine subregion of the Surat Basin (Arrow Energy, 2012). Commercial CSG production in the Maranoa-Balonne-Condamine subregion first commenced in 2006 at Kogan North located west of Dalby, shortly followed by CSG recovery at Berwyndale South, south-west of

Chinchilla (DNRM, 2014b). The major CSG exploration and development companies in the subregion are Arrow Energy (owned by Royal Dutch Shell plc and PetroChina Company Limited), Origin Energy (as partner and operator of Australia Pacific LNG Pty Limited), QGC (a BG Group business), and Santos (as partner of Gladstone LNG). Maps showing current petroleum tenures and CSG wells within the Maranoa-Balonne-Condamine subregion are in Figure 5 and Figure 6. The data available from the IRTM (DNRM, 2014a) do not fully distinguish between CSG permits and conventional tenures (Figure 5). Not all the tenures indicated on the map are subject to CSG exploration or production. In Queensland the petroleum tenures that cover areas of exploration and production are called authority to prospect (ATP) and petroleum lease (PL). The ATP grants the holder the right for petroleum exploration, the PL gives its holder the right to explore for, test for, and produce petroleum (DNRM, 2014c). The term petroleum includes both conventional and unconventional (tight gas, shale gas, CSG) resources.

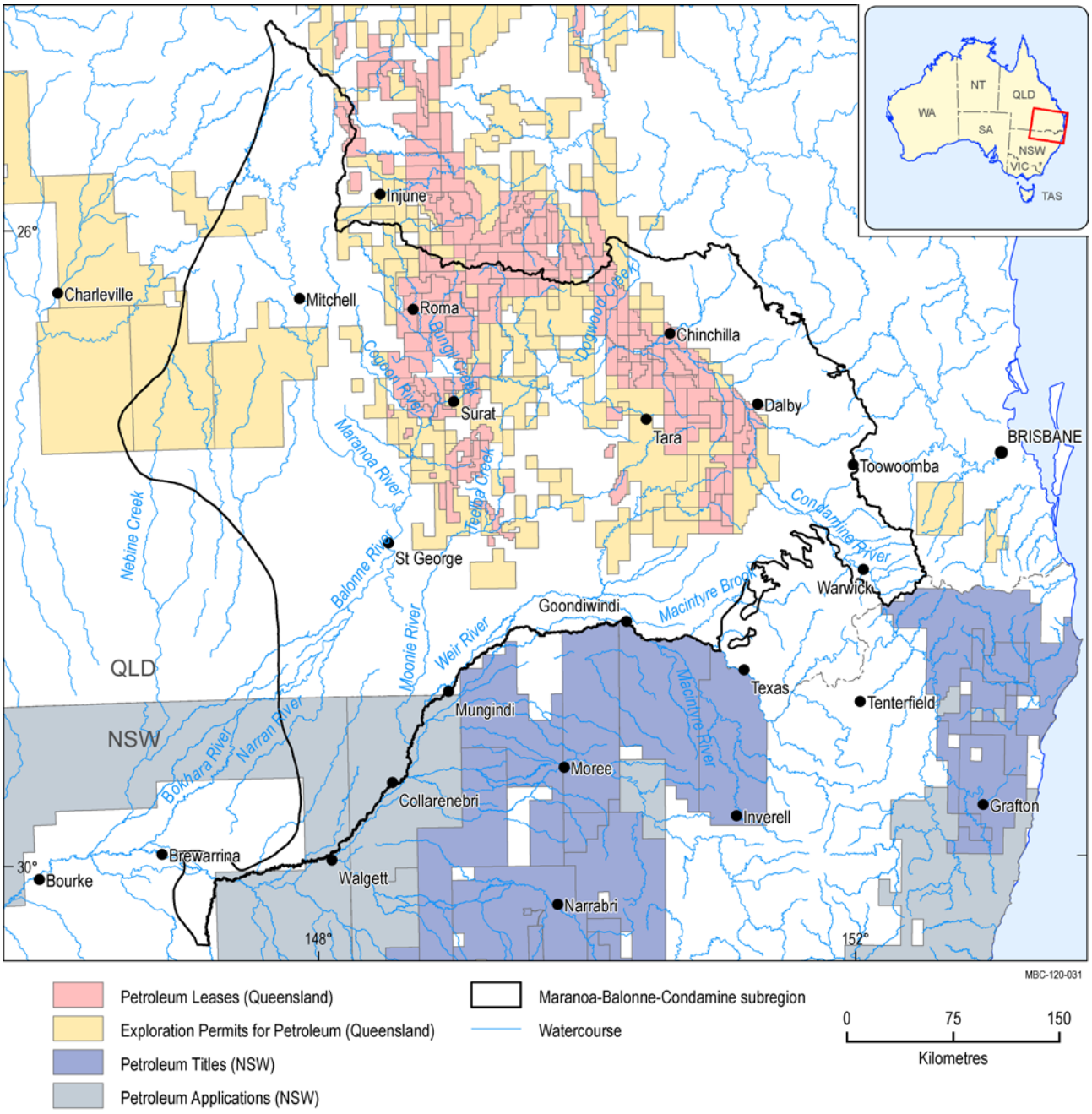

Figure 5 Petroleum tenures in the Maranoa-Balonne-Condamine subregion. The petroleum tenures cover both coal seam gas (CSG) and conventional petroleum activities

Source data: DNRM (2014a), viewed 21 August 2014; DTI (2014), viewed 21 August 2014

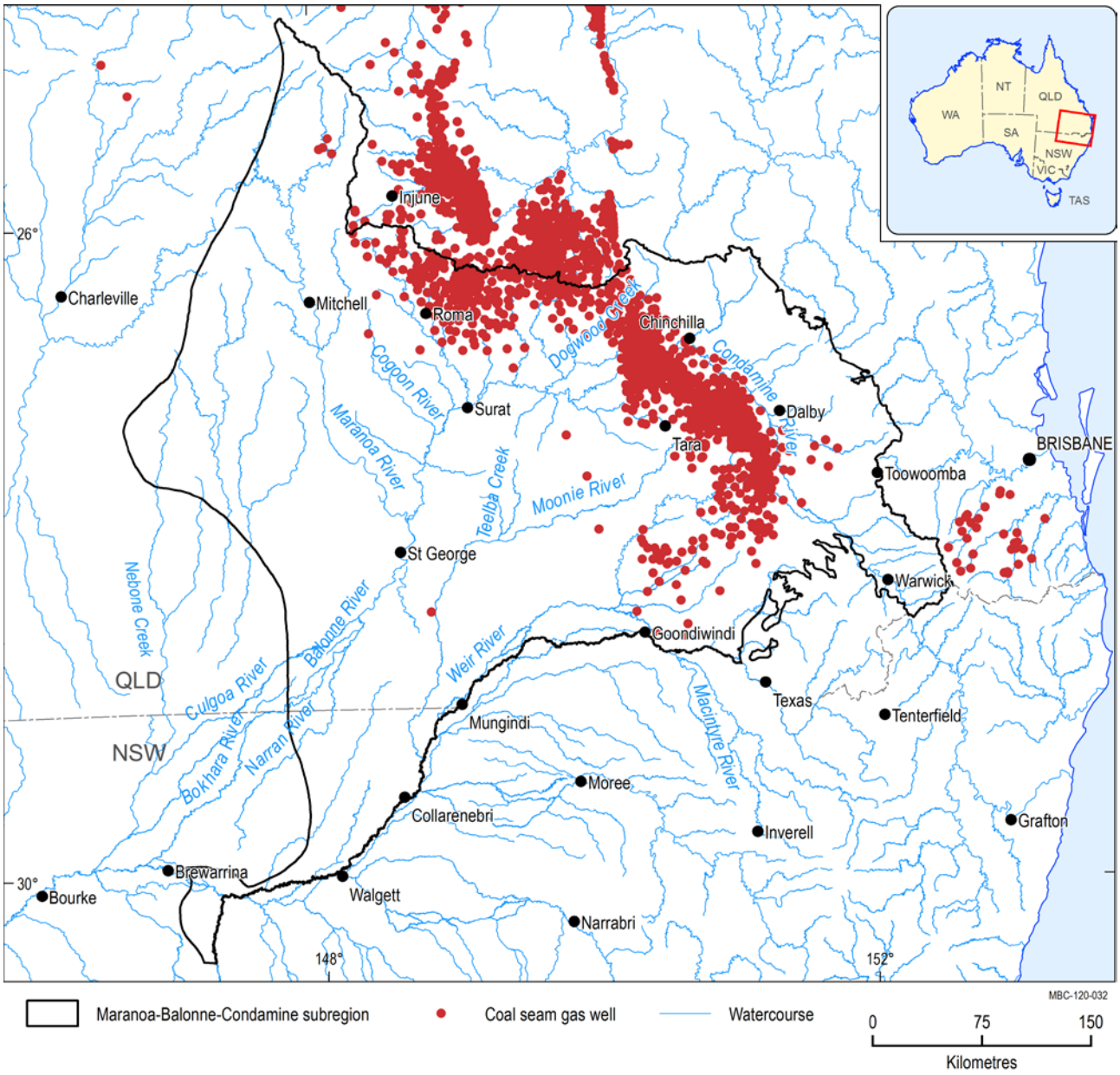

Figure 6 Coal seam gas wells in the Maranoa-Balonne-Condamine subregion. The wells include production, appraisal, and exploration wells

Source data: DNRM (2014a), viewed 21 August 2014

CSG field development in the Maranoa-Balonne-Condamine subregion has escalated in the recent past as a result of the construction of three large scale liquefied natural gas (LNG) projects on Curtis Island near Gladstone. A large portion of the gas to be supplied to the LNG projects will be extracted from the Walloon Coal Measures in the Maranoa-Balonne-Condamine subregion and transported to Curtis Island via pipelines. QGC, Origin Energy, and Santos are the operators of these LNG projects. As the projects were still under development as of 31 December 2012, they are described in Section 1.2.3.2 (Proposals and Exploration). However, part of the gas that is produced during the ramp-up phase of these projects is sold to the domestic market and gas fired power stations. This is further discussed in Section 1.2.2.2.7.

Petroleum leases for current CSG operations are in Figure 7. Currently, Arrow Energy operates the Daandine, Kogan North and Tipton West gas fields; Origin Energy operates the Talinga gas field;

and QGC operates the Argyle-Kenya, Lauren, Bellevue, Berwyndale, and Berwyndale South gas fields. Santos operated the Coxon Creek gas field north of Roma which has since been further developed to supply gas to the LNG project. The Department of Natural Resources and Mines listed the status of the Coxon Creek project as “in operation” for the financial year 2009 –10 (DEEDI, 2011), but for the financial year 2012–13 the status of the project (now called Roma) was given as “under development” (DNRM, 2014b). As the project’s status is under development, it is not depicted in the map below which shows current commercial CSG production in the subregion only. As indicated above, Santos’ CSG developments around Roma will be described in more detail in Section 1.2.3.

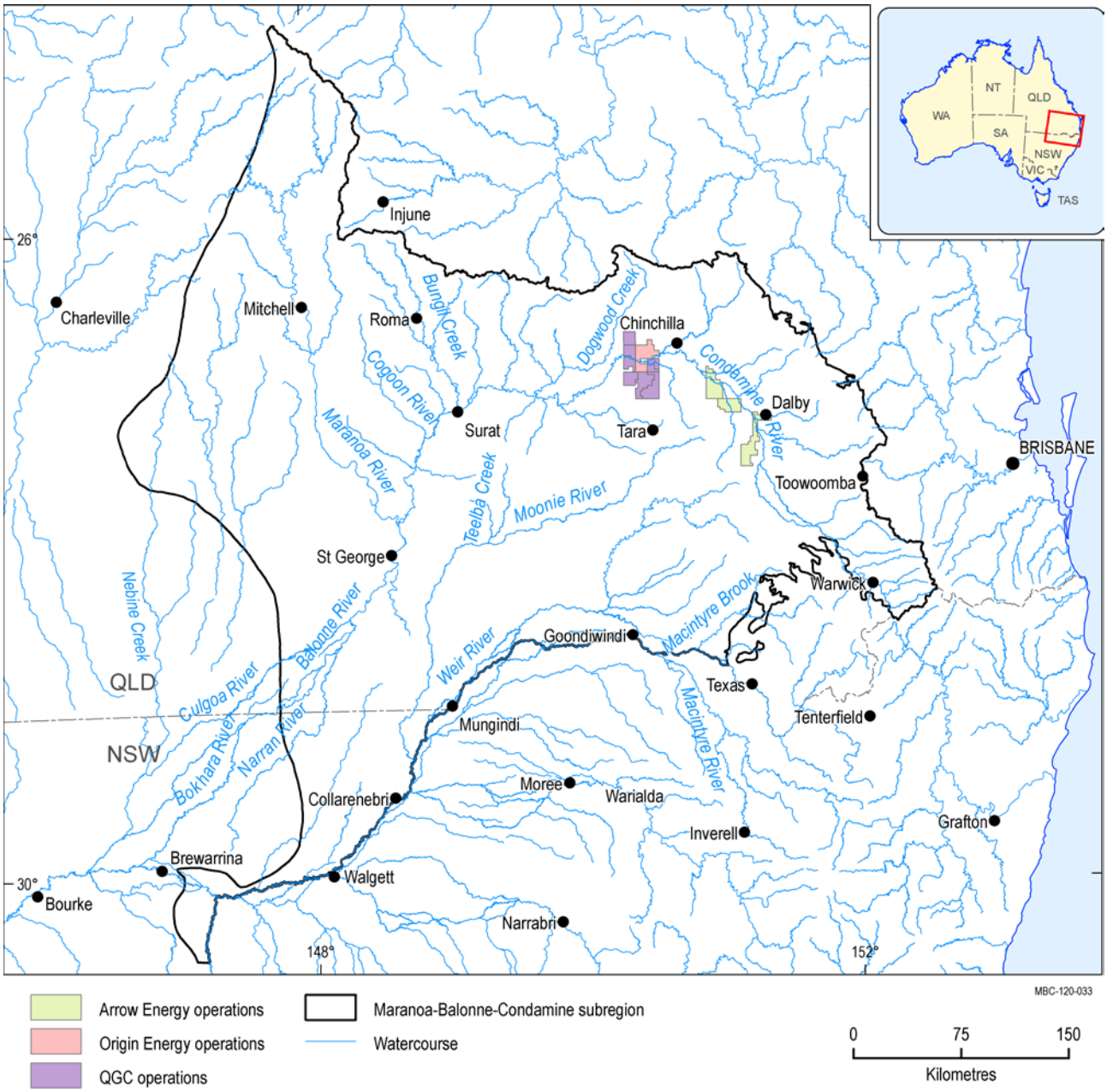

Figure 7 Petroleum leases covering current coal seam gas operations in the Maranoa-Balonne-Condamine subregion

Source data: DNRM (2014a), viewed 22 August 2014

1.2.2.2.1 Daandine

The Daandine gas field is owned and operated by Arrow Energy and located in Petroleum Lease (PL) 230, 40 km west of Dalby in the Surat Basin. Its location relative to other Arrow Energy operations (Kogan North and Tipton West) is shown in Figure 8. Target coals at Daandine are the Walloon Coal Measures. Commercial gas production commenced in September 2006 with produced gas supplied to the 30 megawatt (MW) Daandine Power Station (contracted for 2.2 petajoule per year (PJ/year)) and the 450 MW Braemar 2 Power Station. A 12 year supply of a combined 11.5 PJ/year to the Braemar 2 Power Station has been contracted from the Daandine and Stratheden (described in Section 1.2.3) gas fields (Arrow Energy, 2014). As of 31 December 2013 the 2P reserves at Daandine were 293 PJ (DNRM, 2014d). Under the proposed Surat Gas Project (one of five components of the Arrow LNG project), the Daandine gas field would be expanded to also supply CSG for LNG export (Arrow Energy, 2014, pers. comm.).

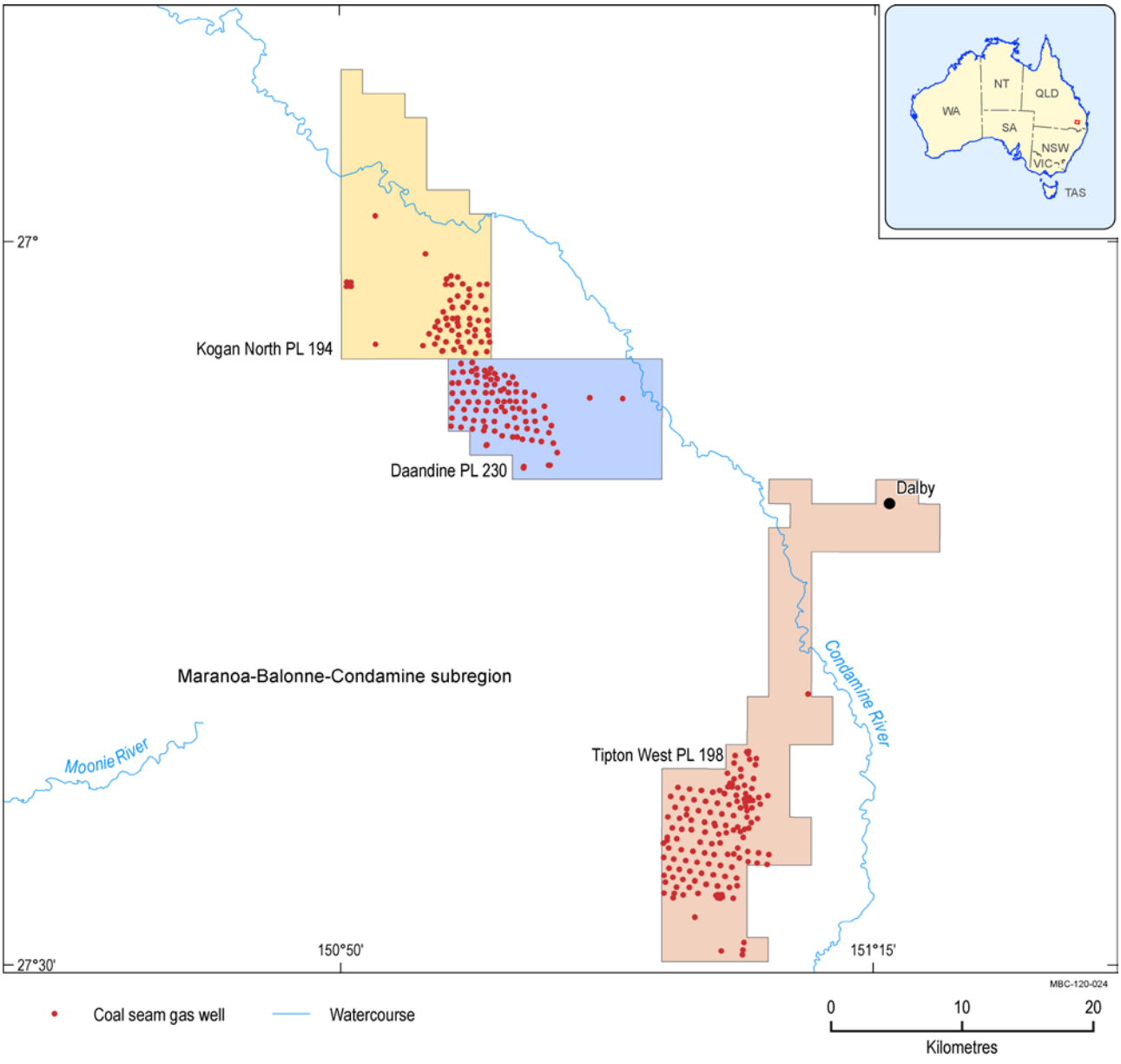

Figure 8 Currently operational Arrow Energy Pty Ltd gas fields within the Maranoa-Balonne-Condamine subregion: Kogan North (petroleum lease (PL) 194), Daandine (PL 230), and Tipton West (PL 198)

Source data: DNRM (2014a), viewed 21 August 2014

1.2.2.2.2 Kogan North Project

The Kogan North Project is in PL 194 (see Figure 8), 40 km west of Dalby in the Surat Basin. The project is operated by Arrow Energy and co-owned by Arrow Energy and Stanwell Corporation Ltd (Stanwell). Production began in January 2006 (Arrow Energy, 2014). The Kogan North gas field supplies 2 PJ/year to Stanwell which takes ownership of the gas at Energy Infrastructure Investments' (EII) Kogan North Gas Processing Facility (Arrow Energy, 2014). As of 31 December 2013 the 2P reserves at Kogan North were 364 PJ (DNRM, 2014d).

1.2.2.2.3 Tipton West

The Tipton West gas field is owned and operated by Arrow Energy and is located in PL 198 (see Figure 8), 20 km south of Dalby in the Surat Basin. Commercial production began in September 2006 and the gas produced is processed at the Tipton West Central Gas Processing Facility (Arrow Energy, 2014, pers. comm.). The Tipton West field is contracted to supply 6 PJ/year to the Braemar 1 Power Station and 3.5 PJ/year to the Braemar 2 Power Station for 15 years (Arrow Energy, 2014). The project has 2P reserves of 691 PJ as of 31 December 2013 (DNRM, 2014d). Under the proposed Surat Gas Project (one of five components of the Arrow LNG project), the Tipton West gas field would be expanded to also supply CSG for LNG export (Arrow Energy, 2014, pers. comm.).

1.2.2.2.4 Talinga Coal Seam Gas Project

The Talinga CSG Project is co-owned and operated by Origin Energy as part of the Australia Pacific LNG Pty Limited (APLNG) partnership. It is located in PL 226 near Chinchilla in the central Walloon fairway between the Berwyndale South and the Argyle-Kenya CSG fields (see Figure 7), which are co-owned and operated by QGC. The current development at the Talinga gas field is indicated in Figure 9. The Talinga CSG Project consists of 111 operating CSG wells (Origin Energy, 2011) with a current mean field production rate of 98 terajoules per day (TJ/day) reported for the March 2014 quarter (Origin Energy, 2014). Commercial production in Talinga started December 2007 (Miningoilgas, 2014b). The gas is processed at the Talinga Gas Processing Facility, which currently has a capacity of 120 TJ/day with a planned expansion to 140 TJ/day (AEMO, 2013). The Talinga Gas Processing Facility supplies gas to power stations and other commercial clients (Origin Energy, 2011). The 2P reserves at Talinga were 569 PJ as of 31 December 2013 (DNRM, 2014d).

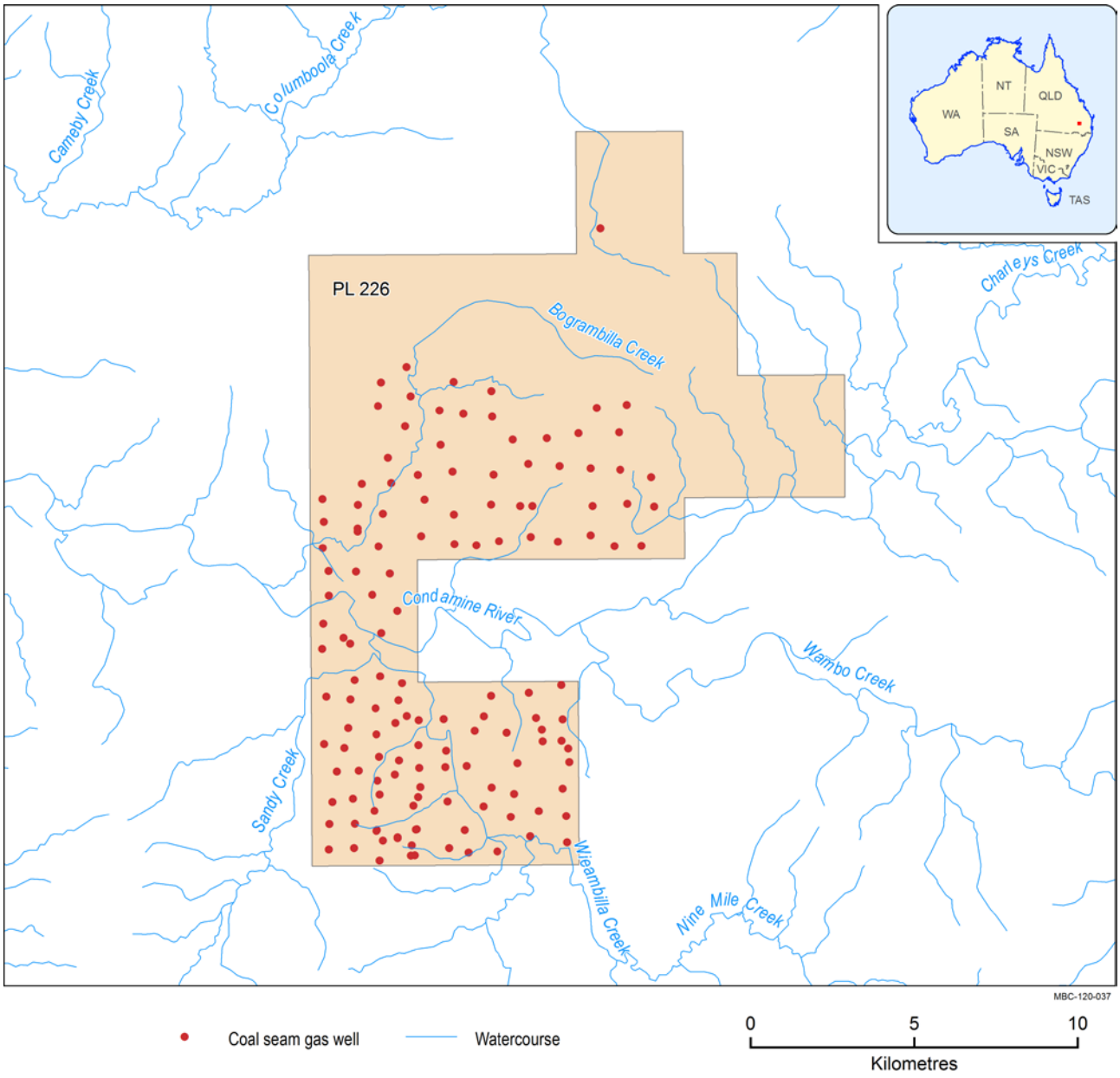

Figure 9 Current development of the Talinga Coal Seam Gas Project in PL 226

Source data: DNRM (2014a), viewed 21 August 2014
PL = petroleum lease

1.2.2.2.5 Argyle, Kenya, Lauren coal seam gas fields

The combined Argyle-Kenya gas field is 25 km south-west of Chinchilla in the central Walloon fairway (Miningoilgas, 2014c) and extends over PL 179, 180, 228 and 229, as indicated in Figure 10. The Argyle and Kenya gas fields have a total of about120 development wells (GPinfo, 2014) with a mean daily production rate of 149 TJ reported for the March 2014 quarter (Origin Energy, 2014). The tenure PL 180 also includes the Lauren gas field, which extends into PL 263 (see Figure 10). This gas field currently has approximately 110 development wells (as of October 2014) (GPinfo, 2014).

The 2P reserves of the five petroleum leases in which these three gas fields are located are summarised in Table 4. Their combined 2P reserves are 2669 PJ as of 31 December 2013 (DNRM, 2014d). The majority stakeholders of these tenures are APLNG, QGC, and Coal Seam Gas

Company Pty Ltd (CNOOC) with QGC acting as the operator. The target coals are the Walloon Coal Measures. Gas processing occurs at the Windibri Gas Processing Facility, which has a capacity of 144 TJ/day, and the Kenya Central Gas Processing Facility, which has a capacity of 180 TJ/day (QGC feedback, received 15 August 2014). The processed gas is supplied to Incitec Pivot's Ammonia Plant (74 PJ over 10 years) (Miningoilgas, 2014c) and QGC's 140 MW Condamine Power Station (Australian Mining Link, 2013a).

Table 4 Petroleum leases and corresponding 2P reserves for the Argyle, Kenya, and Lauren gas fields in the Maranoa-Balonne-Condamine subregion as of December 2013

Petroleum Lease	2P Reserves (PJ)
PL 179	253
PL 180	866
PL 228	904
PL 229	99
PL 263	547
Total	**2669**

Source data: DNRM (2014d)
Code 2P refers to estimated quantities of proved reserves plus probable reserves

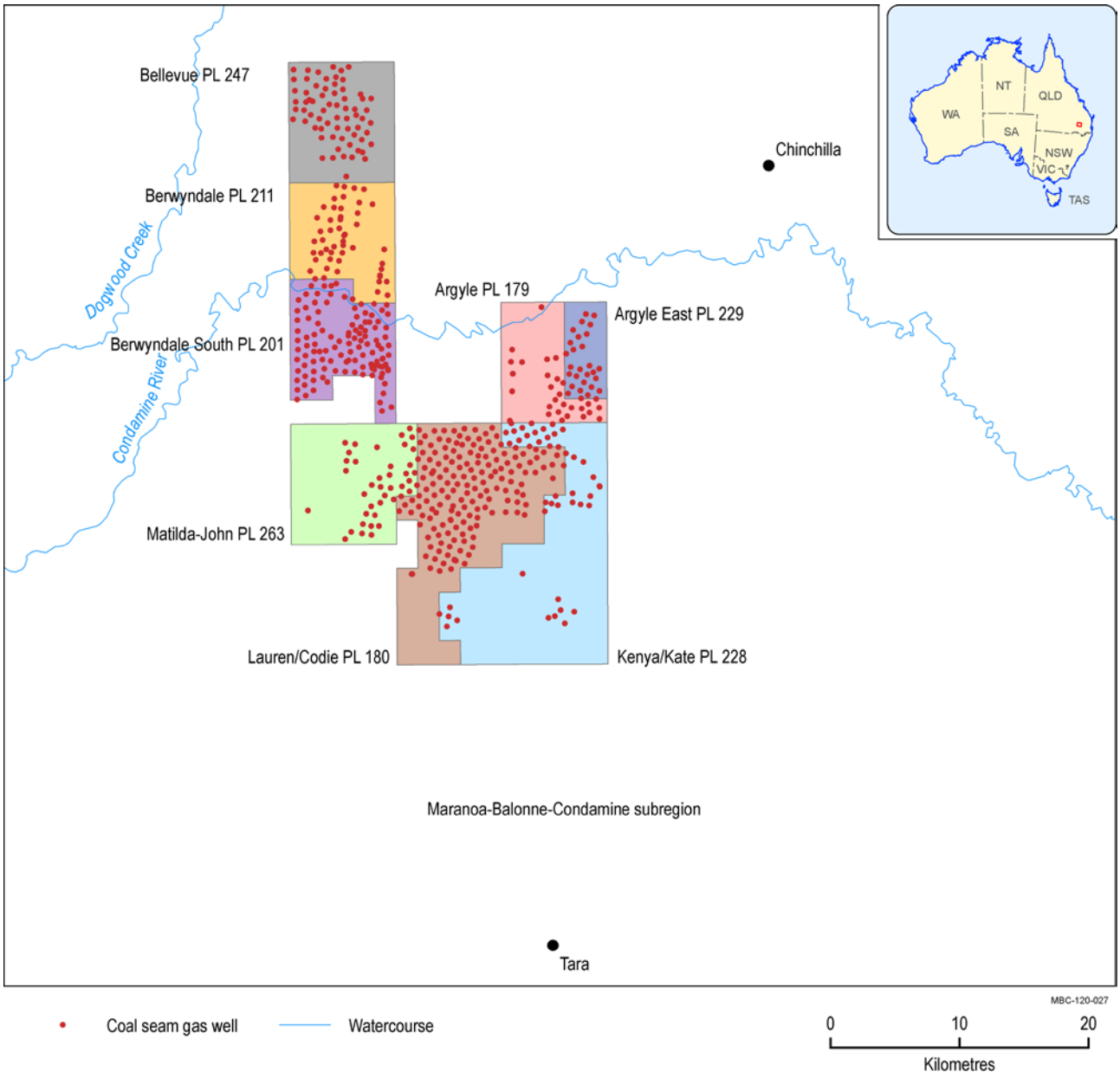

Figure 10 QGC Limited tenures with coal seam gas operations in the Maranoa-Balonne-Condamine subregion: Argyle-Kenya (PL 179, PL 180, PL 228, PL 229), Lauren (PL 180, PL 263), Berwyndale (PL 211), Berwyndale South (PL 201), and Bellevue (PL 247)

Source data: DNRM (2014a), viewed 21 August 2014
PL = petroleum lease

1.2.2.2.6 Bellevue, Berwyndale and Berwyndale South coal seam gas fields

The Berwyndale and Berwyndale South gas fields are co-owned by QGC and CNOOC and operated by QGC. The gas fields are in PL 201 and PL 211, 32 km south-west of Chinchilla in the Surat Basin as shown in Figure 10. At Berwyndale South field development started in August 2005 with the first commercial gas production occurring May 2006. Mean daily gas flow was about 70 TJ/day before it was reduced to 50 TJ/day to enable other nearby CSG fields to be brought into production (Australian Mining Link, 2013b).

The Bellevue gas field, adjoining the Berwyndale gas field in the north in PL 247, is operated by QGC with majority shareholdings by QGC, APLNG, and CNOOC. Mean gas production at Bellevue equalled 24 TJ/day for the March 2014 quarter (Origin Energy, 2014).

Gas produced from the three gas fields is processed at the Windibri gas processing plant which also processes gas from the Argyle, Kenya, and Lauren gas fields (Australian Mining Link, 2013b). The processed gas is supplied to AGL Energy Limited, the 500 MW Braemar 1 and 450 MW Braemar 2 power stations, the 140 MW Condamine Power Station, Incitec Pivot, CS Energy, and others (AEMO, 2013). In the future gas is likely to be supplied to QGC's LNG project (AEMO, 2013).

Remaining 2P reserves at Berwyndale South, Berwyndale, and Bellevue were quoted as 273 PJ, 326 PJ, and 344 PJ respectively as of December 2013 (DNRM, 2014d).

1.2.2.2.7 Gas production for liquefied natural gas projects

Three large scale LNG projects are currently under construction on Curtis Island near Gladstone. These will obtain at least part of their gas supply from gas fields in the Surat Basin in the Maranoa-Balonne-Condamine subregion. These are the Queensland Curtis LNG (QCLNG) Project, the Gladstone LNG (GLNG) Project, and the Australia Pacific LNG (APLNG) Project which are described in more detail in Section 1.2.3.2 (Proposals and Exploration). Due to the characteristics of CSG recovery, CSG production typically does not peak immediately but requires depressurisation of the seams through water production and only peaks after months or even years of recovery. Therefore, gas extraction commences before commissioning of the LNG facilities to allow time to ramp-up production. Strategies to manage ramp-up gas include sale to the domestic market, supply to gas fired power stations, and underground storage (APLNG, 2010; QGC, 2009; Santos, 2009). Thus, the gas fields of the LNG developments already produce and sell gas before the commercial LNG operation commences.

References

AEMO (2013) 2013 GSOO Gas facilities. Australian Energy Market Operator, Sydney. Viewed 16 April 2014, <http://www.aemo.com.au/Gas/Planning/Gas-Statement-of-Opportunities/GSOO-2013-Gas-Processing-Transmission-and-Storage-Facilities>.

APLNG (2010) Australia Pacific LNG Project environmental impact statement. Australia Pacific LNG Pty Limited, Brisbane.

Arrow Energy (2012) Surat Gas Project, environmental impact statement. Arrow Energy Pty Ltd, Brisbane.

Arrow Energy (2014) Surat domestic gas business. Arrow Energy Limited, Brisbane. Viewed 15 August 2014, <http://www.arrowenergy.com.au/projects/domestic-gas-business/surat-domestic-gas-business>.

Australian Mining Link (2013a) Argyle Kenya. Australian Mining Link. Viewed 15 March 2014, <http://mininglink.com.au/mine/argyle--kenya>.

Australian Mining Link (2013b) Berwyndale South. Australian Mining Link. Viewed 17 April 2014, <http://mininglink.com.au/mine/berwyndale-south>.

Clifford Chance (2011) Clifford Chance advises on sale of Syntech Resources to Yancoal Australia. Clifford Chance, Sydney. Viewed 6 March 2014, <http://www.cliffordchance.com/news/news/2011/07/clifford_chance_advisesonsaleofsyntechresourcestoyancoalaustrali.html>.

CS Energy (2013) Kogan Creek fact sheet. CS Energy, Brigalow, Queensland. Viewed 3 January 2014, <http://www.csenergy.com.au/userfiles/file/Kogan%20Creek%20Mine%20fact%20sheet%20-%20April%202013.pdf>.

CS Energy (2012) Annual report 2011/2012. Brigalow, Queensland.

DEEDI (2011) Queensland's coal seam gas overview. Queensland Government, Department of Employment, Economic Development and Innovation, Brisbane.

DNRM (2013) Independent scientific panel report on underground coal gasification pilot trials. Queensland Government Department of Natural Resources and Mines, Australia. Viewed 7 May 2014, <http://mines.industry.qld.gov.au/assets/legislation-pdf/isp-final-report-cs-review.pdf>.

DNRM (2014a) Queensland Government interactive resource and tenure maps (IRTM) system. Queensland Government Department of Natural Resources and Mines, Brisbane., <http://webgis.dme.qld.gov.au/webgis/webqmin/viewer.htm>.

DNRM (2014b) Queensland's coal seam gas overview. Queensland Government Department of Natural Resources and Mines, Brisbane. Viewed 01 September 2014, <http://mines.industry.qld.gov.au/assets/coal-pdf/csg-update-2014.pdf>.

DNRM (2014c) Petroleum and gas tenure types and forms. Queensland Government Department of Natural Resources and Mines, Brisbane. Viewed 30 June 2014, <http://mines.industry.qld.gov.au/mining/petroleum-gas-tenures.htm>.

DNRM (2014d) Coal seam gas reserves 1 January 2005 to 31 December 2013. Queensland Government Department of Natural Resources and Mines, Brisbane. Viewed 29 August 2014, <http://mines.industry.qld.gov.au/mining/production-reserves-statistics.htm>.

Downer EDI (2007) Maintaining a 'step change' approach in health and safety. The Commodore Mine Experience, Australia. Viewed 15 April 2014, <http://www.qrc.org.au/conference/_dbase_upl/Newman_Weeden_Davies_CommodoreMine_DownerEDI.pdf>.

DTI (2014) MinView. New South Wales Government Department of Trade and Investment, Resources and Energy, Sydney. <http://minview.minerals.nsw.gov.au/mv2web/mv2>.

GPinfo (2014) Encom GPinfo version 5.8.2. Pitney Bowes Software Pty Ltd, Sydney. Viewed 3 October 2014.

Intergen (2014) Millmerran operations. Viewed 15 April 2014, <http://www.intergen.com/millmerran/>.

Linc Energy (2007) Underground coal gasification gas to liquids and power generation project – terms of reference for an environmental impact statement. Linc Energy Ltd. Viewed 7 May 2014, <http://www.dsdip.qld.gov.au/resources/project/linc-energy/linc-energy-tor.pdf>.

Linc Energy (2013) ASX announcement – UCG at Chinchilla to decommission after 14 successful years of operations and move offshore, 4pp. Viewed 4 March 2014, <http://www.lincenergy.com/data/asxpdf/ASX-LNC-518.pdf>.

Miningoilgas (2014a) Surat Gas Project – Stratheden. Miningoilgas Pty Ltd, Perth. Viewed 28 March 2014, <http://www.miningoilgas.com.au/index.php/products/energy?energy2Task=energy2Details&catid=3&energy2Id=92>.

Miningoilgas (2014b) Talinga Project. Miningoilgas Pty Ltd, Perth. Viewed 30 March 2014, <http://www.miningoilgas.com.au/index.php/products/energy?energy2Task=energy2Details&catid=3&energy2Id=101>.

Miningoilgas (2014c) Argyle-Kenya. Miningoilgas Pty Ltd, Perth. Viewed 15 March 2014, <http://www.miningoilgas.com.au/index.php/products/energy?energy2Task=energy2Details&catid=3&energy2Id=94>.

New Hope Group (2012b) New Acland – current operations. New Hope Group. Viewed 3 January 2014, <http://www.newhopegroup.com.au/content/projects/operations/new-acland-1/new-acland-current-operations>.

New Hope Group (2012a) New Acland coal mine: Stage 3 project revised project overview, 42pp. Viewed 3 January 2014, <http://www.dsdip.qld.gov.au/resources/project/new-acland-coal-mine/nacp-project-overview.pdf>.

New Hope Group (2013) New Acland coal mine project fact sheet, 2pp. Viewed 3 January 2014, <http://www.aclandproject.com.au/files/files/130828%20New%20Acland%20Coal%20Mine%20Fact%20Sheet.pdf>.

Origin Energy (2011) Facts about Talinga – factsheet. Origin Energy Limited, Brisbane. Viewed 16 April 2014, <http://www.aplng.com.au/pdf/factsheets/Talinga_gas_field.pdf>.

Origin Energy (2014) March 2014 Quarterly Production Report. Origin Energy Limited, Brisbane. Viewed 30 June 2014, <http://www.originenergy.com.au/news/files/quarterly_production_report_march_2014.pdf>.

Peabody Energy (2013) Peabody Energy announces closure of Wilkie Creek Mine in Australia, St Louis 9 December 2013. Viewed 5 March 2014, <http://www.peabodyenergy.com/content/501/Press-Releases/2013>.

Psi-Delta (2010) South west Queensland water demand analysis, non-urban demand, Healthy HeadWaters Coal Seam Gas Water Feasibility Study, prepared for the State of Queensland (Department of Environment and Resource management), 187pp. Viewed 19 August 2014, <http://www.dnrm.qld.gov.au/__data/assets/pdf_file/0014/106106/swq-water-demand-nonurban-report.pdf>.

QGC (2009) Queensland Curtis LNG – environmental impact statement. QGC Limited, Brisbane.

QGC (2014) Feedback on draft chapter 1.2 Maranoa-Balonne-Condamine subregion, received 15 August 2014.

Queensland Government EPA (2006) Assessment report for the *Environmental Protection Act 1994* about the environmental impact statement for the New Acland Coal Mine Stage 2 Expansion Project, proposed by New Acland Coal Pty Ltd. Queensland Government Environmental Protection Agency, 29pp. Viewed 4 March 2014, <http://www.ehp.qld.gov.au/management/impact-assessment/eis-processes/new_acland_coal_expansion_project.html>.

Queensland Government (2010) Terms of reference for the Cameby Downs Expansion Project EIS, 49pp. Viewed 4 March 2014, <http://www.ehp.qld.gov.au/management/impact-assessment/eis-processes/documents/cameby_downs_expansion_project_final_tor_final.pdf>.

Santos (2009) GLNG Project – environmental impact statement. Santos Ltd, Brisbane.

Western Downs Regional Council (2012) Major Projects, Kogan Power Project, Fact sheet, 1pp <http://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=5&ved=0CDgQFjAE&url=http%3A%2F%2Fwww.advancewesterndowns.com.au%2FLiteratureRetrieve.aspx%3FID%3D94545&ei=Sr7EU6jLFcellAWgp4DgBw&usg=AFQjCNEreF2j506ApI0NG5gfCUy9bK66Gw&bvm=bv.70810081,d.dGI>.

Yancoal Australia (2012) Fact sheet – Cameby Downs coal mine. Viewed 4 March 2014, <http://www.yancoal.com.au/icms_docs/122124_Cameby_Downs_Coal_Mine_Fact_Sheet.pdf>.

1.2.3 Proposals and exploration

Summary

There are currently five active coal mine proposals in the Maranoa-Balonne-Condamine subregion. Of these, three are new mines and two are expansion projects and are all in the east and north-east of the subregion. The New Acland Coal Mine Stage 3 Project is an expansion of current open-cut mining, which will introduce three new pits and extend mining at the site until approximately 2042, for which an environmental impact statement (EIS) has been lodged. The Range is a new open-cut mine project for which the target coal will be 20 to 120 m below the surface and will consist of three open pits where low-emission (low emissions of NO_2, SO_x, particulates and CO_2 relative to other traded coals), thermal quality coal will be mined. The coal seams are dipping gently to the west (meaning that they are more shallow towards the east) and an EIS has been submitted for The Range. A coal-to-liquids project (where mined coal will be converted to liquid fuel) has been proposed in the subregion in the name of ambreCTL. The mine will be open-cut and although an EIS has been lodged it is currently listed as 'withdrawn' and its present status is not clear. The Cameby Downs Expansion Project seeks to extend the life of the existing Cameby Downs Mine by up to 40 years. An EIS will need to be submitted so that mining can occur on existing and adjoining mining leases to the present Cameby Downs Mine if approved. The Columboola Project will target coals that are down dip to those extending from Cameby Downs Mine and will be extracted through underground mining. This project is still at the exploration stage and an EIS has not been lodged.

Coal exploration is largely in the north-west, north and east of the subregion. There are currently approximately 190 exploration permits for coal (EPCs) granted in the Maranoa-Balonne-Condamine subregion.

Several coal seam gas (CSG) projects are currently under construction within the Maranoa-Balonne-Condamine subregion to supply gas to three large scale liquefied natural gas (LNG) projects on Curtis Island: the Queensland Curtis LNG Project, the Gladstone LNG Project, and the Australia Pacific LNG Project.

The Stratheden gas field, a comparatively small development, is expected to supply gas to the domestic market. The gas field has been drilled and commissioned.

Another proposed large scale CSG development is the Surat Gas Project. The Surat Gas Project received State and Australian Government approval in 2013, but no financial commitment has been made to date. Other proposed CSG projects are the Gladstone LNG Gas Field Development Project and the Ironbark Project for which EIS are currently being prepared.

Exploration in the Walloon Coal Measures of the Surat Basin in the subregion is being carried out by a number of smaller companies (e.g. Icon Energy Limited, Senex Energy Limited) as well as the four large CSG companies: Arrow Energy Pty Ltd, Origin Energy Limited, QGC Limited, and Santos Ltd.

1.2.3.1 Coal

At present there are five coal mine proposals in the Maranoa-Balonne-Condamine subregion, each at different stages of development. These are:

- New Acland Coal Mine Stage 3 Project
- The Range
- ambreCTL Project
- Cameby Downs Expansion Project
- Columboola Project.

Of these, three are new mines and two are expansion projects. Of the three new mines, one is underground and two are open-cut. Both of the expansion projects are also open-cut. They are in the east and north-east of the subregion (Figure 11).

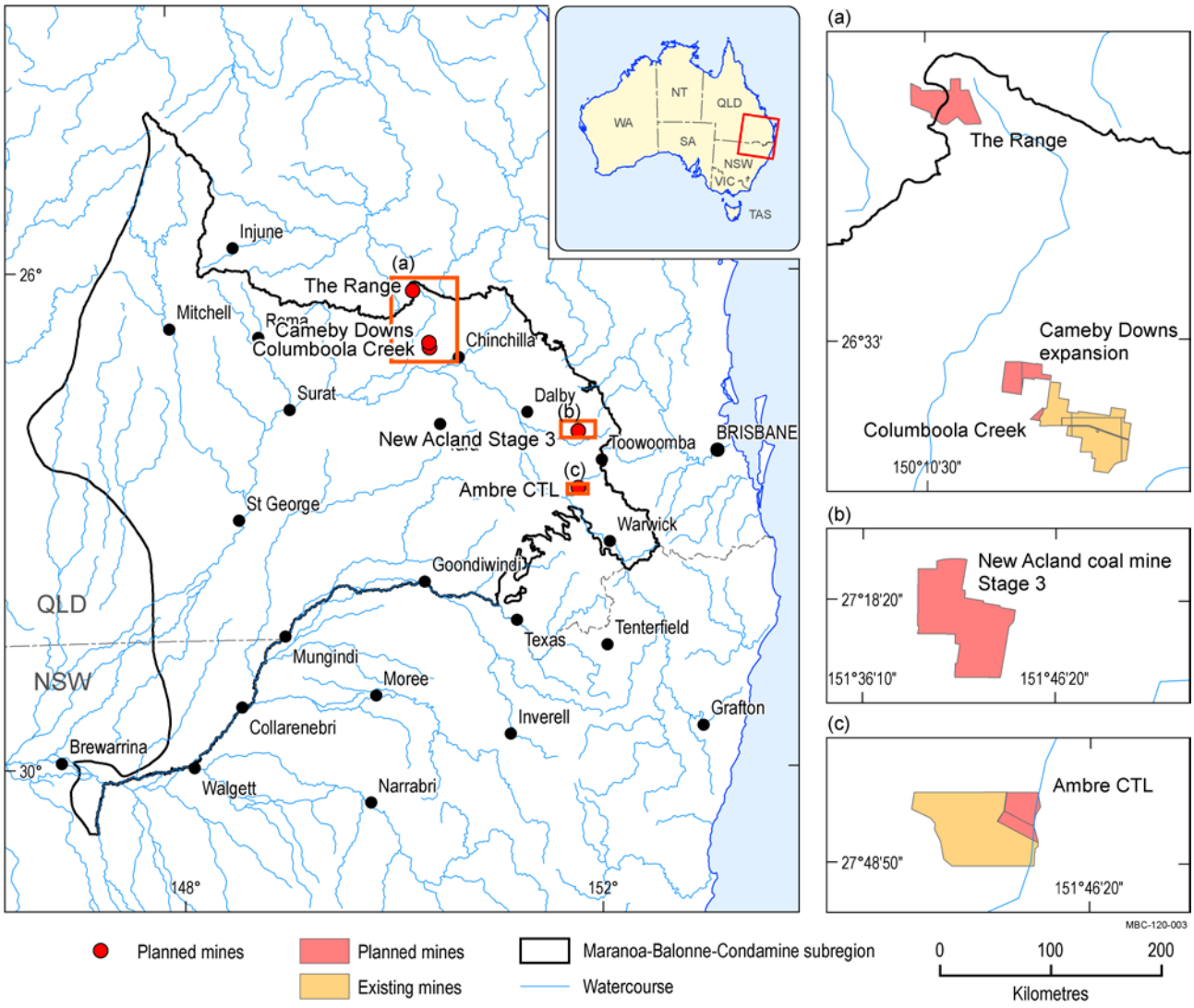

Figure 11 Locations of proposed coal mine projects in Maranoa-Balonne-Condamine subregion with insets showing each mining lease for each project

Source data: DNRM (2014a), viewed 5 March 2014

1.2.3.1.1 New Acland Coal Mine Stage 3 Project

New Acland Coal Pty Ltd, a subsidiary of New Hope Corporation Ltd (and part of the New Hope Group), are currently planning an expansion of the existing New Acland open-cut mine, to be known as the New Acland Coal Mine Stage 3 Project. This project is situated in the Clarence-Moreton Basin and will be mining the Walloon Coal Measures. Originally lodged in 2009, a plan that proposed the progressive expansion of the current mine up to a capacity of 10 Mt/year, extending the mine life until approximately 2042, was substantially revised and is further described here. The current plans (presently a new draft environmental impact statement (EIS)) for the expansion have been lodged with Queensland Government Department of State Development, Infrastructure and Planning as a Coordinator-General project (Queensland Government DSDIP, 2014) after public consultation of these plans in January to March 2014.
In 2007, the Federal Environment Minister declared that the project was a controlled action (under the *Environment Protection and Biodiversity Act 1999* (EPBC Act)) and in 2012 accepted project variations as an amendment (New Hope Group, 2014a, p. 13).

The extension project plans include site access construction, roads, water management structures and supporting infrastructure from 2015 to 2017 (New Hope Group, 2014b, p. 3-20). Supporting infrastructure will include an administration area, workshop and wash-down bay, fuel storage area, two process-water dams, stockpile pads, licensed water bores, upgrades to the existing coal handling and preparation plant and supporting infrastructure, a new coal load-out facility and an approximately 8 km rail spur in addition to water management and power supply upgrades and relocation (Queensland Government DSDIP, 2014; New Hope Group, 2014b, p. 3-48). The extension project will extend the life of the current operation until about 2029 (New Hope Group, 2014b, p. 1).

The extension project will be performed within Mining Lease Application (MLA) 50232 and involves the extension and operation of the existing New Acland Mine to increase production from 4.8 Mt/year to 7.5 Mt/year of thermal product coal (New Hope Group, 2012, p. 8, 2014b, p. 1-8). The Queensland Government reported resources at the expansion site to be 500 to 1000 Mt (Queensland Government, 2013a).

The project includes mining in three new pits (Manning Vale West, Manning Vale East and Willeroo) (New Hope Group, 2014b, p. 3-1) using open-cut mining techniques. This will progressively extend current mining activities to parts of the Manning Vale and Willeroo resources.

Out-of-pit spoil dumps will be created to accommodate material that is beyond the dumping capacity of the pit but will be kept to a minimum as most waste will be used to progressively back-fill the pits (New Hope Group, 2014b, p. 3-34). A life-of-mine development schedule shows progressive pit development per financial year from 2017–18 through to 2027–29, generally showing mining progressing from north to south across each pit over time (New Hope Group, 2014b, p. 3-21).

Water usage for the revised project is estimated to be 3300 ML/year (New Hope Group, 2014b, p. 2-19). Water supply for the project will primarily be sourced from on-site storage, but can be supplemented by external water supply. Water from the site's disturbed area will be diverted to sediment dams for treatment and possible reuse to supplement the mine's supply and potentially contaminated water will receive additional levels of treatment and will be preferentially reused onsite (New Hope Group, 2014b, p. 40). The main external water supply option is from the Toowoomba Regional Council Wetella Wastewater Reclamation Facility (WWRF) (New Hope Group, 2014b, p. 2-19) via a long term contract to the year 2055 that allows New Acland Coal to purchase up to 5550 ML/year from the WWRF utilising a 45 km pipeline that was constructed in 2009 (New Hope Group, 2014b, p. 2-19, 3-79). Potable water will be sourced from aquifers via groundwater bores, treated on-site by a reverse osmosis treatment plant (New Hope Group, 2014b, p. 3-79). New Hope Coal currently has a groundwater use licensed capacity of up to 1412 ML/year (New Hope Group, 2014b, p.2-19). A small amount of additional water (up to 150 ML/year) may be sourced from the Oakey Reverse Osmosis Water treatment plant (New Hope Group, 2014b, p. 3-79, 5-4).

1.2.3.1.2 The Range

Stanmore Coal Limited (Stanmore Coal) have performed a Pre-Feasibility Study and Feasibility Study (the latter, completed April 2013) for a new open-cut coal mine, The Range, at MLA 55001, 55009 and 55010, 25 km south-east of Wandoan in the Surat Basin (Stanmore Coal, 2014; Queensland Government EHP, 2013a, 2013b). Coal targets are expected to be the Pelham Seam within the Taroom Coal Measures that occurs through much of The Range project area (Western Downs Regional Council, 2011). An EIS assessment report was submitted by Stanmore Coal to the Department of Environment and Heritage Protection in April 2013 (Queensland Government EHP, 2013b). Geological interpretation was performed using information from 300 drilled holes, of which 140 were cored. Depth of cover to top of first coal is less than 20 m. Seams dip about one degree towards the west (Stanmore Coal, 2014). The coal is export quality, low-emission (low emissions of NO_2, SO_x, particulates and CO_2 relative to other traded coals) thermal coal and it is expected the mine will produce a mean of 5 million tonnes per year (Mt/year) up to 6.7 Mt/year, with a total of 157 Mt over the mine life of 26 years (Queensland Government EHP, 2013b, p. 1). The project has an estimated reserve of 94 Mt and a total resource of 287 Mt (18 Mt measured, 187 Mt indicated, and 82 Mt inferred) (Stanmore Coal, 2014).

The project consists of three open pits (two initially and the third being developed in the final years), targeting coal seams that are between 20 and 120 m below the natural ground surface, covering a maximum extent of approximately 2200 hectares (ha), including in-pit disposal areas (Queensland Government EHP, 2013b, p. 1–2). The mine will perform conventional truck and shovel mining methods to deliver coal to an onsite coal handling and preparation plant.

Clearing of approximately 183.85 ha of remnant vegetation on MLA 55001 with an additional 3.37 ha for the transport corridor and train loading facility is planned (Queensland Government EHP, 2013b, p. 2). Approximately 8 million cubic metres of topsoil will be removed during the life of the project. Although soil will be stockpiled initially, from years three to five it is expected that there will be no need for long term stockpiling of topsoil as it will be used for progressive rehabilitation (Queensland Government EHP, 2013b, p. 2). Run-of-mine (ROM) stockpiles will be elevated to protect them from stormwater and will cover a maximum area of 10 ha. Dirty stormwater from the ROM area will be directed to a mine water dam (Queensland Government EHP, 2013b, p. 2). At the end of operations, three voids will remain that will cover an area of approximately 73 ha (Queensland Government EHP, 2013b, p. 2).

The transport corridor will house an overland conveyor for transferring coal to the coal handling and preparation plant and the train loading facility as well as electricity lines, water supply pipelines and communication lines. It will be approximately 26 km long and 200 m wide, located within MLA 55009 and MLA 55010 (Queensland Government EHP, 2013b, p. 3). A water management system designed to separate mine cleaning and drainage water is proposed and described in the EIS (Queensland Government EHP, 2013b, p. 4, 28–29, 48–52), and groundwater management is also detailed (Queensland Government EHP, 2013b, p. 53–55). The Commonwealth has determined that the project is a controlled action as it is likely to have significant impacts on listed threatened species and communities and listed migratory species (Department of the Environment, 2013b; SEWPaC, 2011). Therefore, the project must seek

approval under Part 9 of the Commonwealth's EPBC Act (Queensland Government EHP, 2013b, p. 77) and the significance of those impacts is discussed in the EIS (Queensland Government EHP, 2013b).

1.2.3.1.3 ambreCTL Project

The ambreCTL Project (CTL meaning coal-to-liquids) is a proposed open-cut coal mine near Felton, approximately 30 km southwest of Toowoomba. The amberCTL project has been proposed by Ambre CTL (Felton) Limited (Ambre CTL Limited), a wholly owned subsidiary of Ambre Energy Limited. Ambre CTL Limited proposed Australia's first commercial-scale coal-to-liquids project at a 2000 ha site, referred to as the ambreCTL Project (or ambreCTL) (Ambre CTL Limited, 2011).

The project is expected to have a life span of 35 to 40 years and consist of a coal-to-liquids facility that will produce 940 million litres per year of zero-sulfur, low benzene unleaded petrol (Ambre CTL Limited, 2010, p. 4, 15) and 150 million litres per year of liquefied petroleum gas. Adjoining the CTL facility will be an 8 Mt/year open-cut coal mine (Ambre CTL Limited, 2011, p. 10). A proposed expansion to allow up to 3.8 Mt/year has also been planned. Coal from the lower Walloon Coal Measures will be mined using conventional truck and shovel open-cut processes while backfilling of the mine will be performed as mining progresses. A levée on the eastern side of the mine site will protect the pits from flooding and ensure properties upstream of the project will not be adversely impacted during flood events. A zero-liquid discharge facility and water recycling process will be designed to maximise reuse of water (Ambre CTL Limited, 2010, p. 21).

The project has replaced a previous proposal that was lodged with Queensland Government Environment and Heritage Protection as an EIS under the name of Felton Mine and a Dimethyl Ether Pilot Plant. This is now listed as 'withdrawn' and the revised project is cited as a replacement (Queensland Government EHP, 2012) although details of its current status and continuation are not clear. According to an online news report (The Australian, 2013), the Ambre Energy coal mine plan in the 'Felton Valley' will not go ahead although no further confirmation of this nor positive advancements in this project have been found.

1.2.3.1.4 Cameby Downs Expansion Project

Cameby Downs Mine, which is currently operating at ML 50233, is owned by Yancoal Australia Ltd which acquired Syntech Resources Pty Ltd (which was in turn previously owned by Goldman Sachs) in 2011, and with it, the mine (Yancoal, n.d.). The Cameby Downs Expansion Project was developed prior to Yancoal's ownership of the mine and although expansion (Stage 2) to the open-cut mining is still planned, it has been reduced from the original plan by Syntech Resources (Queensland Government EHP, 2013b). Timing is uncertain because of delays to upgrade of facilities and infrastructure including development of stage two of the Wiggins Island Coal terminal and the Surat Basin railway, on which the expansion project relied (Yancoal, n.d.). The mine's water requirements for the life of the project (around 40 years) will be 8,000 to 10,000 ML a year for coal washing, coal dust suppression and production of potable water, it is intended that CSG co-produced water from nearby operations will be sourced for these purposes (Queensland Government EHP, 2010, p. 3).

The original expansion plan proposed that life of mine would be increased by up to 40 years. The revised Cameby Downs Expansion Project is reduced and although revised life of mine is not reported, the expansion may not currently apply to leases 50261 to 50268 (Queensland Government EHP, 2013b). The expansion is expected to increase annual production to 14 Mt ROM coal although this will depend on sufficient port and rail capacity via Brisbane or Gladstone using new rail links yet to be constructed. Until that time, mining is expected to proceed at a rate of up to 3 Mt/year of coal transported by rail to the Port of Brisbane for export (Queensland Government EHP, 2013b).

The EIS was due for submission to the Queensland Government on 31 March 2014 and was intended to be provided for public review (Queensland Government EHP, 2013b). An EIS was not presented to the Queensland Government by the required date and as a result the final terms of reference for the EIS have ceased to have effect (Queensland Government EHP, 2014). Should the proponent wish to continue with the EIS process further requirements must be complied with before an EIS can be submitted (Queensland Government EHP, 2014).

The project proposal includes open-cut mining of the Cameby Downs coal lease and adjoining leases for processing at the Cameby Downs coal handling and preparation plant, out-of-pit spoil dumps and in-pit spoil disposal of waste rock. The proposal also includes a rail loading facility at Cameby Downs Mine to allow transportation of coal to the Port of Gladstone in the longer term, depending on new rail infrastructure.

1.2.3.1.5 Columboola Project

Columboola Project is a joint venture between MetroCoal Limited and SinoCoal Resources Pty Ltd. SinoCoal Resources is the Australian subsidiary of China Coal Import and Export Company (CCIEC), a wholly owned subsidiary of China Coal Group Corp (MetroCoal Limited, 2011). Inferred resources of 1618 Mt and indicated resources of 94.7 Mt (1712.7 Mt total) were reported (MetroCoal Limited, 2013). The project is targeting down dip (deeper) extensions of the coal seams at the nearby Cameby Downs area, currently mined by Yancoal (MetroCoal Limited, n.d.). Exploration so far has established that the inferred resource is amenable to underground mining and drilling results have confirmed potentially economic and mineable coal in MacAlister seam, in addition to other working sections elsewhere in the Walloon Coal Measures (MetroCoal Limited, n.d.). The project is currently at Stage 1, which has included 44 holes and is identifying the most prospective area of the tenement. Stage 2 will assess resource confidence to make a decision on mining studies (MetroCoal Limited, n.d.). No timing is yet available for a potential start to Stage 2 or mining activity planning.

Exploration is ongoing, however with consideration given to CSG activity in the area, the construction and subsequent mining at Columboola will not be permitted to commence before 2023 at the earliest. Desktop planning and concept studies are continuing in the meanwhile (N Villa (MetroCoal Limited), 2014, pers. comm.).

1.2.3.1.6 Coal exploration

There are currently approximately 190 EPCs listed on the Queensland Government Interactive Resource and Tenure Maps (IRTM) system (as at 29 August 2014) of which 18 show the status as

'Application' and the remainder as 'Granted'. Of those 'Granted' some are lodged also as renewals. At the time of performing this study, the most up-to-date source was IRTM. The most recently lodged permit in the area identified by IRTM was dated 2011. A state-wide restricted area was introduced in 2012 to prevent over the counter applications and provide a process for the controlled release of land (S Joseph (DNRM), 2014, pers. comm.). A call for tender process is now in place for the release of land for coal exploration (Queensland Government, 2014). IRTM was deactivated on 29 August 2014, and replaced by MinesOnlineMaps (DNRM, 2014b). However, it should be noted that although this is the most up-to-date searchable resource currently publicly available, the most recently 'lodged' permits in the database are dated 2011. Exploration to date has been situated along the north, north-eastern and east sides of the subregion.

1.2.3.2 Coal seam gas

1.2.3.2.1 Coal seam gas projects under construction

Several CSG projects are currently under construction in the Maranoa-Balonne-Condamine subregion to supply gas to three large scale liquefied natural gas (LNG) projects on Curtis Island: the Queensland Curtis LNG (QCLNG) Project, the Gladstone LNG (GLNG) Project, and the Australia Pacific LNG (APLNG) Project. The Stratheden gas field, a comparatively small scale project, is expected to supply gas to the domestic market. The petroleum tenures of the proposed CSG field developments are presented in Figure 12 which also highlights the network of gas pipelines in the subregion and the pipelines to Gladstone. In Queensland the petroleum tenures that cover areas of CSG exploration and production are called 'authority to prospect' (ATP) and 'petroleum lease' (PL). The ATP grants the holder the right for petroleum exploration, the PL gives its holder the right to explore for, test for, and produce petroleum (DNRM, 2014c).

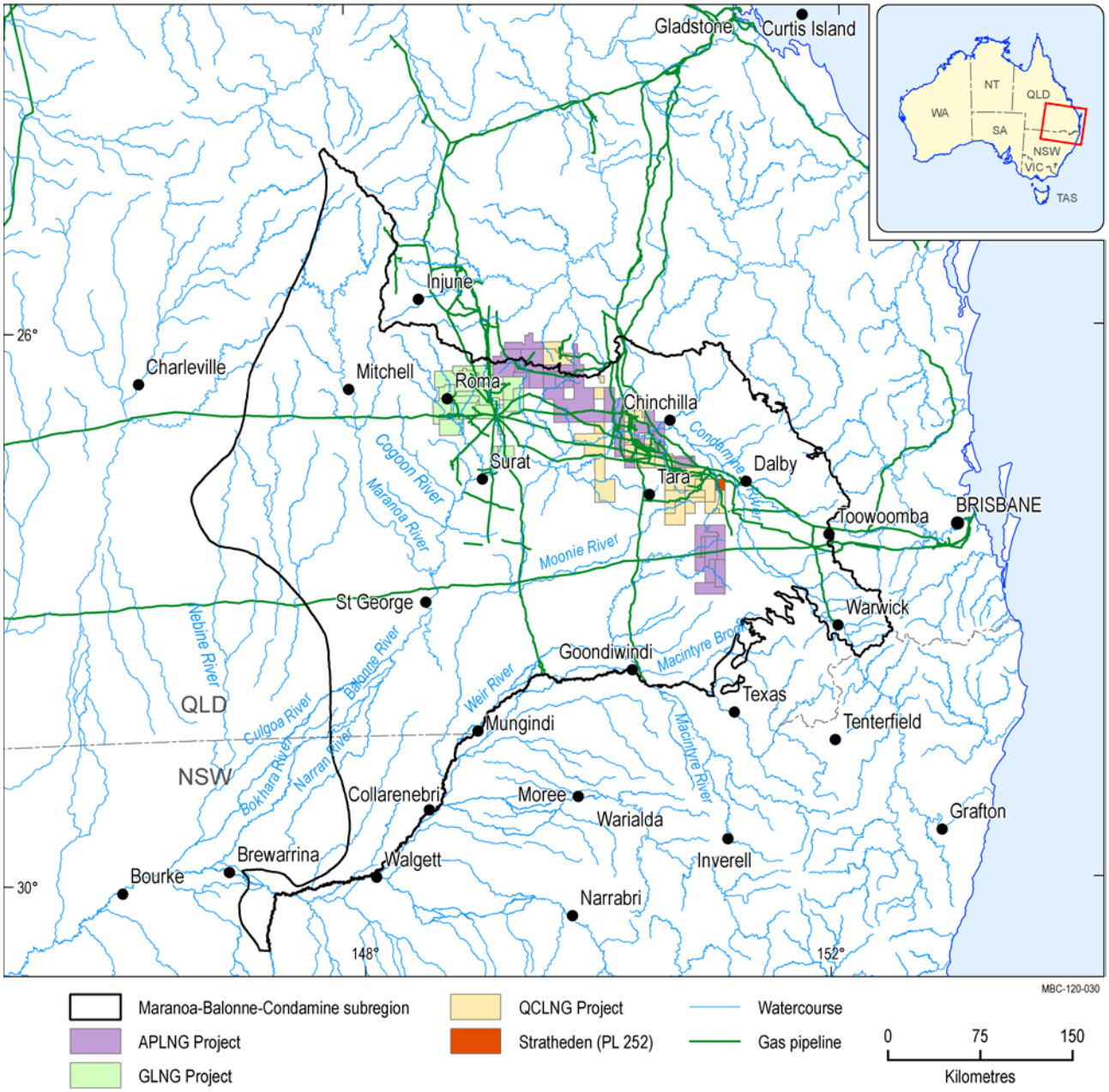

Figure 12 Petroleum tenures of the Stratheden gas field, the Australia Pacific Liquefied Natural Gas Project (APLNG), the Santos Gladstone Liquefied Natural Gas Project (GLNG), and the Queensland Curtis Liquefied Natural Gas Project (QCLNG) in the Maranoa-Balonne-Condamine subregion. The petroleum tenures include both authorities to prospect and petroleum leases

Source data: DNRM (2014a), viewed 21 August 2014

Stratheden

The Stratheden gas field is owned by Arrow Energy and located in PL 252, 20 km north-west of Dalby in the Surat Basin. Its location in the subregion is indicated in Figure 12. The gas field has been drilled and commissioned (Arrow Energy, 2014a) and is currently in a water production stage to enable commercial gas production (Arrow Energy, 2014, pers. comm.). Arrow Energy's Stratheden and Daandine (see Section 1.2.2) gas fields are contracted to supply a combined 11.5 PJ of gas to Arrow Energy's Braemar 2 Power Station and 2.2 PJ to Energy Infrastructure Investments' (EII) Daandine Power Station (Arrow Energy, 2014a). The total proved and probable (2P) reserves at Stratheden were 285 PJ as of 31 December 2013 (DNRM, 2014d). Under the

proposed Surat Gas Project (one of five components of the Arrow LNG project), the Stratheden gas field would be expanded to also supply CSG for LNG export (Arrow Energy, 2014, pers. comm.).

Queensland Curtis Liquefied Natural Gas Project

The QCLNG Project is owned and operated by QGC and involves expansion of QGC's existing CSG operations and development of new gas fields in the Surat Basin in southern Queensland. The location of the project in the Maranoa-Balonne-Condamine subregion is indicated in Figure 12. The gas is to be transported via an underground pipeline to a gas liquefaction and export facility on Curtis Island, near Gladstone, where it will be converted to LNG for export (QGC, 2009). The facility at Curtis Island comprises two LNG trains which are to produce a combined 8.5 million tonnes (Mt) of LNG per year (QG, 2009). Construction of the QCLNG Project commenced in 2010 (QGC, 2012a) and the project is well on track for first LNG delivery in the final quarter of 2014 (Gladstone Observer, 2014). The minimum project life is expected to be 20 years, though the approval conditions allow development over a 50 year period up to 2060 (QGC, 2013).

The gas fields approved to be developed for the QCLNG Project are in the Walloon Fairway, between the towns of Moonie in the south, Wandoan and Miles in the north, Condamine and Tara in the west, and Chinchilla and Kogan in the east (QGC, 2009), as shown in Figure 13. A list of the individual CSG petroleum tenures containing the gas field developments is in Table 5. The total proved plus probable (2P) reserves of the proposed gas field developments in the Maranoa-Balonne-Condamine subregion are 9499 PJ as of 31 December 2013 (DNRM, 2014d) (see Table 5). Gas is extracted from the Juandah Coal Measures and the Taroom Coal Measures within the Walloon Coal Measures. QGC has reported average properties of the Walloon Coal Measures as net coal thickness of 30 m, gas content of 5 m^3/t, gas saturation of 80%, and a methane content of 97%.

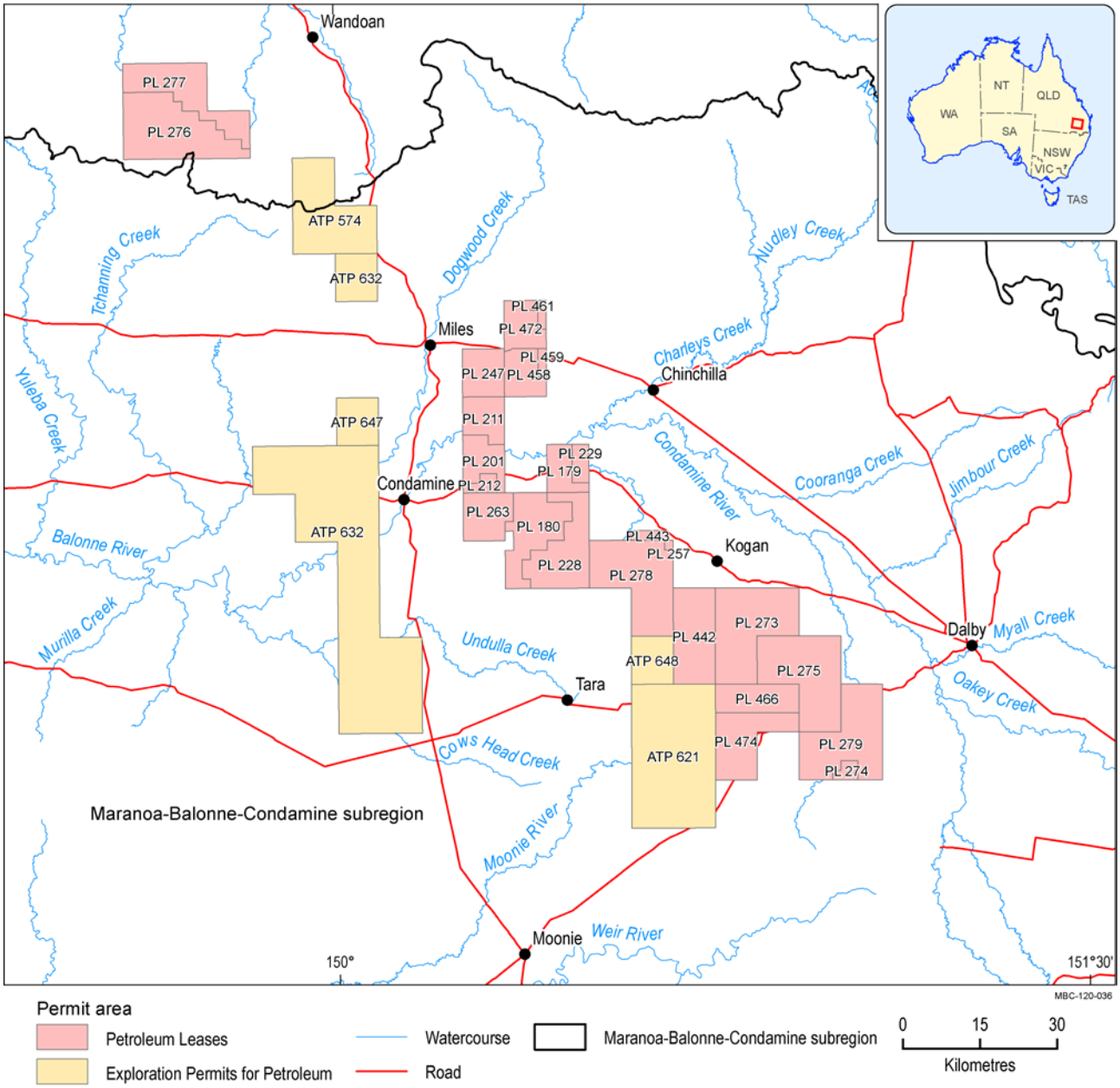

Figure 13 Permits approved for gas field development of the Queensland Curtis Liquefied Natural Gas Project in the Maranoa-Balonne-Condamine subregion

Source data: DNRM (2014a), viewed 21 August 2014
ATP = authority to prospect; PL = petroleum lease

Table 5 Petroleum tenures containing Queensland Curtis Liquefied Natural Gas coal seam gas developments within the Maranoa-Balonne-Condamine subregion

Tenure	Block	Status	2P Reserves (PJ)	Notes
PL 179	Argyle Shallows	Operating	253	
PL 180	Lauren/Codie Shallows	Operating	866	
PL 228	Kenya/Kate Shallows	Operating	904	
PL 229	Argyle East Shallows	Operating	99	
PL 201	Berwyndale South	Operating	273	
PL 211	Berwyndale	Operating	326	
PL 212	Berwyndale Deeps	Development	109	
PL 247	Bellevue Shallows	Operating	344	
PL 257	Jammat Shallows	Development	13	
PLA 261	Ridgewood/Myrtle/Will	Appraisal	NA	PL application over part of ATP 621
PLA 262	Aberdeen/Teviot/Marie Rae	Appraisal	NA	PL application over part of ATP 621
PL 263	Matilda-John Shallows	Development	547	
PL 273	David/Sean/Poppy Shallows	Development	397	
PL 274	Harry Shallows	Development	57	
PL 275	Isabella/Jen/RubyJo Shallows	Development	768	
PL 276	Ross/Woleebee Creek/Kathleen/Cam/Mamdal	Development	942	
PL 277	Kathleen/Cam/Woleebee Creek/Mamdal	Development	692	PL 277 is located outside the subregion, but gas fields from PL 276 (Cam, Kathleen) are encroaching
PL 278	Kenya East/Margaret/Jammat Shallows	Development	763	
PL 279	Broadwater/Harry/Glendower Shallows	Development	848	
PLA 392	Pinelands NE	Appraisal	NA	PL application over part of ATP 574
PL 442	Celeste/Jordan Shallows	Development	350	
PL 443	Owen	Development	59	
PL 458	McNulty	Development	248	
PL 459	McNulty	Appraisal	30	
PL 461	Avon Downs	Appraisal	26	
PL 466	Barney/Clunie Shallows	Development	142	
PL 472	Avon Downs	Appraisal/Development	NA	

Tenure	Block	Status	2P Reserves (PJ)	Notes
PL 474	Barney/Clunie Shallows	Appraisal/Development	272	
PLA 503	Michelle Shallows	Appraisal	NA	PL application over ATP 648
ATP 621	NA	Appraisal	83	Completely covered by PLA 261 and PLA 262
ATP 632	NA	No CSG activity yet	NA	
ATP 632 FO	NA	Appraisal	NA	
ATP 647 BG	NA	No CSG activity yet	NA	
ATP 648	NA	Appraisal	88	Covered by PLA 503
PCAA 76	NA	Appraisal	NA	PCA application over part of ATP 574

2P = proved plus probable reserves; ATP = authority to prospect; PL = petroleum lease; PLA = petroleum lease application; PCA = potential commercial area; PCAA = potential commercial area application
The 2P reserves are as of December 2013 (DNRM, 2014d). NA means 'data not available'

Development of the gas fields is set to occur as a continuous process with some development occurring simultaneously. In October 2014 PL 276 (Ross, Northern Gas Field), PL 211 (Berwyndale, Central Gas Field), and PL 275 (RubyJo, Southern Gas Field) are scheduled to commence production for the QCLNG Project (QGC, 2013) (see Figure 13). A forecast of drilling activity over the duration of the project is in Table 6.

Table 6 Wells forecast to be drilled for development of the gas fields in the Maranoa-Balonne-Condamine subregion

Stage	Year	Cumulative Well Number
1	2010	600
2	2013	2000
3	2020	4300
N	2030	6000

Source data: QGC (2009)

Table 6 highlights that 6000 CSG production wells are estimated to be drilled over the life of the project. In addition, 300 exploration and appraisal wells are predicted to be drilled (estimate based on 5% of total well number (QGC, 2010)). By mid 2014, more than 2150 wells had already been drilled to provide gas for the LNG project (GasFields Commission Queensland, 2014). The basis for the QCLNG Project is the delivery of 1414 terajoules per day (TJ/day) to the LNG plant (QGC, 2009) – the facility at Curtis Island comprises two LNG trains requiring 707 TJ/day each to produce a combined 8.5 Mt of LNG per year. Individual well life is estimated to range from 15 to 20 years or longer, thus, the remaining 4000 wells will be phased in over the life of the project to supplement declining wells (QGC, 2009) and keep production levels steady. Approximately 5000 wells are expected to be in production at any one stage (QGC, 2013).

In the past QGC drilled vertical wells to intersect the target coal seams. However, QGC does not exclude the use of horizontal wells, drilling of multiple wells from a single location (multi-well pads), and hydraulic fracturing for future gas field developments (QGC, 2009). By the end of 2013

14 wells drilled by QGC for the QCLNG Project were hydraulically stimulated. Up to 33 wells are forecasted to undergo stimulation in 2014. QGC's current stimulation program is focused on trialling, developing, and optimising stimulation techniques prior to full scale stimulation activities expected to commence in 2018 (QGC, 2013). It is estimated that approximately 1900 wells may be stimulated throughout the life of the QCLNG Project (QGC, 2013).

Wells are typically drilled to a depth of 200 to 700 m to intersect the target coals of the Walloon Coal Measures (QGC, 2009). The mean well spacing is estimated at 750 m to optimise production. Individual well locations will be finalised throughout the course of the project as exploration and development continues (QGC, 2009). The proposed gas field will entail a cumulative well lease and infrastructure disturbance between 8,000 and 15,500 ha of land (not accounting for decommissioning and rehabilitation). The location of associated infrastructure, such as compression facilities, water treatment and water storage, is dependent on well location, but is expected to be evenly distributed across the tenures (QGC, 2009). Twenty-four compression stations, six central processing plants (at RubyJo, Woleebee Creek, Bellevue, Jordan, Kenya, and Berwyndale South), 6700 km of underground gas and water pipelines, and water management facilities are estimated to be required to manage the produced fluids (QGC, 2010, 2012c). Compression stations and processing plants are required early on in the project so that the produced gas can be transported via pipelines to the LNG facility at Gladstone.

Due to the characteristics of CSG recovery, CSG production typically does not peak immediately but requires depressurisation of the seams through water production and only peaks after months or even years of recovery. Therefore, gas extraction commences before commissioning of the LNG facility to allow time to ramp-up production. QGC estimates that from 2010 to 2014 between 200 and 300 PJ of ramp-up gas will be available before start of the LNG operation. Strategies considered by QGC to manage ramp-up gas are (QGC, 2009, 2010):

- reinjection of gas to subsurface strata (i.e. underground reservoir)
- supply of gas to the domestic market
- storage (linepacking) in existing pipelines
- supply to gas fired power station(s)
- improved gas field modelling
- improved field development and well management.

QGC's CSG fields are currently at various stages of exploration, development, and operation as the company is preparing to meet the gas demand of the LNG plant. Infrastructure at the gas fields and gas processing facilities are nearing completion (Business Spectator, 2014) and more than 2150 wells had been drilled by the end of June 2014 (GasFields Commission Queensland, 2014) with QGC drilling at a rate of over 50 wells per month (Hough, 2013). Initially, to be able to supply the required gas volume for the LNG trains (707 TJ/day per train), additional gas is contracted from a third party supplier while QGC's CSG fields are still ramping up (Swanepoel, 2014). The third party gas is estimated to contribute 10 to 20% to the total LNG gas supply. At production plateau this fraction is expected to be only around 5%. In July 2013 Santos GLNG and QGC signed an industry collaboration deal to support plant operation flexibility and efficiency for the GLNG and the QCLNG projects. The agreement links both projects' major pipelines in two places, thus enabling gas flow from one project to another (Santos, 2013a).

The QCLNG Project is on track for its first LNG production in the final quarter of 2014 with the first train currently being commissioned (GasFields Commission Queensland, 2014). Commissioning of the gas turbine generators began in the second quarter of 2014 and gas was introduced to the plant in the third quarter, allowing commissioning of the refrigeration turbines and compressors to start (GasFields Commission Queensland, 2014). The second train is expected to come online by mid-2015. First gas for LNG production was delivered to Curtis Island in December 2013 (Hough, 2013). Plans for a third LNG train to further expand the project have been dropped for the near term (Swanepoel, 2014).

Other QGC held petroleum tenures within the Maranoa-Balonne-Condamine subregion that were not included in the gas field development described in the EIS of the QCLNG Project are in Table 7. Appraisal is currently occurring in ATP 795 (PLA 311 and PLA 312) and ATP 767. Gas produced from these tenures in the future is likely to be used to further support the LNG project. Including these in the 2P reserves presented above (Table 5) increases QGC's total 2P reserves in the Maranoa-Balonne-Condamine subregion to 9629 PJ as of 31 December 2013 (DNRM, 2014d).

Table 7 Additional QGC Limited petroleum tenures in the Maranoa-Balonne-Condamine subregion not included in the EIS of the Queensland Curtis Liquefied Natural Gas Project

Tenure	Project/Block	Status	2P Reserves (PJ)	Notes
PLA 311	Lacerta West	Appraisal	NA	PL application over part of ATP 795
PLA 312	Lacerta	Appraisal	NA	PL application over part of ATP 795
ATP 767	NA	Appraisal	130	Only part in subregion
ATPA 785	NA	No CSG activity yet	NA	Application over ATP 785
ATP 889	NA	Appraisal	NA	Only part in subregion
ATP 965	NA	Appraisal	NA	
ATP 1188	NA	No CSG activity yet	NA	

2P = proved plus probable reserves, ATP = authority to prospect, ATPA = authority to prospect application, PL = petroleum lease, PLA = petroleum lease application, EIS = environmental impact statement
The 2P reserves are as of December 2013 (DNRM, 2014d). NA means 'data not available'

Santos Gladstone Liquefied Natural Gas Project

The GLNG Project is a joint venture between Santos (30%), Petroliam Nasional Berhad (PETRONAS) (27.5%), TOTAL S.A. (TOTAL) (27.5%), and Korea Gas Corporation (KOGAS) (15%) with Santos acting as operator (Santos, 2014a). The project includes the development of CSG resources in the Bowen and Surat Basins in south-east Queensland, construction of a 420 km underground gas transmission pipeline to Gladstone, and two LNG trains with a total capacity of 7.8 Mt/year on Curtis Island. The project received approval from the Queensland Government and the Australian Government in 2010. The final investment decision was announced in January 2011 (Santos, 2011). The nominal project life is 30 years, though the project may remain operational beyond that point. Santos' existing CSG resources to be further developed for the GLNG Project are the Fairview and the Roma gas fields, while the gas field Arcadia Valley is to be newly developed (Santos, 2009). Only the Roma gas fields, targeting the Walloon Coal Measures of the Surat Basin, are located in the Maranoa-Balonne-Condamine subregion; their location and extent within the subregion is in Figure 12, while the individual petroleum tenures approved for the Roma gas field

development as part of the GLNG Project are in Table 8 (Santos, 2012). The combined 2P reserves of the GLNG Project at Roma are 2745 PJ as of 31 December 2013 (DNRM, 2014d) (see Table 8).

Table 8 Petroleum tenures of the Gladstone Liquefied Natural Gas Project at Roma in the Maranoa-Balonne-Condamine subregion

Tenure	Block	Status	2P Reserves (PJ)
PL 3	Timbury/Beaufort	Appraisal	43
PL 6	Pringle D/Hope Ck	Exploration	NA
PL 7	Richmond/Blyth	Appraisal	4
PL 8	Wallumbilla South	Appraisal	341
PL 9	Maffra/Anabranch	Exploration	NA
PL 322	Grafton R/Mooga	Appraisal	130
PL 93	Stakeyard	Appraisal/Development	13
PL 309	Hermitage/Coxon Ck	Development	208
PL 310	Raslie North	Development	430
PL 314	Pine R/Pleasant H	Development	247
PL 315	Raslie/Yanalah	Development	426
ATP 336 R	Roma	Appraisal/Exploration	NA
ATP 631 R	NA	Exploration	903

Source data: Santos (2012)
2P = proved plus probable reserves, ATP = authority to prospect, PL = petroleum lease, PLA = petroleum lease application
The 2P reserves are as of December 2013 (DNRM, 2014d). NA means 'data not available'

The GLNG Project comprises two trains with a total capacity of 7.8 Mt/year (Santos, 2014b). Part of the gas requirements for these LNG trains will be supplied by the Roma CSG fields. The Roma area was initially developed by Santos as a conventional gas field which has been in production for over 50 years (Santos, 2014a), but the shallower coals are now targets for CSG. As part of the GLNG Project the existing field development will be expanded. Since 2009 more than 290 (appraisal, exploration, and development) wells are estimated to have been drilled at Roma (IRTM, viewed 21 August 2014) of which 52 wells are now on production (as of June 2014) (Santos, 2014c). Another 23 pilot wells are currently online to assess potential future development areas (Santos, 2014c). So far, development around Roma has predominantly occurred in PL 309, 310, 314, and 315 (IRTM, viewed 21 August 2014).

Production wells are estimated to have a production life of 5 to 15 years and will be replaced over time with newly drilled wells in different locations to continue to provide sufficient CSG for the GLNG Project. The schedule of well development will be dictated by field performance and the drilling programme will be adjusted accordingly. The specific locations of exploration and development wells and associated infrastructure are determined incrementally based on the outcome of ongoing exploration programmes (Santos, 2009). Many of the wells to be drilled at Santos' CSG fields will be vertical wells. However, alternative drilling techniques such as directional drilling will also be used for some areas. Directional drilling techniques have the advantage of drilling multiple wells from one lease, accessing resources that are laterally displaced from the

lease area (Santos, 2009). Approximately 50% of the wells at Roma are estimated to be fractured over the life of the GLNG Project based on current knowledge of the geology and the permeability characteristics (Santos, 2013b). To the end of 2013, 18 wells at Roma had been hydraulically stimulated (Santos, 2014d). For the years 2014 and 2015, 10 and 73 wells respectively are forecasted to be hydraulically fractured at Roma (Santos, 2014d).

Gas produced from the Roma gas fields will be processed and compressed for delivery to Gladstone at the Roma Hub 2, which is currently under construction (97% complete as of June 2014) (Santos, 2014b). The Roma Hub 2 has a capacity of 145 TJ/d.

During the ramp-up period, before CSG is delivered and processed in the LNG facility, the produced gas will be supplied to domestic markets and/or stored underground in the depleted conventional gas reservoirs at Roma. The depleted gas fields at Roma have a storage capacity of more than 50 PJ. Currently seven injection wells are online with a combined injection/withdrawal rate of 75 TJ/d (Santos, 2014b). Additionally, production is managed by throttling gas flow at the wellhead where practicable (Santos, 2009).

By mid 2014 the GLNG Project was more than 85% complete and on track for LNG delivery from its first train in 2015 (Santos, 2014e). The second train is expected to come online six to nine months after the first train (Santos, 2014b). To further develop their gas resources, Santos has proposed the GLNG Gas Field Development for which an EIS is currently in preparation. The GLNG Gas Field Development is described in Section 1.2.3.2.2 – Proposed Projects.

Australia Pacific Liquefied Natural Gas Project

Australia Pacific LNG Pty Limited (APLNG) is a joint venture between Origin Energy (37.5% ownership), ConocoPhillips Company (ConocoPhillips) (37.5%), and China Petroleum and Chemical Corporation (Sinopec) (25%). The APLNG Project comprises the development of CSG fields, the gas from which is to be transported to Curtis Island via a newly constructed 520 km pipeline to be processed for export (Origin Energy, 2013). If fully completed, this LNG project will be the largest of its kind in Australia, with a capacity to produce approximately 18 Mt/year from four LNG trains (capacity of 4.5 Mt/year per train) (APLNG, 2010a). Currently, two LNG trains are being built on Curtis Island (Origin Energy, 2013). The project is expected to run for 30 years and will include the development of up to 10,000 CSG wells (APLNG, 2010a). Key features of the project are described below using the most current publically available information. As the project progresses, specific details and figures quoted below are likely to be subject to change as current understanding and conditions evolve.

The gas for the project (11.5 Mt/year) is to be mostly supplied by further developing APLNG's gas fields, with the remainder being sourced from APLNG's existing operations (outside the Walloon gas fields), exploration areas, and equity in tenures operated by other gas producers (APLNG, 2010a). The gas field development areas are highlighted in Figure 14 and the corresponding petroleum tenures and their 2P reserves are summarised in Table 9. The gas field developments Combabula-Ramyard and Woleebee are located partially outside the subregion (see Figure 14) and only petroleum permits of these developments that are in or on the border of the Maranoa-Balonne-Condamine subregion are considered here. The location of the APLNG gas field developments in the subregion is presented in Figure 12. The combined 2P reserves of the APLNG

Project in the Maranoa-Balonne-Condamine subregion are 8977 PJ as of 31 December 2013 (DNRM, 2014d) (see Table 9).

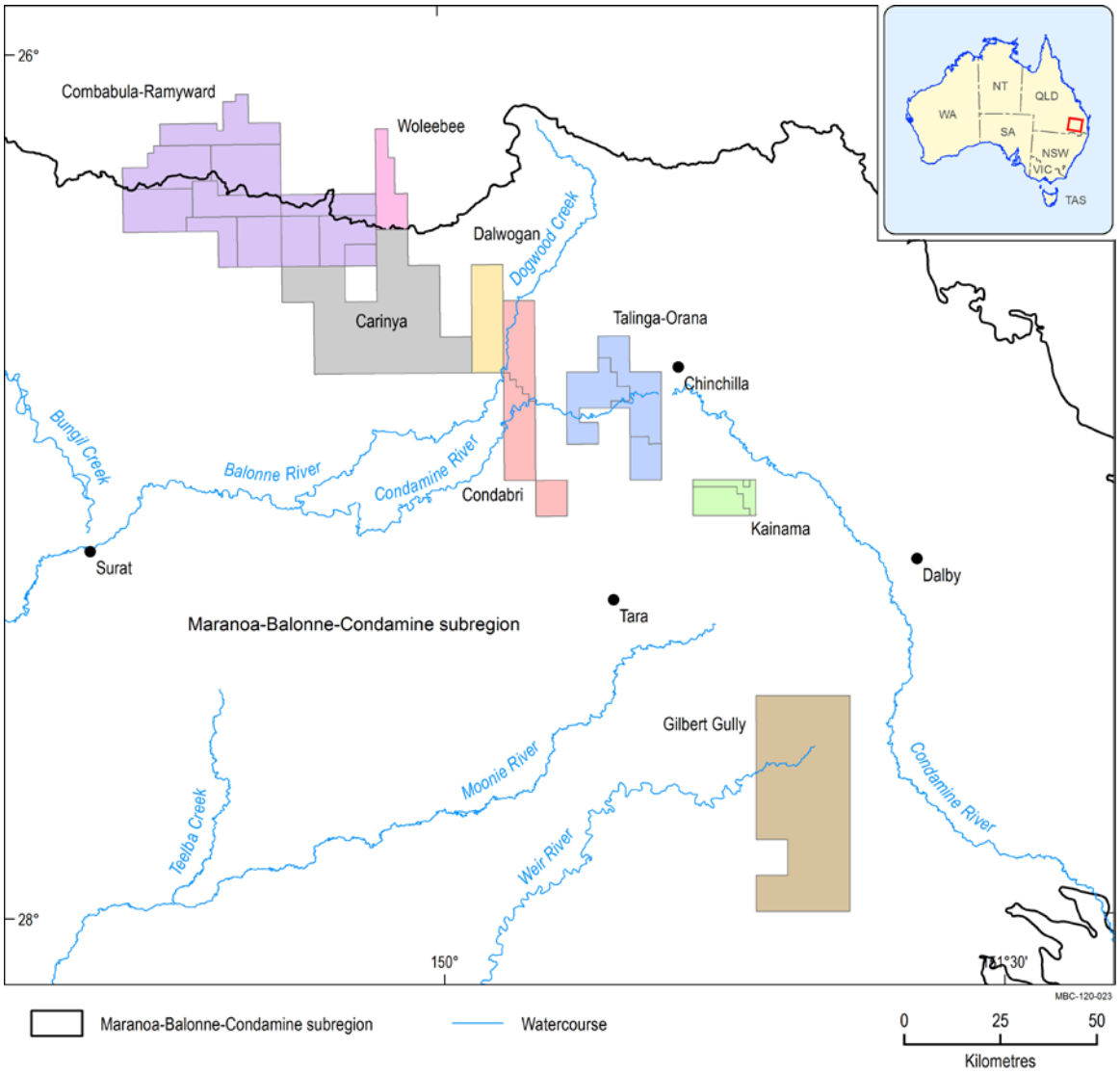

Figure 14 Location of the gas field developments of the Australia Pacific Liquefied Natural Gas Project in the Maranoa-Balonne-Condamine subregion

Source data: DNRM (2014a), viewed 21 August 2014

Table 9 Petroleum tenures containing the gas field development of the Australia Pacific Liquefied Natural Gas Project for the Maranoa-Balonne-Condamine subregion

Tenure	Block	Status	2P Reserves (PJ)	Notes
PL 209	Woleebee	Appraisal	189	
PL 215	Orana	Development	337	
PLA 216	Dalwogan	Appraisal	187	PL application over part of ATP 692
PLA 225	Kainama	Appraisal	202	PL application over part of ATP 692
PL 226	Talinga	Operating	569	

Tenure	Block	Status	2P Reserves (PJ)	Notes
PL 265	Condabri	Development	838	
PL 266	Condabri South	Development	368	
PL 267	Condabri North	Development	700	
PL 272	no name (Orana North)	Development	501	
PLA 289	Kainama North	No past or current activity	159	PL application over part of ATP 692
PL 297	Combabula	Development	978	
PL 404	Reedy Creek	Development	456	
PLA 405	Muggleton	Appraisal	NA	PL application over part of ATP 606
PLA 407	Pine Hills	Appraisal	NA	PL application over part of ATP 606
PL 408	Combabula	Development	543	PL 408 outside subregion, but gas fields from PL 297 are encroaching
PLA 412	Reedy Creek	Appraisal	NA	PL application over part of ATP 606
PLA 413	Reedy Creek	Appraisal	NA	PL application over part of ATP 606
PLA 434	Gilbert Gully	Appraisal	NA	PL application over part of ATP 663
PLA 435	Zig Zag	Appraisal	NA	PL application over part of ATP 663
PLA 436	Zig Zag	Appraisal	NA	PL application over part of ATP 663
PLA 437	Gilbert Gully	Appraisal	NA	PL application over part of ATP 663
PLA 438	Waar Waar	Appraisal	NA	PL application over part of ATP 663
PLA 439	no name (Gilbert Gully)	Appraisal	NA	PL application over part of ATP 663
PLA 469	Ramyard	Appraisal	NA	PL application over part of ATP 972
PLA 470	Horse Creek	Appraisal	NA	PL application over part of ATP 972
PLA 471	Horse Creek	Appraisal	NA	PL application over part of ATP 972
PLA 481	Kainama	Appraisal	9	PL application over part of ATP 692

Tenure	Block	Status	2P Reserves (PJ)	Notes
ATP 606	Combabula	Appraisal	1678	Part of ATP covered by PLA 405, PLA 407, PLA 412, PLA 413 and others outside the subregion
ATP 663	Gilbert Gully	Appraisal	347	Completely covered by PLA 434 - 439
ATP 692	NA	Appraisal	5	Part of ATP covered by PLA 216, PLA 225, PLA 289, PLA 481
ATP 972	Ramyard	Appraisal	911	Part of ATP covered by PLA 469, PLA 470, PLA 471
ATP 973	Carinya	Appraisal	NA	

2P = proved plus probable reserves; ATP = authority to prospect; PL = petroleum lease
The 2P reserves are as of December 2013 (DNRM, 2014d). NA means 'data not available'

Up to 10,000 wells are expected to be drilled throughout the project at a rate of up to 600 wells per year (APLNG, 2010a) (150 to 400 wells per year in the initial five years (APLNG, 2010b)). There are 5000 wells forecasted to be drilled between 2011 and 2021 to meet the demand of the first two trains of the LNG plant. Another 5000 wells are estimated to be drilled over the remaining years to provide gas for the upgrade of the LNG plant from two to four trains (APLNG, 2010a). Construction of the gas fields commenced in 2011, with the development occurring in stages to meet the demand of the LNG plant (Origin Energy, 2011a). Phase 1, which covers the initial five years of the project, focuses on the gas fields Talinga-Orana, Condabri, and Combabula in the Maranoa-Balonne-Condamine subregion. During Phase 1, a total of 1100 production wells are expected to be drilled (Origin Energy, 2013). By March 2014, APLNG had drilled 680 Phase 1 development wells, of which 600 are in the gas fields Condabri (343 wells), Combabula (189 wells), and Orana (68 wells). The remaining 80 wells were drilled at Spring Gully, outside the subregion (Origin Energy, 2014a). An indicative development plan for gas fields in the Maranoa-Balonne-Condamine subregion is outlined in Table 10 (APLNG, 2014). Based on this plan, 6034 wells are estimated to be drilled in the subregion.

Table 10 Indicative Australia Pacific Liquefied Natural Gas field development plan for gas fields in the Maranoa-Balonne-Condamine subregion

CSG field	Tenure	Number of new wells	First year of production
Talinga	PL 226	415	2012
Condabri Central	PL 265	253	2013
Condabri South	PL 266	352	2013
Condabri North	PL 267	185	2013
Reedy Creek	PL 404	820	2014
Combabula	PL 297, PL 408, ATP 606	858	2014
Orana	PL 215, PL 272	330	2014
Dalwogan	PLA216	36	2016
Pine Hills	PLA 407	814	2022
Ramyard	ATP 972	612	2022
Kainama	ATP 692	284	2025
Gilbert Gully	ATP 663	814	2025
Woleebee	PL 209, parts of ATP 606 and ATP 692	270	2029
Carinya	ATP 973	0	NA
	Total number of wells	**6043**	

Source data: APLNG (2014)
ATP = authority to prospect; PL = petroleum lease

The typical well spacing in the APLNG gas fields is estimated at 750 m, though actual well spacing may vary (APLNG, 2010a). The wells are proposed to be conventional vertical wells drilled to depths between 600 and 1000 m with some wells requiring stimulation through hydraulic fracturing or cavitation to improve gas recovery (APLNG, 2010a). Wells will only be hydraulically fractured in lower permeability areas (APLNG, 2014). Wells drilled in Phase 1 will be drilled in areas of higher permeability and productivity and are not planned to undergo stimulation (APLNG, 2014). Hydraulic fracture stimulation will be integrated into Phase 2, which is to start in the second half of 2016 (APLNG, 2014). Hydraulic fracture stimulation during Phase 2 is to begin after 2019 and finish before 2036. An indicative hydraulic fracturing schedule for Phase 2 is in Table 11, based on which 1770 wells are currently expected to be hydraulically stimulated (APLNG, 2014).

Table 11 Indicative Australia Pacific Liquefied Natural Gas Phase 2 hydraulic fracturing schedule for the Maranoa-Balonne-Condamine subregion

CSG field	Tenure	Number of Wells to be fractured (2016–2020)	Number of Wells to be fractured (2016–2036)	Total number of wells to be fractured
Talinga/Orana	PL 215, PL 226, PL 272	0	0	0
Condabri	PL 265, PL 266, PL 267	0	0	0
Dalwogan	PLA 216	100	300	400
Combabula/Ramyard	PL 297, PL 404, PL 408, ATP 606/ATP 972	0	480	480
Woleebee	PL 209	0	285	285
Carinya	ATP 973	0	0	0
Kainama	PLA 225, PLA 289, PLA 481	0	142	142
Gilbert Gully	ATP 663	0	463	463
	Total number of wells	**100**	**1670**	**1770**

Source data: APLNG (2014)
ATP = authority to prospect; PL = petroleum lease, PLA = petroleum lease application

The APLNG Project is on track for first LNG production by mid-2015 (Gladstone Observer, 2013; Origin Energy, 2013). The second train is expected to follow six months later. Trains 3 and 4 are to commence later – depending on the LNG market and the development programme of the APLNG gas fields (APLNG, 2010a). The trains are being built to have a capacity of 4.5 Mt of LNG per train per year (Origin Energy, 2013). Ramp-up gas produced before commissioning and operation of the LNG plant is supplied to the Darling Downs Power Station and the Wallumbilla gas hub for use in the domestic market (APLNG, 2012).

An agreement to build two pipeline connection points between GLNG and APLNG infrastructure and to undertake a gas swap to minimise gas movements and operational costs was signed between Santos GLNG and APLNG in October 2013. Santos GLNG and APLNG are joint venture partners in a number of Santos operated petroleum tenures in the Surat Basin within the Maranoa-Balonne-Condamine subregion (Santos, 2013c).

Other APLNG held tenures in the Maranoa-Balonne-Condamine subregion that were not included in the gas field development described in the EIS of the APLNG Project are in Table 12. Potential gas production from these tenures is likely to be used to further support the APLNG Project.

Table 12 Additional Australia Pacific Liquefied Natural Gas (LNG) petroleum tenures in the Maranoa-Balonne-Condamine subregion not included in the environmental impact statement of the Australia Pacific LNG Project

Tenure	Project/Block	Status	2P Reserves (PJ)	Notes
PL 43	Myrtleville/Springvale	No CSG activity yet	NA	
PL 44	Merivale/Westgrove	Exploration	NA	
PL 183	Punchbowl Gully	No CSG activity yet	NA	
PL 218	Sardine Creek	No CSG activity yet	NA	

2P = proved plus probable reserves, PL = petroleum lease
The 2P reserves are as of December 2013 (DNRM, 2014d). NA means 'data not available'

1.2.3.2.2 Proposed CSG projects

In addition to the projects currently under construction, a number of additional CSG projects have been proposed. These are Arrow Energy's Surat Gas Project, which has received State Government and Australian Government approval, Santos' Gladstone LNG Gas Field Development Project, and Origin Energy's Ironbark Project. The two latter ones are currently in the stage of preparing an EIS. The location of these projects within the Maranoa-Balonne-Condamine subregion and their potential extent is in Figure 15 which also highlights the network of gas pipelines in the subregion and the pipelines to Gladstone.

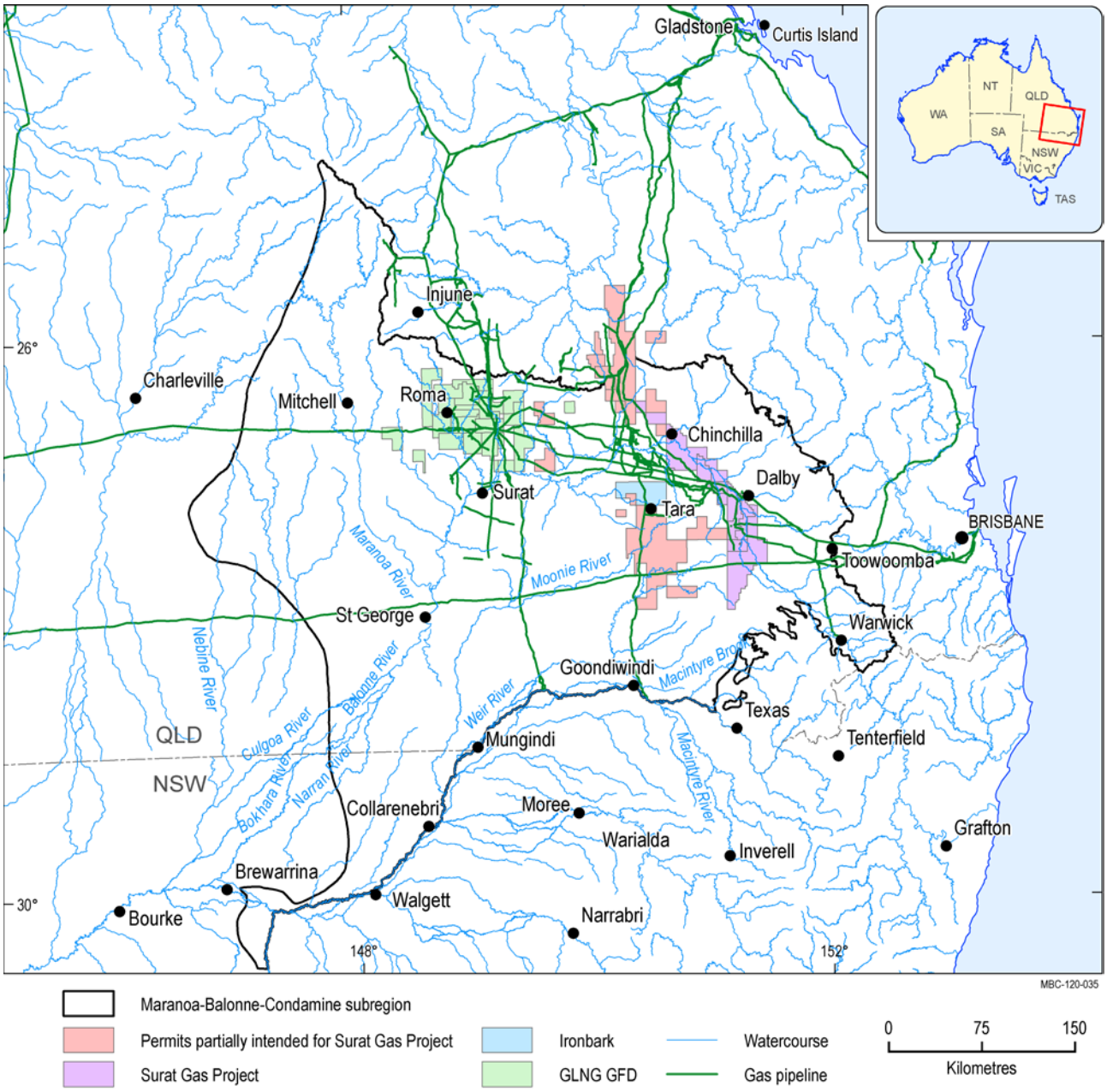

Figure 15 Petroleum tenures of the proposed but not approved coal seam gas developments in the Maranoa-Balonne-Condamine subregion. The petroleum tenures include both authorities to prospect and petroleum leases

Source data: DNRM (2014a), viewed 21 August 2014
GLNG GFD = Gladstone LNG Gas Field Development Project

Surat Gas Project

The Surat Gas Project (SGP) is one of five components of the proposed Arrow Energy LNG project which, at present, involves:

- gas recovery from Arrow Energy's CSG tenements in the Surat and Bowen basins (the Bowen Gas Project is not discussed further here as it is located outside the Maranoa-Balonne-Condamine subregion)
- gas transmission pipelines from those basins to Curtis Island
- an LNG plant where the gas is converted to LNG for export.

The SGP will also continue to provide gas for the domestic market (Australian Mining Link, 2013).

Under the proposed SGP, production at Arrow Energy's existing CSG fields Stratheden, Kogan North, Daandine, and Tipton West would be expanded and other Arrow Energy tenures in the Surat Basin would be developed. The development area of the SGP covers approximately 6100 km^2 and extends in an arc from Wandoan in the north, through Dalby in the east, down to the south-west of Millmerran as demonstrated in Figure 16 (Arrow Energy, 2012, 2013, 2014b). Its location and extent within the Maranoa-Balonne-Condamine subregion is shown in Figure 15 and the individual petroleum tenures containing the gas field developments are summarised in Table 13. The combined 2P reserves of the tenures of the SGP in the Maranoa-Balonne-Condamine subregion, as per Table 13, are 6872 PJ as of 31 December 2013 (DNRM, 2014d).

Table 13 Coal seam gas petroleum tenures of the Surat Gas Project in the Maranoa-Balonne-Condamine subregion

Tenure	Block	Status	2P Reserves (PJ)	Notes
PLA 185	Darvall/Dundee	Appraisal	97	PL application over part of ATP 676
PL 194	Kogan North	Operating	364	
PL 198	Tipton West	Operating	691	
PL 230	Daandine	Operating	293	
PL 238	Plainview	Appraisal	617	
PL 252	Stratheden	Operating	285	
PLA 253	Hopelands	Appraisal	472	PL application over part of ATP 676
PL 258	Meenawarra	Appraisal	359	
PL 260	Longswamp	Development	540	
PLA 304	Kedron	Appraisal	169	PL application over part of ATP 810
PLA 305	Castledean	Appraisal	124	PL application over part of ATP 810
PLA 491	Yeronga	Appraisal	NA	PL application over part of ATP 747
PLA 492	Alderley	Appraisal	NA	PL application over part of ATP 747
PLA 493	Wyalla	Appraisal	NA	PL application over part of ATP 676
PLA 494	Guluguba	Appraisal	NA	PL application over part of ATP 747
ATP 676	NA	Appraisal	79	
ATP 676 KN	Kogan North	Exploration	60	
ATP 683	Bowenville	Appraisal	1029	
ATP 683	Dalby South	Appraisal	370	
ATP 683	Millmerran	Appraisal	165	
ATP 746	NA	Exploration	14	only part of ATP intended for SGP
ATP 747	NA	Exploration	932	only part of ATP intended for SGP
ATP 810	NA	Appraisal	212	only part of ATP intended for SGP

2P = proved plus probable reserves, ATP = authority to prospect, PL = petroleum lease, PLA = petroleum lease application
The 2P reserves are as of December 2013 (DNRM, 2014d). NA means 'data not available'; SGP = Surat Gas Project

Eleven drainage areas (which are in Figure 16) were identified by Arrow Energy for staggered development as part of the SGP (Arrow Energy, 2012). Currently eight of these areas are planned to be developed. Development of the remaining three areas will depend on exploration outcomes

and future LNG and gas market conditions (Arrow Energy, 2012). To optimise production over the life of the project, development of the resources will be staged and will be concurrent in several areas as Arrow Energy incrementally expands its current operations and develops new gas fields (Arrow Energy, 2012). The areas to be developed first are in Dalby (DA7), Miles (DA2), Wandoan (D1), and Chinchilla (DA5) (Arrow Energy, 2013) as shown in Figure 16.

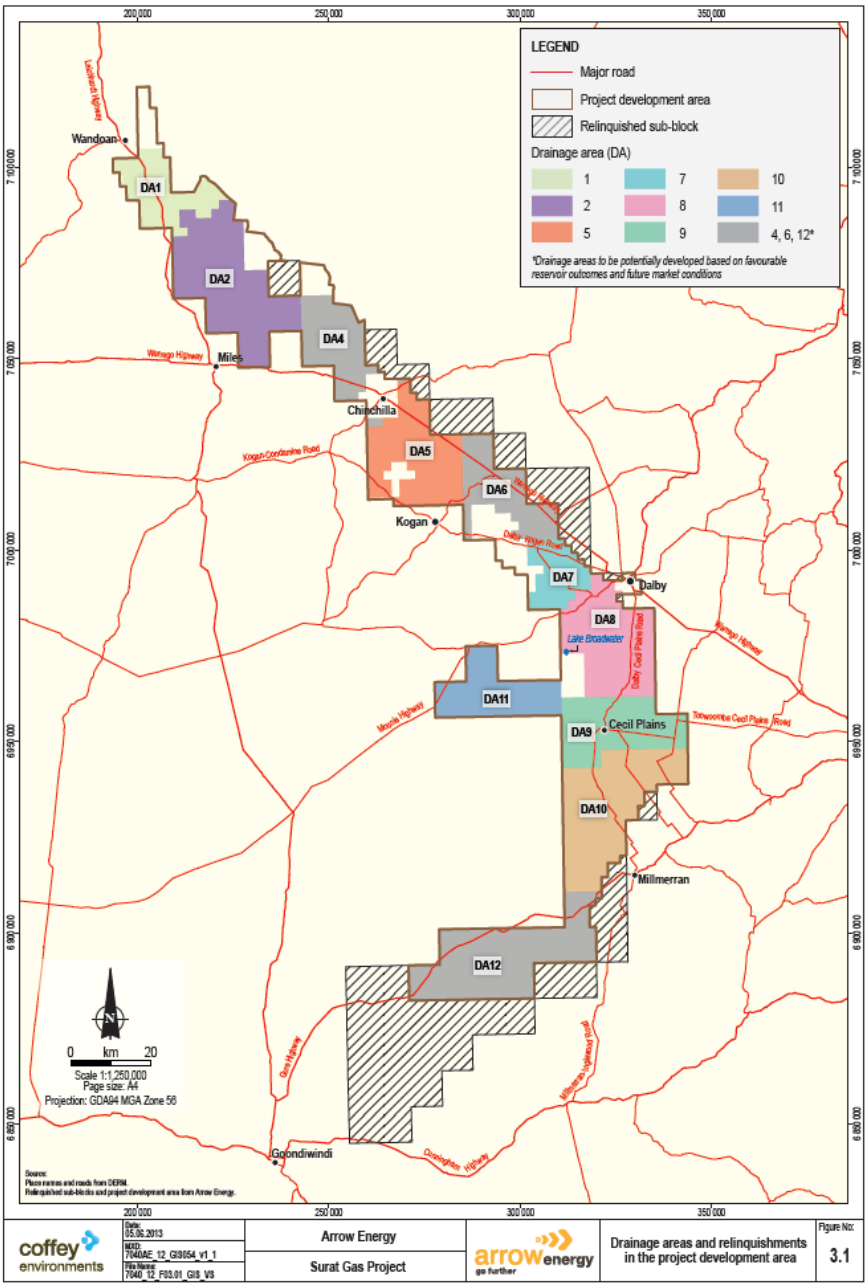

Figure 16 The eleven development areas of Arrow's Surat Gas Project in the Maranoa-Balonne-Condamine subregion. The relinquished blocks highlighted in black diagonal stripes were included in the initial Surat Gas Project proposal but have since been relinquished based on improved knowledge of CSG reserves through exploration

Source: Figure 2-1 in Alluvium (2013). This figure is not covered by a Creative Commons Attribution licence. It has been reproduced with the permission of Arrow Energy.

A maximum of 6500 wells are to be drilled throughout the project life (Department of the Environment, 2013a). The wells will include vertical and deviated wells which apply directional drilling technology (Arrow Energy, 2013). Hydraulic fracturing has been prohibited as a condition

of project approval (Department of the Environment, 2013a). The deviated wells enable larger contact areas between the well and the CSG reservoir and thus enable higher flow rates. The deviated wells also allow multiple wells to be at the same central surface location (multi-well pad). The maximum number of production wells for one multi-well pad is 12, but 9 wells will be typical. Arrow Energy estimates that approximately 30% of the wells drilled will be single vertical wells, while 70% will be deviated wells arranged in multi-well pads. Arrow Energy has committed to a minimum mean well spacing of at least 800 m and aims to be flexible with the siting of well pads, targeting areas that will have minimum impact on land use (Arrow Energy, 2013). Drilling will occur up to a depth of 800 m and production will typically occur from coals between 300 and 750 m depth (Arrow Energy, 2013). The target coals for CSG extraction are those of the Walloon Coal Measures.

Sustained gas production is forecast as 1215 TJ/day, with 80 TJ/day continuing to be used for the domestic gas market and 1135 TJ/day intended for the export market in the form of LNG (Arrow Energy, 2013). Gas production infrastructure will be located throughout the project development area and is predicted to include eight central gas processing facilities (each with a production capacity between 75 and 225 TJ/day). Ramp-up to peak production is estimated to take between four and five years (Arrow Energy, 2012). The ramp-up period is defined as the time from first gas production to sustained production of the targeted gas rate of 1215 TJ/day. More than 1500 wells are estimated to be required in the first five years to achieve this (Arrow Energy, 2012). Strategies considered by Arrow Energy for managing the ramp-up gas include supply of the gas to Arrow Energy's existing power stations, sale on the gas spot market, management through increased well spacing and selective timing of wells coming online, and gas flaring (as a last resort measure) (Arrow Energy, 2012). Production is expected to be sustainable for about nine years before gas rates start to decline. During those nine years new wells will continue to be drilled at an average rate of 400 per year (Arrow Energy, 2013) to maintain the required production when the initial wells start to decline and are eventually phased out and replaced. Total well life is estimated between 15 and 20 years (Arrow Energy, 2012). The project is estimated to have a lifetime of 35 years.

The SGP received environmental approval from the Queensland Government in October 2013 and from the Australian Government in December 2013. A decision to proceed with the SGP and the timing of that decision are matters of Arrow Energy's shareholders Royal Dutch Shell plc and PetroChina Company Limited. Arrow Energy is looking at multiple opportunities, including collaboration with one or more of the existing LNG projects, to develop its gas resource (Arrow Energy, 2014, pers. comm.).

Gladstone Liquefied Natural Gas Gas Field Development Project

As part of the GLNG Project, Santos GLNG is currently planning the GLNG Gas Field Development Project (GLNG GFD Project). The project is a continuation of the GLNG Project and aims to secure gas supply for the next 30 years through drilling of approximately 6100 production wells within the existing approved areas and new surrounding tenures (Santos, 2013d). The EIS is currently being prepared (Queensland Government DSDIP, 2013). The project would involve further development of CSG reserves within the already approved development area of the GLNG Project (Roma within the Maranoa-Balonne-Condamine subregion, as well as Fairview and Arcadia outside the

Maranoa-Balonne-Condamine subregion), as well as the development of additional petroleum tenures within the area highlighted as future development area in Figure 12 (Santos, 2012). The tenures located within the Maranoa-Balonne-Condamine subregion around Roma to be included in the GLNG GFD Project are in Figure 15. The individual tenures containing the GLNG GFD Project in the Maranoa-Balonne-Condamine subregion are in Table 11 (Santos, 2012). These are tenures that were already approved for the GLNG Project as well as additional tenures proposed for new CSG development. The project is estimated to run over 30 years and is planned to commence in 2016 (Santos, 2013d). The specific well locations, well numbers, and timing at Roma will be determined by ongoing exploration and appraisal activities. The combined 2P reserves of the GLNG GFD Project at Roma are 2807 PJ as of December 2013 (DNRM, 2014d) which include the 2P reserves of the approved GLNG Project (2745 PJ) (compare Table 8 and Table 11).

Table 14 Petroleum tenures of the GLNG Gas Field Development Project around Roma in the Maranoa-Balonne-Condamine subregion

Tenure	Block	Status	2P Reserves (PJ)	Notes
PL 3	Timbury/Beaufort	Appraisal	43	Approved for GLNG Project
PL 6	Pringle D/Hope Ck	Exploration	NA	Approved for GLNG Project
PL 7	Richmond/Blyth	Appraisal	4	Approved for GLNG Project
PL 8	Wallumbilla South	Appraisal	341	Approved for GLNG Project
PL 9	Maffra/Anabranch	Exploration	NA	Approved for GLNG Project
PL 322	Grafton R/Mooga	Appraisal	130	Approved for GLNG Project
PL 93	Stakeyard	Appraisal/Development	13	Approved for GLNG Project
PL 309	Hermitage/Coxon Ck	Development	208	Approved for GLNG Project
PL 310	Raslie North	Development	430	Approved for GLNG Project
PL 314	Pine R/Pleasant H	Development	247	Approved for GLNG Project
PL 315	Raslie/Yanalah	Development	426	Approved for GLNG Project
ATP 336 R	Roma	Appraisal/Exploration	NA	Approved for GLNG Project
ATP 631 R	NA	Exploration	903	Approved for GLNG Project
PL 10	Bony Ck/Tarrawonga	Exploration	NA	Proposed future development
PL 11	Back Ck/Snake Ck	Appraisal	62	Proposed future development
ATP 665	NA	Exploration	NA	Proposed future development
ATP 708	NA	Appraisal/Exploration	NA	Proposed future development

Source data: Santos (2012)
2P = proved plus probable reserves, ATP = authority to prospect, PL = petroleum lease, PLA = petroleum lease application
The 2P reserves are as of December 2013 (DNRM, 2014d). NA means 'data not available'

Ironbark Project

Origin Energy's proposed Ironbark Project is in ATP 788 between the towns of Tara in the south, Dalby to the east, and Chinchilla to the north. Its position within the Maranoa-Balonne-Condamine subregion is indicated in Figure 15. The tenure is within the Undulla Nose region in the Walloon

Fairway, adjacent to existing Origin Energy and QGC CSG developments, and covers an area of 64,140 ha (Origin Energy, 2011b). The 2P reserves were 259 PJ as of 30 June 2014 (Origin Energy, 2014b).

As part of exploration and appraisal activities, Origin Energy operates a small number of pilot CSG wells, appraisal wells, and monitoring wells at the Ironbark tenement. These have been drilled to evaluate the Ironbark gas resources ahead of planned possible development. The Duke 2 pilot and the Duke 3 pilot have five operating wells each and have been in operation since July 2012 and May 2013 respectively. Six wells have been drilled as part of a third production pilot, Duke 7, but the wells have not yet been completed (Origin Energy, 2014, pers. comm.).

An EIS for the Ironbark Project is in preparation (as of August 2014). Should the project gain approval, produced gas would be processed in a new gas plant and supplied to the Darling Downs Pipeline (DDPL) for sale to the domestic market (Origin Energy, 2011b).

1.2.3.2.3 Coal seam gas exploration

Exploration targets in the Maranoa-Balonne-Condamine subregion are primarily the seams of the Walloon Coal Measures of the Surat Basin, though the Bandanna Formation of the Bowen Basin has been targeted in the north-western tip of the subregion. However, the coals were not found to have potential for CSG recovery (Blue Energy, 2010). Exploration in the most eastern part of the subregion, where the Surat Basin borders on the western edge of the Clarence-Moreton Basin, has indicated that here the Walloon Coal Measures are very shallow, with low gas content as a result of the proximity to the basin margin (Blue Energy, 2010). The coal seams of the Clarence-Moreton Basin have not presented a target for CSG exploration in the subregion to date (as of August 2014).

In addition to the ongoing exploration carried out by the four large CSG companies to ensure supply for the LNG projects, a number of smaller companies are currently exploring for CSG in the Maranoa-Balonne-Condamine subregion. The locations of three advanced exploration ventures are in Figure 17 and described in more detail below.

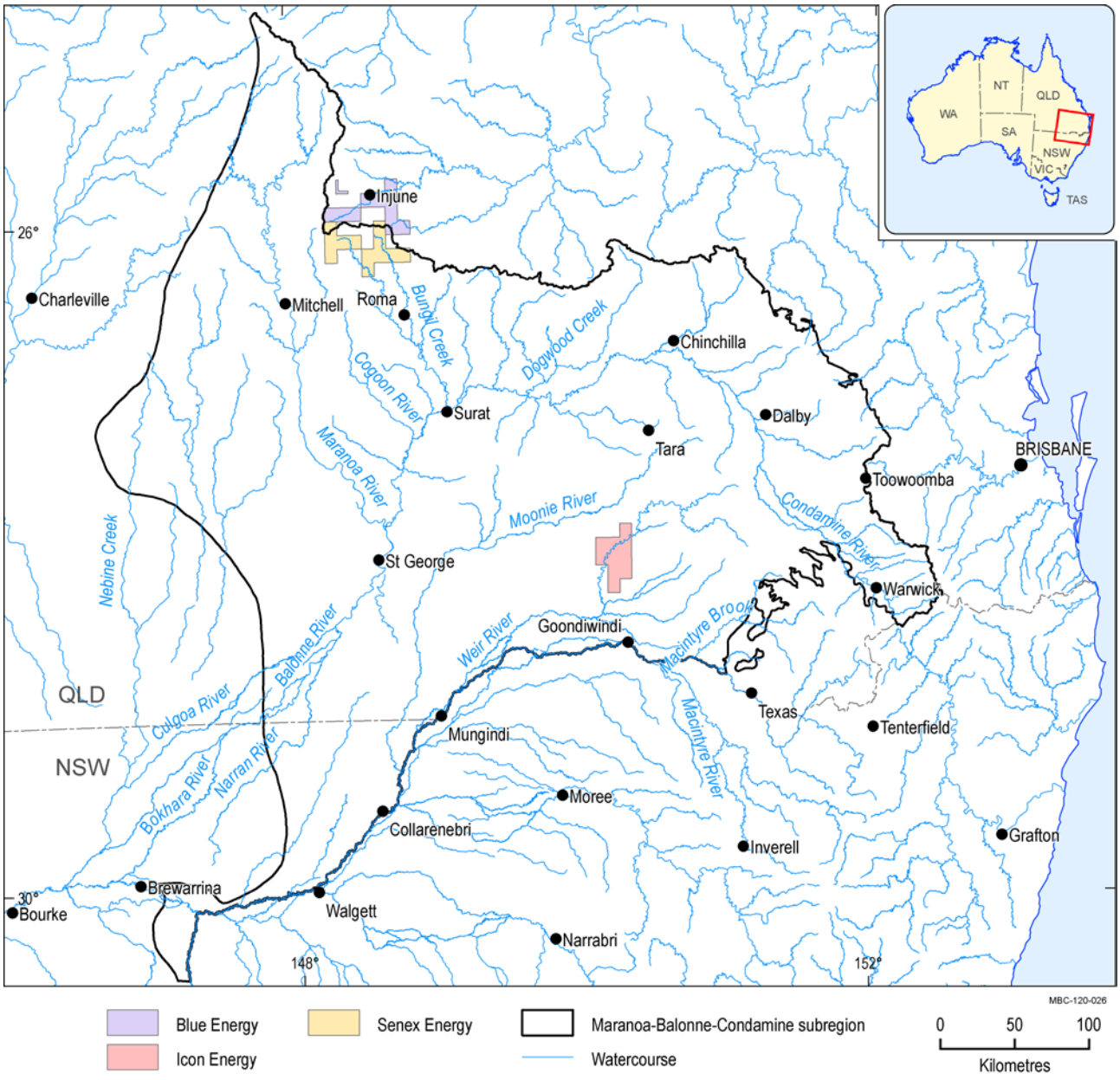

Figure 17 Petroleum tenures with coal seam gas exploration in the Maranoa-Balonne-Condamine subregion

Source data: DNRM (2014a), viewed 21 August 2014

ATP 626 (Icon Energy Limited)

Icon Energy Limited holds a 100% interest in ATP 626, which covers 758 km² north of Goondiwindi in the Surat Basin (GPInfo, 2014, viewed 15 July). Its position within the Maranoa-Balonne-Condamine subregion is indicated in Figure 17.

Icon Energy's 2009 to 2011 exploration programme in the now relinquished Lydia block to the east of ATP 626 (see Figure 18) indicated low coal permeability and was consequently abandoned (Icon Energy, 2011). Two further exploration wells were drilled by Icon Energy in 2012 in the north-east of ATP 626 (see Figure 18): Eolus-1 and Windom-1. Though results of Eolus-1 were reported to be encouraging (Icon Energy, 2012), Icon Energy has since announced that the CSG play in ATP 626 proved to be uncommercial and has lodged a Later Work Program for ATP 626 to conduct conventional exploration (as of August 2014) (Icon Energy, 2014).

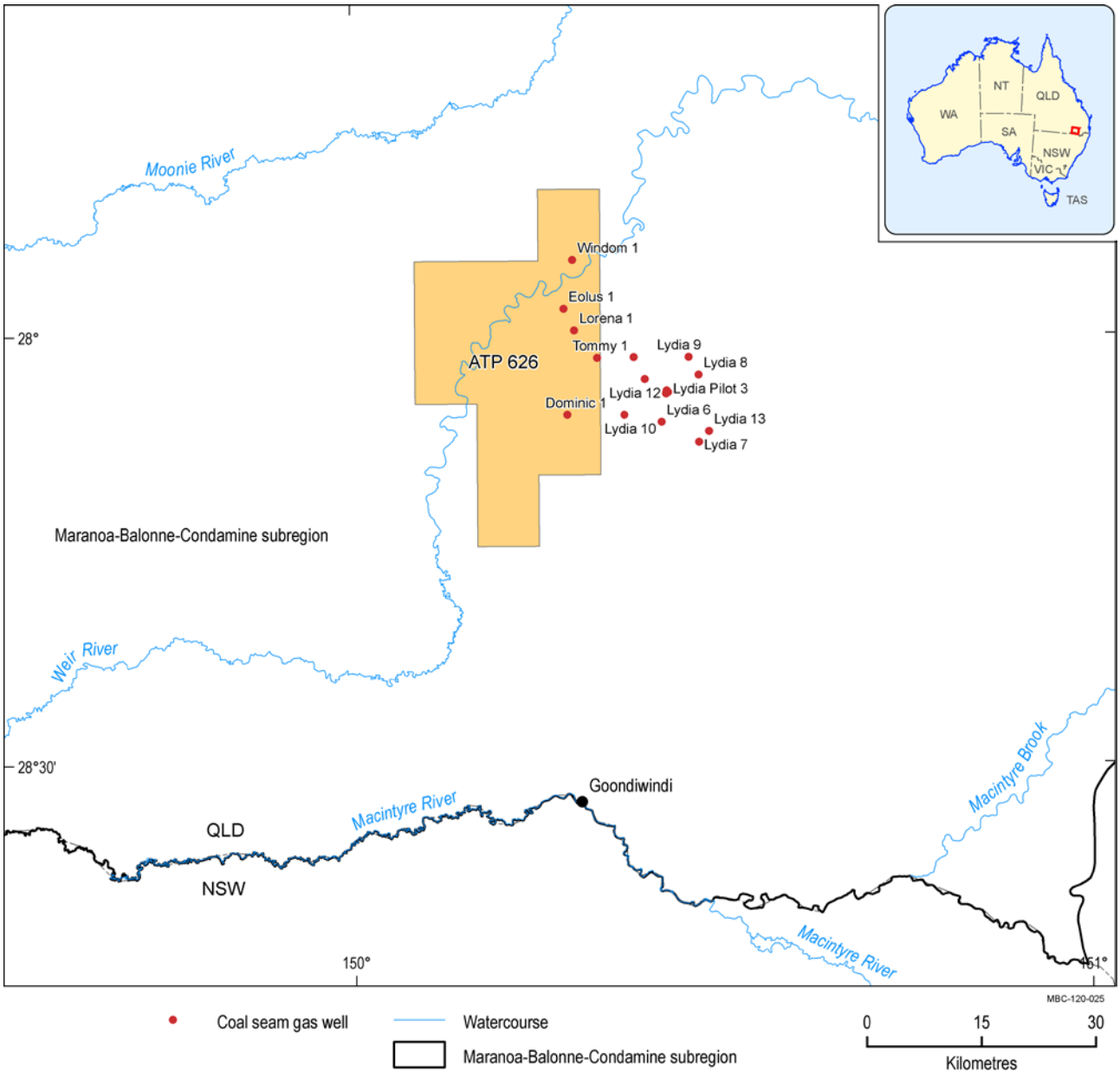

Figure 18 Exploration wells in ATP 626 in the Maranoa-Balonne-Condamine subregion. The Lydia wells indicate the now relinquished Lydia block

Source data: DNRM (2014a), viewed 21 August 2014
ATP = authority to prospect

Don Juan (Senex Energy Limited)

Senex Energy Limited (Senex Energy) is operator and shareholder of petroleum tenures ATP 593 and ATP 771, also known as Don Juan. The individual tenures are presented in Figure 19. The location of the tenures within the Maranoa-Balonne-Condamine subregion is shown in Figure 17.

The 2P reserves of the Don Juan tenure ATP 593 were given as 74 PJ as of December 2013 (DNRM, 2014d). Three exploration and one appraisal well (Kato 1 to 4, see Figure 19) had been drilled by Senex Energy by the end of 2013. Exploration results indicated good coal thickness and excellent permeability (Senex Energy, 2012). The 2P reserves at ATP 771 were quoted as 150 PJ (DNRM, 2014d). Three exploration and one appraisal well (Indy 1 to 4, see Figure 19) had been drilled by

Senex Energy by the end of 2013. Results of the exploration were consistent with those from the Kato wells (Senex Energy, 2013a).

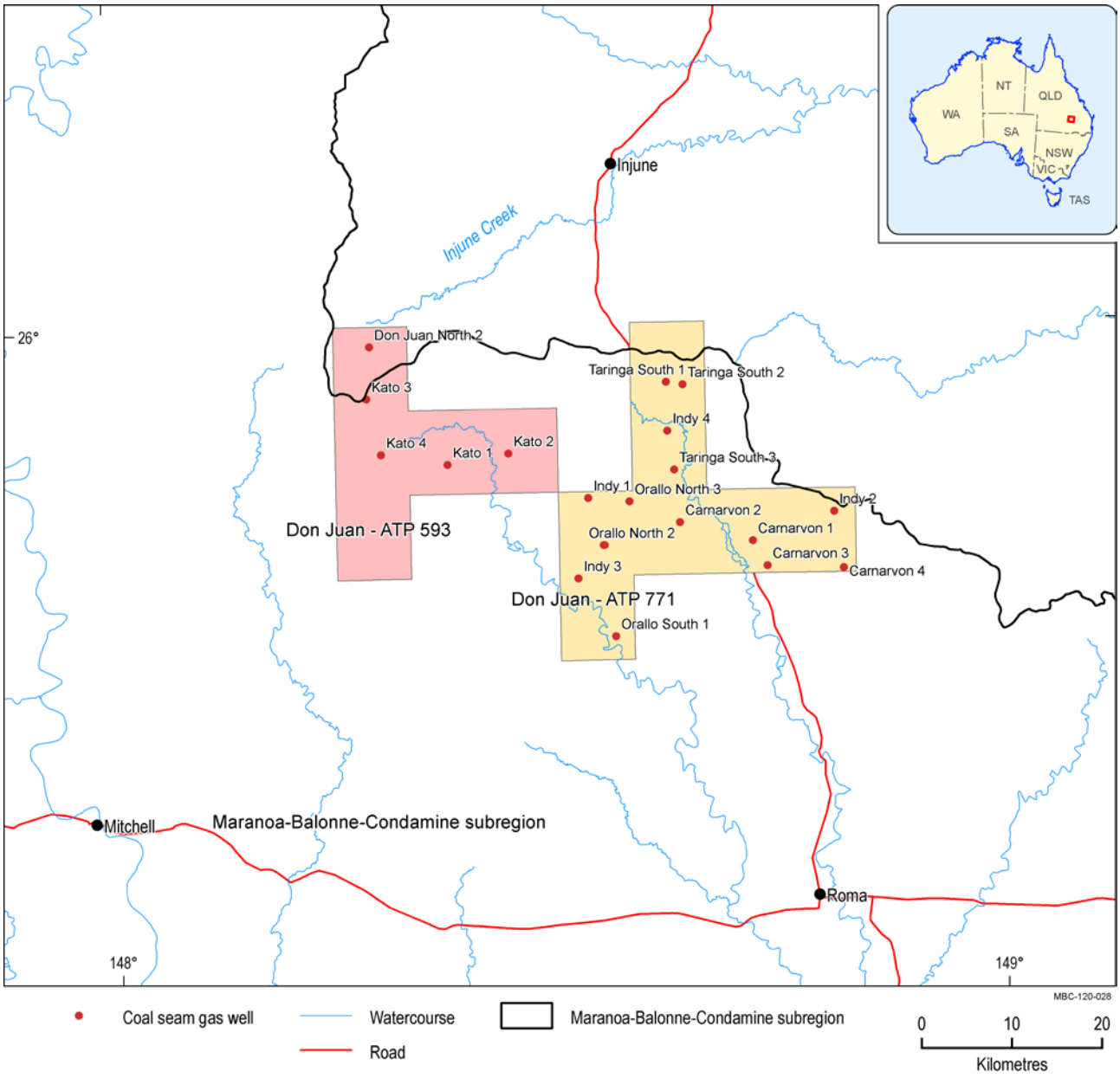

Figure 19 Exploration wells in ATP 593 and ATP 771 (Don Juan) in the Maranoa-Balonne-Condamine subregion

Source data: DNRM (2014a), viewed 21 August 2014
ATP = authority to prospect

ATP 854 (Blue Energy Limited)

ATP 854 is located near Injune, Queensland, on the central-northern border of the Maranoa-Balonne-Condamine subregion. While the tenure is located almost completely outside the Maranoa-Balonne-Condamine subregion, it is still included here as its most southern part borders onto the subregion, as demonstrated in Figure 17. ATP 854 is held and operated by Blue Energy and comprises an area of 800 km^2. Target coals in ATP 854 are those of the Permian Bandanna Formation of the Bowen Basin and the Jurassic Walloon Coal Measures of the Surat Basin (Blue Energy, 2010).

The Itude block of ATP 854 in Figure 20 is in close proximity to the depositional edge of the Surat Basin, indicating shallow coal seams with low gas content and low net coal thickness (Blue Energy, 2011). This was confirmed by the exploration programme (exploration wells Itude 1 to 3, see Figure 20) targeting the Walloon Coal Measures in this block (Blue Energy, 2010).

Exploration of the Bandanna Formation coals in the Bowen Basin in 2008 exhibited more promise. The core data from wells Cerulean 1 and Cobalt 1 (see Figure 20) indicated gas saturated coals with gas content of 8 to 13 m^3/tonne (dry, ash-free basis) (Blue Energy, 2010). However, reservoir permeability was found to be low in pilot well Cerulean 2 (see Figure 20). Blue Energy is considering drilling a lateral well to intersect these coals (Blue Energy, 2010).

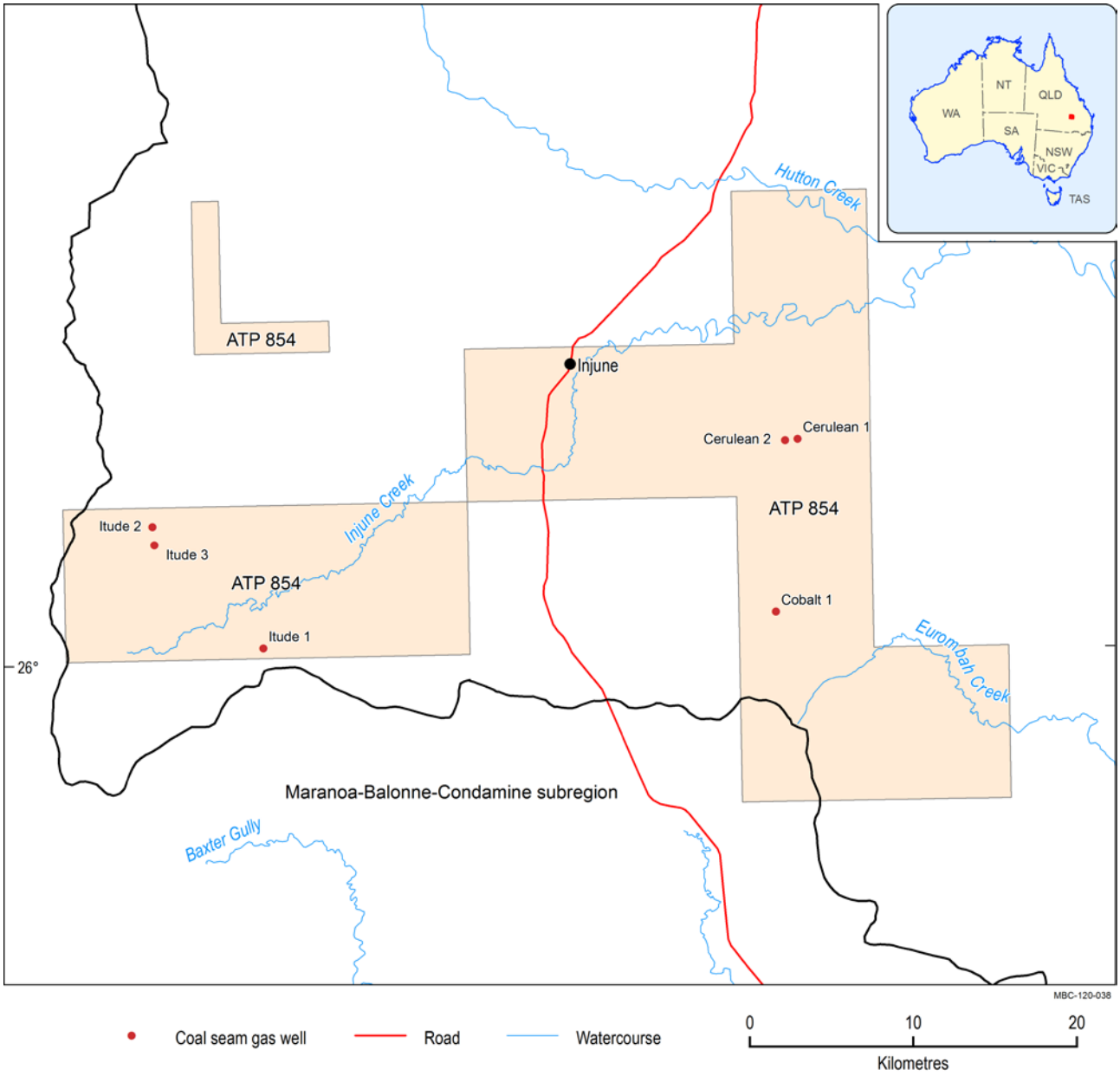

Figure 20 Exploration wells in ATP 854 on the border of the Maranoa-Balonne-Condamine subregion

Source data: DNRM (2014a), viewed 21 August 2014
ATP = authority to prospect

Other exploration activity

A list of CSG petroleum tenures located within the Maranoa-Balonne-Condamine subregion but not currently part of the projects described above is in Table 15. Information on CSG activity in the tenures is also provided as well as exploration plans where available.

Table 15 Coal seam gas petroleum tenures fully or partially in the Maranoa-Balonne-Condamine subregion

Company	Project/ Block	Tenure	Status	2P Reserves (PJ)	Notes
Clark Oil and Gas	NA	PCAA 120	No CSG activity yet	NA	Application for retention of PCA 120. Drilling campaign to start in 2014, but CSG is not the only and not the primary target (Clark Oil and Gas, 2014)
Clark Oil and Gas	NA	PCAA 121	Exploration	NA	Application for retention of PCA 121
Comet Ridge	NA	PELA 137	No CSG activity yet	NA	Application for PEL 137; permit is partially located in Gwydir subregion
Heath, Robert Sturm	NA	ATP 1059	No CSG activity yet	NA	Geological and geophysical studies, drilling of up to one well (GPInfo, 2014, viewed 1 May 2014)
Leichhardt Resources	NA	ATPA 1096	No CSG activity yet	NA	Unsuccessful application for ATP 1096 (competing with applications for ATP 1095 and ATP 1097)
Origin Energy	NA	ATP 647 FO	No CSG activity yet	NA	
Seymour Energy	NA	ATP 1074	No CSG activity yet	NA	Drilling of core wells and 3x5 spot CSG appraisal pilot (GPInfo, 2014, viewed 1 May 2014)
Seymour Energy	NA	ATPA 1097	No CSG activity yet	NA	Unsuccessful application for ATP 1097 (competing with applications for ATP 1095 and ATP 1096)
Surat Gas (now Sierra Oil)	NA	ATP 1072	No CSG activity yet	NA	Geological and geophysical studies, drilling of up to 15 wells (GPInfo, 2014, viewed 1 May 2014)
Surat Gas (now Sierra Oil)	NA	ATPA 1095	No CSG activity yet	NA	Application for ATP 1095 (competing with applications for ATP 1096 and ATP 1097)
Surat Gas (now Sierra Oil)	NA	ATPA 1098	No CSG activity yet	NA	Application for ATP 1098

Source data: GPInfo (2014), viewed 18 August 2014.
2P = proved plus probable reserves; ATP = authority to prospect; ATPA = authority to prospect application; PCA = potential commercial area; PCAA = potential commercial area application; PEL = petroleum exploration licence; PELA= petroleum exploration licence application
The 2P reserves are as of December 2013 (DNRM, 2014d). NA means 'data not available'

References

Alluvium (2013) Surat Gas Project – Supplementary Report to the EIS: Supplementary Surface Water Assessment Part A - Geomorphology and Hydrology. Alluvium Consulting Australia for Coffey Environments.

Ambre CTL Limited (2010) Initial advice statement, ambreCTL, A coal-to-liquids project, 34pp. Viewed 20 August 2014, <http://www.fof.org.au/uploads/media/ambreCTL_IAS_July10.pdf>.

Ambre CTL Limited (2011) Annual report. Ambre CTL Limited, Brisbane. Viewed 6 March 2014, <http://www.ambreenergy.com/FileLibrary/annualreport2011ambrectl.pdf>.

APLNG (2010a) Australia Pacific LNG Project environmental impact statement. Australia Pacific LNG Pty Limited, Brisbane.

APLNG (2010b) Australia Pacific LNG Project supplemental information to the EIS – project description improvement. Australia Pacific LNG Pty Limited, Brisbane.

APLNG (2012) Letter to the the Research Director - Industry, Education, Training and Industrial Relations Committee, Australia Pacific LNG Pty Limited, Brisbane. Viewed 28 August 2014, <http://www.parliament.qld.gov.au/documents/tableOffice/CommSubs/ResourcesLAB/013.pdf>.

APLNG (2014) Australia Pacific LNG Upstream Phase 1 Stage 2 CSG Water Monitoring and Management Plan. Australia Pacific LNG Pty Limited, Brisbane.

Arrow Energy (2012) Surat Gas Project, environmental impact statement. Arrow Energy Pty Ltd., Brisbane.

Arrow Energy (2013) Surat Gas Project supplementary report to the environmental impact statement. Arrow Energy Pty Ltd., Brisbane.

Arrow Energy (2014a) Surat domestic gas business. Arrow Energy Limited, Brisbane. Viewed 15 August 2014, <http://www.arrowenergy.com.au/projects/domestic-gas-business/surat-domestic-gas-business>.

Arrow Energy (2014b) Surat Gas Project. Arrow Energy Pty Ltd, Brisbane. Viewed 18 August 2014, <http://www.arrowenergy.com.au/projects/surat-gas-project>.

Australian Mining Link (2013) Arrow Surat Gas Project. Australian Mining Link, Brisbane. Viewed 15 March 2014, <http://mininglink.com.au/mine/arrow-surat-gas-project>.

Blue Energy (2010) Annual Report 2010. Blue Energy Limited, Brisbane. Viewed 2 July 2014, <http://www.theroom.com.au/clients/blueenergy/flipbook/index.html>.

Blue Energy (2011) Annual Report 2011. Blue Energy Limited, Brisbane. Viewed 2 July 2014, <http://www.blueenergy.com.au/_dbase_upl/Blue%20Energy%202011%20Annual%20Report.pdf>.

Business Spectator (2014) QCLNG on track for Q4 start: BG. Business Spectator. Viewed 4 April 2014, <http://www.businessspectator.com.au/news/2014/2/5/resources-and-energy/qclng-track-q4-start-bg>.

Clark Oil and Gas (2014) Exploration permit ATP840P - Surat Basin, Queensland, Australia. Clark Oil and Gas Pty Ltd, Brisbane. Viewed 23 April 2014, <http://clarkoilandgas.com.au/projects/>.

Department of the Environment (2013a) Surat Gas Expansion Project decision overview. Department of the Environment, Canberra. Viewed 3 April 2014, <http://www.environment.gov.au/system/files/pages/bf780996-30e4-4ad5-bc64-1edcff13273a/files/surat-gas-expansion-project.pdf>.

Department of the Environment (2013b) Final decision on whether water resources is a controlling provision for the specified action, the Range Project near Wandoan, central Queensland. Viewed 3 Oct 2014, <http://www.environment.gov.au/epbc/notices/assessments/2011/5860/2011-5860-water-decision-notice.pdf>.

DNRM (2014a) Queensland Government interactive resource and tenure maps (IRTM) system. Queensland Government Department of Natural Resources and Mines, Brisbane. <http://webgis.dme.qld.gov.au/webgis/webqmin/viewer.htm>.

DNRM (2014b) MinesOnlineMaps. Queensland Government Department of Natural Resources and Minerals. Viewed 20 August 2014, <http://www.dnrm.qld.gov.au/mapping-data/maps/minesonlinemaps>.

DNRM (2014c) Petroleum and gas tenure types and forms. Queensland Department of Natural Resources and Mines, Brisbane. Viewed 30 June 2014, <http://mines.industry.qld.gov.au/mining/petroleum-gas-tenures.htm>.

DNRM (2014d) Coal seam gas reserves 1 January 2005 to 31 December 2013. Queensland Government, Department of Natural Resources and Mines, Brisbane. Viewed 29 August 2014, <http://mines.industry.qld.gov.au/mining/production-reserves-statistics.htm>.

GasFields Commission Queensland (2014) CSG-LNG Projects Update - as at end of June Quarter 2014, GasFields Commission Queensland, Toowoomba. Viewed 3 October 2014, <http://www.gasfieldscommissionqld.org.au/resources/gasfields/csg-lng-project-update-jun-2014.pdf>.

Gladstone Observer (2013) APLNG project on track to deliver first gas in 2015. Gladstone Observer. Viewed 14 April 2014, <http://www.gladstoneobserver.com.au/news/aplng-track-deliver-first-gas-2015/2070741/>.

Gladstone Observer (2014) Commissioning on Cards as QCLNG moves towards first gas. Gladstone Observer. Viewed 4 April 2014, <http://www.gladstoneobserver.com.au/news/commissioning-cards-qclng-moves-towards-first-gas/2203245/>.

GPinfo (2014) Encom GPinfo version 5.8.2. Pitney Bowes Software Pty Ltd, Sydney.

Hough C (2013) First gas reaches Curtis Island's LNG terminal. ABC News. Viewed 25 March 2014, <http://www.abc.net.au/news/2013-12-17/qgc-first-gas/5161522>.

Icon Energy (2011) Share price. Icon Energy Limited, Broadbeach, Queensland. Viewed 15 April 2014, <http://www.iconenergy.com/investor-information/share-price/14-about-icon/management.html>.

Icon Energy (2012) 2012 Annual Report Highlights. Icon Energy Limited, Broadbeach, Queensland.

Icon Energy (2013) 2013 Annual Report Highlights. Icon Energy Limited, Broadbeach, Queensland.

Icon Energy (2014) Quarterly Report Period Ending June 30 2014. Icon Energy Limited, Broadbeach, Queensland.

Macdonald-Smith A (2014) Shell's Arrow Energy to slash hundreds of jobs. Sydney Morning Herald. Viewed 3 April 2014, <http://www.smh.com.au/business/mining-and-resources/shells-arrow-energy-to-slash-hundreds-of-jobs-20140120-3142g.html>.

McCarthy J (2014) Queensland Government refuses to define 'social licence' as Arrow Energy faces opposition from landholders near Dalby. Courier Mail. Viewed 3 April 2014, <http://www.couriermail.com.au/business/queensland-government-refuses-to-define-social-licence-as-arrow-energy-faces-opposition-from-landholders-near-dalby/story-fnihsps3-1226835293932>.

McGrath J (2014) Shell confirms Arrow LNG won't be approved this year. Gladstone Observer, Brisbane. Viewed 3 April 2014, <http://www.gladstoneobserver.com.au/news/shell-confirms-arrow-lng-wont-be-approved-year/2156252/>.

MetroCoal Limited (n.d.) Columboola Project. Viewed 5 March 2014, <http://metrocoal.com.au/projects/columboola-project/>.

MetroCoal Limited (2013) MetroCoal Limited and controlled entities interim financial report for the half year ended 31 December 2013. Viewed 5 March 2014, <http://metrocoal.com.au/news/216/30/December-2013-Audited-Financials/>.

MetroCoal Limited (2011) ASX Announcement, drilling resumes on Columboola Coal project. Viewed 5 March 2014, <http://metrocoal.com.au/news/94/30/Drilling-Resumes-on-Columboola-Coal-Project/>.

New Hope Group (2012) New Acland Coal Mine: Stage 3 project revised project overview. Viewed 8 May 2014, <http://www.dsdip.qld.gov.au/resources/project/new-acland-coal-mine/nacp-project-overview.pdf>.

New Hope Group (2013) New Acland Coal Mine Project Fact Sheet. Viewed 8 May 2014, <http://www.aclandproject.com.au/files/files/130828%20New%20Acland%20Coal%20Mine%20Fact%20Sheet.pdf>.

New Hope Group (2014a) New Acland Coal Mine Stage 3 Project, environmental impact statement, executive summary. Viewed 9 April 2014, <http://asp-au.secure-zone.net/v2/521/574/4427/Executive-Summary---NEW-ACLAND-COAL-MINE---STAGE-3-PROJECT.pdf>.

New Hope Group (2014b) New Acland Coal Mine Stage 3 Project, environmental impact statement, Full Report. New Hope Group, Brisbane. Viewed 20 August 2014, <http://asp-au.secure-zone.net/v2/index.jsp?id=521/574/4422&lng=en>.

Origin Energy (2011a) APLNG Project Overview. Origin Operational Review and Asset Visit. Origin Energy Limited, Sydney. Viewed 19 August 2014, <http://www.originenergy.com.au/files/Site_Tour_Presentations_6to9_APLNG_Project.pdf> .

Origin Energy (2011b) Origin Energy Ironbark Project Initial Advice Statement. Origin Energy Limited, Sydney.

Origin Energy (2013) Australia Pacific LNG – CSG Production, Origin Operational Review and Asset Visit; presented to the QLD Petroleum Exploration Association. Origin Energy Limited, Sydney. Viewed 21 August 2014, <http://www.originenergy.com.au/files/20130520_APLNG_CSG_Production_ORG_Review_and_Asset_Visit_May2013.pdf>.

Origin Energy (2014a) March 2014 Quarterly Production Report, Origin Energy Limited, Sydney. Viewed 21 August 2014, <http://www.originenergy.com.au/news/files/quarterly_production_report_march_2014.pdf>.

Origin Energy (2014b) Origin Energy 2014 Annual Reserves Report, Origin Energy Limited, Sydney. Viewed 21 August 2014, <http://www.originenergy.com.au/news/files/asx_origin_energy_2014_annual_reserves_report.pdf>.

QGC (2009) Queensland Curtis LNG – environmental impact statement. QGC Limited, Brisbane.

QGC (2010) Queensland Curtis LNG – supplementary report to the environmental impact statement. QGC Limited, Brisbane.

QGC (2012a) The Queensland Curtis LNG Project fact sheet. QGC, BG Group, Brisbane. Viewed 4 April 2014, <http://www.qgc.com.au/media/100578/20121023_2013-qclng-project_fs.pdf>.

QGC (2012b) Development of Surat Basin acreage, attachment 4.1 Stage 2 CSG Water Monitoring and Management Plan. QGC Limited, Brisbane.

QGC (2012c) Approaching first LNG, QCLNG project update. QGC Limited, Brisbane. Viewed 8 April 2014, <http://www.qgc.com.au/media/58247/qclngprojupdateed1-jun2012.pdf>.

QGC (2013) Approval Conditions 49 to 64: Stage 3 CSG Water Monitoring and Management Plan. QGC Limited, Brisbane.

Queensland Government EHP (2010) Terms of reference for the Cameby Downs Expansion Project EIS. Viewed 4 March 2014, <http://www.ehp.qld.gov.au/management/impact-assessment/eis-processes/documents/cameby_downs_expansion_project_final_tor_final.pdf>.

Queensland Government EHP (2014) Cameby Downs Expansion Project, Viewed 2 October 2014 <https://www.ehp.qld.gov.au/management/impact-assessment/eis-processes/cameby_downs_expansion_project.html>.

Queensland Government (2013a) Queensland's coal mines – advanced projects, October 2013. Viewed 6 March 2014, <http://mines.industry.qld.gov.au/assets/coal-pdf/queensland-coal-mines-adv-projects-2013.pdf>.

Queensland Government (2014) Business and industry portal, Apply for a mining lease for minerals and coal. Viewed 20 August 2014, <http://www.business.qld.gov.au/industry/mining/applying-for-mining-resource-permits/production-and-development-permits-for-mining/apply-for-a-mining-lease-for-minerals-and-coal>.

Queensland Government DSDIP (2013) Santos GLNG Gas Field Development Project. Queensland Government Department of State Development, Infrastructure and Planning. Viewed 20 March 2014, <http://www.dsdip.qld.gov.au/assessments-and-approvals/santos-glng-gas-field-development-project.html>.

Queensland Government DSDIP (2014) New Acland Coal Mine Stage 3 Project. Queensland Government Department of State Development, Infrastructure and Planning. Viewed 9 April 2014, <http://www.dsdip.qld.gov.au/assessments-and-approvals/new-acland-coal-mine-stage-3-expansion.html>.

Queensland Government EHP (2012) EIS Processes, Felton Mine and Dimethyl Ether Pilot Plant project (withdrawn). Queensland Government Department of Environment and Heritage Protection. Viewed 8 April 2014, <http://www.ehp.qld.gov.au/management/impact-assessment/eis-processes/felton_mine_and_dimethyl_ether_pilot_plant_project.html>.

Queensland Government EHP (2013a) The Range Project. Queensland Government Department of Environment and Heritage Protection. Viewed 9 April 2014, <http://www.ehp.qld.gov.au/management/impact-assessment/eis-processes/the-range.html>.

Queensland Government EHP (2013b) Environmental impact statement (EIS) report under the *Environmental Protection Act 1994*. Stanmore Coal Limited, Brisbane. Queensland Government Department of Environment and Heritage Protection. Viewed 9 April 2014, <http://www.ehp.qld.gov.au/management/impact-assessment/eis-processes/documents/the-range-eis-assessment-report.pdf Viewed 9th April 2014>.

Santos (2009) GLNG Project – environmental impact statement. Santos Ltd., Brisbane.

Santos (2011) First Quarter Activities Report. Santos Ltd., Brisbane. Viewed 21 August 2014, <http://www.santos.com/library/200411_Santos_First_Quarter_Activities_Report_for_period_ending_31_March_2011.pdf>.

Santos (2012) Santos GLNG Gas Field Development Project – initial advice statement. Santos Ltd, Brisbane.

Santos (2013a) Santos GLNG and QGC sign industry collaboration deal, Santos media release from July 4 2013. Santos Ltd, Brisbane. Viewed 7 April 2014, <http://www.santosglng.com/media/pdf3047/130704_santos_qgc_interconnect.pdf>.

Santos (2013b) Santos GLNG Project CSG Water Monitoring and Management Plan Stage 2 Revision 2, Santos Ltd, Brisbane.

Santos (2013c) GLNG and Australia Pacific LNG sign upstream cooperation deal, Santos media release from October 25 2013. Santos Ltd, Brisbane. Viewed 7 April 2014, <http://www.santosglng.com/media/pdf3288/glng_aplng.pdf>.

Santos (2013d) Santos GLNG Gas Field Development Project, Fact sheet No. 1. Santos Ltd, Brisbane. Viewed 7 April 2014, http://www.santosglng.com/media/pdf3154/gas_field_development_fact_sheet_final.pdf

Santos (2014a) Our activities – Surat/Bowen Basins. Santos Ltd, Brisbane. Viewed 1 July 2014, <http://www.santos.com/our-activities/eastern-australia/surat-bowen-basins.aspx>.

Santos (2014b) GLNG Investor Visit. Santos Ltd, Brisbane. Viewed 29 August 2014, <http://www.santos.com/library/240614_GLNG_%20investor_visit_presentation.pdf>.

Santos (2014c) Second Quarter Activities Report. Santos Ltd, Brisbane. Viewed 21 August 2014, <http://www.santos.com/library/180714_2014_Second_Quarter_Activities_Report.pdf>.

Santos (2014d) Coal Seam Water Monitoring and Management Annual Report 2013. Santos Ltd, Brisbane. Viewed 29 August 2014, <http://www.santoswaterportal.com.au/media/pdf1873/140328_santos_glng_cwmmp_annual_report_2013.pdf>.

Santos (2014e) 2014 Half-year results. Santos Ltd, Brisbane. Viewed 29 August 2014, <http://www.santos.com/library/220814_2014_Half-year_results_presentation.pdf>.

Senex Energy (2012) Annual report 2012. Senex Energy Limited, Brisbane.

Senex Energy (2013a) Annual report 2013. Senex Energy Limited, Brisbane.

Senex Energy (2013b) Monthly drilling report – November 2013. Senex Energy Limited, Brisbane. Viewed 15 April 2014, <http://www.senexenergy.com.au/157/Investor-Centre/files?category=Drilling+Reports>.

SEWPaC (2011) Notification of referral decision and designated proponent – controlled action, the range project near Wandoan, central Queensland (EPBC 2011/5860), 1pp. Department of Sustainability, Environment, Water, Population and Communities.

Stanmore Coal (2014) The Range. Viewed 4 March 2014, <http://stanmorecoal.com.au/project/the-range/>.

Swanepoel E (2014) Queensland Curtis LNG project on track for Q4 production – BG Group, Feb. Mining Weekly. Viewed 17 March 2014, <http://www.miningweekly.com/article/queensland-curtis-lng-project-on-track-for-q4-production-bg-group-2014-02-06>.

The Australian (2013) Ambre Energy admits coalmine won't proceed. Viewed 6 March 2014, <http://www.theaustralian.com.au/business/mining-energy/ambre-energy-admits-coalmine-wont-proceed/story-e6frg9df-1226554657649#>.

Western Downs Regional Council (2011) Western Downs Regional Council Major Projects, Factsheet, The Range Project, 1pp. Viewed 2 July 2014, <http://www.advancewesterndowns.com/major-projects.html>.

1.2.4 Catalogue of potential resource developments

Summary

There are currently five potential coal resource developments in the Maranoa-Balonne-Condamine subregion, typically in the north-west, north and east of the subregion in the Surat and Clarence-Moreton geological basins. Three of these are potentially new mines (The Range, Columboola Project and ambreCTL) and two are expansion projects (New Acland Coal Mine Stage 3 Project, Cameby Downs Expansion Project). The future of the ambreCTL Project is unclear and although an online report stated the project is not going ahead, there is no confirmation of this from Ambre Energy Limited to date. The Columboola Project is currently in the exploration phase. Most projects mentioned here have unknown certainty and are largely at the pre-EIS (environmental impact statement) stage.

Three large-scale liquefied natural gas (LNG) projects are currently under construction: the Australia Pacific LNG (APLNG) Project, the Gladstone LNG (GLNG) Project and the Queensland Curtis LNG (QCLNG) Project. Each of these projects includes several coal seam gas (CSG) field developments in the Walloon Coal Measures of the Surat Basin in the subregion. Santos GLNG is also planning the Gladstone LNG Gas Field Development (GLNG GFD) which represents an extension to the GLNG Project.

The Stratheden gas field, a comparatively small-scale project, is expected to supply gas to the domestic market. The gas field has been drilled and commissioned.

The proposed Surat Gas Project is another large-scale gas field development to supply CSG for LNG production. This project received State and Australian Government approval in 2013. A comparatively small CSG development that has also been proposed is the Ironbark Project.

1.2.4.1 Potential coal developments

Table 16 shows a catalogue of potential projects in the Maranoa-Balonne-Condamine subregion as identified by Geoscience Australia's resource database, OZMIN (as at December 2012). The New Acland Coal Mine Stage 3 Project has been deemed a Controlled Action by the Australian Government. As a result the New Acland Coal Mine Stage 3 Project is being managed by Queensland's Coordinator-General under a 'Bilateral Agreement' with the Australian Government. The New Acland Coal Mine Stage 3 Project's EIS process is well advanced, having completed formal lodgement during early 2014 and the associated stakeholder and public comment period on 3 March 2014. The New Acland Coal Mine Stage 3 Project is currently undertaking an additional information process for its EIS. An EIS has been submitted for The Range. An EIS was not provided by the required date for Cameby Downs Expansion Plan, which caused the final Terms of Reference for the EIS to cease to have effect (Queensland Government EHP 2014). The ambreCTL Project EIS and plan is uncertain and the Columboola Project is at a pre-EIS stage. All others listed are pre-EIS stage, and described as a resource that has been reported as Joint Ore Reserves Committee (JORC) compliant and those with resources listed are current according to OZMIN as at December 2012. Locations of the projects in relation to current mines are shown in Figure 21.

Table 16 Catalogue of potential coal resource developments in the Maranoa-Balonne-Condamine subregion

Project name	Company	Longitude	Latitude	Record date[a]	Material[b]	Total coal resources[c] (Mt)	Status of EIS[d]	Notes
ambreCTL Project ('Felton')	Ambre Energy Limited	151.618°	–27.794°	n.a.	CTL (coal to liquids)	NA	Status uncertain	Continuation uncertain
Back Creek	Allegiance Coal Limited	150.283°	–26.283°	26 Nov 2012	Thermal Coal	98.6	Pre-EIS	na
Bottle Tree	Cockatoo Coal Limited	150.179°	–26.156°	26 Jun 2012	Thermal Coal	35.5	Pre-EIS	na
Bringalily	Blackwood Corporation Ltd	151.173°	–28.031°	31 Jul 2007	Thermal Coal	124	Pre-EIS	na
Bushranger (Coal)	Cockatoo Coal Limited	150.246°	–26.273°	NA	NA	145	Pre-EIS	Cockatoo Coal Limited (2013)
Cameby Downs Expansion Project	Yancoal Australia Ltd	150.287°	–26.578°	30 Aug 2011	Thermal coal	723	No EIS submitted and EIS Terms of Reference now lapsed	EIS was due for submission 31 March 2014, but was not submitted by that date and consequently the final Terms of Reference for the EIS have ceased to have effect (Queensland Government 2014)
Columboola Project	MetroCoal Limited and SinoCoal Resources Pty Ltd	150.333°	–26.667°	2013	Thermal coal	1712.7	Pre-EIS	MetroCoal Limited (2013)
Cornwall	Aquila Resources Ltd	148.75°	–26.183°	4 May 2012	Thermal Coal	466	Pre-EIS	Mineral development licence granted; conceptual study will be performed; no EIS reportable
Dalby West	MetroCoal Limited	150.95°	–27.15°	9 Dec 2011	Thermal Coal	520	Pre-EIS	Tenure overlapped by CSG activity and as a result unlikely to be accessible for 15 years (N. Villa (MetroCoal), 2014, pers. comm.)

Project name	Company	Longitude	Latitude	Record date[a]	Material[b]	Total coal resources[c] (Mt)	Status of EIS[d]	Notes
Davies Road	Cockatoo Coal Limited	150.419°	–26.602°	26 Jun 2011	Thermal Coal	49.4	Pre-EIS	na
Glen Roslyn	New Hope Group	151.712°	–27.320°	na	NA	NA	Pre-EIS	na
Glen Wilga	CS Energy Ltd	150.629°	–26.801°	31 Jul 2003	Thermal Coal	162	Pre-EIS	na
Haystack Road	CS Energy Ltd	150.870°	–26.820°	31 Jul 2003	Thermal Coal	172	Pre-EIS	na
Horse Creek	Peabody Energy (Wilkie Creek)	150.486°	–26.368°	31Dec 2006	Thermal Coal	294	Pre-EIS	na
Injune	Cockatoo Coal Limited	148.3°	–25.45°	3 May 2012	Thermal Coal	826.9	Pre-EIS	na
Kogan EPC 867, 869, 11 32	Carbon Energy Limited	150.8°	–27. 2°	na	NA	NA	Pre-EIS	na
Krugers	Cockatoo Coal Limited	150.591°	–26.560°	26 Jun 2012	Thermal Coal	163.2	Pre-EIS	na
Lochbar	NA	151.265°	–27.973°	31 Jul 2003	Thermal Coal	42	Pre-EIS	na
Maryvale	Clean Global Energy Limited	152.084°	–28.076°	7 Oct 2012	Thermal Coal	38	Pre-EIS	na
New Acland Coal Mine Stage 3 Project	New Acland Coal Pty Ltd	151.707°	–27.269°	30 Jul 2013	Thermal coal	441	EIS submitted	Queensland Government 'Coordinated Project' and Australian Government 'Controlled Action'. Managed by Queensland's Coordinator-General under a 'Bilateral Agreement'. EIS process well advanced. New Hope Group (2014)

Project name	Company	Longitude	Latitude	Record date[a]	Material[b]	Total coal resources[c] (Mt)	Status of EIS[d]	Notes
Ownaview	Cockatoo Coal Limited and Mitsui	151.251°	–27.043°	7 Jul 2010	Thermal Coal	171	Pre-EIS	na
Pittsworth	NA	151.7°	–27.7°	31 May 2007	Thermal Coal	196	Pre-EIS	na
Rywung	Yancoal Australia Ltd	150.468°	–26.679°	30 Apr 2009	Thermal Coal	323.37	Pre-EIS	na
Sabine	New Hope Group	151.684°	–27.368°	NA	NA	NA	Pre-EIS	na
Sefton Park	Yancoal Australia Ltd	150.584°	–26.787°	30 Jun 2005	Thermal Coal	47.17	Pre-EIS	na
Surat Coal (Carbon Energy)	Carbon Energy Limited	150.66°	–27.25°	10 Sep 2012	Thermal Coal	1366.6	Pre-EIS	Plans for 35Pj SNG plant adjacent to Bloodwood Creek site pending government approval (M Cid (Carbon Energy), 2014, pers. comm.)
The Range Project	Stanmore Coal Limited	150.211°	–26.204°	26 Oct 2012	Thermal coal	287	EIS submitted	Pre-feasibility and Feasibility studies completed. Stanmore Coal (2014); Queensland Government EHP (2013)
Tin Hut Creek	Cockatoo Coal Limited	150.153°	–26.408°	26 Jun 2012	Thermal Coal	343.6	Pre-EIS	Initial baseline studies have commenced (R Punt (Cockatoo Coal), 2014, pers. comm.)
Wandoan	Cougar Energy Limited	150.034°	–26.436°	18 Aug 2009	Thermal Coal	341.3	Pre-EIS	na

[a]The record date is the most recent date for updated coal resource numbers
[b]Materials fall into one of the following four classes: thermal coal, coking coal, pulverised coal injection (PCI) and unspecified
[c]This is calculated by summing the resources with Joint Ore Reserves Committee (JORC) codes of measured, indicated and inferred
[d]The status of the project within an environmental impact statement (EIS): pre-EIS, EIS in preparation, EIS submitted, EIS closed, supplementary EIS and EIS approved.
NA means 'data not available'; na means 'data not applicable'; EPC = exploration permit for coal

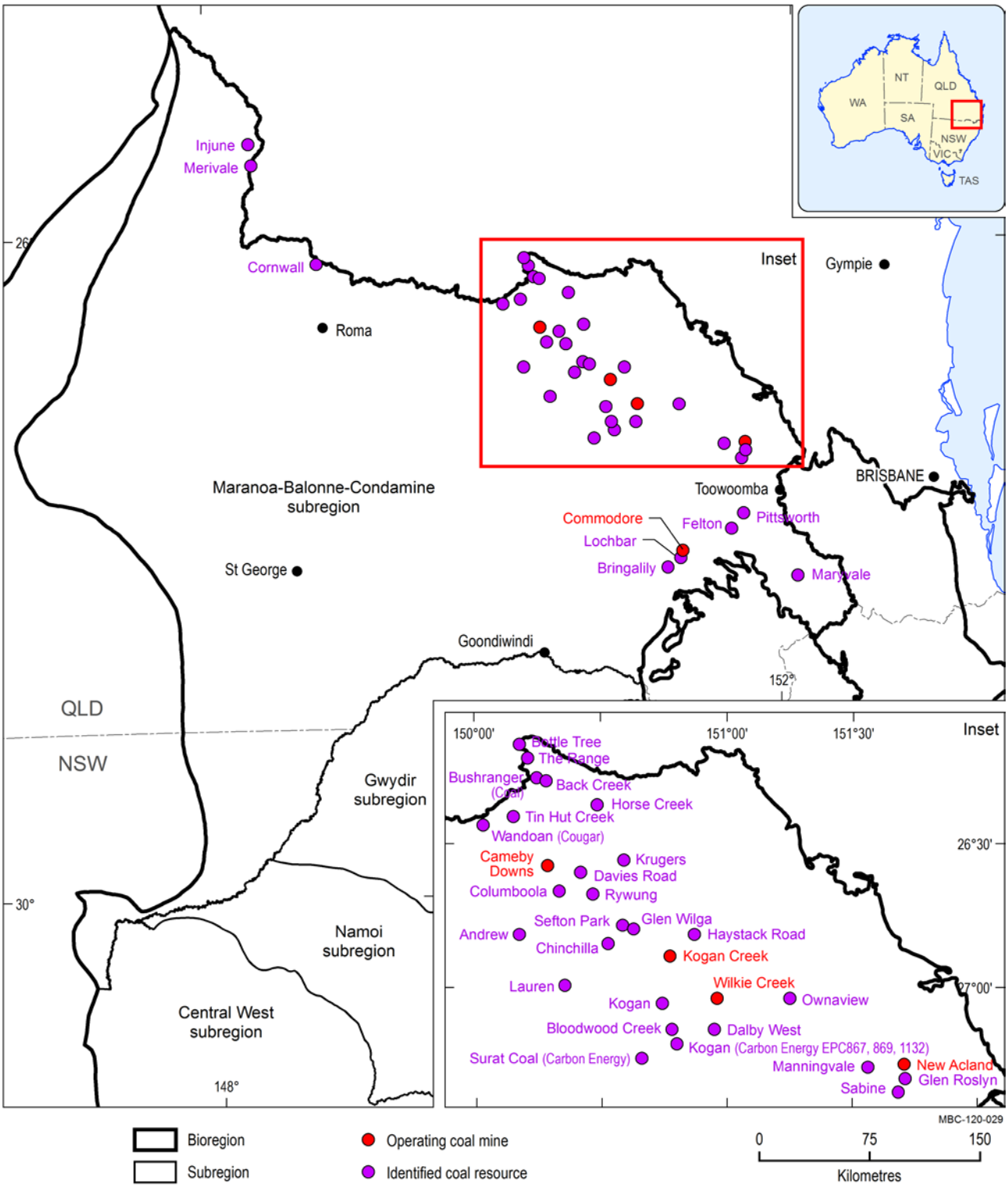

Figure 21 Map showing mining and resources in Maranoa-Balonne-Condamine subregion

Source data: OZMIN database, Geoscience Australia, current as of December 2012

1.2.4.2 Potential coal seam gas projects

Five CSG development projects are currently planned in the Maranoa-Balonne-Condamine subregion. Three have been approved and are currently under construction, one is awaiting financial approval, and one is in planning stages with the EIS currently being prepared.

The projects under construction are the Australia Pacific LNG (APLNG) Project operated by Origin Energy Limited, the Gladstone LNG (GLNG) Project operated by Santos Ltd, and the Queensland Curtis LNG (QCLNG) Project operated by QGC Pty Limited (a BG Group business). These are large-scale projects that each include several CSG field developments targeting the Walloon Coal Measures in the Surat Basin. The gas produced from these projects is intended for the export market in the form of LNG. Conversion to LNG occurs in facilities on Curtis Island, near Gladstone, to which it is transported via pipelines. Santos GLNG is also planning the Gladstone LNG Gas Field Development (GLNG GFD) which represents an extension to their GLNG Project. The GLNG GFD Project involves further development of Santos GLNG's existing CSG developments as well as the development of new tenements (Santos, 2012).

Arrow Energy Pty Ltd's Stratheden gas field, a comparatively small scale project, is expected to supply gas to the domestic market. The gas field has been drilled and commissioned (Arrow Energy, 2014) and is currently in a water production stage to enable commercial gas production (Arrow Energy, 2014, pers. comm.).

The proposed Surat Gas Project (SGP) is another large-scale gas field development to supply CSG for LNG production on Curtis Island and export to global markets. The gas fields are owned and operated by Arrow Energy. State and Australian Government approval was received in 2013. A decision to proceed with the SGP and the timing of that decision are matters of Arrow Energy's shareholders Royal Dutch Shell plc and PetroChina Company Limited. Arrow Energy is looking at multiple opportunities, including collaboration with one or more of the existing LNG projects, to develop its gas resource (Arrow Energy, 2014, pers. comm.).

A comparatively small CSG development is Origin Energy's proposed Ironbark Project. The project location is in ATP 788 between the towns of Tara in the south, Dalby to the east, and Chinchilla to the north. An EIS is in preparation.

The projects are summarised in Table 17. It is important to note that not all the gas field developments of the large-scale CSG projects are in the Maranoa-Balonne-Condamine subregion. The reserves presented in Table 17 are representative of CSG reserves of the Maranoa-Balonne-Condamine subregion only. To determine these, the reserves of the individual petroleum tenures comprising the project area located in the Maranoa-Balonne-Condamine subregion were summed. The data were taken from the reserves report published by the Queensland Department of Natural Resources and Mines (DNRM, 2014). Only proved plus probable (2P) reserves are presented.

Table 17 Catalogue of potential coal seam gas resource developments in the Maranoa-Balonne-Condamine subregion

Project name	Company	Longitude	Latitude	Record date[a]	2P coal seam gas reserves[b] (PJ)	Status of EIS[c]	Notes
Australia Pacific LNG	Australia Pacific LNG Pty Limited	150.15°	–27°	31 Dec 2013	8972 (DNRM, 2014)	EIS approved	Under construction. Forecast Phase 1 production: 1,200 TJ/d (Origin Energy, 2013). The project currently comprises two LNG trains with a capacity of 4.5 Mt/year each (Origin Energy, 2013). The project may have up to four LNG trains (APLNG, 2010)
Gladstone LNG / Gladstone LNG Gas Field Development (GLNG GFD)	Santos GLNG Pty Ltd	149°	–26.4°	31 Dec 2013	2745 / 2807[d] (DNRM, 2014)	EIS approved / EIS in preparation	Under construction. The GLNG Project comprises two LNG trains with a combined capacity of 7.8 Mt/year (Santos, 2014). The GLNG GFD Project is an extension to the GLNG Project and involves CSG development within already approved and additional tenements (Santos, 2012)
Ironbark	Origin Energy Limited	150.25°	–27.1°	30 Jun 2014	259 (Origin Energy, 2014)	EIS in preparation	Max estimated production rate: 120 TJ/d for about 40 years (Origin Energy, 2011)
Queensland Curtis LNG	QGC Pty Limited (BG Group)	150.2°	–27°	31 Dec 2013	9499 (DNRM, 2014)	EIS approved	Under construction. 1414 TJ/d required for two LNG trains with a combined capacity of 8.5 Mt/year (QGC, 2009)
Stratheden	Arrow Energy Pty Ltd	151.02	–27.12	31 Dec 2013	285 (DNRM, 2014)	EIS approved	Gas field has been drilled and commissioned (Arrow Energy, 2014)
Surat Gas Project	Arrow Energy Pty Ltd	151°	–27.1°	31 Dec 2013	6872 (DNRM, 2014)	EIS approved	No financial commitment as of August 2014. Forecast production: 1215 TJ/d for about 35 years (Arrow Energy, 2013)

[a]The record date is the most recent date for updated coal seam gas resource numbers
[b]The Petroleum Resource Management System of the Society of Petroleum Engineers (PRMS-SPE) code 2P refers to estimated quantities of proved plus probable reserves, 3P refers to proved plus probable plus possible
[c]The status of the project within an environmental impact statement (EIS): pre-EIS, EIS in preparation, EIS submitted, EIS closed, supplementary EIS and EIS approved
[d]The 2P reserves of the GLNG GFD Project are inclusive of the 2P reserves of the GLNG Project
LNG = liquefied natural gas

References

APLNG (2010) Australia Pacific LNG Project environmental impact statement. Australia Pacific LNG Pty Limited, Brisbane.

Arrow Energy (2013) Surat Gas Project supplementary report to the environmental impact statement. Arrow Energy Pty Ltd, Brisbane.

Arrow Energy (2014) Surat domestic gas business. Arrow Energy Limited, Brisbane. Viewed 15 August 2014, <http://www.arrowenergy.com.au/projects/domestic-gas-business/surat-domestic-gas-business>.

Cockatoo Coal Limited (2013) Surat Basin projects drilling and resource update, 7pp. Viewed 2 July 2014, <http://www.cockatoocoal.com.au/index.cfm/news-research/-asx-announcements/2013-asx-annouoncements/surat-basin-projects-drilling-and-resource-update/>.

DNRM (2014) Coal seam gas reserves 1 January 2005 to 31 December 2013. Queensland Government Department of Natural Resources and Mines, Brisbane. Viewed 29 August 2014, <http://mines.industry.qld.gov.au/mining/production-reserves-statistics.htm>.

MetroCoal Limited (2013) MetroCoal Limited and controlled entities interim financial report for the half year ended 31 December 2013. Viewed 5 March 2014, <http://metrocoal.com.au/news/216/30/December-2013-Audited-Financials/>.

New Hope Group (2014) New Acland Coal Mine Stage 3 Project, environmental impact statement, executive summary. Viewed 9 April 2014, <http://asp-au.secure-zone.net/v2/521/574/4427/Executive-Summary---NEW-ACLAND-COAL-MINE---STAGE-3-PROJECT.pdf>.

Origin Energy (2011) Origin Energy Ironbark Project initial advice statement. Origin Energy Limited, Sydney.

Origin Energy (2013) Australia Pacific LNG – CSG Production, Origin Operational Review and Asset Visit; presented to the QLD Petroleum Exploration Association. Origin Energy Limited, Sydney. Viewed 21 August 2014, <http://www.originenergy.com.au/files/20130520_APLNG_CSG_Production_ORG_Review_and_Asset_Visit_May2013.pdf>.

Origin Energy (2014) Origin Energy 2014 Annual Reserves Report, Origin Energy Limited, Sydney. Viewed 21 August 2014, <http://www.originenergy.com.au/news/files/asx_origin_energy_2014_annual_reserves_report.pdf>.

QGC (2009) Queensland Curtis LNG – environmental impact statement. QGC Limited, Brisbane.

Queensland Government EHP (2013) The Range Project. Queensland Government Department of Environment and Heritage Protection. Viewed 9 April 2014, <http://www.ehp.qld.gov.au/management/impact-assessment/eis-processes/the-range.html>.

Queensland Government EHP (2014) Cameby Downs Expansion Project. Queensland Government Department of Environment and Heritage Protection. Viewed 2 October 2014 <https://www.ehp.qld.gov.au/management/impact-assessment/eis-processes/cameby_downs_expansion_project.html>.

Santos (2012) Santos GLNG Gas Field Development Project – initial advice statement. Santos Ltd, Brisbane.

Santos (2014) GLNG Investor Visit. Santos Ltd, Brisbane. Viewed 29 August 2014, <http://www.santos.com/library/240614_GLNG_%20investor_visit_presentation.pdf>.

Stanmore Coal (2014) The Range. Viewed 4 March 2014, <http://stanmorecoal.com.au/project/the-range/>.

www.bioregionalassessments.gov.au

Australian Government
Department of the Environment
Bureau of Meteorology
Geoscience Australia

CSIRO