Chapter 2

Background

2.1 This chapter provides a synopsis of Australia's underground water systems, including the Great Artesian Basin and the Murray-Darling Basin. It outlines Australia's major water users by industry, including a breakdown of water used by the mining industry by state/territory, and concludes with a discussion of the different methods of water extraction by various extractive industries.

Australia's underground water systems

2.2 Water is one of Australia's most precious resources.[1] Water shortages have the potential to constrain the future economic growth of Australia, given that Australia has the lowest average rainfall of any continent and is the driest continent with permanent inhabitants.[2] Predictions from the Bureau of Meteorology and CSIRO suggest that rainfall may increase in the future but will be confined largely to intense rainfall events. This could impact the recharge rates of underground water sources because more rainwater will be lost to evaporation.[3]

2.3 Groundwater lies in the sandstone layers trapped between impervious rocks or clays sitting beneath the surface. Artesian water can be drawn to the surface through bores because of the considerable pressure under which it is placed in artesian basins.[4] Most of the water in the artesian basins stretching across Australia is millions of years old and, in some cases, too salty for human consumption, though it can still be used for sheep and cattle and to water crops.[5] Some of these ancient sources of water are not regularly replenished by rainfall.[6]

2.4 The aquifers stretching across the country are located at different levels and may overlay other aquifers (see Figure 2.1). Australia's largest underground water systems include the:

- Great Artesian Basin (in Queensland, the Northern Territory, South Australia and New South Wales);

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1 Australian Petroleum Production and Exploration Association Ltd, *Submission 22*, p. 2.

2 Lin Crase, 'An Introduction to Australian Water Policy', in Lin Crase (ed.), *Water Policy in Australia: The Impact of Change and Uncertainty*, RFF Press, Washington, DC, 2008, p. 2; Conservation Council of South Australia, *Submission 10*, p. 3.

3 Conservation Council of Western Australia, *Submission 27*, pp. 15, 27.

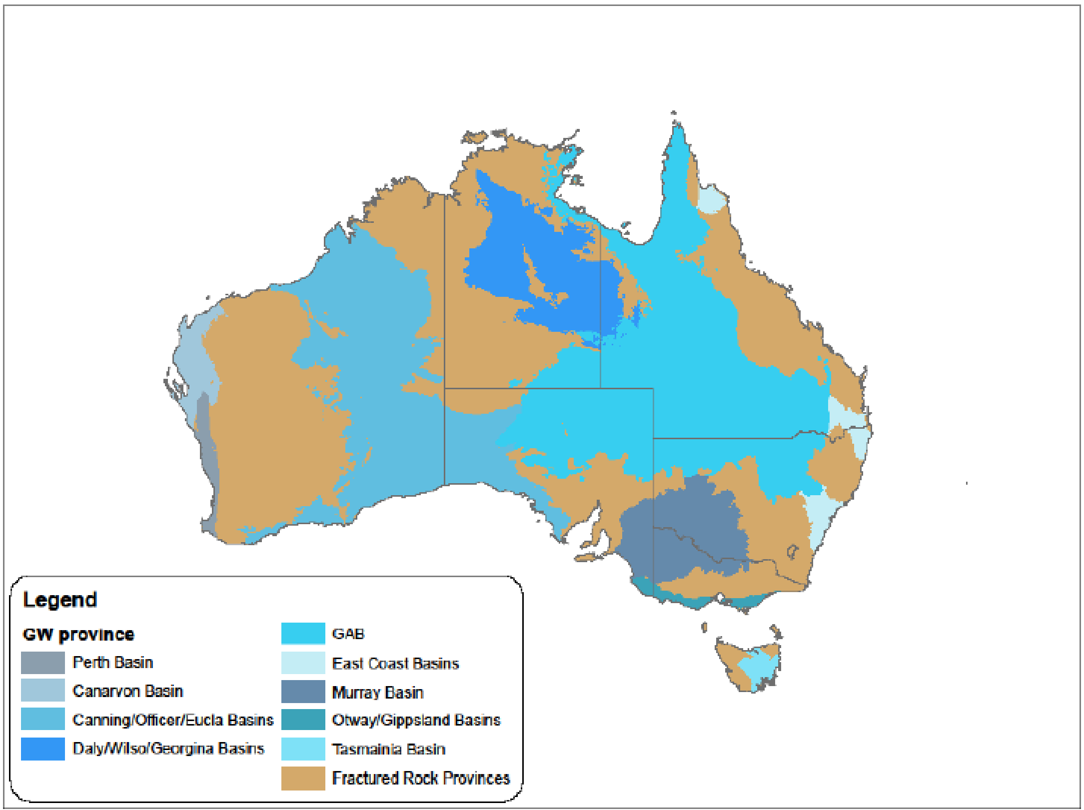
4 Great Artesian Basin Coordinating Committee, *Fact sheet 5: Pressure and heat in the Great Artesian Basin*, July 2016, p. 1, http://www.gabcc.gov.au/sitecollectionimages/resources/78283c5b-16ab-44be-bcb7-972bd9e1196d/files/pressure-and-heat-gab-factsheet.pdf (accessed 22 May 2018).

5 Rachel Dixon, *Water in Australia*, Redback Publishing, Frenchs Forest, 2018, p. 20.

6 Ms Georgina Woods, Policy Coordinator, Lock the Gate Alliance, *Committee Hansard*, 2 May 2018, p. 31.

- Canning Basin (in Western Australia);
- Daly-Wiso-Georgina Basin (in the Northern Territory and Queensland); and
- Murray Basin (in Victoria, South Australia and New South Wales).[7]

Figure 2.1: Groundwater provinces across Australia[8]



Source: Australian Bureau of Meteorology

2.5 The Conservation Council of South Australia argued in its submission that many water systems are currently 'under significant pressures from water use and consumption'.[9] Because of their significance for human consumption and agriculture, recent programs for two systems, the Great Artesian Basin and the Murray-Darling Basin (which includes the Murray Basin), have attempted to address reduced water supply through government intervention.

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7 Buru Energy Limited, *Submission 14*, p. 1; Michael Pelusey and Jane Pelusey, *Natural Water*, Macmillan Library, South Yarra, Vic., 2006, p. 16.

8 Bureau of Meteorology, *Australian aquifer boundary grouping and alignment with National Aquifer Framework*, p. 2, http://www.bom.gov.au/water/groundwater/insight/documents/AquiferBoundariesMethod.pdf (accessed 23 May 2018).

9 Conservation Council of South Australia, *Submission 10*, p. 1.

Great Artesian Basin

2.6 The Great Artesian Basin is a multi-layered system of aquifers that covers around a fifth of Australia.[10] It is 'one of Australia's most essential water supplies' and contains 65 million gigalitres of water.[11] The Great Artesian Basin is the major, in some instances the only, reliable source of water for 180,000 people spread across 120 towns, communities and pastoral enterprises in the arid areas of Queensland, the Northern Territory, South Australia and New South Wales (see Figure 2.2).[12]

Figure 2.2: Map of the Great Artesian Basin[13]

Source: Department of Agriculture and Water Resources

10 Murray-Darling Basin Commission, *Murray-Darling Basin groundwater: A resource for the future*, p. 12, https://www.mdba.gov.au/sites/default/files/archived/mdbc-GW-reports/2173_GW_a_resource_for_the_future.pdf (accessed 23 May 2018).

11 Rachel Dixon, *Water in Australia*, Redback Publishing, Frenchs Forest, 2018, p. 20; Australian Farmers for Climate Action, *Submission 6*, p. 5; Australian Petroleum Production and Exploration Association Ltd (APPEA), *Submission 22*, p. 32.

12 Nature Conservation Council of NSW, *Submission 7*, p. 2; Department of Agriculture and Water Resources, *Submission 30*, p. 5.

13 Department of Agriculture and Water Resources, *Great Artesian Basin*, http://www.agriculture.gov.au/water/national/great-artesian-basin/ (accessed 6 August 2018).

2.7 Declining pressure and reduced flows led in the twentieth century to almost half of the artesian springs from the Great Artesian Basin drying up, and many bores stopped flowing altogether.[14] Since the 1970s and 1980s, governments have engaged in and encouraged rehabilitation work on bores and bore drains, leading to the Great Artesian Basin Sustainability Initiative (2000–2017) between the Australian, New South Wales, South Australian and Queensland governments. In recent years, there has been significant pressure recovery in a number of areas due to these initiatives, with an estimated annual water savings of more than 250,000 ML per year.[15]

Murray-Darling Basin

2.8 The Murray-Darling Basin is a drainage area consisting of thousands of interconnected creeks and rivers flowing above a complex system of groundwater and aquifers, including the Murray Basin.[16] The northern part of the Murray-Darling Basin overlies the southern part of the Great Artesian Basin.[17]

2.9 Although the area covers only 14 per cent of Australia, it includes more than 40 per cent of Australia's farms and is Australia's most important agricultural region (see Figure 2.3).[18] Most groundwater used in the area is taken from shallow aquifers.[19] Because of the extent of water extraction in the region, the Murray-Darling Basin has been subject to coordinated initiatives since 2012 by the Australian, South Australian,

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14 Great Artesian Basin Coordinating Committee, *Fact sheet 5: Pressure and heat in the Great Artesian Basin*, July 2016, p. 1, http://www.gabcc.gov.au/sitecollectionimages/resources/78283c5b-16ab-44be-bcb7-972bd9e1196d/files/pressure-and-heat-gab-factsheet.pdf (accessed 22 May 2018).

15 Great Artesian Basin Coordinating Committee, *Fact sheet 5: Pressure and heat in the Great Artesian Basin*, July 2016, p. 1, http://www.gabcc.gov.au/sitecollectionimages/resources/78283c5b-16ab-44be-bcb7-972bd9e1196d/files/pressure-and-heat-gab-factsheet.pdf (accessed 22 May 2018); Department of Agriculture and Water Resources, *Great Artesian Basin Sustainability Initiative*, http://www.agriculture.gov.au/water/national/great-artesian-basin/great-artesian-basin-sustainability-initiative (accessed 23 May 2018); Department of Agriculture and Water Resources, *Submission 30*, p. 6.

16 Murray-Darling Basin Authority, *Discover the Basin*, https://www.mdba.gov.au/discover-basin (accessed 23 May 2018); J.E. Lau, D.P. Commander and G. Jacobson, *Hydrogeology of Australia*, Bulletin 227, Australian Government Publishing Service, Canberra, 1987, p. 3; Property Rights Australia Incorporated, *Submission 21*, p. 10.

17 Murray-Darling Basin Authority, *Geology*, https://www.mdba.gov.au/discover-basin/landscape/geology (accessed 23 May 2018).

18 Murray-Darling Basin A, *Murray-Darling Basin groundwater: A resource for the future*, p. 4, https://www.mdba.gov.au/sites/default/files/archived/mdbc-GW-reports/2173_GW_a_resource_for_the_future.pdf (accessed 23 May 2018); Discover Murray, *The Murray-Darling Basin*, http://www.murrayriver.com.au/about-the-murray/murray-darling-basin/ (accessed 23 May 2018).

19 Murray-Darling Basin Authority, *Discover groundwater*, https://www.mdba.gov.au/discover-basin/water/discover-groundwater (accessed 23 May 2018).

Victorian, New South Wales, Queensland and Australian Capital Territory governments to reduce water use through the Murray-Darling Basin Plan.[20]

Figure 2.3: Map of the Murray-Darling Basin[21]

Source: Murray-Darling Basin Authority

Australia's water users

2.10 Water is used for human, animal and plant consumption, and plays an important role in Aboriginal cosmologies tied to the land. Native flora and fauna throughout Australia are dependent on access to regular water, with some groundwater-dependent ecosystems such as rivers, wetlands and springs dependent entirely on groundwater that has been discharged to the surface. Groundwater ecosystems existing below the surface also rely on subterranean water, and may include stygofauna and microbial communities.

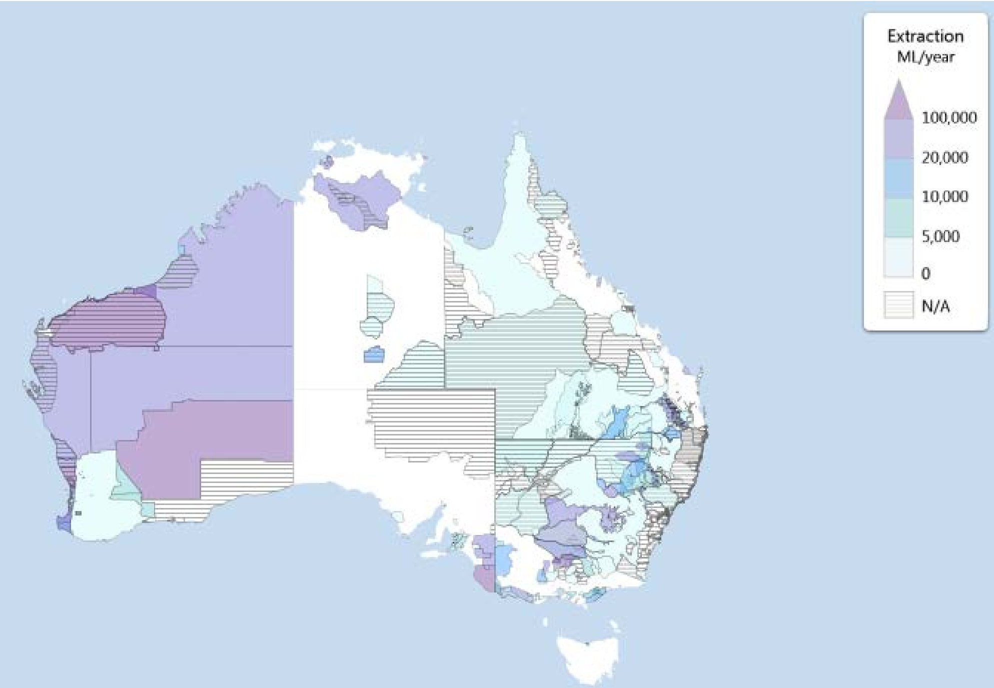
20 Murray-Darling Basin Authority, *What's in the Basin Plan?*, https://www.mdba.gov.au/basin-plan/whats-basin-plan (accessed 23 May 2018).

21 Murray-Darling Basin Authority, *Murray-Darling Basin boundary*, https://www.mdba.gov.au/sites/default/files/cartographicmapping/MDB-boundary-map-2017.pdf (accessed 23 May 2018).

Human and agricultural consumption

2.11 Groundwater comprises around 17 per cent of Australia's accessible water resources. About 30 per cent of Australia's total water use is taken from groundwater, with some regions more reliant on groundwater than others (see Figure 2.4).[22]

Figure 2.4: Total Australian groundwater extraction, 2016–17[23]



Source: Australian Bureau of Meteorology

2.12 Across many regional, remote and arid areas of Australia, groundwater is the main or only source of water for human consumption, stock use and irrigation because of low or unreliable annual rainfall averages. Groundwater is essential for the survival of communities in these areas, including remote Aboriginal communities.[24] For example, 90 per cent of the Northern Territory's consumptive water supplies are drawn from groundwater, with the towns of Alice Springs and Tennant Creek relying completely on groundwater.[25]

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22 Murray-Darling Basin Authority, *Discover groundwater*, https://www.mdba.gov.au/discover-basin/water/discover-groundwater (accessed 23 May 2018); Mr Tom Crothers, Consultant, Property Rights Australia, *Committee Hansard*, 1 May 2018, p. 36.

23 Bureau of Meteorology, *Australian Groundwater Insight: Groundwater management – extraction (2016–17)*, http://www.bom.gov.au/water/groundwater/ (accessed 13 June 2018).

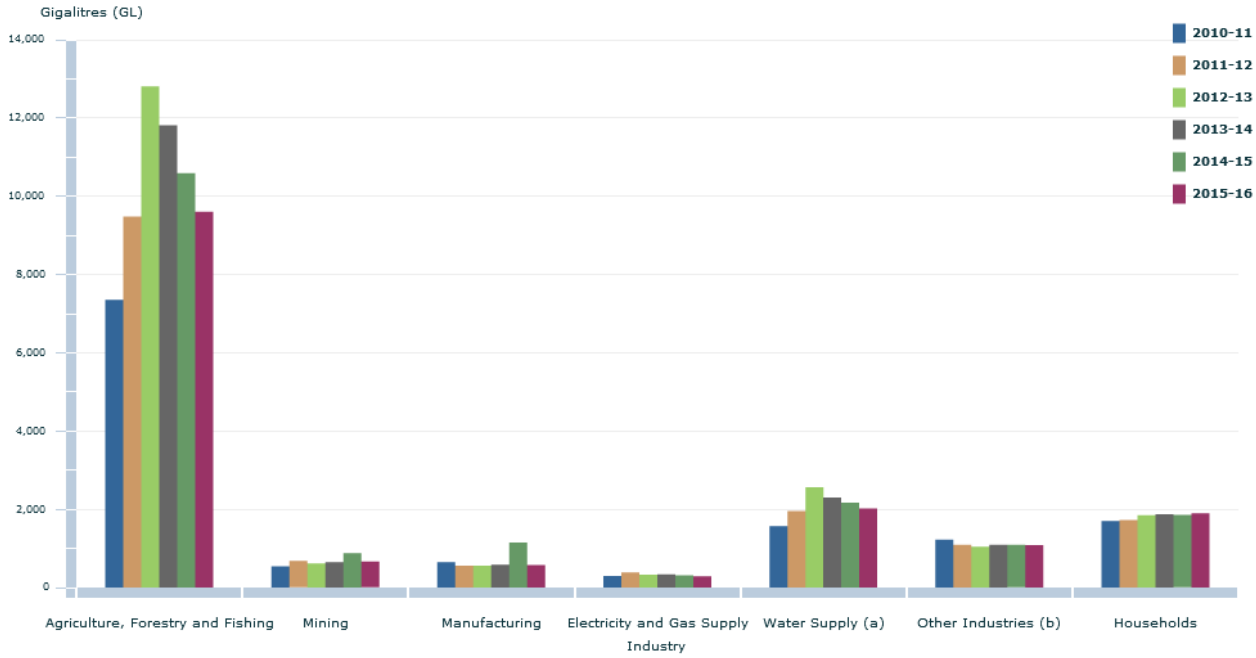
24 Conservation Council of Western Australia, *Submission 27*, p. 2.

25 Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, *Final Report*, April 2018, p. 108; Lock the Gate Alliance, *Submission 28*, p. 8. Miss Helen Bender also noted that 'Groundwater is the only secure water available for feedlot development' for the areas in Queensland dependent upon the Great Artesian Basin (*Submission 29*, p. 11). See also Mr Lee McNicholl, Chairman, Basin Sustainability Alliance, *Committee Hansard*, 1 May 2018, p. 2.

2.13 In 2015–16, approximately 76,544 GL of water was extracted around Australia. The Australian Bureau of Statistics reported that total water consumption by households and industry was 16,132 GL, a decrease of 7.2 per cent compared to 2014–15, largely because of reductions in agricultural consumption in New South Wales and Victoria.[26]

2.14 Most water (58.5 per cent) is used by the agricultural industry, with household use accounting for 11.8 per cent and mining accounting for 4.1 per cent of Australia's total water consumption. Agriculture is the primary user of water in all states and territories except the Australian Capital Territory, where water consumption is dominated by households (see Figure 2.5 and Figure 2.6).[27]

Figure 2.5: Australia's total water consumption by industry, 2015–16[28]



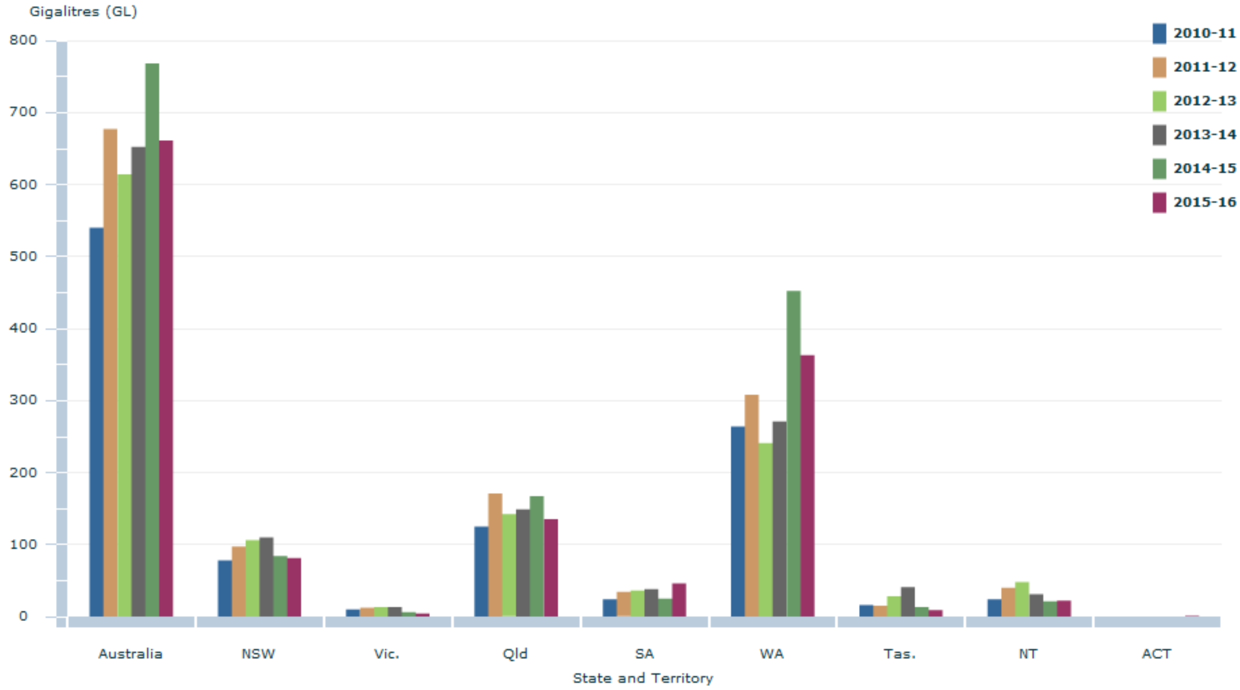
Source: Australian Bureau of Statistics

26 Australian Bureau of Statistics, *4610.0 – Water Account, Australia, 2015–16*, 23 November 2017, http://www.abs.gov.au/ausstats/abs@.nsf/Latestproducts/4610.0Main%20Features22015-16?opendocument&tabname=Summary&prodno=4610.0&issue=2015-16&num=&view= (accessed 23 May 2018).

27 Australian Bureau of Statistics, *4610.0 – Water Account, Australia, 2015–16*, 23 November 2017, http://www.abs.gov.au/ausstats/abs@.nsf/Latestproducts/4610.0Main%20Features22015-16?opendocument&tabname=Summary&prodno=4610.0&issue=2015-16&num=&view= (accessed 23 May 2018).

28 Australian Bureau of Statistics, *4610.0 – Water Account, Australia, 2015–16*, 23 November 2017, http://www.abs.gov.au/ausstats/abs@.nsf/Latestproducts/4610.0Main%20Features22015-16?opendocument&tabname=Summary&prodno=4610.0&issue=2015-16&num=&view= (accessed 22 May 2018).

Figure 2.6: Water use by the mining industry by state/territory, 2015–16[29]



Source: Australian Bureau of Statistics

2.15 The Australian Petroleum Production and Exploration Association (APPEA) emphasised that the oil and gas industry is a relatively small user of water compared with other industries. Dr Malcolm Roberts, APPEA's Chief Executive Officer, asserted that agriculture 'uses more water in Australia in a single day than the industry uses in an entire year. Manufacturing uses 22 times more water than the gas industry'.[30]

2.16 The Minerals Council of Australia argued that 'it is important to note the minerals industry often uses water not suitable for other industrial purposes, including saline and hypersaline water'.[31] The International Association of Hydrogeologists emphasised the mining industry's relative value for money proportional to its total water use.[32] This was echoed by APPEA, who contended that the oil and gas industry's water consumption represented 'exceptionally high economic value-add' compared with other industries.[33]

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29 Australian Bureau of Statistics, *4610.0 – Water Account, Australia, 2015–16*, 23 November 2017, http://www.abs.gov.au/ausstats/abs@.nsf/Latestproducts/4610.0Main%20Features22015-16?opendocument&tabname=Summary&prodno=4610.0&issue=2015-16&num=&view= (accessed 22 May 2018).

30 Dr Malcolm Roberts, Chief Executive Officer, Australian Petroleum Production and Exploration Association, *Committee Hansard*, 2 May 2018, p. 15.

31 Minerals Council of Australia, *Submission 13*, p. 1.

32 International Association of Hydrogeologists, *Submission 9*, p. 3.

33 Australian Petroleum Production and Exploration Association Ltd, *Submission 22*, p. 10.

2.17 However, the Committee also heard from other submitters and witnesses that figures of water use did not necessarily equate to decreased impacts in comparison with other industries. Ms Georgina Woods from Lock the Gate Alliance suggested that estimates of overall water usage by the mining industry did not give an adequate picture of intensive use in small areas:

> In the Hunter region, for example, the mining industry owns more than half of the high-security water licences in the regulated river and is a big groundwater user, particularly in the porous-rock aquifers. The Great Artesian Basin is another example of a water resource that has a significant and growing water use by the mining industry.[34]

2.18 Ms Joanne Rea, the Chair of Property Rights Australia, argued that agricultural use of water 'is necessarily estimated, always overstated and has more to do with the capacity of bores than actual usage'. She contended that although agriculture may use a significant amount of water, its impacts are spread across 'a wide area so that local impacts are minimal or manageable'.[35] The issue of impacts is further discussed in Chapter 4.

2.19 The Committee was told that competition for water resources between different industries may intensify in the future because of anticipated impacts on rainfall from climate change. The Nature Conservation Council of NSW argued in its submission that the:

> Conflict between extractive industry's use of water resources and other users is likely to become more acute as the effects of climate change are felt in Southern Australia, with less water available for all users and for the environment.[36]

Importance of water in Aboriginal cosmologies

2.20 Many remote Aboriginal communities depend entirely on springs sourced from groundwater.[37] However, water, for some traditional owner groups, is important not just as a resource but also because of the cultural and spiritual meanings attached to particular waterways, natural catchment areas and the land.[38] In some instances, sacred sites for traditional owners extend beneath the surface of the earth and may include underground water.[39]

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34 Ms Georgina Woods, Policy Coordinator, Lock the Gate Alliance, *Committee Hansard*, 2 May 2018, p. 30.

35 Ms Joanne Rea, Chair, Property Rights Australia, *Committee Hansard*, 1 May 2018, p. 31.

36 Nature Conservation Council of NSW, *Submission 7*, p. 1.

37 Ms Revel Pointon, Lawyer, Environmental Defenders Office Queensland, *Committee Hansard*, 1 May 2018, p. 28.

38 Law Council of Australia, *Submission 8*, p. 7; Miss Helen Bishop, *Submission 29*, p. 1.

39 Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, *Final Report*, April 2018, p. 25.

2.21 Miss Helen Bishop, in a submission prepared on behalf of the traditional owners of the area where the Rum Jungle abandoned uranium mine is located, stated that:

> Several significant and sacred sites are located in the area which holds significant relevance to Koongurrukun and Warai people in bestowing and maintaining Mookunungunuk [epistemology] that maintains the knowledge of life for the area...
>
> The importance of best practice rehabilitation and successful implementation of the rehabilitation plan are paramount to the maintenance of Mookunungunuk, in particular the sacred sites identified within the rehabilitation areas. These sites hold significant cultural values directly connected to underground water.[40]

2.22 The importance of water to Aboriginal identity was raised during the Northern Territory Government's *Scientific Inquiry into Hydraulic Fracturing in the Northern Territory*. The final report noted the centrality of water to Aboriginal identity:

> Water is an essential part of traditional Aboriginal culture, both in terms of access for survival for groups living in remote areas, and also in terms of its spiritual link to Aboriginal sacred sites and religious customs.[41]

2.23 The Aboriginal Fracking Forum stated that:

> We are concerned about the damage to our water, our country, our dreaming and our songlines. This damage would be irreversible…Drilling in one area has a bigger impact than just that place. It will damage neighbouring language groups on country and the entire water system…People and country are one and the same, any damage to our country impacts us, our identity and who we are.[42]

2.24 The issue of how regulatory frameworks address water rights for Traditional Owners is addressed in Chapter 3, while impacts specific to Traditional Owners are outlined in Chapter 4.

Groundwater-dependent ecosystems

2.25 Groundwater-dependent ecosystems rely on groundwater for some or all of their water requirements, whether directly or indirectly. These may include surface water ecosystems such as wetlands and rivers that rely on the surface expression of groundwater; terrestrial fauna and flora; terrestrial ecosystems dependent on

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40 Miss Helen Bender, *Submission 29*, p. 3.

41 Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, *Final Report*, April 2018, p. 102.

42 Statement from the Aboriginal Fracking Forum, 19 November 2017, *Ban Fracking, Protect Country*, provided by Seed Indigenous Youth Climate Network, Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, *Final Report*, April 2018, p. 268.

subsurface groundwater; and subterranean ecosystems, such as aquifer and cave ecosystems.[43]

2.26 Some flora and fauna species that rely on artesian springs are listed as endangered species and communities, notably in areas lying above the Great Artesian Basin.[44] Several submitters argued that there is very little knowledge about local flora and fauna and how groundwater might interact with these species in some areas, including very remote regions where relatively little research has been conducted.[45]

2.27 The Committee heard evidence from an expert in groundwater ecosystems, Associate Professor Grant Hose, outlining the importance of water for ecosystems that live entirely underground, and how the organisms, stygofauna and microbes that live in aquifers contribute to the composition and quality of the aquifers' water. Professor Hose commented:

> The biodiversity and the ecological functions, the importance of what lives in aquifers, is all too frequently overlooked. It does have immense value, just as we can go out on the street and quantify what a tree does; we can understand what that tree does and how important that tree is to the global environment...[O]rganisms in groundwater…have a similar function in making the environment better…Their capacity to do that is important, because it provides us with clean drinking water. It also supports the movement of water through aquifers. What lives in aquifers is important to the quality and the availability of water that's in there.[46]

2.28 Groundwater ecosystems, or ecosystems living entirely in water systems below ground, contribute to water quality by breaking down pollutants, purifying groundwater so that it is fit for consumption, and contributing to the storage and flow of water through aquifers. Stygofauna—the invertebrates that live in groundwater—are especially diverse in Australia. Few are listed as threatened species or members of threatened ecological communities, despite their rarity, because of the relatively recent recognition of their significance and difficulties associated with developing stygofauna taxonomy.[47] The Western Australian Government recognises the global significance of stygofauna; the Queensland Government has released guidelines for

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43 Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, *Final Report*, April 2018, p. 113; Geoscience Australia, *Groundwater dependent ecoystems*, http://www.ga.gov.au/scientific-topics/water/groundwater/understanding-groundwater-resources/groundwater-dependant-ecosystems (accessed 24 May 2018).

44 Geoscience Australia, *Submission 2*, p. 3; Lock the Gate Alliance, *Submission 28*, p. 6.

45 Conservation Council of Western Australia, *Submission 27*, p. 21 (see Response from Vimy Resources, p. 6 for a counterargument to this claim); The Colong Foundation for Wilderness Ltd, *Submission 16*, p. 6.

46 Associate Professor Grant Hose, Department of Biological Sciences, Macquarie University, *Committee Hansard*, 2 May 2018, p. 36.

47 Associate Professor Grant Hose, *Submission 5*, pp. 2–3.

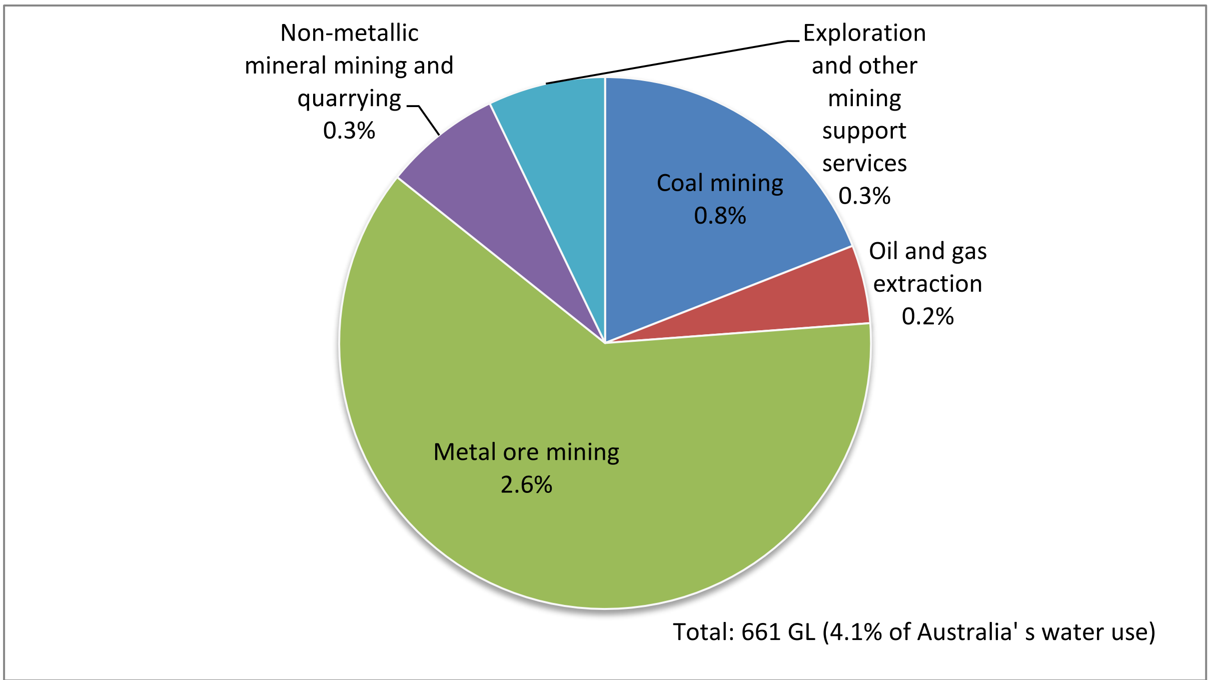
the assessment of stygofauna; and the New South Wales Government has risk assessment guidelines for groundwater-dependent ecosystems.[48]

Methods of water use by the extractive industry

2.29 The amount of water extracted and methods of extraction employed by the extraction industry depend on the type of material being extracted, as well as local geography and geology.

2.30 As noted above, the mining industry as a whole was responsible for 4.1 per cent of Australia's total water consumption in 2015–16. Metal ore mining accounts for more than half of the mining industry's total water use (2.6 per cent of Australia's total water consumption), followed by coal mining (Figure 2.7).

Figure 2.7: Water use by mining sectors as a proportion of total water use, 2015–16[49]



Source: Australian Bureau of Statistics

2.31 Water use in the mining industry may differ in a number of aspects from water use in the oil and gas industry, as outlined below.

Water use by the mining industry

2.32 The mining industry utilises water in various ways before, during and after mining operations. The New South Wales Minerals Council outlined types of water

48 Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, *Final Report*, April 2018, p. 115.

49 Australian Bureau of Statistics, *Water Account, Australia, 2015–16*, 23 November 2017, http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/4610.02015-16?OpenDocument (accessed 23 May 2018).

take by mining companies that require water licenses, including: water that is extracted, is dewatered, is required for processing or washing, is required for dust suppression or water that flows into a void post-mining.[50]

2.33 The Queensland Department of Environment and Heritage Protection set out a definition of 'mine-affected water' that includes the following:

- groundwater from a mine's dewatering activities;
- mine pit water, tailings dam water, processing plant water;
- rainfall runoff which has been in contact with areas disturbed by mining activities (excluding rehabilitated areas); and
- groundwater which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated.[51]

Dewatering of mines operating below the water table

2.34 For mines operating at depths below the natural water table, water is extracted in a process called dewatering to allow mining to occur safely.[52] This water is removed via dewatering wells adjacent to the mine void. The Minerals Council of Australia noted in its submission that water extracted in this way may be used for operational purposes (such as minerals processing), and may either be managed onsite, or discharged where an operation has a license that allows this.[53]

2.35 Mining below the water table can result in final pit voids being left in the landscape after mining activities have ceased, with pit lakes forming once dewatering is no longer occurring. Geoscience Australia stated that this process can result in permanent changes to the local water table due to evaporative loss from pit lakes, as shown in Figure 2.8.

50 New South Wales Minerals Council, *Submission 15*, p. 5.

51 Queensland Department of Environment and Heritage Protection, *Guideline: Application of Operational Policy requirements to obtain enhanced environmental authority conditions for Fitzroy Basin Mines*, February 2014, p. 4, https://www.ehp.qld.gov.au/assets/documents/regulation/rs-gl-apply-fitzroy-ea-conditions.pdf (accessed 7 June 2018).

52 Minerals Council of Australia, *Submission 13*, p. 27.

53 Minerals Council of Australia, *Submission 13*, p. 27.

Figure 2.8: Schematic diagram showing impacts of dewatering and final pit voids[54]

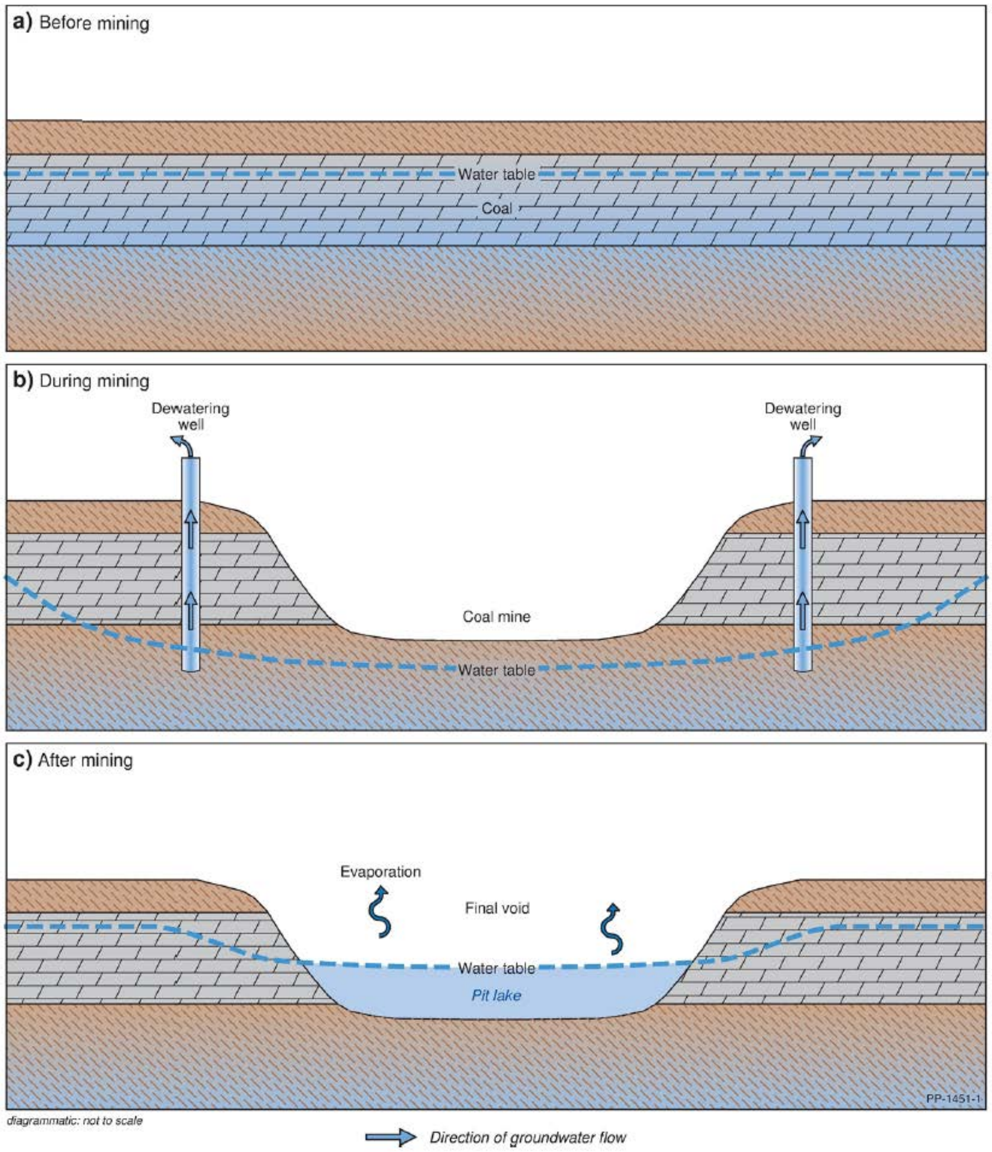


Figure 2 Schematic diagram of (a) an unmined, unconfined Coal seam; (b) the same system after dewatering during open-cut mining - the water table has been lowered around the mine so that groundwater does not discharge into the mine void; and (c) the same system after the mine has closed – dewatering has ceased and the water table rises again, however the final void becomes a groundwater 'sink' permanently lowering the water table in a zone around the void.

Source: Geoscience Australia

Management of mine-affected and process water

2.36 In many cases, mine-affected water requires active management and cannot simply be released into the surrounding environment. This includes water used in minerals processing procedures (often referred to as process water), for example to

54 Geoscience Australia, *Submission 2*, p. 4.

wash and prepare coal extracted in coal mining operations.[55] Processing uranium from its raw form into usable end product also involves significant water use.[56]

2.37 Management of mine-affected water is dealt with in various ways by the mining industry, depending on the type of water and the level of impact or contamination. The Minerals Council of Australia pointed to several examples of mines in Australia implementing specific measures to deal with mine-affected and process water, including:

- construction of a reverse osmosis water treatment plant at a coal mine in Queensland's Fitzroy Basin, to reduce the amount of mine-affected water held onsite to allow water treated in the plant to be used for other parts of the mining operations; and
- construction of a brine concentrator at the Ranger Uranium mine, which allows process water from the mine's tailings storage facility to be treated and discharged.[57]

Accounting for water use by the minerals industry

2.38 The Minerals Council of Australia discussed how the mining industry describes and accounts for its water use across the industry. It drew the Committee’s attention to the Minerals Council of Australia Water Accounting Framework which, it stated, 'is widely considered international best practice in accounting'. It explained the purpose of the Water Accounting Framework as follows:

> The framework enables water flows to be accounted for and quantified by source and destination through an input-output model. Standard definitions for both water 'source' and 'destination' categories create uniformity between companies and hence across the sector in how water quality, quantity and purpose is described. Agreed categories also describe the 'level of treatment effort' required to achieve a standard of water quality fit for human consumption. While indicative only and not reflective of end uses, this process supports benchmarking and continuous improvement.[58]

Water use by the oil and gas industry

2.39 The oil and gas industry in Australia incorporates the extraction of various petroleum products, including petroleum liquids (crude oil, condensate and liquid petroleum gas) as well as natural gas products.

2.40 Conventional gas extraction involves the drilling of wells to extract natural gas located in permeable material beneath impermeable rock. The gas is generally located in relatively large reservoirs and can be extracted via vertically drilled wells. Unconventional natural gas is located in less permeable rock or spread more diffusely

55 Lock the Gate Alliance, *Submission 28*, p. 2.

56 Conservation Council of Western Australia, *Submission 27*, p. 4.

57 Minerals Council of Australia, *Submission 13*, pp. 11–12.

58 Minerals Council of Australia, *Submission 13*, p. 10.

throughout a deposit. Forms of 'unconventional' gas include coal seam gas (natural gas located within coal seams), shale gas (located in shale rock formations) and tight gas (located within low permeability sandstone rock). Extraction of unconventional gas requires additional extractive processes.

2.41 APPEA's overview of how water is used in extractive oil and gas projects is summarised below. It noted that water use varies in each stage of the project life (exploration, development and production) and is different for different project types.[59]

Water used in well drilling

2.42 Water is a component of the drilling muds used for well drilling, with the amount of water used depending on how many times the mud is reused in different wells and the lifetime production of each well. APPEA stated that in Australia, 'the general rule of thumb for onshore wells is approximately 1 ML per well for drilling'.[60]

Water found in oil and gas reserves brought to the surface during extractive processes

2.43 Oil and gas extraction also involves bringing to the surface water that is present alongside the targeted resource. This water is called produced formation water (PFW) or, in coal seam gas operations, associated water.[61] APPEA noted that PFW is made up of various components and 'may include petroleum hydrocarbons, suspended solids, dissolved oxygen and salts'. It noted further that the volume and properties of PFW vary from location to location and over the productive life of a reservoir.[62]

2.44 APPEA explained how associated water is extracted in coal seam gas operations:

> [Coal seam gas] is absorbed into the coal matrix and is held in place by the pressure of formation water. To extract the gas, a well is drilled into the coal seam and formation water from the coal cleats and fractures is pumped and withdrawn. The removal of water in the coal seam reduces the pressure, enabling the CSG (coal seam gas) to be released (desorbed) from the coal micropores and cleats, and allowing the gas and 'produced water' to be carried to the surface.[63]

59 Australian Petroleum Production and Exploration Association Ltd (APPEA), *Submission 22*, p. 11.

60 Australian Petroleum Production and Exploration Association Ltd (APPEA), *Submission 22*, p. 13.

61 Australian Petroleum Production and Exploration Association Ltd (APPEA), *Submission 22*, p. 13.

62 Australian Petroleum Production and Exploration Association Ltd (APPEA), *Submission 22*, p. 13.

63 Australian Petroleum Production and Exploration Association Ltd (APPEA), *Submission 22*, p. 30.

2.45 APPEA commented further that the volume of associated water and the amount of gas produced depend on the particular geological and hydrogeological features of a location:

> No two wells or coal seams behave identically and associated water production can vary from a few thousand to hundreds of thousands of litres a day, depending on the underground water pressures and geology. A well will deliver most of its water at the start of the pumping phase. As the water is pumped from the coal formation, the pressure is released from the seam, and the gas begins to flow.
>
> Associated water production and gas production are inversely proportional. As water rates decline, gas production increases…
>
> Coals with lower permeability do not require as much water to be pumped to reduce the pressure on the coal. This is why some operations –for example in NSW and Queensland's Bowen Basin – produce lower volumes of water. Areas with higher permeability generally produce higher volumes of water. Different CSG operations produce differing amounts of water.[64]

2.46 APPEA noted that associated water extracted during coal seam gas operations can be treated and used in a range of different ways once brought to the surface, including:

- industrial reuse (for example, using associated water as cooling water for industrial projects which would otherwise have taken water from local streams or groundwater);
- agricultural reuse (for example, crop irrigation), reducing the need to extract water from local aquifers;
- injection of associated water back into local aquifers, increasing the volume of water stored in these aquifers; and
- river discharge—blending associated water with seasonal non-permanent streams.[65]

Water used in hydraulic fracturing (fracking)

2.47 Water is a major component of hydraulic fracturing (or fracking). Hydraulic fracturing involves pumping fluid at high pressure down a wellbore to initiate and encourage cracks in low permeability rock to recover gas and oil. This fluid contains water, sand or other solids and chemicals.[66]

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64 Australian Petroleum Production and Exploration Association Ltd (APPEA), *Submission 22*, pp. 30 and 31.

65 Australian Petroleum Production and Exploration Association Ltd (APPEA), *Submission 22*, p. 34.

66 Australian Petroleum Production and Exploration Association Ltd (APPEA), *Submission 22*, p. 13; BBC News, 'What is fracking and why is it controversial?', *BBC News*, 16 December 2015, https://www.bbc.com/news/uk-14432401 (accessed 7 June 2018).

Moratoria and bans on particular forms of gas extraction

2.48 Queensland and New South Wales are the only states in Australia where coal seam gas extraction is currently being undertaken, while other unconventional gas extraction involving fracking processes occurs in northeast South Australia.[67]

2.49 Victoria, Tasmania and Western Australia have moratoriums in place on hydraulic fracturing activities, while the Northern Territory Government has recently announced a decision to lift a moratorium on fracking previously in place.[68] The South Australian Government has proposed a ten-year moratorium on fracking activities in the Limestone Coast area of the state's southeast.[69]

Conclusion

2.50 This chapter has outlined the background to Australia's underground water systems, major water users and how extractive industries take and use water. The following chapter outlines the regulatory frameworks governing water use.

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67 Australian Government Department of the Environment and Energy, 'Coal and coal seam gas – Regulation', http://www.environment.gov.au/water/coal-and-coal-seam-gas/regulation (accessed 25 May 2018); Government of South Australia, 'Petroleum: Frequently asked questions', http://petroleum.statedevelopment.sa.gov.au/frequently_asked_questions (accessed 25 May 2018).

68 Australian Petroleum Production and Exploration Association Ltd (APPEA), *Submission 22*, pp. 23–24; The Hon Michael Gunner, Chief Minister of the Norther Territory, *Media Release*, 'Fracking moratorium lifted – Strict laws to be in place before exploration or production can occur', 17 April 2018.

69 Nick Harmsen, *ABC News Online*, 'Fracking ban in SA's south-east may not need legislation, Steven Marshall says', 12 April 2018, http://www.abc.net.au/news/2018-04-12/decade-long-fracking-ban-may-not-need-law-change/9642876.