appea the voice of australia's oil and gas industry

Submission

January 2018

Submission to the Inquiry into water use by the extractive industry

Table of Contents

1. Executive Summary

The Australian Petroleum Production and Exploration Association (APPEA) is the peak body representing Australia's oil and gas explorers and producers. Our members account for nearly all of Australia's oil and gas exploration and production.

The oil and gas industry is a vital part of the Australian economy:

- supplying energy to 5 million households;
- supplying the fuel for gas-fired generation in the electricity market;
- supplying essential inputs to the manufacturing sector, underpinning 225,000 jobs;
- investing more than $200 billion in developing new supply for domestic and export customers;
- paying more than $9 billion in taxes and resource charges to governments;
- employing tens of thousands of Australians in highly skilled, highly paid jobs; and
- generating $25.5 billion in export earnings – adding almost 0.5% to annual GDP growth.[1]

Water is one of Australia's most precious assets. Industry recognises its responsibilities to protect that natural asset for other users today and for future generations. The industry's use of water is relatively modest – less than 0.2 per cent of the water consumed by Australians (by comparison, the agricultural industry accounts for almost 59 per cent of water consumption).

The oil and gas industry applies the highest standards in its operations. The industry has decades of experience operating safely in Australia. Contrary to the claims made by activists, the latest research by the CSIRO confirms that subsurface risks as a result of well integrity or hydraulic fracture stimulation is considered to be low[2], and that the risks to people or groundwater dependent terrestrial ecosystems from subsurface chemicals are considered to be very low[3]. While a surface spill of chemical additives *could* affect water resources, this risk is well understood and is managed effectively by many industries (not just the oil and gas industry) through a mix of regulation and industry best practice. A recent study by the Department of Environment and the National Industrial Chemicals Notification and Assessment Scheme (NICNAS) found that the probability of a surface spill damaging water resources is also very low and that "*we can be confident that it can be used safely*"[4]

The onshore oil and gas industry is subject to stringent regulation and scrutiny, far more so than other industries with comparable or greater consumption of water. The possible impact of industry activities on water resources is monitored closely by government agencies. In Queensland, the onshore industry has strict obligations to 'make good' impacts on the supply of water to landowners; such impacts have been limited to a handful of local cases which have been readily addressed.

In the case of Queensland coal seam gas projects, the industry is more of a supplier than a user of water. Most water removed from coal seams as a by-product of gas production is treated and provided free or at low cost to other users such as agricultural users and local government or used to recharge aquifers. Industry in Queensland has invested more than $3 billion in water treatment infrastructure, and over 40 gigalitres of water was provided by the industry for beneficial use in 2016/17 with 83 per cent of this volume used for irrigation. About one-quarter of the water removed from local coal seams is returned to aquifers.

The oil and gas industry delivers an exceptionally high economic return from the water it uses. According to the Australian Bureau of Statistics, the gas industry's value-add is $933m Gross Value Add per gigalitre of water used, compared to $4m for agriculture, $37m for aquaculture and $83m for wood, pulp and paper.

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[1] EnergyQuest (2017) EnergyQuarterly December 2017. Access at: http://www.energyquest.com.au; Reserve Bank of Australia *Statement on Monetary Policy*, August 2017, p.33.

[2] CSIRO (2017) Report into The shale gas well life cycle and well integrity Prepared for the Northern Territory Hydraulic Fracturing Inquiry

[3] CSIRO (2017) Deeper groundwater hazard screening for chemicals used in coal seam gas extraction - Overview , http://www.environment.gov.au/system/files/resources/370d0bcd-8fe2-436f-88d7-1c3361ef8cd5/files/deeper-groundwater-hazard-screening-research-overview.pdf

[4] Department of Environment (2017) National Assessment of Chemicals (page 11) http://www.environment.gov.au/system/files/resources/03137f85-1bea-46a4-b9e7-67d985b4aeb5/files/national-assessment-chemicals-overview.pdf

Regional communities benefit the most from the onshore industry, with new jobs and infrastructure creating stronger, diversified regional economies. In places, such as the Western Downs, the resources sector (including the natural gas industry) has become the largest contributor to gross regional product. Research by the CSIRO and the Department of Industry, Innovation and Science confirms a very positive social dividend in regions which host the industry, including low unemployment, higher family incomes, a reversal of population decline, more employment opportunities for women and higher levels of youth education.[5]

Key points:

- The petroleum industry is subject to stringent regulation. The full range of potential impacts – environmental, social and economic – are assessed at local and regional levels to manage the resource safely and sustainably.
- Petroleum is essential to the Australian economy and way of life. As well as generating $25.5 billion in export earnings the industry supplies an important energy and commodity resource. Natural gas is also an essential input for many manufacturing businesses.
- The petroleum industry is a minor user of water compared to other larger water users and represents a very high economic value-add to the Australian economy.
- The industry works collaboratively with all stakeholders to minimise impacts of the oil and gas industry's use and take of water.
- Conservation and protection of groundwater and surface water is a high priority during all oil and gas activities.
- Safeguards are used to protect water resources at all stages of a petroleum project. Wells are constructed to a high standard and include multiple engineered barriers to ensure containment and isolation from geological formations.
- Surface water is protected by employing comprehensive water protection safeguards and risk controls. Studies and decades of practical experience show the risk to groundwater and surface water is low.
- The regulatory frameworks governing the oil and gas industry's use and impact on ground and surface water resources are comprehensive.
- State Governments are active managers of water resources. Ongoing and detailed regulatory reviews occur frequently and these enable the detailed consideration of all issues including social, economic, and environmental outcomes.
- The regulatory regimes have evolved and adapted over time as information is collected. APPEA advocates for effective, efficient and streamlined regulation and assessment processes. APPEA seeks to identify ways to reduce the regulatory burden while maintaining strong protections for the environment.
- The water trigger was introduced for political reasons, targeting two industries rather than the most significant water users. The trigger adds an unnecessary and costly layer of Commonwealth regulation, duplicating what are essentially State responsibilities. The costs to industry (e.g. project delays, political uncertainty) can be significant with no clear environmental benefit. Previous government reviews of the trigger have recommended removal or modification of the trigger.
- There is NO justification for extending the water trigger to shale and tight gas; these activities are already regulated effectively by State regulators. Further, essentially no water is extracted during gas production, with only minor use of water required to support well drilling, completion and construction activities.

[5] Office of the Chief Scientist, Department of Industry, Innovation and Science; GISERA (2015) *Review of the socioeconomic impacts of coal seam gas in Queensland.* https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/coal-seam-gas/Socioeconomic-impacts-of-coal-seam-gas-in-Queensland.pdf

2. The social, economic and environmental impacts of extractive projects' take and use of water

- The petroleum industry uses water as a direct input to the process of producing petroleum.
- Developing these resources is vital to Australia. Petroleum products, from gasoline to plastics, are integral to our everyday lives.
- Petroleum is the raw feedstock for many chemical products, including pharmaceuticals, solvents, fertilizers and pesticides on which we rely.
- Australia's $28 billion per year oil and gas industry contributes 58% of Australia's primary energy, 2.5% of Australia's gross domestic product, and almost $9 billion in direct tax payments.
- The petroleum industry uses water efficiently, generating significant value add for the wider Australian economy.
- Further development of natural gas can have significant climate benefits, reducing emissions intensity.

Petroleum is essential to the Australian economy and way of life. As well as generating $25.5 billion in export earnings the industry supplies an essential energy and commodity resource.

Almost half of Australian homes – five million households – are connected to the natural gas network. In NSW and Victoria alone, 2.3 million homes are connected. Gas accounts for 44 per cent of household energy use, with more than 11 million residential gas appliances in use.[6]

Petroleum and refined and derived products are used to power our cars, to provide energy and support manufacturing. Oil is the largest single energy source in Australia and accounts for close to 40 per cent of total energy end use[7]. Australia's reserves of liquid fuels are declining, with an increasing proportion of these products being imported.

Natural gas is indispensable to many manufacturing processes. Gas is used to produce non-ferrous metals (such as aluminium, copper and zinc), chemicals and polymers (such as fertilisers and anti-freeze), plastics and non-metallic mineral products like glass, ceramics, cement and bricks, and is also used in food preparation, processing and packaging, fermentation and brewing.

APPEA estimates about 225,000 jobs in the manufacturing sector rely on natural gas. Manufacturing clusters dependent upon gas are found in all Australian states.

Historically, the demand for natural gas has been largely met from 'conventional' gas reserves (for example, the Cooper, Gippsland and Carnarvon basins). In eastern Australia, production from these established conventional sources has peaked. New conventional gas projects, such as the $5.5 billion Kipper-Turrum project, are underway but will only partly replace lost output.

Fortunately, the last decade has seen a growing source of supply created – the coal seam gas reserves of Queensland. The potential of coal seam gas was identified in the 1990s. However, technical challenges and higher production costs prevented significant investment and development. The opportunity to use coal seam gas as the feedstock for liquefied natural gas (LNG) exports changed the equation, drawing in an unprecedented $70 billion in investment to unlock the resource.

Today, Queensland's unconventional gas reserves are the largest source of natural gas in eastern Australia. More than half of the gas consumed on the east coast is coal seam gas from Queensland; almost 90 per cent of gas reserves on the east coast are unconventional gas.[8]

The LNG industry has not only created its own supply – it has created much of the new supply flowing into the domestic market.

[6] Deloitte Access Economics (2016), *Analysis for Gas Vision 2050.*
[7] Australian Government (2016), *Australian Energy Statistics* https://www.industry.gov.au/Office-of-the-Chief-Economist/Publications/
[8] EnergyQuest (2017) *Energy Quarterly September 2017 Report*. http://www.energyquest.com.au

Queensland's oil and gas industry employs an estimated 27,000 people, generates more than $9 billion in value added activities, including $2 billion in annual associated salaries. Average earnings in the industry are over $150,000 per annum, double the Queensland average.[9]

Over the last two financial years, $15 billion of industry investment has help sustain 3,100 Queensland businesses; most of these businesses (more than 80 per cent) are based in regional areas such as the Gladstone, Callide, and Maranoa local government areas.

The industry has a relatively small physical 'footprint' which limits its impact on traditional and existing rural industries. Access to land is negotiated under a regulatory framework which seeks to minimise impacts and ensures fair compensation for landowners. There are 5,861 conduct and compensation agreements signed with Queensland landowners who have received $387 million in co-existence payments from 2011 to 2017.

Regional communities and other local industries are sharing the benefits of the infrastructure funded by the gas industry. For example, renewable energy projects are connecting to new power infrastructure built to serve gas projects. The agricultural users now have access to new supplies of treated water for irrigation, lifting productivity and farm incomes.

Outside Queensland, unconventional gas production is in its infancy, largely because of regulatory restrictions. While most of New South Wales is effectively closed to development, the one project seeking approval from the State government is- Santos's Narrabri project – which could supply up to 50 per cent of the state's gas demand. The Northern Territory has major prospective unconventional resources. Victoria has significant natural gas potential with up to 27 TCF (28,514 PJ) of unconventional gas in the onshore Gippsland and Otway basins. Western Australia and South Australia also have promising resources which could underwrite significant additional gas supply and industrial development within the states.

In eastern Australia, time is running out for the development of new gas resources in time to replace declining output from existing supplies. Independent analysis by McKinsey and partners indicates that $50 billion may be required to fund new supply to 2030. McKinsey warns that a failure to make timely investment in new supplies will create tight supply and push up prices.[10]

2.1.1. Essential for Australian manufacturing

Natural gas is both a source of energy and an essential raw material (feedstock) for manufacturing. Almost one-third of the gas consumed in Australia is used by manufacturers.

About 225,000 people work in manufacturing sectors that rely heavily on gas; another 500,000 people work in related industries. The main industrial uses of natural gas and gas-derived products are producing:

- non-ferrous metals (e.g. aluminium, copper, zinc, tin)
- chemicals and polymers (e.g. fertilisers, antifreeze)
- non-metallic mineral products (e.g. glass, ceramics, cement, bricks)
- plastic packaging for foods and beverages.
- Gas is also needed in food preparation and processing, fermentation and brewing.

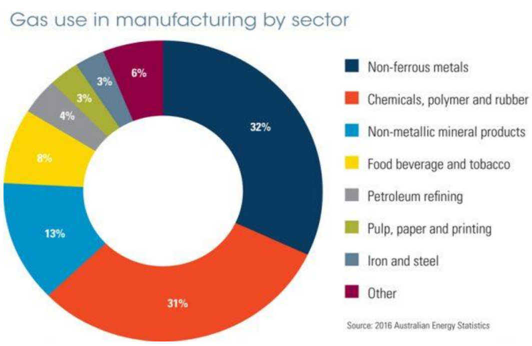

Figure 1 Gas — powering industrial processes

Gas is second only to oil as an energy source for manufacturing. Gas is essential for many industrial processes, especially processes requiring high temperatures — without gas to fire kilns and furnaces, it would be impossible to make everyday products such as glass, bricks, paper, cement, steel and alumina.

[9] Laurence Consulting (2017) *Queensland LNG Economic Contribution Report*, prepared for APPEA.

[10] McKinsey and Company (2017), *Meeting Australia's Gas Supply Challenge*, www.mckinsey.com/Global-themes/asia-pacific/meeting-east-australias-gas-supply-challenge

Gas — the invisible ingredient of everyday products

Natural gas is also a raw material (feedstock) for creating products such as fertilisers, explosives, paper, plastics and chemicals. In most cases, there is no substitute for gas. Gas is used to produce ammonia, which is an important feedstock for several industries.

The most commonly used fertiliser in the world is urea, which is produced from ammonia.

Producing each tonne of urea requires 21GJ of natural gas — the same amount of gas that the average NSW household uses in a year. Australian industries, such as agriculture, use 1.6 million tonnes of urea each year.

Ammonia is also used to make explosives and cleaning products, and in fermentation, brewing and winemaking.

The plastics used in food packaging, plumbing, guttering, fibres, textiles, machine parts and a host of other applications are made from ethane derived from natural gas.

2.1.2. Climate Benefit of Natural Gas

The International Energy Agency, the Climate Change Authority and most independent experts agree that the world will and should be using *more* gas in the transition to a low-emissions economy.

Gas-fired generation offers reliable, on-call and low emissions power. The emissions intensity of gas-fired plant can be as low as one-third of coal-fired plant. Experience in the United States shows how the substitution of gas-fired generation for coal-fired generation can slash emissions without jeopardising reliable, affordable supply. The US Energy Information Administration (EIA) reports that the shift to gas-fired generation accounts for 63 per cent of the 12 per cent reduction in U.S. energy-related CO_2 emissions during the last decade.[11] This shift has prevented 1.5 billion metric tons of carbon dioxide being emitted from power plants in the United States.

Australia has a similar opportunity to meet our energy needs while reducing emissions.

Gas-fired generation technologies can slash greenhouse gas emissions by 55 per cent compared to the National Electricity Market (NEM) average, and by 68 per cent compared to current brown coal generation technologies and 61 per cent compared to current black coal generation technologies[12].

The on-call nature of gas-fired generation means it is ideally suited to 'firm up' intermittent renewable energy as well as to respond to surges in electricity demand. International research shows that the increasing penetration of renewable energy in OECD countries between 1990 and 2013 has been facilitated by fast-reacting, gas-fired generation.[13]

Australians have seen how gas-fired generation underpins energy security. The Australian Energy Market Operator made this point clear. The 2017 Gas Statement of Opportunities begins with the statement: *"Gas-powered generation is vital to continued security of electricity supply as the National Electricity Market transitions to lower emissions targets."*[14]

Numerous reports have shown that natural gas has a critical role to play in a low-emissions future as both a replacement for coal and a partner for renewables. For example:

- Modelling for the Climate Change Authority's August 2016 *Special Review on Australia's Climate Goals And Policies,* found under its preferred policy option that Australia must triple its use of gas in electricity generation by 2030 if we are to achieve our emissions reduction targets.[15]

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[11] U.S. Energy-Related Carbon Dioxide Emissions, (2015) https://www.eia.gov/environment/emissions/carbon/

[12] Commonwealth of Australia, (2016), *Preliminary Report of the Independent Review into the Future Security of the National Electricity Market*, , p.63, www.environment.gov.au/system/files/resources/97a4f50c-24ac-4fe5-b3e5-5f93066543a4/files/independent-review-national-elec-market-prelim.pdf

[13] Verdolini, Vona and Pop (2016), *Bridging the Gap: Do Fast Reacting Fossil Technologies Facilitate Renewable Energy Diffusion?* *http://www.nber.org/papers/w22454*

[14] AEMO, (2017) 2017 Gas Statement of Opportunities (page 1) http://www.aemo.com.au/-/media/Files/Gas/National_Planning_and_Forecasting/GSOO/2017/2017-Gas-Statement-of-Opportunities.pdf

[15] Climate Change Authority, special review on Australia's climate goals and policies (2016), http://climatechangeauthority.gov.au/sites/prod.climatechangeauthority.gov.au/files/files/Special%20review%20Report%203/Climate%20Change%20Authority%20Special%20Review%20Report%20Three.pdf

- The December 2016 Preliminary Report of the Finkle Review stated: *"Gas has the potential to smooth the transition to a lower emissions electricity sector"* and *"The need for greater gas supplies for electricity generation is increasingly urgent."*[16]
- The May 2016 *Final Report of South Australia's Nuclear Fuel Cycle Royal Commission* highlighted the critical role of cleaner-burning natural gas in the low-carbon economy of the future, including as a partner for renewable energy. It found *"Gas-fired generation plays a significant role in providing reliable supply under all future low-carbon scenarios for the electricity sector."*
- The November 2015 *Australian Power Generation Technology Report* provided a thorough, independent assessment of renewable, coal and gas technologies. It found gas-fired generation is cleaner than coal, cheaper than renewables and can adapt quickly to meet changing demand.

2.1.3. Community Benefit

Regional communities benefit the most from the onshore gas industry, with new jobs and infrastructure creating stronger, diversified regional economies.

In places, such as the Western Downs, the resources sector (including the natural gas industry) has become the largest contributor to gross regional product. Research by the CSIRO and the Department of Industry, Innovation and Science confirms a very positive social dividend in regions which host the industry, including low unemployment, higher family incomes, a reversal of population decline, more employment opportunities for women and higher levels of youth education.[17]

In Queensland, an analysis of the longitudinal contribution of the petroleum industry has proven an immense benefit including:

- Approximately $50.7 billion in direct spending to the Queensland economy over the period 2011/12 to 2016/17
- $4.1 billion in wages and salaries to an average direct workforce (i.e. not including all contract workers) of approximately 4,685 fulltime resident employees, representing an average salary level across the sector of approximately $147,146 per annum.
- $46.5 billion in purchases of goods and services from local over 3,400 local businesses (including contract payments), community contributions and payments to local government (including rates, developer contributions and other payments) and state government (including royalties, stamp duty, payroll tax and land tax).

The industry has always regarded the support of local communities and the informed consent of landholders as essential to the long-term partnerships that enable our activities to be successfully conducted.

Many reputable and independent studies have identified significant positive regional socio-economic benefits of onshore gas and resources production. Community attitudes to the industry have also generally been found to be positive. Research confirms that the resources industry is most supported in areas where it operates

- The Australian Government's Bureau of Resource and Energy Economics (BREE) reported in 2015 that there are long term net economic benefits from CSG and negligible impacts of water and air quality to date.
- The CSIRO reported in 2013 that the CSG industry is contributing to poverty reduction, increasing employment and family income, and that there is a growing youth population in regions with CSG development.
- A 2013 study by KPMG showed that resources developments are not only making regions more prosperous, but also making their communities more stable and socially sustainable.
- A 2014 report by the CSIRO found that the majority of the community in Tara, Chinchilla, Miles, and Dalby accept, approve, or embraces the industry with only a small minority rejecting the industry:
- A 2018 social impact assessment for gas development in the Northern Territory found community concerns and threats can be mitigated and managed. They also identified significant opportunities for the

[16] Dr Alan Finkle AO, Independent Review into the Future Security of the National Electricity Market, (2016) https://www.energy.gov.au/sites/g/files/net3411/f/independent-review-future-nem-prelim.pdf

[17] Office of the Chief Scientist, Department of Industry, Innovation and Science; GISERA (2015) *Review of the socioeconomic impacts of coal seam gas in Queensland.* https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/coal-seam-gas/Socioeconomic-impacts-of-coal-seam-gas-in-Queensland.pdf

enhancement of social values, such as collaboration between the community and industry, increased training and employment opportunities, better infrastructure, and indigenous participation.[18]

In addition to the broader socioeconomic benefits that come with increased economic activity and a more diverse regional economy, Queensland's natural gas and LNG industry has made significant public investments in the communities within which it operates. More than 220 different community organisations, based primarily in rural areas, received support from the industry.

2.1.4. Fiscal Contribution

Oil and gas production in Australia is subject to numerous layers of taxation, including income (company) tax, GST and numerous other fees and charges (at a federal, state/territory and local government level). The industry is also subject to a variety of resources taxes, including petroleum royalties and the petroleum resource rent tax (PRRT). No other fuel in the energy market is subject to an additional, profits-based tax like the PRRT.

Company tax is levied at a corporate level, while resource taxes are generally applied at a project or production licence level. In terms of resource taxation:

- States and the Northern Territory levy royalties on onshore production (both from conventional and unconventional sources) and from offshore production in state/territory waters.
- Commonwealth crude oil and condensate production excise and Commonwealth petroleum royalty applies to production sourced from licences derived from Offshore Exploration Permits WA-1-P and WA-28-P (including the North West Project). Commonwealth crude oil and condensate production excise also applies to crude oil and condensate production from areas under state and territory jurisdiction.
- PRRT applies to production (conventional and unconventional) from all projects (offshore and onshore).

Before 2014-15, taxes and resource charges on average accounted for about one half of the oil and gas industry's pre-tax profit. Put simply, governments received close to 50 cents in every dollar of industry profit. Reflecting the significant fall in commodity prices since late 2014 (together with the peak in spending associated with new gas projects) the industry recorded a net operating loss of $0.6 billion in 2014-15 and another loss of $4.5 billion for the year 2015-16. Despite these losses, the industry's total tax payments remained strong – estimated at $4.3 billion for 2015-16 (compared with $5.2 billion in 2014-15). The industry's overall return on assets was estimated at -1.3 per cent, based on a total asset value of $345 billion.

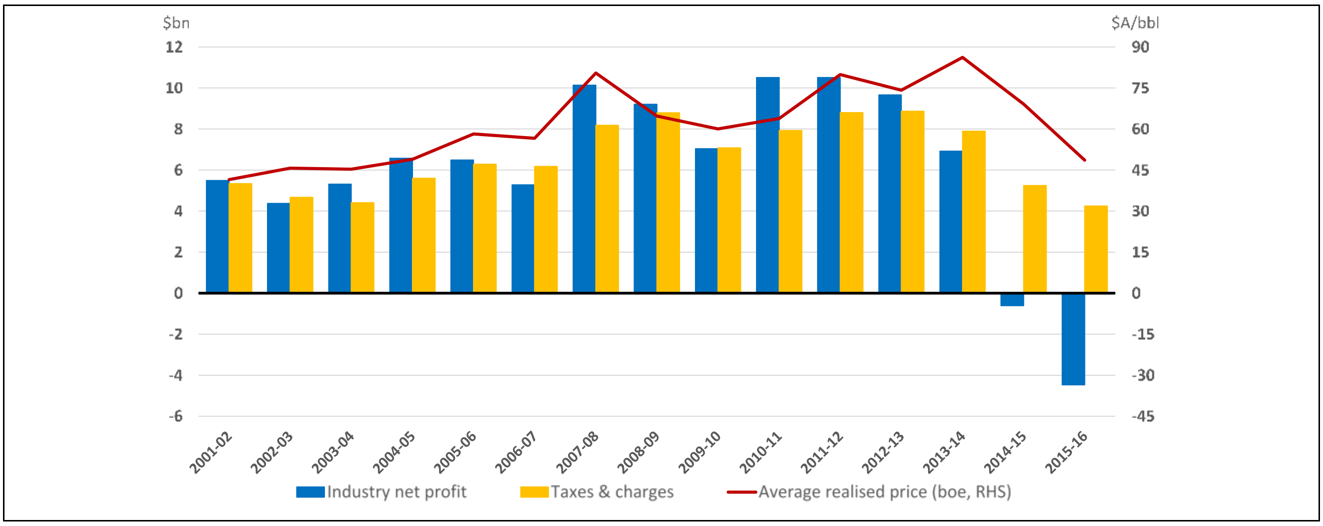

Figure 2 Oil and Gas Industry Net Profit, Tax Contribution and Average Prices Realised: 2000-01 to 2015-16.
Source: APPEA Financial Survey (2017)

[18] Coffey (2018), Beetaloo sub-basin Social Impact Assessment Case Study https://frackinginquiry.nt.gov.au/inquiry-reports?a=476739

2.1.5. Petroleum Royalties

Each state and territory collects royalties on the production of oil and gas (from conventional and unconventional sources). Royalties are generally assessed as a percentage of the wellhead value of production. The wellhead value is calculated by subtracting the cost of transportation and processing involved in bringing the raw products from the wellhead to a point at which marketable products are sold. Royalties are generally assessed on a licence area basis.

Allowable deductions when determining the wellhead value include some post-wellhead production costs, including certain treatment, transportation and storage expenses and eligible depreciation and operating expenses. Most jurisdictions levy royalties at a rate of 10 per cent of the wellhead value.

The petroleum royalty paid depends on a range of factors, including costs and the level of production. As the sales price is critical to the wellhead value, movements in oil and gas prices significantly affect royalty payments. The Queensland Government has forecast petroleum royalty collections of $296m in the year 2020-21 (see below).

2.1.6. Petroleum Resource Rent Tax

PRRT is a profits-based resource tax applying to all oil and gas projects in Australia. It is levied by the Commonwealth under the *Petroleum Resource Rent Tax Assessment Act 1987*. A liability to pay PRRT arises after a project has recovered all eligible project costs and achieves a modest, risk-adjusted rate of return.

PRRT was introduced in the mid-1980s for new offshore projects. In the early 1990s the regime was expanded to cover the Bass Strait project. From 1 July 2012, the PRRT was extended to all onshore petroleum production, including unconventional gas. For onshore oil and gas projects (captured by the 2012 extension), the then existing resource taxes and charges that applied at the time of the extension have been fully retained.

PRRT is a profits-based tax:

- It is assessed on an individual project basis – a project may comprise one or more petroleum production licences.
- A tax rate of 40 per cent applies.
- A liability is incurred when all allowable expenditures have been deducted from assessable receipts.
- Assessable receipts include the amounts received from the sale of all petroleum.
- Deductions include capital and operating costs relating to the petroleum project. These are deductible in the year they are incurred. Deductible expenditures include those related to exploration (including eligible exploration costs incurred by a taxpayer in other areas), development, operating and closing down activities.
- Costs associated with the liquefaction of gas and storing and shipping LNG are outside the scope of the tax - a 'marketable petroleum commodity' exists before these processes occur.
- Undeducted expenditures are compounded forward at a variety of set rates depending on the nature of those expenditures and when they are incurred.

Other resource taxes and charges (including royalties) incurred in relation to a project are rebateable against a project's PRRT liability. This avoids imposing double taxation on projects. Like other resource charges, PRRT is deductible in determining a taxpayer's income tax liability.

The PRRT a project pays is determined by numerous factors, including:

- A tax liability under the PRRT regime is incurred once a threshold return has been generated. As such, PRRT is unlikely to be paid from a project until many years of production.
- Other resource taxes and charges from a project (such as state and federal royalties and production excise) can be rebated against a PRRT liability from the same project.
- As PRRT is a profits-based tax, a tax liability depends on factors such as commodity prices, exchange rates and project costs. This is a design feature of the regime, and reflects the high rate of tax that is applicable when a tax liability is incurred.

2.2. Volume of Water used in oil and gas

The oil and gas industry uses very little water, relative to other industries.

During 2015-16, an estimated 76,544 gigalitres (GL) of water was extracted from the environment to support the Australian economy across all sectors – 60,702 GL of this was used in-stream and is a non-consumptive use (such as hydroelectricity). Total consumptive use of water in 2015-16 was 16,132 gigalitres. Of this 16,132 GL, 9,604 gigalitres were consumed by the Agriculture, Forestry, and Fishing industry; 2,014 gigalitres were consumed by the Water Supply, Sewerage and Drainage Services industry; a further 2,615 gigalitres by all other industries; and 1,899 gigalitres by households.[19]

The broad extractive industry sector (i.e. mining, mineral processing, oil and gas) accounted for about 4 per cent (661 GL) of water consumption in 2015-16. The oil and gas industry used just 26 GL or 0.16 per cent of total Australian water consumption (see Figure 3)

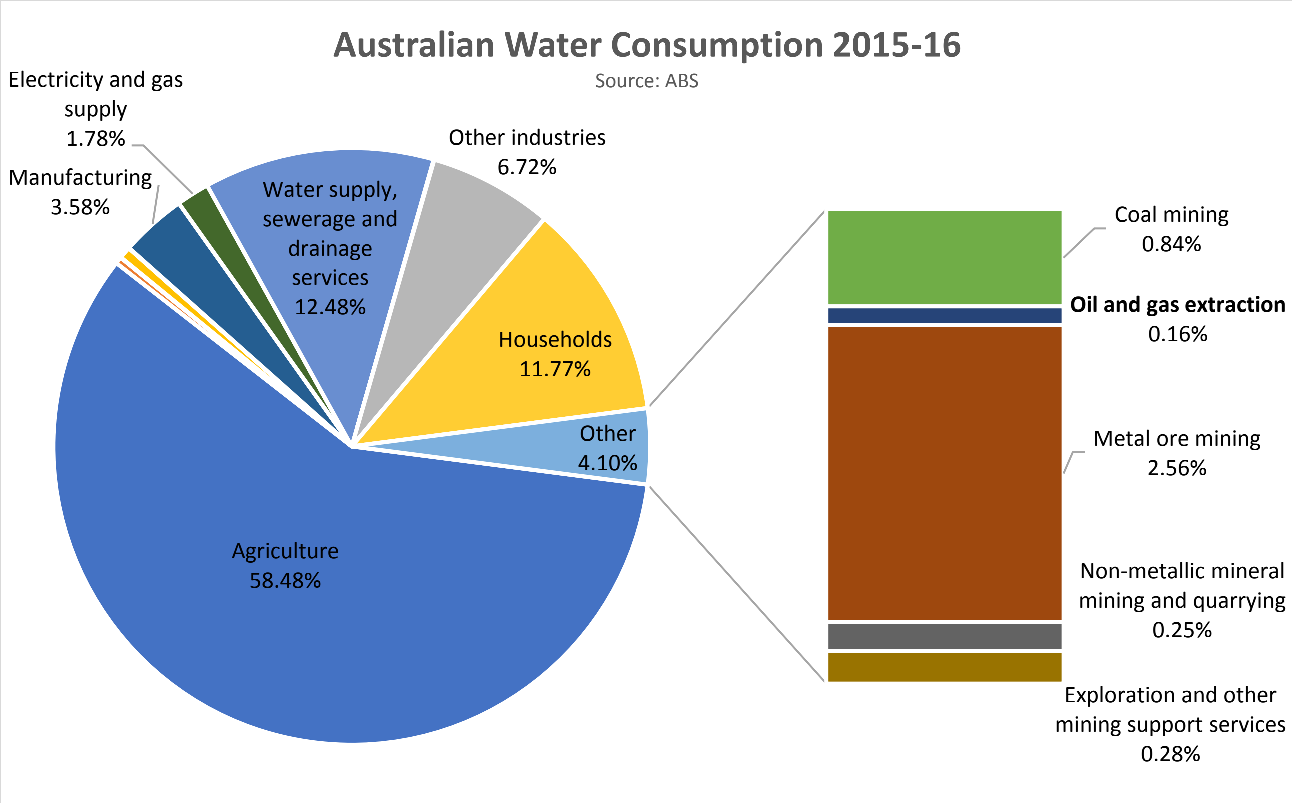

Figure 3 Water consumption by Industry and Disaggregated Mining Sector, 2015-16 (%).

2.3. High economic value of water use

The water used by the oil and gas industry generates an exceptionally high economic value-add.

Value added measures the value of the end product compared to the water used in its production - calculated as millions of dollars per gigalitre of water. According to the Australian Bureau of Statistics, every gigalitre of water consumed by the oil and gas industry generates over $933 million of value. This return is extremely high compared to other large water users; $127 million per gigalitre in coal mining, $37 million in aquaculture and just $4 million per gigalitre for agriculture (see Figure 4).

[19] Australian Bureau of Statistics, (2017) *4610.0 Water Account 2015-16.* www.abs.gov.au

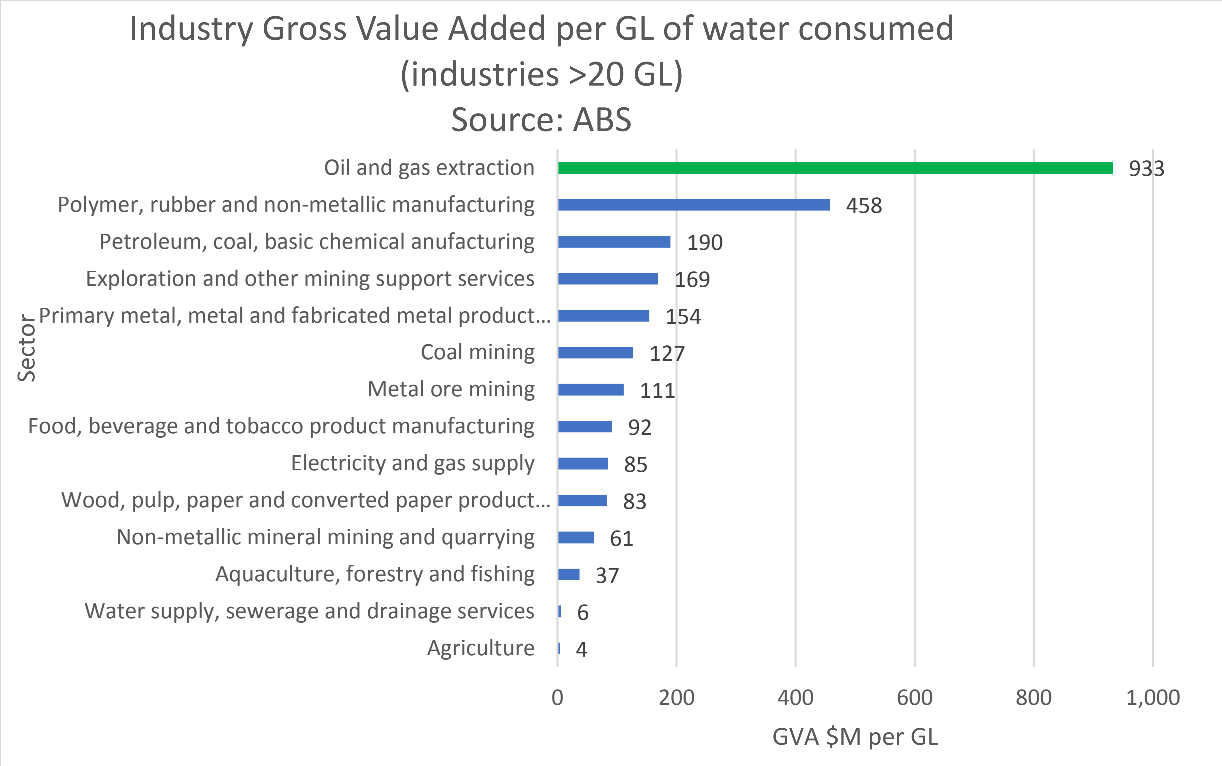

Figure 4 Industry Gross Value Added per GL of water consumed[20]

2.4. How water is used in the oil and gas industry

- Water is used in all stages of an oil and gas project from exploration to development. Water is used for well drilling and completions infrastructure construction, rehabilitation and decommissioning and other activities.
- The volume and type of water used is highly dependent on the geology and requirements of a development.
- The oil and gas industry is also generally a water provider to local users, treating the water associated with production and supplying it to agricultural, local governments and other users.

The petroleum industry uses surface and groundwater sources.

Petroleum projects have three primary phases: exploration, development and production. Each stage has a different use of water depending on the type of petroleum development, project size, and location.

Petroleum operations also produce water which is brought to the surface along with hydrocarbons (see Produced Formation Water). In the case of coal seam gas, water is also a by-product of production, with a significant volume of water treated and then made available to agricultural, local government and other users.

A significant volume of water in Queensland is also treated to improve its quality, then reinjected into aquifers, increasing the water pressure in these aquifers and storing water for use by current and future generations.

Water can be used in petroleum operations to increase reservoir pressure and enhance the recovery of oil and gas. Table 1 below describes the relative water demand at each stage of the project lifecycle for different developments. The duration of each step varies across projects.

[20] Australian Bureau of Statistics (2007), *An Experimental Monetary Water Account for Australia*, Cat. No. 4610.0.55.005, August

Table 1 Water and the Development cycle	Exploration	Development	Operations
Conventional	Low water demand	Low water demand construction, dust suppression, camp supply	Typically low water use, potential to use water for enhanced recovery
Coal Seam Gas	Low water demand for drilling. Hydraulic fracturing may or may not be required	More wells, camp supply, construction, dust suppression	Low water demand – excess water available for beneficial reuse
Shale / Tight Gas	Few wells, low water demand, hydraulic fracturing likely to be required	Hydraulic fracturing (predominantly), construction, dust suppression, camp supply	Low water demand

2.4.1. Exploration

Exploration for oil and gas resources starts with geological and geophysical surveys to identify areas of interest. As water is only required for human consumption and vehicle use, the potential risk of impact to water resources are negligible.

Should geophysical surveys indicate a prospective area, water is required to support the exploration drilling and testing process and camp supply.

2.4.2. Oil and Gas Development

Where a commercial resource is located, a well is used to flow oil and gas to the wellbore. Any pressure in the reservoir above hydrostatic pressure will cause fluids or gas to flow up the wellbore. If the pressure is not sufficient the resource may be pumped or lifted.

Typically, gas occurs under pressure within the reservoir and will flow into the wellbore and then to the surface. In conventional reservoirs the gas can easily flow through the reservoir-rock pore spaces towards the wellbore. Unconventional reservoirs may need additional stimulation treatment to increase this flow.

As the field matures, secondary recovery (also called enhanced recovery) may be employed. In some cases, fluids (e.g. water) may be pumped into the ground to increase pressure and properties to release additional hydrocarbons. This technique has been employed in Australia.

Water is required to support drilling, completion and construction activities as well as camp supply.

2.4.3. Water found in oil and gas reserves (Produced Formation Water)

Water present in the geological formations where oil and gas resources are found is called Produced Formation Water (PFW) or, in coal seams, Associated Water (see below). This water is brought to the surface along with oil or gas and varies in quality and quantity from reservoir to reservoir.

PFW is made up of a range of components and may include petroleum hydrocarbons, suspended solids, dissolved oxygen and salts.[21] The volume and properties of produced formation water vary from location to location and over the productive life of a reservoir (for example the oil-to-water ratio decreases over time).

The disposal of PFW is highly regulated and managed in Australia. Industry uses a range of techniques to minimise, reuse and recycle, and treat PFW:

- Minimising PFW: dual completion wells (downhole water sink), mechanical blocking devices, downhole separators, subsea separation, etc.
- Reuse and Recycle: underground injection, irrigation for crops, industrial use, dust control, etc. treatment may be required depending on the reuse or recycle option selected.

[21] Swan et al, Environmental implications of offshore oil and gas development in Australia, 1994

- Treat and dispose: Treated then managed according to State regulations.

2.4.4. Water used in drilling

Water is consumed in well drilling. The amount of water used depends on how many times the mud is reused in different wells and the lifetime production of each well. In Australia, the general rule of thumb for onshore wells is approximately 1 ML per well for drilling. Drilling muds are expensive to produce, so they are constantly recirculated in the well and recycled for use in other wells.

2.4.5. Water used in Enhanced Recovery

Enhanced Recovery (or secondary production) generally refers to maintaining reservoir pressure to sustain economic rates. At this point, new wells can be drilled to inject water (or other fluids) into the reservoir. Enhanced recovery is generally deployed in conventional oil extraction activities.

The injection well is positioned some distance from the production well, with the position chosen based on an understanding of the reservoir characteristics. The injection water may be obtained from seawater, reuse of produced water, from purpose-drilled brackish water wells, from freshwater sources or from municipal wastewater sources. Seawater is typically used offshore, or at onshore sites near the coast.

Australia's Barrow Island Windalia reservoir is Australia's largest onshore Enhanced Recovery project and was developed in the late 1960s. It is estimated that using water to manage the field pressure effectively reduced the field decline rate from approximately 18 % per annum to less than 2 %—adding millions of barrels in recovery and years to productive field life.[22]

2.4.6. Water used in Hydraulic fracturing

Oil and gas can be produced from reservoir rocks that have very low permeability by using hydraulic fracturing technology. In hydraulic fracturing treatments, a fluid is pumped at high pressure down a wellbore to initiate and propagate cracks in the low permeability rock.

The fluid is a water-based mixture containing sand or other solids, called proppants, that can prop open the newly created fractures. The amount of water used in hydraulic fracturing varies depending on resource and the amount of stages required. The source of water for hydraulic fracturing is an important consideration for industry, particularly in new and remote field locations.

2.4.7. Hydraulic Fracturing

Hydraulic fracturing injects water-based fluids at high pressure into rock formations deep underground to create tiny fractures that enhance the flow of oil and gas. The process has developed over more than 65 years and has been applied to millions of wells around the world, including more than 1,500 wells in Australia since the 1960s. Hydraulic fracturing is also used in renewable (geothermal) energy production and to enhance the productivity of water bores.

Numerous Australian and international reviews have found that the risks associated with hydraulic fracturing can be managed effectively with a robust regulatory regime.

In Queensland, around 6 per cent of all wells have been hydraulically fractured, without incident. In the Cooper Basin in South Australia, some 40 wells have been hydraulically fractured over the last 2 years. Hydraulic fracturing in the Cooper Basin has occurred for many decades without incident. In Western Australia, hydraulic fracturing has been used extensively to assist with the recovery of oil and gas from conventional resources – an estimated 800 wells have been hydraulically fractured since 1958, without incident.[23]

Since the 1970s, hydraulic fracturing has been used to produce oil from the Class 'A' Nature Reserve of Barrow Island.

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[22] Hartanto Lina, Widjanarko Wisnu, Muna Diala (2011) The success story of Windalia waterflood optimisation through integrated asset management in a mature field. The APPEA Journal 51, 726-726. https://doi.org/10.1071/AJ10106

[23] Department of Mines and Petroleum (2017), Gas Fact Sheet: Hydraulic Fracture Simulation, Government of Western Australia, http://dmp.wa.gov.au/Petroleum/Hydraulic-fracture-stimulation-20018.aspx.

2.4.8. Associated Water

Associated water refers to the water that naturally exists in petroleum formations. Coal Seam Gas is adsorbed to the coal matrix by the hydrostatic water pressure. The removal of water in the coal seam reduces the pressure, enabling the gas to be released from the coal. More information on Associated water from coal seam can be found in Appendix 1: Coal Seam Gas and Associated Water.

3. Existing safeguards in place to prevent the damage, contamination or draining of Australia's aquifers and water systems

- Conservation and protection of groundwater and surface water is a high priority during all oil and gas activities.
- All surface activities that could potentially affected water resources are regulated and controlled.
- Studies and decades of experience show the risk of groundwater and surface water contamination is very low.
- When a well reaches the end of its life, it is decommissioned (plugged and abandoned). This is done to a high standard to ensure long-term containment and isolation from geological formations.[24]

Conservation and protection of groundwater and surface water is a major priority during all oil and gas activities.

The use of chemical additives during drilling, cementation and hydraulic fracture stimulation of wells is controlled, strictly regulated and managed to minimise environmental risk. Studies and decades of experience show the risk of groundwater and surface water contamination is very low.

The Australian petroleum industry focuses on conducting all aspects of its activities safely and sustainably. Conservation and protection of ground water is a priority. Environmental protection during oil and gas production is achieved by:

- Designing wells to standards that protect aquifers by ensuring multiple failsafe levels of protection;
- Isolating all fluids to within the well bore; and
- Being transparent and consulting with communities and government agencies before, during and after activities.

The oil and gas sector is committed to ensuring that its impacts on the environment are minimised. To ensure the adequate protection of groundwater it is common practice that operators use a number of risk mitigation measures, including robust well construction and well integrity management systems, safe handling and use of chemical additives and extensive environmental monitoring.

Ensuring that well integrity is maintained throughout the life of operations is critical to safety and the protection of the environment. Wells are routinely inspected and subjected to maintenance. The industry is committed to monitoring and fixing wells that are not functioning to the standards required.

All surface activities that could potentially affect water resources (such as drilling, construction, transport etc) are strictly regulated and controlled. The management of chemicals and materials on the surface are not unique to the oil and gas industry and comprehensive regulation and risk management is in place.

3.1. Water management

Water management is an essential component of oil and gas operations. Although the volume of water used by the oil and gas industry is considerably lower than in the agriculture, power and many other sectors, oil and gas operations do involve the handling and management of produced water, wastewater and rainfall run-off.

[24] Report into the shale gas well life cycle and well integrity, CSIRO. December 2017.

There are a number of industry practices which mitigate and reduce the risks of petroleum activities damaging water quality and quantity. These include:

- Detailed design, testing and monitoring during all stages of well construction, hydraulic fracture stimulation, production testing, suspension, development, water storage, treatment and decommissioning.
- Monitoring local weather and climate information to make informed decisions regarding site operations.
- Ensuring site environmental inductions for all site personnel and contractors include protective measures to prevent avoidable discharge into, or contamination of, waterways, groundwater or established drainage systems.
- Ensuring appropriate storage of fuel and other flammable and combustible liquids in accordance with "*AS1940:2004 The storage and handling of flammable and combustible liquids*".
- Maintaining stormwater containment systems.
- Having a procedure in place to manage large quantities of water (e.g. pumping to an existing dam or watering point).
- Regular inspection and integrity checks of flowback tanks.
- All access roads, culverts and creek crossings maintained in proper working order.
- Ensuring adequate freeboard is maintained in ponds to allow for a prolonged period of intense rainfall.
- Ensuring all pipes and hoses are in good condition and fit for purpose to minimise risk of leaks from pipe.
- Periodic inspections of the site's stormwater and waste water containment systems.
- Refuel and transfer chemicals at a distance from drainage lines.
- Ensure site is equipped with spill clean-up equipment.
- Ensure well control critical equipment and systems on stimulation equipment are fit for purpose, certified, maintained in good working order and tested as required.
- Ensure appropriate well control training/certification for rig personnel.
- Ensuring sufficient distance between exploration targets and aquifers.
- Continuous real-time pressure, rate and volume monitoring during fracturing stimulation to ensure an immediate response in the unlikely event a loss of containment occurs.
- Maintaining all waste water systems in working order to minimise impact on groundwater

3.1.1. Protection of Surface Water

The management of water, chemicals and other substances on the surface is a key consideration for the oil and gas industry.

Proper handling of fluids that are returned to the surface is crucial. Once hydraulic fracturing fluids return to the surface, they are typically stored in tanks or lined pits to isolate them from soils and shallow groundwater zones.

The risks associated with water and chemicals handling are common to many industries such as agriculture and transport. Possible sources of impact on water quality may include:

- Accidents with chemical spills when handling the fracturing fluid and flowback fluid;
- Leakage of fluid through pipelines during flowback; and
- Erosion and leaching from cuttings, drill mud.

Oil and gas production involves use of water, fracturing fluids, flowback water and produced water, chemical additives, as well as drilling muds and drill cuttings.

Best practice is to minimise the amount of these materials on site, contain materials as fully as possible, reuse or recycle to the greatest extent feasible, and dispose responsibly any residual materials offsite.

Operators develop detailed waste management plans that consider all of the planned handling, treatment and disposal of waste. Best management practices are applied to avoid contaminating water supplies, bodies of standing water (e.g. lakes, swamps, etc.) and watercourses.

A recent study by the Department of Environment and NICNAS identified stringent protective measures imposed by state and territory and Commonwealth governments for the petroleum industry and found that the probability of a surface spill damaging water resources is very low and that "*we can be confident that it can be used safely*"[25]

3.1.2. Protecting Groundwater

The risk of contamination of aquifers by drilling or fracture stimulation fluids is very low for numerous reasons, including:

- Few coal seam gas wells require fracturing – only six per cent of the wells drilled in Queensland have required hydraulic fracturing;
- Hydraulic fracturing fluids are 90 to 98 per cent water and sand. Additives make up a relatively small proportion of fluids; most additives are benign;
- The few additives which could, in theory, present a potential risk to human health or the environment would need to be discharged in large quantities, over a long period, to reach concentration levels which could affect the much larger volumes of water present in aquifers. Such a scenario would require an exceptional failure of preventative measures to occur and continue undetected over a protracted period;
- Natural barriers – i.e. thick layers of impermeable rock separating aquifers and wellheads – isolate the point of fracturing from aquifers;

There are unsubstantiated claims about the potential risk of fractures propagating into aquifers. Based on current technology, geological data (including thousands of metres of sealing rock between aquifers and the fracture stimulation targets) and site-specific evaluations and risk assessments, experts agree that there is very little risk that fracture propagation will lead to contamination of shallow aquifers.

A recent report by the CSIRO found that chemicals remaining underground after hydraulic fracturing are unlikely to reach people or groundwater dependent terrestrial ecosystems in concentrations that would cause concern. Risks are therefore likely to be very low. Risks from naturally-occurring chemicals in the coal seam mobilised by hydraulic fracturing are also likely to be very low for the same reasons.[26].

Generally, the risks of aquifer contamination can be assessed on three levels:

1: Concentration and toxicity
While a number of additives are used in hydraulic fracturing, very few of these additives could pose a risk to the environment or human health in the quantities and concentrations used. The additives used in hydraulic fracturing are known and regulated by State governments. The additives used are strategically placed hundreds of meters beneath the surface, in very low concentrations. Risks at the surface relate to transportation, storage, and handling of chemicals which are common to all industries that use chemicals and are effectively managed by existing regulations.

2: Likelihood that the chemicals remain in the ground
Drilling fluids are mostly returned to surface for proper disposal or recycling for reuse in the next well. Cementation chemicals are contained in the cement. For fracture stimulation operations, 40 per cent to 60 per cent of the stimulation fluids are return to surface as the well is flushed and cleaned out in the following weeks. This material is either disposed of through regulated facilities, or recycled. The remaining quantities represent the proppant (i.e. sand) that is placed within the fractures or organic compounds that become bound within the coal seam. Over the life of a gas well – which may be decades – the pressure gradient towards the well ensures that any trace chemical additives that may be freed up over time are swept to the well and up to the surface for proper processing.

3: Likelihood the chemicals will migrate to uncontrolled areas
The volume of stimulation fluid is carefully calculated and monitored to ensure it cannot travel material distances from the well in a vertical direction. Typically, there are hundreds if not thousands of metres of rock between a

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[25] Department of Environment, (2017) National Assessment of Chemicals (page 11) http://www.environment.gov.au/system/files/resources/03137f85-1bea-46a4-b9e7-67d985b4aeb5/files/national-assessment-chemicals-overview.pdf

[26] CSIRO (2017) Deeper groundwater hazard screening for chemicals used in coal seam gas extraction - Overview , http://www.environment.gov.au/system/files/resources/370d0bcd-8fe2-436f-88d7-1c3361ef8cd5/files/deeper-groundwater-hazard-screening-research-overview.pdf

fracture stimulation and any sensitive aquifers such as those used for domestic or agricultural purposes. This can be monitored with seismic or tracer technologies to verify the models for fluid travel.

3.1.3. Ensuring well integrity

Concerns around well integrity are often raised in relation to the potential for oil and gas wells to leak and cause water impacts.

An oil or gas well is a technically advanced bore hole that reaches hundreds to thousands of metres beneath the earth's surface to tap petroleum resources. In Australia, wells can vary in depth from 300 meters to 2,000 to 4,000 metres deep. For the industry, these are not challenging depths; overseas, wells beyond 10,000 metres are becoming common. Water wells for agriculture or domestic use are usually less than 100 metres deep.

Controlling the gases and liquids as they are brought to the surface relies upon long-term well integrity. Not only does the well have to contain the petroleum products inside the well, it must also ensure that subsurface rock layers and any related aquifers penetrated by the well remain isolated from each other. Achieving all this requires high standards of well design and construction.

Structural elements termed well barriers are essential in both the design and construction of wells. There are numerous types of barriers, including well casing, drilling muds, and blowout preventers. These barriers function as containment envelopes to prevent unintentional fluid flow between the geology and / or the atmosphere. The barriers have built-in redundancies to reduce the risks that gases or liquids can escape from a well anywhere along its length, enter a well from untargeted zones, or migrate from one geological zone to another.

Development of oil and gas resources using modern well cementing and completion techniques leads to excellent wellbore integrity. Technological advances are continually improving well integrity and leak detection.

The most common well integrity risk is slow leakage of methane around the external casing, but the consequences of such leaks, although negative from a climate change perspective, do not threaten health because natural gas is not toxic, the frequency of substantial leaks is low, and the leakage rates are low as well.

3.1.3.1. Well Casing ensures isolation of zones

The well is lined with multiple layers of pipe (also called 'casing').

Image 1 Well Casing

Using several casing strings helps back up the integrity of the well if one of the pipes fails. Cement is pumped into the casing between the well and the rock, and between the various strings of casing. This isolates rock or aquifer zones, and prevents unwanted flow between rock zones or inside the well itself. This use of multiple casing strings and cement is the first line of defence for well integrity. There are usually three strings:

- Conductor casing – to secure the near surface section – soil and gravel etc -8 $^5/_8$" diameter
- Intermediate casing – from surface down to the base of weathered or weak strata – 6 $^5/_8$" diameter
- Production casing – down to the top of the target formation – 4 ½" diameter

All strings are cemented in place to isolate any aquifers.

3.1.3.1. Well Cementing ensures well integrity

Cement is a critical component of well construction and cementing is a fully designed and engineered process. Cement is used in casing at the time of well construction, as well as in plugging at the time of well abandonment, and less commonly to address production or perforation issues.

It is important to note that the cement used in well construction is a highly engineered, specialised product. It is not the same as the cement used in traditional construction activities such as building and civil works. Well cementing practice and design has decades of research to underpin it. Special formulations and additives are available to customise cement to individual well conditions, including increased resistance to gas migration, naturally occurring chemical ions, low pH environments, carbon dioxide (CO2), high temperatures, sulphate, and mineral acids (King, 2012). Designs may call for using different cements for casing than for plugging a well.

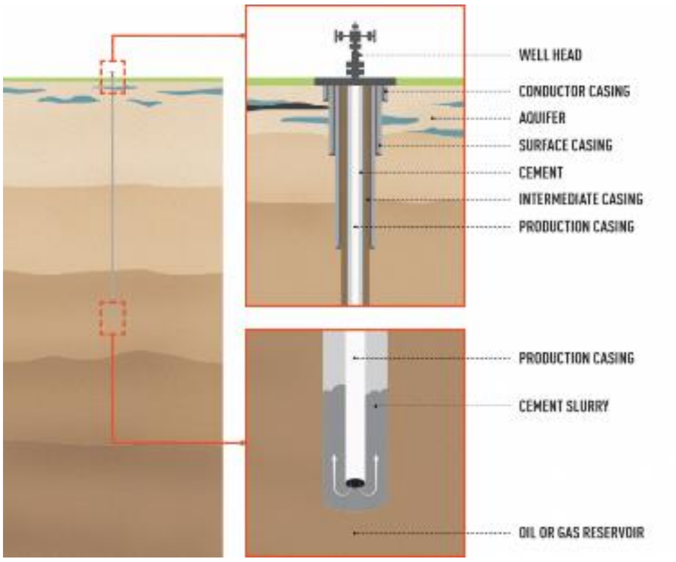

Image 2 Well Casing and Cementing

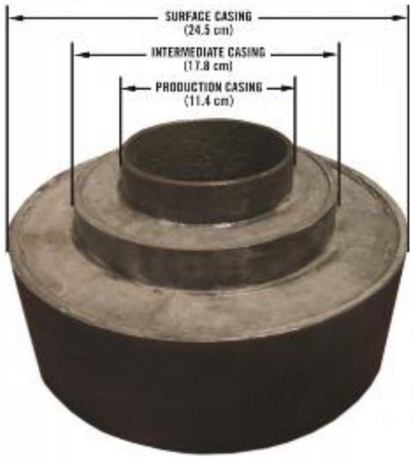

Image 3 Multiple Pipe Casings and Cementation:

3.1.3.2. Well failure is very rare

Historically, the highest instance of well barrier integrity failures appears to be related to insufficient or poor-quality cementing coverage to seal aquifers or non-reservoir hydrocarbon-bearing formations. In older wells, this was probably due to a lack of information on non-reservoir hydrocarbon-bearing geological layers and the regulatory regime under which the wells were constructed.

As described above there are multiple barriers in place to protect wells. The terms "well failure" and "well integrity" have sometimes been misunderstood.

A failure of a well barrier element will usually result in a well with *reduced* integrity. A reduction in well integrity does not necessarily mean any environmental impact. If a barrier has failed, there are actions that can be done to restore the failed well barrier (such as re-working the well). Failure of all barriers is called a 'loss of well integrity'. The obvious consequences of a loss of well integrity is blowouts or leaks that can cause material damage, personnel injuries, loss of production and environmental damage.

A single barrier loss is more common than a complete barrier loss. Studies indicate that wells are extremely unlikely to have barrier or well integrity failures when wells are constructed according to modern construction standards.[27]

27 Stone et al. 2016b.

The United States has the world's longest history of oil and gas production, and the most intensive drilling programs. The Ground Water Protection Council in the US examined more than 34,000 wells drilled and completed in the state of Ohio between 1983 and 2007, and more than 187,000 wells drilled and completed in Texas between 1993 and 2008. Included in the study period were more than 16,000 horizontal shale gas wells, with multi-staged hydraulic fracturing stimulations, completed in Texas.

The data[28] shows only 12 incidents in Ohio related to failures of (or graduate erosions to) casing or cement – a failure rate of **0.03%.** In Texas, the failure rate was only about **0.01%.** Obviously zero is the aim, but this is still a very low percentage considering the large number of wells drilled. A recent review by King and King (2013) of the data from 253,090 wells in Texas found that only 4 in every 100,000 (0.004%) wells constructed to modern standards experienced a loss of well integrity, compared to 0.2% for older wells.

The Queensland Gasfields Commission has released some information on well integrity in that state.[29] The cementing 'failure' rate after testing, remediation, and follow-up according to the Queensland code has been zero. The likelihood and therefore risk of a subsurface breach of well integrity is assessed to be very low to near zero.

- In July 2015, the Petroleum and Gas Inspectorate advised that, from 2010 to March 2015, 6,734 CSG exploration, appraisal and production wells had been drilled in Queensland.
- According to the P&G Inspectorate, no leaks have been reported for subsurface equipment. This is consistent with recent scientific field measurements which found, in a sample of 43 wells "...no evidence of leakage of methane around the outside of well casings..." (Day et al, 2014: p2).
- There have been 21 statutory notifications (a rate of 0.3%) under the well construction code concerning suspect downhole cement quality during construction.
- For all of these 21 notifications, the gas companies followed up with subsequent testing to assess well integrity and undertake any remedial work.
- The P&G Inspectorate followed-up on all 21 notifications to ensure that the tests, and any required remediation work, conducted on the well was successful before gas production commenced, with the company also having appropriate monitoring programs in place to ensure ongoing integrity of the well.

In 2015, the Western Australia Department of Mines and Petroleum (DMP) conducted a survey of 1,035 non-decommissioned wells (both offshore and onshore wells) which found that: "*the vast majority of petroleum and geothermal wells are drilled, completed, produced and decommissioned without any adverse environmental impacts*".[30] DMP found that, of the 953 active petroleum wells surveyed, 9% have had production tubing failures and 3% have had production casing failures well away from aquifers which were still protected by the surface and conductor casings. There have been no failures of surface or conductor casings.

3.1.3.3. Long term well integrity can be achieved

Once a well has reached the end of its useful life, it must be decommissioned and remediated (the common industry term is 'plugged and abandoned'). Steps taken to remediate a well are usually well defined by the relevant regulator. A typical well remediation uses a drilling rig to remove any equipment in the wells, such as subsurface pumps and pipe tubing. The rig then pumps cement into the well and sets mechanical plugs as a back-up, to create long-term barriers to fluid flow and isolate rock zones. Once this is done, the well-head is removed, and, in onshore wells, it is cut off below ground level so that past practices such as agriculture can resume over the well site.

A properly remediated well is very different to a producing well that needs regular measurement and monitoring. A remediated well is designed to be safe and pose no material threat to safety and the environment for future generations. The industry restores the natural integrity of the formation penetrated by the wellbore. This isolates permeable and hydrocarbon bearing formations are isolated to protect underground resources, prevent potential contamination of potable water sources and preclude surface leakage.

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[28] Kell, S. (2011), State Oil and Gas Agency Groundwater Investigations and their Role in Advancing Regulatory Reforms: A Two-State Review: Ohio and Texas, Ground Water Protection Council , fracfocus.org/sites/default/files/publications/state_oil__gas_agency_groundwater_investigations_optimized.pdf

[29] QLD Gasfields Commission (2016), Well Integrity. www.gasfieldscommissionqld.org.au/resources/gasfields/onshore-gas-well-integrity-in-qld.pdf

[30] S Patel, S Webster & K Jonasson, *Review of well integrity in Western Australia*, Petroleum in Western Australia, April 2015, p 24

The claim that 'cement can't last forever' is often made by industry opponents to suggest that, over time, all plugged and abandoned gas wells will leak – causing contamination of groundwater.

Modelling and analysis into well corrosion show that a properly designed and implemented well can last indefinitely. Yamaguchi, Shimoda, Kato, Stenhouse, Zhou, Papafotiou, Yamashita, Miyashiro & Saito (2013) have investigated the long-term corrosion behaviour of cement in abandoned wells under CO_2 geological storage conditions by simulating the geochemical reactions between the cement seals over a simulated period of 1,000 years. While alteration of the cement seals was found after a period of time, the alteration length after 1,000 years was approximately one meter, leading to the conclusion that cement will isolate CO_2 and upper aquifers over the long-term.[31]

Cement plug integrity in CO2 subsurface storage was also assessed by Van der Kuip, Benefictus, Wildgust & Aiken (2011)[32]. Using estimates for degradation after 10,000 years they likewise came to similar conclusions stating that "*mechanical integrity of cement plugs and the quality of its placement probably is of more significance than chemical degradation of properly placed abandonment plugs*" (literature on corrosion and cement degradation considers CO2 stored at high pressure to be more aggressive than methane).

3.1.4. Potential for hydraulic fractures to act as pathways for aquifer contamination

Concerns have been raised about the potential for hydraulic fracturing activities to reach water-bearing formations, overlying aquifers or nearby water bores.

Recent studies by the CSIRO and others have looked into the possibility of shallow groundwater being impacted due to hydraulic fracturing migration from deeper aquifers. Based on modelling studies, the authors concluded that the likelihood of hydraulic fracturing reaching a water resource is low when the vertical separation between the reservoir and the overlying aquifer is large and other natural pathways (such as faults or leaky wells) are absent.

CSIRO research also found that chemicals remaining underground after hydraulic fracturing are unlikely to reach people or ecosystems in concentrations that would cause concern. This conclusion is based on natural dilution and degradation that reduce concentrations to negligible levels. Risks are therefore likely to be very low.[33]

3.1.1. Chemical management and water

The chemicals used in hydraulic fracturing are commonly occurring and used for a range of applications outside of oil and gas extraction.[34]

In December 2017, the Australian Department of Environment and Energy (DoEE) and the National Industrial Chemicals Notification and Assessment Scheme (NICNAS) released an assessment of chemicals associated with coal seam gas extraction in Australia.

This study examined the risks to health and the environment from surface (above-ground) chemical spills. The NICNAS assessment focusses on what it describes as "worst-case" scenarios, which are highly-implausible and assume that all the safety and handling precautions required by law are not used.

The NICNAS assessment found the most significant potential risk to public health and the environment was exposure to chemicals after a large-scale transport spill, a risk facing any industry that uses chemicals. The chemicals used for hydraulic fracturing in the CSG industry accounts for less than one hundredth of one per cent of chemicals transported by road in Australia. Extensive regulation of heavy vehicle movements and chemical storage already minimizes the risks identified.

[31] Kohei Yamaguchi, Satoko Shimoda, Hiroyasu Kato, Michael J. Stenhouse, Wei Zhou, Alexandros Papafotiou, Yuji Yamashita, Kazutoshi Miyashiro, Shigeru Saito, *The Long-term Corrosion Behavior of Abandoned Wells Under CO2 Geological Storage Conditions: (3) Assessment of Long-term (1,000-year) Performance of Abandoned Wells for Geological CO2 Storage*, Energy Procedia, Volume 37, 2013, Pages 5804-5815, ISSN 1876-6102, www.sciencedirect.com/science/article/pii/S1876610213007467.

[32] M.D.C. van der Kuip, T. Benedictus, N. Wildgust, T. Aiken, *High-level integrity assessment of abandoned wells*, Energy Procedia, Volume 4, 2011, Pages 5320-5326, www.sciencedirect.com/science/article/pii/S1876610211007922.

[33] CSIRO (2017) *Deeper groundwater hazard screening research* https://www.csiro.au/en/Research/Major-initiatives/Unconventional-gas/CSG-chemicals

[34] Department of Environment. What does fracking fluid contain? http://www.environment.gov.au/system/files/pages/2d9f9167-3826-4d59-8be5-67c8c731fb59/files/what-does-fracking-fluid-contain-factsheet.pdf

Studies from the CSIRO and NICNAS have confirmed that the use of chemicals in the coal seam gas (CSG) industry poses little risk to the community or the environment.

In five technical papers, the CSIRO found that residual chemicals remaining underground after hydraulic fracturing are unlikely to reach people or ecosystems in concentrations that would cause concern and therefore risks are very low. The CSIRO studies are the latest independent research to again confirm that, properly regulated, hydraulic fracturing is safe.

4. Any gaps in the regulatory framework which may lead to adverse social, economic or environmental outcomes, as a result of the take and use of water by extractive projects

State Governments, as constitutional owners of the resource, have the lead in the management of their water resources. Where cross-border issues exist, cooperative arrangements are in place.

State Governments are active managers of water resources given the importance of these resources to communities across their States. Ongoing and detailed regulatory reviews occur and these enable the detailed consideration of all issues including social, economic, and environmental outcomes.

For example, in 2017 the Queensland Government introduced a new water plan covering the Great Artesian Basin and Other Regional Aquifers (the GABORA Plan). Development of the plan included a comprehensive consultation process during which 57 submissions were received and 26 workshops were held across Queensland. The Queensland Government also regularly convenes a Water Engagement Forum which consists of a broad range of community, environment, and resource industry groups.

The Queensland Government has also introduced in recent years new requirements covering the take of and use of water by resource industries including:

- A Coal Seam Gas Water Management Policy
- Make good arrangements that apply to all resource projects
- Beneficial use requirements and standards
- Specific standards for the construction and operation of water storage dams associate with resource projects
- Water management conditions within environmental authorities
- Water reporting
- Bore assessment
- The development of regional underground water impact reports
- Amendments to water rights such that petroleum projects must apply for authorisation for the take of 'non-associated' water.

All social, economic, and environmental issues resulting from the take and use of water by extractive projects are therefore comprehensively considered and, where necessary, acted on as part of existing Queensland Government water reform process which are ongoing and will continue to be refined and reformed in the future. Similar processes and arrangements exist in other States and Territories (see Section 5).

The development and approval process for oil and gas projects is rigorous and provides an additional layer of regulation for project-specific water management. No other water user is subject to the same level of regulation. Scientific, social and economic analysis of both surface and groundwater at both a local and regional scale is undertaken to ensure potential impacts are understood, mitigated and managed.

It is important to note that the regulatory regimes in which we operate have evolved and adapted over time as information is collected. In this regard APPEA supports regulatory processes that consider adaptive management systems that allow gaps in the framework to be addressed.

Adaptive management involves continually monitoring a process to evaluate its effectiveness, and improving the process based on this evaluation. It requires transparent planning systems and implementation strategies, and a strong emphasis on monitoring and reviewing to ensure emerging information is reflected in future planning.

Regulation does not come without cost. Too often there is perceived to be a trade-off between environmental outcomes and economic growth. This has led to a regulatory environment that limits sensible economic development without achieving any particular environmental outcomes, causing project delays and costs being driven up as well as otherwise viable projects being cancelled.

APPEA advocates for effective, efficient and streamlined regulation and assessment processes. In this regard APPEA seeks to identify ways to reduce the regulatory burden without also reducing environmental protection.

The Commonwealth Government and state and territory governments should, as a priority, continue to consider their regulatory regime to ensure it is efficient and conditions are necessary. Governments should also to continue to seek bilateral agreements under the EPBC Act which accredit state government approval processes that meet the required environmental standards. Bilateral agreements should be accompanied by an assurance framework that demonstrates the agreements are being adhered to, environmental outcomes are being achieved, and that the regulatory burden on project proponents is lower than is currently the case.

5. The Regulatory framework surrounding the oil and gas industry's water use

- The oil and gas industry is one of the most highly regulated industries in Australia.
- Under the Constitution the states and territory governments have primary responsibility for managing water resources
- State Governments that host activity have an established suite of legislation, regulation, and reporting requirements that apply to the oil and gas industry.
- The Commonwealth has a role in facilitating a collaborative approach to water management, such as through COAG.
- The Commonwealth regulates the oil and gas industry and water impacts under Federal Environmental Legislation. However, there is no value in expanding the 'water trigger' to include other projects.

Water issues have long been managed under comprehensive approvals regimes at the State level. This constitutional responsibility has required States to develop detailed assessment processes for the impacts of an activity on water resources and for water use. These processes require scientific, social and economic analysis of both surface and groundwater at both a local and regional scale to ensure potential impacts are understood, mitigated and managed. There was no justification that this system was broken and for the Federal Government to unilaterally override State Governments

The water used and produced by the Australian oil and gas industry is comprehensively managed and regulated. State and Territory governments are primarily responsible for the management of water resources within their jurisdictions (see State Government Regulation for further detail). The Federal Government has a role in water management in certain circumstances under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). This includes water resources as they apply to coal seam gas projects (the water trigger).

The oil and gas industry accesses water for operations in strict accordance with the framework relevant in that jurisdiction. A summary of the arrangements as they apply to water is below.

5.1. State Government regulation of water

Primary responsibility for regulating environmental impacts associated with the petroleum and resource sectors rests with state and territory governments. In additional to detailed Environmental approval processes, Australian States and Territories have specific legislation that covers petroleum operations and water management. Numerous Australian and international standards also apply to the oil and gas industry throughout operational and approvals processes. These also expand upon the requirements provided in regulations and legislation.

Onshore petroleum activity has occurred in all states and territories. Current onshore activity is focused on South Australia and Queensland with activity also underway in Northern Territory, New South Wales and Western Australia. The below section provides a summary overview of the regulatory arrangements in specific Australian jurisdictions.

5.1.1. New South Wales:

Primary responsibility for the regulation of the petroleum industry in NSW rests with the Division of Resources and Energy in NSW Trade & Investment. Other government agencies also have significant roles including the NSW Office of Water. The exploration for and production of petroleum requires authorisation under the *Petroleum (Onshore) Act 1991* by the Minister for Resources and Energy. Petroleum activities can require approvals under other legislation including the *Water Management Act 2000 or Water Act 1912* (water licences), *Protection of the Environment Operations Act 1997* (dealing with pollution), and *Petroleum (Onshore) Act 1991* (disposal of returned fracking fluids).[35]

Under section 60I of the *Water Management Act 2000* (NSW), mining activities require a licence for any water taken as part of those activities.

The NSW Aquifer Interference Policy was released in September 2012. It sets out the requirements for assessing the impacts of aquifer interference activities on water resources. The aquifer interference regulation amended the *Water Management (General) Regulation 2004* to require mining exploration and petroleum (including coal seam gas) exploration activities that take more than three megalitres of water per year to hold a water access licence.

Petroleum activities may be required to provide additional demonstration of water use as a component of their environmental approvals. For instance, under the conditions of PEL 238, Santos is required to have an approved Produced Water Management Plan in place for operations which generate more than three megalitres of produced water per year. Santos has an integrated Produced Water Management Plan for its PEL 238 and PAL 2 operations.[36]

5.1.2. Victoria

Victoria has a permanent ban on hydraulic fracturing and a moratorium on conventional oil and gas development until 2020.

Onshore gas exploration and production is regulated differently in Victoria depending on its type. Coal seam gas is classified as a mineral and is regulated by the *Mineral Resources (Sustainable Development) Act (MRSDA) 1990*.

In Victoria extractive industries are required to obtain a take and use licence to secure water access, either from the market or via a new entitlement in areas where unallocated water exists.

5.1.3. Queensland

Petroleum operations in Queensland are subject to a range of regulations and subject to stringent monitoring and compliance regimes.

The CSG industry's environmental and water management obligations are governed by a regulatory framework that includes elements of the Environmental Protection Act 1994; Water Act 2000; and the Petroleum and Gas (Production and Safety) Act 2004.

Under the Queensland regulatory framework, petroleum and gas tenure holders have a limited right for the extraction of groundwater in the process of producing Petroleum and Gas. The rationale for this authority is that petroleum cannot be produced without this water also coming to surface. New requirements have been introduced requiring non-associated water take to be measured and authorised by the State, for example through a water licence or permit granted under the *Water Act 2000*. These authorisations are typically granted for a defined period and include conditions which minimise impacts to the environment and other water users such as an annual volumetric limit for water taken under the licence.

Associated water can only be produced to the extent necessary to produce petroleum, and with this authority comes significant additional responsibilities that are not applied to other water users. These include, for example, requirements to monitor for impact, fund or undertake regional level modelling to forecast impacts, make good for any impacts on other water users, and limitations of how the water can be used that specify that water must be

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[35] NSW Government (2017), Regulation and Monitoring.http://www.water.nsw.gov.au/water-management/groundwater/regulation-and-monitoring

[36] Santos, PPL3 Water Management Plan
https://narrabrigasproject.com.au/uploads/2015/06/PEL238_PAL2_and_PPL3_Produced_Water_Management_Plan.pdf

beneficially reused where feasible. [37] More information is available from the regulator at https://www.ehp.qld.gov.au/management/non-mining/water.html

Under Queensland's *Beneficial Use Policy,* companies are also required to identify beneficial uses for produced water including treating the water for other uses such as irrigation, town water supplies, environmental flows and aquifer recharging.

To ensure a comprehensive cumulative groundwater assessment is completed and to provide clarity on the management responsibilities of individual tenure holders, areas with multiple tenement holders can be declared a 'cumulative management area' (CMA) under Queensland legislation.

Where a CMA is established, the Office of Groundwater Impact Assessment (OGIA) is responsible for preparing an Underground Water Impact Report (UWIR) which includes establishing management arrangements and identifying responsible tenure holders to implement specific aspects of those management arrangements. The Surat CMA was established in April 2010 and the Surat UWIR 2016 took effect from 19 September 2016.[38]

The Surat UWIR 2016 is a comprehensive regional groundwater flow model that was constructed to predict the impact of current and planned CSG development on groundwater pressures in aquifers. The model is an important part of the process of assessing regional groundwater impacts. Other important elements in the process include a full assessment of sensitive receptors, and how they may be impacted should drawdowns occur.

5.1.4. Western Australia

Western Australia's water licensing framework applies to water taken by extractive industries, with further guidance on licensing requirements and conditions outlined in government guidelines. Water used in petroleum operations in WA is licenced under the *Rights in Water and Irrigation Act 1914* (WA) as administered by the Department of Water and Environmental Regulation.[39]

Western Australia's *Petroleum and Geothermal Energy Resources (Environment) Regulations (2012), Petroleum and Geothermal Energy Resources (Management of Safety) Regulations (2010*) and *Petroleum and Geothermal Energy Resources (Resource Management and Administration) Regulations (2015)* provide regulatory guidance for environmental, safety and resource management.[40]

The Western Australian petroleum resource management regulations address issues such as well integrity and baseline water monitoring.[41]

5.1.5. South Australia

Upstream petroleum and geothermal energy exploration, development, production and transport in South Australia are regulated under the *Petroleum and Geothermal Energy Act 2000* (PGE Act) and associated regulations.

Under the SA regulatory regime, only after potential risks to social, natural and economic environments during all phases of petroleum operations are robustly addressed, and effective risk mitigation strategies are implemented, are any upstream petroleum operations approved pursuant to the PGE Act. Section 106 and Section 107 of the South Australian *Petroleum and Geothermal Energy Act 2000* requires that an Environmental Register be established for public inspection. This process and register provides an extensive public process and public access to environmental data. More information is available from the regulator at http://www.petroleum.statedevelopment.sa.gov.au

Mining and petroleum operations require a water licence where they take water from a prescribed water resource (many mines are outside of prescribed resource areas). In areas outside of prescribed areas, the *Natural Resources Management Act 2004* (NRM) (SA) allows for control of water take through regional NRM policies which can manage some aspects of water interception and extraction through water affecting permits, but normally do not directly

[37] Queensland Government, Make Good Obligations. https://www.ehp.qld.gov.au/management/non-mining/faqs-make-good.html
38 Queensland Office of Groundwater Impact Assessment (OGIA) (2017), SURAT Underground Water Impact Report https://www.dnrm.qld.gov.au/__data/assets/pdf_file/0007/1257838/surat-uwir-annual-report-2017.pdf
[39] Western Australian Government (2016), Water and the shale and tight gas industry https://www.water.wa.gov.au/__data/assets/pdf_file/0020/7841/109620.pdf
[40] Western Australian Government (2016), Shale and Tight Gas in WA – regulatory overview. http://www.dmp.wa.gov.au/Documents/Petroleum/Shale_and_Tight_Gas_overview.pdf
[41] Western Australia, well design and integrity. http://www.dmp.wa.gov.au/Documents/Petroleum/PD-SBD-NST-109D.pdf

control volume. The exception is the Alinytjara Wilurara NRM Plan which does directly control the actual take of water. Licences are not required for water used to drill petroleum and gas wells for exploration purposes; instead these activities are authorised by the Minister for Sustainability, Environment and Conservation under section 128 of the NRM Act.

5.1.6. Northern Territory

Petroleum activities are currently exempt from the application of the *Water Act 1992* (NT). As part of the existing approvals process, the DPIR requires that a company must demonstrate that the taking of water will not have unacceptable impacts on aquifers.

In a current review of the *Water Act 1992*, the NT Government intends to remove petroleum industry exemptions, and this is supported by industry providing that this does not lead to a duplication of regulation by both the DPIR and Department of Environment and Natural Resources.

Mining and petroleum operations are exempt from water licence and permit provisions under section seven of the Water Act 1992 (NT). Currently, a memorandum of understanding seeks to clarify the relationship between relevant agencies with the aim of ensuring water resource use for mining purposes does not impinge on existing allocations for other uses and vice versa. The Northern Territory Government has announced amendments to the Water Act 1992 (NT) which will require all new and increased water use by mining and petroleum activities to be subject to the same water licensing requirements as other water users from 2018 onwards. The amendments have not yet been passed.

5.1.7. Tasmania

While exploration activities for hydrocarbons in Tasmania are supported by the Tasmanian Government, a moratorium on hydraulic fracturing is in place until March 2020. Petroleum activities in Tasmania are regulated under the *Minerals resources development Act 1995*. This legislation includes petroleum (except shale oil). Extractive activities are required to have a licence under the *Water Management Act 1999* (Tas) to take water from for a watercourse or lake but groundwater does not require a licence unless specified under a water management plan or a Groundwater Area.

5.2. Federal Government Regulation of water

5.2.1. Standing Council on Energy and Resources (SCER) – Coal Seam Gas

The harmonisation approach to regulatory reform has been promoted through the National Harmonised Regulatory Framework for Natural Gas from Coal Seams (SCER Framework) and the Multiple Land Use Framework (MLUF) prepared by the Standing Council on Energy and Resources (SCER)[42].

SCER (2013) contends that 'a nationally consistent application of leading practices for the regulation of industry activities is currently not in place' and that consequently 'governments should work towards streamlined, transparent and consistent legislated approvals processes where duplication is minimised.' The outcome of this process should be a 'strong, consistent and harmonised leading practice regulatory regime that will assist in the sustainable development of the industry' and 'ultimately…build community confidence in the operation of the industry' (SCER, 2013).

The SCER Framework sets out 18 guiding principles and overarching strategies pertaining to key issues such as well integrity (principles 3, 4, 5 and 6), hydraulic fracturing and chemical use (principles 5, and 12-18) and water management.

5.2.2. National Water Initiative and oil and gas

State and Territory Governments have been undertaking a process of continuous reform of water policy, commencing with a national approach in 1994 under COAG's Water Reform Framework. Subsequent commitments were made

[42] Council of Australian Government (2013) *National Harmonised Framework for Coal Seam Gas,* http://www.coagenergycouncil.gov.au/publications/national-harmonised-regulatory-framework-natural-gas-coal-seams

under the National Water initiative in 2004.[43] The main objectives of a national strategic approach was to establish an efficient and sustainable water industry to achieve efficient and sustainable urban and rural water use.

On 25 June 2004 the Council of Australian Governments (CoAG) signed the Intergovernmental Agreement on a National Water Initiative (NWI). The Australian oil and gas industry supports the principles in the NWI and agrees that clear and transparent market and water access can increase investment certainty and increase efficiency in water use.

The NWI recognises (clause 34) that the oil and gas industry may face 'special circumstances' and those issues facing the sector will have to be addressed by policies and measures beyond the scope of the agreement.[44] This recognition reflects the remote nature of many of the industry's operations where there is little or no competition for water resources, the relatively temporary operational nature (relative to other users such as agriculture) and its use of non-potable/hyper saline water.

The oil and gas industry supports the *2004 Intergovernmental Agreement on a National Water Initiative* (NWI) and state regulatory processes for accessing water. Further clarity on Clause 34 should be included in the NWI.

Water resource planning should include a broad range of economic sectors, including the petroleum industry and greater emphasis needs to be given to the extractive industries to ensure high-value use and to incentivise the use of 'fit for purpose' waters.

5.2.3. 2011 National Partnership Agreement and the Independent Expert Scientific Committee

The National Partnership Agreement on Coal Seam Gas and Large Coal Mining Development (the NPA) was entered into in 2012 between the Australian Government and state governments of Queensland, New South Wales, Victoria and South Australia.

The overarching objective of the NPA was to strengthen 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. To achieve this objective, the NPA provided for the following outcomes:

- increased evidence supports strategic and regional scale management of coal seam gas and large coal mining developments and their impact on water resources
- strengthened scientific evidence and independent expertise informs regulatory decisions on coal seam gas and large coal mining developments that are likely to have a significant impact on water resources
- well informed communities have greater confidence in Commonwealth and state regulation of coal seam gas and large coal mining development.

On 9 November 2012, the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (Committee) was established following the coming into force of amendments to the *Environment Protection and Biodiversity Conservation 1999* (Cth) (EPBC Act). These reforms require decision makers to obtain and take into account the Committee's advice on the impacts of coal seam gas (CSG) and large coal mining (LCM) developments that are likely to have a significant impact on water resources before deciding whether or not to approve the development.

The Commonwealth, with advice from the Independent Expert Scientific Committee and input from relevant jurisdictions, should continue to develop and implement its research program on the water-related impacts of coal seam gas development. This research will help ensure that decisions involving projects that may have a significant impact on water resources are based on the best available science.

5.2.1. Water and the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Australian Government's key environmental legislation. The EPBC Act focuses Australian Government interests on the protection of matters of

[43] http://www.agriculture.gov.au/water/policy/coag

[44] Council of Australia Government (2004), Intergovernmental Agreement on a National Water Initiative, clause 34, pp. 6-7, June.

national environmental significance (NES), with the states and territories having responsibility for matters of state and local significance.

The nine matters of national environmental significance (MNES) are:

1. world heritage properties
2. national heritage places
3. wetlands of international importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed)
4. nationally threatened species and ecological communities
5. migratory species
6. Commonwealth marine areas
7. the Great Barrier Reef Marine Park
8. nuclear actions (including uranium mining)
9. a water resource, in relation to coal seam gas development and large coal mining development (since 22 June 2013).

Oil and gas projects are assessed under the EPBC Act when a proposed project has the potential to have a significant impact on a matter of national environmental significance.

6. The effectiveness of the 'water trigger' under the Environment Protection and Biodiversity Conservation Act 1999, and the value in expanding the 'water trigger'

- The water trigger adds duplication and inefficiency for no benefit at a time when clarity and investor certainty are required.
- There is no justification for extending the water trigger to shale and tight gas as such activities are already covered effectively by State water planning processes.
- Queensland and South Australia, for example, have considered potential water demand for shale and tight gas in recent water plans.
- In Queensland, new requirements have been introduced for non-associated water take, which includes water used for hydraulic fracturing and construction activities. These requirements provide that such water be authorised under the same process that applies to all water users and such authorities are not typically issued if they would impact existing water users.
- Government reports and studies have recommended the removal or modification of the water trigger. It's expansion to other sectors is not justified.

The 'water trigger' was introduced into parliament via the *Environment Protection and Biodiversity Conservation Amendment Act 2013* on 13 March 2013 and entered into force on 22 June 2013. The trigger created a new subdivision (Subdivision FB) in the EPBC Act that applies to actions that involve coal seam gas development (and large coal mines) and that action has, or will have, a significant impact on a water resource; or is likely to have a significant impact on a water resource.

The water trigger was a political fix to secure Tony Windsor's vote in 2013. There was no regulatory impact assessment and no evidence that State regulation was deficient. While adding another layer of Commonwealth regulation, the trigger did not add any new scientific assessment or evidence.

There is a clear commitment from Australian Governments, through the Council of Australian Governments (COAG) process, to streamline and reduce regulatory burdens on business, and to implement best-practice regulatory approaches. It is also contrary to the objects of the EPBC Act (*...to promote a co-operative approach to the protection and management of the environment involving governments..)* and the recommendations made by the Hawke Review of the Act.

The EPBC Act was never intended to duplicate or override state environmental law. Its objective was always to facilitate and promote an effective framework for inter-governmental relations on the environment in order to "provide greater certainty for participants in environment issues, minimise **duplication** of effort to achieve common goals and facilitate improved environmental outcomes". The Act is meant to encourage Bilateral Agreements, not remove them (*Environment Protection and Biodiversity Conservation Bill Explanatory Memorandum 1995).*

Matters of National Environmental Significance (NES) under the EPBC Act are generally on the protected matter, rather than a specific industry or activity. The unilateral creation of an industry specific trigger is inconsistent with the EPBC Act matters of NES that focus on impacts to protected matters.

The water trigger considers that an action is likely to have a significant impact on a water resource if there is a real or not remote chance or possibility that it will *directly or indirectly result in a change to the quantity of a water resource, and / or quality of a water resource*. By no standard are coal seam gas developments the largest users of water resources nor does it have a higher risk of significant impact on water resources.

APPEA recommends the removal of the water trigger.

Layers of regulation materially affect the viability, location and timing of project investment decisions. Even small changes in the process can make significant differences to the viability of a project. Unnecessary regulation has impacts on project profitability. In turn, this reduces the taxation revenue governments can expect to receive from the projects (such as resource taxes and company tax). All regulation increases costs, and all regulation can undermine the overall profitability and economics of a project to some degree. The worst-case outcome is that a project fails to proceed, resulting in a major loss of revenue for government.

The financial impact of overlapping or duplicative regulations is generally viewed from two perspectives: the impact on project economics; or, through a direct increase in compliance costs. Both affect projects where delays and/or additional costs exist. Compliance costs are the direct additional costs to businesses of performing the various tasks associated with complying with government regulation. However, it is through project delays where the most significant impact can occur.

A number of Government reviews and inquiries have considered the water trigger, they are summarised below:

6.1.1.1. Productivity Commission consideration of the Water Trigger

In its 2013 report on *Major Project Development Assessment Processes*[45], the Productivity Commission estimated that the indicative cost of a one-year delay to a major liquefied natural gas project is in the order of $500 million to $2 billion, depending on assumptions made. The central estimate of $1.1 billion represents a reduction in the net present value of the investment by about 9 per cent. The equivalent cost of delay for a major project of more average size (with capital expenditure of $473 million) might be around $26 million to $59 million.[46]

"The water trigger amendment (in combination with the prohibition on use of bilateral approval agreements) imposes an extra layer of regulation on affected proponents. Further, it is not obvious that existing laws are deficient or that the particular legislative amendment adopted by the Australian Government is the best approach to deal with any identified gap in the regulatory framework"[47]

Duplicative assessment, as presented in the water trigger, is also a preventable burden on the resources of the Australian Government. Productivity Commission also model what the potential cost of a delay may have on a major LNG project. This may assist the review in understanding the potentially large impacts even small delays can have on a project. The report finds that:

"the indicative cost of a one-year delay to a major liquefied natural gas project is in the order of $500 million to $2 billion, depending on assumptions made. The central estimate of $1.1 billion represents a reduction in the net present value of the investment by about 9 per cent. The equivalent cost of delay for a major project of more average size (with capital expenditure of $473 million) might be around $26 million to $59 million."

6.1.1.2. Independent review of the Water Trigger

The water trigger legislation also requires that the Minister for the Environment commission an independent review to be undertaken of the operation of the Act and the extent to which its objectives have been achieved. The independent review was completed in 2015 by Dr Stephen Hunter. Mr Hunter found that there is no "direct evidence

[45] Productivity Commission (2013) Major Project Development Assessment Processes http://www.pc.gov.au/inquiries/completed/major-projects/report
[46] Ibid (page 201)
[47] Ibid (Page 149)

about the effectiveness" of the legislation and "no direct evidence that the water trigger legislation has protected water resources." Despite this the water trigger is considered "appropriate to alleviate public concern" and "address the regulatory gap that was identified at the time of its enactment".[48]

Dr Hunter also found that the provision that limits bilateral agreement coverage of the water trigger should be changed; "as a matter of principle, scope should exist within the legislation for bilateral approval agreements between the Australian Government and state governments to include decisions under the water trigger."

The Post Implementation Report that was developed in conjunction with the review found that "the annual regulatory burden associated with the water trigger has been estimated at $46.8M per year." The direct cost to Government is also considered to be ~$357,000 per year. "Delay costs are currently estimated at an average of 105 days per project."[49]

6.1.1.3. The Senate Select Committee on Red Tape consideration of the Water Trigger

On 11 October 2016, the Senate resolved to establish the Select Committee on Red Tape and is to be known as the 'Red Tape Committee'. As part of its inquiry into the effect of red tape on the economy and community, the Senate Select Committee on Red Tape, examined the effect of red tape on environmental assessment and approvals.[50]

The interim report of the committee, released on 18 October 2017 recommended that "*The committee recommends that the 'water trigger' be removed from the Environment Protection and Biodiversity Conservation Act 1999".*

The committee also considered the review of the EPBC Act by Dr Allan Hawke AC in 2008-09. Dr Hawke found that "*including water extraction or use as a matter of NES under the Act is not the best mechanism for effectively managing water resource".* He notes that there is "limited value in attempting to regulate individual extractions of water" and that the EPBC Act could already assess the impacts of water extraction where that extraction or use has, will have or is likely to have a significant impact on a matter of National Environmental Significance.

7. Conclusion

The continued development of petroleum resources in Australia is important for energy security, economic development and growth. There are significant climate benefits in transition to increased use of natural gas.

The Australian oil and gas industry takes its commitment to protect water resources seriously and employs the highest standards in operations and well design.

The risks associated with oil and gas extraction in Australia are managed under a comprehensive regulatory framework that ensures all risks are considered and managed. The oil and gas industry is arguably the most highly regulated users of water in Australia, despite not being the biggest water user.

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[48] Independent review of the water trigger. www.environment.gov.au/epbc/publications/independent-review-water-trigger-legislation
[49] Stephen Hunter, Independent Review of the Water Trigger Legislation, April 2017, p. 10, www.environment.gov.au/system/files/resources/905b3199-4586-4f65-9c03- 8182492f0641/files/water-trigger-review-final.pdf (accessed 01 December 2017).
[50] Senate Select Committee – Environmental assessment and approvals www.aph.gov.au/Parliamentary_Business/Committees/Senate/Red_Tape/Environment (accessed 01 December 2017).

8. Appendix 1. Associated Water from Coal Seams

- Associated water is water that is pumped from the coal seams in order to extract gas.
- Water production by the Queensland natural gas industry accounts for a small fraction of national water use.
- In Queensland, associated water is regulated under numerous acts of legislation, including the Petroleum and Gas (Production and Safety) Act 2004; Petroleum Act 1923; Environmental Protection Act 1994; and the Water Act 2000
- The Underground Water Impact Report (UWIR) by the Office of Groundwater Impact Assessment indicates that water production by the CSG industry will have a localised impact on existing private water bores in Queensland. In large this is because the private water bores also take water from the target coal seams.
- If a petroleum activity in QLD impacts on the capacity of a landholder's bore the relevant company is required to make good the impact.
- CSG water quality varies across regions, but typically has a quality which restricts its highest beneficial use to stock watering.
- >90% of Associated Water produced in Queensland is treated and made available for beneficial use with most being used in the agricultural industry.
- Landholders receiving treated water use the water to increase irrigated cropping and livestock watering - boosting agricultural production, economic flow-on opportunities and community benefits.
- The Darling Downs region in Queensland accounts for a significant proportion of the petroleum industry's onshore water take and because of the industry the region is now one of the most extensively studied and monitored aquifer systems in the world. All work to date indicates there will be minimal impacts on existing water users as a result of the industry's water take.

In Australia, coal seam gas resources are primarily located in Queensland and New South Wales.

All coals contain natural gas to some extent. In the early days of coal mining, removing gas from mines was a major challenge if mining was to proceed safely. In modern times, the gas in coal became seen as a valuable energy resource.

8.1.1. CSG Water

CSG is adsorbed 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 to be released (desorbed) from the coal micropores and cleats, and allowing the gas and 'produced water' to be carried to the surface.

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. (Figure 5 Gas and water flow for a typical coal seam gas operation)

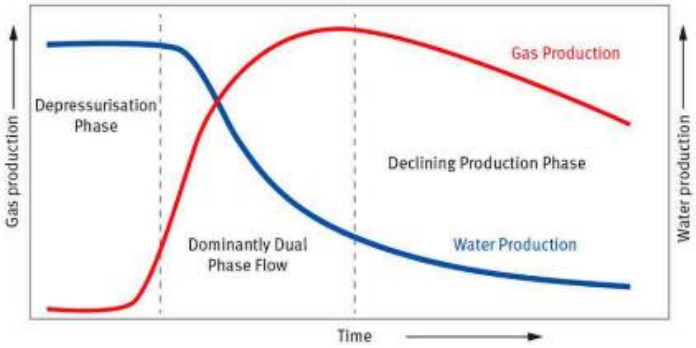


Figure 5 Gas and water flow for a typical coal seam gas operation

The water pumping phase is unique to producing gas from coal seams. But the drilling techniques, surface equipment and gas compositions are not materially different from conventional gas production, which has been going on for decades in Australia. Not all coals are suitable for production. Commercial viability depends on the permeability of the coal, and its ability to flow gas, as well as the costs of drilling and proximity to infrastructure and customers.

Coal is naturally fractured. Cracks in the structure of the coal are referred to as "cleats". Water and natural gas are trapped in these cleats. Coals with more cleats are more permeable, which enhances the rate at which the water and gas can move through the coal's structure.

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.

8.1.2. Quality of Associated Water

Water trapped in situ contains salts and minerals that were part of the inland seas in which they were formed. Water that has entered the coal seam via aquifer recharge will collect salts and minerals as it travels through the surrounding geological formations. These salts and minerals are then captured in the water within coal seams in the same way that they are found in surrounding aquifers.[51]

Associated water quality varies across regions, but is typically high in total dissolved solids, bicarbonate, hardness, and silica. The water contains mainly sodium chloride varying from 200 to more than 10,000 milligrams per litre, sodium bicarbonate and traces of other compounds. Co-produced water is generally brackish, with salinity levels ranging from about 300 to 10 000 milligrams per litre (mg/L) By comparison, the salinity of water supplies for Australian towns can range from less than 250 up to about 1000 mg/L, and seawater is about 35 000 mg/L[52]

Consequently companies have invested in water treatment to improve the quality of the water for beneficial use in line with the QLD Government's water policy (23)[53]. The most common treatment system is reverse osmosis (RO) desalination with suitable pre-treatment steps have been employed to remove elevated salts and other compounds before CSG water can be used beneficially. One common form of beneficial reuse of the treated water is the irrigation of agricultural crops and forestry.

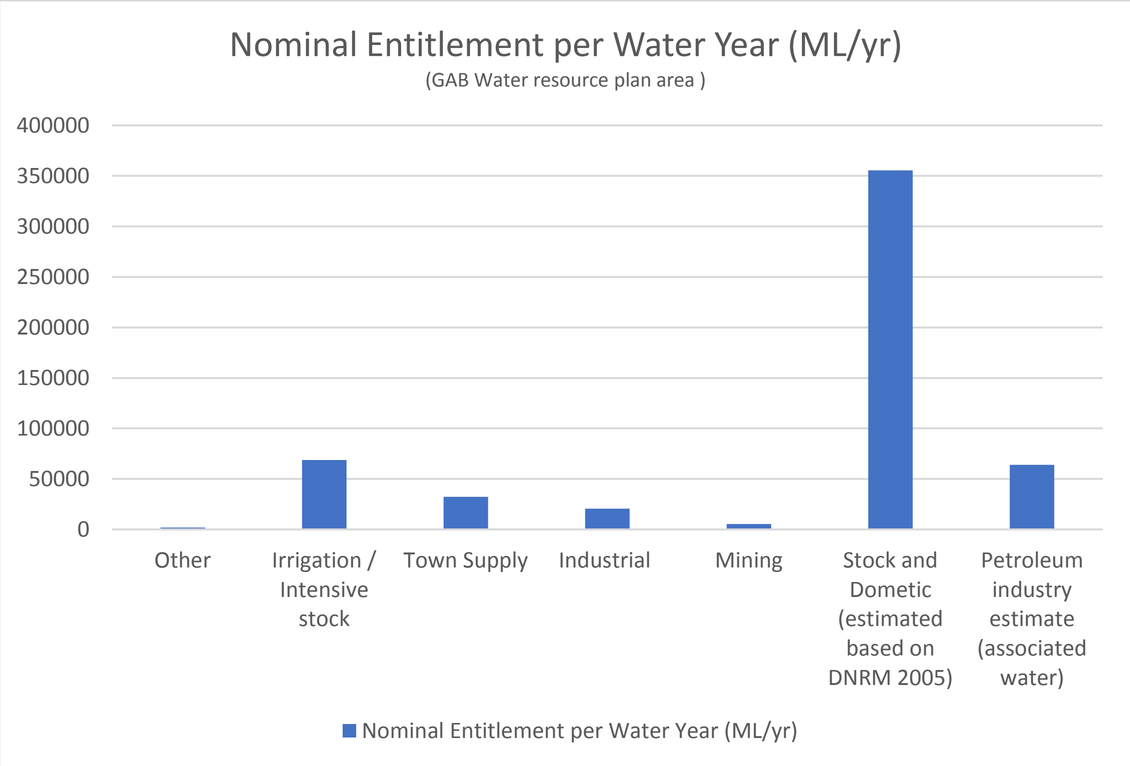
8.1.3. Associated water volumes

The volume of produced water extracted from each well can vary considerably between wells and regions depending on geological conditions. During the planning phase for gas field development, estimates of co-produced water volumes are necessary to formulate appropriate management arrangements. As the gas field is further developed, more representative data is available on well yield, enabling volumetric predictions to be refined over time.

[51] CSIRO (2014) Great Artesian Basin and Coal Seam Gas. Factsheet 14-00589. Canberra
[52] Australian Government (2017), Independent Expert Scientific Committee. http://www.iesc.environment.gov.au/publications/csg-extraction-and-co-produced-water#fn4
53 Coal Seam Gas Water Management Policy 2012 https://www.ehp.qld.gov.au/assets/documents/regulation/rs-po-csg-water-management-policy.pdf

The total volume of co-produced water in Queensland (Surat CMA) is estimated to be approximately 55 Gigalitres per year. The rate of associated CSG water extraction is less than initially expected due to the nature of the coal being encountered. The Great Artesian Basin (GAB) contains 65 million gigalitres (GL) of water.[54,55]

There are around 6,500 licences and 21 water permits in Queensland. Cumulatively, Queensland water users take about 315 GL per year from the Great Artesian Basin. According to the Queensland Government, in 2015–16, approximately 60.5 GL of associated water was produced as part of the state's CSG production. In 2016-17 more than 40 GL was provided for beneficial use by the QLD gas industry in 2015/16.



8.1.4. Non-Associated Water Use

Non-Associated Water is the water that is required for authorised petroleum activities but intentionally abstracted from a target aquifer with the express purpose of being used within the project.

The demand for water by the petroleum industry is often misunderstood and overestimated. Demand for non-associated water is short duration, with the highest demand being during construction activities prior to production. Long term demand is in small volumes. Overall water demand from the petroleum industry is expected to decrease as the primary construction phase of the large LNG developments in South-Eastern Queensland is completed.

8.1.5. Aquifers and CSG wells

When water is produced from a well, there is a decline in the water pressure in the deeper formations around the individual well. Under the Queensland regulatory framework, an area of concentrated development, where impacts on water pressure in aquifers are likely to be overlapping from multiple petroleum operations, can be declared a cumulative management area (CMA).

[54] Great Artesian Basin Coordinating Committee (2014) *Great Artesian Basin Strategic Management Plan - Progress & Achievements to 2008 -* http://www.gabcc.org.au/images/DL_684_.pdf

[55] CSIRO, 2008. *Background report on the Great Artesian Basin. A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project.* Contributing author Herczeg, A.L. http://www.clw.csiro.au/publications/waterforahealthycountry/mdbsy/technical/S-GreatArtesianBasin.pdf

In 2012, the Queensland Government commissioned the preparation of the *Surat Underground Water Impact Report*[56] which covers the vast majority of producing coal seam gas operations in Queensland. This report was updated in 2016.

In the CMA, the Office of Groundwater Impact Assessment (OGIA) is responsible for:

- predicting the regional impacts on water pressures in aquifers
- developing water monitoring and spring management strategies
- assigning responsibility to individual petroleum tenure holders for implementing specific parts of these strategies

The report collated information on regional aquifers, existing water bores and petroleum wells, as well as the number and location of further wells to be drilled as part of the CSG industry's development. It used this information to forecast the expected level of impacts. The report also identified "immediately affected areas" and "long-term affected areas".

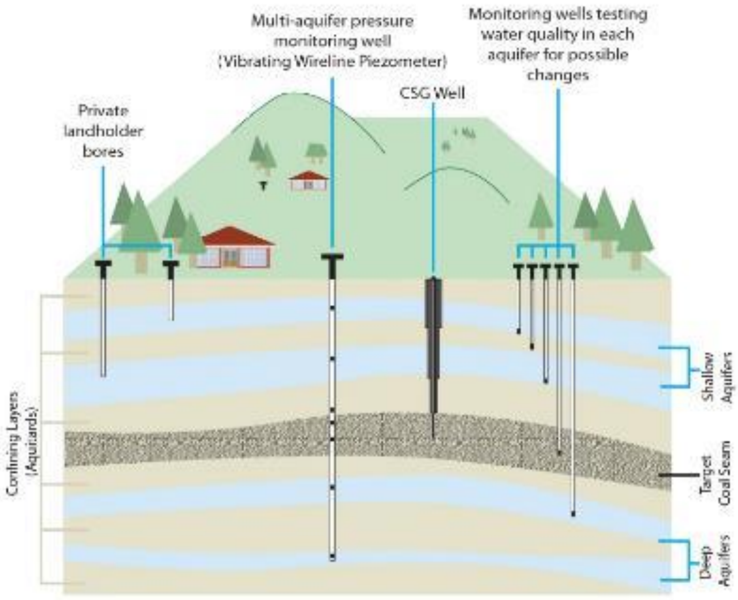


Image 4 CSG wells, landholder and groundwater monitoring bores (Source: Capital Energy Group)

The immediately affected area is defined as the area where water level impacts will exceed a nominated threshold level within a three-year period. Long-term affected areas are those that will be affected at any time in the future.

The threshold levels have been set at greater than five-metre decline in water level, in consolidated aquifers (i.e. sandstone aquifers) and three- metre decline in unconsolidated aquifers (i.e. sand aquifers).

This information was collated into one mega-model[5] to predict areas that may experience future groundwater impacts. The cumulative model covers an area the size of Germany and is referred to as the Surat Cumulative Management Area.

Gas companies have installed close to 1,500 monitoring points to detect any changes in aquifer pressure (using vibrating wireline piezometers) or changes in the chemistry in the aquifers underlying their permit areas. This information is delivered to the Queensland Office of Groundwater Impact Assessment (OGIA[57]) on a six-monthly basis.[5] Tenement holders are required to "Make-Good" on any bore level decline by providing alternative water supplies to the landholders. This may include drilling new, deeper bores, or supplying treated water to the affected properties.[4]

[56] https://www.dnrm.qld.gov.au/ogia/surat-underground-water-impact-report
[57] https://www.dnrm.qld.gov.au/ogia/role

8.1.6. Beneficial use of associated water

Where properly managed and treated, CSG associated water can be reused in a range of different ways including irrigation. Regulatory requirements in Queensland ensure where possible associated water is used for a purpose that is beneficial to one or more of the following: the environment, existing or new water users, and existing or new water-dependent industries.[58] Beneficial reuse can include:

- Industrial Reuse–e.g. cooling water which would otherwise have been taken from local streams or groundwater
- Agricultural Reuse – reducing the need to extract water from local aquifers
- Injection – increasing the volume of water stored in local aquifers
- River Discharge – blending with seasonal non-permanent streams

In order to fulfil the requirements of the CSG Water Management Policy, companies are required to investigate options for beneficial reuse of the CSG water and to treat the water so that it is fit for purpose. While the level of salt in CSG water varies depending on the source, CSG water treatment processes typically involve desalination, and the most commonly used desalination technique is reverse osmosis.

The industry has invested over $3 billion in water treatment and recycling infrastructure to meet these requirements. In the last financial year 41.8 GL of water was provided for beneficial use with the vast majority (83%) treated to a high quality and used in irrigation[59]. Associated water is also used to recharge depleted aquifers through managed reinjection.

Two main processes are used to treat water drawn from coal seams:

Desalination

Capital cities around Australia have adopted desalination to produce drinking water from the ocean. The industry is using the same proven technology to purify water it withdraws from coal seams.

Amendment

Water with a low salt content (i.e. naturally or after desalination) can be treated by using an amendment process. This involves changing the mineral make-up of the water to produce water that is suitable for the intended purpose. The suitability of amended water for any other uses is determined by the water quality and is regulated by the state government.

After desalination a brine (salty water) is produced. Industry works within strict government guidelines to ensure brine is always managed safely and responsibly. At Roma, the brine left over after desalination is reinjected into deep underground aquifers which are already high in salt. In any new areas of operation in future, this will be dependent on the geology of the areas.

8.1.6.1. CASE STUDY: CSG water used to grow crops

The Fairymeadow Road Irrigation Pipeline (FRIP) project was delivered by Origin on behalf of Australia Pacific LNG. The project involved construction of the 1,870 megalitre irrigation storage dam located on the Monreagh property, the Monreagh pump station, the pipeline along Fairymeadow Road, and offtake points for participating landholders.[60]

The FRIP project provides the opportunity for landholders to supplement their cropping programs with new irrigation.

This irrigation scheme is an example of the CSG industry working with local farmers for mutual benefit. It allows the Fairymeadow area to be farmed more intensively, which leads to increased local jobs in agriculture, and a financial boost for the local agricultural contractors and associated agricultural businesses. This supply of water is especially important in times of drought.
Water began flowing to participating landholders in April 2014, filling on-farm dams and allowing farmers to prepare fields for planting winter crops which have since been harvested.

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[58] https://www.ehp.qld.gov.au/management/non-mining/csg-water.html
[59] Water reuse from APPEA industry survey 2016-17.
[60] Origin Energy – Fairymeadow Road. Water to Landholders (2017) https://www.originenergy.com.au/content/dam/origin/about/our-approach/docs/OurApproach-2016-Fairymeadow-Road.pdf

During 2016, the program delivered 11,208 ML of treated water to participating landholders. Treated water is delivered via pipeline from reverse osmosis water treatment facilities at Talinga and Condabri and stored in Monreagh Dam, and transferred to landholders via the Fairymeadow Road Irrigation Pipeline.

The FRIP project forms part of Australia Pacific LNG's broader CSG water management strategy, which uses a variety of solutions to find the best outcome for water resources according to local conditions.

The FRIP project is a practical application of the Queensland Government's Coal Seam Gas Water Management Policy (2012) which requires CSG companies to find beneficial uses for treated CSG water, and demonstrates how the agricultural and resources industries can work together to develop shared benefits.

Image 5 Treated water being used for irrigation (Source: APPEA)

About the Fairymeadow Road Irrigation Pipeline Project:

- Seven participating landholders
- Covering an estimated 3,500 hectares
- 15 gigalitres of treated water per year during peak production
- A 22 km water distribution pipeline along Fairymeadow Road
- A 1,870 megalitre irrigation dam, located on the Monreagh property (Monreagh Dam) which provides buffer storage
- A pump station at Monreagh Dam
- Irrigation off-takes for each participating landholder property along the water pipeline
- Water delivery gates to measure flow at each participating landholder property
- Talinga Water Treatment Facility
- Condabri Water Treatment Facility and booster pump station.