The Senate

Rural Affairs and Transport References Committee

Management of the Murray Darling Basin

Interim report: the impact of mining coal seam gas on the management of the Murray Darling Basin

November 2011

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1.72 The committee recommends that federal and state governments conduct a thorough review of the appropriateness of 'adaptive management' in the context of regulating the industry, given the significant gaps in information regarding cumulative and long term impacts of the industry.

Recommendation 2

1.85 The committee recommends that the Commonwealth Government, through the Council of Australian Governments, or Standing Council on Energy and Resources (SCER), take the initiative in promoting a consistent national regulatory framework for all aspects of the coal seam gas industry.

Recommendation 3

2.58 The committee recommends that, given the degree of uncertainty about the long-term consequences of the CSG industry on the water resources of the Great Artesian Basin, that the Commonwealth not give any further approvals for production of CSG in that part of the Murray-Darling Basin overlying the Great Artesian Basin pending the completion of the Queensland Government's regional groundwater model and the CSIRO & Geoscience Australia basin scale investigation of water resources.

Recommendation 4

2.59 The committee recommends that the Commonwealth await the completion of the Namoi Catchment study before considering any applications under the Water Act or the *Environment Protection and Biodiversity Conservation Act 1999* for approvals to undertake coal seam gas production.

Recommendation 5

2.60 The committee recommends that all future CSG development approvals should be preceded by the development of "... a regional-scale, multi-state and multi-layer model of the cumulative effects of multiple developments" of ground and surface water as recommended by Geoscience Australia.

Recommendation 6

2.70 The committee recommends that the Commonwealth take the necessary steps to amend the *Water Act 2007* to include that part of the Great Artesian Basin that underlies the Murray-Darling Basin within the definition of Basin water resources.

Recommendation 7

2.75 The committee recommends that the Commonwealth take the necessary steps to amend the *Environmental Protection and Biodiversity Conservation Act 1999* to include the sustainable use of the Great Artesian Basin as a 'matter of national environmental significance'.

Recommendation 8

2.81 The committee recommends that all future approvals require independent comprehensive monitoring of regional earth surface movements to assess whether any measurable subsidence is occurring. Where subsidence occurs and has an adverse effect on land management or the natural environment, for example by altering drainage, the responsible gas companies would be liable for any necessary remediation. Further all gas exploration and/or production in an area subject to subsidence or impacts from subsidence not foreseen in the EIS should cease until action is taken to ensure that no further damage will occur. Where subsidence occurs in a gas producing region the onus lies with the gas companies to demonstrate that the subsidence is not a result of gas production activities.

Recommendation 9

2.85 The committee recommends that it be a requirement of all exploration or production approvals that the fluids extracted from wells after fraccing are kept isolated in secure separate storages and prior to disposal are treated to the highest standards.

Recommendation 10

2.96 The committee recommends that the Commonwealth provide funds to NICNAS to enable that organisation to undertake a comprehensive review of the chemicals used in fraccing, having particular regard to the quantities, combinations of chemicals and the way in which these chemicals are used and to confirm safe levels for their use. This study should be completed within the next two years. The Commonwealth and state governments should act promptly to ensure all fraccing activities comply with any NICNAS recommendations.

Recommendation 11

3.64 The committee recommends that all CSG water should be included in the calculation of the total withdrawal from the ground and surface water systems. Seepage into depressurised coal seams, reinjection into regulated formations and virtual reinjection or surface disposal must be monitored and recorded if a complete picture of the state of artesian and sub-artesian water is to be maintained.

Recommendation 12

3.65 The committee recommends that where any aquifer used for the supply of stock or domestic water is depleted as a result of coal seam gas activities, the relevant company or companies should be required to pay for that water at the prevailing rate or make good the loss of water by virtual reinjection or reinjection where water to be reinjected is of an environmentally appropriate standard. The onus should rest with the gas companies to prove that, where an aquifer is depleted, it is not the result of coal seam gas extraction.

Recommendation 13

3.69 The committee recommends that as a general principle it should be established that where a gas company supplies treated CSG water for beneficial use to an existing water user in agriculture, industry or for domestic use that supply must be as a substitute for an existing allocation.

3.70 Where treated water is supplied to landholders (including on a company's own land) to develop a new crop or enhance existing production, that supply should be clearly understood to create no entitlement, above a pre-existing water licence, to water from any other source once the supply of CSG water ceases.

Recommendation 14

3.72 The committee recommends that comprehensive water management plans, *and the capacity to implement those plans*, particularly with regard to the disposal of salt and brine, be a requirement before any further production approval for coal seam gas be granted.

Recommendation 15

3.74 The committee recommends that all salt and brine residues that cannot be disposed of within the short term, either as part of an industrial process or by safe injection into a suitable aquifer, should be required to be removed from agricultural areas and water catchments. No controlled landfills for the disposal of salt should be permitted in the Murray-Darling Basin.

Recommendation 16

4.70 The committee recommends that the Commonwealth, in cooperation with the states, establish an independently managed trust funded by the gas companies to make financial provision for long-term rectification of problems such as leaks in sealed wells or subsidence and erosion caused by collapsing pipelines.

Recommendation 17

4.91 The committee supports the concept of strategic agricultural land and recommends that, when identified, exploration for, or production of, coal seam gas be banned from land identified under defined criteria.

Recommendation 18

4.99 The committee recommends that the Commonwealth, through the Council of Australian Governments, or other appropriate forum, request the States to insert in the relevant legislation a requirement that arbitration bodies charged with resolving disputes between landholders and the holders of exploration or production titles – the Land Court in Queensland; the Land and Environment Court in NSW – must give priority to the maintenance of agricultural production with minimal disruption in deciding any dispute.

4.100 Similarly, where a ministerial discretion such as that exercised under s.71 of the NSW Petroleum (Onshore) Act exists, the exercise of that discretion should be required to give priority to maintaining agricultural production with minimum disruption to the existing land-use.

Recommendation 19

4.107 The committee recommends that draft access agreements between landholders and gas companies include a requirement that company employees must have a landholder's approval whenever they wish to enter a property and that companies must maintain logs of staff entering private property.

Recommendation 20

4.108 The committee recommends that draft access agreements clarify the gas companies responsibility with regard to fire safety and require the gas company to advise landholders of all chemicals that are brought on to the land.

Recommendation 21

4.112 The committee recommends that legislation governing compensation to landholders include provisions that recognise as compensatable effects the involuntary nature of landholders' dealings with coal seam gas companies and the social impact of coal seam gas exploration and production.

Recommendation 22

4.117 The committee recommends that States' include in the relevant legislation as a compensatable effect the costs incurred by a landholder in seeking independent arbitration of a dispute over an access and compensation agreement, except where it can be demonstrated that the landholder had not negotiated reasonably and in good faith.

Recommendation 23

4.122 The committee recommends the Queensland and New South Wales governments establish mechanisms that provide where a landholder, having an access and compensation agreement with a coal seam gas exploration or production company, believes that that agreement was entered into without proper advice or understanding of its implications, then the landholder be entitled to seek a review of the agreement.

Recommendation 24

4.124 The committee recommends that the position of residents of small regional communities and on small blocks of land also be clarified and that enforceable conditions, including a buffer zone around houses, are included in exploration or production permits to ensure that, despite having no development on their land, they are not subject to excessive interference from coal seam gas developments.

Chapter 1

Introduction

Conduct of the Inquiry

1.1 This committee's inquiry into the Coal Seam Gas (CSG) industry is a subset of its broader inquiry into the Murray-Darling Basin and its capacity to maintain its position as a significant food producer in the context of reduced availability of water for agriculture, both as a result of water management decisions and, potentially, as a consequence of changing weather patterns resulting from climate change.

1.2 The Committee, as part of that general inquiry has been examining:

> The economic, social and environmental impacts of mining coal seam gas on:
>
> - the sustainability of water aquifers and future water licensing arrangements;
> - the property rights and values of landholders;
> - the sustainability of prime agricultural land and Australia's food task;
> - the social and economic benefits or otherwise for regional towns and the effective management of relationships between mining and other interests; and
> - other related matters including health impacts.

1.3 The committee is required to report on the inquiry into the management of the Murray-Darling Basin by 30 November 2011. This report constitutes a first report on that matter. A final report will be tabled in the Senate on 29 June 2012. The committee will continue to monitor developments in the CSG industry.

1.4 This report concentrates on CSG developments within the Basin, which are the focus of the industry and of public concern. The main regions of concern to this committee, where the industry is expanding very rapidly, are in south-west Queensland and north-west New South Wales. The committee held hearings and inspections in Roma, Dalby and Narrabri and further hearings in Brisbane and Canberra. Details of these and of the submissions that the committee has received can be found in Appendices 1 and 2.

1.5 The committee has received 370 submissions to the general inquiry into the Murray-Darling Basin. Submissions specifically relating to the coal seam gas issue start at approximately number 200.

1.6 The committee has received submissions and some evidence from groups in areas outside the Basin, the Myall Lakes area and the Southern Highlands of New South Wales for example. Many of the issues and concerns dealt with in this report are of immediate relevance to those communities as well.

Acknowledgements

1.7 The committee acknowledges the contribution of all those individuals and organisations that made written submissions and also those who appeared as witnesses. The committee regrets that it was unable to hear all those who wished to appear in person during hearings and appreciates the efforts made by individuals and organisations in providing information to the committee and giving their time to hosting the committee on its inspections.

Structure of the Report

1.8 This chapter provides an outline of the CSG industry and of its potential impact on Murray-Darling Basin water resources and agricultural production. Subsequent chapters examine the impact on groundwater, the management of the very large volumes of water that the industry will extract, land access, land use and social impacts. A final chapter reviews the debate over the greenhouse gas footprint of the CSG industry.

What is Coal Seam Gas?

1.9 Coal seam gas, also known as Coalbed methane (CBM) or Coalbed natural gas (CBNG) in the US, is predominantly methane found in coal deposits un-minable using conventional techniques. Methane is the major component of what is commonly known as fire-damp, a major safety hazard in underground coal mining. Chemically CSG is virtually identical to 'conventional' natural gas. The use of terms such as CSG, shale gas and, generically, unconventional gas, refer to the sources of the gas rather than its chemical composition.

1.10 CSG is a valuable energy source which, with a minimal amount of cleaning, can be used in the same way as natural gas from conventional sources. In 2008 Australia produced 139 Petajoules (PJ)[1] of coal seam gas, predominantly from the Bowen and Surat Basins in Queensland. CSG represented approx 10% of Australia's, and 80% of Queensland's, gas consumption.[2] It is estimated that Australia's demonstrated economic reserves of CSG are some 16 590 PJ; demonstrated reserves are 46 590 PJ and inferred reserves 122 020.[3]

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1 Petajoule is a measure of energy equivalent to 10^{15} joules. 1 petajoule is the heat energy approximately equivalent to 43 000 tonnes of black coal or 29 million litres of petrol. [Energy in Australia 2010, Australian Government Department of Resources, Energy and Tourism.]

2 NSW Parliamentary Library Research Service, e-brief 1/2011, January 2011, p 2.

3 CSIRO, presentation to the committee, 6 July 2011. Demonstrated economic reserves are proven reserves, commercially viable with current technology. Demonstrated reserves are those which have been proven but are not commercially viable at current prices or with current technology. Inferred reserves reflect the content of known geological formations which, by extrapolation from demonstrated reserves, are likely to contain given quantities of gas.

1.11 Natural gas, which when burnt is a cleaner fuel than coal or oil, is promoted as an important transitional fuel for economies, particularly rapidly industrialising countries such as China and India, moving to lower emission and renewable energy futures. The whole of life emissions produced by the coal seam gas industry is the subject of some debate, which is discussed below in Chapter 5. Proponents also note that, used in conjunction with solar thermal power stations, gas-powered generation can provide the required base-load power.

1.12 As a resource CSG is, potentially, highly valuable both as a domestic energy source and as an export commodity, and these new developments are driven by export demand, for it to be realistic to think that some kind of outright ban on further development is likely. For example, the Queensland government clearly views CSG as a driver of economic development and a valuable source of energy, employment, export income and revenue.[4]

Water

1.13 CSG is dispersed throughout coal seams and occurs:

> …in a near-liquid state, lining the inside of pores within the coal (called the matrix). The open fractures in the coal (called the cleats) can also contain free gas or can be saturated with water.[5]

1.14 The gas is held in that state by water pressure. Thus it is necessary to reduce the pressure in the coal seam to allow the gas to flow:

> Methane is commonly extracted from coal deposits by pumping large quantities of aquifer groundwater.[6]
>
> A defining characteristic of nearly all CBNG developments is the requirement to initially pump large quantities of formation water from the coal seams (dewatering) to reduce the reservoir pressure and allow the methane to desorb and flow into the cleat or fracture system.[7]

1.15 The term 'dewatering' is frequently used to describe this process. To the extent it suggests the removal of all the water in a coal seam from which gas is being extracted, the term is misleading. Pressure in the target seam is only reduced to a level where the gas will flow. Origin Energy, part of the Australia Pacific LNG (AP LNG) consortium, for example, advises that lowering the pressure of its production field in the Walloon Coal Measures involves the removal of approximately 5% of the water.

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4 See, *Blueprint for Queensland's LNG Industry*, Department of Employment, Economic Development and Innovation (2009) http://www.industry.qld.gov.au/documents/LNG/Blueprint_for_Queenslands_LNG_Industry.pdf (accessed 14 June 2011).

5 http://www.amisglobalsolutions.com/coalseamgas.htm (Accessed 2 June 2011).

6 *Coalbed Natural Gas; Energy and the Environment* (2010), ed. K J Reddy, p. 6.

7 *Coalbed Natural Gas; Energy and the Environment* (2010), ed. K J Reddy, p. 11.

This still represents a large volume of water; AP LNG estimates that it will produce from 25 000 and 57 000 megalitres of water per annum.[8]

1.16 It is important to note that, as the poor quality of most CSG water suggests, this water is generally not coming from the most commonly used artesian or sub-artesian water sources used by agriculture or for domestic and town water supply. In fact it is normally separated from these sources by tens or hundreds of metres of intervening strata.

1.17 The main cause for concern is with the potential impact of the extraction of large volumes of water on the pressure within adjacent aquifers, the stability of the intervening strata, the levels of water and directions of flow, and the possibility of contamination of higher quality water, all of which may have a long term impact on sources of groundwater used for agriculture, rural communities and the environment.

1.18 These concerns are compounded by the uncertainty surrounding many of these issues. In a briefing to the committee, for example, CSIRO emphasised that it was difficult to accurately estimate impacts of CSG production on water particularly because of the long time delays associated with groundwater processes and the lack of knowledge of baseline conditions against which impacts could be measured.

1.19 Other major issues are use, storage, treatment and disposal of the water. The industry does not have fully developed plans for the management of the water and associated salts and brine. Salt and brine are very significant issues. For example AP LNG advised the committee that, over the 40 to 45 year life of its projects in Queensland, it expected to produce approximately 3.5 million tonnes of salt.[9] Queensland Gas (QGC) expects to produce 4.6 million tonnes of salt from its operations in South-Western Queensland over the next 30 years.[10]

1.20 In addition, the fact that CSG operators are permitted to remove this water outside the normal water approvals and licensing regimes applying to other users has been a significant cause of the hostility of many rural communities and landowners. They have been subject to ever-tightening restrictions on their access to groundwater for agricultural or domestic use, while, at the same time being involved in expensive programs of well-capping and other measures to manage water resources more efficiently.

Wells

1.21 Extraction of the gas requires the drilling of a very large number of wells. Early estimates were of some 40 000 wells being drilled over the 40 to 50 year life of

8 AP LNG, Submission 366, p.24

9 Mr P. Maxon, CEO, AP LNG, *Committee Hansard*, 9 September 2011, p. 3.

10 Queensland Gas Co. (QGC), *Submission 259*, p. 11.

the industry. More recent experience with production suggests that fewer wells will be required, perhaps 20 000.

1.22 There is wide-spread concern about the security of the gas wells. They will, in most cases, be drilled through shallower sub-artesian and artesian aquifers used for domestic and agricultural supply. To avoid leakage and contamination the wells must be to a very high standard, completely sealed from these intervening strata. The industry is confident that it can do this and will have in place monitoring equipment to ensure that any leakage is identified and rectified very promptly.

1.23 The industry has been complying with its own best practice standards and the Queensland Government has recently published its *Code of Practice for Constructing and Abandoning Coal Seam Gas Wells in Queensland*.[11] The objectives of the code are to,

> ... to ensure that all CSG wells are constructed and abandoned to a minimum acceptable standard resulting in long term well integrity, containment of gas and the protection of groundwater resources. CSG wells and their associated facilities can be made low risk through compliance to high design standards, robust safety obligations, documented industry standards and experience, and strong governance programs.[12]

1.24 The stability of the wells for the long term and responsibility for their monitoring subsequent to decommissioning remain issues of particular concern.

Fraccing

1.25 The geology of the coal seam determines the complexity of the gas recovery process. Some reserves may be tapped by simple vertical and horizontal wells in greater or lesser numbers depending on the permeability and flow paths within the seam.

1.26 In less favourable conditions, perhaps 30% - 40% of wells in the current developments, some method of 'flow enhancement' including hydraulic fracturing, fraccing, may be necessary to free the gas from the geological structures which contain it. The use of fraccing can reduce the number of wells required thus limiting the impact of the industry on the land surface.

1.27 Hydraulic fracture involves pumping large volumes of water mixed with sand and a range of chemicals into the coal seam under high pressure to fracture the seam, allowing the gas to flow. The purpose of the sand is to hold open the fractures while the gas is extracted. Fraccing fluids are stored and handled separately from the rest of the produced water.

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11 Queensland Government, *Code of Practice for Constructing and Abandoning Coal Seam Gas Wells in Queensland* (November 2011) Version 1.0

12 *Code of Practice,* p.3

1.28 As explained by CSIRO, most of the water and added chemicals used in the fraccing process is immediately pumped out of the well. However, fraccing can involve very large volumes of water – from 100 to 10 000 cubic metres. Thus a residue of even one per cent is still a significant volume.[13]

1.29 Fraccing has become a cause for concern for two main reasons: the potential for the process to damage the strata surrounding coal seams, causing movement of water and gas between them; and the health risks posed by the chemicals used in fraccing fluid.

Agriculture

1.30 Much of the land affected by this industry is productive agricultural land and, properly managed, will remain a valuable resource for Australia and the world for many generations. Given the growing world population, and the consequent pressures on water and agricultural land, it is vital that the interests of a valuable, but relatively short lived industry are not allowed to put at risk vital food producing industries and the land, water and communities on which they depend.

1.31 The requirement to give access to a gas company that holds an exploration permit over private land has been a source of considerable anxiety and, in some cases, hostility. The potential impacts on agriculture, the network of exploration and production wells, access roads, pipelines and associated easements, compressors and residential work camps could make some agricultural properties unworkable in their present form.

1.32 The risks of the loss of access to groundwater as a result of CSG mining and of contamination of the soils by salts or brine are of major concern to landholders. The possible alteration of surface drainage patterns as a result of gas related construction or subsidence have also been referred to in evidence to the committee. These matters are discussed below.

1.33 In focussing on agricultural land, the committee is not ignoring the important environmental values of such areas as the Pilliga in New South Wales which must also be protected. It would be an unwelcome outcome if the efforts to protect productive agricultural land led to a relaxation of protection for areas of high conservation value.

Public concern

1.34 The coal seam gas industry has become the focus of public concern for a number of reasons. Coal seam gas has been produced in Queensland in relatively small volumes from the Bowen Basin since 1997. It did not attract much public attention until the rapid expansion of the last five years. Public anxiety has grown dramatically with the intrusion of the industry into regional areas with highly productive agricultural industries and urban centres.

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13 CSIRO, *Coal Seam Gas Fact sheet no.3, p.2.* 100 cubic metres= 100 000 litres.

1.35 The very high volumes of water that will be produced as a by-product of gas production, the potential threat that poses to the long-term security of ground and surface water, the potential impact of the industry on agriculture and the impact on rural and regional communities have combined to generate broadly based opposition to the industry.

1.36 Public concern was exacerbated by the realisation that possession of an exploration permit for coal seam gas entitled the holder of that permit to have access to land even without the consent of the landowner. In fact there are very few examples of a company seeking to enforce that legal right, but it nonetheless added to community anxiety about the industry.

1.37 At the same time there is a perception that the rapid expansion of the coal seam gas industry has caught government out, leading to a sense that regulators are playing 'catch up', responding to issues once they emerge rather than anticipating them.

Social Impacts

1.38 The gas industry is already having a range of social impacts which can be expected to grow as the intensity of development increases. The weight of evidence the committee received dwelt on the negative impacts of the industry, reflecting the fact that those who are benefiting from it see little need to contact parliamentary inquiries.

1.39 For landholders the intrusion of a gas company, even at the exploration stage, is significant. Drilling rigs, well heads, access roads, pipelines and other infrastructure have a direct impact on the operation of an agricultural property and the associated noise, dust and movement of people also have a large and often disturbing impact on farming families.

1.40 At the community level, the 'two speed economy' is becoming a day-to-day reality. On the positive side local jobs are created and the demand for a range of local goods and services increases. The obverse of this is that increased demand for many services such as skilled trades and higher wages offered by gas companies can raise the cost of labour, services and housing to other users and make it more difficult to find workers while an influx of fly-in-fly-out workers can create a sense of insecurity for permanent residents.

1.41 Local government faces similar challenges with increased demand on infrastructure such as roads and for some services, and increased costs. The industry can, at the same time, present an opportunity to improve some infrastructure.

1.42 At the committee's hearings in Roma representatives of the Maranoa Regional Council commented that the council was neither for nor against the industry: "Our job is simply to try to represent the community as best we can, such as the different interests you heard today...". A Coal Seam Gas Consultative Council was formed in 2010 with:

> the role of bringing the two [gas] companies together, along with a lot of the government departments and the other impacted bodies around Roma, to try and get some agreement on some of the infrastructure developments and so on.[14]

1.43 The two areas of greatest direct concern to the Council were roads and housing. The increase of traffic associated with the industry, particularly heavy vehicles requires greater expenditure on upgrading and maintaining roads in the region. The Council and the companies:

> ... are having arguments about whether [the gas companies] are or are not and we are agreeing, where we can, on the proportion of damage that is attributable to that industry. So we are having those discussions and trying to leverage money from them for that.[15]

1.44 The Mayor described the housing situation as 'untenable'. Rents are more than doubling and long-term tenants are not having their leases renewed. These problems are typical of all mining towns. Various responses are being developed.

1.45 The Queensland Government is developing some low-cost housing for Roma and the companies have committed funds to construct new houses as well. In addition, the use of fly-in-fly-out workers has been justified as helping to control housing costs.

1.46 The gas companies are also making contributions to the local communities in other ways. Some of it is dismissed as public relations but is no doubt welcomed by the sporting and service clubs that benefit. Other projects such as the redevelopment of Roma Airport and the reinjection of water into the Gubberamunda aquifer will provide the community with lasting benefits.

1.47 The gas companies obligations in this area have been written in to the conditions applying to the production approvals granted in Queensland. For example, the Co-ordinator-General has imposed the following requirements on AP LNG,

> - Cooperate with local authorities and service providers with specific actions documented in agreements and underpinned by evidence-based plans approved by the Coordinator-General where there is disagreement,
>
> - Provide mandatory housing in communities to be affected by project-induced population increases,
>
> - Provide financial investments in certain community services,

14 Robert Loughnan, Mayor, Maranoa Regional Council, *Committee Hansard*, 18 July 2011, p. 20.

15 Robert Loughnan, Mayor, Maranoa Regional Council, *Committee Hansard*, 18 July 2011, p. 20.

> · Fund road upgrades agreed to by road authorities and in accordance with pre-existing standards related to numbers of vehicles using particular roads ...[16]

1.48 It is important that it be born in mind that this is a relatively short lived boom and that as far as is possible, communities should seek to gain lasting benefits from it. At the same time, communities must avoid creating demands or expectations that are unsustainable once the boom has passed. Where change can be managed it is important that as the industry spreads, the lessons of these early developments are learned and applied.

1.49 State and local government need to have new funding arrangements in place to deal with increased demands; the gas industry has to be given clear guidelines for what will be expected of it in terms of contributions to mitigate disruption of communities.

1.50 There are practical responses to tangible problems such as housing, infrastructure, or public health. However there is relatively little that can be done for those who simply find change difficult to come to terms with.

1.51 For many families it creates a high degree of uncertainty both about the long term viability of their farm or 'lifestyle block' and the immediate changes to a way of life, which may include loss of privacy, increased dust and noise and a loss of a sense of security as gas company employees have access their land.

1.52 The changes are often double edged. A number of submissions have expressed concern about the impact of fly-in-fly-out workers citing research that shows the disruptive impact on the local community and commenting that the employment benefits of development may not necessarily flow to the local community. Yet the use of such workers eases the pressure on housing and the cost of local services

1.53 This conflict was neatly encapsulated on a recent *Insight* television program on the industry from a representative of a local football club:

> ... there has been a drop off in volunteers because they are working the shifts, they are not home on weekend and the disposable income helps them go away. If they want to go down and the watch the Broncos play they will go there instead of staying in Chinchilla.[17]

1.54 It is easy to understand that the decline in volunteers to help the junior players represents a real loss to the community while, at the same time, welcoming the higher disposable income that give workers the chance to get away for the weekend.

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16 AP LNG, *Submission 366*, p.53

17 *SBS Insight*, 20 September 2011.

Governance

1.55 The industry is primarily regulated under an array of state laws but approvals are also required under Commonwealth legislation, principally the *Environment Protection and Biodiversity Conservation Act 1999* and the *Water Act 2007*.

1.56 The gas companies have made much of the extremely demanding regulatory environment in Australia. In submissions to the committee, QGC noted that the:

> QCLNG Project was assessed for environmental and social impact under Queensland and Commonwealth legislation in a process that began in 2008 and took more than two years. The environmental and social impact assessment totalled more than 12,000 pages.[18]

1.57 AP LNG has described the conditions imposed on it as "unprecedented":

> ... the Coordinator-General has, in addition to existing legislative requirements, imposed a set of conditions that have not been used to previously regulate project impacts in Queensland. ...
>
> - 58 imposed conditions mainly related to environmental and water issues,
> - 16 imposed conditions related to traffic and transport issues, and
> - 5 imposed conditions (including many sub-components) related to social and economic impacts.
>
> Conditions imposed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* for each of the three components of the Australia Pacific LNG Project (gas fields, pipeline and LNG facility) total 261.[19]

The large number of conditions is indicative of the many complex issues, challenges and uncertainties that are presented in regulating this industry.

1.58 The Queensland Government has established:

> ... the LNG Enforcement Unit to ensure the industry complies with the strict new regulatory regime. Fifty new specialist groundwater, environmental and safety staff have been employed. A proactive compliance plan is also in place to closely monitor CSG industry actions.[20]

Committee view

1.59 The coal seam gas industry is a relatively short-term prospect. Individual gas wells have a life of about fifteen years. The industry is likely to be worked out in the next fifty years. Thus the interests of the industry must not be allowed to undermine or

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18 QGC, *Submission 259*, p. 5.

19 AP LNG, *Submission 366*, p. 5.

20 Queensland Government, *Submission 358*, p. 4.

permanently compromise the long term future of other sectors, most notably agriculture and the environment.

1.60 Given the progress of the industry, it is clear that workable compromises must be struck between the competing interests. This may require further delay in approving new developments or temporary suspension of exploration in particular regions while a sound research-based understanding of geology, groundwater, aquifers and soils is developed. It may involve the exclusion of prime agricultural land (though that can be hard to define) or land exhibiting particular soil types or topography from gas exploration and production. Restrictions on drilling in particularly sensitive aquifers and on certain production techniques such as fraccing might be necessary.

1.61 The public debate on this matter has become very polarised. Particularly in its early stages there was no shortage of examples of 'cowboy' behaviour by exploration companies. This was exacerbated by the high degree of uncertainty that surrounds many of the potential impacts of the industry. The reliance on examples drawn from experience in other countries, particularly the United States, with different legal regimes, financial imperatives and geologies, has not contributed to an understanding of the Australian situation.

1.62 For example, in evidence to the committee, Dr J R Underschultz pointed out to the committee that in the US the industry had been driven by:

> ... a tax inventive primarily around drilling. The coal seam gas industry received its tax incentive based on the yard stick of how many metres of well that they drilled. ... it became known as factory drilling. They more or less did not worry about the geology. They had a grid pattern that they drilled because there was a tax incentive around drilling.[21]

1.63 In practice the industry's impacts in Australia will vary considerably depending on the regulatory framework, scale of operation, the geology and hydrology of particular locations and regions, the existing land use and the technologies used.

1.64 Cooperation between Queensland and New South Wales in developing similar regulatory regimes reflecting best practice in the industry will also offer a degree of regulatory certainty to the gas companies. A clear regulatory framework which offers CSG companies certainty will also encourage technical innovation to conduct production with the minimum impact both on the land surface and the sub-surface geology.

1.65 It must also be acknowledged that the performance of the gas industry has been highly variable. The committee has received a great deal of evidence about the best practices that the industry can demonstrate and its high aspirations with regard to

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21 Dr J R Underschultz, Theme Leader, Petroleum & Geothermal Portfolio, CSIRO, *Committee Hansard*, 9 August 2011, p. 62.

every aspect of its operations. Equally, examples of poor behaviour have contributed to public hostility to the industry.

1.66 The committee has seen examples of land degradation caused by seepage from extracted water storage ponds, leaking gas pipes, untreated water seeping into watercourses and erosion caused by poorly installed pipelines. It has heard from landholders who felt bullied or patronised by gas company representatives seeking access to their land. These practices may not be typical of the industry but in a highly contested area such as CSG mining they can have a disproportionate impact on public perception.

1.67 Failures to engage with the public have allowed misunderstandings or hostile views to go effectively unchallenged. On the issue of the greenhouse gas footprint of the industry, for example, a scholarly article from the US dealing with shale gas has been the basis for much adverse comment from opponents of the industry even though its direct relevance to Australia and CSG was limited.

1.68 A submission from the *Lock the Gate Group*, in its original version, altered quotations from the same US article to suggest that it was a study of coal seam gas when it clearly related to gas extracted from shale.

1.69 An independent study of the industry in Australia, commissioned by the APPEA and completed in April 2011, which addressed many of these concerns was not made public until November, despite the major gas companies having no stated objection to its publication.[22]

1.70 Despite the extent of the Environmental Impact assessment process required prior to approval, and the array of conditions attached to the approvals, a perception remains that the industry is inadequately regulated.

1.71 The Queensland Government describes its approach to managing the industry as one of 'adaptive management'. This allows it to develop policies in response to evolving knowledge and changing circumstances. Critics see adaptive management as confirmation that government is playing 'catch up'. In addition many submissions to the committee have suggested that the regulatory framework is not sufficiently robust, and particularly that the regulatory authorities lack the resources to monitor such a dispersed and complex industry.

Recommendation 1

1.72 The committee recommends that federal and state governments conduct a thorough review of the appropriateness of 'adaptive management' in the context of regulating the industry, given the significant gaps in information regarding cumulative and long term impacts of the industry.

22 Worley Parsons, *Greenhouse Gas Emissions: Study of Australian CSG to LNG* (April 2011).

1.73 This review should consider particularly whether 'adaptive management' in this context is consistent with the precautionary principle.

1.74 In its submission to this committee the Queensland Government noted four "recent initiatives" which a neutral observer might consider should have been in place somewhat earlier in the development of the CSG industry:

- the development of a code of practice setting "minimum technical requirements" for the construction of CSG wells;
- stringent water quality safety standards for CSG water discharged into the environment;
- restrictions on the use of BTEX chemicals; and
- a requirement that operators submit a plan outlining how they "...propose to manage their CSG water".[23]

1.75 The adoption by the Queensland Government of reinjection, after production approvals had been given, as the preferred method of dealing with produced water is another example of the management of a key impact of the industry being left ill-defined.

1.76 In addition, some baseline research that should have been conducted prior to the commencement of production is in fact being carried out in parallel with it. For example, a submission to the committee quotes from a Queensland Gas Compnay (QGC) request seeking amendments to its consent conditions for extraction in the Ruby (Qld) area on the grounds that:

- There is no regional groundwater model for the Ruby area – the Queensland Water Commission is currently developing one;
- QGC will be "better able to map groundwater contours" once the baseline bore assessments have been completed. The results from the monitoring ... is "many months" away; and
- Information regarding the location and types of aquifers "will be much better" once baseline assessments are completed.[24]

1.77 Concern about uncertainty should be mitigated to an extent by the fact that in New South Wales no production approvals have been given in the Murray-Darling Basin and that the development of the industry in both Queensland and NSW will be phased over time.

> The Australia Pacific LNG Project will be developed gradually in stages. As a result, there are large areas within the Project's tenements that are not planned to be developed for more than ten years. This will mean that any

23 Queensland Government, *Submission 358*, pp 13–14.

24 OzEnvironmental, *Submission 346*, p. 2, quoting pages 32 & 33 of the QGC submission to the Queensland Department of Resources & Environmental Management.

lessons learned in the initial stages of production will improve the processes for subsequent stages of development.[25]

Commonwealth Action

1.78 The committee is aware that many of the issues which are dealt with in this report are the constitutional responsibility of the states and, in other areas, there are overlapping jurisdictions. However the committee believes that there are sound arguments for the Commonwealth to take the initiative in seeking a coordinated approach to this industry.

1.79 The Great Artesian Basin underlies three states and the Northern Territory, thus its management is a matter of national importance. The surface waters of the Murray-Darling Basin are now managed nationally; it is desirable that GAB waters be managed in the same way.

1.80 Coal seam gas is found in several states and the issues surrounding the industry can be expected to recur as it expands beyond its current areas of interest. Thus matters such as land access, land management, extracted water management, technical standards and the disposal of salt and brine should be the subject of a coordinated approach.

1.81 It would, for example, be an unjust outcome if the rights of landholders in Queensland were to be significantly less than those in New South Wales just because the industry originated there and other governments had the opportunity to learn from the problems that emerged.

1.82 The industry will also benefit from a uniform approach to regulation. Regulatory uncertainty is a major risk for any industry and can be a significant cost. In addition the committee has been aware throughout its inquiry of the significant variation in behaviour and approach between the companies. As a general statement if 'best practice' in every area of activity became the industry norm, a great deal of public opposition and concern would dissipate.

1.83 The legal regime in Queensland governing the coal seam gas industry has been evolving rapidly on the basis of actual experience. The lessons learned and the changes made as a result should be available to New South Wales in developing its law in this area.

1.84 The committee trusts that there is extensive consultation between the Queensland and New South Wales authorities. NSW has the opportunity to have a comprehensive regulatory framework in place before production commences, drawing on lessons learned, and Queensland at least has the opportunity to refine its approach for later developments.

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25 AP LNG, *Submission 366*, p. 32.

Recommendation 2

1.85 The committee recommends that the Commonwealth Government, through the Council of Australian Governments, or Standing Council on Energy and Resources (SCER), take the initiative in promoting a consistent national regulatory framework for all aspects of the coal seam gas industry.

1.86 The committee notes the recent announcement by the Commonwealth that it will,

> Provide $150 million to establish a new Independent Expert Scientific Committee that will provide scientific advice to governments about relevant coal seam gas and large coal mining approvals where they have significant impacts on water; oversee research on impacts on water resources from coal seam gas and large coal mining projects; and commission and fund water resource assessments for priority regions.
>
> Establish a new National Partnership Agreement with the states through COAG, agreeing that the Commonwealth and states have to take into account the advice of the Committee in their assessment and approval decisions.[26]

1.87 It is too early to make any comment on how these new arrangements will work but it is to be hoped that they contribute to a more considered approach to the industry.

26 *New focus on scientific evidence to build confidence in coal seam gas and coal mining* 21 November 2011, Prime Minister, Deputy Prime Minister and Treasurer http://www.pm.gov.au/press-office/new-focus-scientific-evidence-build-confidence-coal-seam-gas-and-coal-mining

Chapter 2

WATER

Introduction

2.1 There is a range of potential impacts on the Murray-Darling system from the coal seam gas industry which are of major concern both in their own right and to the committee's general inquiry - the impacts on ground water and aquifers, the extraction or recovery methods used, the treatment and disposal of extracted water, the management of salt and brine, the impact of the whole process on surface water and soils and the implications for agricultural land use where gas production facilities are located on productive land are all areas of concern to the committee. These matters are considered in this and later chapters.

2.2 Groundwater is a vital resource for agricultural, domestic and urban use across much of the Murray-Darling Basin. Nor can it be considered in isolation from surface water. Depending on the topography and geology, at various places in the Basin surface flow recharges aquifers and, conversely, groundwater contributes to surface flows. The National Water Commission has stated:

> Although it is not always apparent, surface water in many rivers, dams, lakes and wetlands is connected to underground water resources in aquifers. There are several different examples of these connections ...This connectivity means that issues such as over-extraction, environmental flows and river salinity could impact on the water quantity and quality in both ground and surface water systems.[1]

2.3 The major risks associated with the coal seam gas industry are whether it has the potential to significantly deplete the groundwater on which agriculture and regional communities depend, to contaminate higher quality water, to alter the hydrology of the affected regions, or to do irreparable damage to the aquifers containing that water.

Groundwater

2.4 As described in the previous chapter, CSG mining requires the removal of very large volumes of water from coal seams to reduce the pressure in them, enabling the gas to flow into wells for extraction.

2.5 The CSG water is, generally, extracted from much deeper underground than the depths of bores used in agriculture or for town water supply and the coal seams are separated from those water sources by low permeability aquitards. However, while most town and agricultural bore water is at much shallower levels, and the water in

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1 National Water Commission, http://www.nwc.gov.au/groundwater/groundwater-surface-water-connectivity (Accessed 4 November 2011).

coal seams is of low quality, there is some limited use of water extracted from these seams, including, as AP LNG acknowledged in information material, the Walloon Coal Measures in south-west Queensland.[2]

2.6 Some of the gas companies have tended to express the amount of water to be extracted as a proportion of the total volume of the Great Artesian Basin (GAB). For example AP LNG, in its submission to the committee, commented that:

> Compared to the total storage capacity of the GAB, the amount of water projected to be extracted during CSG production is very small. At the peak of water production, the annual water extraction is likely to be less than 0.0002% of total storage. ... It is therefore submitted that the CSG industry will have negligible impact on total storage volumes.[3]

2.7 QGC in its submission stated that:

> At this continental scale, the QCLNG Project environmental impact assessment did not identify any measurable impacts on the MDB surface and subsurface water resources as a result of QGC's gas development.
>
> Hydrogeologic evaluations using available data and modelling also indicated that the impact of coal seam gas extraction on the overall Great Artesian Basin would be insignificant with the QCLNG Project likely to extract less than 0.001% of the water in the basin over the life of the Project.[4]

2.8 The impact on the total storage volume of the GAB is not the issue. The core issue with regard to the possible impact of the CSG industry on groundwater is clearly stated in advice to the Australian Government:

> ...we consider that the overriding issue in CSG development is the ***uncertainty surrounding the potential cumulative regional scale impacts of multiple developments.*** The information provided in the assessed EIS documents is not fully adequate for understanding the likely impacts of CSG development across the Surat and Bowen Basins; nor will any level of information or modelling that can be provided by individual proponents.[5] [emphasis added]

2.9 The Geoscience Australia/Habermehl Advice goes on to state that what is required to provide a full understanding of the possible impacts is "... a regional-scale,

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2 AP LNG, *Coal Seam Gas production and groundwater supplies*, p. 2.

3 AP LNG, *Submission 366*, p. 24.

4 QGC, *Submission 359*, p. 8.

5 Geoscience Australia & Dr M A Habermehl, *Summary of Advice in Relation to the Potential Impacts of Coal Seam Gas extraction in the Surat and Bowen Basins, Queensland, Phase one report summary , (*Canberra, September 2010*)* p. 1. This advice was provided to the Commonwealth Department of Sustainability, Environment, Water, Population & Communities as part of the approval process of the Santos, Queensland Gas and AP LNG projects under the *Environmental Protection & Biodiversity Conservation (EPBC) Act 1999.*

multilayer ground water flow model which incorporates data from both public and private sector sources".[6] The Advice's third recommendation is for the creation of such a model, requiring "concerted Commonwealth and State action" as a "high priority".[7]

2.10 There is an element of 'Catch 22' in the Advice, given that it is part of the approval process for production, in that it also concludes that,

> ... any modelled outcomes will be accompanied by high inherent uncertainties until sufficient CSG production data is available to calibrate the groundwater model.[8]

This suggests that the cumulative impact of CSG production on groundwater will only be fully assessed as production increases.

2.11 The GAB underlies much of the northern part of the Murray-Darling system in northern New South Wales and south-west Queensland, the major areas in which CSG exploration and production is currently taking place. The GAB is,

> ... composed of a sequence of sediments that form aquifers and confining layers (aquitards). The thickness and lateral extent of sediments that have formed aquifers and aquitards depend on conditions at the time of sediment deposition, which ranges from 65 to 250 million years ago, and all the geologic forces that have occurred since.[9]

2.12 The CSIRO adds, with masterly understatement, that "... it is challenging to visualize the exact structure". Aquitards are layers of very low hydraulic conductivity; i.e. water flows through them, if at all, at a very slow rate. The aquitards restrict vertical flow of groundwater resulting in artesian pressure in the aquifers. Similarly aquifers have varying rates of horizontal conductivity.

2.13 The structure of the Basin is important when considering the likely impact of CSG extraction on groundwater. It is not a vast underground 'sea' in which levels and pressures quickly and uniformly adjust to the extraction of water from one part. Rather it is a highly complex system of geological formations at a range of depths, of variable permeability holding water of different quality, at different pressures and through which water flows at very different rates, if it flows at all.

2.14 The reduction in pressure in a coal seam will result in a local fall in the water level and pressure in that particular area which may alter the rate and direction of the movement of groundwater in adjacent formations. The impact of this change may take many years to have a measurable impact on adjacent aquifers. Similarly the contingent

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6 Geoscience Australia & Dr M A Habermehl, *Summary of Advice*, p. 1

7 Geoscience Australia & Dr M A Habermehl, *Summary of Advice*, p. 7, Recommendation 3.

8 Geoscience Australia & Dr M A Habermehl, *Summary of Advice*, p. 1

9 CSIRO, *Hydrology of the Great Artesian Basin*, Coal Seam Gas Factsheet #6, (August 2011).

loss of water from adjacent aquifers may not be made good by natural recharge for decades or even centuries.

2.15 As CSIRO states:

> The principles [of hydrogeology] are well understood, but applying those to characterise the unique situation of each aquifer is fraught with difficulty. To properly understand a groundwater aquifer relies on information about aquifer dimensions, structure, and permeability, as well as the timescales of recharge, discharge and groundwater flow. It requires many bore holes to be drilled and pumped tests to be undertaken.[10]

And:

> The difficulty in the Great Artesian Basin is that groundwater flow velocities are slow, waters are old and any unforeseen consequences of extraction will take decades or centuries to work through the aquifers. ***The overriding issue is the uncertainty of the potential cumulative, regional impacts of multiple developments***.[11] [emphasis added]

2.16 In addition to the possible loss of water from aquifers used for agriculture, town supplies or to maintain environmental flows, depressurisation may allow lower quality water to contaminate higher. CSIRO has warned that,

> The complex movement and interactions of different layers of water can be hard to detect but they have a direct effect on the sustainable use of the resource, such as protecting fresh groundwater from being polluted by nearby saline layers.[12]

2.17 Landholders' organisations have also identified the local impact of water extraction as a key issue. A spokesman for the Basin Sustainability Alliance in Queensland told the committee that,

> The water has to go back to where it came from. We have to maintain that groundwater system; there is no option. The companies cannot develop irrigation farms or tree plantations or pipe it down the river or send it to Toorong or Nathan Dam. It has got to be used beneficially in the area of extraction to maintain the groundwater system for future generations.[13]

2.18 The question of the level of understanding of the system and the capacity to predict likely impacts is at the heart of this whole inquiry. The National Water Commission (NWC) has produced a position paper on coal seam gas in which it identifies a number of areas of concern, both for surface and groundwater. The

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10 Andrew Herczeg, *Groundwater*, in CSIRO, *Water*, (2011), pp 59–60

11 I. Prosser, L. Wolf & A. Littleboy, *Water in Mining and Industry*, in CSIRO, *Water,* (2011) p. 144.

12 Andrew Herczeg, *Groundwater*, in CSIRO, *Water*, (2011), p. 47.

13 Mr I Hayllor, *Committee Hansard*, 19 July 2011, p. 11.

Commission considers that "...Potential impacts of CSG developments, particularly the cumulative effects of multiple projects, are not well understood".[14]

2.19 The NWC's reservations are based on its scientific work, which has been supported by other scientific bodies. In a recent briefing to members of Parliament, CSIRO emphasised that:

> Prediction of specific impacts of CSG developments requires ongoing research because groundwater responses may take decades or centuries to move through aquifers, especially when groundwater flow velocities are slow.[15]

2.20 CSIRO notes that the attitude to the management of groundwater in Australia has changed in recent decades:

> Groundwater was managed as a resource to be mined, much like the rocks in which it lies, but it is now managed as a renewable resource, recognising that it is recharged from rainfall and discharges in to rivers, lakes and oceans, and through vegetation. Consequently groundwater management faces many of the same sustainability issues as surface water. Ecosystems depend on the discharging groundwater, and over-extraction of groundwater can lower water tables or the pressure of water ... .[16]

2.21 The Organisation has also emphasised the level of uncertainty with regard to the various risks associated with the extraction of water on this scale. In a briefing to the committee, it identified a range of risks associated with lowering aquifer pressures:

- migration of methane ... through aquifers and to other wells;
- changed hydraulic gradients, leading to leakage of water from aquifers or of migration of saline water into aquifers; and
- impact on mound springs; and subsidence.

2.22 CSIRO also commented that "whether these risks are significant depends on the hydrogeological context: information is not available to judge this at the larger scale".[17]

2.23 A paper from the Queensland Department of Mines & Energy makes similar points:

> With the large induced pressure gradients induced by dewatering, hydraulic connections with other seemingly isolated aquifers can easily appear ... the

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14 National Water Commission, Position Paper, *Coal Seam Gas and Water Challenge*, December 2010.

15 CSIRO, *Coal seam gas developments – predicting impacts*, (November 2011).

16 Andrew Herczeg, *Groundwater*, in CSIRO, *Water*, (2011), p. 47.

17 CSIRO, Briefing to the Senate Standing Committee on Rural Affairs and Transport, 7 July 2011, Power Point slide no.17

> reduction of pressure in the aquifer because of dewatering could induce noticeable hydraulic connection in places where it was not noticeable previously.[18]

2.24 CSIRO noted the it was "Difficult to accurately estimate impacts because of":

- the relatively recent history of extraction;
- long time delays associated with groundwater processes; and
- the challenges with setting baseline conditions and measuring cumulative impacts.[19]

2.25 It is important to bear in mind, when considering this issue, that the Murray-Darling system including groundwaters and aquifers, was already a system under stress before the gas industry appeared. The NWC has identified a major risk:

> Extracting large volumes of low-quality water will impact on connected surface and groundwater systems, some of which may already be fully or overallocated, including the Great Artesian Basin and Murray-Darling Basin.[20]

2.26 Major efforts have been undertaken in recent years to try to rectify this situation.

> Thousands of wells have been drilled into the Basin's highly productive confined aquifers, and many have been left to flow, lowering aquifer pressure and encouraging feral animals and weeds ... a program of well capping is restoring pressure to the system to enable sustainable use and maintenance of dependent ecosystems.[21]

2.27 At a regional level, a witness described the impact of the situation on local water users to the committee:

> About 20 years ago bore owners within the entire management area were cut back to 70 per cent of their nominal entitlement and in the last few years during the height of the drought bores within subarea 3 were cut back to 50 per cent. This was without compensation and without access to north branch water or overland flows and so we had to turn the pumps off and watch our crops die.[22]

2.28 This comment refers to the area dependent on the Condamine Alluvium, described elsewhere as, "...one of the most heavily extracted aquifers in the Murray-

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18 Geoff Edwards, *An Issues Paper on the Management of Water Co-produced with Coal Seam Gas*, (December 2006), p. 26.

19 CSIRO, 7 July 2011, Briefing, slide no. 26.

20 National Water Commission, Position Paper, *Coal Seam Gas and Water Challenge*, December 2010, p. 1.

21 Andrew Herczeg, *Groundwater*, in CSIRO, *Water*, (2011), p.56.

22 Mrs Ruth Armstrong, *Committee Hansard*, 19 July 2011, p. 13.

Darling Basin".[23] Another key area for coal seam gas development, the Namoi Catchment in northern NSW, is described as:

> ... one of the most intensely exploited groundwater resources in Australia. It is a stressed system in which it was realised too late that rates of groundwater pumping were too high.[24]

2.29 Government and the industry are not blind to these concerns. Extensive research is being undertaken. The Queensland Government is close to completing a groundwater model of the cumulative impact on the Surat Basin of the CSG industry and the industry itself is undertaking very extensive drilling to contribute to this model and to try to predict the impact of this industry's activities.

2.30 The Environmental Impact Statements (EIS) submitted by QGC, Santos and AP LNG for their Queensland projects were reviewed by Geoscience Australia and given qualified approval at the individual project level. The need for further work and the accumulation of more data was referred to repeatedly.[25]

2.31 In some areas, particularly with regard to the risk of cross contamination and artesian pressure, the likely impact was assessed as low. Groundwater was considered likely to flow into the coal seams rather than the reverse and, because most of the bores in the CSG tenements are sub-artesian (not under natural pressure) they were unlikely to be affected by changing artesian pressures in the medium term.[26] The large variation in pressure between aquifers which gas company drilling confirms does suggest that the strata between them – the aquitards – have very low permeability.

2.32 The wells themselves are also a potential channel which could cause linkage between aquifers, especially in the long-term where abandoned wells degrade over time. Evidence to the committee suggested that this area has not received much attention in Australia.[27]

2.33 It is in the longer term and having regard to the cumulative impacts of a number of developments that uncertainty becomes a real cause for concern. This is acknowledged by the gas companies. For example AP LNG commented in its submission to the committee that:

> The Queensland and Commonwealth Governments have taken the approach of adaptive environmental management with regard to the CSG to LNG industry. This acknowledges that ***there are some unknowns with regard to***

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23 *Draft Water Group Advice on EPBC Act Referrals*, September 2010, p. 14, tabled in the Senate, 16 November 2010.

24 Andrew Herczeg, *Groundwater*, in CSIRO, *Water*, (2011), p. 56.

25 Geoscience Australia & Dr M A Habermehl, *Summary*

26 Geoscience Australia & Dr M A Habermehl, *Summary*

27 CSIRO, *Committee Hansard*, 9 August 2011, p.65-66

> ***groundwater behaviour*** and allows for changes to be made to processes to accommodate new understandings.[28] [emphasis added]

2.34 A study carried out by the University of Southern Queensland for four major gas companies[29] operating in the Surat Basin commented that:

> Despite the low permeability of the aquitards overlying and underlying the Walloon Coal Measures, groundwater extraction to reduce the water pressure in the coal seams may induce some vertical leakage into the coal seams and produce impacts on the surrounding sandstone aquifers.[30]

Baseline Knowledge & Make good provisions

2.35 A key issue for both affected communities and the gas industry is the development of reliable baseline knowledge of groundwater levels and pressures and the condition of existing bores. The issues of compensation and making good adverse affects attributable to the gas industry depend on having such knowledge.

2.36 The industry has already had to deal with claims that its activities are resulting in methane flowing into agricultural bores. AP LNG in its submission to this inquiry noted that, in the Hopelands area in Queensland:

> ... where the Walloon Coal Measures are shallow and are used for stock water supply ... heavy water extraction from water bores can replicate the CSG production process, depressurising the coal measures and causing significant amounts of natural gas to flow.[31]

2.37 As part of its baseline monitoring program AP LNG has tested a large number of bores and "... more than 80% have recorded various levels of methane within the bores. This is prior to CSG operations taking place in these areas".[32] Anecdotal evidence suggests that the presence of methane in stock and domestic bores in this region has been obvious for generations.

2.38 The state governments in cooperation with industry sets trigger points for water levels and pressures in bores which are monitored to give early warning of an adverse impact from CSG mining. To avoid uncertainty (and litigation) no project should be given approval until a comprehensive study of all bores likely to be impacted by a project has been undertaken not only to assess water levels or pressure but also to test for the presence of methane.

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28 AP LNG, *Submission 366*, p. 31.

29 Queensland Gas Co (QGC); Santos, Origin and Arrow Energy.

30 USQ, Preliminary Assessment of Cumulative Drawdown Impacts in the Surat Basin Associated with the Coal Seam Gas Industry, (March 2011), p. 1.

31 AP LNG, *Submission 366*, p. 29.

32 AP LNG, *Submission 366*, p. 29.

2.39 The Queensland Government has recently amended its Water Act to require the industry to:

- provide baseline assessment plans and conduct baseline bore assessments;
- determine potential impacts to landholder's water supply bores and enter into 'make good' agreements with bore owners if bore supply is likely to be impaired by a petroleum tenure holder's extraction of underground water;
- avoid and manage impacts on springs; and
- respond to groundwater modelling by the Queensland Water Commission which will identify areas that are likely to experience groundwater level decline and therefore areas where bores may experience an impaired capacity.[33]

2.40 As an example, Santos has developed a program of groundwater monitoring that:

> includes installation of more than 40 new groundwater bores, installation of automated monitoring facilities on more than 40 existing farm bores, installation of several deep multi-level pressure sensors, and conversion of conventional oil and gas wells to deep basement groundwater monitoring locations. A baseline inventory of more than 350 bores in the Roma, Fairview and Arcadia Valley regions, has been completed already, accompanied by an extensive sampling program.[34]

2.41 The company argues that this will enable it to detect "...groundwater changes several years in advance of their first appearance in local aquifers".[35] This early detection would allow the company to implement 'make good' actions well in advance of any impact on local landholders or communities. Santos has indicated that the 'make good' provision could include the ceasing of water production in the affected area.

2.42 Where there is proven impact by a CSG company on an adjacent landholders water supply, the company is required to make good that damage. The most likely impacts are the loss of pressure in a landholder's bore or the lowering of the water level to such an extent that the bore no longer produces water. Make good options range from the relatively straight forward to the complex and unproven.

2.43 The simplest responses will be to deepen existing bores, sink new bores or improve the capacity of pumps. It may also be possible to provide the landholder with suitably treated water from the companies own storage ponds to supplement or replace the impacted supply.

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33 Queensland Government, *Submission 358*, pp 10–11.

34 Santos, S*ubmission 353*, p. 15.

35 Santos, S*ubmission 353*, p. 15.

2.44 The Queensland Government has adopted reinjection of produced water as its favoured method of managing CSG water. One application of this would be to inject suitably treated water from a coal seam into the aquifer supplying agricultural or domestic users. The gas companies are working on the reinjection question but, at this stage its feasibility is not proven.[36] As a last resort the gas companies acknowledge that some form of 'alternate compensation' may be necessary.

2.45 The committee did not get a satisfactory explanation of what alternative compensation means. A farmer deprived of his water supply requires an alternate, reliable, long term supply; without it the property may cease to be viable. Does alternate compensation mean that in extreme circumstances the property holder will be bought out at a price that reflects the pre-CSG value of his property plus a premium reflecting his loss of livelihood?

2.46 The committee believes that the extent of the gas companies' liability in such extreme circumstances needs to be clarified.

Committee view

2.47 The committee is concerned that the combination of the complexity of interactions within and between aquifer systems, uncertainty with regard to the long-term impact of CSG-related water extraction and the fact that the GAB in the areas under most intensive CSG development is already generally acknowledged to be a system under stress is not being given sufficient weight by policy makers in approving the expansion of the industry.

2.48 As mentioned above the Commonwealth and Queensland Governments have adopted an approach described as adaptive management, which will enable the management of the industry to be adjusted in response to the developing body of knowledge and unanticipated problems. This approach assumes that any unforeseen consequences that appear within the relatively short lifetime of the industry will be manageable.

2.49 The uncertainty inherent in such an approach would be significantly reduced if, before any more approvals are granted for CSG production, the Commonwealth acted on the advice of Geoscience Australia and developed:

> ... a regional-scale, multi-state and multi-layer model of the cumulative effects of multiple developments and a regional scale monitoring and mitigation approach ... to assess and manage these impacts.

Geoscience Australia considered the need for this to be a "high priority".[37]

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36 Santos is at an advanced stage in investigating the potential of reinjection of water into the Gubberamunda aquifer from which Roma draws its water.

37 Geoscience Australia & Dr M A Habermehl, *Summary*.

2.50 The committee recognises that the accumulation of understanding of the system is a major undertaking.

> To resolve the issues of water extraction ... across several development proposals and thousands of wells requires a good characterisation of basin geology and how it controls groundwater pressures, flows, connections and quality. This will help to answer the critical question of how much leakage will occur between coal seam beds and useable aquifers.[38]

2.51 The development of the necessary knowledge is heavily dependent on the research work being carried out by the gas companies. Exploration bores are expensive and, without commercial incentives, including a level of security that discovery of commercial quantities of a resource will lead to production of that resource, it is unlikely that industry would undertake the necessary research.

2.52 Origin Energy report that early production experience in Queensland suggests that the volume of water required to be removed from coal seams is significantly less than was predicted in the early stages of development.[39] While this is welcome it does underline the uncertainty with regard to the reliability of estimated impacts.

2.53 In this situation it appears that the best workable compromise is that future production approvals be delayed until comprehensive modelling at a regional level is undertaken and sufficient data is accumulated to ensure the robustness of the modelling and that no individual project be given approval unless it has been fully assessed in terms of the cumulative impact of all proposals in a given region.

2.54 The Queensland Government is developing "...a regional groundwater model to predict possible cumulative impacts of CSG extraction" including data provided by the CSG companies.[40] CSIRO and Geoscience Australia have also been commissioned by the Commonwealth to undertake "...a basin-scale investigation of water resources to fill knowledge gaps about the status of water resources in the basin and the potential impacts of climate change and resource development".[41] This study is expected to be completed by the end of 2012.

2.55 In New South Wales the Namoi Water catchment includes most of the area currently subject to exploration for coal seam gas. The catchment is the subject of a study undertaken:

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38 I. Prosser, L. Wolf & A. Littleboy, *Water in Mining and Industry*, in CSIRO, *Water*, (2011), p. 144.

39 Data from Origin, Santos, QGC and Arrow was combined for presentation at a recent series of APPEA Water Forums, and indicates that the current estimated average production volumes over the following 30 years is 75,000ML/year (75GL/year), which is approximately 20% lower than that estimated at the time of submission of the 3 approved EIS's. Letter to the committee, A Moser, Groundwater Manager, Origin Energy, 8 November 2011.

40 Queensland Government, *Submission 358*, p. 9.

41 CSIRO, http://www.csiro.au/science/Great-Artesian-Basin-Assessment.html.

- To provide a spatial understanding of underground and surface water flows in the catchment ... [and]
- To undertake a strategic assessment of the likelihood of potential impacts posed by coal and gas developments in the Namoi catchment on the quantity and quality of surface and ground water resources in the catchment.[42]

2.56 In view of the consensus of expert opinion that detailed regional studies of underground water should be undertaken before CSG production is approved, and given the comment quoted above from CSIRO that the Namoi catchment is "... one of the most intensely exploited groundwater resources in Australia", it is clearly desirable that no production permits should be approved for this region prior to the completion and evaluation of this study. The study is scheduled for completion in April 2012.

2.57 In this committee's opinion, in view of the levels of uncertainty acknowledged by professional bodies and industry, the production approvals for the initial projects in Queensland were given prematurely. Studies that are underway should have been completed and their implications fully assessed and recommended studies such as that in the Geoscience Australia/Habermehl report should have been undertaken.

Recommendation 3

2.58 The committee recommends that, given the degree of uncertainty about the long-term consequences of the CSG industry on the water resources of the Great Artesian Basin, that the Commonwealth not give any further approvals for production of CSG in that part of the Murray-Darling Basin overlying the Great Artesian Basin pending the completion of the Queensland Government's regional groundwater model and the CSIRO & Geoscience Australia basin scale investigation of water resources.

Recommendation 4

2.59 The committee recommends that the Commonwealth await the completion of the Namoi Catchment study before considering any applications under the Water Act or the *Environment Protection and Biodiversity Conservation Act 1999* for approvals to undertake coal seam gas production.

Recommendation 5

2.60 The committee recommends that all future CSG development approvals should be preceded by the development of "... a regional-scale, multi-state and multi-layer model of the cumulative effects of multiple developments" of ground and surface water as recommended by Geoscience Australia.

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42 Namoi Water Catchment Study, Terms of Reference, http://www.namoicatchmentwaterstudy.com.au/client_images/966741.pdf

2.61 The potential for the resource industries generally to require special regulation was recognised in the National Water Initiative (NWI):

> Under clause 34 of the NWI the signatory governments agreed that there may be special circumstances facing the petroleum and minerals sectors that need to be addressed by policies and measures beyond the scope of the NWI Agreement.

2.62 The NWC paper notes that "...little progress has been made ... in fleshing out the special provisions for the minerals, petroleum and related industries. As a consequence, there has been little integration of those industries with broader water markets and water planning processes".[43]

2.63 The committee notes the recent announcement by the Commonwealth that it will establish an Independent Expert Scientific Committee to advise the Commonwealth on 'best practice' for the CSG industry. This body may assist in the better integration of the CSG industry with broader water policy. It needs to be noted that this body is primarily to advise the states, which will continue to be the primary regulator of the CSG industry. If implemented as currently envisaged by the Commonwealth Government the states will only need to "take account" of that advice.

2.64 The committee is concerned that the impact of the coal seam gas industry on the Great Artesian Basin is being considered in a piecemeal way. Approvals for the first two CSG projects in Queensland only considered their likely impact at the level of the individual project.

2.65 Later approvals now require an assessment of the regional or cumulative impacts. However given that the Great Artesian Basin in the areas subject to intensive CSG development does not fit neatly into state boundaries, the committee believes that it is important to assess cumulative impacts on the Basin of all projects. The Commonwealth has two main legal avenues to do this.

2.66 The *Water Act 2007* (C'wealth) at section 255 AA states that:

> Prior to licences being granted for subsidence mining operations on floodplains that have underlying groundwater systems forming part of the Murray-Darling system inflows, an independent expert study must be undertaken to determine the impacts of the proposed mining operations on the connectivity of groundwater systems, surface water and groundwater flows and water quality.

2.67 This part of the Act has been used by the Commonwealth to require independent studies of CSG proposals. However the committee believes it would improve the approval system to go further and include the relevant parts of the GAB in the definition of Murray-Darling Basin water resources. This would make it explicit that 'groundwater' included the deep aquifers of the GAB.

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43 National Water Commission, Position Paper, *Coal Seam Gas and Water Challenge*, December 2010

2.68 The general object of the Commonwealth's *Water Act 2007* is "... to enable the Commonwealth, in conjunction with the [Murray-Darling] Basin States, to manage the Basin water resources in the national interest", and specifically to:

> (i) to ensure the return to environmentally sustainable levels of extraction for water resources that are overallocated or overused;
>
> (ii) to protect, restore and provide for the ecological values and ecosystem services of the Murray-Darling Basin (taking into account, in particular, the impact that the taking of water has on the watercourses, lakes, wetlands, ground water and water-dependent ecosystems that are part of the Basin water resources and on associated biodiversity); and
>
> (iii) subject to subparagraphs (i) and (ii)—to maximise the net economic returns to the Australian community from the use and management of the Basin water resources.[44]

2.69 The Act specifically excludes "ground water that forms part of the Great Artesian Basin".[45] The committee believes that the effective management of the Murray-Darling Basin, having regard to the objects set out in section 3 of the Act, requires management of the surface and underground water in an integrated manner.

Recommendation 6

2.70 The committee recommends that the Commonwealth take the necessary steps to amend the *Water Act 2007* to include that part of the Great Artesian Basin that underlies the Murray-Darling Basin within the definition of Basin water resources.

2.71 The *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) also has a significant part to play in regulating the coal seam gas industry. One of the specific 'triggers' for review of a project under this Act is that it may pose a threat to Ramsar wetlands and "...listed threatened species or endangered ecological communities".[46]

2.72 The committee notes the view expressed by CSIRO that the GAB:

> ... is one of the world's largest continuous groundwater systems and supports hundreds of springs and wetlands, many of which are listed as significant by the Ramsar Convention on Wetlands of National Importance.[47]

2.73 The approvals for the three projects currently in the production phase in Queensland – QGC, Santos and AP LNG – all required approval under the EPBC Act for, among other things their potential impact on Ramsar listed wetlands and the

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44 *Water Act 2007* (C'wealth), s.3 (a) & (d).

45 *Water Act 2007* (C'wealth), s.4 (1)

46 *Environmental Protection and Biodiversity Conservation Act 1999* (C'wealth), s.16 & 18

47 Andrew Herczeg, *Groundwater*, in CSIRO, *Water*, (2011), p.56

communities of native species dependent on natural discharge of groundwater from the GAB.

2.74 All the literature on the movement of groundwater in aquifers, particularly artesian aquifers, agrees that it is slow and complex and that the consequences of changes in one part of the system may take many years to show up in another place. Therefore protecting wetlands and springs ultimately dependent on the GAB must require consideration of 'actions having a significant impact' on the GAB generally, not just in the specific area of the particular spring or wetland.

Recommendation 7

2.75 The committee recommends that the Commonwealth take the necessary steps to amend the *Environmental Protection and Biodiversity Conservation Act 1999* to include the sustainable use of the Great Artesian Basin as a 'matter of national environmental significance'.

Subsidence

2.76 Land subsidence as a result of water and gas extraction has been raised as an issue for the industry. There is concern that significant subsidence could alter surface drainage patterns, with a serious detrimental impact on agriculture on the affected land.

2.77 Extraction of groundwater is a common cause of land subsidence. However the incidence of subsidence is a product of the geology both of the seams from which the water is extracted and the surrounding layers. In the case of coal seams they are largely composed of consolidated material with a very limited capacity for compaction.

2.78 The committee notes the conclusion of Geoscience Australia's advice to the Australian Government on this question: that although "...there is a likelihood of subsurface subsidence and that this could result in surface subsidence...we consider the risk of impacts to surface water and shallow groundwater systems is very low".[48]

2.79 The advice went on to recommend that monitoring by two of the three proponents be "... strengthened by assessing deformation at the land surface". Both surface and subsurface monitoring by the third proponent was considered appropriate.[49]

2.80 The committee has been advised that the three proponents considered in the Geoscience Australia advice, QGC, Santos and AP LNG, plus Arrow Energy have now combined and:

48 Geoscience Australia & Dr M A Habermehl, *Summary*

49 Geoscience Australia & Dr M A Habermehl, *Summary*

> ... have commissioned a regional Interferometric Synthetic Aperture Radar study of historical and current earth surface movements to provide certainty for regulatory and public concerns.[50]

Recommendation 8

2.81 The committee recommends that all future approvals require independent comprehensive monitoring of regional earth surface movements to assess whether any measurable subsidence is occurring. Where subsidence occurs and has an adverse effect on land management or the natural environment, for example by altering drainage, the responsible gas companies would be liable for any necessary remediation. Further all gas exploration and/or production in an area subject to subsidence or impacts from subsidence not foreseen in the EIS should cease until action is taken to ensure that no further damage will occur. Where subsidence occurs in a gas producing region the onus lies with the gas companies to demonstrate that the subsidence is not a result of gas production activities.

Fraccing

2.82 Much of the anxiety about this industry has focussed on the process of flow enhancement by hydraulic fracture. Fraccing has become almost synonymous with the industry as a whole and a shorthand for a wide range of anxieties about the industry.

2.83 As described in the introduction methane, is trapped in pockets or cleats within coals seams. If those seams are relatively open, once the water pressure in them is reduced, the gas will flow. However in some seams the cleat system is too tight to permit easy gas flow and the seam must be opened by fraccing. Fraccing may also be used to increase the efficiency of individual wells thus reducing the number of wells that need to be drilled.

2.84 This involves the injection of large volumes of water, up to 10 megalitres according to CSIRO,[51] mixed with chemicals and sand directly into the target seam to cause cracks to run through the seam; the sand is there to hold the cracks open after the fraccing water is withdrawn. The chemicals have a number of functions, principally to keep the sand in suspension in the water. After fraccing most of the fluid used, including chemicals is withdrawn from the well. The fluids extracted contain both the fraccing chemicals and other chemicals mobilised in the coal seam plus other elements including heavy metals.

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50 E-mail advice, Andrew Moser, Groundwater Manager, Origin Energy, 8 November 2011.

51 CSIRO, *Coal Seam Gas Fact sheet no.3,* p.2.

Recommendation 9

2.85 The committee recommends that it be a requirement of all exploration or production approvals that the fluids extracted from wells after fraccing are kept isolated in secure separate storages and prior to disposal are treated to the highest standards.

2.86 Fraccing is not a new process; it has been practiced in Australia and overseas for many years. It is not in the industry's interest for fraccing to cause unintended damage or leakage into adjacent aquifers during the productive life of the well – that would defeat the purpose of the frac.

2.87 It is important to note that fraccing is not necessary in a large proportion of wells and there are alternative and less intrusive methods of encouraging gas flow. Eastern Star Gas has stated that there is no requirement to use fraccing in its Narrabri, NSW, project:

> Fraccing was tried at Narrabri but the process was found to be unsuitable ... Lateral wells as now utilised are much more efficient and cost effective.[52]

2.88 Similarly Dart Energy, which is undertaking exploration activities in the Newcastle region of NSW indicated that they would rely on horizontal drilling rather than fraccing.[53] AP LNG estimates that approximately 30% of its wells will require fraccing. Note that fraccing and horizontal drilling are not mutually exclusive production methods. Horizontal wells may be fracced. This will reduce the impact of drilling on the land surface.

2.89 In addition to the potential of fraccing to cause damage to geological structures public concern has focussed on the toxicity of the chemical additives in the fraccing fluid and the potential of the fraccing process to mobilise naturally occurring BTEX chemicals. The industry has tended to play down the potential risks associated with the chemical additives used in fraccing, pointing out that they are subject to stringent regulation requiring testing of water both before and after their use, reporting to the authorities and landholders and publication of the chemicals used.[54] However the wide discrepancies in the lists of chemicals used suggests that there is a need for more stringent reporting requirements. There must be a public listing of all fraccing chemicals used by the industry.

2.90 The chemicals represent a small proportion of the fluid and are almost all present in ordinary household products:

> Materials used in the fracturing process include around 99% water and sand, as well as about 1% of a range of chemicals in minute, diluted

52 Eastern Star Gas, *Gas Production well Design- No Need for Fraccing*, undated publication, provided to the committee secretariat.

53 Mr Robert de Weijer, CEO, Dart Energy Ltd, *Committee Hansard*, 9 September 2011, p. 18.

54 See, for example, AP LNG, *Submission 366*, pp 44–46.

> quantities, which assist in carrying and dispersing the sand in the coal seam. The chemicals are not specific to the CSG industry and have many common uses such as in swimming pools, toothpaste, baked goods, ice cream, food additives, detergents and soap.[55]

In addition, it is claimed, residues of the chemicals used quickly degrade.

2.91 The chemicals, when used in household products, are very carefully regulated as to concentrations and use. For example, hydrochloric acid is included in one company's list of fraccing chemicals with the note that it is used in swimming pool maintenance while caustic soda is described as being used as a cleaning agent and in food preparation. At different concentrations or 'not used as directed' many of these chemicals can in fact be extremely dangerous.

2.92 Critics point out that while the proportions may be small the actual amounts used and the residue left in the ground can be very large:

> Environmental authorisations by Queensland regulators identified that in one CSG operation, approximately 18,500kg of additives were to be injected during the hydraulic fracturing process in each well, with only 60% of these recovered and up to 40% of the hydraulic fracturing fluid volume remaining in the formation, corresponding to 7,400kg of chemicals per injection well.[56]

2.93 It is beyond the resources of this committee to settle the claims and counter claims with regard to the safety of the chemicals used in the fraccing process. However it was claimed by the National Toxics Network that,

> In Australia, a review of a selection of CSG companies' environmental authorisations identified 23 compounds commonly used in fracking fluids. Australia's industrial chemical regulator, the National Industrial Chemical Notification and Assessment Scheme (NICNAS) has assessed only 2 out of the 23.[57]

2.94 The committee heard from NICNAS and formed the impression that it is drastically underfunded for the responsibilities it has.[58] NICNAS has considered only four of the "50 to 60" chemicals used in fraccing fluids. The wide discrepancy between the figures given for the number of chemicals used reinforces the need for a public listing of all chemicals used by the industry.

2.95 NICNAS does establish priorities for reviewing chemicals and relies on assessments conducted in other countries that have similar regulatory systems and

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55 Santos, *Submission 353*, p. 29.

56 Coal Seam Hydraulic Fracturing Fluid Risk Assessment. Response to the Coordinator-General Requirements for Coal Seam Gas Operations in the Surat and Bowen Basins, Queensland. Golder Associates, 21 October 2010, in National Toxics Network, *Submission 227*, p. 10.

57 National Toxics Network, *Submission 227*, pp 9–10.

58 *Committee Hansard*, 9 September 2011, pp 40–56.

standards to Australia in deciding whether review of a particular chemical is a matter of urgency. In addition, many of the chemicals used by the gas industry have been in common use in this country for many years and were 'grandfathered' on to NICNAS registers and may never have been subject to assessment in the way that new chemicals are.

Recommendation 10

2.96 The committee recommends that the Commonwealth provide funds to NICNAS to enable that organisation to undertake a comprehensive review of the chemicals used in fraccing, having particular regard to the quantities, combinations of chemicals and the way in which these chemicals are used and to confirm safe levels for their use. This study should be completed within the next two years. The Commonwealth and state governments should act promptly to ensure all fraccing activities comply with any NICNAS recommendations.

2.97 The committee notes that the BTEX group of chemicals which have attracted some comment are not permitted to be used as fraccing chemicals in either Queensland or NSW.[59]

2.98 The responsibility for licensing the use of these chemicals in mining lies with state authorities, who do not have to take NICNAS's findings into account.[60] Action needs to be taken by the Commonwealth and state governments to ensure all fraccing activities comply with any NICNAS recommendations.

2.99 A second major cause of anxiety with regard to fraccing is the physical impact of the process on the coal seams and the surrounding formations. Here again there are disputed claims about the safety of the process. Recent publicity of fraccing carried out in shale formations in north-west England has talked of explosions and minor earthquakes.

2.100 CSIRO has described fraccing as "... injecting fluid ... under high pressure into the cased well. The pressure caused by the injection typically creates one fracture in the coal seam where the well is perforated that ... might typically extend to a distance of 200 to 300 metres from the well. The fracture will grow slowly ... an average velocity may be less than 10 metres per minute initially and slowing to less than 1 metre per minute ...".[61]

2.101 In contrast, the industry describes the process thus:

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59 BTEX is a shorthand for benzene, toluene, ethylbenzene and xylelnes which are found in association with petroleum products. Though not permitted to be used as fraccing chemicals naturally occurring BTEX may be found in coal seams and extracted water and is present in petroleum fuels and lubricants used in industry and agriculture.

60 *Committee Hansard*, 9 September 2011, p. 54.

61 CSIRO. *Coal Seam Gas Factsheet no. 3*, July 2011, p.1

> Hydraulic fracturing is not an explosive or high impact process. It involves pumping a specifically blended fluid, charged with proppants[62] such as sand, down a well at sufficient pressure to force small passageways into the coal seam.[63]

2.102 There is a risk that fraccing, in addition to opening up the coal seam, might also affect geological structures surrounding the coal seam thus allowing the movement of gas and/or water from the seam into adjacent aquifers or conversely allowing groundwater to flow from the aquifer into the depressurised coal seam. Secondly, there is a risk that residues of chemicals used in fraccing may contaminate groundwater and aquifers used for human or stock consumption or irrigation.

2.103 It is acknowledged that in one case in Australia, fraccing resulted in damage to the Walloon Coal measures, causing leakage between that and the Springbok aquifer. While apparently the damage was eventually made good by sealing the damaged area, submissions to the committee raised a number of concerns:

- that there seemed too little accountability. It is claimed that the company involved did not advise the government for 13 months and the Commonwealth Water minister may never have been advised;
- that the potential for damage to occur was known prior to the fraccing and that this was treated as an acceptable risk;
- that part of the boundary between the aquifer and the coal seam was intentionally fracced; and
- that it took 21 months to seal the interconnection.[64]

2.104 The Geoscience Australia report to the Commonwealth concluded that "... the potential risks posed by fraccing are low". While fraccing would "... fundamentally alter the structure of the targeted coal seam aquifers" and that "... the potential for fraccing activities to impact on ... other aquifers and aquitards ... can never be completely eliminated ..." the report concluded that the measures adopted would minimise any risk.[65]

2.105 The Queensland Government has tightened its regulations with regard to fraccing, requiring notification to landholders both before and after a frac and comprehensive reporting to the Government within two months which must include details (and volumes) of all the chemicals.[66] These details should be made public to

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62 Proppants are substances, usually sand, included in fraccing fluids to hold open the fissures made in the rock, allowing the gas to flow.

63 Santos, *Submission 353*, p. 29.

64 Anne Bridle, *Submission 328*, p. 30.

65 Geoscience Australia & Dr M A Habermehl, *Summary*, pp 4–5.

66 Queensland Government, *Submission 358*, pp 20–21.

afford the opportunity for independent evaluation of the health implications of the chemicals.

2.106 With regard to contamination from fraccing fluids, CSIRO advised the committee that "The risk associated with contamination from fracking is a fairly small-scale, low-volume risk associated with a particular well bore".[67]

2.107 The committee accepts that fraccing is an established practice in the industry for which there is many years experience and accepts Geoscience Australia's assessment of the risks involved. However the incident referred to above where fraccing did damage an adjacent aquifer does emphasise the need for the applicable regulatory regimes to be backed up by an independent regulatory agency with the capacity to impose significant penalties for breaches of the regulations.

67 Dr J Underschultz, Theme leader, Petroleum and Geothermal Portfolio, CSIRO, *Committee Hansard*, 9 August 2011, p. 68 .

Chapter 3

Use of produced water

Introduction

3.1 As discussed in the previous chapter, the volume of water to be produced by the coal seam gas industry is very large indeed. It will vary from region to region both in total volume and in proportion to the volume of gas produced. A paper prepared for the National Water Commission has estimated, for example, that CSG produced from the Surat Basin will entail the extraction of some 192 megalitres of water per petajoule of energy while for the Bowen Basin the ratio will be 50 ML/pj.[1]

3.2 The estimated total volumes will be 2 360 g/l from the Bowen Basin, 5290 g/l from the Surat and, depending on the development scenario adopted, up to 46.9 g/l from New South Wales.[2] The rate of production of this water will fluctuate over time. Individual wells typically produce high volumes of water in the early months or years of production and then taper off. Gas fields will be managed to maintain the required level of production thus new wells will be brought on as required and the overall production of water will fluctuate accordingly.

3.3 The National Water Commission estimates that the total volume of water that will be extracted by the CSG industry to be 7 500 gigalitres.[3] The probable volumes of water have been indicated by the companies. For example AP LNG expects that it "... will typically produce water at the annual rate of 25,000 ML per year, with a peak of 57,000ML per year".[4] Santos estimates that in NSW its Gunnedah project will produce "... water at an average extraction rate of approximately 3.5 GL per annum, and a maximum rate of 5GL per annum".[5]

3.4 While the water is of variable quality, little of it is expected to be of a quality that could be used in agriculture, and none will be suitable for human consumption. The chemical make–up of the water varies but all of it will have significant levels of dissolved salt plus a range of other chemicals – heavy metals such as arsenic, mercury and lead, naturally occurring BTEX chemicals and uranium. The water may also contain residues of chemicals used in the drilling and hydraulic fracturing processes.[6]

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1 RPS Australia East Pty Ltd, *Onshore co-produced water: extent and management*, Waterlines Report Series No. 54 September 2011, table 2, p. 11. By comparison CSG produced in the Sydney Basin yields a ratio of 1.2 ml/pj.

2 RPS Australia East Pty Ltd, *Onshore co-produced water*, table 7, p. 16.

3 Recent estimates for produced water are much lower. See chapter 1.

4 AP LNG, *Submission 366*, p 24. (25 to 57 gl/pa)

5 Santos, *Submission 353*, p. 17.

6 The concentration of total dissolved solids (tds) in CSG water ranges from 200 to 10 000+ milligrams per litre. In comparison, sea water has tds values of 36 -38 000 mg/l.

3.5 Obviously many of these chemicals are potentially dangerous to human health, livestock and soils. Thus the management of these very large volumes of water – storage, treatment and disposal - presents complex challenges.

3.6 It is expected that virtually all produced water will be treated prior to disposal. Santos, for example, intends to treat 100 per cent. The company estimates that reusing extracted water productively will result in its net water use in the Gunnedah project, for example, being reduced by approximately 80% to 0.7 to 1.4 GL/pa.[7]

3.7 AP LNG, for example, has two reverse osmosis plants in operation and proposes to build others throughout its development area. It reports that it is achieving recovery rates in excess of 90 percent from these plants and hopes to achieve 97.5 per cent recovery of useable water from these plants.

3.8 There are three main treatment options. To produce high quality water, suitable for human consumption, reverse osmosis or filtration is required. Depending on the quality and the intended use, water may also be treated by amendment - blending lower and higher quality waters to produce water of an acceptable standard for a given purpose.

3.9 The National Toxics Network did warn that reverse osmosis:

> ... has significant limitations and cannot remove all contaminants, particularly organic compounds with low molecular weight. Reverse osmosis involves forcing water through a semi-permeable membrane, which filters out a select number of water contaminants, depending on the size of the contaminants. In general, if the contaminants are larger in size than water molecules, those contaminants will be filtered out. If the contaminants are smaller in size, they will remain in the water.[8]

3.10 It is essential that, where treated water is to be used for human consumption or food production, it conforms to the Australian Drinking Water Guidelines published by the NHMRC.

3.11 A downside of this is that treatment will result in the production of large quantities of salt and brine. Arrow Energy estimates a range of 5 - 8 tonnes of salt per megalitre of water produced by the industry.[9] On the AP LNG figures quoted above, that company's annual production of salt could be in the range of 125 000 – 285 000 tonnes per annum.

3.12 AP LNG advised the committee in their submission that, over the 40 to 45 year life of its projects in Queensland, it expected to produce approximately 3.5 million tonnes of salt. Queensland Gas (QGC) expects to produce 4.6 million tonnes

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7 Santos, *Submission 353*, p. 17.

8 National Toxics Network, *Submission 227*, p. 15.

9 http://www.arrowenergy.com.au/icms_docs/73090_Water_and_salt_management_brochure.pdf

of salt from its operations in south western Queensland over the next 30 years. The management of salt and brine is dealt with later in this chapter.

3.13 Storage of extracted water prior to treatment is a major issue. In the early stages of the industry in Queensland, companies stored water, and evaporation was an accepted means of disposal. Queensland has since banned evaporation but large volumes of water remain in storage. A long-term storage pond can be an evaporation pond in all but name. Thus it is extremely important that the industry has the capacity to treat water at the rate at which it is produced.

3.14 Queensland's *Coal Seam Gas Water Management Policy* (June 2010) recognises that aggregation of produced water is necessary prior to reinjection or treatment and seeks to address the issue of *de facto* evaporation ponds by requiring that:

- aggregation dams are deep with a small footprint, and
- that "... during any period of thirty days, following the first 90 days after commissioning ... the total volume of water leaving the dam, other than by evaporation, must be not less than 85 per cent of the volume of water that has entered the dam".[10]

3.15 The stability of storage ponds is an important issue. Given the chemical make-up of the stored water, any seepage will be extremely damaging to the environment. The committee has seen, in the Pilliga area of NSW, the damage done by seepage, and in worst cases, failure of small water storages.[11] There are also concerns about water storages being overtopped by extreme rain events or floods.

3.16 On the other hand the committee also visited Santos's exploration site near Gunnedah where very large storage tanks were being used to manage produced water. It is clear that there is a range of approaches to managing this water.

3.17 It has been put to the committee that the only safe storage ponds are those completely lined with high density polyethylene or a similar material. Ideally storage should be only a short term requirement – companies should have the capacity to treat extracted water as it is produced. However, even where produced water is cycled through holding ponds relatively quickly, sealing of ponds in regular or constant use is still needed – arguably more so where deep storage ponds exert increased seepage pressure. The Queensland policy mentioned above has strict requirements for the construction of storage dams.

3.18 The rehabilitation of storage ponds after the industry moves on is an important issue. The committee would assume that it will be a requirement in any exploration or

10 Queensland Government, *Coal Seam Gas Water Management Policy* (June 2010), p. 4.

11 Mr A Pickard, *Submission 207.*

production approval that every storage pond would be emptied, any residues removed and the site rehabilitated before a company abandons a gas field.

Use of extracted water

Reinjection

3.19 As noted in chapter 1, reinjection into groundwater systems has been adopted by the Queensland Government as its favoured method of dealing with CSG water. The Queensland Government has recently announced that:

> Coal Seam Gas companies must make reinjection their first priority in their water management practices to give the greatest protection to the environment and landholders ... .[12]

3.20 It is an attractive option because reinjection will help to maintain the water balance in a given area. There are various approaches to this. A method favoured by many localities is to put water into aquifers that have been depleted by agricultural or domestic use over many years.

3.21 Santos, at Roma in Queensland, has committed to recharging with treated water the heavily depleted Gubberamunda aquifer from which the town water supply is drawn. Santos is confident that it can put 10 ML/day into the aquifer, about three times the average withdrawal. The company estimates that this reinjection would also far exceed the maximum vertical seepage from the aquifer that might be attributed to the CSG industry.[13]

3.22 The committee notes the comments of the National Toxics Network at paragraph 3.9 above about the limitations of reverse osmosis. Any water reinjected into an aquifer used for human consumption or agriculture must meet Australian Drinking Water Standards.

3.23 Reinjection is not a universal panacea. AP LNG has described some of the factors that need to be considered:

> Aquifer injection ... involves pumping water into rock formations underground and is not as easy as ... pumping water down a well. There are a number of factors that need to be taken into consideration such as aquifer permeability, aquifer pressure levels, existing water quality and chemical makeup, mineralogy of receiving aquifers, removal of oxygen from the water prior to injection and the capacity of each injection well.[14]

3.24 QGC made the same point:

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12 Queensland Government, The Hon Vicki Darling, Ministerial Media Statement, 9 August 2011.

13 Santos, *Submission 353*, pp 18–19.

14 AP LNG, *Submission 366*, p. 35.

> While it is technically feasible in some circumstances to re-inject water produced as a result of coal seam gas extraction, this is unlikely to be possible in most cases.
>
> Re-injection in the same location as the water is drawn from is even less likely to be possible.[15]

3.25 Reinjection has been proposed as a possible solution to the disposal of the brine residue produced by reverse osmosis. However that would be subject to many of the constraints mentioned in the previous paragraphs. The receiving aquifer would have to be at a depth and of a stability to ensure that there was no risk of contamination of other aquifers and the water in the aquifer would need to be of a similar quality to the brine. Pumping into deep aquifers is both expensive and technically demanding.

Virtual reinjection

3.26 Virtual reinjection refers to the supply of appropriately treated extracted water to existing agricultural or domestic users as a substitute for the water they would otherwise extract from aquifers. Given the technical limitations on reinjection described above, virtual reinjection should be an important intermediate option to achieving a similar outcome. However water used in this way must be properly measured and regulated – it must be a substitute for an existing water entitlement, not a supplement to such an entitlement.

Direct use in agriculture and industry

3.27 Virtual reinjection is one method of using extracted water. In addition, there have been numerous proposals to supply water to other users in agriculture or industry. Superficially this is an attractive option but it carries with it a range of problems.

3.28 CSG water will be available for a relatively short period of time in any given region, little more than a generation. It is important that the water not be used to develop otherwise unsustainable industries that will later make demands on already allocated sources of water to maintain their activities.

3.29 In its submission to the committee, AP LNG identified a number of issues:

- How the water will be delivered,
- How much water supply can be guaranteed,
- How much demand can be guaranteed,
- How seasonal demand can be managed, and
- How the variability and decline of CSG water production over time can be managed.[16]

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15 QGC, *Submission 259*, p. 10.

3.30 These considerations do not necessarily preclude expanding existing activities or developing new uses, but they do show that it is not a straight-forward option. Any such developments must have regard to the relatively short term availability of this additional water.

3.31 In Queensland, Santos is providing water to a private landowner to irrigate forage crops:

> Farm productivity could be expected to increase 25 fold during CSG water production, and a legacy productivity improvement of 5 fold could be expected to remain once the water production has ceased.
>
> ... That is, the landholder will experience an increase in agricultural productivity while CSG operations are underway, and CSG will leave a legacy of an increase even after water supply has ended.[17]

3.32 This is clearly a productive use of extracted water but it must be understood that landholders who benefit from such arrangements have no call on other sources of water once the CSG industry moves on. If there is a 'legacy' improvement in productivity that is an advantage, but the landholder must be prepared for the decline in income resulting in the withdrawal of CSG water.

3.33 There is a related issue with regard to the regulation and pricing of water supplied by the CSG industry to commercial users. This water is extracted outside the existing water entitlements and regulatory systems applying to all other ground water used in agriculture. These matters are dealt with later in this chapter.

3.34 Gas companies are also using produced water on their own properties. Where major infrastructure is installed, for example storage ponds or compressor stations companies have bought properties and now manage the remaining land as agricultural enterprises. Both Santos and AP LNG provided details of such projects.

3.35 Santos is using produced water to irrigate forage crops and support forestry projects on two properties associated with its Fairview field. AP LNG is developing a range of crops associated with its Spring Gully and Talinga water treatment facilities. Crops include pongamia, a feedstock for bio-diesel production and for fodder, and a range of other fodder crops.[18]

Disposal into surface water

3.36 Untreated water cannot be released into surface water courses. However the committee has received claims that untreated water has been released; for example, in small quantities from low points in gas pipelines. While volumes of such releases

16 AP LNG, *Submission 366*, p. 36.

17 Santos, *Submission 353*, p. 19.

18 Santos, *Submission 353*, p. 19 and *Submission 366*, p. 35.

may be small, where such water is released into intermittent creeks there is a risk of build up of toxic pollutants which will, ultimately, be mobilised by seasonal flows.

3.37 Release of treated water is not straightforward. Matching the quality of released water to that of the surface water is not easy; ironically water can be too clean. The release of water must also match the natural, seasonal flow pattern in a watercourse.

3.38 Companies do release treated water into surface flows under strict conditions. For example:

> Under an agreement with SunWater, a Queensland Government-owned corporation for the Central and Southern Project development areas, QGC will provide treated water into the Chinchilla Weir in the upper Condamine River for beneficial use in a scheme managed by SunWater.[19]

3.39 Similarly, AP LNG releases:

> ... some of the water from the Talinga water treatment facility into the Condamine River. This is done under stringent environment conditions set as part of the Environmental Approval for the Talinga development. The released water meets, as a minimum, Australian Drinking Water standards.[20]

3.40 Queensland's *Coal Seam Gas Water Management Policy* identifies disposal of CSG waters to surface water as a "non-preferred option".[21] Despite this purported commitment to the protection of surface water, the Queensland Government granted a significant number of permits for emergency release of large amounts of contaminated waters into Queenslands rivers and streams during the months following the Queensland floods of early 2011. Given the risk of severe weather events in the coming decades, there is a clear need for a step change in the management of water both in normal and severe weather situations.

Use by industry

3.41 Produced water is used by the CSG industry on site principally for dust suppression and may be supplied to coal companies for dust suppression or washing coal. It is important that where water is used in these ways that it is treated prior to use. The committee has heard claims of residues of water used for dust suppression causing environmental damage and health problems.

3.42 It must be an absolute requirement that no untreated water can be used in any circumstance where there is any run-off.

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19 QGC, *Submission 259*, p. 10.

20 AP LNG, *Submission 366*, p.37

21 Queensland Government, *Coal Seam Gas Water Management Policy*, (June 2010), p.2

Regulation and pricing of extracted water

3.43 At present, water extracted by the coal seam gas industry is regulated under the Petroleum and Gas Act not the Water Act. This reflects the fact that the water is not, for the most part, being withdrawn from the aquifers and alluvial sources that supply agriculture and domestic users and is viewed as a by-product of the gas industry. To the industry it is an expensive encumbrance.

> Unlike other water producers and users, coal seam gas producers have no economic incentive to produce water. Water is a by-product of gas production and adds significant capital and operating costs to a gas producer.[22]

3.44 Coal seam gas water cannot, in the end, be separated from other water. As has been said earlier in this report, groundwater and surface water systems are linked. Actions in one area will have impacts in others. The timescales may be slow and difficult to predict but the linkage is real.

3.45 Santos has stated that "Modelling indicates that, at the period of maximum groundwater impact, the vertical drainage from CSG activities, from Gubberamunda, will be minimal at 0.04 megalitres per day".[23] It has also been stated that "...groundwater extraction to reduce the water pressure in the coal seams may induce some vertical leakage into the coal seams and produce impacts on the surrounding sandstone aquifers".[24]

3.46 There is a perception that CSG companies do not pay for the water they extract. This may have arisen because they are operating outside the regulatory system applying to all other water users and do not pay a fee based on the volume of water taken. However, in an answer to a question put by the committee, the CEO of AP LNG stated that:

> We pay a fair bit. We pay between $1.5 million and $2 million a year to the government directly for administration of it, which I would say is not a trivial amount.[25]

3.47 In response to another question Mr Maxon indicated that the company "...do[es] not intend to sell it or try to make it a revenue source".[26]

3.48 It has been suggested that the companies should pay a fee based on the volume of water extracted, which would be reimbursed on the basis of the beneficial

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22 QGC, S*ubmission 259*, p. 9.

23 Santos, *Submission 353*, p.19

24 USQ, *Preliminary Assessment of Cumulative Drawdown Impacts in the Surat Basin Associated with the Coal Seam Gas Industry*, (March 2011), p.1 It has been suggested that vertical movement of water into the Walloon Coal Measures after depressurization could be significant.

25 Mr P Maxon, CEO AP LNG, *Committee Hansard*, 9 September 2011, p.12.

26 Mr P Maxon, CEO AP LNG, *Committee Hansard*, 9 September 2011, p.12.

use of the water, thus giving them an incentive to find uses for the water. Extracted water, its storage, treatment and disposal is already a very significant cost to the companies; it is unlikely that an additional fee would add any extra incentive.

Salt

3.49 The management and disposal of salt and brine is a major concern. As has been described earlier in this report, water produced in conjunction with coal seam gas is generally brackish. There is considerable variation in the salt content from particular gas fields but no one has disputed that the overall volumes of salt produced will be very large. QGC expects to produce more than 4.5 million tonnes of dry salt over the next 30 years while AP LNG estimated that it would produce 3.5 million tonnes over the 45 year life of its projects.[27]

3.50 These are only two of a number of projects. Combining Arrow Energy's estimate for salt production and the National Water Commission's estimate of total water production for the industry provides a range of 37 500 000 to 60 000 000 tonnes over the whole life of the industry. Conservatively, the industry will be handling some 750 000 tonnes of salt per annum. Water purification will also result in a concentrated brine residue.

3.51 At present the Queensland Government's position appears to be that the gas companies are expected to apply their best efforts to finding a beneficial use for salt, for example as an industrial feedstock. However, in the absence of such a use, disposal in an appropriate landfill will be acceptable. For example, QGC stated in its submission that,

> While the QCLNG Project base case suggests that salt will be managed by solar crystallisation with longterm storage of solids in landfill, QGC wants a better salt management solution. In June 2010 the Queensland Government published its Coal Seam Gas Water Management Policy requiring preference be given to "beneficial use" rather than "waste disposal" solutions.[28]

3.52 In evidence to the committee, Mr P Maxon, CEO of AP LNG said,

> We do have the base plan, which is that at a minimum we will concentrate it, segregate it and ultimately dispose of it in controlled landfill. The basis on which we proceed is that if nothing better can come about that is reasonable and doing that does not pose a significant risk.[29]

3.53 The committee has been briefed on a proposal to use brine as a feedstock for the production of table salt, sodium bicarbonate and soda ash. The latter two products

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27 QGC, *Submission 359*, p. 11; Mr P Maxon, CEO, AP LNG, *Committee Hansard*, 9 September 2011, p. 3.

28 QGC, *Submission 259*, p. 11.

29 Mr P Maxon, CEO AP LNG, *Committee Hansard*, 9 September 2011, p. 3.

have a range of uses, including in glass making. QGC has entered into an agreement with Penrice Holdings and GE for the construction and operation of a pilot plant to test this process.

> The GE Penrice BPP is part of a wider initiative by the coal seam gas industry to investigate the technical and commercial viability of producing products such as table salt and soda ash from brine, a by-product of coal seam gas water treatment.[30]

3.54 This is a welcome development but at the same time a cause for concern. The pilot plant will be operational early in 2012. Presumably the process has to be proven and then, having demonstrated that there are markets for the products, scaled up to a commercial level.

3.55 In the absence of any details of the size of the potential markets or the volumes of brine that the plant could utilise, there remains a high degree of uncertainty about the handling of brine and salt by the industry. Until some industrial applications or other disposal options can be found for the salt and brine produced by the industry, storage will be a major issue.

3.56 Reinjection of brine is also frequently mentioned as an option for disposal but, as discussed above, that remains unproven as a practical option.

3.57 Storage of solid salt and brine constitutes a major potential risk to agricultural land and to waterways. The salt could be spread onto adjacent agricultural land either by flood waters, wind or by seepage from even well-constructed storages.

3.58 In a paper provided to the committee, it was pointed out that:

> ... the salt will be highly alkaline made up of sodium carbonate and bicarbonate mixed with sodium chloride salt. The environmental impacts of these mixed salts are substantially more complex than that of ordinary salt.[31]

3.59 The paper went on to identify a number of problems with storage of the salt or the development of a salt harvesting industry and concluded that:

> ... there is also an overwhelming need for the CSG-LNG industry to consider the options for minimisation of the cumulative effects of brine management issues at catchment level (ie, beyond the boundaries of the individual upstream CSG operations) ...[32]

3.60 Queensland's *Water Management Policy* requires brine storage ponds to be constructed to very high standards and have safety monitoring systems built in. The

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30 GE Penrice, Media Release, 24 October 2011.

31 Mr A Arakel, *Brine Management in the CSG Industry- the untold story*, 24 June 2011.

32 Mr A Arakel, *Brine Management in the CSG Industry*

committee notes that AP LNG has developed what the company considers to be a 'fail-safe' design for storage ponds in response to these requirements.

> The selected liner system consists of a dual layer with intermediate drainage. A highly impermeable polymer geomembrane layer forms the uppermost layer. As a contingency in case of a leak developing in the primary liner, a secondary polymer membrane liner is laid underneath. A system for leak detection is used that consists of a pair of probes, one in the stored liquid and one in the surrounding soil, to measure the electric resistivity across the pond liner to detect flaws in the liner which allow the passage of brine.[33]

3.61 It is clear that, at the time of making their submissions to this inquiry, the gas industry envisaged long-term storage and removal of solid salt to approved land fill as the only proven means of handling brine and salt.

Committee view

3.62 Management of the surface and groundwater resources of the Murray-Darling Basin relies on having reliable data on all inflows into, and withdrawals from, the system. Thus all water removed by the CSG industry should be metered and the volumes extracted reported to the Murray-Darling Basin Authority.

3.63 The industry already monitors the flow of water through its wells, thus it should be no imposition on them to require that the volumes of water being produced be reported to the relevant state water authority to ensure that there is a clear picture created of all the withdrawals and inflows within a system.

Recommendation 11

3.64 The committee recommends that all CSG water should be included in the calculation of the total withdrawal from the ground and surface water systems. Seepage into depressurised coal seams, reinjection into regulated formations and virtual reinjection or surface disposal must be monitored and recorded if a complete picture of the state of artesian and sub-artesian water is to be maintained.

Recommendation 12

3.65 The committee recommends that where any aquifer used for the supply of stock or domestic water is depleted as a result of coal seam gas activities, the relevant company or companies should be required to pay for that water at the prevailing rate or make good the loss of water by virtual reinjection or reinjection where water to be reinjected is of an environmentally appropriate standard. The onus should rest with the gas companies to prove that, where an aquifer is depleted, it is not the result of coal seam gas extraction.

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33 AP LNG, *Submission 366*, p. 38.

3.66 The committee considers that produced water offers considerable opportunities to improve the management of groundwater in the affected areas of the Murray-Darling Basin. The use of reinjection or virtual reinjection to 'rest' or replenish stressed aquifers that are heavily used by agriculture, industry or domestic use has the potential to be a significant and unexpected benefit of the industry.

3.67 It is important that treated CSG water is not used to undermine the long-term objectives of getting the use of GAB and sub-artesian water under control and returned to sustainable levels. For example the Santos project to reinject water into the Gubberamunda aquifer must be treated as an opportunity to recharge a depleted aquifer. It is not an excuse for continuing to deplete the aquifer at unsustainable rates.

3.68 Similarly virtual reinjection, by substituting for withdrawal of water from an aquifer, is an opportunity to 'rest' that aquifer. The water available to a licence holder as virtual reinjection must be governed by the same conditions as the licence holder's ordinary entitlement.

Recommendation 13

3.69 The committee recommends that as a general principle it should be established that where a gas company supplies treated CSG water for beneficial use to an existing water user in agriculture, industry or for domestic use that supply must be as a substitute for an existing allocation.

3.70 Where treated water is supplied to landholders (including on a company's own land) to develop a new crop or enhance existing production, that supply should be clearly understood to create no entitlement, above a pre-existing water licence, to water from any other source once the supply of CSG water ceases.

3.71 All the companies that the committee has spoken to have emphasised that they have, or will develop, programs to treat and dispose of extracted water in ways that are not damaging to the environment. Reinjection of produced water has been identified by the Queensland Government as its preferred method of water management. With regard to salt and brine, reinjection and use as an industrial feedstock are the preferred management methods. However, as indicated above, the industry is still seeking to determine the feasibility of all of these options.

Recommendation 14

3.72 The committee recommends that comprehensive water management plans*, and the capacity to implement those plans*, particularly with regard to the disposal of salt and brine, be a requirement before any further production approval for coal seam gas be granted.

3.73 The management of salinity in the Murray-Darling Basin is a priority for the Basin Authority. Given the toxicity of brine and salt, long term storage of brine or disposal of solid salt should not be permitted in an agricultural area.

Recommendation 15

3.74 The committee recommends that all salt and brine residues that cannot be disposed of within the short term, either as part of an industrial process or by safe injection into a suitable aquifer, should be required to be removed from agricultural areas and water catchments. No controlled landfills for the disposal of salt should be permitted in the Murray-Darling Basin.

3.75 In view of the fees paid to government for the use of the water, and the extensive regulatory requirements governing its management, the committee takes the view that there is no need for an additional fee based on the volume of water extracted.

3.76 If at any stage consideration is given to allowing companies to sell water to other users, the state governments should review the charges the companies pay and impose a volume based fee on such water.

Chapter 4

LAND ACCESS & LAND USE

Land Access

4.1 The questions of land access and land use have generated much of the controversy surrounding the coal seam gas industry. For many landholders, despite understanding that they do not own the mineral resources under their land, the realisation that they are legally required to give access to their land to gas exploration companies and that those companies could, for example, construct roads, clear drilling sites, build work camps and, ultimately, construct gas production facilities, came as a profound shock. This represents a huge imposition on the landholder who may have believed that freehold title meant what it said.

4.2 The legal position in both NSW and Queensland has no process for dealing with a situation in which a landholder simply does not wish to have CSG activity on their land under any circumstances. In such a situation, should the company choose, it can require the landholder to enter into arbitration and comply with the result of that arbitration, which will include access to the land.

4.3 It is important to note that, whenever it was put to a gas company by the committee whether they intended to use these powers the answer was that they had not and would prefer not to use them in the future. For example, in evidence to the committee, a senior company executive summed up Santos's position:

> As you saw when you came out and visited our area, we have to have respectful relations with our community. We employ locals because we want to understand the area; we want to understand particular farmers' issues. If a farmer does not want us on his property, we will not be going through that gate.[1]

4.4 The campaigns against giving land access to coal seam gas exploration and production companies, particularly those such as Lock the Gate seeking to deny access altogether, have contributed to a public perception that landholders have few legal rights when dealing with these companies and that the only alternative is 'civil disobedience'. At the other extreme, some landholders, perhaps lacking the resources, knowledge, or the confidence to 'take on' a major corporation, simply accepted what was offered by way of an access agreement and compensation and permitted access to their land.

4.5 In fact the law in this area has been evolving quite rapidly to respond to public concern and, while it is correct to say that a landholder cannot absolutely deny access

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1 Mr J Baulderstone, Vice President Eastern Australia, Santos, *Committee Hansard*, 9 August 2011, p. 15.

to the land, equally it is wrong to imply that a gas (or other resources) company has an unfettered right of access to conduct whatever activities they see fit on any land.

The Legal Position in Queensland & New South Wales

4.6 Under Australian law minerals under the earth's surface belong to the Crown, represented by the States.[2] The right to explore for, and produce, minerals, oil and gas, is generally granted by the State to private exploration and production companies. There are differences in the legal regimes governing exploration and production between the two States but, with regard to the rights of a permit holder to access land to exercise his rights under an exploration or production permit, the situation in the two States is broadly similar.

4.7 The holder of an exploration permit in Queensland – an authority to prospect – has the right to carry out "...authorised activities ... despite the rights of an owner or occupier of land on which they are exercised". These activities are:

- exploring for petroleum;
- testing for petroleum production;
- evaluating the feasibility of petroleum production; and
- evaluating or testing natural underground reservoirs for petroleum storage.[3]

4.8 The Queensland Act goes on to list activities that are "... reasonably necessary for, or incidental to, an authorised activity" and these include:

> 1. constructing or operating plant or works, including, for example, communication systems, pipelines associated with petroleum testing, powerlines, roads, separation plants, evaporation or storage ponds, tanks and water pipelines
>
> 2. constructing or using temporary structures or structures of an industrial or technical nature, including, for example, mobile and temporary camps
>
> 3. removing vegetation for, or for the safety of, exploration or testing under section 32(1)[4]

4.9 Obviously not all of these activities would be carried on at every site, and many of the larger works are located on land owned by the companies. However this list makes it clear how intrusive and disruptive CSG exploration might be.

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2 There are some minor exception to this in relation to long-standing rights, for example to coal, and the situation with regard to off-shore minerals, oil and gas and in the Territories is different but this report is concerned only with onshore CSG exploration and production in the Murray-Darling Basin.

3 *Petroleum and Gas (Production & Safety) Act 2004(Qld),* s.31(2) & s.32(1).

4 *Petroleum and Gas (Production & Safety) Act 2004(Qld),,* s.33(1).

4.10 The right to access land to carry out these activities is not uncontrolled. In Queensland, it is governed by the land access laws and the *Land Access Code*, introduced into Queensland law in October 2010. The purpose of the laws is to ensure that all holders of an authority to explore for, or produce, resources comply with a single set of rules.

4.11 The law's key features are:

> • an entry notice requirement for 'preliminary activities'[5] i.e. those that will have no or only a minor impact on landholders
>
> • a requirement that a Conduct and Compensation Agreement be negotiated before a resource authority holder comes onto a landholder's property to undertake 'advanced activities' i.e. those likely to have a significant impact on a landholder's business or land use
>
> • a graduated process for negotiation and resolving disputes about agreements which ensures matters are only referred to the Land Court as a last resort
>
> • stronger compliance and enforcement powers for government agencies where breaches of the Land Access Code occur.[6]

4.12 The *Land Access Code*[7] sets out the requirements that govern the relationship between an exploration or production company and the landholder. The general principles embodied in the Queensland Code encourage both parties to negotiate in good faith, to respect the rights of the other party, to act responsibly and to provide all relevant information necessary to the creation of a satisfactory working relationship. These are perfectly sound and, if followed in spirit as well as to the letter, would minimise the friction between landholders and the gas companies.

4.13 The Code also includes mandatory conditions in relation to:

- the training of personnel operating on a landholder's property;
- the selection, construction and use of access points, roads and tracks;
- livestock and property;
- the spread of declared pests;
- the siting and management of camps;
- bringing items on to the land – firearms, domestic animals and alcohol are banned (without the owner's consent); and

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5 Examples of preliminary activities are walking the area, taking soil samples or survey pegging.

6 Department of Employment, Economic Development & Innovation (Qld), *Guide to Queensland's new land access laws*, November 2010, p. 1. http://mines.industry.qld.gov.au/assets/land-tenure-pdf/6184_landaccesslaws_guide_print.pdf
See also: http://mines.industry.qld.gov.au/mining/land-access-policy-framework.htm.

7 Department of Employment, economic Development & Innovation (Qld) Land Access Code, November 2010, http://www.agforceqld.org.au/file.php?id=685&open=yes.

- gates, grids and fences.

4.14 These mandatory conditions generally place an obligation on the company to minimise its impact on the land, its occupants and their farming and other activities. Where a problem arises relating to any of these headings, the company is required to advise the landholder and, if relevant, make good the damage.

4.15 In addition to the Code, the *Guide to Queensland's New Land Access Laws* sets out conditions relating to land access and provides definitions of commonly used terms. One of those is a requirement that a copy of the *Land Access Code* be provided to landholders with the first entry notice, prior to a company gaining access to land.

4.16 Queensland has also moved to protect its agricultural resources by introducing a Strategic Cropping Land policy:

> The Queensland Government's policy position is that strategic cropping land is a finite resource that must be conserved and managed for the long-term. Such land should be protected from those developments that would result in its permanent alienation (that is, when a use on or near strategic cropping land will endure for 50 years or more and prevents cropping during that time or in the future) or diminished productivity.[8]

4.17 The criteria which define what constitutes strategic cropping land go to slope, soil depth and quality and soil water storage capacity.[9] The areas which the policy will apply have been defined. The criteria will be applied to individual properties to determine whether they, in fact, fall under the definition of strategic cropping land. The legislation to give effect to the policy was to be introduced into the Queensland Parliament on 25 October 2011.

4.18 The Queensland Government has identified CSG activities such as large water storage ponds and compressor stations as falling under the heading of activities likely to alienate strategic cropping land and thus unlikely to be given approval. Thus it can be assumed that some of the areas of greatest concern, black soil country along the Condamine River for example, will be protected from intensive development.

4.19 In addition, other lower impact actions may come under the policy's ambit:

> The policy will also apply to activities that have a temporary affect on strategic cropping land. These are activities where the land is able to be restored to its previous strategic cropping land condition at a later date. For example, activities such as pipelines or wells associated with petroleum and gas production and geothermal developments generally have a smaller footprint and may have a temporary impact. These activities will still be

8 Queensland Government, *Submission 358*, p. 23.

9 The criteria can be found at http://www.derm.qld.gov.au/land/planning/pdf/strategic-cropping/proposed-criteria.pdf

> assessed under the strategic cropping land policy to ensure appropriate conditions requiring full restoration are applied.[10]

4.20 Much of the area affected by CSG mining falls outside the areas of designated strategic cropping land.

4.21 New South Wales access and compensation arrangements are governed by the *Petroleum (Onshore) Act 1991*[11]. This Act sets out both the matters that may be covered by an access agreement and the restrictions which apply to the holder of a petroleum title.

> 69D Matters for which access arrangement to provide
>
> (1) An access arrangement may make provision for or with respect to the following matters:
>
> (a) the periods during which the holder of the prospecting title is to be permitted access to the land,
>
> (b) the parts of the land in or on which the holder of the prospecting title may prospect and the means by which the holder may gain access to those parts of the land,
>
> (c) the kinds of prospecting operations that may be carried out in or on the land,
>
> (d) the conditions to be observed by the holder of the prospecting title when prospecting in or on the land,
>
> (e) the things which the holder of the prospecting title needs to do in order to protect the environment while having access to the land and carrying out prospecting operations in or on the land,
>
> (f) the compensation to be paid to any landholder as a consequence of the holder of the prospecting title carrying out prospecting operations in or on the land,
>
> (g) the manner of resolving any dispute arising in connection with the arrangement,
>
> (h) the manner of varying the arrangement, ...[12]

4.22 This section of the Act further provides that "...If the holder of a prospecting title contravenes an access arrangement, a landholder of the land concerned may deny the holder access to the land until:

> (a) the holder ceases the contravention, or
>
> (b) the contravention is remedied to the reasonable satisfaction of, or in the manner directed by, an arbitrator appointed by the Director-General."[13]

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10 Queensland Government, *Submission 358*, p. 25.

11 http://www.dpi.nsw.gov.au/minerals/titles/landholders-rights/petroleum_onshore_act_1991

12 Petroleum (Onshore) Act 1991(NSW) s.69D

13 *Petroleum (Onshore) Act 1991(NSW)*, s.69D (4)

4.23 Sections 71 and 72 of the Act further limit the rights of a permit holder.

> (1) The holder of a production lease must not carry out any mining operations or erect any works on the surface of any land which is under cultivation except with the consent of the landholder.[14]

4.24 This limitation is subject to Ministerial discretion,

> (2) The Minister may, however, if the Minister considers that the circumstances warrant it, define an area of the surface of any parcel of cultivated land on which mining operations may be carried out or works may be erected, and may specify the nature of the operations to be carried out or the works to be erected.

4.25 Section 71 does not, except in exceptional circumstances, apply to cultivation of pasture.[15]

4.26 Exploration and production are subject to the following restrictions:

> (1) The holder of a petroleum title must not carry on any prospecting or mining operations or erect any works on the surface of any land:
>
> > (a) on which, or within 200 metres of which, is situated a dwelling-house that is a principal place of residence of the person occupying it, or
> >
> > (b) on which, or within 50 metres of which, is situated any garden, vineyard or orchard, or
> >
> > (c) on which is situated any improvement (being a substantial building, dam, reservoir, contour bank, graded bank, levee, water disposal area, soil conservation work, or other valuable work or structure) other than an improvement constructed or used for mining or prospecting operations,
>
> except with the written consent of the owner of the dwelling-house, garden, vineyard, orchard or improvement (and, in the case of the dwelling-house, the written consent of its occupant).

Disputes arising over these limitations are determined in the Land and Environment Court.[16]

4.27 The right of access to land to explore for CSG must be balanced by the right of the landholder, whether on free or leasehold, to exercise some control on who comes on to their property and what activities are undertaken on that property. Given the array of legal protections available to the landholder, short of an absolute right of refusal of access, why has the issue generated so much hostility?

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14 Petroleum (Onshore) Act 1991(NSW), s.71

15 Petroleum (Onshore) Act 1991(NSW), s.71

16 Petroleum (Onshore) Act 1991(NSW), s.72

4.28 There are two aspects to the problem. Firstly, the issue of access has, in many instances, been mishandled by some gas companies and the resulting community hostility has been combined with anxiety among those subject to exploration permits who were 'waiting for the axe to fall'. Secondly, there is a very real impact on the lives and businesses of landholders if CSG exploration and production takes place on their land. This is considered later in this chapter.

4.29 Extensive evidence of offhand, patronising and simply insulting behaviour by companies – unannounced arrivals, phone calls at wholly inappropriate times and gratuitous, not to say stupid, advice on how to manage the land in conjunction with gas exploration was given to the committee. For example, a landholder near Narrabri explained that:

> ...when they come to us for meetings, they have made no effort to actually do any research into how we conduct our businesses. They had the audacity to ask us if we had heard of sorghum when they were telling us what we could do with the water. They said: 'We irrigate a crop; I think it's called sorghum. Have you heard of that?' Then they want us to trust them that they are going to do the right thing by us.[17]

4.30 The same witness also gave example of the casual approach of a company to a number of other landholders:

> I know firsthand that my sister was contacted at 20 past eight on a Sunday morning asking for access to her property. That was her first contact. That was before the mail out. ... I know that he rang other landholders in our PEL on a Saturday afternoon as well. Apparently the reasoning for that is, 'Because that is the only time we can get hold of you lot.'[18]

4.31 Another landholder described her experience of dealing with a gas company holding an exploration permit over her land:

> It was immediately evident to my husband and me that they were completely ignorant of the type of farming that we do. They had no idea that we are on a flood plain and that the area where they wanted to put the pilot was right in a major floodway. They did not understand our land values, our irrigation practices or the level of intrusion that their activities would cause to our property.[19]

4.32 As an example of the type of approach that angers landholders and undermines belief that some companies are acting in good faith, the committee received a copy of a letter sent to landholders by Leichhardt Resources, the holder of a Petroleum Exploration Licence (PEL) in the Moree Region of New South Wales.[20] The letter,

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17 Ms Natalie Tydd, *Committee Hansard*, 9 August 2011, p. 32.

18 Ms Natalie Tydd, *Committee Hansard*, 9 August 2011, p. 35.

19 Mrs R Armstrong, *Committee Hansard*, 19 July 2011, p. 15.

20 Letter tabled at the committee's hearing in Narrabri, 2 August 2011.

posted in Brisbane, is dated 30 June 2011 (a Thursday). It is fair to assume that it would not have been delivered to rural property owners near Moree until the following Monday at the earliest, that is 4 July 2011.

4.33 The letter announced that the drilling contractor "... proposes to drill an exploration core hole on your property" and that "... the well program is scheduled to commence in July." It then quite properly advises the property owner of the legal requirements relating to access and compensation including that the landholder has 28 days to reach an agreement after which the matter would go to arbitration; i.e. the landholder is entitled to take until at least 1 August to reach an agreement.

4.34 Thus by the company's own calculation it could not meet its own target for the commencement of operations if the landholder chose to exercise his or her full legal entitlement of 28 days to reach an access and compensation agreement. It is also unacceptable that the first direct contact with a landholder should also be the request for an access agreement and the trigger for the 28 day period in which the landholder is required to negotiate the agreement.

4.35 In too many cases it appears that the gas companies adopted a 'take it or leave it attitude' to negotiations with farmers, shifting the onus to the farmer to seek to negotiate reasonable conditions of entry and appropriate compensation for CSG activity on their land.

4.36 One witness at a hearing, who stressed that her family had a good relationship with the company seeking access to their land, nevertheless commented that landholders had to demand that access and compensation agreements covered issues of concern to them:

> **Senator STERLE: ...** Have you directly asked questions like who is going to fix your bores, what happens to the flaring in the dry, who is on the property and what chemicals are being used?
>
> **Mrs Scott:** Yes we have but we want it in writing. We want it to be written in the conduct and compensation agreement. At the moment, the current conduct and compensation agreement that was put before us does not mention any of those things. So it is up to us to highlight them and to make sure that they are in writing to try to protect ourselves.[21]

4.37 As outlined above, both Queensland and NSW have detailed guidelines that should govern the interaction between landholders and gas companies and include requirements that the parties act in good faith. The behaviour described in preceding paragraphs is clearly unacceptable and in breach of the guidelines.

4.38 The Queensland Government has, in the last year, introduced a number of measures to support landholders in their negotiations with the gas industry:

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21 Mrs Kate Scott, *Committee Hansard*, 18 July 2011, p. 12.

- a training program, to assist landholders negotiate a successful Conduct and Compensation Agreement;
- A program of landholder and resource industry information sessions on the new laws in late 2010; and
- Opening a new Mines office in Dalby in January 2011 with officers trained in mediation conferencing.[22]

4.39 These initiatives are to be welcomed and should be extended to areas subject to future expansion by the industry in advance of that expansion. It is regrettable that landholders involved in the first wave of the industry did not have that level of support.

Land use

4.40 The impact of gas exploration and extraction varies, having regard to the type of farm it is on – grazing or intensive cropping, the soil type, rainfall patterns, the dependence on groundwater, whether it is an irrigated property etc. In addition which of the range of mining related activities is to be carried out on a particular property will have a major impact on the extent of disruption.

4.41 Disruption to agricultural production can be such that the viability of a property is threatened. This is not restricted to the prime cropping lands such as the Liverpool Plains in New South Wales or the land east of the Condamine River in Queensland.

4.42 The operators of a major grazing property near Roma in Queensland identified continued, reliable access to water as their major concern. The property, part of a major integrated beef producer including grazing and feedlotting, gets 50 per cent of its water from overland flow and the remainder from groundwater entitlements.

4.43 The operators were deeply concerned that loss of a groundwater source could not readily be replaced or compensated for:

> [The gas company will] guarantee that if we ruin or destroy your water or water-taking ability, we will give you an alternative.' Generally, the alternative is to sink another bore. So will we just sink another bore in an already depleted and/or contaminated water-bearing seam? I am a little bit confused as to how it has easily passed that that is the solution for the future ...[23]

4.44 In addition to anxieties about reliability of water supply and the capacity to make good damage to it, day-to-day grazing operations could also be adversely affected:

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22 Queensland Government, *Submission 358*, p. 21.

23 Mr D Foote, Australian Country Choice, *Committee Hansard*, 18 July 2011, p. 3.

> The animals are not allowed to settle because there is a flared well every 405 metres across your land. But, all importantly, our cattle eat grass. Because of dust and disturbance to the grass the cattle cannot eat.[24]

4.45 Mr Foote also highlighted the problem of compensation:

> In our situation, through the integrated operation we run, we will never be able to be fully compensated, because how can you get compensation for tenderness, which is a measure of the beef that we provide and put into those supermarkets across the eastern states? How do you get compensation for that?
>
> At the moment, compensation is focused on the immediate impact of that well or that well head.[25]

4.46 The impact goes far beyond the well-head. Exploration for, or production of, gas has the potential to severely disrupt virtually every aspect of agricultural production on cropping lands and, in extreme circumstances, remove the land from production.

> They compensate us for impact and they think the square footprint of that well is an impact, but it is not. Our labour bill has gone up 20 or 30 per cent in the last 12 months to keep staff on. Our access to transport and roads is all getting more expensive. There are so many things that are impacting our business. As far as the impacts on the management of the farm, it is the fact your runs are not as long as they used to be so you are turning around. It is just all these inefficiencies. It is very hard to say exactly what it is worth until you have worked through it ...[26]

4.47 In a submission to the committee a producer of high quality wheat identified the likely impact of coal seam gas wells on his property. The gas company with a permit over this property estimated it would require only one acre in 250 for its wells. The landholder, having regard to the topography, drainage patterns, risk of erosion, plus the need for safety zones along pipelines and around wells, arrived at a figure of some 38 acres in 250. This calculation assumed that only wells and associated access roads and pipelines would be put on his land.[27]

4.48 A partner in the same group described the importance of careful land management to retain soil quality and prevent erosion:

> Summer rain is intense and water erosion is a major issue on our black, self-mulching clay soils. We manage this by reducing tillage, retaining stubble or planting cover crops in addition to the installation of contour

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24 Mr D Foote, Australian Country Choice, *Committee Hansard*, 18 July 2011, p.4

25 Mr D Foote, Australian Country Choice, *Committee Hansard*, 18 July 2011, p.4

26 Mr I Hayllor, *Committee Hansard*, 19 July 2011, p. 8.

27 Mr D Cush, Bellata Gold, *Submission 347*

> banks and waterways to convey stormwater from the upper slopes to the natural watercourses at the base of the slopes.
>
> Any development on these productive but fragile black soils can result in serious erosion if inappropriately designed and constructed. We also actively manage salinity on our soils and any development that impacts on the groundwater flow system may contribute to soil scalding. [28]

4.49 A second impact is that the presence of the wells would require changes to farming practices:

> ... there is the inconvenience factor and loss of production efficiencies because our machinery is in multiples of 40ft, 60 ft or 120 ft and fixed overheads are spread over a lower number of production acres.[29]

Mr Cush estimated that the loss of production on his property would be in excess of 25 per cent.

4.50 Ms Tydd described these problems in detail:

> At an operational level, we carry out controlled traffic farming, confining compaction to permanent traffic lanes, optimising soil conditions and reducing overlap. The machinery we use is up to 36 metres wide, set up on three-metre wheel spacing and equipped with the latest GPS navigation systems. Machinery of this scale requires plenty of room to move and turn around. Fields need to be free of any fencing, ponds, dams and roads. A one-quarter-acre well site every 250 acres with interconnecting gravel roads and pipelines would severely hinder our use of this machinery. Investment in the latest equipment delivers both environmental and economic benefits. For example, the use of GPS navigation delivers immediate production savings of 10 to 12 per cent. That means less diesel, less chemicals and less water.[30]

4.51 A paper prepared for the Queensland Government some years ago made a similar point:

> Laser levelling for cropping operations now means that long runs are required by grain and cotton farmers to operate machinery; and controlled traffic techniques require runs to be on established configurations. A network of even small obstacles in a paddock may make cultivation impracticable ...[31]

4.52 Gas company representatives indicated that they "were sensitive" to these issues and were willing to modify their practices accordingly:

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28 Ms N Tydd, *Committee Hansard*, 2 August 2011, p. 23.

29 Mr D Cush, Bellata Gold, *Submission 347*

30 Ms Tydd, *Committee Hansard*, 2 August 2011, p. 23

31 G Edwards, *An Issues Paper on the Management of Water Co-produced with Coal Seam Gas*,(December 2006)

> ... we do have some existing production in the Denison Trough, which is north of Rolleston. That is in black soil country and in that country ... the arrangements we have with the farmers is that we will walk into the wells.[32]

4.53 The committee has been told of cooperative processes where companies have agreed to site their facilities in such a way as to have the minimum negative impact on the landholder's own business; for example a gas company had worked with the landholder to agree the positioning and upgrading of roads within a property, thus providing some long term benefit to the landholder beyond the life of the gas field. In another example a company was open to negotiate the placement of wells when the landholder pointed out that the company's original proposal would intrude both on the operation of his business and the amenity of his family.[33]

4.54 The gas companies have stressed in evidence to this committee that they wish to have good relations with landholders and rural communities, that they prefer to avoid being required to go to arbitration and that they wish to have regulatory certainty. Santos and Dart Energy have also indicated in evidence to the committee that they would not enter land without the owner's consent.

Other land users

4.55 The Queensland Government has moved to restrict future minerals exploration near populous areas.[34] However this may be of little benefit to one group of landholders.

4.56 While the focus of much of the comment received by the committee was on landholders with significant holdings, the impact of the CSG industry extends beyond that group. The committee has received a number of submissions from people living on smaller blocks; people who have made a 'lifestyle' choice to move to a rural area or have been compelled by rising costs in urban areas to move to the country.

4.57 This group may not be faced with the direct intrusion of a gas company on to their property but they are nonetheless adversely affected by production facilities on adjacent land, increased traffic and industrial noise and related dust, and rising costs. These changes represent a real loss of the ambience and sense of community that may have drawn them to the land.

4.58 In addition to these impacts, there are claims of adverse health impacts from chemicals used by the industry:

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32 Mr K Horton, Group Manager, Upstream Queensland, AP LNG, *Committee Hansard*, 9 September 2011, p. 3.

33 Ian Hayllor,e-mail.

34 See, for example *Australian*, 16 August 2011 http://www.theaustralian.com.au/national-affairs/mining-free-zones-for-queensland-towns/story-fn59niix-1226115571800

> The small size of rural residential allotments (many are 12 hectares in area) and higher population density, particularly in the Tara-Chinchilla locality, increases the risk for gas field activities to cause environmental harm and nuisance when compared to other parts of the gas field. In particular, noise and vibration, dust and light could affect more residents and these effects could have more severe impacts on residents who through physical and financial circumstances are more sedentary.[35]

4.59 The special position of this group was recognised in the Queensland Co-ordinator General who commented that,

> This suggests strongly that the special circumstances of rural residents in this locality should be effectively addressed by quality liaison and social impact management.[36]

4.60 The author of this submission has argued that the responses of the gas company, QGC, and the Queensland Department of Environment and Resource Management (DERM) to specific complaints has been derisory. Dust suppression was carried out with water that produced a toxic run-off; claims of leaking gas wells were dismissed by DERM; complaints about excessive noise took months to be addressed.

4.61 Consultation with locals was also inadequate:

> Recently QGC brought on line 5 wells near my home.
>
> Not once was I consulted about their activities all I got was a letter telling us work would commence - as far as I am concerned that is not consulting I was merely told what was going to happen. The work lasted over 100 days and was clearly audible inside my house. Security guards would patrol the area 24hrs a day. I experience reverse beepers going off at 1 am in the morning ... trucks and vehicles run up and down the road causing dust and damage to the road. The road was repaired only after the work had been finished. The road was only usable for 4wd vehicles.[37]

4.62 A number of submissions to this committee have expressed similar frustrations and a sense that the agencies responsible for regulating the gas industry are not prepared to stand up to that industry. Whether all the claims of inaction are justified or not, there is clearly a very strong perception emerging in regional communities that the needs of the gas industry are being given priority over those of the local community.

4.63 While it may be of little consolation to affected individuals, the committee notes that the responsibilities of both the Queensland and New South Wales

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35 Mr D Pratzky, *Submission 360*, p. 2–3, quoting a report from the Queensland Coordinator General

36 Mr D Pratzky, *Submission 360*, p 2–3, quoting a report from the Queensland Coordinator General

37 Mr D Pratzky, *Submission 360*, pp 8–9. (Minor corrections have been made to this quotation)

Ombudsman extend to the failure of public officials to investigate complaints about breaches of government regulations.

Restoration

4.64 The obligations comprising the requirement to restore well sites, pipelines, dam sites (and other land used by the companies) need to be clearly identified in individual agreements and in the general conditions governing exploration and production licenses.

4.65 Much of the infrastructure associated with the industry will be removed but sealed wells and in-ground pipelines will remain. Wells will be sealed with cement and cut off some metres below the surface. Old pipelines are considered to be stable for the very long term.

4.66 The committee is particularly concerned with the rehabilitation of storage pond sites. It has been put to the committee that small ponds associated with exploration wells were not being adequately restored but merely bulldozed, burying saline residues. If the land is to be restored to a productive condition all residues must be removed and lining material whether impermeable or clay-based must also be removed.

4.67 Pipelines have also been raised as a cause for concern. Once production ceases, over the long term old metal pipelines will corrode and create areas of subsidence which will erode. The National Farmers Federation expressed concern that:

> Leaving the poly pipes in the ground may resolve the short-term impact but these will collapse in the longer term resulting in subsidence issues. Some examples show that crops cannot be grown on pipes installed 50 years ago so there may also be very long-term production impacts.[38]

4.68 The committee has heard no suggestion that old pipelines would be removed as part of site restoration works.

4.69 In evidence to the committee the gas companies accepted full responsibility for the clean-up and restoration of all their wells and sites and also for monitoring the stability of sealed wells in the future. However there must be some question about how long that responsibility will be retained by the companies, given that corporate structures and ownership change. This responsibility should not simply devolve on the public over time.

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38 Mr D Fraser, Chair, Mining & Coal Seam Gas Taskforce, National Farmers Federation *Committee Hansard*, 9 August 2011, p. 6.

Recommendation 16

4.70 The committee recommends that the Commonwealth, in cooperation with the states, establish an independently managed trust funded by the gas companies to make financial provision for long-term rectification of problems such as leaks in sealed wells or subsidence and erosion caused by collapsing pipelines.

Access and Compensation agreements

4.71 The issue of access and compensation agreements for the intrusion of a gas company onto a landholder's property is at the core of much of the hostility to the industry. It is important to bear in mind that in dealing with a gas company a landholder is being compelled to enter into an arrangement not of their choosing. Thus a satisfactory access and compensation agreement is essential to creating an amicable working relationship.

4.72 The significance of compensation agreements was emphasised in evidence to the committee:

> Conduct and compensation agreements are of extreme importance. Notwithstanding that they are not able to be registered on the title, they forever run with the land and bind future landowners. They contain extremely important rights and obligations and constitute equitable easements over land even though no plan need be registered. The make-good obligation also involves negotiation of a no less important document. The importance of securing water supply to maximise the productivity of land cannot be understated.[39]

4.73 Many witnesses were concerned at the imbalance of power between the two parties to the negotiations on conduct and compensation – the individual landholder and the multi-national gas company. This has been addressed to some extent by the requirement to complete a Conduct and Compensation Agreement before undertaking 'advanced activities' on the land. (See paragraph 4.11 above)

4.74 It is clear that there is wide variation in agreements even having regard to differences in land use, etc, and that the capacity of individual landholders to negotiate, seek legal advice, act cooperatively with neighbours, etc. has a significant impact on outcomes. A witness emphasised the need for a consistent approach to agreements:

> We do not want legislation that is actually going to prescribe what must be done but some legislation that will actually underpin something as simple as consistent codes of conduct, consistent agreements, and consistent heads of compensation positions. ... we have tried very hard to work with the

39 Mr P Shannon, *Committee Hansard*, 19 July 2011, p. 3.

> companies but we are relying on personal goodwill with individuals within the companies.[40]

4.75 The Queensland *Guide* is particularly relevant to the question of compensation. It lists "compensatable effects" (which can also be found in the *Petroleum and Gas (Production and Safety) Act 2004*). These are:

- Deprivation of possession of land surface;
- Reduction in land value;
- Reduction in land use including reduced use including reduced use that could be made through any improvements to it;
- Severance of any land from other parts of the land owned by the landowner;
- Any costs, damage or loss arising from activities carried out under the land surface;
- Accounting, legal or valuation costs reasonably incurred by the landholder to negotiate or prepare a Conduct and Compensation Agreement, other than costs involved to resolve disputes via independent alternative dispute resolution (ADR) [when parties have failed to reach an agreement]; and
- Damages incurred by the landholder as a consequence of matters mentioned above. [41]

4.76 It should be noted that reduction in land value and reduction in the opportunity to improve the land are both included in the list of compensatable effects. This subject has been the subject of much comment.

4.77 Anecdotal evidence suggests that the gas industry is having a negative effect on land values, though in the view of the Queensland Government:

> Due to the infancy of the industry and the subdued state of the rural property market, at this point in time, there is insufficient market sales data to provide definitive evidence about the impact of CSG operations on land values.[42]

Confidentiality clauses

4.78 Access and compensation agreements have generally included a confidentiality clause. Such a clause is included in the Queensland Standard Conduct and Compensation Agreement. However it comes with the following qualification:

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40 Mr P Shannon, *Committee Hansard*, 19 July 2011, p. 12.

41 *Guide to Queensland's new land access law*, pp 3–4; *Petroleum and Gas (Production & Safety) Act* (2004) (Qld), s.532 (4)(a)(b)(c).

42 Queensland Government, *Submission 358*, p. 22.

> ... the clause is optional and if the parties agree it may be deleted by crossing through the clause and initialling the deletion.[43]

4.79 Most of the landholders that the committee spoke to had negotiated agreements with a gas company which included such clauses. However, generally there did not seem to be much support for them. In fact confidentiality agreements were perceived as offering an advantage to the gas companies in that they prevented unified action by landholders to ensure that all agreements were in similar form and that compensation payments were soundly based and included similar levels of compensation for similar types of landholding.

4.80 The major gas companies did not view confidentiality clauses as particularly important; indeed it seemed to be recognised that such clauses merely heightened community suspicion of the industry. When asked by the committee if the companies were quite happy to waive existing clauses and forego their use in the future if that was the landholder's wish:

> The current landholder agreement used by Santos includes a standard confidentiality clause. ... Santos is aware that there is a public concern about potential for the clause to limit a landholder's ability to discuss their compensation arrangement. In response to this concern, whilst the confidentiality clause will remain standard practice, if, at any time a landholder wishes to waive the confidentiality clause, Santos will be willing do so.[44]

Committee view

Land Access

4.81 It needs to be recognised that land access is a business arrangement between two entities, both of whom have legal rights and reasonable expectations. All too often it appears that gas company representatives, or their sub-contractors, have not behaved in a responsible and business-like manner. Farms are businesses and their owners and managers deserve to be treated as responsible business people. At the same time, many farms are the private homes of families who should be treated with ordinary politeness and respect.

4.82 The request for land access involves major commercial and personal decisions for landholders which will have significant long-term impacts both on their business and their private lives and that of their families. Thus they should be given ample time to consider all of these issues, seek advice, consult neighbours, etc. without the threat of compulsory arbitration hanging over them.

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43 Standard Conduct & Compensation Agreement, clause 20, drafting note. This document may be accessed at http://mines.industry.qld.gov.au/mining/landholder-information.htm.

44 Santos, *Submission 353*, p. 23.

4.83 The coal seam gas industry is a relatively short lived industry. It may have a life of only 25 to 30 years in most regions. However, if it is not properly regulated, that period of time is sufficient to do serious damage to agricultural productivity on some of the best farmland in Australia. Landholders are legitimately concerned about water supply, disturbance to livestock, erosion caused by access roads and pipelines, interruption to natural drainage flows, damage to soil, particularly from salt, and the spread of noxious weeds.

4.84 The committee recognises that the holders of exploration or production permits for underground minerals must have access to the land surface to exercise their rights. However, in the context of the increasingly demanding food task that Australia and the world face it would be irresponsible to put at risk highly productive agricultural areas in exercising those rights.

4.85 In the committee's view it is both unreasonable and unwise to expose agricultural properties to the risk of long term damage, for example from loss of water, erosion or salt contamination, or to compel the owners of productive agricultural land to undertake significant changes to their farming practice to accommodate the gas industry.

4.86 Significant changes would include adopting less efficient production methods, re-equiping with machinery to operate on a smaller scale, cultivating different crops or undertaking major reconfiguration of a property to accommodate any of these changes.

4.87 The committee believes that the CSG industry can co-exist with agriculture but that this requires the industry to negotiate with landholders on matters such as the location of wells, the alignment of access roads and pipelines and the placement of major facilities such as compressor stations to ensure that they make the minimum intrusion on the management and operation of the property.

4.88 In some areas intensive CSG production may be incompatible with agriculture. The committee notes that Queensland and New South Wales are developing strategic cropping land policies to protect land use. Queensland's policy is explained thus:

> Strategic cropping land (SCL) is an important, finite resource that must be conserved and managed for long-term food and fibre production, and regional growth. Currently, the state's SCL resources are subject to a range of competing land-use activities, including agriculture, mining and urban development.
>
> It is important to find a balance between these sectors and minimise land-use conflicts by assessing potential impacts of development on this land.[45]

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45 Department of Environment & Resource Management, http://www.derm.qld.gov.au/land/planning/strategic-cropping/background.html

4.89 These policies will define land of high agricultural value which will be protected from development. The criteria which will be used to determine what is strategic cropping land in Queensland are:

- Slope;
- Rock size and content;
- Gilgai microrelief;
- Soil depth;
- Favourable drainage;
- ph levels;
- chloride content; and
- soil water storage capacity.

Strategic cropping land must also be in minimum areas of 50 hectares in the Eastern Darling Downs and 100 hectares in the Western Cropping Zone.[46]

4.90 New South Wales "... has a moratorium on issuing exploration licences while it develops regional strategic land use plans", which

> ... will identify the best places for cropping, viticulture, thoroughbred breeding, mining, coal seam gas extraction, conservation, and urban development.
>
> Until these plans are in place, all applications for licences will have to be exhibited for public comment and have to submit an agricultural impact assessment.[47]

Projects will not be supported if they have unacceptable impacts on agricultural lands or industries that are considered to have high strategic value.

Recommendation 17

4.91 The committee supports the concept of strategic agricultural land and recommends that, when identified, exploration for, or production of, coal seam gas be banned from land identified under defined criteria.

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46 Department of Environment & Resource Management, Queensland, *Protecting Queensland's strategic cropping land*, (April 2011), p. 4-5

47 NSW Department of Primary Industries, *States move to protect agricultural land for food production* (July 2011), http://www.dpi.nsw.gov.au/aboutus/news/agriculture-today/july-2011/states-move-to-protect-agricultural-land-for-food-production

4.92 This will protect areas such as the Liverpool Plains in New South Wales and the land east of the Condamine River in Queensland. The exclusion of land having these characteristics would apply to that land only; exploration and production could be permitted in a region containing strategic cropping land as long as it did not pose a risk to the reserved land.

4.93 It is important to note that a great deal of land subject to CSG exploration or production permits falls outside the areas identified in Queensland as 'strategic cropping land'. For example, AP LNG comment that the majority of their tenements lie outside the Strategic Cropping Protection and Management Areas.[48] In practice, drawing a distinction between 'high quality agricultural land' and the rest in trying to manage the impact of the CSG industry may oversimplify the issue.

4.94 To provide protection to agricultural land that falls outside the criteria of strategic cropping land the committee believes that the relevant laws relating to land access should be amended to make it clear that the overriding concern in access agreements for exploration or production must be the maintenance of the agricultural productivity or the land in question.

4.95 A grazing property may be average land and fall outside the definition of strategic cropping land but at the same time be a highly productive source of food. Thus the committee considers it appropriate to focus on agricultural productivity in general rather than restrict protection to 'prime' land.

4.96 At present where a dispute arises between a landholder and a gas company that dispute is resolved by going to either the Land Court in Queensland or the Land and Environment Court in New South Wales. Very few disputes, in practice, go to arbitration. Landholders have in the past been unwilling to go to arbitration because of cost and a perception that they can do little to prevent the gas company coming on to their land. Gas companies rarely enforce their rights through the courts.

4.97 The committee considers that the position of landholders when negotiating with mineral exploration and production companies needs to be strengthened, by making it clear that any arbitration process or the exercise of a ministerial discretion in relation to land access must be required to give priority to the protection of agricultural productivity.

4.98 Such a change is also consistent with the Queensland Government's draft food policy - *Food for a Growing Economy: An Economic Development Framework for the Queensland Food Industry* – as outlined in its submission to this inquiry.[49]

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48 AP LNG, S*ubmission 366*, p.13

49 Queensland Government, *Submission 358*, pp 26–27.

Recommendation 18

4.99 The committee recommends that the Commonwealth, through the Council of Australian Governments, or other appropriate forum, request the States to insert in the relevant legislation a requirement that arbitration bodies charged with resolving disputes between landholders and the holders of exploration or production titles – the Land Court in Queensland; the Land and Environment Court in NSW – must give priority to the maintenance of agricultural production with minimal disruption in deciding any dispute.

4.100 Similarly, where a ministerial discretion such as that exercised under s.71 of the NSW Petroleum (Onshore) Act exists, the exercise of that discretion should be required to give priority to maintaining agricultural production with minimum disruption to the existing land-use.

4.101 The committee notes that section 71 of the *Petroleum (Onshore) Act 1991(NSW)* provides a significant degree of protection to cultivated land generally while at the same time, through the exercise of a Ministerial discretion, providing protection for the interests of the holders of a production lease.

4.102 The committee believes that the inclusion of such a provision, extended to include exploration permit holders, in the relevant laws of all the states would further strengthen the position of landholders. At the same time the committee believes that it would be desirable to clarify the meaning of 'cultivated land' to include land that was generally cultivated but that might, as part of a normal rotation, be pastured in some years.

4.103 In speaking to this committee the companies have all stressed that they believe that their activities can co-exist successfully with existing land use. Clearly there are already examples of 'best practice' behaviour by companies that are working cooperatively with landholders. These should become the industry norm. The committee believes that, by making it clear in legislation that the protection of agricultural productivity must be the priority in developing plans for land access for the conduct of CSG mining operations, this will be achieved.

4.104 The committee believes that section 69D of the *Petroleum (Onshore) Act 1991 (NSW)* provides a reasonable guide to the sort of general issues that need to be covered by an access agreement. However certain matters need to be added to that list including an obligation to inform the landholder what chemicals a company may bring on to a property and arrangements with regard to fire safety.

4.105 The access agreement should also clarify the obligation on the gas company to advise the landholder when and for what purpose its workers will be on a property. Farming involves the use of heavy machinery and the application of chemicals, for example, and the use of contracted services can also reduce the landholder's flexibility. Avoiding interference with a landholders business and occupational health and safety considerations require that landholders know who is on their property at any given time.

4.106 A requirement to inform the landholder before any gas workers came on to a property would also do something to reduce the anxiety caused to families by the presence of strangers on a property.

Recommendation 19

4.107 The committee recommends that draft access agreements between landholders and gas companies include a requirement that company employees must have a landholder's approval whenever they wish to enter a property and that companies must maintain logs of staff entering private property.

Recommendation 20

4.108 The committee recommends that draft access agreements clarify the gas companies responsibility with regard to fire safety and require the gas company to advise landholders of all chemicals that are brought on to the land.

Compensation

4.109 The committee believes that the list of matters to be dealt with in compensation agreements contained in the Queensland *Guide* is, with two important exceptions, a good summary of matters for which compensation should be paid. As discussed above, the disruption to the lives of landholders when coal seam gas exploration or production occurs on their land is considerable and the intrusion into the landholders life is forced on him. It is appropriate that the compensation recognise both the involuntary nature of the landholder's situation and the loss of social amenity.

4.110 This view is supported in evidence to the committee:

> The compensation regime at the moment makes no allowance for the social impacts and no allowance for the compulsory nature of the imposition.[50]

4.111 It has been suggested that a premium of 20 per cent be added to any compensation package to recognise the involuntary nature of the landholder's participation. The committee does not wish to propose a specific figure but it certainly endorses the principle.

Recommendation 21

4.112 The committee recommends that legislation governing compensation to landholders include provisions that recognise as compensatable effects the involuntary nature of landholders' dealings with coal seam gas companies and the social impact of coal seam gas exploration and production.

4.113 A further proposal put to the committee was that, in extreme circumstances, a landholder should have the right to demand that he be bought out.

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50 Mr P Shannon, *Committee Hansard*, 19 July 2011, p. 3.

> If a landowner loses his water and has to rely on water being piped from an uncertain source of uncertain quantity and quality, aside from the interference with his land values, there is likely to be a general interference with his enthusiasm to continue on the land. I see no reason why a landowner so affected should not have the right to require the immediate acquisition of his farm at its pre-market value and consequential damages.[51]

4.114 The committee is generally inclined to support such a proposal where CSG activity either renders an agricultural property unviable or requires fundamental changes to its operations to maintain its viability. However it is to be hoped that if the committee's recommendations are adopted then the situation where a farm was rendered non-viable would not occur.

4.115 It would be desirable to have a clear statement that where a property suffers irreversible damage due to unforeseen circumstances, for example long-term interruption to water supply or saline pollution over a significant area, the liability of the gas company to 'make good' must includes a liability to acquire the property "... at its pre-market value and consequential damages".

4.116 The committee also considers that compensation for legal costs incurred by a landholder in negotiating an agreement are unnecessarily restrictive. The exclusion of "... costs involved to resolve disputes via independent alternative dispute resolution" discourages a landholder from seeking independent arbitration of a dispute with a gas company.

Recommendation 22

4.117 The committee recommends that States' include in the relevant legislation as a compensatable effect the costs incurred by a landholder in seeking independent arbitration of a dispute over an access and compensation agreement, except where it can be demonstrated that the landholder had not negotiated reasonably and in good faith.

4.118 Some landholders were not fully informed of their legal rights or received misleading advice about the time available for landholders to respond to a request for access; some felt bullied and intimidated by the prospect of expensive and time-consuming legal action and were talked into signing confidential agreements about access and compensation, which prevented concerted action to assert and defend their rights.

4.119 Given the evidence the committee has received of wide variation in the terms of agreements and in standards of practice between companies, some requirement to review existing agreements in light of these published principles should be considered. For example, industry representatives did acknowledge in informal conversation that

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51 Mr P Shannon, *Committee Hansard*, 19 July 2011, p. 2.

there had been some 'cowboy' behaviour by companies and that they had put considerable effort into improving this aspect of their performance.

4.120 In view of the wide variation in practice by gas companies, particularly in the earlier stages of the rapid expansion of the industry, the committee supports a proposal put forward by the Basin Sustainability Alliance (BSA) and others, that land access and compensation agreements that have already been entered into should be subject to review. Such reviews could be conducted by a specially appointed official of the State Ombudsmen's offices, for example.

4.121 If a landholder believes that an agreement was entered into under duress or with inadequate or misleading advice then there should be some right of redress. The BSA identified the following circumstances that might trigger a review:

- Lack of independent legal advice;
- Age, language, lack of understanding of the implications, etc can be shown to have influenced the process;
- Where clauses in the agreement can be shown to have compromised make-good obligations, future rights or materially changed rights; and
- Where there is evidence of misleading or deceptive conduct; or where reasonably unforeseeable consequences or interference have affected the landholder subsequent to the agreement.

Recommendation 23

4.122 The committee recommends the Queensland and New South Wales governments establish mechanisms that provide where a landholder, having an access and compensation agreement with a coal seam gas exploration or production company, believes that that agreement was entered into without proper advice or understanding of its implications, then the landholder be entitled to seek a review of the agreement.

4.123 The committee notes that many landholders and residents of small regional communities having no gas facilities on their land, particularly those on small blocks, may be subject to many of the negative impacts of the gas industry but have no protection under an access and compensation agreement.

Recommendation 24

4.124 The committee recommends that the position of residents of small regional communities and on small blocks of land also be clarified and that enforceable conditions, including a buffer zone around houses, are included in exploration or production permits to ensure that, despite having no development on their land, they are not subject to excessive interference from coal seam gas developments.

4.125 There has been some discussion before the committee as to whether compensation payments to landholders should reflect the value of the gas being

extracted through wells on their land. The committee does not support this view. The minerals under the ground belong to the Crown, not to the landholder.

4.126 Payment for the right to extract those minerals is made to the relevant government through royalties, fees and other taxes and charges. In addition, the disruption to a landholder's activities may be wholly unrelated to the value of the gas being extracted through his land. Compensation to the landholder should reflect that disruption.

4.127 Representatives of the industry made it clear that they were not wedded to any particular distribution of the taxes they paid but that changes to one could not be isolated from consideration of the rest:

> We pay royalties, which in effect come to $6 billion. Those royalties ... are the compensation to the Australian people. On top of that we pay the landholders an additional sum. We are more than happy to look at different regimes covering where the money is distributed–whether it is Commonwealth, state or landholders. What we cannot do, however, is just have money added on top of money.[52]

4.128 The committee does not believe that it is necessary to take any action with regard to confidentiality clauses beyond ensuring that all parties to a negotiation are aware that they are optional.

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52 Mr J Baulderstone, Santos, *Committee Hansard*, 9 August 2011, p. 14.

Chapter 5

Coal Seam Gas and Greenhouse Gasses

5.1 The merits or otherwise of CSG as a means of reducing greenhouse gas emissions, while not directly relevant to this committee's terms of reference, have been canvassed in a number of submissions. On the one hand its environmental benefits as a low green house gas fuel are used to justify the rapid expansion of the industry and 'offset' other potentially harmful environmental impacts of the industry; on the other claims that it is a worse source of greenhouse gas than coal are used to suggest the industry should not be allowed to proceed.

5.2 In the context of global warming, natural gas is considered to be an attractive 'transitional' energy source, being much lower in carbon dioxide (CO_2) emissions than coal or petroleum when burnt.[1]

Table 2: Average carbon emission intensity of selected fossil fuels. Fuel	**Emissions of carbon dioxide per GJ of produced energy**
Brown coal	93.3 kg
Black coal	90.7 kg
Petroleum	68.2 kg
Gas	50.9 kg

5.3 While natural gas is relatively 'cleaner' than coal when burnt, there is debate about the advantage of natural gas over coal when the total production process is considered. As the table above shows, CO_2 emissions from the combustion of natural gas are significantly lower than those from other hydrocarbon energy sources. However the release of methane, 'fugitive emissions', during the production and subsequent processing and transport of the gas may negate this advantage.

5.4 Methane is a much more potent greenhouse gas than CO_2; it is more than 20 times more effective at trapping heat in the atmosphere than carbon dioxide.[2] Methane is much less persistent in the atmosphere than CO_2, dispersing after little more than a decade, compared with CO_2 which can persist for much longer periods of time.[3] Thus methane's impact is of particular importance in the short term.[4]

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1 Commonwealth Parliamentary Library, Mike Roarty, Research Paper no. 25, 2007-08, Australia's Natural Gas, issues & trends, p. 16 http://www.aph.gov.au/library/pubs/rp/2007-08/08rp25.pdf Accessed 22 August 2011.

2 Approximately 21 times more efficient at trapping heat in the atmosphere than CO_2, by weight over a 100 year period. http://www.epa.gov/methane/scientific.html Accessed 22 August 2011.

3 Solomon et al, *Persistence of climate changes due to a range of greenhouse gases*, Proceedings of the National Academy of Sciences of the United States of America (PNAS), 2010, October 26, 2010 vol. 107 no. 43 18354-18359 http://www.pnas.org/content/107/43/18354.full Accessed 29 November 2011

4 *Nova: Science in the News*, the Australian Academy of Science, http://www.science.org.au/nova/118/118key.html Accessed 25 October 2011.

5.5 Much of the adverse comment has relied on references to an article published in April 2011 by researchers at Cornell University, *Methane and the greenhouse-gas footprint of natural gas from shale formations.*[5]

5.6 This article does conclude that:

> The footprint for shale gas is greater than for conventional gas or oil when viewed on any time horizon, but particularly over 20 years. Compared to coal, the footprint of shale gas is at least 20% greater and perhaps more than twice as great on the 20-year horizon and is comparable when compared over 100 years.[6]

5.7 The authors also comment that:

> Our analysis does not consider the efficiency of final use. If fuels are used to generate electricity, natural gas gains some advantage over coal because of greater efficiencies of generation. However, this does not greatly affect our overall conclusion: the GHG footprint of shale gas approaches or exceeds coal even when used to generate electricity.[7]

5.8 It is necessary to note a number of qualifications which suggest that this conclusion cannot be directly applied to CSG production in Australia. The article is not looking at coal seams, nor does it include the efficiency of end use in its considerations. It evaluates "... the greenhouse gas footprint of natural gas obtained by high-volume hydraulic fracturing from shale formations" and comments that "the higher emissions from shale gas occur at the time wells are hydraulically fractured – as methane escapes from flow-back return fluids – and during drill out following the fracturing".[8]

5.9 As table 2 of the paper shows, the fugitive emissions profile for shale gas is exactly the same as for conventional gas with the exception of those two stages of production. Thus the requirement for fraccing in any given gas field is critical to analysis of the greenhouse gas footprint of the gas.[9]

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5 Climatic Change, DOI 10.1007/s10584-011-0061-5, *Methane and the greenhouse-gas footprint of natural gas from shale formation,* A letter, Robert W. Howarth, Renee Santoro, Anthony Ingraffea http://www.sustainablefuture.cornell.edu/news/attachments/Howarth-EtAl-2011.pdf Accessed 25 October 2011.

6 *Methane and the greenhouse-gas footprint of natural gas from shale formation,,* Abstract, p. 679.

7 *Methane and the greenhouse-gas footprint of natural gas from shale formation,,* section 6

8 *Methane and the greenhouse-gas footprint of natural gas from shale formation,,* p. 679. 'Flow back' is when fraccing fluids are withdrawn from a well, and 'drill-out', is the removal of concrete plugs used in the fraccing process. p. 681. Table 2 of the paper, p. 683, illustrates the sources of fugitive emissions clearly.

9 *Methane and the greenhouse-gas footprint of natural gas from shale formation,* Table 2, p. 683

5.10 Coal seams generally are less likely to require fraccing than shale. For example AP LNG states that:

> ... during the first 5 years of the current Australia Pacific LNG Project Implementation Plan, it is not expected that any development wells in the Walloons areas will need to be fracture stimulated as wells will be located in areas of high permeability coals.[10]

5.11 Eastern Star Gas has stated that its Narrabri project will not involve fraccing and Dart Energy representatives advised the committee that, depending on the structure of the coal seam, horizontal drilling was a preferred alternative to fraccing.

5.12 In addition, at section 7 of the paper by Howarth et al, the authors consider whether fugitive emissions can be reduced and conclude that there is a range of measures and technologies which, if adopted, can significantly reduce emissions. However they also note that "... Industry has shown little interest in making the investments needed to reduce these emission sources ..." and that "Better regulation can help push industry towards reduced emissions".[11]

5.13 In evidence to this committee, a representative of Dart energy noted his company aimed at "zero fugitive emissions" and that:

> On an operational basis, coal seam gas wells are hooked up before they start producing gas. They are online to produce water first before they produce the gas. Fugitive emissions compared to those industries [shale gas] are very, very low.[12]

5.14 The gas industry in Australia has commissioned a study of this subject from consultants, Worley Parsons, who made:

> ... a life cycle comparison of the greenhouse gas (GHG) emissions of Australian liquefied natural gas (LNG) derived from coal seam gas (CSG) and Australian black coal, from extraction and processing in Australia to combustion in China for power generation.[13]

5.15 The report states that adopting the scenario comparing of CSG/LNG and black coal produced for export is reasonable.

> To achieve a like-for-like comparison (since the CSG/LNG industry examined is export driven) this L[ife] C[ycle] A[ssessment] only considers

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10 AP LNG, *Submission 366*, p. 42.

11 Climatic Change, *Methane and the greenhouse-gas footprint of natural gas from shale formation*, op cit, section 7.

12 Mr J Needham, Explorations Operations Manager, Dart Energy, *Committee Hansard*, 9 September 2011, p. 20.

13 Worley Parsons, Resources & Energy, *Greenhouse Gas Emissions, Study of Australian CSG to LNG*, April 2011, p. 3. http://www.appea.com.au/images/stories/Policy_CSG/appea%20worley%20csg%20greenhouse%20emissions%20study%20final%20110411.pdf

> export streams of CSG and black coal for combustion in power plant in China. This simplifying assumption is realistic since most LNG and a large proportion of black coal is likely to follow this route ...[14]

5.16 The report produced a range of results showing that, when used in electric power generation CSG has an advantage over most forms of coal.

> The results are sufficiently clear and robust to confirm that on a life cycle basis CSG/LNG produced for combustion in a Chinese power plant is less GHG intensive than coal, based on the stated assumptions and scenarios, including the application of best practice in GHG and environmental management.
>
> Depending on the end combustion technology, switching from coal to CSG/LNG for electricity generation avoids up to 0.87 tonnes CO_2-e for every life cycle tonne CO_2-e from CSG/LNG, and up to 4.5 tonnes CO_2-e for every tonne CO_2-e emitted from CSG/LNG in Australia.[15]

5.17 CSG/LNG's advantage diminishes where lower efficiency open cycle gas turbines are compared with higher efficiency coal plants and, at the margin, a worst case gas scenario may produce more greenhouse gasses than a best case coal scenario.[16] It has also been suggested that the 'best case' scenarios for CSG compare its use with "... the dirtier subcritical coal technology that the Chinese no longer build".[17]

5.18 There are significant differences in the profile of emissions over the production and combustion cycle for the two products. For coal the overwhelming majority of emissions are produced as a result of combustion, while for CSG the emissions during production are a much higher proportion of total emissions.

> The two products have different emissions profiles. For the export situation considered, most GHG emissions from coal (94%) will result from combustion in China, whereas extraction and processing in Australia accounts for only 2.7%. For CSG the respective figures are 74% and 22%.[18]

5.19 The Howarth paper concludes that:

> ...the uncertainty in the magnitude of fugitive emissions is large. Given the importance of methane in global warming, these emissions deserve far greater study than has occurred in the past. We urge both more direct

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14 Worley Parsons, p. 7.

15 Worley Parsons, p. 29.

16 Worley Parsons, table 1.2, p. 5.

17 Beyond Zero Emissions, http://beyondzeroemissions.org/media/newswire/green-deals-csg-cleaner-coal-111108, accessed 14 November 2011.

18 Worley Parsons, p. 3.

> measurements and refined accounting to better quantify lost and unaccounted for gas.[19]

5.20 One of the authors of the Howarth et al paper has made the comment that:

> We do not intend for you to accept what we've reported on today as the definitive scientific study in regards to this question. It's clearly not ... What we're hoping to do with this study is to stimulate the science that should have been done before.[20]

Committee view

5.21 This is a serious issue and it does merit continued study. Because methane is such a potent greenhouse gas, fugitive emissions do have the capacity to alter any net reduction in greenhouse gases quite significantly and, as the Worley Parsons paper shows, efficiency of end use is also critical. Because of the sensitivity of modelling to the data fed into it, it is vitally important to have accurate data collected from the actual gas facilities rather than relying on extrapolation from a small sample or another region.

5.22 Any assessment of fugitive emissions must be specific to the gas field, whether it is coal or shale (or any other source of natural gas), to the technologies used in extracting transporting, processing and burning the gas, and the regulatory framework under which the industry operates.

5.23 The most important message to emerge from this debate is that governments must have in place rigorous monitoring and regulatory regimes. These must have the necessary technical capacity to monitor all gas wells and other potential sources of fugitive emissions. They must also require the adoption of the most efficient technologies to minimise fugitive emissions in natural gas production and consumption. The regulatory regimes must be backed up by a qualified inspectorate that can ensure compliance.

Senator the Hon. Bill Heffernan
Chair

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19 Climatic Change, , *Methane and the greenhouse-gas footprint of natural gas from shale formation*, section 8

20 Anthony Ingraffea, quoted, *Cornell Chronicle*, 11April 2011, http://www.news.cornell.edu/stories/April11/GasDrillingDirtier.html.

Additional Comments from The Nationals

1.1 The report reflects the immense concern around a number of issues pertaining to Coal Seam Gas however no person on the committee has recommended the cessation of the industry. There are evident concerns which include prime agricultural land, aquifer integrity and quiet enjoyment of residential areas. These have been addressed in the report and we hope they become a guide for action to address these issues for both the sake of the industry and the sake of the environment.

1.2 The quiet enjoyment of residential tenants is a term well understood in tenancy agreements. Residential areas provide one of the most prominent attributes of so many Australians, the house they live in. Coal Seam Gas represents an extraordinary and unanticipated intrusion in urban areas.

1.3 Prime agricultural land is an asset whose lifetime is infinite and therefore the prospective cash flow would have to take into account the value of agricultural produce over thousands of years. The return to the nation over the long term is vastly superior from agriculture than from mining and as the premier of agricultural assets, prime agricultural land should be protected.

1.4 We strongly believe that if the environmental, residential and agricultural issues are not addressed that public pressure would place the whole industry at risk with the economic future of both state budgets and, to some extent, the economic development of certain regional communities within the gas field areas exposed.

1.5 A subject in addition to the report that we believe does need to be further addressed is that of the compensation to landholders, as such we would delete from paragraph 4.123 all after and including “the committee does not support this view,” as well as delete paragraph 4.124.

1.6 The lack of the bargaining position for farmers and landholders became quite apparent to the committee, and that mining companies coming on to private land to access coal seam gas have substantial and unfair capacity to access their rights over and at the expense of the diminution of the farmer or landholder’s property rights.

1.7 On examination of the Act it also became apparent that in many instances the coal seam gas was an asset owned by the farmer or landholder which had been excised from the title holder by reason of state or federal Acts from time to time over the previous century. A good expose of the variant states intrusion into the property rights of landholders can be seen in Premier Neville Wran’s second reading speech in 1981 doing precisely this.

1.8 We believe that to underwrite the landholder’s bargaining position on access agreements onto the landholders land that a default agreement be in place to put a floor on the return to the most affected party, the owner of the land with the gas wells on it.

1.9 As miners have argued that a standard price does not reflect the variant returns of the wells then it would seem logical and fair that just as the state gets a percentage in royalties so should the landholder. If 99% is shared between the state and the miners then 1% for farmers should hardly be deemed unreasonable for an asset that is extracted from their place and an asset that historically in many instances they owned.

Recommendation 1

1.10 To bring about a greater parity in the bargaining position of the farmer or landholder the Nationals Senators recommend a default position, that the title holder of land be allowed a default position on access agreements equivalent to 1% of the gross income from the well head on the property which it is located.

Senator Fiona Nash **Senator Barnaby Joyce**

Additional Comments from the Australian Greens

1.1 The Australian Greens welcome this report, which clearly sets out many of the concerns that the Australian community and key scientific research bodies have with the rapidly evolving coal seam gas industry. We are pleased to see tri-partisan agreement on a number of issues raised in the report, including risks to groundwater and farming communities.

1.2 We note that the Inquiry was focussed only on coal seam gas in the Murray Darling Basin, which did not allow detailed consideration of the impacts of coal seam gas across the country, or of shale gas which predominates in Western Australia, or of the land-based and marine impacts of transportation and export facilities for LNG, or the emissions intensity of coal seam gas. The Australian Greens will be moving for a fresh, dedicated Senate Inquiry into these broader issues to ensure that the Senate concerns itself fulsomely with this issue of such importance to the community.

1.3 The Australian Greens support the recommendations in the Report, however wish to make some brief additional comments on a number of issues not fully canvassed by the report and its recommendations.

1.4 We are very pleased there is tri-partisan support for Recommendation 1 of the Report calling for a thorough review of the appropriateness of 'adaptive management' in regulating the coal seam gas industry. As is highlighted throughout the report, there are significant gaps in information regarding particularly the cumulative and long term impacts of the industry. The Australian Greens have concerns that the much touted adaptive management framework to environmental regulation is inappropriate for this rapidly developing industry, due to the high levels of uncertainty associated with aspects of its development, and the potential for it to cause irreversible harm to Australia’s ground water systems. We would like to see this framework carefully scrutinised with, as noted in paragraph 1.73 of the report, particular focus on the question of whether 'adaptive management' of the coal seam gas industry’s development is consistent with the precautionary principle.

1.5 With regard to Recommendation 2 of the report, we believe the more appropriate body to have responsibility for promoting a strong and consistent regulatory framework for the coal seam gas industry is the Ministerial Standing Council on Environment and Water. While regulatory responsibilities for the industry varies across the states and territories, it is more appropriate for the Ministers with responsibility for surface and groundwater to have oversight through this process, rather than energy and resources ministers who all too often define their role as promoters rather than regulators of industrial development.

1.6 The Australian Greens strongly support Recommendations 3 and 4 of the report which say that we must wait for the results of specific scientific studies before issuing any further coal seam gas approvals. This approach is consistent with my Senate motion on 13 September 2011 for a moratorium on further coal seam gas approvals

until the long-term impacts of the industry on our groundwater, agriculture, rural communities, threatened species, the climate and the Great Barrier Reef are known, which unfortunately was not supported. Clearly significant uncertainties remain about the long-term consequences of the coal seam gas industry on Australia's groundwater resources. Far more research is needed to understand the extent to the full potential impacts of coal seam gas on our water supplies, particularly over the longer term. Once that information on the impacts of coal seam gas on the long term sustainability of our water resources, agricultural land and natural environment is amassed, there must be a conversation with the community about whether this short-term fossil fuel industry is an appropriate investment for Australia given the scarcity of our water resources, good quality food producing land and the urgency of moving to renewable energy as quickly as possible to avert dangerous climate change. The Australian Greens believe it is not, when we have alternatives to energy production but not to food.

1.7 We strongly support Recommendation 7, that the Commonwealth amend the Environment Protection and Biodiversity Conservation Act 1999 to include the sustainable use of the Great Artesian Basin as a 'matter of national environmental significance'. While we note the terms of reference of the inquiry are limited to consideration of the Murray Darling Basin, the Australian Greens support extending that trigger to all groundwater and surface water. My bill currently before the Senate, the Environment Protection and Biodiversity Conservation Amendment (Protecting Australia's Water Resources) Bill 2011 proposes the introduction of such a trigger to pick up the water impacts of mining (including coal seam gas). This bill proposes that a new matter of national environmental significance be mining operations that have, will have or are likely to have a significant impact on the quality, structural integrity or hydraulic balance of a water resource. If passed the bill would mean that federal assessment and approval would be required for mining operations likely to have a significant impact on Australia's water resources. Our conviction as to the need for this bill is all the stronger after hearing the evidence from communities, scientists, state governments and other interested parties through this Inquiry. We believe that this Report strengthens the case for our bill to receive support from all parties and will be seeking that in earnest.

1.8 We strongly support Recommendation 13, requiring comprehensive water management plans - and the capacity to implement those plans - before any further production approval for coal seam gas be granted. We consider the issues raised in paragraph 3.40 of the Report require special emphasis here: that given the risk of severe weather events in the coming decades, there is a clear need for a step change in the management of water both in normal and severe weather situations. As such, these water management plans need to ensure adequate protection of groundwater, agricultural land and downstream users at all times, including in times of severe weather and natural disasters like the summer flooding on Queensland earlier this year. Further, plans currently in place should be reviewed by state and federal regulators for their adequacy to ensure continuous protection of our rivers, creeks and groundwater throughout all seasons and weather.

1.9 We note and support the numerous recommendations of the report that seek to enhance the rights of landholders in their engagement with the coal seam gas industry. This is an issue that the Australian Greens have already proposed a clear solution for, in the Landholders' Right to Refuse (Coal Seam Gas) Bill 2011, introduced in August of this year. If passed, this Bill will provide Australian landholders the right to refuse the undertaking of coal seam gas mining activities on their land without prior written authorisation. The Australian Greens believe that farmers should have the legal right to decide that they would prefer to be able to keep farming on their land, and for their children to have that option, rather than take the risk of possible long term groundwater depletion or contamination. This bill does not alter the ownership of the minerals and gas, which remain vested in the states, and acquisition laws with appropriate compensation would still apply.

1.10 The Australian Greens support the general discussion in the report on greenhouse intensity of the domestic coal seam gas and LNG export industry, particularly the findings in paragraphs 5.20 to 5.22.

1.11 As highlighted in a recent paper prepared by Merril Lynch[1], a number of significant questions are yet to be answered regarding the emissions profile of Australia's domestic coal seam gas and LNG export industries, including:

- The accuracy of the diverse assumptions built into industry commissioned life-cycle analysis of CSG to LNG projects (including assumptions that gas will substitute for coal), and
- The accuracy of current Australian emissions reporting standards, and the risk that current practices under-estimate actual emissions as they are not specific to the Australian context.

1.14 The government and the public has a significant interest in ensuring the full costs and benefits of this industry, including greenhouse implications, are fully understood when deciding the degree to which this industry should be supported. Noting that this support from our society takes many forms - through regulatory approvals, the various forms of public support extended through subsidies, grants and infrastructure investments by Australia's governments, and the social and environmental costs of this industry. It is also very much in the interest of industry and investors to have accurate information available about the emissions intensity of coal seam gas projects, to ensure accurate projection of the future carbon liability of these projects.

1.15 Further, steps must be taken, as noted in the report's paragraph 5.22 to put in place rigorous monitoring and regulatory regimes, with the necessary technical capacity to monitor all gas wells and other potential sources of fugitive emissions.

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1 Merrill Lynch Green gas debate: substantive report a matter of weeks away 21 November 2011

1.16 Building on the findings in Chapter 5 of the report, the Australian Greens make the following additional recommendations:

Recommendation 1

1.17 That a comprehensive independent life cycle assessment of the greenhouse gas intensity of Australia's domestic and export coal seam gas industry is undertaken promptly, to ensure that decisions to approve such activities are informed by independent, accurate information, noting such information is also invaluable for industry and investors.

Recommendation 2

1.18 That the federal Government promptly develop greenhouse gas accounting methodologies appropriate to coal seam gas extraction and production in Australia.

Recommendation 3

1.19 Any projections of emissions from proposed coal seam gas activities must be specific to the gas field, whether it is coal or shale (or any other source of natural gas), to the technologies used in extracting transporting, processing and burning the gas, and the regulatory framework under which the industry operates.

Recommendation 4

1.20 Governments must have in place rigorous, independent monitoring of greenhouse emissions throughout coal seam gas extraction and production processes, including monitoring of each gas well and all other potential sources of greenhouse emissions. The regulatory regimes must be backed up by a qualified inspectorate that can ensure compliance.

1.21 With regard to paragraph 5.1, we note there are still significant questions around whether the life-cycle emissions of coal seam gas is significantly less than coal, and secondly, even if it is found to have lower emissions intensity, this simply may not be good enough given need to urgently stabilise and start reducing global emissions (particularly when the adverse water, food security, rural community and Reef impacts are considered).

1.22 The Australian Greens would like to thank the many scientific, environmental and community groups, and members of the public, that made invaluable submissions to this inquiry, particularly the landholders and groups who gave evidence during the committee's hearings in Roma, Dalby, Brisbane, Narrabri, and Canberra.

Senator Larissa Waters
Australian Greens Senator for Queensland

APPENDIX 1

Submissions Received

Submission Number	Submitter
1	Matthew Devine
2	Debbie Buller
3	Geoff Tuckett
4	Finley Chamber of Commerce - Industry and Agriculture
5	David Leaman
6	Peter Oataway
7	Murray Valley Water Diverters Advisory Association (NSW)
8	Margot Marshall
9	Pechelba Trust
10	Donald Ward
11	Robyn Schmetzer
12	Greg Parr
13	Peter Millington
14	Michael Tonner
15	Environmental Farmers Network
16	Country Women's Association of NSW
17	Urban Taskforce Australia Ltd
18	South Australian River Communities
19	Les Hill
20	Pentreaths Lockington
21	Grand Junction Pty Ltd
22	Barrie Dexter and Donald Macleod
23	Brian Kelaher
24	Bill Murray
25	Murrumbidgee Valley Food and Fibre Association (MVFFA)
26	Virginia Tropeano
27	Les Worland
28	Robert Shaw
29	Yenda Producers Co-operative Society Ltd

30 John Fensom

31 Ken Jury

32 NSW Irrigators' Council

33 Wakool Shire Council

34 Meredith Whykes

35 Grampians Regional Development Australia Committee

36 Josephine Kelly

37 Australian Plantation Products and Paper Industry Council (A3P)

38 Leeton Shire Council

39 National Irrigator's Council

40 Citizens Electoral Council of Australia

41 Loddon Shire Council

42 Murray Irrigation Ltd

43 John Martin Total Property Services

44 Bruce Lang

45 Christine O'Callaghan

46 Tobacco and Associated Farmers Co-operative Ltd Rural Supplies (TAFCO)

47 Myrtleford Chamber of Commerce and Industry (MCCI)

48 East End Mine Action Group Inc. (EEMAG)

49 South Pacific Seed PL

50 Ian Rowan

51 Bill Hetherington

52 Mark Cameron

53 Jessica Stanford

54 Australian Floodplain Association

55 Max Winders

56 Kristy Bartrop

57 University of New England (UNE)

58 National Association of Retail Grocers of Australia PL (NARGA)

59 Mildura Rural City Council

60 Western Murray Irrigation Limited

61 Griffith Business Chamber

62 B and W Rural

63 Namoi Councils Water Working Group

64 Inland Rivers Network

65 Wentworth Shire Council

66 High Security Irrigators - Murrumbidgee
67 Victorian Farmers Federation (Corryong Branch)
68 The Hon. Tony Catanzariti MLC
69 Peter Calabria
70 Jason Richardson
71 Citrus Australia Ltd
72 Wine Grapes Marketing Board (WGMB)
73 Julie Andreazza
74 Ben Witham and Family
75 Young Irrigation Network
76 NSW Business Chamber
77 Bourke Shire Council
78 Loddon Mallee RDA Committee
79 Stephen Tynan
80 NSW Murray Darling Basin Catchment Authorities
81 Kitty Schiansky
82 Victorian Farmers Federation (Kiewa Branch)
83 Jason Reid
84 Murrumbidgee Irrigation
85 David Reid
86 Des Morgan
87 Barossa Infrastructure Ltd
88 Bart Brighenti
89 National Association of Forest Industries (NAFI)
90 Gannawarra Shire Council
91 Terry Court
92 Borders Rivers Food and Fibre
93 Murrumbidgee Private Irrigators Inc
94 Casimiro Damiani
95 Bill Johnston
96 Don Ciavarella
97 FutureFlow
98 RDA Committees (Hume, Grampians and Loddon Mallee)
99 Rural City of Wangaratta
100 Namoi Water
101 West Corurgan Private Irrigation District

102 Conservation Council of South Australia

103 Roger Shemilt

104 Walter Mitchell AM

105 North East Victorian Catchment Councils

106 AgForce Queensland

107 Anthony Roddy

108 University of Newcastle, Centre for Rural and Remote Mental Health

109 Tanya Clarke

110 Sally Dye

111 Booth Associates - Agribusiness and Environmental Solutions

112 Michael Ryan

113 Tom Condon

114 Riverina Citrus

115 Hay Shire Council

116 CSIRO

117 Municipal Association of Victoria (MAV)

118 National Farmers' Federation (NFF)

119 Indigo Shire Council

120 Tandou Ltd

121 Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES)

122 Running Stream Water Users Association Inc

123 National Program for Sustainable Irrigation

124 Bogan Shire Council (Nyngan)

125 Murrumbidgee Groundwater Inc

126 Riverina Eastern Regional Organisation of Councils (REROC)

127 Department of Agriculture, Fisheries and Forestry (DAFF)

128 Annette Commins

129 Tim Commins

130 Australian Centre for Agriculture and Law, UNE

131 Australian Dairy Farmers Ltd

132 Shire of Campaspe

133 Hydrology Research Laboratory, University of Sydney

134 Mildura Development Corporation

135 Balonne Shire Council

136 Australian Wetlands and Rivers Centre, UNSW

137 Towong Shire Council

138 South Australian Murray Irrigators

139 Uniting Church of Australia

140 Rubicon Water

141 Regional Development Australia - Hume Committee

142 Australian Network of Environmental Defender's Office (ANEDO VIC)

143 Gwydir Valley Irrigators Association Inc

144 RDA-Riverina

145 Strengthening Riverina Irrigation Communities

146 John Chant

147 National Water Governance Initiative

148 Moira Shire Council

149 Australian Conservation Foundation

150 Border Rivers - Gwydir Catchment Management Authority

151 Victorian Farmers Federation

152 Tumbarumba Shire Council

153 Michael Erny

154 Peter Smith OAM

155 Macquarie River Food and Fibre

156 SA Citrus Board

157 Queensland Farmers' Federation (QFF)

158 NSW Farmers' Association

159 SA Minister for Environment and Conservation; the River Murray; and Water

160 Caroona Coal Action Group

161 Dean Brown AO

162 Department of Regional Australia, Regional Development and Local Government

163 Kim Hann

164 Murray Group of Concerned Communities (MGCC)

165 Louise Burge

166 Glen Andreazza

167 Laura Andreazza

168 Brendan Andreazza

169 Teneeka Andreazza

170 Ian Bowditch

171 Upper Catchment Water Committee

172 Larry and Narelle Willams

173 Murray Shire Council

174 Murray Williams

175 Joan Pickersgill

176 NSW State Member for Barwon

177 John Cox

178 Bob Culhane

179 RDA Grampians Committee

180 Ace Regional Marketing

181 Jean Gall

182 David Gall

183 Trevor Loxton

184 Robert Caldwell

185 National Water Commission

186 Ricegrowers' Association of Australia

187 GetSet Inc.

188 Fonterra

189 Holm Trading

190 Sophie Mirabella, MP, Federal Member for Indi

191 Gilbert and Tobin Centre of Public Law, UNSW

192 Department of Sustainability, Environment, Water, Population and Communities

193 City of Wodonga

194 Irrigation Australia Ltd

195 DHI Water and Environment

196 Brian Mills

197 Jeanine McRae

198 Fifth Estate

199 Alison Walpole

200 Henry Schneebeli

201 Shadow Minister for Natural Resource Management, Member for Burrinjuck

202 J Cunningham

203 Trevor Randall

204 Alice Fiumara

205 Campbell Partnership

206 Ron Miller

207 Tony Pickard

208 David Allen

209 Australian National University (ANU)

210 NSW Government

211 Southern Riverina Irrigators

212 Max Talbot

213 T Bowring and Associates Pty Ltd

214 David McCabe

215 Jim Leggate

216 Central Downs Irrigators Limited

217 Australian Lot Feeders' Association (ALFA)

218 Natalie Tydd

219 Ben Rees

220 Doctors for the Environment Australia

221 Federal Member for Parkes

222 Dart Energy Ltd (Australia)

223 Victoria Hamilton

224 Joesph, Jennie and Ben Hill

225 Lock The Gate Alliance Inc

226 Queensland Conservation Council (QCC)

227 National Toxics Network (NTN)

228 Ruth Armstrong

229 Southern Highlands Coal Action Group

230 United Myall Residents Against Gas Extraction

231 Daniel Reardon

232 Australian Network of Environmental Defender's Offices (ANEDO NSW)

233 Cotton Australia

234 Claudia Cortizo

235 Basin Sustainability Alliance (BSA)

236 George Carrard

237 Australian Petroleum Production and Exploration Association (APPEA)

238 Penny Blatchford

239 Australian Water Campaigners Inc

240 Pamela Stoves Sefton

241 Annette Lovecek

242 Bart Ristuccia

243 Brian Cotgrove

244 Sue Wilmott

245 W. J Bryan

246 T. C Hall

247 Bev Pattenden

248 Xavier Marton

249 Moree Community Consultative Community (Coal Seam Gas)

250 Caroona Coal Action Group (Coal Seam Gas Committee)

251 John and Kate Scott

252 Drillham Action Group

253 Steve and Robyn White

254 John and Penny Taylor

255 Simon and Katrina Body

256 Alan Ellis

257 Queensland Beekeepers Association Inc.

258 Queensland Resources Council (QRC)

259 QGC Pty Ltd

260 Scott Collins

261 Alistair and Jenny Donaldson

262 James Kerr and Ms Judy Whistler

263 Mullaley Gas and Pipeline Accord

264 Kate Ausburn

265 Lynda Windsor

266 Robert Barry

267 Debbi Orr and Mr Rod Matthews

268 State Social Justice Committee of St Vincent De Paul Society of Queensland

269 Stuart Setzer

270 Kate Lloyd

271 Allen and Barbara Clark

272 Darling Downs Cotton Growers Inc

273 Peter Shannon

274 Angela Smith

275 Save Bunnan Inc

276 Ian Falconer

277 Susan Gourley

278 Friends of Felton

279 Stephanie Weaver-Wong

280 Eric Heidecker

281 Craig and Iris Kelehear

282 Gail Evlerstain

283 Bill Hastings

284 Darryl and Julie Bishop

285 Nerida Mills

286 Putty Community Association Inc - CSG subcommittee

287 Ronald and Dawn Childs

288 Denis and Anthea Itzstein

289 James Murphy

290 Marilyn Bidstrup

291 Brian Sinnamon

292 Fiona Paul

293 Katie Ledingham

294 Maules Creek Community Council Inc

295 Janet Cox

296 Beverly Smith

297 Jackie Reardon

298 Jill Wiltshire

299 DJ and MP Wall

300 Marko Klemen

301 Matt Wiseman

302 Friends of Pilliga

303 Michelle Shaw

304 Craig and Michele Radford

305 North West Ecological Services (NWES)

306 Beth Williams

307 AGL Energy Ltd

308 Michael and Margaret Chamberlain

309 Judy Bloomfield

310 Mullaley Gas Pipeline Accord

311 Jane Vickery

312 Northern Inland Council for the Environment, Friends of the Earth Melbourne, Nature Conservation Council of NSW, The Wilderness Society, the Colong Foundation for Wilderness, Coonabarabran Local Environment Group and the Armidale National Parks Association

313 Richard Golden

314 Janet Robertson

315 Scott Cooper

316 Kerrie Eather

317 Sonya Marshall

318 Paul Brieotto

319 Northern Grampians Shire Council

320 David Hubbard

321 Omega Labels

322 Peter Faulkner

323 Bill Crawford

324 L K Wray

325 Barambah Organics

326 Queensland Murray-Darling Committee Inc.

327 Boudicca Cerese

328 Anne Bridle

329 Gilgandra Shire Council

330 Megan Donnelley

331 Len Martin

332 Alicia Harrison

333 Sarah Ball

334 Gordon Gilder

335 Trevor Crouch

336 Tracey and Clive Parker

337 Coast and Wetlands Society Inc

338 Rivers SOS Alliance

339 Sue Odgers

340 John and Peggy Hann

341 Narrabri Shire Council

342 Glen Zimmerle

343 Sandra Fasullo

344 Cotton Catchment Communities CRC

345 Moree Plains Shire Council

346 OzEnvironmental Pty Ltd

347 Bellata Gold

348 Martin Molesworth

349 Anne Cameron

350 John Bridle

351 J. L. Rohde

352 Judith Deucker

353 Santos Ltd

354 Bob McFarland

355 Arrow Energy Pty Ltd

356 Peter Gillbank

357 Elfian Schieren

358 Queensland Government

359 Northern River Guardians

360 Dayne Pratzky

361 Deedre Kabel

362 Murray Scott

363 Geo-Processors Pty Limited

364 Wayne Somerville

365 University of Sydney

366 Australia Pacific LNG

367 Noondoo Partnership

368 Tom Lyons

369 Carol Jones-Lummis

370 Gympie Water, Air and Soil Protection Group

371 Rabobank Australia and New Zealand Group

372 Hunter Valley Protection Alliance (HVPA)

373 Charlie Shuetrim

374 Denise Ewin

375 Fodder King Ltd

Additional Information Received

- Received on 12 August 2011, from Australian Petroleum Production and Exploration Association (APPEA). Answers to Questions taken on Notice on 20 July 2011 in Brisbane, QLD;
- Received on 22 August 2011, from Basin Sustainability Alliance (BSA). Answers to Questions taken on Notice on 19 July 2011 in Dalby, QLD;
- Received on 26 August 2011 & 29 August 2011, from Eastern Star Gas (ESG). Answers to Questions taken on Notice on 2 August 2011 in Narrabri, NSW;
- Received on 29 August 2011, from National Farmers' Federation (NFF). Answers to Questions taken on Notice on 9 August 2011 in Canberra, ACT;
- Received on 30 August 2011, from Commonwealth Scientific and Industrial Research Organisation (CSIRO). Answers to Questions taken on Notice on 9 August 2011 in Canberra, ACT;
- Received on 31 August 2011, from Arrow Energy. Answers to Questions taken on Notice on 9 August 2011 in Canberra, ACT;
- Received on 31 August 2011 & 9 September 2011, from Queensland Gas Company (QGC). Answers to Questions taken on Notice on 9 August 2011 in Canberra, ACT;
- Received on 8 September 2011, from the National Water Commission (NWC). Answers to Questions taken on Notice on 9 August 2011 in Canberra, ACT;
- Received on 9 September 2011, from AGL Energy Lt. Answers to Questions taken on Notice on 9 August 2011 in Canberra, ACT;
- Received on 12 September 2011, from Mr Bruce Brown, General Manager, Naomi Catchment Management Authority. Letter regarding the document (Naomi Catchment Management Authority, *Report on the flooding and soil degradation impacts of the use of Public and Crown roads that dissect Lot 1 DP1093884 'Inering' Mullaley*, 2009) tabled in Narrabri on 2 August 2011 by Mr David Quince, Secretary, Mullaley Gas Pipeline Accord;
- Received on 19 September 2011 & 25 October 2011, from Dart Energy Ltd. Answers to Questions taken on Notice on 9 September 2011 in Canberra, ACT;
- Received on 19 September 2011, from the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC). Answers to Questions taken on Notice on 9 August 2011 in Canberra, ACT;
- Received on 27 September 2011, from the Queensland Department of Energy & Resource Management (QLD DERM). Answers to Questions taken on Notice on 9 August 2011 in Canberra, ACT;
- Received on 7 October 2011, from Doctors for the Environment. Answers to Questions taken on Notice on 9 September 2011 in Canberra, ACT;
- Received on 18 October 2011, from NSW Farmers' Federation. Answers to Questions taken on Notice on 2 August 2011 in Narrabri, NSW;
- Received on 24 October 2011, from Australia Pacific LNG/Origin Energy. Answers to Questions taken on Notice on 9 September 2011 in Canberra, ACT.

TABLED DOCUMENTS

18 July 2011, Roma, QLD:

- Tabled by Mayor Robert Loughnan, Maranoa Regional Council. *Briefing Paper*, 18 July 2011, Ed Sims, Manager, Organisational Performance, Maranoa Regional Council;
- Tabled by Ms Kate Scott. Opening statement*;*

19 July 2011, Dalby, QLD:

- Tabled by Mr Ian Hayllor, Chairman & Mr David Hamilton, Committee member, Basin Sustainability Alliance (BSA).
    - Opening Statement;
    - BSA, *Not at any cost – Blueprint for Sustainable CSG operations* report;
    - *Surat Basin Groundwater Management Plan – Preliminary Concept* Chart;
    - *Issues of Concern* document;
    - *Example of a well designed and managed floodplain farming system* photo;
    - Overview of CSG activity in grazing country (Kogan/Grassdale);
- Tabled by Ms Ruth Armstrong, Yanco Farms.
    - *Additional Documents,* 4 photos & 3 maps;
    - Copy of the Queensland Government Department of Natural Resources and Water, *Great Artesian Basin - resource operations plan*;
- Tabled by Mr Graham Clapham, Central Downs Irrigators.
    - 3 Maps;
    - Copy of the Queensland Government Department of Environment and Resource Management (DERM), *Central Condamine Alluvium Groundwater Management Area* Report, 23 June 2010;
    - *Schedule of Fixed Charge Component Yearly payment options and costs* table;
    - QLD Government DERM Public Notice, Water Regulation 2002 (Section 66);
    - Letter to Mr Clapham from QLD Government DERM, regarding Application for Review of original decisions relation environmental authority PEN100449509*;*
    - Letter from, QLD Government Department of Infrastructure and Planning to the Hon. Tony Burke MP, Minister for Sustainability, Environment, Water, Population and Communities, 18 October 2010, regarding Coal Seam Gas extraction near Gladstone;
- Tabled by AgForce Queensland. *Coal Seam Gas Policy* document;
- Tabled by Ms Anne Bridle.
    - Copy of the Queensland Government Department of Natural Resources and Water, *Great Artesian Basin - resource operations plan 2007* Report;
    - Copy of the Queensland Government Department of Infrastructure, *Liquefied Natural Gas Whole of State Environmental Impacts Study*, 2007 Report;

- Copy of the Queensland Government Department of Natural Resources and Mines, *Hydrogeological Framework Report for the Great Artesian Basin Water Resource Plan Area*, 2005 Report;
- Copy of the Program Proposal, *Water, Agriculture and Mining: Regional Development Outcomes for Groundwater in the Condamine Alluvial and Surat Basin Aquifers* prepared for Regional Development Australia, by University of Southern Queensland;
- Condamine Alliance, *Environmental Values – Consultation Pack, February 2011*;
- *Ground water concerns from Coal Seam Gas Extraction* paper, Anne Bridle, 2010;
- *A risk to Ground water from Coal Seam Gas Extraction in the Surat Basin*, Bridle, A and Harris, C, 2010;
- *ESG and the Energy Sector – Water Concerns: QLD Coal Seam Gas Developments* Report, J.P. Morgan, © 2010;
- *Typical Queensland CSG Gas field and CSG Gas field Infrastructure* photos;
- Copy of an article from *International Journal of Coal Geology 70 (2007), p.209-222*, "Coal petrology and coal seam contents of Walloon Subgroup – Surat Basin, Queensland, Australia", Scott, Anderson, Crosdale, Dingwall and Leblang;
- Copy of the *Advice in relation to the Potential impacts of Coal Seam Gas Extraction in the Surat and Bowen Basins, Queensland* report prepared for the Department of the Environment, Water, Heritage and the Arts by Geoscience Australia and Dr M A Habermehl;
- Copy of Department of Sustainability, Environment, Water Population and Communities, Proposed Approval for Queensland Gas Company Ltd (QGC) And BG International Limited (BG) for coal seam gas field component of the Queensland Curtis LNG Project;
- Letter from, QLD Government Department of Infrastructure and Planning to the Hon. Tony Burke MP, Minister for Sustainability, Environment, Water, Population and Communities, 18 October 2010, regarding Coal Seam Gas extraction near Gladstone;
- Copy of *Environmental Authority Applications* QGC areas map and information;
- Letter to Ms Bridle from QGC, 12 July 2011, regarding notice of application for internal review;
- Copy of the Oil & Gas Accountability Project (a project of Earthworks), *Our drinking water at risk* report;
- Copies of Queensland Government Department of Employment, Economic Development and Innovation maps of Dalby district ©.

20 July 2011, Brisbane, QLD:

- Tabled by Mr Ross Dunn, QLD Director, Australian Petroleum Production and Exploration Association (APPEA). Email from Ms Stacey Milner, Producer, 612 ABC Brisbane Mornings, ABC Radio to Mr Dunn regarding questions about statement Mr Dunn made on QLD Country Hour, ABC Radio.

2 August 2011, Narrabri, NSW:

- Tabled by Mayor Katrina Humphries & Councillor John Tramby, Moree Plains Council.
    - Copy of a letter of introduction and request for an Access Agreement to conduct well program from Leichardt Resources;
    - *Fracking chemicals, their uses and hazards* document;
    - Caltex: *Material Safety Data Sheet – Delo Extended Life Coolant Premixed* document;
    - Copy of the NSW *State Environment Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007*;
- Tabled by Ms Natalie Tydd. 17 photos of property;
- Tabled by Ms Rosemary Nankivell, Chairman Caroona Coal Action Group.
    - Letter from Ms Nankivell, Caroona Coal Action Group to the NSW Department of Primary Industries, regarding Santos' report on the Review of Environmental Factors at Glasserton pilot wells;
    - Copy of the *Environmental Hazards of Oil and Gas Exploration* report;
- Tabled by Mr David Quince, Secretary, Mullaley Gas Pipeline Accord.
    - Proposal for Narrabri to Wellington gas transmission pipeline, 11 April 2011;
    - Naomi Catchment Management Authority, *Report on the flooding and soil degradation impacts of the use of Public and Crown roads that dissect Lot 1 DP1093884 'Inering' Mullaley*, 2009 and photos;
    - Copy of the NSW Government Department of Natural Resources, *Upper Coxs Creek Floodplain Management Plan* report, 2005;
- Tabled by Ms Carmel Flint, Northern Inland Council for the Environment. Copy of the *Under the Radar – How Coals Seam Gas Mining in the Pilliga is impacting matters of national environment significance* report.;
- Tabled by Mr Peter Fox, Executive General Manager – Stakeholder Division, Eastern Star Gas Ltd.
    - Eastern Star Gas, *Narrabri Project – June 2011* Presentation;
    - Eastern Star Gas, *About Eastern Star Gas* information.

9 August 2011, Canberra, ACT:

- Tabled by Mr James Baulderstone, Vice President, Eastern Australia, Santos/GLNG. Opening Statement;
- Tabled by Ms Catherine Tanna, Managing Director, Queensland Gas Company (QGC) Pty Ltd. Opening Statement;
- Tabled by CSIRO. Coal Seam Gas fact sheets 1-9.

9 September 2011, Canberra, ACT:

- Tabled by Doctors for the Environment. Additional information;
- Tabled by National Toxics Network.
    - Additional information;
    - National Toxics Network, *Hydraulic Fracturing in Coals Seam Gas Mining: The Risks to Our Health, Communities, Environment and Climate r*eport, 2011;
- Tabled by National Industrial Chemicals Notification & Assessment Scheme (NICNAS). *Outline of industrial regulatory framework* chart;
- Tabled by NSW Government Department of Trade & Investment, Regional Infrastructure & Services. *NSW Government Statement*;

APPENDIX 2

Public Hearings and Witnesses

Monday, 18 July 2011 – Roma, QLD

- FOOTE, Mr David Michael, Chief Executive Officer,
  Australian Country Choice
- LOUGHNAN, Mayor Robert, Mayor,
  Maranoa Regional Council
- SCOTT, Mr John Robertson
- SCOTT, Mrs Katherine Lucy (Kate)
- SCOTT, The Hon. Bruce,
  Member for Maranoa
- SIMS, Mr Edward Thomas, Manager Organisational Performance,
  Maranoa Regional Council
- THOMPSON, Mr Peter Laidlaw
- WALKER, Mr Jack James, Agribusiness Coordinator,
  Australian Country Choice
- WASON, Mr Scott, Councillor,
  Maranoa Regional Council

Tuesday, 19 July 2011 – Dalby, QLD

- ARMITAGE, Mr Stuart, Director,
  Central Downs Irrigators Limited
- ARMSTRONG, Mrs Ruth Ann Grace
- BREMNER, Mr Kim, South-East Water Spokesman,
  AgForce Queensland
- BRIDLE, Mr Robert Newton
- BRIDLE, Mrs Anne, Committee Member,
  Basin Sustainability Alliance
- BRIDLE, Mrs Anne, (Private capacity)
- CLAPHAM, Mr Graham, Chair,
  Central Downs Irrigators Limited

- HAMILTON, Mr William David, Committee Member,
  Basin Sustainability Alliance
- HAYLLOR, Mr Ian, Chairman,
  Basin Sustainability Alliance
- JOHNSTON, Ms Genevieve, Policy Adviser,
  AgForce Queensland
- LLOYD, Mrs Kate Burgoyne, Committee Member,
  Basin Sustainability Alliance
- NEWTON, Mr Wayne, Mining Spokesman,
  AgForce Queensland
- SHANNON, Mr Peter Charles, Solicitor,
  Basin Sustainability Alliance

Wednesday, 20 July 2011 – Brisbane, QLD

- BOYLAND, Mr Des, Policies and Campaigns Manager, Wildlife Preservation Society of Queensland; Member, Queensland Conservation Council
- DUNN, Mr Ross, Director, Coal Seam Gas,
  Australian Petroleum Production and Exploration Association
- GALLIGAN, Mr Dan, Chief Executive Officer,
  Queensland Farmers Federation
- HUTTON, Mr Drew, President,
  Lock the Gate Alliance
- JOHNSON, Mr Ian, Water Adviser,
  Queensland Farmers Federation
- MURRAY, Mr Michael Bernard, National Water Policy Manager and Queensland Policy Manager, Cotton Australia
- PARRATT, Mr Nigel, Rivers Project Officer,
  Queensland Conservation Council
- PAULL, Mr Matthew Andrew Mather, Director, Policy, Queensland and New South Wales, Australian Petroleum Production and Exploration Association
- WILKINSON, Mr Richard John, Chief Operating Officer, Eastern Australia, Australian Petroleum Production and Exploration Association

Tuesday, 2 August 2011 – Narrabri, NSW

- ADAMS, Mr James, Member,
  Mullaley Gas Pipeline Accord
- BAKER, Mrs Jon-Maree, Executive Officer,
  Namoi Water
- CASEY, Ms Brianna, Senior Policy Manager,
  New South Wales Farmers Association
- CLEMENTS, Mr John Ewen, Narrabri Shire Delegate,
  Namoi Water
- COOK, Mrs Charmaine, Member,
  Mullaley Gas Pipeline Accord
- DONNAN, Mr Timothy Patrick, Government Approvals and Environmental Supervisor, Eastern Star Gas Ltd
- DUDDY, Mr Timothy, Public Officer and Director,
  Namoi Water
- FLINT, Ms Carmel Therese, Member,
  Northern Inland Council for the Environment
- FOX, Mr Peter, Executive General Manager, Stakeholder Relations,
  Eastern Star Gas Ltd
- HAMILTON, Ms Victoria Ann
- HUMPHRIES, Mrs Katrina, Mayor,
  Moree Plains Shire Council
- KELLY, Mr Michael John, General Manager, Health, Safety and Environment,
  Eastern Star Gas Ltd
- MACFARLANE, Ms Jane Lindsay, Catchment Program Leader,
  Cotton Catchment Communities CRC
- NANKIVELL, Ms Rosemary Margaret, Chairman,
  Caroona Coal Action Group
- PARISH, Mr Donald, Member,
  Mullaley Gas Pipeline Accord
- PICKARD, Mr Anthony John
- QUINCE, Mr David Michael, Secretary,
  Mullaley Gas Pipeline Accord
- REARDON, Mr Daniel Walter
- ROTH, Dr Guy Weeden, Strategy Adviser,
  Cotton Catchment Communities CRC

- SIMSON, Ms Fiona, President,
  New South Wales Farmers Association
- SLEEMAN, Mr Roland Kingsbury, Chief Commercial Officer,
  Eastern Star Gas Ltd
- SPARK, Mr Philip Harold, Member,
  Northern Inland Council for the Environment
- TRAMBY, Mr John, Councillor,
  Moree Plains Shire Council
- TYDD, Mr James
- TYDD, Ms Natalie

Tuesday, 9 August 2011 – Canberra, ACT

- BAKER, Mr Peter, Principal Science Advisor,
  Department of Sustainability, Environment, Water, Population and Communities
- BAULDERSTONE, Mr James Leslie, Vice President, Eastern Australia, Santos
- BIRCHLEY, Mr Michael Francis, Assistant Director-General, Regional Service Delivery, Department of Environment and Resource Management, Queensland
- BRIER, Mr Andrew Stuart, General Manager, Coal and Coal Seam Gas Operations, Department of Environment and Resource Management, Queensland
- CAMERON, Mr James David Alan, Acting Chief Executive Officer, National Water Commission
- COLREAVY, Ms Mary, First Assistant Secretary, Environment Assessment and Compliance Division, Department of Sustainability, Environment, Water, Population and Communities
- DRIPPS, Ms Kimberley, Deputy Secretary,
  Department of Sustainability, Environment, Water, Population and Communities
- ELDER, Miss Leisa, Vice President, Community and Corporate Affairs, Arrow Energy Pty Ltd
- FAULKNER, Mr Andrew, Chief Executive Officer,
  Arrow Energy Pty Ltd
- FRASER, Mr Duncan, Chair, Mining and Coal Seam Gas Taskforce, Vice President, National Farmers Federation

- GOSSMAN, Mr Simon Markus, Groundwater Management Coordinator, Arrow Energy Pty Ltd
- JURINAK, Dr Jeff, Vice President, Developments, QGC Pty Ltd
- KENDALL, Mr Matthew, General Manager, Sustainable Water Management, National Water Commission
- KERR, Ms Deb, Manager, Natural Resource Management, National Farmers Federation
- KNIGHT, Mr Tony, Vice President, Exploration, Arrow Energy Pty Ltd
- MACFARLANE, Mr Mark Stuart, President, Santos GLNG
- McNAMARA, Ms Sarah, Head of Government and Community Engagement, AGL Energy Ltd
- MILLHOUSE, Mr Rob, General Manager, Government Affairs, QGC Pty Ltd
- MORAZA, Mr Mike, Group General Manager, Upstream Gas, AGL Energy Ltd
- NUNAN, Mr Tony, General Manager, Land and Community Management, QGC Pty Ltd
- PARKER, Mr David, Deputy Secretary, Department of Sustainability, Environment, Water, Population and Communities
- PURTILL, Mr James Anthony, General Manager, Sustainability, Santos
- ROSS, Mr John, Manager, Hydrogeology, AGL Energy Ltd
- SLATYER, Mr Tony, First Assistant Secretary, Water Reform Division, Department of Sustainability, Environment, Water, Population and Communities
- STONE, Dr Peter, Deputy Chief, Ecosystem Sciences, CSIRO
- TANNA, Ms Catherine, Executive Vice President, BG Group Australia, and Managing Director, QGC Pty Ltd
- TODD, Mr Michael, Government Relations Manager, Arrow Energy Pty Ltd
- UNDERSCHULTZ, Dr James (Jim) Ross, Theme Leader, Petroleum and Geothermal Portfolio, CSIRO

- WALKER, Dr Glen, Theme Leader, Water for a Healthy Country Flagship, CSIRO

Friday, 9 September 2011 – Canberra, ACT

- CAREY, Dr Marion, Victorian Committee Member, Doctors for the Environment Australia
- CRISP, Dr George, Management Committee Member, Doctors for the Environment Australia
- DE WEIJER, Mr Robbert, Chief Executive Officer, Australia, Dart Energy Ltd
- GREGSON, Mr Andrew David, Chief Executive Officer, New South Wales Irrigators Council
- HEALY, Dr Marion Joy, Director, National Industrial Chemicals Notification and Assessment Scheme
- HORTON, Mr Ken, Group Manager, Corporate Affairs, Upstream Queensland and CSG to LNG, Australia Pacific LNG
- LINDSAY, Mr Alan Robert, Member, Southern Highlands Coal Action Group
- LLOYD-SMITH, Dr Mariann, Senior Adviser, National Toxics Network
- MAXSON, Mr Page, Chief Executive Officer, Australia Pacific LNG
- McKINNON, Mrs Angela Mary, Head of Existing Chemicals Program, National Industrial Chemicals Notification and Assessment Scheme
- MOORE, Mr Mark Andrew, Policy Analyst, New South Wales Irrigators Council
- MULLARD, Mr Brad William, Executive Director, Mineral Resources, New South Wales Department of Trade and Investment, Regional Infrastructure and Services
- NEEDHAM, Mr Jason, Exploration Operations Manager, Dart Energy Ltd
- O'NEILL, Mr Rob, Director, Water Policy and Planning, New South Wales Office of Water
- PATERSON, Mr Mark Ian, AO, Director General, New South Wales Department of Trade and Investment, Regional Infrastructure and Services

- REDMOND, Dr Helen, New South Wales Committee Member,
  Doctors for the Environment Australia
- SATYA, Dr Sneha, Head of Science Strategy and International Program,
  National Industrial Chemicals Notification and Assessment Scheme
- SHORT, Mr John, General Manager, Government Relations,
  Australia Pacific LNG
- WICKENS, Mr John,
  National Toxics Network
- WINDEYER, Mr Gordon Phillip, Member,
  Southern Highlands Coal Action Group