



Inquiry into Unconventional Gas (Fracking) Interim report

ONE HUNDRED SIXTH REPORT

of the

NATURAL RESOURCES COMMITTEE

Tabled in the House of Assembly and ordered to be published 17 November 2015

Second Session, Fifty-Third Parliament

Presiding Member's Foreword

The Natural Resources Committee's Inquiry into Unconventional Gas (Fracking) was referred by the Legislative Council to the committee on 19 November 2014, on the motion of Hon MC Parnell MLC, as amended by Hon TA Franks MLC, pursuant to section 16(1)(a) of the *Parliamentary Committees Act 1991*.

The terms of reference for the inquiry include inquiring into potential risks and impacts in the use of hydraulic fracture stimulation (fracking) to produce gas in the South East of South Australia and in particular:

1. The risks of groundwater contamination;
2. The impacts upon landscape;
3. The effectiveness of existing legislation and regulation; and
4. The potential net economic outcomes to the region and the rest of the state.

Since the inquiry was advertised on 26 November 2014, more than 175 separate submissions have been received and evidence has been taken from 48 witnesses at 14 public hearings held both in Adelaide and the South East of South Australia. Much of the evidence received has been of very high quality and has been important to the committee in drafting both this interim report and commencing developing its recommendations, to be included in its final report, which is anticipated to be tabled in 2016.

In February 2015 the committee made a fact-finding visit to Millicent in the South East of South Australia to take evidence from local communities and visit sites relevant to the inquiry. A further fact-finding visit was made to the Darling Downs region of Queensland to meet with community representatives who had experienced the recent rapid development of the gas industry 'build phase' in their region and to view and discuss the many associated impacts.

The Queensland visit was particularly useful in providing members with insight into what unconventional gas development looks like in an established agricultural and residential region, albeit one larger than South Australia's South East. While it has been emphasised repeatedly during the inquiry that fracking has been occurring in South Australia's Cooper Basin for several decades it was obvious to the committee that there are a number of significant differences between existing gas development in the Cooper Basin's sparsely populated arid zone and potential gas developments in the more densely populated and much wetter South East region.

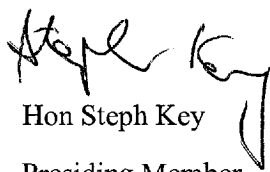
One sentiment expressed by a number of people with whom we met in Queensland was that they were impressed that the Parliament of South Australia was doing an inquiry into unconventional gas development before any production had occurred, suggesting that this would have been beneficial in Queensland rather than waiting until mid- and post-development to try to understand and mitigate the impacts.

The committee returned to the South East in September 2015 for well-attended hearings at the Robe Council Chambers and to view the site of the Jolly-1 exploration well, which has been a point of some contention in the region.

The committee appreciates the strong public interest in this inquiry and the considerable efforts made by witnesses to attend hearings and present evidence. We understand that there remain some knowledge gaps in the information we've received thus far, and the committee will be seeking out relevant expertise to address these.

Members look forward to continuing their work on the unconventional gas inquiry into the new year and to delivering the final report in 2016.

I wish to thank all those who gave their time to assist the committee with this inquiry. I commend the members of the committee, Hon Robert Brokenshire MLC, Hon John Dawkins MLC, Mr Jon Gee MP, Hon Gerry Kandelaars MLC, Mr Chris Picton MP, and Mr Peter Treloar MP, for their contributions to this report. All members have worked cooperatively on this report. I also extend thanks to Mr Troy Bell MP, Hon John Darley MLC, Hon Mark Parnell MLC, Mr Adrian Pederick MP and Mr Mitch Williams MP for their assistance with and interest in the inquiry. Finally, I thank the committee staff for their assistance.



Hon Steph Key

Presiding Member

17 November 2015

Executive Summary

The Natural Resources Committee's Inquiry into Unconventional Gas (Fracking) was referred by the Legislative Council to the committee on 19 November 2014, on the motion of Hon MC Parnell MLC, as amended by Hon TA Franks MLC, pursuant to section 16(1)(a) of the *Parliamentary Committees Act 1991*.

The terms of reference for the inquiry include inquiring into potential risks and impacts in the use of hydraulic fracture stimulation (fracking) to produce gas in the South-East of South Australia and in particular:

1. The risks of groundwater contamination;
2. The impacts upon landscape;
3. The effectiveness of existing legislation and regulation; and
4. The potential net economic outcomes to the region and the rest of the state.

The unconventional gas inquiry has attracted a high level of community interest. Since the call for submissions was made on 26 November 2014, more than 175 separate submissions have been received and evidence has been taken from 48 witnesses at 14 public hearings held both in Adelaide and the South East of South Australia.

This interim report presents an overview of evidence received and the work of the committee during the first 12 months of this inquiry. It also takes the important step of establishing meanings of the basic terms and concepts of unconventional gas activity, particularly hydraulic fracturing, also known as 'hydraulic fracture stimulation', or colloquially as 'fracking', sometimes spelled 'fracking'.

A collective understanding of these concepts is crucial to this inquiry as it is not just about fracking. Fracking is only one part (though a complex one) of the overall process of gas extraction. This inquiry is about the myriad aspects of unconventional gas development and how the process may potentially impact the South East of South Australia.

This report aims to provide a sound basis for a more detailed analysis of evidence and the committee's recommendations, which will follow in the final report, to be tabled in 2016.

Table of Contents

Presiding Member's Foreword.....	i
Executive Summary	iii
Table of Contents	v
1 Natural Resources Committee	1
1.1 Membership and staff.....	1
Members.....	1
Staff.....	1
1.2 Functions of the Committee	1
1.3 Referral process.....	2
2 Inquiry into Unconventional Gas (Fracking)	3
2.1 Establishment of the inquiry	3
2.2 Terms of Reference	3
3 Introduction.....	4
3.1 Unconventional gas vs. conventional gas	4
Drilling, well construction, and production	5
3.2 Coal-seam gas (CSG).....	7
Dewatering.....	8
3.3 Shale gas	8
3.4 Tight gas.....	8
3.5 Underground coal-seam gasification (UCG).....	8
3.6 Hydraulic fracturing ('fracking')	9
Fracturing fluid	10
4 Context.....	12
4.1 Gas in South Australia	13
Legislation.....	13
History.....	14
4.2 The South East region of South Australia.....	15
Gas exploration and production in the South East of South Australia.....	15
4.3 The rest of Australia.....	19
Commonwealth	19
New South Wales.....	20
Northern Territory	21
Queensland.....	21
Tasmania	22
Victoria.....	23
Western Australia.....	23

5	Evidence.....	24
5.1	Hearings and meetings	24
5.2	Fact-finding visits, meetings and study.....	24
5.3	Public submissions	27
6	Conclusion	29
7	Abbreviations	30
8	Bibliography	31
	Appendix A: List of Submissions	34
	Appendix B: Witnesses.....	36
	Appendix C: Table of Figures.....	39

1 Natural Resources Committee

The Natural Resources Committee was established pursuant to the *Parliamentary Committees Act 1991* on 3 December 2003.

1.1 Membership and staff

Members

Hon Steph Key MP, Presiding Member

Hon Robert Brokenshire MLC

Hon John Dawkins MLC

Mr Jon Gee MP

Hon Gerry Kandelaars MLC

Mr Chris Picton MP

Mr Peter Treloar MP

Staff

Mr Patrick Dupont, Executive Officer

Ms Barbara Coddington, Research Officer

1.2 Functions of the Committee

Pursuant to section 15L of the *Parliamentary Committees Act 1991*:

- (1) The functions of the Committee are—
 - (a) to take an interest in and keep under review—
 - (i) the protection, improvement and enhancement of the natural resources of the State; and
 - (ii) the extent to which it is possible to adopt an integrated approach to the use and management of the natural resources of the State that accords with principles of ecologically sustainable use, development and protection; and
 - (iii) the operation of any Act that is relevant to the use, protection, management or enhancement of the natural resources of the State; and
 - (iv) without limiting the operation of a preceding subparagraph—the extent to which the objects of the Natural Resources Management Act 2004 are being achieved; and
 - (b) without limiting the operation of paragraph (a), with respect to the River Murray—
 - (i) to consider the extent to which the Objectives for a Healthy River Murray are being achieved under the River Murray Act 2003; and

- (ii) to consider and report on each review of the River Murray Act 2003 undertaken under section 11 of that Act by the Minister to whom the administration of that Act has been committed; and
 - (iii) to consider the interaction between the River Murray Act 2003 and other Acts and, in particular, to consider the report in each annual report under that Act on the referral of matters under related operational Acts to the Minister under that Act; and
 - (iv) at the end of the second year of operation of the River Murray Act 2003, to inquire into and report on—
 - (A) the operation of subsection (5) of section 22 of that Act, insofar as it has applied with respect to any Development Plan Amendment under the Development Act 1993 referred to the Governor under that subsection; and
 - (B) the operation of section 24(3) of the Development Act 1993; and
 - (c) to perform such other functions as are imposed on the Committee under this or any other Act or by resolution of both Houses.
- (2) In this section—
- ‘natural resources’ includes—
- (a) soil;
 - (b) water resources;
 - (c) geological features and landscapes;
 - (d) native vegetation, native animals and other native organisms;
 - (e) ecosystems.

1.3 Referral process

Pursuant to section 16(1) of the Act, any matter that is relevant to the functions of the Committee may be referred to it in the following ways:

- (a) by resolution of the Committee’s appointing House or Houses, or either of the Committee’s appointing Houses;
 - (b) by the Governor, or by notice published in the Gazette;
- or
- (c) of the Committee’s own motion.

2 Inquiry into Unconventional Gas (Fracking)

2.1 Establishment of the inquiry

The Natural Resources Committee's Inquiry into Unconventional Gas (Fracking) was referred by the Legislative Council to the committee on 19 November 2014, on the motion of Hon MC Parnell MLC, as amended by Hon TA Franks MLC, pursuant to section 16(1)(a) of the *Parliamentary Committees Act 1991*.

2.2 Terms of Reference

The committee is inquiring into potential risks and impacts in the use of hydraulic fracture stimulation (fracking) to produce gas in the South East of South Australia and in particular:

1. The risks of groundwater contamination;
2. The impacts upon landscape;
3. The effectiveness of existing legislation and regulation; and
4. The potential net economic outcomes to the region and the rest of the state.

3 Introduction

This inquiry into unconventional gas has attracted a high level of community interest. This interim report presents an overview of evidence received and the work of the committee during the first months of this inquiry. A more detailed analysis of evidence will form the basis of the final report, to be published next year.

One consistent issue has been clarity: some of the most frequently used terms and phrases associated with hydraulic fracture stimulation are often misunderstood, misused or misconstrued, leading to communication problems among stakeholders. Therefore working definitions for the central concepts and common terms of the inquiry are needed.

3.1 Unconventional gas vs. conventional gas

The use of the terminology ‘unconventional’ is misleading as there is nothing ‘unconventional’ about the gas; it is methane (CH₄). It really refers to the geology from where the gas is extracted.¹

In the US, where unconventional gas was first produced commercially, resources deemed too expensive or difficult to recover were considered ‘unconventional’, but in recent years as these formerly inaccessible sources have become economically viable resources, they are no longer referred to as unconventional.² In Australia, the term ‘unconventional gas’ usually refers to 1) a resource’s geological location and 2) the fact that special (unconventional) means are required to extract it.

Conventional gas is trapped in porous and permeable rock such as sandstone or limestone, which will release the gas readily from the formations when a well is drilled. If a reservoir is not under sufficient pressure to force the gas into a well at a commercially viable rate, hydraulic fracture stimulation (‘fracking’) may be used to speed up the flow, as is the case in the South Australian Cooper Basin.³ Therefore, use of fracking does not necessarily mean the gas is unconventional.⁴ Conventional gas wells in the South Australian Cooper Basin have been fracked for several decades⁵, with unconventional shale gas production beginning only in 2012.⁶ (See Section 4.1 for more information on fracking in the Cooper Basin.)

Gas that is considered unconventional is trapped in low permeability rock requiring stimulation and/or directional drilling techniques to flow gas at commercial rates.

Unconventional gas is known by different names including shale gas, tight gas or coal seam gas (CSG), depending on its situation underground. All of these are mostly methane (natural gas), with varying degrees of other hydrocarbons (ethane, propane, butane, etc). Table 1 lists some of the main distinguishing characteristics.

As shown in Table 1, one feature of deeper gas resources, as opposed to shallower coal seam gas wells, is that fewer well pads are usually required. Multiple wells with horizontal segments may be drilled on one pad, which reduces the overall impact on landscape. The committee heard from Mr David Guglielmo, a representative of Halliburton, a company which describes itself as a leading provider of hydraulic fracturing services worldwide, that one well pad may feature four wells to 16 wells.⁷

1 (South Australian Chamber of Mines and Energy, 2015, p. 5)

2 Law and Curtis 2002, in Submission 57 (Department of State Development)

3 (Gibbins, 2015, p. 160)

4 (Department of State Development Energy Resources Division, 2015)

5 (Malavazos, 2015, p. 21)

6 (Koutsantonis, 2012, p. 3514)

7 (Guglielmo, 2015, p. 108)

Table 1. Indicative table showing differences in 'types' of natural gas resources in Australia.

Name	Shale gas	Tight gas	Coal seam gas	Conventional gas
Resource type	Natural gas	Natural gas	Natural gas	Natural gas
Depth below surface	2000–5000m	2000–5000m	300–1000m	1000–5000m
Rock type	Shale	Sandstone and limestone	Coal seams	Sandstone and limestone
Production well type	Vertical or horizontal	Vertical or horizontal	Vertical	Vertical and horizontal
Is hydraulic fracturing required?*	Always	Always	Occasionally	Rarely
Average number of wells per well pad	6	6	1	1
Average well pad density in producing field	1.5km apart	1 well pad per 2.5 km ² (1.6km apart)	1 well pad per 0.25–1 km ² (0.5–1km apart)	Varies

Source: Government of Western Australia Department of Mines and Petroleum, *Shale & Tight Gas Fact Sheet*

*NB: While fracking is rarely required for a well that is considered conventional, it may be used for a variety of reasons without the well being considered unconventional.

Drilling, well construction, and production

Santos describes the drilling and well construction process as follows:⁸

Drilling and completing a well or 'well construction' consists of several activities as listed below, some of which are conducted several times:

- Building the well pad
- Setting up the drilling rig
- Drilling hole
- Running formation evaluation logs to determine what the formation is and what it contains
- Casing the well in steel and concrete
- Removing the rig
- Logging the casing to ensure bonding of cement to the formation and casing and the top of the cement relative to formation depths
- Perforating the casing
- Stimulating [i.e., fracking] the well if required⁹
- Installing production tubing and surface equipment
- Production of oil/gas from well
- Monitoring well performance/integrity
- Reclaiming parts of well pad no longer needed

Drilling can take days or weeks depending on the location and depth of the well. As drilling takes place, layers of steel tubing ('casing') and cement are inserted progressively into the well to form barriers to 'protect and isolate groundwater resources and aquifers from the oil or gas.'¹⁰

Gas, when it begins to flow, is separated from water, fracking fluids and other substances which flow back from the rock; the gas is metered and sampled regularly to determine composition. It then may be processed directly, burned off ('flared'), or vented, or some combination of these. The committee has heard that flaring can be used to detect unwanted methane outside the well ('fugitive emissions'), or to keep a new well open and flowing if further processing is delayed. Venting is the release of

⁸ (Santos, 2013, p. 4)

⁹ Fracking may be conducted several times (i.e., conducted in multiple 'stages') during production

¹⁰ (Santos, 2013, p. 5)

methane directly to the atmosphere; while flaring releases only carbon dioxide and water when methane burnt. The committee has heard that flaring is preferable; ‘in terms of greenhouse warming, methane is far more damaging. It traps a lot more heat than CO₂’ when released into the air unburnt.¹¹

Cement placement and security is critical to well integrity. The committee has received evidence regarding the monitoring of this aspect of well construction:

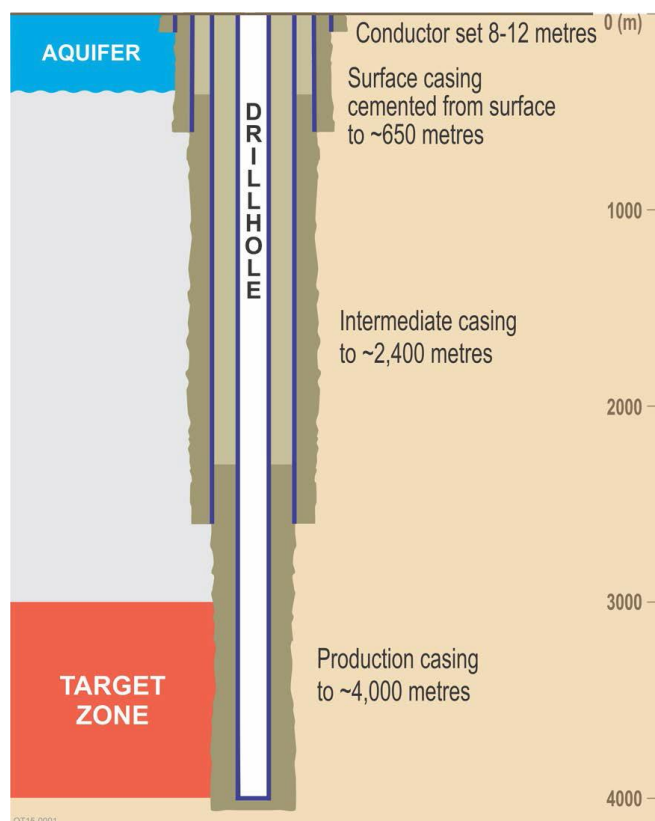
Cement integrity is verified by various means, including:

- a. monitoring of the cement placement during pumping to confirm it is placed as per the cement design;
- b. pressure testing of the cement; and
- c. cement bond logs of the production casing string (prior to stimulation), using an acoustic tool to detect whether spaces are present behind the casing.¹²

James Baulderstone, Eastern Vice President for Santos, provided evidence in a presentation about risk prevention and well casing design and construction:¹³

What has been often put forward for the natural gas industry is some sort of risk-free position, which is clearly not acceptable for mining, sheep farming, cotton farming, airplane travel or car travel. Of course, there are risks in everything we do. That is why it is so important to have regulations, particularly around things like well integrity. Using New South Wales as an example, we are talking about drilling a couple of hundred wells in that region. Surrounding our area, there are currently 18,000 water wells drilled. Again, it is exactly the same process used in drilling. One is for water and one is going into coal seam gas.

The wells that we drill have two layers of cement, so you drill a hole in the ground into the rock. We then cement it, we then put steel casing down, we cement it again and we put steel casing down. So



there are four barriers preventing any cross-contamination with various aquifers in various different zones. It is then pressure tested and it is cemented to the surface. The amount of technical engineering that has gone into a well design is very, very thorough. Again, if you have the right regulatory regime, it is world class. That prevents risks such as: can you cross-contaminate aquifers; can you have oil or gas flowing to the surface—blowouts, and those things we all saw from films in the 1950s and 1960s where you see oil flowing through and fires and those types of things. That’s all down to design and engineering of these wells.

Figure 1. Indicative well design. Wells are designed to meet engineering and regulatory requirements for specific well objectives. Casing size, weight, grade, depths and cement volumes will be varied to meet engineering design specifications. (Beach Energy, 2015)

¹¹ (Cooke, 2014, p. 10)

¹² (Beach Energy, 2015, pp. 15-16)

¹³ (Baulderstone, 2015, p. 10)



Figure 2. A display model of a triple-cased well design in cross section, viewed by the Natural Resources Committee at the Katnook Gas Plant, SA, February 2015. The centre (yellow) casing on this model is approximately 10cm across and each subsequent casing is surrounded by cement.

3.2 Coal-seam gas (CSG)

Coal seam gas (also known as coalbed methane or CBM) is natural gas generated during the transformation of organic material to gas and trapped within coal, often with water, requiring wells to be dewatered before gas extraction. CSG targets in Australia are usually at depths of less than 1,000 m.¹⁴

There are different ways to extract CSG, including vertical, horizontal or directional drilling.¹⁵ If water and gas do not flow freely from a coal seam well after drilling, fracking may be used to obtain economic flow rates; Santos has stated it fracks fewer than 10% of its CSG wells.¹⁶

In general, shallow CSG resources may be near shallow, multiple use water resources generally at depths less than 1,000 metres below surface, while deep gas in South Australia includes targets generally at depths greater than 2,500 metres below surface.¹⁷

Coal seam gas has been produced in Australia since 1996, when extraction began in Roma, Qld.¹⁸ The committee has received evidence from the South Australian Department of State Development that shallow coal seam gas is not a prospect anywhere in South Australia¹⁹, and coal seam gas at any depth

¹⁴ (South Australian Chamber of Mines and Energy, 2015)

¹⁵ (NSW Government, 2015d)

¹⁶ (Santos, 2013)

¹⁷ (Department of State Development Energy Resources Division, 2015, p. 4)

¹⁸ (NSW Government, 2015e)

¹⁹ (Department of State Development, 2015a)

is not a consideration for South East South Australia.²⁰ This is important to note as the infrastructure associated with shale and tight gas is different to coal seam gas. (See Table 1.)

Dewatering

Dewatering is primarily associated with coal seam gas and occurs when gas is trapped in place by a water reservoir or trap, so that water must be pumped out before gas can be extracted from the well. The recovered water varies in quality and quantity but can be treated and reused for a variety of purposes. Water can be recovered from a coal seam gas well for periods of time ranging up to years.²¹

3.3 Shale gas

Shale is a very common, fine-grained sedimentary rock which forms on the beds of large bodies of water over very long periods of time. Layers slowly build up, sometimes in great thicknesses, with organic matter which forms hydrocarbon deposits as it decomposes. If no fracturing (either natural or manmade) occurs, gas and oil can remain trapped in shale indefinitely.²²

Because of the difficulty and expense in recovering gas trapped in impermeable shale, it has not been a focus for production until the last decade, when developments in hydraulic fracturing and drilling (such as horizontal or deviated vertical drilling) have made shale gas an economically attractive option.

Fracture stimulation is used to produce fissures in the thin layers of shale that trap gas, allowing it to flow through these induced pathways to the production well.²³

Shale gas was produced in small quantities from shallow depths in the US since the 19th century; however, production there has boomed since 2009, when advances in technology allowed extraction from new reservoirs.

In South Australia, primary unconventional targets are shale and deep coals. In the South East, the unconventional targets are between 3,000–4,000m below ground level and at least 2,500m below the aquifers.²⁴

3.4 Tight gas

Tight gas is considered ‘not dissimilar to conventional gas in terms of geological setting’, but it is limited in its ability to migrate upward by low-permeability reservoir rock (such as sandstone or limestone) where it becomes trapped. It generally occurs at depths between 2000–5000m. Hydraulic fracturing is required to create commercial gas flows. Tight gas is in some instance considered conventional and has been produced in the Cooper Basin for ‘some decades through the use of hydraulic fracture stimulation’.²⁵

3.5 Underground coal-seam gasification (UCG)

UCG (also known as in-situ gasification) is a newer type of unconventional gas extraction currently being trialled in the northern parts of South Australia and in Queensland, near Chinchilla and Dalby, by Linc Energy.²⁶ It is mentioned here solely for purposes of clarification and to eliminate confusion

20 (Malavazos, 2015, p. 21)

21 (Cooke, 2014)

22 (Stephenson, 2015, p. 25)

23 (South Australian Chamber of Mines and Energy, 2015, p. 4)

24 (Ibid., p. 5)

25 (Santos, 2013, p. 3)

26 (Queensland Department of Natural Resources and Mines, 2015b)

between this type of gas production and the types of production under consideration for the South East of South Australia.

UCG, although unconventional, is not natural gas. The phrase ‘underground coal-seam gasification’ describes a process that creates a gas product (called ‘syngas’) from coal by burning the coal while it is still underground, using controlled, high-pressure combustion. Oxygen and steam are fed into the coal seam through injection wells to enhance the combustion process. The product gas is then extracted to the surface through wells. Syngas can be used as ‘either a fuel or as feedstock for a range of chemical products’.²⁷

Linc Energy is exploring for UCG in South Australia’s Walloway Basin (as well as conventional hydrocarbons, shale oil and CSG in the Arckaringa Basin).²⁸ Recently, an announcement was made regarding the possible development of a UCG processing plant at Leigh Creek.²⁹ Further discussion of this process or these proposals is beyond the scope of this report.

3.6 Hydraulic fracturing (‘fracking’)

Hydraulic fracturing (also known as ‘hydraulic fracture stimulation’, and colloquially as ‘frack(ing)’, sometimes spelled ‘frac(cing)’ is the process of injecting a mixture of mainly water, proppants (small particles, such as sand or ceramic) and chemicals (‘fracking fluid’) at very high pressure³⁰ to create small cracks through which hydrocarbons can flow from a reservoir. For the sake of brevity, this report uses the colloquial word ‘fracking’ to mean ‘hydraulic fracturing’.

The terms ‘fracking’ and ‘unconventional gas’ are sometimes used interchangeably, but they are not equivalent terms. The former is a single (though complex) process; the latter is a broad descriptive phrase for a sector. The committee has received evidence that fracking was first conducted in Texas in the 1940s³¹ and has been in use for several decades in conventional gas extraction in Australia; whereas unconventional gas extraction and refinement is a recent development in the energy industry, made physically and economically possible by advances in technology, including liquification and shipping, and by combining various exploration/extraction practices, including hydraulic fracturing and horizontal or deviated drilling.

The committee has received evidence that Santos, as operator of the South Australian Cooper Basin Joint Venture, has undertaken more than 2,000 hydraulic fracture stimulation treatments in more than 900 conventional wells since 1967, with unconventional shale gas production commencing production in 2012.³² No fracking has been conducted in wells in the South East, all of which have been conventional wells, nor are there any current proposals for operations involving fracking.³³

Fracking may be performed to speed up the flow of the contents of a conventional hydrocarbon reserve or to stimulate the flow of otherwise inaccessible reserves, and a single well may be fracked in stages (i.e., fracked multiple times). A fracked well may be vertical or have a horizontal or diagonal (‘deviated’) segment, and fracking can be done for shallow wells as well as deep, with the composition of fluids varying depending on the location and purpose of the frack. Beach Energy

27 (Wilson, 2014)

28 (Department of State Development, 2013)

29 (Nicholson, 2015)

30 As high as 700 atmospheres (or about 70,000 kPa/10,000 psi) (Stephenson, 2015, p. 61)

31 (South Australian Chamber of Mines and Energy, 2015)

32 (Boulderstone, 2015, p. 104)

33 (Gibbins, 2015, p. 160)

states in its submission to the inquiry that a typical fracture stimulation in low-permeability shale in the Cooper Basin requires 1.3 to 1.6 megalitres (ML) of water per frack treatment.³⁴

The materials and machinery used for mixing water and components to make fracking fluid are brought to the site by truck, while water is usually piped in. The committee heard evidence from Halliburton, which provides hydraulic fracturing services to the oil and gas industry, that about 30 trucks might move onto a site and perform a series of works before moving on to another location. Each frack treatment (of approximately 7 to 10 per well) would last about one to three hours. The trucks would remain onsite for one to two weeks.³⁵

Fracking occurs after a well is drilled and cased (sealed with layers of steel and cement, ranging from two layers in very shallow wells to three or more for deeper wells; see Figure 2) and the casing is perforated (holes punched through to allow transmission of fluids or deposits from the source rock).

Stimulated fractures are typically ‘a few millimetres wide, about 30 metres high and extend anywhere from tens of metres to a few hundred metres from the well’.³⁶ A peer-reviewed study conducted by UK researchers using data collected in the US has shown the maximum extent of a stimulated fracture to be 588m, with the probability of an artificial fracture extending vertically more than 350m estimated to be about 1 per cent.³⁷

Fracturing fluid

The composition of fracking fluid varies. The majority of the fluid is water, with proppants added to water to hold open the fractures created, and additional chemicals to carry the proppants as well as reduce friction, kill microbes, prevent scale/corrosion, and enhance surface tension, among other purposes.³⁸ Submissions to the inquiry indicate that the materials added to water are of great concern to many people.

Table 2. Fracturing fluid composition as provided in submissions to the inquiry

Company/Agency	Water	Proppant	Additional chemicals
Beach Energy	97%	2.5%	0.5%
Cooper Energy	97–98%	2–2.5%	>1%
Department of State Development	+/- 97–99%		1–3%
Halliburton	96.7%	3.0%	0.3%
Santos	90%	+/- 9.5%	0.5%

When the pressure is released, the proppant remains behind, holding the fractures open, allowing oil and gas to move into the wellbore. Most of the fluids (along with any fluids which were already present in the source rock) also flow back out of the well, where they are captured and either recycled for use in further fracking stages or treated and disposed of. This mixture is known as ‘flowback’.

Chemicals in fracturing fluid

The amount of chemicals added to the water and proppant, while a relatively small amount of the mixture overall, can be potentially significant given the quantity of fracking fluid used in a well. The

34 (Beach Energy, 2015, p. 18)

35 (Guglielmo, 2015, p. 109)

36 (Santos, 2013, pp. 6–7)

37 (Davies et al. 2012, ‘Hydraulic fractures: how far can they go?’, in Stephenson 2015 pp. 78-9)

38 The additives create a slick texture, which is why fracking fluid is also sometimes known as slickwater and hydraulic fracturing sometimes called slickwater fracking.

committee has received conflicting evidence regarding fracturing fluid: on one hand that it is possibly toxic, and on the other that it uses food-grade ingredients and poses extremely low risk.

The committee has heard evidence that the makeup of fracking fluid can be considered intellectual property due to the great amount of research conducted into the most effective and safest materials to use.

Halliburton's submission to the inquiry lists additives to fracking fluid as: friction reducer, gelling agent, surfactant, scale inhibitor, crosslinker, iron control, hydrochloric acid (15%), corrosion inhibitor, breaker, buffer and biocide and goes on to state that:

The functions served by the less than 1% of chemical additives used in a typical frac formulation include: increasing the viscosity of the fluid to improve proppant transport, reducing friction, inhibiting bacterial growth, preventing corrosion in the well casing and limiting the formation of scale and other precipitants that could impede the flow of oil and gas and fluids.

Many of the chemicals in the additives used in the process are also found in foods or in household products such as cosmetics, shampoo and cleaning products.³⁹

Other submissions to the inquiry have listed chemical additives generally, as follows:

Table 3. General purpose of chemicals added to fracking fluid, by company/agency

Beach	'...additives, which constitute only 0.5% of the total fracture stimulation fluid, include acid, buffers, biocides, surfactants, iron control agents, corrosion and scale inhibitors, crosslinkers, friction reducers, gelling agents and gel breakers. Several of these ingredients are essential to maintaining well integrity.' ⁴⁰
Cooper Energy	'...the remainder made up of chemicals to improve the treatment's effectiveness, such as friction reducers and thickeners plus substances to protect the production casing, such as corrosion inhibitors and biocides. These fluids are designed by service companies that tailor fracturing treatments to suit the needs of a particular job.' ⁴¹
Santos	'Chemicals account for the remaining 0.5% of the mixture and assist in carrying and dispersing the sand in the low-permeability rock.' ⁴²

Wastewater capture, recycling and disposal

In the period after fracking, the fluids flowing back from a deep unconventional (shale or tight) gas well are mostly fracturing liquids which, Beach Energy has told the committee, are directed to either a lined pond or tank. Additionally, substances which may have been present in the source rock, which can include naturally occurring heavy metals, benzene, toluene, and/or radioactive material, also flow from the well and must be handled and disposed of with caution. Some issues have also been identified around potential risks associated with wastewater and its disposal.

A certain proportion of flowback water can be recovered. Beach Energy (citing King 2012) stated in its submission that US shale gas statistics indicate approximately 40 per cent to 50 per cent of injected fluid may be recovered. Dr Dennis Cooke, a researcher in the area of unconventional gas who addressed the committee, has estimated fluid recovery of about one-third to one-half, noting the quality of water can vary considerably due to salinity as well as natural contaminants, and it is not always suitable for re-use. Production of recovered fracture fluid diminishes over the flowback period.⁴³

39 (Halliburton, 2015, p. 5)

40 (Beach Energy, 2015)

41 (Cooper Energy, 2015, p. 12)

42 (Santos, 2013, p. 3)

43 (Cooke, 2014, p. 7)

4 Context

The rapid expansion of unconventional gas extraction has caused marked changes to the world petroleum market since the early 2000s. New combinations of existing extraction and production practices along with technological advances in areas including drilling, well stimulation, refining, export, and shipping practices, have enabled the development of new sources of oil and gas.

Unconventional gas exploration and extraction is a contentious issue for many reasons; in short, the committee has heard that many people distrust the gas industry's ability to protect the environment, and public pressure on governments has led to bans or moratoriums on fracking and gas activities in various jurisdictions, nationally and internationally. Additionally, many groups have organised to declare opposition to gas development on private land, with regional community groups such as Lock the Gate and Gasfield Free seeking to deny access to exploration companies.

Although unconventional gas is being produced commercially around the world—in South Australia production is occurring in the Cooper Basin—the United States has unquestionably led the development. In the US, shale gas went from being a fraction of natural gas production in the year 2000 to being the dominant form in 2015⁴⁴. The Energy Information Administration (EIA), an independent US agency, has predicted that by 2035, shale gas would make up about half the US's total natural gas production. '[A]n entirely new energy source will have risen from obscurity to dominance within 35 years', according to the British Geological Survey's chief scientist, Michael Stephenson, adding that the US was predicted to become an exporter of LNG in 2016.⁴⁵

The world's total shale gas reserves have been estimated at about 7.3 trillion cubic feet, and Australia has been ranked among the top 10 countries in terms of highest shale gas reserves.^{46, 47}

Table 4. Indicative table showing differences in 'types' of natural gas resources in Australia.

Rank	Country	Estimated reserves (tcf) ⁴⁸
1	China	1,115
2	Argentina	802
3	Algeria	707
4	United States	665
5	Canada	573
6	Mexico	545
7	Australia	437
8	South Africa	390
9	Russia	285
10	Brazil	245
Total	World	7,299

Although this report is focused on potential development of unconventional gas (particularly shale/tight gas) in the South East region of South Australia, it is important to reflect on unconventional gas and oil developments overseas, especially the US, because of the advanced state

44 In 2000, US shale gas production made up about 0.5 trillion cubic feet (tcf) of about 21 tcf; in 2015, shale gas was about 12 tcf of total production of about 26 tcf. Tight gas in 2015 was about 6 tcf. (Stephenson, 2015, p. 2)

45 (Stephenson, 2015, pp. 2–3, 8).

46 (Robins, 2013)

47 In terms of scale, the committee heard evidence in a 2013 hearing that 1 tcf (trillion cubic feet) represented current demand per year for all of Australia's needs, including heating, cooking, electricity and manufacturing. (Goldstein & Malvazos, Coal Seam Gas and Unconventional Gas Exploration and Extraction in South Australia, 2013)

48 Tcf: trillion cubic feet

of the US industry. Events and developments there, whether technical, social, political or otherwise, should be instructive for other jurisdictions.

In a 2015 report, the UK House of Commons Environmental Audit Committee addressed the relevance of the US industry to other nations:

The evidence from a range of government bodies and independent scientific institutions is generally in agreement that fracking can proceed in the UK safely and without harm to the environment provided proper environmental safeguards are introduced and adhered to. However, uncertainties remain because of the experience in the United States and the fledgling state of the industry in the UK, meaning that the perception that fracking is inherently risky prevails.⁴⁹

The committee has heard from various sources that reasons to develop unconventional gas resources in the South East of South Australia may include:

- Energy security for Australia, particularly South Australia
- To attract investment to South Australia
- Build export potential to meet high demand: ‘Population growth and strong economic activity, particularly in India and China, are the main contributors to these high levels of energy demand.’⁵⁰
- Increased employment
- Reduced fossil-fuel emissions
- Gas as a ‘bridging’ fuel to renewable energy

All of these are subject to myriad external forces including production and export price, advances in other technologies, particularly renewables, and very notably, public opinion.

The world energy market is in a period of rapid change. Though it is beyond the scope of this report to address these changes in detail, consideration must be given to the broader context as it has economic implications for gas industry development in South Australia.

4.1 Gas in South Australia

Legislation

Gas production in South Australia takes place under a three-stage process regulated chiefly under the *Petroleum and Geothermal Energy Act 2000* (PGE Act), with any interaction between PGE Act and other South Australian Acts administered through arrangements with respective agencies. Other relevant acts are:

- *Environment Protection Act 1993*
- *Natural Resources Management Act 2004*
- *National Parks and Wildlife Act 1972*
- *Aboriginal Heritage Act 1988*
- *Development Act 1993*
- *Work Health and Safety Act 2012*
- *Public and Environmental Health (Waste Control) Regulations 2010*
- *Environment Protection and Biodiversity Conservation Act 1999 (Cth)*

Under Stage 1, the Department of State Development (DSD) handles applications for and grants petroleum exploration licenses (PELs).

49 (House of Commons Environmental Audit Committee, 2015, p. 16)

50 (Australian Petroleum Production and Energy Association, 2015, p. 2)

Under Stage 2, the DSD assesses development proposals, including the licensee's environmental impact report (EIR), which 'is there to enable informed decisions to be made about the risks' by the community, the approving authority, and the minister.⁵¹ Concurrent with the EIR, the licensee must submit a draft of a detailed activity proposal called the statement of environmental objectives (SEO).

This document, for all intents and purposes, is a form of regulation, but the beauty about this document is that the community have a say in what conditions and what objectives they want a company to meet to meet their expectations.⁵²

The committee heard that both the EIR and the SEO are developed in consultation with relevant stakeholders, which includes landholders, community, native title claimant groups, and government agencies, before they are assessed by the DSD. 'That assessment is not done in isolation by DSD,' said Michael Malavazos, DSD director of engineering operations, energy resources division. 'Through our administrative arrangements with the EPA, with DEWNR, with the Department of Health, we consult in reaching an understanding of what the level of the impact of that particular activity would be, whether it is low, medium or high.'

In Stage 3, the committee heard, the licensees must demonstrate how they will achieve the objectives set out in the SEO. 'The community set the standard; we then, as the agent to the community, ensure that companies can demonstrate that they can meet those objectives,' said Mr Malavazos.⁵³

History

South Australia's history of petrochemical exploration and production dates back more than 100 years. The state's first oil well was drilled in 1866 in the Otway Basin, and a replica of it is on display outside the Salt Creek roadhouse on Princes Highway in the Coorong. Since the 1960s, exploration and development onshore has been centred on the Cooper and Eromanga basins in the state's North East.

Potential unconventional hydrocarbon reserves in South Australian basins include shale gas, tight gas, coal seam gas, in situ gasification (underground coal gasification) and surface syngas processes. 'Exploration for these new resources is at an early stage in the state, however significant potential exists' and exploration research is underway.⁵⁴

In over 50 years of exploration and production, Santos has drilled over 2,700 wells and currently produces from approximately 1,300 oil and gas wells. To date, over 700 wells have been fracture stimulated in the Cooper Basin with over 1,500 individual fracture stimulation stages having been pumped.⁵⁵

Unconventional gas production commenced in South Australia in October 2012, when the Moomba-191 deep gas well in the Cooper Basin began commercial flows from 'sandstone, shale-type rock'.⁵⁶ By December 2012, a minimum of nine unconventional gas 'plays' (i.e. prospective hydrocarbon development regions with similar geology) were being explored by more than 20 joint ventures in South Australia.⁵⁷

51 (Malavazos, 2015, p. 22)

52 (Ibid.)

53 (Malavazos, 2015, p. 23)

54 (Department of State Development, 2013)

55 (Santos, 2013, p. 2)

56 (Boulderstone, 2015, p. 105)

57 (Department for Manufacturing, Innovation, Trade, Resources and Energy, 2012, p. 11)

There is a high probability for two or more unconventional gas plays being profitably developed in the next five years....Gas has been flowed during production tests of shale gas, tight gas and deep coal seam gas in the Cooper Basin and shale gas reservoirs in Moomba 191 have already been commercialised by the Santos operated joint venture that includes Origin Energy and Beach Energy.⁵⁸

4.2 The South East region of South Australia

This inquiry is focused on unconventional gas in the South East of South Australia; Natural Resources South East describes the region as follows:

The South East Natural Resources Management (SE NRM) region covers an area of approximately 28,000 square kilometres and is bounded by the Victorian border to the east, the Southern Ocean to the south and the Coorong to the west. This area of South Australia is commonly referred to as the Limestone Coast due to its proximity to the coast and the abundance of limestone located under the soil, which acts as a filter to produce high quality water.

The climate of the region is characterised by cool wet winters and mild to hot, dry summers. Average annual rainfall varies considerably within the region, from approximately 850mm in the south to 450mm in the north of the region. With a favourable climate, suitable soils and underground water, the South East has a strong history as a highly productive area that supports a diverse and profitable industry base. The region contributes about \$5 billion per annum towards the South Australian GDP with more than 30% of the State's GDP produced by the South East's agricultural sector. The key economic activities in the region supported by natural resources include plantation forestry, wine/viticulture, agriculture, dairy, potatoes, fishing/aquaculture and their associated industries.⁵⁹

The groundwater resources supporting agriculture, horticulture, municipal and industrial activity in the South East are the Quaternary Bridgewater Formation and mid to late Tertiary period Gambier Limestone and Dilwyn Sand aquifers. The base of the deepest of these, the confined Dilwyn Sand aquifer, is less than several hundred metres below ground surface in the area around Penola.

The shallow potable aquifers of the Gambier Limestone and Dilwyn Formation in the South East of South Australia are generally at depths no more than 500m below surface.⁶⁰

Between the main sources of groundwater and the formations targeted for unconventional gas exploration there is a Cretaceous sedimentary layer between about 2,000m and 4,000m thick. The committee received evidence from inquiry witness Dr Geoff Harrington that:

Many of these intervening sediments are low-permeability mudstones and shales, which will act to isolate any deleterious impacts caused by changes in water pressures or water quality in the gas target formation.⁶¹

Gas exploration and production in the South East of South Australia

The South East's gas resources lie in the Otway Basin, which spans Victoria and South Australia and extends offshore. There is currently no gas being produced in the South East, and no formal proposals have been made for unconventional gas production in the area.⁶²

The South Australian Otway Basin has an onshore area of 9,650km². The region's first commercial natural gas discovery there was south-west of the regional centre of Penola, at Katnook-1, in 1987, after which exploration yielded five gas fields.

58 (Department for Manufacturing, Innovation, Trade, Resources and Energy, 2012, p. 11)

59 (Natural Resources South East, n.d.)

60 (Department of State Development Energy Resources Division, 2015, p. 4)

61 (Harrington, 2014)

62 (Department of State Development, 2015b)

The discovery at Katnook created a small boom in domestic and local industrial gas use in the region. The Katnook field produced approximately 80 billion cubic feet of gas until production declined, eventually became uneconomic and was suspended in 2011. Sources of that gas were conventional, located primarily in Pretty Hill sandstone.⁶³

In 1991, the South East Pipeline System (SEPS) was built to transport gas from the Otway Basin's Katnook gas fields to users at Penola, Snuggery and Mount Gambier in the South East.

The South East Australia (SEA) Gas Pipeline, completed in 2004, doubled capacity into South Australian markets, increasing competition and energy security.⁶⁴ The system runs from South West Victoria to Adelaide along points including Naracoorte, Keith, Coonalypyn, Tailem Bend, Gawler and Pelican Point. The SEA Gas pipeline transports gas to three regional delivery points: Teys Australia at Naracoorte, Dairy Farmers at Jervois and the South East South Australia (SESA) pipeline.⁶⁵

In 2005, following the decline in production from the Katnook gas fields, the SEPS was linked to the SEA Gas Pipeline via the SESA Pipeline. Gas is now sourced from Victoria's offshore Otway basin gas fields near Port Campbell and storage at Iona.⁶⁶

In a joint venture with Cooper Energy,⁶⁷ Beach Energy is currently exploring onshore in the Lower Sawpit Shale and the Casterton Formation within the Penola Trough of the Otway Basin. Deposited in the late Jurassic and early Cretaceous periods, respectively, these formations are located between approximately 2,500m and 5,000m below ground level in the area around Penola.

Beach Energy's submission to the inquiry states the company:

has a long history of exploring for hydrocarbons in the Otway Basin. Early in the company's history, Reg Sprigg, the company founder, mapped a large part of the Otway Basin and undertook surveys to determine whether hydrocarbons existed below the earth's surface. Beach drilled Geltwood Beach-1 in 1963, south west of Millicent, to look for oil. Beach also explored for gas in Victoria and made the first commercial gas discovery in the Port Campbell area in 1979.⁶⁸

The company also states:

Current exploration, development and production assets are located onshore in both the South Australian and Victorian sections of the Otway Basin. Included in these assets is the Katnook gas/condensate plant near Penola and associated production licences. The Otway Basin is prospective for conventional and unconventional gas and oil.⁶⁹

In 2014, Beach and Cooper drilled the deep exploration wells Jolly-1 and Bungaloo-1 (3km south-south-east and 10.5km west-north-west of Penola, respectively) intersecting shale and tight sandstone.

Beach undertook a water quality monitoring program for both sites to 'establish baseline conditions, especially groundwater quality, prior to drilling the exploration wells and possible future gas regulated activities.'⁷⁰ Neil Gibbins, Beach Energy's Chief Operating Officer, told the committee in a hearing: 'I can tell you, broadly speaking, that we saw no impact from the operations that we

63 (Malavazos, 2015, p. 21)

64 (Department of State Development, 2013)

65 (South East Australia Gas, n.d.)

66 (Australian Energy Market Commission, n.d.)

67 (Cooper Energy, 2015, p. 2)

68 (Beach Energy, 2015, p. 10)

69 (Beach Energy, n.d.)

70 (John Leonard Consulting Services for Beach Energy, 2015, p. 1)

undertook. We didn't see any change in the water.'⁷¹ Groundwater reports from Bungaloo-1 and Jolly-1 were received by the committee in response to questions taken on notice by Mr Gibbins and have been appended to Beach Energy's written submission to the inquiry.

Beach Energy's submission also states that initial exploration results have indicated tight gas potential in the Lower Sawpit Shale and conventional gas potential in the Sawpit Sandstone.⁷²

In June 2015, Mr Gibbins told the committee:

At this stage, we are still waiting on final results from our core sample analysis to determine our possible next steps. Early results have suggested good conventional reservoir quality at depths of around 2,000 metres plus, but Beach has not yet considered or sought approval to fracture stimulate.⁷³

The committee has visited the Katnook gas plant and numerous well locations in the South East, including the Jolly-1 deep exploration well, which is approximately 700m from the Riddoch Highway. The committee heard from representatives of Beach Energy while visiting the Jolly-1 well pad that this well will not be developed further; it has been plugged with cement and awaits removal of the wellhead.

71 (Gibbins, 2015, p. 161)

72 (John Leonard Consulting Services for Beach Energy, 2015, pp. i, 1)

73 (Gibbins, 2015, p. 158)



Figure 3. The Natural Resources Committee visited the Jolly-1 exploration well outside Penola, September 2015. The committee has heard that the well will not be developed further and wellhead removal is planned.

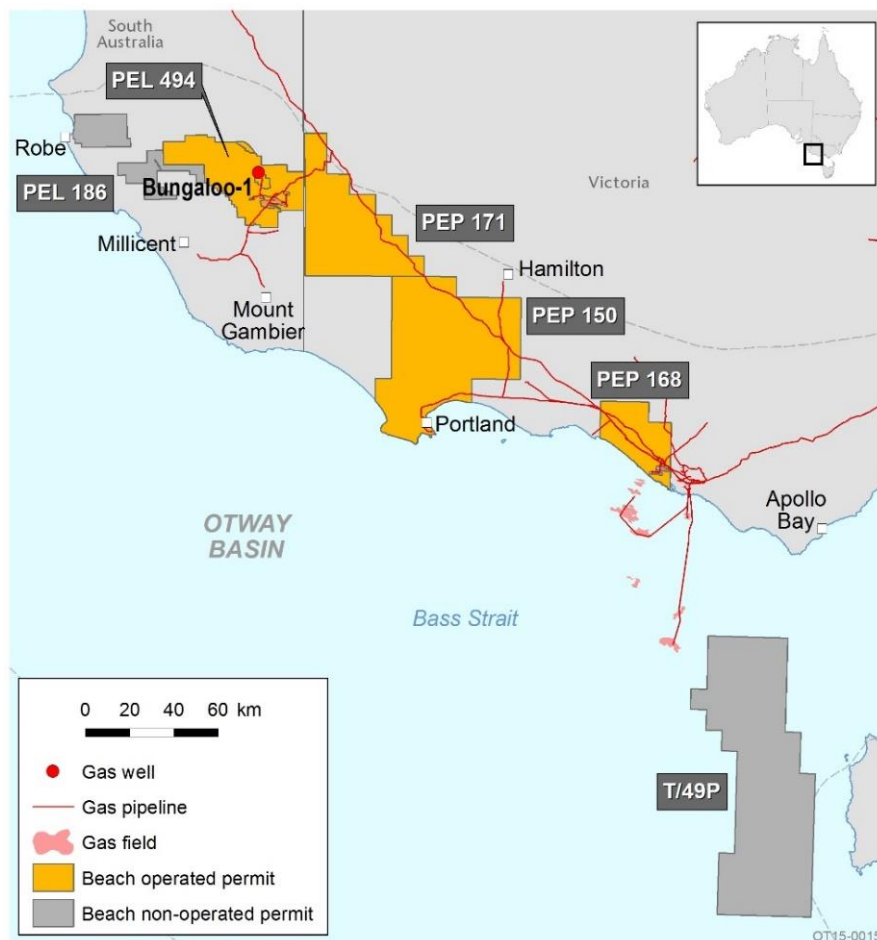


Figure 4. Beach Energy gas activity in the Otway Basin. Source: Beach Energy⁷⁴

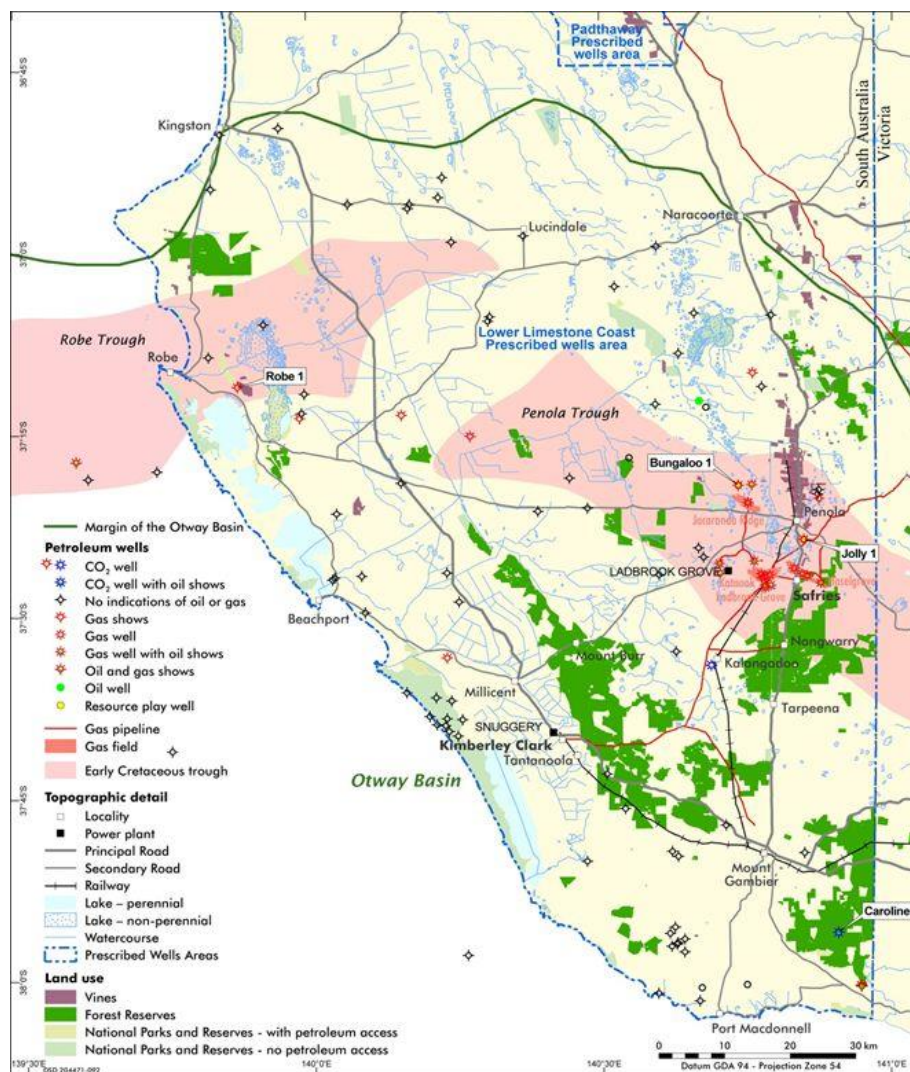


Figure 5. Map of petroleum activity in South East of South Australia, 1910 to present. (Department of State Development Energy Resources Division, 2015)

4.3 The rest of Australia

Although this inquiry and interim report focus on the South East of South Australia, unconventional gas developments and proposals in the rest of the Australia are necessarily related to events in this state, so brief consideration is given to other areas of the country. The information provided here is not comprehensive but is intended to provide a general picture of events outside South Australia.

Commonwealth

Following is a list of relevant reports produced by Commonwealth Government and agencies:⁷⁵

- 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 (2011).
- Standing Council on Energy and Resources (now COAG Energy Council), National Harmonised Regulatory Framework for Natural Gas from Coal Seams (2013).

74 (Beach Energy, n.d.)

75 Parliamentary and government initiated reports listed here come in part from the Parliament of Australia's website (Parliament of Australia, n.d.)

- Productivity Commission, Mineral and Energy Resource Exploration (2014).
- Senate Select Committee into Certain Aspects of Queensland Government Administration related to Commonwealth Government Affairs (2015).

New South Wales

Unconventional gas development in NSW has been chiefly coal seam gas extraction at depths of about 200m to 1,000m. Distance between reservoir targets and shallow groundwater varies ‘up to hundreds of metres’ so the potential, though limited, exists for hydraulic connection. There are no proven shale gas reserves in NSW. NSW coal seams have been found to be drier than those in Queensland, requiring significantly less dewatering.⁷⁶

AGL’s Camden Gas Project has been producing natural gas from coal seams since 2001. It supplies around five per cent of New South Wales’ domestic and business gas needs. At the time of this report, the project included 144 gas wells (with 96 currently producing gas), low-pressure underground gas gathering lines, and the Rosalind Park Gas Plant.⁷⁷

Also at the time of this report:

- Regulations were pending in NSW which would ban all new coal seam gas activity (exploration and production) within 2 kilometres of residential areas.
- Coal seam gas activity is prohibited within the ‘Upper Hunter equine and viticulture Critical Industry Cluster’ areas. In the Sydney drinking water catchment ‘special area’ zone, there is a moratorium on exploration and extraction of CSG pending an investigation by the NSW Chief Scientist and Engineer on the impact of CSG activities.⁷⁸
- The NSW Government had drafted *Guidelines for the economic assessment of mining and coal seam gas proposals* and was calling for feedback.⁷⁹

Between 2013 and 2014, the NSW Chief Scientist and Engineer, Professor Mary O’Kane, conducted an independent review of CSG activities in NSW, focusing on potential impacts including on human health, the environment and water catchments. An interim report was published in July 2013, with the major finding that risks to health and environment can be mitigated with ‘engineering best practice; superb monitoring by industry; diligent and transparent compliance checks by regulators and a rapid and effective response, then remediation, should an incident occur.’⁸⁰

The New South Wales Legislative Council General Purpose Standing Committee No. 5 conducted an inquiry into coal seam gas in 2011–2012 to report on the environmental, health, economic and social impacts of coal seam gas activities and the role of CSG in meeting the future energy needs of NSW.⁸¹

An independent review of the process for arbitrating land access arrangements for mining and petroleum exploration in NSW concluded in June 2014 with the publication of a report by Bret Walker SC. The NSW Government published its response the following month.⁸²

The NSW Government has banned several exploration and production practices used in CSG activities in other parts of the world, including the use of BTEX chemicals (benzene, toluene, ethane

76 (NSW Government, 2015b)

77 (AGL, n.d.)

78 (NSW Government, 2015a)

79 (NSW Government, 2015c)

80 (NSW Government, 2015b)

81 (Parliament of New South Wales, n.d.)

82 (NSW Government, 2014b)

and xylene) in the hydraulic fracturing process and evaporation ponds with the aim of encouraging treatment and reuse of water extracted in CSG process.^{83, 84}

Northern Territory

In March 2014, the Northern Territory Government appointed Dr Allan Hawke AC to conduct an inquiry into hydraulic fracturing. The inquiry concluded early in 2015 with the publication of the *Report of the Independent Inquiry into Hydraulic Fracturing in the Northern Territory*.

The report's covering letter, by Dr Hawke, states that:

there is no justification whatsoever for the imposition of a moratorium on hydraulic fracturing in the NT.... The major recommendation, consistent with other Australian and International reviews, is that the environmental risks associated with hydraulic fracturing can be managed effectively subject to the creation of a robust regulatory regime.

Exploration for shale gas was still under way at the time of the NT report, with no certainty regarding the commercial viability of any resources. In the interim, the report recommended:

...establishment of a Cabinet Sub-Committee to oversee the work required for the NT to set the standard for a best practice regulatory regime. It is at the political level that the balance can be struck between promoting shale gas production, setting the environmental management parameters, facilitating land access and fostering the NT's economic development.⁸⁵

Queensland

The Natural Resources Committee travelled to Queensland in August 2015 to observe community impacts of unconventional gas development first-hand. The findings of this visit will be presented in greater detail in the final report.

In the last two decades, coal seam gas production in Queensland has grown to become the dominant form of natural gas in the state. In 1996, coal seam gas accounted for just 1 petajoule (PJ) of the 20 PJ produced; by 2013, CSG accounted for all *but* 1 PJ of 254 PJ produced⁸⁶ (more than doubling from 94 PJ in 2002-03 to 235 PJ in 2012-13 alone)⁸⁷ and now provides about 90 per cent of Queensland's domestic gas supply. Well drilling rates rose from 1,374 wells drilled in 2012-13 to 1,634 in 2013-14, the latter figure comprising 1,573 CSG wells and 61 petroleum wells. Of the CSG wells drilled in 2013-14, the majority (1,394) were development wells.⁸⁸

Queensland has three major liquid natural gas (LNG) projects:

- Queensland Curtis LNG Project (QGC) (Queensland Gas Commission)
- Australia Pacific LNG (APLNG) (Origin)
- Gladstone Liquefied Natural Gas (GLNG) (Santos)

Late in 2014, QGC became the first company in the world to export CSG, in the form of liquid natural gas. Origin followed shortly thereafter, and the GLNG project began exporting in October 2015.⁸⁹

83 (NSW Government, 2014a)

84 (NSW Government, 2015a)

85 (Hawke, 2014)

86 (Quinn, 2014, p. 30)

87 (Haylen, 2014)

88 (Queensland Department of Natural Resources and Mines, 2015a)

89 (Macdonald-Smith, 2015)

The Queensland Competition Authority has reviewed the regulation of the CSG industry, with its final report provided to the Queensland government in January 2014.

The state's *Regional Planning Interests Act 2014* (RPI Act) and *Regional Planning Interests Regulation 2014* commenced on 13 June 2014; these seek to manage the impact and support coexistence of resource and other regulated activities. Under the RPI Act, resource companies must apply for regional impact development approval (RIDA) in order to undertake resource activities in areas identified as 'areas of regional interest' (ARIs), which are categorised as follows:

- Priority Agricultural Areas
- Priority Living Areas
- Strategic Environmental Areas
- Strategic Cropping Areas (formerly Strategic Cropping Land).⁹⁰

Land currently protected by the superseded act is included as one of four ARIs above.

The state also has a number of regulations and policies in place to address the complex issue of produced water management.⁹¹

At the time of this interim report, independent Queensland Senator Glen Lazarus was petitioning the Federal government⁹² for further changes and restrictions to unconventional gas works in the state, including:

- Stopping the expansion of CSG mining
- Banning fracking and providing support to those affected by CSG
- Ensuring health impact assessments and baseline monitoring occur before coal, coal seam gas and other unconventional gas developments are approved
- Implementing exclusion zones preventing CSG, shale gas and coal mining near residential and agricultural and farming areas
- Giving people the right to say no to gas wells or coal mines on their property

Tasmania

The Tasmanian Department of Primary Industries, Parks, Water and Environment, together with the Environment Protection Authority and Mineral Resources Tasmania, completed a review of hydraulic fracturing in Tasmania in 2015. The government, taking into account the findings, extended an existing moratorium on hydraulic fracturing by five years:

The Liberal Government supports a strong and thriving agriculture industry in Tasmania, which is why we have applied a precautionary principle when considering any measures that could impact on the sector's ability to grow ten-fold to \$10 billion a year by 2050.⁹³

The initial moratorium, introduced in March 2014, was for one year and will now extend to 2020. Exploration for shale oil and gas would be permitted to continue but hydraulic fracturing would not be allowed under the moratorium.⁹⁴

⁹⁰ (Queensland Government, a)

⁹¹ (Queensland Government, b)

⁹² (Senator Glen Lazarus, n.d.)

⁹³ (Jeremy Rockliff, Minister for Primary Industries and Water, n.d.)

⁹⁴ (Smiley, 2015)

Victoria

On 26 May 2015 the Legislative Council of the Parliament of Victoria moved that the Environment and Planning Committee, chaired by Hon David Davis, would conduct an inquiry into the potential exploration, extraction and production of onshore unconventional gas in Victoria. An interim report was tabled on 1 September 2015 with a final report to be tabled in December 2015.

Terms of reference included risks to environment, land productivity and public health, coexistence of onshore unconventional gas activities with existing land and water uses; potential contribution to the state's overall energy sources and emissions; and policy and regulatory safeguards to enable exploration and development of onshore unconventional gas resources, including further scientific work to inform the effective regulation of an onshore unconventional gas industry.

Public interest in the Victorian inquiry was reported to be extremely high, with the call for submissions attracting more than 1,700 pieces of written evidence, likely the largest ever response to a Victorian Parliamentary committee.

As of October 2015, there was no commercial production of unconventional gas underway in Victoria and a moratorium on unconventional gas was in place.

In January 2013, a Gas Market Taskforce, chaired by former Federal Minister Peter Reith, was established by then Premier Ted Baillieu to examine gas supply issues.⁹⁵ The final report was received by the Victorian government in November 2013.

The report noted that although Australia's eastern market faced considerable uncertainty, it was predicted to triple in size by 2017, with demand changing from domestic to export; gas prices were rising; and community concerns with onshore gas were significant and must be addressed.

The report made 19 recommendations including proactive support for developing the Victorian onshore gas industry; the removal of holds on coal seam gas exploration, hydraulic fracturing and new exploration licenses, subject to regulatory reform; and the appointment of a gas commissioner to build stakeholder confidence in unconventional gas exploration and production processes.⁹⁶

Western Australia

On 7 August 2013, the Environment and Public Affairs Committee resolved to inquire into and report on the implications for Western Australia of hydraulic fracturing for unconventional gas, including how hydraulic fracturing may impact on current and future uses of land; the regulation of chemicals used in the hydraulic fracturing process; the use of ground water in the hydraulic fracturing process and the potential for recycling of produced water; and the reclamation (rehabilitation) of land that has been hydraulically fractured. As of October 2015, the final report was still in progress.

⁹⁵ (Victoria State Government, 2013)

⁹⁶ (Gas Market Taskforce, 2013, pp. 1,4,18)

5 Evidence

5.1 Hearings and meetings

As of 30 October 2015, the Natural Resources Committee had heard evidence from 48 witnesses over the course of 14 hearings relevant to its unconventional gas inquiry.

Eleven hearings have been held in Adelaide at Parliament House, with 29 witnesses appearing. Nineteen witnesses have appeared before the committee at three days of regional hearings in the South East—two days at the Civic Centre in Millicent SA in February 2015, and one at the Council Chambers in Robe SA in September 2015.

Prior to the formal commencement of the inquiry, the committee also held two hearings in which evidence was heard from three witnesses, under the references ‘coal seam gas and unconventional gas exploration and extraction’, and ‘fracking’.

Two more hearings are scheduled through the end of 2015. See Appendix B: Witnesses for a complete list of witnesses who have appeared before the committee regarding unconventional resource development.



Figure 6. Members take evidence on fracking from witness Anne Daw. Old Chamber Parliament House, Adelaide, 10 April 2015.

5.2 Fact-finding visits, meetings and study

The committee travelled to the South East of South Australia twice and to Queensland’s Darling Downs region once during the calendar year. A day trip to Moomba in the South Australian Cooper Basin, to view hydraulic fracturing in progress, was in the planning stages at the time of this report.

Millicent, South Australia (South East), 17–19 February 2015

In February 2015, the committee travelled to Millicent in the South East, where they heard evidence from 12 witnesses over a day and a half of hearings held at the Millicent Civic and Arts Centre on 17–18 February. The committee travelled to Penola on 19 February and, accompanied by representatives of Beach Energy and the Australian Petroleum Production and Energy Association, visited the Katnook gas plant, the well head at the Beach Energy exploration well Bungaloo-1, and the Sawpit-1 and Sawpit-2 rehabilitated well sites.

Darling Downs, Queensland (Surat Basin), 24–27 August 2015

In August 2015, the Natural Resources Committee visited Queensland's Darling Downs, where coal seam gas production has risen sharply over the last several years.

While in the region from 24–27 August, the committee members met and spoke with a range of stakeholders including landholders, community residents, energy companies, small business owners, legal and financial groups, Western Downs and Maranoa councils, and the local Member of the Queensland Parliament. The visit, which will be explored in greater detail in the final report, provided the committee with valuable insights.

In brief, the committee saw that the community has experienced both advantages and disadvantages following the industry's expansion. For example, some landholders have secured new sources of water for irrigation and the region's employment has increased overall; while construction related to gas development brought with it a population surge of thousands of workers (from nearby towns, Brisbane, other parts of Australia and, to a lesser degree, overseas) into communities which were unprepared in terms of basic services such as housing, road infrastructure (including parking), supplies, medical care and police availability.

The committee heard that the region is now coming to terms with such changes and working to ensure sustainable growth. The Queensland stakeholders who met with the committee offered practical advice and perspectives.

Western Downs Regional Council, Dalby, Qld (24–25 August)

The committee travelled to Brisbane early on Monday morning and continued on to Dalby in the Western Downs Regional Council area.

- Meeting in Dalby with the Western Downs Regional Council mayor, elected members, and staff
 - Presentation from Origin Energy, Scott Bird
- Bus tour of Dalby area (conducted by Mayor Ray Brown)
- Meeting with members of the Basin Sustainability Alliance, a landholder group committed to working with industry/government to achieve a CSG industry that protects environmental resources (groundwater, lifestyle, food/fibre production, succession planning) at BMO Accountants, Dalby
 - Lyn Nicholson, BSA Chair (until October 2015), landholder/grazier, and retired solicitor
 - Peter Shannon, solicitor, Shine Lawyers
 - Neil Cameron, farmer, grazier, accountant
 - Rory Ross, solicitor, Shine Lawyers

Chinchilla, Qld (25 August)

After an early meeting of the committee, the members travelled west from Dalby towards Roma, stopping in Chinchilla for an informal meeting with local resident Karen Auty, who had made a written submission to the inquiry outlining her experience, as a community member, of local coal seam gas development.

Maranoa Council, Roma, Qld (25–26 August)

25 August

- Briefing with Andrew Snars, Maranoa Regional Manager, Santos shop front, and other staff
- Site visit to Roma gas hub/control centre and irrigation project with Santos representatives
- Evening meeting with Ms Ann Leahy MP (Warrego, Qld); mayor; council members; council staff

26 August

- Morning committee meeting
- CSG Research Forum: Agriculture and Coal Seam Gas, with University of Queensland, CSIRO (GISERA), Department of Agriculture and Forestry hosted by Agforce
 - Interactions between agriculture and CSG—Jim Cavaye and Lisa Kelly, the University of Queensland
 - Groundwater research—Sue Vink, the University of Queensland
- Meeting with Maranoa Council staff (Roma Cultural Centre/Council Admin Centre Ernest Brock Room)
 - Ed Sims, Manager—Economic & Community Development
 - Presentation: Infrastructure, Peter Weallans, Specialist—Infrastructure Contracts
- Meeting with Daniel Phipps, CSG Project Leader, AgForce Projects
- Meeting with GasFields Commission
 - Ben Deverson (General Manager)
 - Professor Steven Raine (Commissioner)

The committee returned to Adelaide on the night of 26 August 2015.



Figure 7. The NRC members met with stakeholders in Western Downs Regional Council, Queensland. From left: Mr Peter Treloar MP, Mr Chris Picton MP, Hon Robert Brokenshire MLC, Hon Gerry Kandelaars MLC, Hon Steph Key MP, WDRC Cr and Mayor Ray Brown, Mr Jon Gee MP, and Hon John Dawkins MLC.

Groundwater management course

To help the committee gain a better understanding of the potential impacts of unconventional gas development on groundwater, two committee members and two committee staff attended a two-day course, Groundwater Essentials, run by the International Centre for Excellence in Groundwater Management, in Adelaide in September 2015. The course covered the following topics:

- Global and local water balances
- Introduction to hydrogeology and aquifers
- Resource assessment: accessing groundwater (investigation, drilling, bore construction), storage, movement, aquifer testing and estimation using pumping tests
- Monitoring groundwater
- Groundwater—surface water interactions
- Groundwater chemistry and water quality
- Pollution and remediation of groundwater
- Managing and protecting groundwater
- Unconventional gas extraction and water management (including regulation, water quality, transport and storage)

Committee members who attended provided a briefing to other members in a subsequent meeting.

Robe, South Australia (South East), 14–15 September 2015

On 14 September, the committee travelled to Robe in the South East, where they heard evidence from seven witnesses. The following day, the committee travelled to Penola to visit the Beach Energy exploration well Jolly-1.

5.3 Public submissions

The committee placed an advertisement in the *Advertiser* on 26 November 2014 and distributed via email lists a call for interested persons to provide submissions to the inquiry or to register an interest in appearing before the Natural Resources Committee. As of 25 September 2015, the committee had received 178 written submissions. See Appendix A: List of Submissions for more information. All written submissions received by the committee may be found on the Parliament of South Australia website: www.parliament.sa.gov.au/Committees/Pages/Committees.aspx?CTId=5&CIId=295.

Submissions: opinion summary

The inquiry received 178 written submissions, varying in length from very short emails to extensive, multi-part reports in the hundreds of pages. Approximately 40 of these were form letters, 26 of which were explicitly in support of a lengthy report co-written by several members of a community group.

Seventy-four percent of submissions to the inquiry do not support hydraulic fracturing in the South East. Of these submissions, many call directly for the process to be banned statewide while a small number of submissions would consider allowing its use to continue elsewhere in the state. There were many reasons stated for desiring that unconventional gas exploration/production be excluded from the South East (if not the state). Many were related to the terms of reference and some were presented outside the terms.

Submissions supporting gas industry development, comprising 5 per cent of submissions, were received from companies or entities either directly engaged in gas exploration and production or directly linked to it: the South Australian Chamber of Mines and Energy, Cooper Energy, Halliburton, Beach Energy, Santos, the Australian Petroleum Production and Energy Association, and the Norwood Resource. This group of submissions indicates existing awareness of many criticisms

levelled at the unconventional gas sector and have offered information to counter some of the more prevalent concerns.

A submission providing an overview of gas industry activity in South Australia and related issues was received from the Department of State Development, with input from the Department of Environment, Water and Natural Resources, the Environment Protection Authority, Primary Industries and Regions SA, SA Health, and SafeWork SA, which the committee heard also ‘have a key regulatory role in managing the potential impacts from fracture stimulation’ activities.⁹⁷

A third group of submissions to the inquiry (17 per cent) came from private individuals, businesses and organisations with no direct ties to the energy industry. These submissions suggest unconventional gas exploration in the South East might go ahead, though with conditions. A number of recommendations are presented within this group of submissions.

Some of the submissions in this group request a moratorium on unconventional gas while further review and research takes place. Others, while so averse to even the lowest levels of risk that they border on expressing opposition to unconventional gas, also express recognition that a strict ban on gas development may be unrealistic and thus present suggestions or recommendations to mitigate identified risks.

In these submissions, an emphasis is made on:

- thorough and objective risk analysis;
- the gathering of baseline data specific to the region;
- reviewing and (if necessary) amending or adding to the existing legislation to (among other things) empower landholders and separate regulation and promotion of petroleum industry;
- including gas exploration/production in local water allocation plans; and
- ensuring policy and decision-making are informed by independent research.

A fourth group of submissions representing 4 per cent of the total did not explicitly state a position on unconventional gas in the South East of SA.

⁹⁷ (Department of State Development, 2015a, p. 3)

6 Conclusion

The Natural Resources Committee will continue its work on the Inquiry into Unconventional Gas (Fracking) in 2016. Noting that opinions differ on the potential impacts and risks of unconventional gas in the South East of South Australia, the committee will reflect on the evidence it has received thus far, and source relevant additional information, such as expert witness evidence, to inform the final stage of the inquiry as it deems necessary.

7 Abbreviations

BOM	Bureau of Meteorology
BSA	Basin Sustainability Alliance
BTEX	benzene, toluene, ethane, xylene
COAG	Council of Australian Governments
CBM	coalbed methane
CH ₄	methane
CSG	coal seam gas (Australian usage; CBM used internationally)
DEWNR	Department for Environment, Water and Natural Resources
DMITRE	Department for Manufacturing, Innovation, Trade, Resources and Energy
DSD	Department of State Development (formerly DMITRE)
EIA	Energy Information Administration (US)
EIR	environmental impact report
EPA	Environment Protection Authority (South Australia)
LCPA	Limestone Coast Protection Alliance
LNG	liquid natural gas
ML	megalitres
MLC	Member of the Legislative Council
MP	Member of Parliament
NRC	Natural Resources Committee
NRM	Natural Resources Management
NRM Act	Natural Resources Management Act 2004
NRM Board	Natural Resources Management Board
PEL	Petroleum Exploration License
PGE	Petroleum and Geothermal Energy (Act)
PJ	petajoules
SACOME	South Australian Chamber of Mines and Energy
SE	South East
SEA	South East Australia
SELGA	South-East Local Government Association
SEO	Statement of Environmental Objectives
SEPS	South East Pipeline Service
SESA	South East South Australia pipeline
UCG	underground coal-seam gasification (<i>not</i> unconventional gas)
US EPA	Environmental Protection Agency (US)
WAP	Water Allocation Plan

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Appendix A: List of Submissions

All written submissions received by the committee may be found on the Parliament of South Australia website at: <http://www.parliament.sa.gov.au/Committees/Pages/Committees.aspx?CTId=5&CId=295>

No. From

- 1 Jan Telford
- 2 Barney McCusker
- 3 Frances Winfield (Vic)
- 4 Vivonne Thwaites
- 5 Alison Hamilton
- 6 Colin Ball
- 7 Judy Rees
- 8 Sharon Holmes
- 9 David Clarke
- 10 Alan Richardson
- 11 Greg
- 12 Lois Doeven (Vic)
- 13 Chris Penfold
- 14 Joy Mayberry
- 15 Sophie Henke
- 16 Jonathan Peter & Josephine Prowse
- 17 Allie Pitman
- 18 Ralph Meznar
- 19 Rural Communities Australia Ltd
- 20 Burr Dodd
- 21 Justin
- 22 National Toxics Network (NTN)
- 23 Green Triangle Forest Products
- 24 SA Rock Lobster Advisory Council, SE Professional Fishermen's Assn, Southern Rocklobster Ltd
- 25 Peter (Huck) Shepherd
- 26 Mark Jones
- 27 Alison Nunan
- 28 No Fracking Way
- 29 Margeaux Chandler
- 30 Jodie Wilson
- 31 Lucy Trethewey
- 32 Lisa Marcus
- 33 Heather Heggie
- 34 Robyn Russell
- 35 Tumby Bay Residents and Ratepayers Association Inc; Port Lincoln Residents and Ratepayers Association Inc
- 36 Joscelin Spurr
- 37 Gilda Mashado
- 38 M.R. Leach
- 39 Sustainable Communities SA Inc
- 40 Christine McCombe

No. From

- 41 Ash Dearman
- 42 Signature illegible
- 43 Patricia McAuliffe
- 44 Irene Yuill
- 45 District Council of Robe
- 46 Limestone Coast Protection Alliance
- 47 Anne Rafferty
- 48 Donald Grey-Smith
- 49 Dr Clive Carlyle
- 50 Kathryn Wright
- 51 Tim Kelly
- 52 Ed Peucker
- 53 Brett Mashado
- 54 Helen & Steve Russell
- 55 Boudicca Cerese
- 56 Chloe Aldenhoven
- 57 Department of State Development
- 58 Jon Gray
- 59 Aaron Izzard
- 60 Karen Auty
- 61 Rosey Pounsett
- 62 Treasury Wine Estates
- 63 South Australian Wine Association Inc
- 64 South Australian Chamber of Mines and Energy
- 65 Heather Gibbons
- 66 Pauline Bosco
- 67 Pip Rasenberg
- 68 Tammy Parham
- 69 Julie Hart
- 70 Suzanne Moss
- 71 Doctors for the Environment Australia
- 72 Peter Clark
- 73 Gilbert John Daw
- 74 Australian Petroleum Production & Exploration Association Ltd
- 75 John Coverdale
- 76 South East Local Government Association
- 77 Cooper Energy
- 78 Halliburton
- 79 Teys Australia Pty Ltd
- 80 Marcia Lorenz
- 81 Angus Ralton

No. From

82 David Smith
 83 Traudi Lepse
 84 Kerry Picard-Arnott
 85 Name withheld
 86 LJ LaBarthe
 87 Primary Producers SA
 88 Mrs E Pauline Johnston
 89 River Lakes and Coorong Action Group
 90 Rod McArthur
 91 Bill Doyle
 92 Wayne Philp
 93 Karen Bubna-Litic
 94 Sandra Brown
 95 Bronwen Hennessy
 96 Kurt Florimond
 97 Dorothy Scown
 98 Terry Allen
 99 Stop Invasive Mining Group
 100 Bronte Gregurke
 101 Peter Couch
 102 Friends of the Earth Adelaide
 103 Kungari Aboriginal Heritage Association
 104 Deiniol Griffith
 105 James Panipucci
 106 Melton Mowbray
 107 Judith Ludwig
 108 Jo-Anne Seater
 109 Karen Wilson
 110 Agravaine MacLachlan
 111 Hayley Rundell
 112 Jenny Allen
 113 Tania Cudmore
 114 Susan Chalcroft
 115 Chantelle Roberts
 116 Donella Peters
 117 Natural Resources South East
 118 Beach Energy Ltd
 119 Sarah Dickens
 120 John Berger
 121 Winegrape Council SA
 122 Limestone Grape and Wine Council
 123 Tony Beck
 124 Kathryn Bersee
 125 Emery Rural
 126 Sue Hill
 127 Environmental Defenders Office (SA) Inc
 128 Dr Michelle Sherrieff
 129 Livestock SA
 130 Kalangadoo Organic

No. From

131 Brad Mann
 132 Damian McMahon
 133 Sue Westgarth
 134 Anne Daw
 135 Carol Bailey
 136 Port MacDonnell Landcare Group
 137 Shannon Pedler
 138 The Norwood Resource
 139 Woodsoak Wines
 140 Conservation Council of South Australia
 141 Marilyn Paxton and John Brook
 142 Sonia Legoe
 143 Bob Daly
 144 Graeme & Joyce Douglas
 145 Sandra Young
 146 Michelle Berlin
 147 Community Alliance
 148 Brian Ling
 149 Dr Catherine Pye
 150 The Australia Institute
 151 Kalnya Micenko
 152 Australian Lot Feeders' Association
 153 Nature Glenelg Trust
 154 Neville Moody
 155 Coonawarra Grape and Wine Inc
 156 Santos
 157 Debbie Nulty
 158 Mount Gambier Friends of Parks
 159 John & Dee Hill
 160 Gasfield Free Drumborg
 161 Sally Watson
 162 Mnemosyne Giles Round
 163 Rivoli Bay Sailing Club Inc
 164 Australian Wine Research Institute
 165 Roy McLean
 166 Will and Sonia Legoe
 167 Will Legoe
 168 Brett & Gilda Mashado
 169 Nina Michielan
 170 CSG Free Maffra and Districts
 171 Claire Easterbrook
 172 Sally Richards
 173 James Smith
 174 Jaye Seal
 175 Rebecca Adams-Fulton
 176 Alan Richardson
 177 Thomas Giles
 178 Sharyn Munro

Appendix B: Witnesses

The following witnesses appeared before the Natural Resources Committee in 2014, prior to formal commencement of inquiry, regarding unconventional gas development.

Friday, 26 July 2013—Balcony Room, Parliament House, Adelaide

Coal Seam Gas and Unconventional Gas Exploration and Extraction in South Australia

1. **Barry Goldstein**, Executive Director, Energy Resources Division, Department of State Development
2. **Michael Malavazos**, Director Engineering Operations, Energy Resources Division, Department of State Development

Friday, 8 August 2014—Balcony Room, Parliament House, Adelaide

Fracking

3. **Dennis Cooke**, Program Manager, Unconventional Resources, Australian School of Petroleum, University of Adelaide

As of 30 October 2015, the following witnesses had appeared before the committee as part of the inquiry:

Friday, 5 December 2014—Balcony Room, Parliament House, Adelaide

1. **Neil Power**, Director, State Research Coordination, Department of Environment, Water and Natural Resources

Friday, 13 February 2015—Balcony Room, Parliament House, Adelaide

2. **Barry Goldstein**, Executive Director, Energy Resources Division, Department of State Development
3. **Michael Malavazos**, Director Engineering Operations, Energy Resources Division, Department of State Development

Tuesday, 17 February 2015—Millicent Civic and Arts Centre, Millicent

4. **Chris McColl**, Kalangadoo Organic Orchards
5. **Tony Beck**, prime lamb and beef producer
6. **Peter Balnaves**, Vice President, Coonawarra Grape and Wine Incorporated
7. **Fraser Bell**, Legal Adviser, Coonawarra Grape and Wine Incorporated
8. **Glenn Harrington**, Technical Expert, Coonawarra Grape and Wine Incorporated
9. **Peter Bissell**, Chair, Limestone Coast Grape and Wine Council
10. **Stuart Sharman**, Chairman, Unconventional Shale Gas Committee, Limestone Coast Grape and Wine Council
11. **Allen Jenkins**, Regional Vineyard Manager, Limestone Coast Treasury Wine Estates
12. **Simon Marton**, Chief Marketing Officer, Limestone Coast Treasury Wine Estates

Wednesday, 18 February 2015—Millicent Civic and Arts Centre, Millicent

13. **Ann Aldersley**, Executive Officer, South-East Local Government Association
14. **Erika Vickery**, President, South-East Local Government Association, Mayor, Naracoorte Lucindale
15. **Geoff Wells**, Director, Rural Communities Australia

Friday, 27 March 2015—Balcony Room, Parliament House, Adelaide

16. **Frank Brennan**, Presiding Member, South East Natural Resources Management Board
17. **Tim Collins**, Regional Manager, Natural Resources South East (DEWNR)

Friday, 10 April 2015—Old Chamber, Old Parliament House, Adelaide

18. **James Baulderstone**, Vice President, Eastern Australia, Santos
19. **Matthew Doman**, Manager, Public Affairs, Eastern Australia, Santos
20. **David Guglielmo**, Country Manager—Production Enhancement, Halliburton Australia Pty Ltd
21. **Anne Daw**, Member, Roundtable for Unconventional Gas Projects in South Australia
22. **Melissa Balantyne**, coordinator/principal solicitor, Environmental Defenders Office
23. **Karen Bubna-Litic**, Professor of Law, University of South Australia; board member, Environmental Defenders Office

Friday, 8 May 2015—Balcony Room, Parliament House, Adelaide

24. **Deb Nulty**, South East landholder

Friday, 15 May 2015—Old Chamber, Old Parliament House, Adelaide

25. **Kate Wheldrake**, Member, Doctors for the Environment Australia, South Australia
26. **John Willoughby**, Secretary, Doctors for the Environment Australia, South Australia

Friday, 19 June 2015—Balcony Room, Parliament House, Adelaide

27. **Stedman Ellis**, Chief Operating Officer, Australian Petroleum Production and Exploration Association
28. **Andrew Taylor**, Senior Policy Adviser, Australian Petroleum Production and Exploration Association
29. **Neil Gibbins**, Chief Operating Officer, Beach Energy
30. **Charles Hollingworth**, Group Manager, Corporate Affairs and Environment, Teys Australia Pty Ltd

Friday, 31 July 2015— Balcony Room, Parliament House, Adelaide

31. **Heather Gibbons**, Limestone Coast Protection Alliance
32. **Peter (Huck) Shepard**, Limestone Coast Protection Alliance

Friday, 11 September 2015—Balcony Room, Parliament House, Adelaide

33. **Dayne Eckermann**, Senior Policy Analyst, South Australian Chamber of Mines and Energy
34. **Jason Kuchel**, Chief Executive, South Australian Chamber of Mines and Energy
35. **Nigel Long**, Director, Policy and Community, South Australian Chamber of Mines and Energy

Wednesday, 16 September 2015—Robe Council Chambers, Robe, South Australia

36. **Peter Riseley**, Mayor of Robe
37. **Merilyn Paxton**, Mootatunga
38. **John Brook**, Mootatunga
39. **David Smith**, landholder
40. **Dr Geoff Manefield**, veterinarian
41. **Dr Melissa Haswell**, Associate Professor, Public Health, University of NSW
42. **Angus Ralton**, landholder/business owner

Friday, 16 October 2015—Balcony Room, Parliament House, Adelaide

- 43. **Adrian Coulter**, Senior Oenologist, the Australian Wine Research Institute
- 44. **Mark Gishen**, Project Manager, Environment and Technical, South Australian Wine Industry Association Incorporated
- 45. **Peter Hackworth**, Executive Officer, Wine Grape Council of South Australia
- 46. **Jack England**, Livestock South Australia
- 47. **David Smith**, Livestock South Australia

Friday, 30 October 2015—Balcony Room, Parliament House, Adelaide

- 48. **Heather Heggie**, South East landholder

Appendix C: Table of Figures

<i>Figure 1. Indicative well design. Wells are designed to meet engineering and regulatory requirements for specific well objectives. Casing size, weight, grade, depths and cement volumes will be varied to meet engineering design specifications. (Beach Energy, 2015).....</i>	<i>6</i>
<i>Figure 2. A display model of a triple-cased well design in cross section, viewed by the Natural Resources Committee at the Katnook Gas Plant, February 2015. The centre (yellow) casing on this model is approximately 10cm across and each subsequent casing is surrounded by cement.....</i>	<i>7</i>
<i>Figure 3. The Natural Resources Committee visited the Jolly-1 exploration well outside Penola, September 2015. The committee has heard that the well will not be developed further and wellhead removal is planned.....</i>	<i>18</i>
<i>Figure 4. Beach Energy gas activity in the Otway Basin. Source: Beach Energy.....</i>	<i>18</i>
<i>Figure 5. Map of petroleum activity in South East of South Australia, 1910 to present. (Department of State Development Energy Resources Division, 2015).....</i>	<i>19</i>
<i>Figure 6. Members take evidence on fracking from witness Anne Daw. Old Chamber Parliament House, Adelaide, 10 April 2015.....</i>	<i>24</i>
<i>Figure 7. The NRC members met with stakeholders in Western Downs Regional Council, Queensland. From left: Mr Peter Treloar MP, Mr Chris Picton MP, Hon Robert Brokenshire MLC, Hon Gerry Kandelaars MLC, Hon Steph Key MP, WDRC Cr and Mayor Ray Brown, Mr Jon Gee MP, and Hon John Dawkins MLC.....</i>	<i>26</i>