A review of community concerns about onshore gas development

Challenges and opportunities

Andrea Walton, Rosemary Leonard, Rachel Williams, and Rod McCrea

April 2015
A review of community concerns about onshore gas development
## Contents

Acknowledgments .................................................................................................................. v

Executive summary ............................................................................................................. vi

1 Introduction ...................................................................................................................... 1

2 Topics of local community concern .................................................................................. 2
   2.1 Water ........................................................................................................................... 3
   2.2 Human health .............................................................................................................. 8
   2.3 Landowner concerns ................................................................................................. 13
   2.4 Local infrastructure and facilities ........................................................................... 17
   2.5 Economic changes .................................................................................................... 22
   2.6 Community changes ................................................................................................ 26

3 Wider public concerns ...................................................................................................... 29
   3.1 ‘Fracking’ and public attitudes towards onshore gas .................................................. 29
   3.2 The nature of environmental concerns ...................................................................... 30
   3.3 Possibilities for ameliorating environmental concerns .............................................. 31

4 Discussion ........................................................................................................................ 33
   4.1 Accessing and using information .............................................................................. 33
   4.2 Governance ................................................................................................................ 34
   4.3 Communities as active stakeholders ....................................................................... 36

5 Conclusions ....................................................................................................................... 37

References ............................................................................................................................ 39
Case studies

Case Study 1 Sun Water’s Kenya to Chinchilla weir pipeline: beneficial reuse of coal seam gas produced water ................................................................. 6
Case Study 2 Coal seam gas and health concerns from Tara residents in the Western Downs region of Queensland ................................................................. 10
Case Study 3 Submission to the New South Wales Inquiry into Coal Seam Gas by the Doctors for the Environment, Australia ......................................................... 12
Case Study 4 The Surat Basin, Queensland: Improving co-existence between agriculture and coal seam gas ................................................................................ 14
Case Study 5 Conduct and Compensation Agreements in Queensland ............................................................................................................................... 16
Case Study 6 Improving housing stress for low to middle income residents in a region experiencing coal seam gas development: the Western Downs Housing Trust (WDHT) ................................................................. 20
Case Study 7 Coal seam gas regions of the Surat Basin: reversal of ‘rural decline’ .................................................................................................................. 24
Case Study 8 Toowoomba and Surat Basin Enterprise (TSBE): connecting local business to the gas industry ............................................................................. 25
Case Study 9 Addressing drunken behaviour: community resilience drawing from its social capital .............................................................................. 28
Case Study 10 Center for Sustainable Shale Development: An independent body setting standards and monitoring the industry ........................................................................... 32

Figures

Figure 1 Topics of community concern linked with onshore gas development, identified for this report ......... 2
Figure 2 Coal seam gas water management options ............................................................................................ 6
Figure 3 Median rent prices for four-bedroom houses in Chinchilla and the Western Downs region, Queensland ..................................................................................................................... 18

Tables

Table 1 Percentage of youth new to region since previous census .................................................................................. 24
Acknowledgments

This research was funded by the Department of State Development Business and Innovation, Government of Victoria in partnership with the CSIRO. It forms part of a project led by Jane Hodgkinson “Report on the technologies and processes that may be used for Victorian onshore natural gas exploration, development, production and closure”
Executive summary

This report reviews societal concerns related to onshore gas development, drawing on the literature on coal seam gas development in Australia and shale gas development in Northern America. A companion report reviews technologies and processes associated with extracting onshore gas (Hodgkinson et al., 2015).

It is important to note that community perceptions of an industry, such as unconventional gas, or activities around the industry may not reflect scientific knowledge on the topic. Nonetheless, Australian and US experiences suggest that public and community concerns cannot be ignored if public trust and acceptance of onshore gas development is to be ensured.

The report focuses primarily on issues raised by communities directly affected by gas development; however, it also briefly discusses concerns prevalent in the wider public discussion about onshore gas development.

Concerns expressed by communities have been discussed under six main topics: water, health, landowner concerns, local infrastructure and facilities, economic changes, and community changes. The concerns discussed under each topic sometimes overlap others, reflecting some interdependencies among the topics. This allows each topic to be read as a standalone section.

COMMUNITY CONCERNS

Water

Threats to water availability and water quality are the two primary water-related social concerns in relation to onshore gas development and production. Water availability is a particular concern for communities in gas development areas in low rainfall and drought-prone areas of Australia.

Risks of concern for surface and ground water quality include contamination from hydraulic fracturing fluids and from saline groundwater, and from sediment run-off from infrastructure sites.

For coal seam gas extraction, concerns about water availability relate to concerns about drawdown on fresh-water aquifers due to water extraction from coal seams and competition for domestic water from the construction workforce. In the case of shale gas extraction, the concern is about the amount of water used in the hydraulic fracturing process. People are also concerned that contamination from hydraulic fracturing will decrease the amount of water available for domestic and stock purposes.

There is also the potential for reusing extracted water from CSG wells. For example, re-injecting it underground, irrigating crops, and watering stock. However, extracted water needs to be treated to suitable standards and salty bi-products safely disposed.

Human Health

Concerns raised in relation to human health are: perceived risks of exposure to water or soil potentially contaminated through hydraulic fracturing; methane exposure; environmental stressors such as increased noise and light pollution; and stressors affecting quality of life, such as increased road traffic.

Onshore gas activities may contribute to mental health issues by adding additional stressors to farming and community life, resulting in cumulative stress to the landowner. Thus strategies to address potential mental health effects of onshore gas development should target not only CSG related stressors, but any significant community stressor, particularly for residents and farmers who are already under stress and socially isolated.
Landowner concerns

While the impact on individual farmers varies, their concerns typically relate to concerns about water, dust, noise, road traffic (both on-farm and off-farm), farm production, soil compaction, weed management, increased farm labour costs, and lack of privacy.

Establishing protocols, codes of conduct and guidelines for gas companies’ on-farm behaviour has potentially helped to improve co-existence, although the effectiveness of these sorts of practices has yet to be reported in the literature specifically. However, the earlier these best practices become typical of the land access protocols the more likely effective farm-gas relationships can emerge.

Adequate compensation payments to the farmer or landowner are important to achieving satisfactory co-existence and good working relationships between farmers and gas development companies. The negotiating process must also be considered procedurally fair and equitable by the farmer if this outcome is to be achieved.

Local Infrastructure and Facilities

In the Western Downs in southern Queensland, “services and facilities” was found to be the strongest driver of perceptions of community wellbeing. Negative impacts on housing availability and affordability and on roads and traffic are significant sources of concern for local communities. Housing development can be slow to respond to the accommodation needs of an expanding construction and service industry workforce. Home prices and rents follow a boom and bust trajectory, tracking the construction and post-construction phases, though temporary worker camps can alleviate this somewhat.

People have a high level of concern about roads and traffic because they have multiple negative effects: damage to roads from heavy vehicles; road works disrupting traffic; dust; reduced road safety; and increased traffic. A pro-active approach to strengthening roads before they are damaged and to avoid the disruption of ongoing roadwork during peak industry construction periods would be beneficial.

Investment in infrastructure is crucial to meet the demands of a rapidly increasing population during the construction phase, including roads, utilities, health-care, transport, housing and other services. However, flexible strategies are also needed for reduced activity after the construction phase.

Economic Changes

The promise of economic benefits to small communities is often overestimated. There are challenges for local businesses in engaging with large multinational mining companies and contractors to access potential supply contract opportunities. These include: access to information for business planning and investment; meeting compliance and regulatory requirements for engaging with gas companies, which can be costly to small business; responding to workforce pressures such as attracting and retaining employees, and meeting increased wage rates; and managing an uneven revenue stream, as peak work activity associated with the construction phase is followed by a relative slowdown in the post-construction phase.

Many local businesses feel disempowered and ill-equipped to do business with a larger gas company or first tier sub-contractors, particularly in the early stages when knowledge about the industry and employment processes and systems is developing. Networking organisations can be effective in sharing information, fostering learning and providing increased agency to groups and individuals.

Employment of local labour by the gas industry, including tradespeople, also has negative flow-on effects for other local businesses, especially agriculture, as they are less available for local work and able to charge much higher rates for their work.

Community Changes

The shift from a rural landscape to a combined rural and industrial landscape brings changes to the ambiance and social fabric within communities. Studies in both the US and Australia highlight that impacts on the social fabric of a community from onshore gas development are of significant concern for residents. Issues of concern include the influx of ‘strangers’ who interact differently; alienation from local social
venues like hotels; and limited community participation from the newcomers, including as volunteers. Increased traffic and work vehicles also change the visual amenity of a town for residents. Many of these issues can be addressed with local initiatives.

For many people living in communities potentially impacted by onshore gas their feelings and attitudes towards the industry are ‘luke-warm’. While environmental management and employment and business opportunities are both important to acceptance by the local community, other issues are equally important. These include levels of trust in government and industry stakeholders, having a role in decision-making, and community perceptions of how well they are responding to the changes. Key to this is reducing uncertainties relating to the industry.

**RESPONDING TO COMMUNITY CONCERNS**

Three main groups of activities emerged as important for reducing uncertainty and improving community acceptance. These included access to and use of information; adequate governance including policy, planning, and monitoring; and community engagement and collaboration such that community partakes as an active stakeholder.

From the outset, planning for onshore gas development needs to cover the construction, operation and closure phases. Also, implementation of government and industry plans need to be better integrated in gas development projects, matching the time frames and cumulative impacts of the new industry. Data collection for monitoring activities should commence during the planning phase, to provide a baseline. The most beneficial legacy projects should aim to build community capacity and regional infrastructure for the longer-term, including after the closure of onshore gas projects.

A ‘one-size fits all’ solution is not going to successfully address the diversity of community concerns. Solutions need to be tailored to community segments and where necessary individuals within communities (e.g., individual land-access agreements). Any new systems of community engagement need to take into account the power imbalances between local communities and other stakeholders (e.g., gas companies and state government). Well-staffed and resourced, community and regional development organisations which are independent from the CSG industry and State government with capabilities to support local interests and build local capacities are one way to assist all community sectors to act on their concerns.

** ISSUES OF CONCERN TO THE WIDER PUBLIC**

Broader public concerns relate mainly to the environment, including the greenhouse gas ‘footprint’ of the industry; the effect of development and production on native bushland and wildlife, as well as marine environments; and the effects of hydraulic fracturing.

The public discourse has also shifted from a discussion of the technical aspects of hydraulic fracturing to an emotive dialogue about ‘fracking’ as an umbrella term for all things negative about onshore gas development, for example, fracking as reflecting wider concerns about human health, water quality, and co-existence with agriculture.

Diverse interests and views are present in the national discourse as well as within affected communities. Societal discussion can become polarised, between environmental and economic perspectives for example and such divisions are promulgated in the popular media.

Public support for onshore gas development varies from region to region, and between urban and rural residents, with more environmental concerns associated with environmentally sensitive regions and city dwellers. Substantial research would be required to address current knowledge gaps; for example around public perceptions of risk and trust. However, such research would assist in understanding wider public acceptance of onshore gas, though is unlikely to shift strong positions against onshore gas development, particularly where they are underpinned by a preference for renewable energy sources.
IMPLICATIONS FOR VICTORIA

It cannot be assumed that all Victorian communities would react in similar ways and that these reactions would stay stable throughout a CSG development. The most stable views could be expressed either by those who support the industry because of the potential for economic growth from the industry itself and access to cheaper fuel or by those who oppose the industry due to the environmental risks and a commitment to renewable energy. For others their attitude will depend on their experiences.

Many lessons have been learned during the construction phase of the Queensland onshore gas fields. However, because the operations stage is just commencing in Queensland, there is as yet no Australian data on community reactions to this phase and certainly nothing about the closure phase. Caution would be needed in extrapolating from closures of other types of mining because of the distinctive way in which CSG extraction co-exists with agriculture and other industries.

Although this review has produced some useful insights there is a clear need for specific studies of Victorian community perceptions. Our review has depended principally on studies in the US and the Western Downs in Queensland, which may not directly translate to Victoria. Furthermore, the political debates surrounding on-shore gas have become more forceful in recent months so in this changing landscape even recent results may need revisiting.

Issues specific to Victoria might include: impacts on tourism in the vicinity of tourist destinations; the proximity of the city and large regional centres to potential gas fields encouraging (drive in drive out) arrangements rather than workers settling in a given region; and whether gas production is for domestic consumption and/or for export.

Finally we note that it takes time to implement the good planning, independent scientific knowledge, careful monitoring, and consultation that communities need to avoid negative consequences and maximise the benefits of the industry. This suggests long lead times; however, the timeframe communities require for reassurance is likely to be at odds with the timeframe that the industry might demand. Much has been learnt from the Queensland experience, which can assist Victorian decisions, though lessoned learned need to be enacted early and there will be continual hard decisions about competing interests in on-shore gas development.
1 Introduction

This report discusses common concerns and issues related to onshore gas development. It explores peoples' perceptions of the challenges and opportunities associated with various conventional and unconventional gas activities and provides a platform for enriching public discussion. Understanding these perceptions will assist the evaluation of potential technologies when considering onshore gas development in Victoria. In addition, it provides insight into matters that can inform communication and information activities, and aid planning and stakeholder engagement processes.

In particular, the report draws from the literature on coal seam gas development in Australia and shale gas development in Northern America where many studies around community and public perceptions of unconventional gas have been undertaken. A recent media analysis of media discussion on unconventional gas (Taylor, M. et al., 2013) has been used to help identify the topics for discussion. In addition, a quantitative study of community wellbeing and resilience in southern Queensland (Walton et al., 2014) was used to identify further matters that concern communities affected by unconventional gas development. The community wellbeing and resilience study was conducted in a region of coal seam gas development in the Surat Basin where towns and communities have experienced Australia's largest onshore coal seam gas development.

The report presents fifteen aspects of community concern grouped into six main topics: water, health, landowner concerns, local infrastructure and facilities, economic changes, and community changes. The concerns discussed under each topic sometimes overlap, reflecting some interdependencies among the topics. This allows each topic to be read as a standalone section. It also presents case studies to highlight real-world examples of different responses to the various challenges and opportunities experienced with unconventional gas in communities. Broader public concerns for the environment, such as the greenhouse gas ‘footprint’ of the industry and the effect of development and production on native bushland and wildlife are discussed in a separate section. The concept of ‘fracking’ (hydraulic fracturing) and the shift in public discourse from a discussion of the technical aspects of hydraulic fracturing to its use as an umbrella term for all things negative about onshore gas development is also discussed.

This report concludes with a discussion of three main areas that cut across many of the concerns to communities: accessing and using information, governance, and communities as active stakeholders. These three areas have emerged as aspects integral to meeting community expectations for effective management of the activities related to onshore gas development.

Sources and type of information

The report uses peer reviewed academic literature and technical reports from government and scientific research institutions to provide evidence for discussion. Media reports and online information have been used to provide Australian examples of matters described within each topic and to support some of the case studies.

In many instances, research studies have not assessed the extent of the views and perceptions that are described in the study. This means that our report seldom provides the number (or percentage) of people in a community or in the general population who hold these views. Where possible this type of information is included, but in its absence the report presents only a description and analysis of the issue.

It is relevant to note that community perceptions of an industry, such as unconventional gas, or activities around the industry may not reflect scientific knowledge on the topic. This report reviews the literature on these topics and uses the evidence to discuss the topic in a way that addresses community concerns. It is not the aim to provide an in-depth review of the technical aspects of each area. Technologies and processes associated with extracting onshore gas are reviewed in a companion report (Hodgkinson et al., 2015).
2 Topics of local community concern

This section of the report addresses common topics of concern related to extracting gas onshore. The concerns were identified from two main sources. The first of these focussed on a recent analysis of the media relating to coal seam gas development, which was prepared as a background paper for the New South Wales Chief Scientist and Engineer and identified matters of concern to the public (Taylor, M. et al., 2013). Drawing largely from key groups opposed to coal seam gas development and online media reports over a one-month period, Taylor et al. (2013) identified key community concerns expressed in these forums. These included: water issues; threats to agriculture and the natural environment; landowner and community rights; issues of trust; and the role of the media. The second main source is a study conducted in a region of southern Queensland where citizens were experiencing significant coal seam gas development. The study involved a telephone survey of a randomly selected sample considered to be representative of the region. It identified a range of issues some which were overlapping with the Taylor and colleague’s media analysis and some which were additional. In combination these two studies formed the basis for the topic areas reviewed in this section and are in line with previous Victorian government reports that have identified issues related to unconventional gas (Ross and Darby, 2013; Victorian Government, 2013).

Fifteen areas of concern have been grouped into six main themes including: 1) water, 2) health, 3) landowner concerns, 4) local infrastructure and facilities, 5) economic changes, and 6) community changes. Three additional areas, information, governance, and community as an active stakeholder cut across all aspects of community concern and are discussed separately in Section 4. In contrast, Section 3 covers wider community concerns.

Figure 1 Topics of community concern linked with onshore gas development, identified for this report
It is important to acknowledge that community perspectives may be different from other stakeholders within the industry including gas companies and different levels of government. Often this difference in perspective relates to the scale at which an issue has been examined (Taylor, B. and Stone, 2012). For example, a problem or concern at an individual or local level is less evident at a regional or state level. Similarly, community perspectives also differ depending on factors such as how directly the community is impacted and the extent of the impact (Williams, R. and Walton, 2014). For example, differences emerge between people who live in town compared to people who live on farms. Also, the issues for people living in cities that are remotely situated from a gas development community may be different from those living close to, or within the development region.

In addition, differences may emerge within a community based on different demographic segments, such as the length of residency in the community, or level of involvement in different industry sectors (Walton et al., 2014). Each community segment may have similar needs or share similar values and beliefs yet these may be different from other segments within the same community. Furthermore, perceptions may change over time and depend on the stage of the development of the industry. For example, some concerns are more prevalent during the construction phase and the nature of those concerns change over time. Housing concerns during construction phase, for example, may be centred on housing shortages and fly-in-fly-out (FIFO) camps, which then translate to housing oversupply as the industry matures and progresses into a production stage.

2.1 Water

Threats to water quality and water availability are the two primary water related social concerns in relation to onshore gas development and production. Impacts on water quality can reduce the availability of water for domestic and agricultural use, which causes concerns for communities. Water availability is a particular concern for communities in gas development areas in Australia as its variable climate means that water availability is critical in regions with low rainfall and which are periodically affected by drought.

Risks of concern for water quality particularly include contamination from hydraulic fracturing fluids and from saline groundwater. Concerns relate to the risks of contamination of both underground aquifers during gas extraction and of surface water, from flowback of injected water used in hydraulic fracturing or from spillage of ‘waste’ water during transport, storage, treatment and disposal (Taylor, M. et al., 2013). There is also concern about contaminated run-off and sediment from infrastructure sites going into nearby water bodies (Johnson, 2010, p22).

There are also social concerns about reduced water availability arising from onshore gas extraction. In the case of coal seam gas, these concerns are about draw down of fresh water in aquifers due to water extraction from coal seams (Taylor, M. et al., 2013). In the case of shale gas extraction, the concern is about the amount of water used in the hydraulic fracturing process (e.g. Gurule, 2013). People are also concerned that contamination from hydraulic fracturing will decrease the amount of water available for domestic and stock purposes (Taylor, M. et al., 2013). Additionally, there are concerns about the demands placed on the domestic water supply to supply the construction workforce (Williams, R. and Walton, 2014).

2.1.1 WATER QUALITY: SURFACE AND GROUNDWATER

Perceived threats of water contamination from onshore gas development have been a major source of social concern particularly where residents are dependent on it for their livelihoods and domestic water use (Swayne, 2012; Taylor, M. et al., 2013) and where there are concerns for the local environment (Rassenfoss, 2011). Potential contamination from the chemicals used in hydraulic fracturing is the major source of concern (Williams, J. and Pittock, 2012). Again, it is important to distinguish between risks to groundwater and surface water, depending on the locality and the technology. The concern in Australia has been directed at the risk of contaminating groundwater aquifers, adjacent to the coal seams, some of
which are accessed for agricultural use. More general concern extends to the risk of contamination of the Great Artesian Basin.

While there is an intrinsic concern about threats to water quality, the concerns extend to the potential consequences for water users, for agriculture, in terms of irrigation and stock watering and for human health.

Hydraulic fracturing is used extensively in shale gas extraction in the US. The chemicals used in hydraulic fracturing that attract particular attention and public concern, based on the documented health effects, are the BTEX hydrocarbons, (benzene, toluene, ethylbenzene and xylene) that may be used in the process (Lloyd-Smith and Immig, 2011; Taylor, M. et al 2013). Short term exposure to these chemicals can affect the central nervous system and the respiratory system and benzene is a known carcinogen (ATSDR, 2004). Numerous other chemicals are also present in hydraulic fracturing mixtures and the exact mixture varies between wells. The extent to which some of the many chemicals that may be used in onshore gas operations may pose risks to human health if used in hydraulic fracturing mixture is not yet known (GISERA, 2014b). Assessment of the cumulative effect of these chemicals is also lacking (Lloyd-Smith and Immig, 2011). Public concern reflects the perceived risk that these chemicals could get into the surrounding environment during the hydraulic fracturing process and that this could adversely affect human health, agriculture and the environment (Taylor, M. et al., 2013).

The concern about hydraulic fracturing chemicals has been amplified due to a perception that the industry has been secretive with regard to the specific composition of the hydraulic fracturing fluid components, for proprietary reasons, which also leads to reduced trust of the gas companies (Taylor, M. et al., 2013). In Queensland and New South Wales the use of BTEX chemicals in hydraulic fracturing is banned and industry is required by law to disclose the chemicals that are used in hydraulic fracturing. Lists of chemicals that may be used in onshore gas operations and their potential health effects are publicly available (e.g., Lloyd-Smith and Immig, 2011; TEDX, 2015). Nonetheless, the lack of knowledge about the cumulative and long term environmental and human impacts from the chemicals used in hydraulic fracturing mixtures contributes to significant ongoing public concern and resistance to onshore gas development.

A risk identified by environmental authorities that has been less prominent in public discourse in the US is spillages of the flow-back water at the surface (Williams, J. and Pittock, 2012). Spillages could contaminate the ground around the well and also be washed into nearby lakes and streams (Johnson, 2010). BTEX chemicals, and small amounts of heavy metals and radioactive elements, may be naturally present in some shale and in coal seams and there is concern that they could also be mobilised during gas extraction and be present in the produced water. Queensland legislation requires the quality of produced water to be tested and managed (DEHP, 2012). A spillage incident from a water treatment plant in the Pilliga State Forest in New South Wales in 2011 gained significant media attention (e.g., ABC Television, 2013; SMH, 2013b), particularly as it became apparent that the owner of the plant at the time had not reported the incident to the New South Wales regulator.

Hydraulic fracturing has been more extensive in the US than in Australia, as the bulk of the onshore gas developments in the US have been shale gas; all shales require artificial fracturing due to their depth and lack of permeability. However, in Australia, the bulk of onshore gas development has been coal seam gas for which hydraulic fracturing has only occasionally been used as the coal is relatively shallow with better permeability, and gas flows more easily when the water is released. However, the public concern about hydraulic fracturing has been picked up in Australia. Campaigns such as ‘Lock the Gate’ (Lock the Gate, 2015) and the distribution of the US-produced film GasLand (2010), which documents the concerns around hydraulic fracturing in North America, have been influential in this regard.

In areas of onshore gas extraction, there have been instances of methane bubbling up in rivers and water bores, such in the Condamine river in Queensland (Taylor, M. et al., 2103) or methane being in elevated concentrations in aquifer drinking water supplies adjacent to shale gas extraction sites such as in Pennsylvania and upstate New York (Osborne et al., 2011). While the appearance of methane in bore water predates gas extraction operations (Mallants, 2014), these instances have raised questions by the public about gas ‘contaminating’ the water supply, whether the methane itself is a problem for human health, and whether the gas extraction process is causing gas to appear in these places.
2.1.2 WATER QUALITY: FLOW BACK AND PRODUCED WATER

Perceived threats of water contamination from onshore gas developments are a major source of social concern, particularly where residents are dependent on it for their livelihoods and domestic water use. Following a shale artificial fracturing process, approximately 10-30% of the injected fluid returns to the surface (Rassenfoss, 2011). This product is referred to as ‘flow back’ water. Hydraulic fracturing can also release water that was present in the shale formation (produced water), which can contain high levels of salts, traces of heavy metals, carcinogens and radioactive elements that occur naturally in the formation. Concerns arise regarding disposal of the flow-back hydraulic fracturing water and produced water.

In the US, the most common method of disposal of flow back and produced water from shale gas extraction has been reinjection underground. Recycling and reuse of flow back water occurred but not widely (Theodori et al., 2011, 2014; Veil, 2010). However, in the Marcellus Shale in Pennsylvania, the industry has recently begun to recycle and reuse the flow back and produced water for further artificial fracturing operations; this is addressing some of the concerns about disposal, concerns about the quantity of water used in hydraulic fracturing, and competition with other demands on water (Gurule, 2013). The geology in the Marcellus Shale region is generally not suitable for reinjection and gas companies had been disposing their waste water via public water processing plants into nearby water bodies. However, in 2013, following public concern and a letter from the state’s Department of Environmental Protection to 15 public water treatment plants, this practice was discontinued, forcing the industry to look for alternatives (Rassenfoss, 2013).

Theodori et al., (2009, 2011, 2014) have published extensively on repeated studies across 12 counties in the Marcellus Shale region exploring people’s attitudes to a wider range of uses of recycled water from shale gas production. Two key findings were

a. People were progressively less prepared to consider uses where human or animal consumption was more likely
b. The more familiar with the technology people were, the more likely they were to be comfortable with non-industrial uses of the recycled water. It was also noted that familiarity with the technology is currently low.

In the Surat Basin in Australia, the reuse story has been different. Coal seam gas production produces larger quantities of water from the coal seam (termed produced water, coal seam gas water) than is produced from a shale formation, particularly in the early stages of coal seam gas production. The produced water is usually highly saline and, as with the produced water from shale formations, can contain low levels of carcinogens, heavy metals and radioactive elements liberated from the coal seam and underground rock with which the water has been in contact (Taylor, M. et al., 2013). Again, there has been significant public concern about contamination from spillage of this water onto the ground (e.g., ABC Television, 2013; SMH, 2013b). However, there is also recognition from landholders that it could be a potential source of water, provided it is of appropriate quality, and processed through some form of water treatment for example (BSA, 2013a). In Queensland, the state government’s policy is to “encourage the beneficial use of coal seam gas water in a way that protects the environment and maximises its productive use as a valuable resource” (DEHP, 2015). In line with this intent, the Environmental Protection Regulation 2008 has been amended to enable better quality water to be exempt from being categorised as regulated waste and makes it available for reuse (ibid). However, while preferred options have been identified for managing the by-products of the treatment process, such as concentrated brine (DEHP, 2012), coal seam gas companies in Queensland are still in the process of developing their brine management solutions (e.g., Arrow Energy, 2013; QGC, 2015). There has also been some media attention on the issue of what do with the residual brine (e.g., SMH, 2013b). Drawing on the US experience “...a water management cycle which seeks to re-cycle and develop a zero discharge can be technically demanding, but in the end it is essential for there to be community acceptance.” (Boling cited in Williams, J. and Pittock, 2012, p34).
Case Study 1 Sun Water’s Kenya to Chinchilla weir pipeline: beneficial reuse of coal seam gas produced water

There are multiple potential options for managing the produced water from onshore gas production, ranging from direct discharge at the surface or reinjection underground, through to varying levels of water treatment to improve the water quality to a point where it can be reused, discharged, or some combination of these. The use of evaporation ponds was discontinued in Queensland in 2010, in response to concerns about leakage of produced water from the ponds (Ross and Darby, 2013).

Figure 2 Coal seam gas water management options
Source: Murray (2012)

The actual options available to a gas producer depend on the quantity and quality of the produced water, legislation, social pressures, geology (suitability for reinjection) and the economics of the different treatment options.

The Queensland Government Coal Seam Gas Water Management Policy 2012 objective is “To encourage the beneficial use of coal seam gas water in a way that protects the environment and maximises its productive use as a valuable resource” (GasFields Commission Queensland, 2014a). A Beneficial Use Approval (BUA), issued by the Queensland Department of Environment and Heritage Protection, requires standards to be met consistent with the specified use.

The four major operators in Queensland, QGC, Origin (APLNG), Santos and Arrow, have adopted a range of reuse options, such as irrigation for agriculture or forestry (treated and untreated), stock watering, power station cooling and steam generation (treated water) and coal washing (untreated water). APLNG is also reinjecting treated water into an aquifer for reuse (National Water Commission, 2011). In this instance, the quality of the reinjected water needs to match that of the aquifer.

QGC, Origin and Santos have also opted to build water treatment plants which use reverse osmosis (RO) in the desalination step of the treatment. The process produces purified water and a concentrated brine by-product.

For a coal seam gas operator in Queensland to supply water to a third party, it would need to obtain a water licence, under the Water Act 2000. If the operator owns the supply infrastructure, and wishes to charge for the water, it also needs to become a registered service provider. If the water is to contribute to a drinking water supply, the company also requires an approved recycled water management plan (Swayne, 2012).

QGC has contracted SunWater to build, own and operate an underground pipeline from the QGC water treatment plant at Kenya to the Chinchilla Weir. The pipeline mainly provides water to agricultural users en route, who use the
water for irrigation, and some water is supplied to customers along the Condamine River, upstream and downstream of the Weir. In these instances, the water is mixed with river water before use. Any excess water is released to the Weir, from which it is processed through Chinchilla’s existing water treatment plant, before being distributed for urban and industrial use (GasFields Commission Queensland 2014a; SunWater, 2014). Through this arrangement, QGC provides the water from its reverse osmosis plant, but responsibility for the water management then passes to SunWater. The supply agreements are between water customers and SunWater, a pre-existing registered service provider. SunWater is also required to regularly monitor the quality of the water available for 3rd party users (GasFields Commission Queensland, 2014a).

The primary issue for non coal seam gas industry users is that the water supply will only be available for the life of the gas supply, and is anticipated to last for 25-35 years. This raises questions about how to take advantage of this temporary resource, without becoming dependent on it in the longer term. In particular, it should not be viewed as a means of meeting ‘make-good’ requirements for the loss of existing water supplies due to coal seam gas extraction (Swayne, 2012).

2.1.3 WATER QUANTITY

Threats to the availability of water, from gas extraction, are a significant concern for existing users who rely on those water sources. It is important to distinguish between different sources of water as different gas extraction processes affect different water sources. Groundwater availability can be reduced through processes that extract large volumes of groundwater, which can lower the water table if there is connectivity between the extraction point and the aquifers that supply local use. This has been a concern in the Surat Basin in Queensland (Taylor, M. et al., 2103), where many of the farmers use groundwater from shallow water bores for irrigation and or stock watering. The Surat Underground Water Impact Report (OGIA, 2012) has identified that some of the water bores will be affected by coal seam gas extraction. The Queensland Water Act 2000 requires that companies holding tenures ‘make good’ any reductions in bore water availability resulting from their operations. It is unclear exactly how make good arrangements will operationalise.

Hydraulic fracturing is another source of concern for water availability as it uses large quantities of water. This has been a concern for shale gas extraction in the US (e.g., Gurule, 2013) as hydraulic fracturing is a necessary aspect of the extraction process. The high water requirements for hydraulic fracturing have been less of a publicly expressed concern in Australia to date, where large scale shale gas extraction has not yet developed and where the hydraulic fracturing concern has been much more focussed on the risk posed by the chemicals used to fracture some coal seam gas sources.

In the US, Anderson and Theodori (2009) and Duncan (in Williams, J. and Pittock, 2012) note the use of hydraulic fracturing water as an issue depends on ready availability of water. For example, they note that existing oversight had neglected to consider the potential impact for people who were reliant on bore water and in drier areas versus those people near large sources of surface water, where water is plentiful. Drought conditions in the US have also extended people’s attention to issues of water availability in the context of shale gas extraction, from the initial focus on the risks of contamination of the water supply from hydraulic fracturing chemicals (Dittrick, 2012). As noted in the section on water quality, recycling and reuse of flow back water from the hydraulic fracturing process is one strategy starting to be adopted in the US that can mitigate the potential impact of water use.

The final source of concern for water availability is potable water drawdown to provide to the industrial workforce. This has been an issue of concern for residents in Chinchilla in the Surat Basin, and was particularly a concern towards the end of the millennium drought, where the Weir almost ran dry, providing a visible indicator of decline in the town’s water supply and prompting questions about the amount of water being taken by the coal seam gas companies (Williams, R. and Walton, 2014).
2.1.4 ADDRESSING SOCIAL CONCERNS ABOUT WATER

Much of the technical and environmental literature focuses on technical risks and how to manage them from a technical perspective, rather than on the social perception of risk. The US experience with shale gas has shown that the focus of public concern in relation to threats to water often contrasts with what the science indicates are the areas of highest risk (Duncan, in Williams, J. and Pittock, 2012). For example, the public concern tends to be focussed on groundwater contamination during the hydraulic fracturing process. The author notes that there have been no scientifically confirmed instances of underground contamination occurring in the history of shale gas extraction in the US. However, there were 20 significant surface spills in Pennsylvania between 2009-2011; suggesting surface contamination from chemical spillage is a much greater risk to water quality than the underground hydraulic fracturing process. Nonetheless, the lesson from the US experience is that public and community concerns cannot be ignored if public trust and acceptance of onshore gas development is to be ensured (Williams cited in Williams, J. and Pittock, 2012, p49). Rather, transparency and ready availability of information is critical, both in relation to the issues of public concern, such as contamination of water supplies by hydraulic fracturing chemicals and methane, as well as in relation to the issues that the science suggests pose greater threats (ibid), such as surface spills, well integrity and equipment maintenance (Duncan, cited in Williams, J. and Pittock, 2012, p25). Further, the information is more likely to be trusted if it is provided by a body or individual that is perceived to be independent (ibid, GasFields Commission Queensland, 2013a).

A significant remaining issue is that the long term cumulative effects of multiple onshore gas operations on the groundwater in a region are still unknown. As noted by Swayne (2012), in an extract from Geoscience Australia and Habermehl (2010) in relation to the potential impacts of coal seam gas extraction in the Surat and Bowen Basins in Queensland (p24),

> the information provided in the assessed EIS documents is not fully adequate for understanding the likely impacts of widespread coal seam gas development across the Surat and Bowen Basins; nor will any level of information or modelling that can be provided by individual proponents... a regional-scale, multilayer groundwater flow model which incorporates data from both private and public sector sources is necessary... however... no matter how thorough a model or detailed the underlying data, any modelled outcomes will be accompanied by high inherent uncertainties until sufficient coal seam gas production data is available to calibrate the groundwater model.

This uncertainty underpins residents’ concerns about the impact of coal seam gas extraction on water resources in the region. It leads them to question whether onshore gas developments should be going ahead when it is not fully known what the impacts will be (Williams, R. and Walton, 2014).

2.2 Human health

This section discusses possible human health impacts from exposure to natural environments that have been impacted by onshore gas development. For example, water, air, soil, noise, and light pollution. A comprehensive literature review on these and other health impacts associated with unconventional natural gas development was recently conducted by Werner et al. (2015). From initial electronic searches identifying over 1,000 potential studies only seven provided strong evidence to examine direct relations between onshore gas development and health impacts; though other studies focussed on health risk factors and implied health implications. In their summary five main points were identified:

1. The main body of research is dominated by traditional environmental health issues (e.g., water, air and soil contamination).
2. Highly relevant evidence of direct health outcomes caused by unconventional natural gas development is lacking.
3. There are few methodologically rigorous studies of unconventional natural gas development and actual health outcomes.
4. Most studies focus on short-term, rather than long-term, health impacts.
5. The evidence (or lack thereof) is not sufficient to rule out possible health impacts.

2.2.1 WATER CONTAMINATION AND HEALTH

Most research on the potential health impacts of onshore gas developments concerned water and air quality. The effects of water contamination are a predominant concern for residents, with 69% of the studies in the review by Werner et al. (2015) being related to concerns over hydraulic fracturing (or hydraulic fracturing). As mentioned previously, hydraulic fracturing invariably occurs with shale gas extraction, though in only 10-60% of cases with coal seam gas extraction (GISERA, 2014c).

Hydraulic fracturing concerns relate mostly to contamination of the water supply by fracturing chemicals, as well as potential contamination from other hazardous organic compounds and heavy metals. Some hydraulic fracturing chemicals, if ingested, inhaled or absorbed through the skin, can cause “…effects on skin, eyes, and other sensory organs, respiratory system, gastrointestinal system, and the liver, as well as effects on the brain, nervous system and immune system (Colbern et al., 2011; Kargbo et al., 2010)” (Werner et al., 2015, p 1131). Interestingly, contamination of water or soil from hydraulic fracturing chemicals can not only occur in the hydraulic fracturing process itself, but also in any stage of the drilling lifecycle such as during the transport, storage and mixing of chemicals (Cooley and Donnelly, 2012). However, causal links between onshore gas activities and these possible health outcomes in surrounding communities have not been established. Nonetheless, community concerns about water contamination persist. Hence, Werner et al. call for further research to reduce uncertainty and address community concerns around hydraulic fracturing and related water quality issues (e.g., base-line studies, longitudinal studies, prospective studies and epidemiological studies).

2.2.2 AIR QUALITY AND HEALTH: FUGITIVE EMISSIONS

Most concerns regarding air quality and its impact on health is around the methane venting or flaring of methane gas during exploration, as well as methane seeps or fugitive emissions associated with onshore gas development activities. One study into chemical air emissions associated with extracting tight gas in Colorado, USA, found that “short-term health effects, including headaches and other neurologic symptoms, as well as airway and mucous membrane irritation were probable” (Witter, et al., 2013 cited in Werner et al., 2015, p1135).

Since the review by Werner et al., (2015), two other studies in the US have found ‘concerning’ levels of air pollutants associated with shale gas and tight gas developments (Macey et al., 2014; Thompson et al., 2014). While distinctions can be made between those air pollutants associated with shale or tight gas extraction, and those with coal seam gas extraction, these US studies have raised public concerns about coal seam gas extraction in Australia (Egan, 2014). In particular, there have been a range of symptoms allegedly associated with coal seam gas developments near Tara in Queensland (see Case Study 2). However, as with water quality, there is a lack of evidence showing direct effects of onshore gas development activities on health via air quality.

To address concerns about exposure to air-borne pollutants, setback restrictions can be used, which specify distances between onshore gas operations and populated areas; though, these have usually been set via political negotiations rather than the establishment of ‘safe distances’ from onshore gas developments (Fry, 2003 cited in Werner et al., 2015).
Case Study 2 Coal seam gas and health concerns from Tara residents in the Western Downs region of Queensland

In 2012, a group of residents from Tara in Queensland reported a range of symptoms that were allegedly derived from their proximity to coal seam gas activities, including complaints of headaches, rashes and nose bleeds (ABC News, 2012). These concerns were also made public through a locally organised support group, the Gasfields Community Support Group. The associated media coverage resulted in the Queensland Department of Health launching an investigation, as well as a visit to an affected Tara resident by the newly elected Prime Minister, Tony Abbott (SMH, 2013a).

The outcome of Queensland Health’s investigation was reported in Coal seam gas in the Tara region: Summary risk assessment of health complaints and environmental monitoring data (Queensland Health, 2013). The report examined health complaint data from the Darling Downs Public Health Unit (DDPHU) and from consultations with residents by a visiting specialist in occupational medicine, Dr Keith Adams, arranged by Queensland Health, as well as data on air, water, soil and noise monitored by a coal seam gas company (QGC) and the Queensland Department of Environment and Heritage Protection. The report found that

... a clear link cannot be drawn between the health complaints ... and impacts of the local CSG industry on air, water or soil... The available evidence does not support the concern among some residents that excessive exposure to emissions from the CSG activities is the cause of the symptoms they have reported. (p 18)

Establishing direct links between onshore gas activities and health symptoms is often difficult and any links may also be related to psychosocial stressors associated with onshore gas activities rather than environmental contaminants per se. Not surprisingly, the findings from the report were met with mixed responses from proponents and opponents of coal seam activities and were contested (National Toxic Network, 2013).

2.2.3 DUST, NOISE AND LIGHT POLLUTION

Relatively few studies have been undertaken on possible soil pollution from onshore gas development activities, though there is potential for soil to be contaminated from leaks or spills of hydraulic fracturing chemicals (Cooley and Donnelly, 2012). Dust from potentially contaminated soil may be accidently ingested or inhaled on dusty days (Coons and Walker, 2008). However, Werner et al. (2015) found a lack of evidence directly linking onshore gas development activities to health impacts via soil contamination. There is also a related concern over the impacts of soil contamination on farming in agricultural areas, including contamination by leaks or spills of water produced as a by-product of coal seam gas operations.

The literature review by Werner et al. (2015) identified a number of other concerns relating to environmental stressors affecting quality of life. For example, noise pollution from drilling, compressors, pumps and other equipment; light pollution from flaring and continuous illumination of onshore gas development infrastructure; and stressors affecting quality of life, such as increased road traffic, especially during the drilling and pipeline construction phases.

Regulations can be used to limit noise to specified decibel levels during the day and night, while light pollution can be reduced with “directional lighting, glare restrictions, sodium vapour lights, light shields, and modifications to drilling rig placements” (New York State Department of Environmental Conservation, 2011 cited in Werner et al., 2015). Road works and traffic congestion can be a major source of community dissatisfaction (Walton et al., 2014). However, increased volumes of vehicle traffic can also have health effects via increased levels of pollution (noise, dust, and diesel exhaust) and increased risks of road accidents.
2.2.4 LONG TERM IMPACTS ON HEALTH

As well as highlighting the lack of high quality studies examining direct links between onshore gas development activities and health outcomes, Werner et al. (2015) found that most studies only focussed on short-term health outcomes. Since onshore gas development is a relatively new industry, there is a lack of longitudinal studies examining potential longer-term impacts of the industry on health. There is a large longitudinal study planned for Marcellus Shale region in Pennsylvania, United States, examining potential impacts of shale gas developments on environmental health (Geisinger Health System, 2013). In Australia, Werner is presently examining hospitalisation data over a 17 year period (along with cross-sectional survey data) for three geographic areas, one of which is a coal seam gas area. However, by definition, results from any long-term studies on potential impacts from the surrounding environment on health may not be known for decades. There have been a number of risk assessment and screening studies relating to chronic exposure to high levels of contaminants, though mainly in the grey literature. However, despite the lack of high quality studies into links between onshore gas activities and environmental health impacts, it is important to note that this is not sufficient to rule out possible long term health impacts (Werner et al., 2015).

2.2.5 MENTAL HEALTH

Onshore gas development activities can add a variety of additional stressors to farming and community life. While any one stressor may not be associated with mental illness, they can add to cumulative stress.

While there is limited research on onshore gas development activities and community concerns about associated mental health, onshore gas development activities may contribute to mental health issues by adding additional stressors to other life pressures. For example, exposure to cumulative stressors after a flood event has been associated with post-traumatic stress disorder symptoms five years later (Verger et al., 2003).

Farmers with unconventional gas mining leases over their land may face additional stressors, such as uncertainty over lease arrangements, inability to refuse property access, and disruption to farming activities and lifestyle. However perceptions will vary between farmers and may depend on perceived gains from unconventional gas activities on their property such as a second income source which may alleviate financial stress. In a survey of farmers from Queensland and New South Wales (predominantly) Morgan et al. (in preparation) examined the effects of farming stressors on mental health in the context of coal seam gas activities. They found that general concerns over coal seam gas predicted depression and went on to identify four different types of farmers: unstressed (39%), financially stressed (31%), coal seam gas stressed (15%), and generally stressed (15%).

Whilst, Morgan and colleagues found that coal seam gas development concerns did predict depression, a much stronger predictor was social isolation. This is important in terms of strategies for reducing cumulative stress for coal seam gas farmers who may also experience social isolation. According to the stress buffering hypothesis (Cohen and Wills, 1985), relationships between stress and wellbeing are moderated by social support. For example, Stain et al. (2008) surveyed farming communities in rural New South Wales, including drought affected communities, and found that the number of adverse life events predicted psychological distress. However, this was ameliorated to some extent by individual and community level social support. Thus, social support is important for segments of the wider community who may be distressed and socially isolated.

Another stressor relating to negatively perceived changes in one’s home environment has recently been identified in the literature. Solastalgia or distress that was caused by environmental change has been examined in the context of coal mining in New South Wales (Albrecht, 2005, 2006, 2011; Albrecht et al., 2007; Higginbotham et al., 2006). In the survey by Higginbotham et al. (2006), an open-cut mining area was compared to a nearby farming area. They found that residents in the open cut mining area more observations and more threats from environmental hazards. They also perceived higher feelings of
solastalgia and more impact from environmental change (including physical, emotional and psychological symptoms).

In workshops conducted in 12 communities in Southern Queensland facing both coal mining and coal seam gas developments, Hossain et al. (2013) identified a broader list of ‘major issues’ which contributed to stress and uncertainty in the region. These were broadly grouped into health, social and economic issues, with the following main issues reported in at least half the communities:

- **Health issues** - lack of primary health care services such as doctors and allied health professionals; lack of support services; lack of professional support; and the stigma of mental illness.
- **Social issues** - the changing community structure; fly-in fly-out nature of the mining workforce; and relationship breakdowns as mining stressors increase.
- **Economic issues** - high cost of living; lack of transport; and housing shortages.

In summary, onshore gas development activities can add a variety of additional stressors to farming and community life. While any one stressor may not be associated with mental illness, they can add to cumulative stress. Thus strategies can target not only coal seam gas related stressors, but any significant community stressor, particularly for residents and farmers who are already under stress and socially isolated.

**Case Study 3 Submission to the New South Wales Inquiry into Coal Seam Gas by the Doctors for the Environment, Australia**

Doctors for the Environment, Australia (DEA) is part of an international network of politically engaged doctors with an objective to “conserve and restore the natural environment because of its relationship to and impact on human health” (DEA, 2014). In September, 2011, DEA made a submission to the New South Wales Inquiry Into Coal Seam Gas outlining their public health concerns associated with coal seam gas operations, including “mental health impacts on communities who have had environmental changes imposed on them.” (DEA, 2011)

In their submission they drew on the concepts of accumulative stress and solastalgia. In particular, they drew on the experiences of a psychiatrist in the Hunter Valley, Dr Steve Robinson, regarding the mental health impacts he has associated with coal seam gas extraction in his community:

*Exploration is when the psychological stresses are first noticed in the community. Exploration maps are placed in the local newspaper but they are difficult to decipher and individual landholders are not notified. This uncertainty starts to generate community anxiety...*  
*A few properties are purchased for good prices, other houses close-by cannot be sold and their value drops. Lifetime plans are put on hold or cancelled. Property development in the area declines as a result of the general uncertainty. Rental property is more expensive...*  
*The Gloucester Valley is a heritage and very beautiful landscape, which has drawn tourists and retirees to the valley in large numbers. The long time residents have a particularly strong attachment to the landscape and the potential devastation caused by 350 closely sited gas wells sows the seeds for depressive illnesses for many of the 1000 residents of the valley and the 2500 residents of Gloucester town...*  
*What are the effects on the individual of this general stress on residents of a town and valley? Stress is cumulative and will highlight the weak link in those already at risk. Those with illnesses of depression, anxiety or paranoia that are currently under control run the risk of having those illnesses reactivated. These were the most numerous group of the disorders I saw in psychiatric practice.... (selected excerpts from pp23-24)*

With regard to mental health, the DEA made two recommendations to the New South Wales Inquiry Into Coal Seam Gas:

- The mental health impacts of coal seam gas mining should be recognised as part of Health Impacts Assessment prior to any approval of developments.
- Landholders and communities should have a say in the approval process for coal seam gas operations and have the right of veto.
2.3 Landowner concerns

2.3.1 FARM AND GAS CO-EXISTENCE

Issues of co-existence between farmers and gas companies arise from onshore gas extraction when wells are located on agricultural land. Typically, the gas development requires extensive infrastructure: multiple drilling wells; pipelines to transport gas from wells; pipelines for electricity to power pumps and compressor stations; access roads and tracks for maintenance of wells; and ponds, dams, processing plants, and water treatment plants for managing water; all of which may require location on or nearby farming land. In addition, the process of gas extraction involves water extraction or injection, depending on the type of gas, and may involve other extraction technologies such as hydraulic fracturing, ‘flaring’ of gas wells, and management of water brine. All processes which are potentially of concern to the land owner.

A survey of community wellbeing in a region affected by coal seam gas in south-west Queensland measured landowners’ attitudes towards coal seam gas development in their area and found that landowners on average had negative feelings towards coal seam gas and that ‘worry’ was the most negative feeling assessed. The survey also found that these views were significantly different from residents in the region who lived in town; on average in-town residents measured positive feelings towards coal seam gas development in their region (Walton et al., 2014).

The impact on the farmer varies but farmer concerns typically relate to concerns about water, dust, noise, road traffic (both on-farm and off-farm), farm production, soil compaction, weed management, increased farm labour costs, and lack of privacy. These concerns have been reported in research conducted in coal seam gas areas in Australia (de Rijke, 2013; Huth et al., 2014; Sherval and Hardiman, 2014) and shale gas regions in America (Brasier et al., 2014). Some of these concerns relate more to the initial construction phase and some to the ongoing production phase. These concerns can also vary depending on the type of farm enterprise, for example, intensive agriculture compared to livestock grazing, or the dependency (or not) on bore water for watering livestock or crop irrigation. During the construction phase positioning of wells, pipelines, and access tracks; and the potential interference with farm design, farming practices, and farm production are keys areas of negotiation. During the production phase factors relating to the running of the wells also need to be agreed upon including such things as shutting farm gates, vehicle speeds, weed management, and issues around privacy and safety.

Huth et al. (2014) in a qualitative study of farmer’s perceptions of coal seam gas development identified three main areas that contributed towards problems in the engagement process with land owners. First, farmers attach their identity to their farm or ‘place’. This means that their view of themselves and their farm are closely enmeshed (Wester-Herber, 2004) such that an impact on their farm becomes very personal, potentially affecting their self-esteem and wellbeing, and is amplified in ways that is difficult to understand by someone external to their situation, particularly by those from non-rural backgrounds. Huth et al. also found that farmers and coal seam gas companies viewed the aesthetics of the landscape differently. Farmers identified a lack of understanding and appreciation by coal seam gas companies of farmers’ perspectives and feelings towards their farms (Huth et al., 2014), a sentiment echoed in other research of landowners’ attitudes (de Rijke, 2013). Finally, Huth and colleagues point out that the farm is both a family home as well as a business enterprise and that this interface of family, business and gas development underpins many of the difficulties and issues for many landowners.

A range of initiatives to improve co-existence have emerged in areas affected by onshore gas development and these are discussed in detail in Case Study 4. Some of these initiatives have been in response to complaints and reports of farmer worry and stress in dealing with these issues. One initiative has been for landowner groups to create guidelines outlining principles and criteria for agriculture and gas co-existence (BSA, 2013b). Another has been the creation of guidelines from government and regulatory bodies (Clarke, 2013; DEEDI, 2010a; GasFields Commission Queensland, 2014b), and a third approach has been for onshore gas companies and farmers to identify solutions together through extensive consultation processes (Arrow Energy, 2014). Establishing protocols, codes of conduct and guidelines for gas companies’ on-farm behaviour has potentially helped to improve co-existence issues; although the effectiveness of these sorts
of practices has yet to be reported in the literature specifically. However, the earlier these best practices become typical of the land access protocols the more likely effective farm-gas relationships can emerge.

**Case Study 4 The Surat Basin, Queensland: Improving co-existence between agriculture and coal seam gas**

In the Surat Basin a range of approaches have been used to address and improve co-existence between agriculture and coal seam gas development.

Coal seam gas companies have worked together with affected farmers to develop more acceptable approaches and solutions that foster coexistence of coal seam gas with farm practices. Some of these measures also include improvements to drilling technology, which aim to mitigate the coal seam gas ‘footprint’ on farms during both construction and production phases (Arrow Energy, 2014). Some technology changes that are under trial include:

- pitless drilling to minimise soil and water contamination,
- use of industrial matting to reduce soil compaction,
- increased use of directional drilling so that multiple well pads can be positioned on farm perimeters and increased spacing can be achieved between wells.
- submersible pumps to reduce maintenance and consequent number of farm visits during production phase

Identifying acceptable solutions were achieved through farmer consultation with a diversity of farmers each experiencing varying types and extent of impacts. The aim of consultation was to engage in a two-way dialogue with a focus on the co-creation of solutions. Some of these technology changes are being trialled and showcased on ‘demonstration farms’ in the Western Downs (Arrow Energy, 2014).

In addition, coal seam gas companies have worked on improving their landowner-company liaison processes, allocating dedicated representatives to deal with each landowner on a one-to-one and face-to-face basis; recruiting staff with rural backgrounds; and ensuring that the representative lives within the community fulltime (QGC, 2014). Gas companies have also developed codes of conduct, rules, public commitments and respective policies to guide their on-farm behaviour (APLNG, 2015a, 2015b; QGC, 2012; Santos, 2015).

From the farmers’ perspective, a landowner group comprising residents from the Western Downs lobbied for improved behaviour from coal seam gas companies. Their actions resulted in the generation of codes of conduct for the industry and government legislation to protect strategic cropping land (BSA, 2014). National agriculture industry groups, such as AgForce, now have dedicated portfolios and officers to provide education and assistance to farmers (AgForce, 2015).

The GasFields Commission Queensland, a Queensland State Government independent statutory body, has also become involved with coal seam gas and agriculture coexistence conducting frequent and regular consultation with community leaders and seeking outcomes to address issues raised by community stakeholders, including landowners. Fostering coexistence is a stated objective of the Commission with six commissioners each dedicated to a specific portfolio that reflect landowner and community concerns. These portfolios include: water and salt management; land access; gas industry development; science and research; local government and infrastructure; and community and business. In addition, governments at the state and federal levels have developed guidelines, ‘tips’ and fact sheets that promote co-existence (Clarke, 2013; DEEDI, 2010a, 2010b).

Many of the regulatory instruments, codes, and guidelines that exist to provide guidance for stakeholders emerged from 2010 (Land Access Framework) and within a broader framework of adaptive environmental management (Land Access Review Panel, 2012; Queensland Government, 2014). In many cases in the Surat Basin, this has been some years after landowners began interacting with coal seam gas exploration and production companies and has been possibly in response to concerns expressed by stakeholders. Early establishment of publicly available and endorsed frameworks for assisting co-existence would have been beneficial. If government and proponents are to promote co-existence it is reasonable that appropriate resources and capabilities, both human and other, that support the process are in place prior to development to foster the most favourable outcome.
2.3.2 LANDOWNER COMPENSATION

Closely linked to achieving satisfactory co-existence and good working relationships between farmers and gas development companies is the farmer or landowner receiving adequate compensation payments. This involves a considerable negotiation process often involving a team of legal, accounting, tax, and land valuation professionals working together to achieve adequate compensation. Compensation and agreement about land access matters form the basis of the Conduct and Compensation Agreement (CCA), which governs the arrangements of ‘co-existence’ with the farmer (see Case Study 5).

Many of the concerns related to landowner compensation stem from the laws governing ownership of the resources and the property rights of the landowner. Unlike some other countries around the world, property rights of landowners in Australia are largely restricted to the surface soil, and any resources below the surface are the property of the State, and this creates uncertainty and worry for landowners when faced with potential onshore gas exploration and extraction. This type of anxiety has been found, for example, in research of landowners in the Surat Basin in Queensland (de Rijke, 2013; Huth et al., 2014) and Gloucester of New South Wales (Sherval and Hardiman, 2014).

In contrast, compensation of affected landowners in the Marcellus shale region of America typically involves a lease payment and a royalty payment (Jacquet, 2012). The lease payment covers activities associated with exploration and access to the drilling well and the royalty payment compensates the resources that are extracted. Survey data of attitudes towards shale gas development in this US region demonstrated that more positive attitudes towards the gas development were associated with those farmers that had wells on their property and were receiving direct economic benefit than those landowners who did not (Jacquet, 2012).

For the farmer the level of compensation must be considered to be fair and cover many aspects important to their future livelihood, considerations that the farmer often finds difficult to value and cause for concern. For example, a farmer faced with the likelihood of shale gas development on his property described the following: “everything that I’ve worked for, for years, could be devalued at the drop of a hat” (Taylor, B. and Stone, 2012, p 17).

Not only is the amount of compensation important to satisfaction but also the negotiating process must be considered procedurally fair and equitable. Huth et al. (2014) in research investigating co-existence between coal seam gas development and agriculture found that fair and equitable processes were an integral component of achieving acceptable compensation agreements. Procedural fairness and the quality of the relationships underpin development of trust between the landowner and gas company and trust has been shown to be fundamental to acceptance of coal seam gas extraction in landowners (Moffat and Zhang, 2014).

Farmers have also felt intimidated when negotiating compensation payments feeling that the balance of power in the negotiating process is imbalanced (Jacquet and Stedman, 2011). To counter this feeling of unequal power, some farmers in America have formed coalitions as a way to improve their negotiating power and to maximise their financial outcomes. This approach improved the direct benefits to the members of the coalition and indirect benefits to the wider community (Jacquet and Stedman, 2011). However, it is important to note that property rights of these landowners are different from Australian property rights.
Case Study 5 Conduct and Compensation Agreements in Queensland

In Queensland, Conduct and Compensation Agreements (CCA’s) form the basis of legally binding arrangements for matters between the landowner and the gas company. In general, a coal seam gas company cannot enter a property and undertake its ‘advanced’ activities unless it has a CCA with the landowner (DEEDI, 2010a).

These agreements are best developed with the assistance of a team of experts such as a lawyer, accountant, land valuer, and tax advisor (DEEDI, 2010b; GasFields Commission Queensland, 2014b). In addition to compensation payments, the CCA sets out how coal seam gas related activities are to be undertaken on a person’s land so it is important that expert advice is sought to ensure that fair compensation is achieved and impacts on farm productivity, family life and lifestyle are minimised. Lawyers working in this field advise that the terms of the agreement are ‘often more important than the amount of compensation’ (Shine Lawyers, 2014).

Each CCA is specific to the unique situation of the landowner’s property. In line with Queensland’s Land Access Code, 2010, the sorts of issues (DEEDI 2010a, 2010b) that are agreed upon include:

- access periods
- access roads and tracks
- accessibility
- proximity to homes and other buildings
- speed limits for vehicles
- how disputes will be resolved
- consideration of practices relating to livestock and property
- gates, grids and fences
- managing the risks of pests and weeds
- prevention of erosion
- damage to cropping activities
- levels, review, and payments of compensation

In the Surat Basin of Queensland, hundreds of CCA’s have been established with landowners, and millions of dollars of compensation have been negotiated. Whilst some farmers are unhappy with the process related to negotiating agreements, others are satisfied with their arrangements (Land Access Review Panel, 2012) and view the compensation as a way to ‘drought proof’ their farming enterprise and enable investment in income-generating farm assets (DPI, 2013). On the other hand, the sorts of issues that some farmer groups in the region have complained about in the past has been the time spent in preparing the landowner case, which farmers felt was an impost on their time that was not adequately addressed by compensation (Land Access Review Panel, 2012). The time taken by the farmer to negotiate the CCA has not always been accounted for in the compensation claim; however, this has changed and the cost of the farmer’s time, in addition to the cost of experts to assist in the negotiating process are included in the compensation payment (DEEDI, 2010b). Another issue raised by farmers in the early days of negotiating compensation agreements was the confidentiality clauses, which fostered perceptions that the process of compensation and the amounts paid lacked transparency, which further promulgated feelings of unfairness (Land Access Review Panel, 2012). Recommendations from a 2012 review of the Land Access framework included changes to the standard CCAs such that the confidentiality provision be solely decided by the landholder (Land Access Review Panel, 2012). In current standard CCA’s the confidentiality clause is optional and confidentiality may be deleted from the agreements if parties agree (Queensland Government, 2015). Coal seam gas proponents are now offering landowners the opportunity to waiver confidentiality of the compensation levels if the landowner prefers (Arrow Energy, 2011; Santos, 2012).

The level of compensation has also been cause for complaint. Compensation levels have varied considerably throughout the Surat Basin and have come under criticism as being unfair and taking advantage of less resourced farmers unable to negotiate to their advantage. This was particularly so in the earlier days of the industry when some farmers felt they had signed unfavourable agreements because they felt pressured into signing an agreement too quickly because of the ‘threat’ to be taken to the Land Court (Land Access Review Panel, 2012). However, CCA’s include all legal costs upfront and information and education around negotiating CCAs has become widespread and more accessible with information and education sessions available from government, national agricultural industry websites, and local groups of landowners (AgForce, 2014; BSA, 2015; DEEDI, 2010b).

In 2012, a review of the Land Access Framework underpinning the CCA’s concluded that whilst the framework had changed the negotiation processes, it had not necessarily improved the working relationships and 12 recommendations were provided in the review. The recommendations aimed to promote more transparent and streamlined processes, whilst recognising that many negotiations have resulted in successful outcomes (Land Access Review Panel, 2012).
2.4 Local infrastructure and facilities

For those concerned with planning for new gas developments and for those in communities affected by developments, infrastructure and facilities are crucial considerations. As Williams et al. (2012) concluded, investment in infrastructure is crucial to meet the demands of an increased population, including roads, utilities, health-care, transport, housing and other services. The Social Impact Management Plans of gas companies similarly recognise that the sudden population increase will place a strain on facilities and services (APLNG, 2011; QGC, 2010). These concerns are confirmed by studies of the affected communities (Hossain et al., 2013; Rolfe et al., 2007; Williams, R. and Walton, 2014). In the Western Downs, the dimension “services and facilities” was found to be the strongest driver of perceptions of community wellbeing (Walton et al., 2014). Indeed the strain on local infrastructure and facilities may be so great that the burden may outweigh any benefits from the additional local economic activity, especially when those benefits are not equally distributed within local communities.

However studies of the longer term impacts have identified benefits from the resource booms in terms of improved facilities (Smith et al., 2001). In the U.S. longer term improvements have been found in poverty, local police, medical and health care facilities, quality of local schools, and fire protection services (Anderson and Theodori 2009; Theodori, 2009).

In this section we look at two major infrastructure concerns “Housing” and “Roads and Traffic” which can raise major problems for local communities. In both cases, the speed at which coal seam gas development occurred made it difficult to respond to the infrastructure needs in a timely way.

2.4.1 HOUSING

The sudden influx of workers at the construction phase of gas development inevitably places a strain on local housing. The population of a small town can double within a few months with an influx of workers on high incomes so house prices and rents can increase exponentially. At a time when there are many more visitors to a town short-term accommodation in hotels, motels and caravan parks also becomes scarce and expensive as they are used by people who cannot find rental accommodation, which then has implications for tourist accommodation.

Gas production companies provide temporary accommodation in camps, which can be constructed quite rapidly for their fly-in-fly-out (FIFO) and drive-in-drive-out (DIDO) construction workforces, and they also rent existing properties and construct new dwellings for managers and employees with families. There was some initial resistance to camps because the townspeople would like the newcomers to contribute to the town both financially and to the life of the town. This lack of community involvement was interpreted by some locals as a disinclination on behalf of these workers, to be ‘part of the community’ (Walton et al., 2013). However over time this view was less frequently expressed as people recognised the scale of the work force and the nature of the work (eg 12 hour shifts) made it difficult for newcomers to contribute to the life of the town. It is not only those working directly for the gas production companies that need to be housed but also a range of contracted services for the gas industry and the new workers in the service industries to support the larger population such as retail and hospitality. However, new housing can be slow to develop in response to such increased demand. Pressure on under resourced local government offices that process housing applications, the release of new land for housing, and the development of roads, water and sewerage infrastructure to support new housing may result in time delays for easing increased accommodation demands through new housing development.

The effects are likely to differ across areas depending on the range of gas and other industries in the region. For example in Roma in Queensland where the gas industry has been established for some time and there are a range of industries including 30 major projects for coal seam gas, liquid natural gas, coal mining and new power stations, a relatively steady growth in employment is expected directly creating 9,500 construction jobs and 6,400 operational jobs. About 60 private dwellings need to be built every year in Roma to accommodate increased population till 2026 (Akbar et al., 2013). In contrast in Chinchilla in
Queensland, coal seam gas development was recently brought to a more intensive agricultural area and has created a boom and bust effect on local housing, with median rents for four bedroom houses in Chinchilla peaking at the end of 2014 and then declining sharply (see Figure 3). Early in the construction boom, lack of availability of affordable rental housing for low income families was the main focus in discussions about housing pressure, with reports that long-term residents who were low income renters were leaving the town (Williams, R. and Walton, 2014). Hossain et al. (2013) also found high levels of financial stress around housing in the region. In contrast homeowners who wished to move away would take advantage of the inflated house prices. Within a few years the construction boom finishes as the gas industry moves into the operational stage. Thus the availability of housing is no longer a problem but a number of housing investors are likely to face major losses. One option may be for the gas companies to close the remaining camps and house all people for the operations phase in town. In the Western Downs region, Queensland, numerous homes have become unoccupied, houses cannot be sold, and rents have declined. However, regional effects are averaged out across towns at different stages and with different levels of CSG development and so may not be as pronounced as local effects.

Figure 3 Median rent prices for four-bedroom houses in Chinchilla and the Western Downs region, Queensland

![Median rent prices for four-bedroom houses in Chinchilla and the Western Downs region, Queensland](source)

The problems of housing in onshore gas developments appear to occur despite identification of housing as an impact in Social Impact Management Plans (SIMPS). In the Surat Basin, problems of housing have occurred in some towns despite government approval of the coal seam gas companies’ SIMPS which recognised housing as a major issue. These SIMPS identified the need for temporary accommodation and the companies’ intention to and responsibility for establishing camps for their construction workers (APLNG, 2011; QGC, 2010). However SIMPS are often vague about industry involvement in community and affordable housing and focus on industry involvement at the level of ‘monitoring effects’ or ‘planning action’, leaving open potential problems to actually deliver additional housing stock into a community.
The longer term effects on housing values from onshore gas developments in Australia are hard to assess. Examining changes over time in the housing market in the U.S. from 1997 to 2013 Weber et al. (2014) found that houses in areas with shale gas increased on average 5-6% more than those houses in areas without shale gas. The greater appreciation of house values partly reflected improved local public finances, but it is not clear that similar benefits will accrue locally to the same extent in Australia. Also Weber et al. found that, within gas fields, a higher density of wells was associated with a decrease in property values. In another study investigating shale gas development on property values, factors such as the visibility of the wells and the property’s water source were found to influence property values (Muehlenbachs et al., 2014) there were large negative impacts on homes that depended on groundwater, but those with piped-water exhibited small positive impacts.

For housing values to be maintained in the long term, towns need to attract permanent residents. In Australia, a longitudinal study of coal mining towns in the Bowen Basin suggests that a planned town centre, a sense of community, and the presence of women and families were key factors in creating a sustainable town (Petkova et al., 2009).

Evaluation of possible solutions to improve housing issues and mitigate the impact of onshore gas development is seldom reported. However suggested improvements have been identified and include the following:

- Improved planning: Residents of coal seam gas communities have indicated that they have strong expectations around adequate planning and preparation for managing the housing shortages associated with the population influx of onshore gas development (Williams, R. and Walton 2014).
- Workers camps: mandating that all FIFO and DIDO workers be housed in camps rather than having access to accommodation in the town was recommended by some residents (Williams, R. and Walton 2014). However camps have only been used for direct employees of the gas companies. Many of the additional population are subcontracted or working in service industries.
- Pressure on gas companies to provide accommodation before commencing operations: governments could require gas companies to address the housing issue as part of the companies’ local accountability to communities. This pressure was seen as appropriately coming from State or Federal levels rather than local government.
- Increasing short-term and temporary accommodation for non-gas workers and visitors to the town: An initiative that could be managed by local council and is relatively inexpensive is increasing the size and number of caravan parks or caravan park type accommodation with demountable homes. At the end of the construction boom, these homes can be moved to new construction areas as required.
Case Study 6 Improving housing stress for low to middle income residents in a region experiencing coal seam gas development: the Western Downs Housing Trust (WDHT)

“The Western Downs Housing Trust was formed for the specific purpose of alleviating housing stress among key workers on low to moderate income levels in the Western Downs region. … Population increases due to the massive development of the energy resource sector are placing rapid pressure on affordable housing across the Western Downs region. The trust’s goal is to alleviate this housing stress in the region.” (Western Downs Housing Trust, 2015). The trust is a joint response by local government and coal seam gas proponents to address housing needs for low and middle income residents of the Western Downs who provide key services to the local community, including not only essential service workers such as police, fire-fighters, or nurses, but also teachers, shop assistants or apprentice mechanics. In May 2011 KPMG were contracted to assess the housing situation and develop a strategy. In May 2012 the Trust was settled.

The housing strategy has a complex structure. WDHT is a public charitable trust, governed by a Statutory Board consisting of three Directors, an Advisory Board, and a Reference Group with representatives from government institutions, resource sector, academia, local businesses and the local community. QGC and Horizon Housing Solutions are partners in the Trust. The Western Downs Housing Fund Pty Ltd authorises money to the Housing Trust which then works through Horizon Housing Solutions, a not-for-profit organisation with expertise in tenancy and property management to build houses, assess the eligibility of rental applicants, and manage the rental (Western Downs Housing Trust, 2015).

Despite these efforts to improve the housing situation in the Western Downs, the responses from the community to the strategy were often less than positive. The major problem was the timing. In interviews conducted in October 2012 for a study on community resilience in Chinchilla (Walton et al., 2013), welfare workers were already reporting that low income renters had to leave town because rents had increased dramatically (see Figure 3). In February 2014 over half the survey respondents in the Western Downs region agreed or strongly agreed that “rent or mortgage repayments impact greatly on your household finances” (Walton et al., 2014). Interviewees believed that a housing strategy needed to be developed prior to the influx of workers from the industry. Residents generally thought that housing should have been planned by government at the time of coal seam gas development approvals, not left up to local council to manage (Williams, R. and Walton, 2014). Further the complex nature of the arrangements with an Advisory Board, and a Reference Group has some advantages in terms of broad community input but it appears to have decreased the speed of the council’s response to an urgent problem.

Although there had been a marked increase in the building of new homes, many respondents were unhappy with their quality (Williams, R. and Walton, 2014). They felt that the poor quality was likely to reflect a limited budget, haste to complete the homes, and a shortage of skilled tradespeople as many were working for the gas industry.

By 2014, the construction boom had finished and the housing problem was easing rapidly (see Figure 3). Thus an organisational infrastructure which took a year to develop, followed by several months to build the first homes, was then no longer needed two years later. Further, it is unclear if the initiative was in time to make an appreciable difference to low or medium income earners living in the area. It appears that the housing trust setup had difficulty dealing with an urgent but short term crisis.

2.4.2 ROADS AND TRAFFIC

Roads and traffic are perhaps not the first problems that spring to mind when thinking about gas developments but surveys of people living in areas affected by those developments in both Australia (Walton et al., 2014) and the U.S. (Anderson and Theodori, 2009) identified roads and traffic as the major cause of dissatisfaction.

Increased traffic may be caused by a number of reasons, including:

1. Transport of heavy equipment for the construction of wells, gas compression installations and pipelines
2. Transport of pipes for both the gas and water
3. Employment of DIDO workers who commute from larger towns or cities

4. Regular inspections of gas wells

5. Increased population

6. Increased business activity supporting the industry

For shale gas, water transportation is needed for the well-fracturing process. Freshwater must first be transported to the well site in large quantities, then the saline water that emerges from the fractured well must be transported to a disposal site. This has been identified as the major cause of traffic concern in shale-gas areas (Anderson and Theodori, 2009).

People have a high level of concern about roads and traffic because of the potential diverse and negative effects, including endangering lives. These effects include:

1. **Damage to roads not built for heavy vehicles:** Unconventional gas developments uses a widely distributed network of wells which requires accessing sites often via small unsealed roads, which have only been designed to take farming vehicles. Even the sealed country roads and regional highways are often not designed to take a large amount of traffic or to take wide heavy construction vehicles. Hence, they are invariably damaged in the construction phase of gas developments.

2. **Roadworks disrupting traffic:** Effort to repair damaged roads or upgrade them leads to ongoing roadworks which disrupt the flow of traffic.

3. **Dust:** In rural areas where roads are often unpaved, increased traffic on dirt roads means dust is a problem especially in areas near private property. Dust can reduce visibility, deteriorate air quality, cause nuisance to private residents (e.g. dust on roofs contaminating tank water), and change soil production (Bennett and Raine, 2012). Currently the gas companies control dust by using water sprayed from trucks. A problem with this form of dust control is that the need for dust control is greatest in dry periods, which is also when the demands on water are greatest. As a solution, Bennett and Raine (2012) suggest that water produced from the coal seam gas process could be used for dust suppression.

4. **Safety in towns:** Small country towns are usually safe places for children but the increase in traffic makes them significantly more dangerous especially as there are few traffic control devices. Research in areas affected by gas development show that communities seek improvements to their traffic conditions, including speed limits, traffic lights, traffic diversion around the town and railway boom gates (Williams, R. and Walton 2014).

5. **Safety on regional roads:** The increased number of large vehicles can pose a threat to other drivers. In a U.S. study, informants claimed that many truck drivers fail to adhere to the road rules and usual safety precautions, leading to an increase in traffic accidents and fatalities (Anderson and Theodori, 2009). In the Western Downs region, many workers typically commute from larger regional centres by car, driving long distances after 12 hour shifts, a cause for concern to local residents (Williams, R. and Walton, 2014).

6. **Ambiance of the towns reduced by traffic:** Increased traffic had other indirect effects. The towns felt less friendly because the newcomers do not give a casual wave when driving past someone in the street (Williams, R. and Walton, 2014). The ambience of the town was also changed by having dozens of trucks parked in the residential areas.

7. **Unintended side effects:** Sealing of dirt roads allows residents of small towns easier access to larger centres potentially affecting business custom in the smaller town.

The local residents of the Western Downs in southern Queensland saw road quality as an issue that governments should be addressing, particularly in relation to the Warrego Highway, which was seen as a Federal responsibility. Suggested funding sources were coal seam gas companies and the Royalties for Regions program (Williams, R. and Walton 2014). Local traffic control measures are the responsibility of State Government. To address the concerns about roads, Miller and Sassin (2014) describe four approaches for partnerships between energy companies, road authorities, and other organizations. The proactive, performance-based approach strengthens pavements prior to energy development. The reactive, performance-based approach assesses the damage and then imposes fees on the energy corporations. The
third approach imposes fees that are not attached to actual roadway deterioration. The fourth approach is to promote applications for government grants for transportation infrastructure projects affected by oil and gas production activities.

In the Western Downs, minor roads have been upgraded by local council and coal seam gas companies. For the main highway there have been major upgrades planned since 2012 (DTMR, 2012). The plan is based on the expectation that light traffic will double and heavy vehicle traffic will treble over the next 20 years. Although the report recognises the needs of an expanding coal seam gas industry the planned upgrades are not set for a timeframe that would assist the construction phase, for example, many of the overtaking lanes that are planned are set down for an 11-15 year time frame.

Much of the major roadwork that has been completed was funded by federal grants which might fit Miller and Sassín's (2014) fourth approach except that the grants were prompted by the need for road repairs after serious flooding and thus unrelated to the coal seam gas industry. Clearly the pro-active approach would be beneficial to strengthen roads before they are damaged and to avoid the disruption of ongoing roadwork during peak construction periods.

2.5 Economic changes

This section discusses economic issues and concerns that arise in the context of onshore gas development, rather than evaluating the actual economic benefits of unconventional gas extraction.

2.5.1 INCOME AND COSTS

Apart from income accruing to companies in the unconventional gas industry, considerable income accrues to state governments via royalty payments and economic growth. For example, the Queensland State Government estimated that royalty payments from LNG projects could exceed $850 million per year and add over 1 percent to state gross product (or $3.2 billion) (Queensland Government, 2010); however, this income may also depend on fluctuating commodity prices. While the vast majority of Queensland gas is earmarked for export, other states have the option to use the gas locally with the possibility of reducing imports of oil and stimulating local industries. However relative to overseas markets, local markets are small and less attractive for coal seam gas companies.

State revenues associated with royalties and economic growth also need to be seen in the context of additional costs resulting from unconventional gas development. One major cost is the upgrading and repair of road infrastructure (especially for the phase of gas well and pipe construction) and care needs to be taken in estimating these expenses. Various states in the US have found that severance taxes are not covering the considerable cost of repairing roads from shale drilling activities (Rogers, 2013). In Queensland, the government requires a Road Impact Assessment as part of Environment Impact Statements from gas companies, and three major coal seam gas companies have spent over $300 million on road infrastructure and maintenance as of December 2013 (GasFields Commission Queensland, 2013b).

From a state and local government perspective, other costs also need to be taken into account. It is not uncommon for local communities to shoulder the burden of development while the bulk of the benefits are experienced in the cities or outside the regions (Collins et al., 2012; Rolfe et al., 2007). For example, in areas affected by onshore gas development there may be decreased output from other industries (e.g., agriculture, tourism, and catering for retirees “treechangers”). Further the effects are not only for local industries. An economic evaluation by Deloitte Access Economics (2014) predicts rising gas prices will mean that all other sectors are likely to experience losses of income, especially manufacturers which are large gas users. Estimates of $118 billion lost income and 14 thousand lost jobs are predicted for manufacturers from 2014 to 2021.

State and local governments also face increased demand for police, health, community and local government services. When taken into account with environmental and health uncertainties, and given the
limited life of extractive industries, the net benefit to state and local economies from unconventional gas extraction may be less than initially envisaged, particularly for regional and local economies (Barth 2013, Chen and Randall 2013). Thus, there is a rationale for community investment by unconventional gas development companies and for affected regions to share in state royalty revenues.

2.5.2 EMPLOYMENT

An important economic benefit from unconventional gas development is additional employment opportunities. The Queensland Government predicted over 18,000 direct and indirect jobs would be generated from seven major LNG projects in the state (Queensland Government, 2010). However, there are some issues with employment generation from unconventional gas development. One is that most of the jobs occur outside the geographic regions that are most impacted by development activities such as gas well and pipe construction. For example, much of Queensland’s coal seam gas will be sourced from the Surat Basin, but less than 25% of the 18,000 jobs (approximately 4,300) were expected to be generated in the Surat Basin (Queensland Government, 2010).

Within a mining region like the Surat, the effect on direct and indirect employment from unconventional gas mining is also offset somewhat by diversion of employees in local industries to mining and associated industries offering higher earnings. For example, during the construction phase of the coal seam gas boom in the Surat and Bowen basins of Queensland, Fleming and Measham (2014) estimated that for every direct job generated in the mining industry, there were also 1.4 indirect jobs generated in the local construction industry, 0.5 jobs in accommodation and food services, and 0.4 jobs in professional services in the Surat and Bowen Basin regions. However, these jobs were also offset somewhat by 1.8 jobs lost in the agriculture industry within the same regions. One option is for mining companies to employ agricultural workers and farm owners to maintain gas wells and infrastructure on farms with gas wells. However, there is still a danger of overselling local employment opportunities to local communities affected by unconventional gas developments.

At the individual level, incomes from employees in the mining industry and associated industries are likely to be higher than average, especially for compensating FIFO or DIDO workers travelling from outside coal seam gas regions. However, average incomes for residents living in the regions are likely to rise too. Fleming and Measham (2014) compared income growth in local areas with coal seam gas development activities to similar local areas without coal seam gas activity in Queensland between 2001 and 2010. They found that median income per capita for residents in the Surat and Bowen Basins increased by 24% more than residents in comparable non coal seam gas areas. However, higher costs of living also need to be considered, particularly increased housing costs and rents, and not all residents will benefit from increasing incomes.

To understand the contribution of the industry it is important to distinguish between the construction and operation phases. Most jobs will not continue beyond the construction phase (Chen and Randall, 2013). According to the GasFields Commission Queensland (2014c), the workforce was peaking at 40,000 before stabilising at 12,000 to 14,000 in the following 18 months, as the industry transitions from a construction to production phase.
In the Surat Basin of Queensland, regions that experienced coal seam gas development showed growth in their youth populations, with more young people staying in the regions than leaving (Measham and Fleming, 2014). This trend for young people to stay in a rural region is not typical of most rural communities in Australia and other parts of the world. Usually, rural communities experience a loss of their young people to larger metropolitan areas, particularly women; a phenomenon termed ‘rural decline’. Rural decline is characterised by:

- Migration out of a rural town / region, particularly migration of rural youth (note: young women are more likely to leave rural regions compared to young men).
- Reduced human capital due to skilled and educated young people moving to the city and not returning.
- Increasing rural poverty due to low incomes of rural regions compared to urban areas.

(GISERA, 2014a)

However, for communities in coal seam gas areas of southern Queensland this trend of rural decline was reversed during the construction phase of coal seam gas development. Analysis of 15-29 year olds tracked over time, from 2001 to 2011, showed that the youth population increased. In contrast, when compared to non coal seam gas communities, the non coal seam gas community showed a migration out of their young people, particularly when they reached their early 20’s.

Table 1 shows the percentage of youth by age and sex who had moved to Chinchilla, a rural town in the middle of a CSG development region in Queensland, compared to other rural regions across the state without, or with very low, CSG development (control group). The percentages for Chinchilla are all higher than the control group, reflecting increased movement to these regions for both males and females.

Table 1 Percentage of youth new to region since previous census

<table>
<thead>
<tr>
<th></th>
<th>15-19 yrs old</th>
<th>20-24 yrs old</th>
<th>25-29 yrs old</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td><strong>2006</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinchilla</td>
<td>20</td>
<td>27</td>
<td>40</td>
</tr>
<tr>
<td>Control</td>
<td>23</td>
<td>24</td>
<td>30</td>
</tr>
<tr>
<td><strong>2011</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinchilla</td>
<td>25</td>
<td>36</td>
<td>40</td>
</tr>
<tr>
<td>Control</td>
<td>23</td>
<td>24</td>
<td>27</td>
</tr>
</tbody>
</table>

Note: based on place of usual residence ABS 2013 data
Source: adapted Measham and Fleming (2014)

However, as the coal seam gas industry matures and shifts from its construction phase to production phase it is unclear what change will occur to the younger demographic of the population. Retaining its youth is an opportunity for communities in the region; albeit challenging.

### 2.5.3 LOCAL BUSINESS OPPORTUNITIES

A main predictor of acceptance of unconventional gas mining in local communities is the perceived economic opportunities associated with mining activity, such as perceived job and local business opportunities (Walton et al., 2014). However, there are challenges for local businesses in engaging with large multinational mining companies and contractors (Walton et al., 2013). These include: access to information for business planning and investment; meeting compliance and regulatory requirements for engaging with gas companies, which can be costly to small business; responding to difficult workforce
pressures, such as attracting and retaining employees and meeting increased wage rate pressures; and managing an uneven revenue stream, such as peak work activity associated with the construction phase followed by a relative slowdown post-construction phase.

In addition, not all local businesses experience the increased economic development similarly. For some business sectors there is growth and opportunity, but for others there are challenges. For example, local tourism is likely to be affected in a number of ways. First the change from a rural to a combined rural and industrial landscape is unattractive (Wearing et al., 2014). When the development includes port facilities, coastal attractions are also negatively affected. As tourism relies on reputation even the deterioration of a small part of the landscape can damage the reputation of the site as a tourist destination (Barth, 2013). Second, during the construction phase the lack of casual accommodation even in caravan parks severely limits tourism. Third, problems with roads and traffic detract from the experiences of motoring tourists (see the sections the on housing and roads above). Some of the negative effects on tourism could be ameliorated by slowing down the rate of development and requiring gas companies to make their installations less conspicuous, for example, through the use of camouflage and earthen mounds (Rumbach, 2011).

Even local businesses that operate in the mining services sector compete with onshore gas companies for the same skilled worker, or face market-driven increases in wage rates, both factors creating considerable pressure on local businesses. Further problems arise in matching the skills and size of local providers to the needs of the industry. Although gas companies may have a commitment to the local industries in their SIMPs (APLNG, 2011; QGC, 2010) this might not be easy; for example, local tradesmen need to do considerable training to upgrade their skills, often being required to do a different course for each gas company. Improvements in capability are needed at each stage of the contracting cycle in order to better integrate regional and local suppliers into the gas industry (Kinsella and Xu, 2013).

Finally, for many local businesses there is an issue of corporate dominance when a smaller local business attempts to do business with a larger gas company or first tier sub-contractors. Many local businesses feel disempowered and ill-equipped to manage this lack of agency, particularly in the early stages when knowledge about the industry and employment processes and systems is developing. However, research shows that ‘bridging organisations’ can be effective in helping to elevate the human and social capital within the community, foster learning and provide increased agency to other groups and individuals. Case Study 8 details how a local business-oriented group self-organised and functioned across regions of southern Queensland to link small business to larger businesses and to support the smaller business in creating opportunity from onshore gas development.

**Case Study 8 Toowoomba and Surat Basin Enterprise (TSBE): connecting local business to the gas industry**

The Toowoomba and Surat Basin Enterprise (TSBE) functions in southern Queensland as a regional development group linking business enterprises with opportunity for growth and development. During the recent onshore gas development in the Surat Basin the group emerged as a self-organised, business-oriented, regional development group that facilitated learning and provided increased agency to local businesses trying to engage with coal seam gas companies.

In the early stages of the gas industry development, the group recognised a need to provide cross-scale connections, ‘linking local business with opportunity’, so that the local business community ‘will survive, adapt, and prosper’. TSBE envisioned a regional role that spans the boundaries of three Councils, recognising that “decisions and flow on impacts in one part of the region may have impacts at another”. This is in keeping with the geographic range of both local businesses and companies associated with the coal seam gas industry, which operate at varying scales across the region rather than within municipal boundaries. TSBE hoped to foster development that was not constrained by jurisdictional issues.

TSBE has pursued its objectives through fostering information sharing, being involved in planning and undertaking a coordination and connection role with community business groups. Once a month, the group hosts ‘Enterprise’
evenings - information and networking forums for local business and large regional employers, including coal seam gas companies and major first-tier subcontractors in the coal seam gas industry. The meeting location rotates between the towns in the region and typically attracts 100-150 attendees. These gatherings enable the large employer groups, often national and multinational companies, to meet directly with local business owners and operators.

In addition to the networking opportunities provided by these events, a particular benefit for the local business people is that they are able to find out about future work prospects and informally learn about the processes involved in tendering for and securing ongoing work. There are often implicit aspects to these processes that are not apparent through the formal arrangements. These types of information sharing initiatives are important for a local business community that is “trying to understand how it fits into the picture of doing business with an operator on a much larger scale”. The learning acquired through activities such as this contributes to the capacity building of the local business community, enabling it adapt to change in the commercial environment thereby fostering long term economic viability.

Support from a larger regional development group to smaller community based businesses is one way the business community as a whole can try to address the perceived unequal power relations between large multinational companies and smaller local business operators.

By 2014, the group had extended its activities beyond the resources sector and connects local business enterprises with growth opportunities in agriculture, including access to new market opportunities globally. This expansion of focus is highlighted in remarks made by the chairman of TSBE at their 2014 Annual General Meeting (TSBE, 2014)

“we have set about further cementing some of our previous work but also expanding our efforts further, particularly in the agribusiness and export sector.”

“Amidst the growth, we have remained steadfast to our purpose of being the ‘go-to’ organisation that links business with opportunity to provide sustainable growth and diversity for the region’.”

2.6 Community changes

The shift from a rural landscape to a combined rural and industrial landscape brings changes to the ambiance and social fabric which are perhaps less obvious and often harder to articulate than other concerns but are nevertheless experienced within the communities. Changes to the social relationships and physical beauty of the places that residents call home were the most prominent concerns raised by community leaders experiencing the early stages of Marcellus Shale development. They were rated as more of a concern than environmental quality, agriculture, and roads and related physical infrastructure (Brazier et al., 2011). In the Western Downs, of the six significant predictors of community wellbeing, four dimensions related to the social fabric of the community (community spirit, community cohesion, social interaction, and personal safety) and one dimension, environmental quality, related to the ambiance of the region (e.g. dust and noise); whilst the strongest predictor was services and facilities. Place attachment was also examined in relation to expectations for the future wellbeing of the community and found to be strongly linked (Walton et al., 2014).

The ambience of the town can also be changed by having considerably more traffic, numerous strangers in Hi-Vis vests, and work vehicles parked in residential areas (Williams, R. and Walton, 2014). Further, in small country towns many of the residents know each other and acknowledge each other when passing in the street in vehicles or on foot. Residents noted that newcomers would not give a casual wave when driving past which was an indicator for them that the nature of the town had changed. The number of young men gathering at the local hotels changed the feel of these places so that it felt less comfortable going there. The integrity of a community’s sense of place, centred on community, rurality and agricultural production can be undermined (Sherval and Hardiman, 2014). The loss of a strong sense of place can also flow-on effects for a community’s social capital and levels of community participation.
It is not unusual for country towns to have a culture of community participation and volunteering. This culture of volunteering not only provides a range of activities such as sport, arts and civic activities for the town but also strengthens relationships amongst the townspeople as reflected in high levels of social capital, a resource that accrues in social networks, and is usually higher in country towns than in cities (Onyx and Bullen, 2000). Locals might reasonably expect that the newcomers to the town would take an active part in their activities and be disappointed when they do not do so either for practical reasons such as long shifts, short intended stay in the area, or because they do not share the culture of civic participation. In addition, the town may experience increases in incivility ranging from littering to drunkenness (Walton et al., 2013) and social problems such as drug and alcohol abuse, domestic violence, rising divorce rates and mental health issues (Brazier et al., 2014).

It is only relatively recently that researchers have recognised the importance of the connection between having a strong sense of place and community participation (e.g. Lewicka, 2011; Wood and Giles-Corti, 2008) but it is becoming clear that place attachments can motivate cooperative efforts to improve one’s community (Manzo and Perkins, 2006), increase attachment to community (Trentleman, 2009), and influence social networks (Jorgensen, 2010). For communities experiencing gas developments, it seems that the strong sense of place that is an important underpinning to their social capital is under pressure at a time when they most need to mobilise their social capital to respond to the changes.

Given that coal seam gas exploration is new to Australia, the longer term effects on community wellbeing are harder to assess. A ten year longitudinal study of three towns in rural US that experienced boom growth from energy resource development found that aspects of good community declined during the boom but rebounded afterwards, suggesting that although there were social disruptions during the boom periods, effects were not permanent. These towns also benefitted from the boom in terms of facilities, and increases in the number and diversity of the population (Smith et al., 2001). However, in Wise County in the U.S. where citizens have been exposed to intense shale gas development efforts for over a decade, respondents unanimously reported that the costs outweighed the benefits (Anderson and Theodori, 2009). This suggests that each community will be different in how it responds to the disruption associated with onshore gas developments.

A number of writers have emphasised the need for soft infrastructure to ameliorate the effects of the industry and to help communities adjust to the changes. For example Williams et al. (2012) recommend the establishment of regional development plans and the actions outlined in, for example, the Queensland Government’s Surat Future Directions Statement. Casaril et al. (2012) recommended the establishment of a perpetual fund to ensure collaboration at all government levels, with industry and with communities through a regional governance framework. Giving some support to the notion that soft infrastructure is essential, Brasier et al (2014) in the U.S. found that counties that invested in their county planning staff and resources had been able to respond more quickly to the needs of the industry in terms of leasing and land management and in terms of community needs for information and planning. Without soft infrastructure that facilitates public involvement and information dissemination it is left to individuals to make contact with the coal seam gas companies. Potterf et al. (2014) examined community perceptions in the Eagle Ford Shale Play in the U.S. and found that most community leaders had had some personal interactions with representatives of some of the oil and gas development companies active in the region but serious and sustained communication and engagement were the exception rather than the rule. It also appeared that the information provided to the community leaders by industry representatives did not necessarily get passed on to other community leaders or the public at large. Furthermore, in Queensland Morrison et al. (2012) found that in the absence of an effective regional framework with a clear and defined role for governments and corporations powerful corporate interests risk effectively capturing the regional development agenda within a framework that works on short-term paternalism rather than long-term regional partnerships. They argue that stronger institutional arrangements need to be developed to strengthen the capacity of the state to oversee these relationships.

It is important to recognise that communities themselves can actively respond to gas industries to take advantage of possible benefits and avoid the negative impacts. There many good examples of rural communities using their social capital to respond effectively to the changes. Communities in the Western Downs exercised strategic thinking, made links within their communities, used their limited resources...
effectively, showed commitment and perseverance, and built meaningful relationships to develop a range of community organisations to respond to the multifaceted nature of the changes. While some organisations worked at a broad scale and engaged with the State government others addressed issues at the regional or local level (Walton et al., 2013). Furthermore, this “bottom up” approach to the development of soft infrastructure meant that diverse interests within the community could be recognised. So separate organisations furthering the interests of farmers, small businesses, townspeople etc could develop. Responding to single issues and at an appropriate scale allowed the community to engage its resources so that its human and financial capital produced the most effective and efficient outcomes. As illustrated in the following case study, if issues can be addressed at lower levels in the system then they can often be addressed more flexibly and quickly (Folke, 2006).

**Case Study 9 Addressing drunken behaviour: community resilience drawing from its social capital**

One example of a smaller scale, and local, response was a self-organised community group that established itself to address drunken and disorderly behaviour. Excessive alcohol consumption and associated disorderly behaviour was a complex local issue and related mainly to the FIFO/DIDO workforce. Local police estimated a significant increase in public order offences in Chinchilla over the next three years. “Probably our biggest impact [from CSG expansion] is the public order offences …[mainly] effects from alcohol fuelled violence”. As part of a community policing initiative, the group worked proactively and collaboratively to address alcohol related issues locally and quickly. The group, under leadership from the local police, comprised key stakeholders, including the coal seam gas companies, pubs and clubs, and developed a co-regulation and zero tolerance approach, which has proved effective at managing alcohol related problems.

*We had a major issue with one particular contractor... we ended up getting a close relationship, ended up getting a social performance contract drawn up with their workers. So effectively they would sign a contract to say if you are charged with any public disorder offences ... you will be sacked.*

The group saw this as an effective and alternate approach to fines, which appeared to be of little deterrence for high paid coal seam gas workers who don’t necessarily reside in Chinchilla. The group also addressed instances of disorderly behaviour by making group decisions to ban problem patrons from all licensed premises for a number of months. “Then all the pubs will say righteo, we’re all on board, one in, all in, so they can’t come to any pub in Chinchilla for three months”. Another outcome of the group’s actions was the organising of a bus service from licensed premises to camps at night to reduce loitering after hours, and continuing a Drink Right program for teenagers which had lapsed due to lack of funding.

*[The Drink Right program] had fallen over because there wasn’t any funding and [our group] said well this has fallen over, we’d really like to do this again but we don’t have the funding. One of them, I think it was [a CSG company], put their hand up and said how much is it and we said it’s about five grand and they said, yep we’ll pay for it.*

(Adapted from Walton et al., 2013)

Achieving the right balance between top-down and bottom-up approaches is not easy. It is difficult to assess in advance all the issues that will be of concern for a given community and their ability to mobilise action around those issues. Although often high in social capital communities might have have relatively low levels of human or financial capital. Some forms of soft infrastructure need to be organised at the state or regional levels because consistency is needed across regions or because action needs to be taken promptly and community processes take time. Nevertheless there should be scope for participation by those most affected by the changes. The resourcing of independent local community umbrella groups would allow communities access to the human and economic capital they need to take action on local issues and increase their sense of control in a “tsunami of change” (Walton et al., 2013, p8).”
3 Wider public concerns

3.1 ‘Frac’king and public attitudes towards onshore gas

This report is being written at a time when discussion in the public media on coal seam gas has become increasingly polarised. The term ‘fracking’ or ‘fraccing’ (hydraulic fracturing) has become synonymous with unconventional gas with people commonly referring to gas technology and related activities as ‘frac’king even though some types of gas extraction do not require hydraulic fracturing to be performed. The public discourse about fracking has shifted from a discussion of the technical aspects of hydraulic fracturing to an emotive dialogue about ‘frac’king that combines many concerns related to onshore gas development into a single umbrella term that the public uses to cover concerns about water, health, and the impact on the climate and agriculture.

The many groups opposed to onshore gas developments can now be recognised as a social movement which has promoted a national debate linking community groups across and beyond Australia (Lloyd et al., 2013). The movement seems to be gathering force as public attitudes to coal seam gas appear to be trending in a negative direction however there are no national scientific studies of the nature and extent of anti-coal seam gas attitudes or their motivations so evidence can be pieced together from media sources and a small number of scientific studies. For example the number of local councils that have banned coal seam gas developments in their areas is increasing, with all the councils in the Northern Rivers Region of New South Wales now opposing coal seam gas developments. In Queensland in 2012, a poll published in ‘The Australian’ showed that 40% of respondents opposed the coal seam gas industry, 27% were undecided about their support of the coal seam gas industry and 33% supported the industry (Walker, 2012). In New South Wales in 2013, a Fairfax Media/Nielsen poll found that 17% supported the industry (Nicholls and Manning, 2013).

In the scientific literature there are two national studies that investigate attitudes towards coal seam gas. A national survey in 2012 on attitudes to agriculture and coal seam gas found only 14% said mining on agricultural land should be allowed, 38% said it should be strictly controlled, and 29% said it should not be allowed at all (Worsley et al., 2014). More recently, a national survey of Australian attitudes towards mining conducted in 2014, included extraction of natural gas into its definition of ‘mining’ (Moffat et al., 2014). The survey showed that Australians on average accept mining activities taking place (an average response of 3.62 out of 5, where a response above 3 indicates a positive view). This finding was consistent across the different areas of Australia: mining, non-mining and metropolitan areas. However, unlike Worsley et al’s (2012) national survey, any inferences to onshore gas mining should be made with caution since onshore gas was not separately identified.

A recent Western Downs survey that did investigate attitudes and feelings towards coal seam gas development specifically was conducted at the regional level. This survey found that on average people across the region viewed coal seam gas development negatively (2.97 out of 5) with differences in attitude dependent on where the person lived within the region. On average, people who lived in town showed positive views whilst people who lived out of town (land-owners) showed negative views. In this survey, approximately 10% of respondents rejected coal seam gas development and 10% embraced it with the rest tolerating (33%), accepting (36%) or approving (14%) the industry (Walton et al., 2014).

Environmental perspectives on onshore gas appear to differ across geographical areas. Of those in regions affected by gas developments, it is those from areas with extensive natural bushland who are more likely to express concern for the environment per se. For example, in the Western Downs when people in commercial farming areas had expressed a concern about the environment it was mainly in terms of managing it for future generations whereas those near Tara which has extensive bushland were concerned for the bush (Williams, R. and Walton, 2014). Similarly, in New South Wales there have been protests to
protect the natural environment for example the protests against the clearing and fragmentation of the Pilliga State Forest.

There is also a difference between the city and rural areas with greater environmental support in the cities (e.g., The Greens vote in Victoria’s upper house in the city was over twice that for country regions, VEC (2014)), which can affect attitudes to gas development. A study of people in Brisbane found that they were ambivalent about the employment benefits to people in coal seam gas communities but were unanimous in their support and willingness to pay for environmental monitoring (Windle and Rolfe, 2014). Furthermore, there have been differences across regions in the strategies used by those resisting coal seam gas developments. In New South Wales there has been an alliance between landholders and environmentalists. This is an unusual alliance because many landholders are conservative, for example, those who identified as traditional farmers aligned with traditional animosities between the National Party and the political left, and rejected collaboration with environmentalists in favour of direct lobbying of parliamentarians (Lloyd et al., 2013). The divisions which are becoming evident in Australia reflect similar trends in the U.S. where there is strong lobbying in a number of states to ban hydraulic fracturing or at least constrain its activities and the topic has become a key election issue (Biello, 2014).

### 3.2 The nature of environmental concerns

Three major concerns from a wider environmental perspective are the effects on water, native flora and fauna, and climate changes. First, disturbance and possible contamination of the groundwater system is a major concern with environmentalists often emphasising our lack of knowledge about the groundwater system and future effects. So, for example, Sherval and Hardiman (2014) note that detailed critiques of the current New South Wales state regulations on coal seam gas have outlined serious gaps in the gateway assessment process especially the fact that there is no recognition that impacts from coal seam gas may be cumulative and currently unknown. Furthermore, all the concerns expressed in this present report in the section on Water (Section 2.1) about surface water quantity and quality are relevant but the focus of concern is the effects of lack of water or contaminated water on native bushland and wildlife. In the U.S. environmental issues were found to be the second greatest cause for concern (after traffic) with a focus on the amount of fresh water that is needed for shale gas extraction (Theodori, 2009).

Second, some people express the environmental concern that coal seam gas extraction can have a direct effect on native bushland and wildlife as the clearing of bushland in some locations is necessary for coal seam gas exploration and infrastructure such as wells, roads, pipes and compressor stations, which can lead to fragmentation of important remnant native vegetation, the spread of invasive species and the increased risk of bushfires (Ponce-Reyes et al., 2014; Williams et al., 2012). In the U.S. there is fragmentation of the forests of the Allegheny Plateau in several states with the likelihood of increased fragmentation in the future as there were many leases not yet developed (Drohan et al., 2012).

A third major area of concern for the environment from onshore has developments is global warming. Although coal seam gas and shale gas are promoted as beneficial because they make a smaller contribution to global warming than coal or oil and have been documented as reducing the effects of greenhouse gases in the U.S., environmentalists have a number of reservations. One is the potential increase in fugitive emissions which is a concern because methane has 20 times the greenhouse effect of coal or oil emissions (EPA, 2014). In Australia, footage of methane leaking water bores being set alight have been shown in programs such as ABC’s *Four Corners* (ABC Television, 2013). Methane bubbling up in the Condamine River in Queensland has also received media attention (McCarthy, 2013). However, in many of these regions this is not a new phenomenon, and there has been a long history of methane in bore water (Mallants, 2014): what is of concern is the extent to which these emissions may be increasing given that in many places no baseline readings were taken. Thus, the degree to which these emissions have increased due to gas production is contested.
Another reservation relates to fears of the potential impacts on the Great Barrier Reef from export facilities being developed on Curtis Island particularly as UNESCO is re-evaluating the Great Barrier Reef’s world heritage status as a result (Lloyd et al., 2013). UNESCO’s annual World Heritage Committee meeting recommended a strategic planning framework be put in place with monitoring of the site, and a final report outlining long-term sustainable development and management to be produced by the Australian Government in 2015. UNESCO postponed its decision on whether to put the reef on the endangered list until 2015 (PTBA, 2014; Sturmer, 2014).

The final reservation is the question of whether the level of effort and resources invested in the development of onshore gas would be far better directed at renewable sources of energy, which would more effectively reduce global warming and avoid the other environmental risks they believe to be associated with gas. There is a concern that rather than being part of a transition to a lower emissions economy, unconventional gas has simply increased the amount of greenhouse gas fuels available. This shift in position is illustrated in the changes in the public statements of The Greens political party. For example, in March 2012 they called on the Government to “implement an immediate moratorium on any new coal seam gas approvals until the long-term impacts of the industry … are known” (Parliament of the Commonwealth of Australia, 2012). In 2014 they took a firmer stand “No new coal seam, shale or tight gas developments, given the short and long term risks to our water, land, communities, the climate, food production and marine areas … Rather than expanding our dirty industries, rich countries like Australia should be leading the global transition to renewable energy” (The Greens, 2014).

### 3.3 Possibilities for ameliorating environmental concerns

Ameliorating these environmental concerns would require, first and foremost, substantial preparation and scientific study to demonstrate beforehand that the environment was not going to be seriously damaged. Mapping of groundwater and baseline measures of methane seepage would be needed and scientific studies of the effects of hydraulic fracturing and other procedures to show that onshore gas can be extracted safely. Ongoing monitoring would then be needed to demonstrate that it was being done safely. If such evidence and monitoring were in place there would still be the task of reassuring the public that all is well in a climate where an anti-coal seam gas movement has already mobilised. The public is not automatically accepting of science. Perception of risk, trust, emotions, cultural values, and beliefs can all affect acceptance (Cham and Stone, 2014; Price et. al., 2014).

Trust is a key factor that can be earned through transparent and independent processes. For the general public who do not have specialist knowledge of gas development, risk perceptions are likely to be informed by the trustworthiness of the responsible authority and whether it has reliable sources of information (Cham and Stone, 2014). In Australia there is a general lack of trust in onshore gas developers and a lack of confidence in government to regulate the industry. In addition, information provided by gas developers and government agencies is generally treated with suspicion (Cham and Stone, 2014). Case Study 10, the Center for Sustainable Shale Development (CSSD, 2014) in the U.S., is an example of an independent body setting standards and monitoring the industry.

Those concerned about potential cumulative long term effects, however, will not be reassured by current findings and those who believe that all efforts should be put into renewable energy will not be interested. Indeed given the polarisation that appears to be emerging in Australia it seems unlikely that those who identify as serious environmentalists would support gas development in any form. But again we would emphasise that the whole domain of public attitudes to onshore gas including key aspects such as emotions, cultural values, and beliefs needs far more research.
The Center for Sustainable Shale Development (CSSD), focused on the Marcellus shale development. The CSSD is an independent 501(c)(3) nonprofit organization “whose mission is to support continuous improvement and innovative practices through performance standards and third-party certification. Focused on shale development in the Appalachian Basin, the Center provides a forum for a diverse group of stakeholders to share expertise with the common objective of developing solutions and serving as a center of excellence for shale gas development.”

The CSSD’s Board of Directors and Strategic Partners include oil and gas companies, environmental non-governmental organizations (Clean Air Taskforce & Pennsylvania Environmental Council), philanthropic foundations (eg Environmental Defense Fund), and former political notables. It is funded by philanthropic foundations and participating energy companies.

The CSSD has developed 15 initial performance standards for operators that are protective of air quality, water resources and climate. These standards represent consensus on what is achievable and protective of human health and the environment.

CSSD’s air and climate performance standards focus on the following key areas: Limitations on Flaring; Use of Green Completions; Reduced Engine Emissions; Emissions Controls on Storage Tanks

CSSD’s water performance standards focus on the following key areas: Maximizing Water Recycling; Development of Groundwater Protection Plan; Closed Loop Drilling; Well Casing Design; Groundwater Monitoring; Wastewater Disposal; Impoundment Integrity; Reduced Toxicity Fracturing Fluid.

Though not without its critics, the CSSD is a formalized and intensive effort to engage stakeholders, if not the general public, in decisions around creating more stringent standards of operation. It is relatively early in its development, and its effectiveness in developing voluntary standards, getting those standards widely adopted, and gaining trust remains to be seen.

Source: CSSD (2015)


4 Discussion

Public perceptions and views around onshore gas development are diverse and reflect different values, interests and ways that a person engages with the issues it raises. For many people engagement is at a broad level and this has been discussed in Section 3. It may be the broader concerns for the impact of the industry on the environment, particularly the industry’s greenhouse gas footprint and the effects of development and production on water and native bushland and wildlife that predominates these views, or it may be the broader economic benefit that onshore gas development provides to the state and nation. People with economic priorities may oppose the types of strict monitoring and regulation that would ameliorate some of the concerns of the environmentalists. Often these views, in wider society, become polarised and contested in public discourse and the division of opinion is promulgated by the focus of popular media.

However, for many people living in communities potentially impacted by onshore gas the relationship with onshore gas development becomes more complex and multifaceted. For many in this situation their feelings and attitudes towards the industry are ‘luke-warm’ and a range of factors in combination contribute to their level of acceptance. Although environmental management and employment and business opportunities are both important to acceptance by the local community other issues also play a part. Levels of community trust in government and industry stakeholders, community having a role in decision-making, and how well the community appears to be responding to the changes are also factors that influence community acceptance. Planning, leadership, and the effectiveness of stakeholders working together are important for a community to adapt and effectively respond to changes such as those associated with onshore gas development.

For many of these communities dealing with the onshore gas industry, whether it is in the exploration, production or closure phase, uncertainty underpins many of the negative feelings towards the industry. Initially uncertainty may relate to the location, timing and extent of the development and then extend to the ‘risks’ associated with the social, economic, and environmental aspects of community life. This uncertainty has been reported in shale gas development regions of Western Australia (Taylor, B. and Stone, 2012), and coal seam gas development regions in New South Wales and Queensland (Taylor, M. et al., 2013). In these studies three main themes emerge as important for reducing uncertainty and improving community acceptance. These include access to and use of information; adequate governance including policy, planning, and monitoring; and community engagement and collaboration such that community partakes as an active stakeholder.

4.1 Accessing and using information

Access to information repeatedly surfaces as important to communities if they are to overcome some of their uncertainty. Information that is timely, transparent, and from trusted sources has been identified as critical if credibility, legitimacy and ultimately trust is to be fostered among stakeholders. This need for independent and trusted information supports the role of the scientific community in providing robust science particularly for those issues that are most contested (Cham and Stone, 2013).

The Marcellus Center for Outreach and Research in the Marcellus shale region of America exemplifies the role that a state education research centre can take in not only conducting science to support policy and industry around shale gas extraction but also undertaking ‘outreach’ activities to support affected communities. These activities aim to take the research findings into the community assisting in the transference of knowledge and information (MCOR, 2015). In Australia, the ‘outreach’ model is less prevalent. However, key science institutions and universities are actively engaging in research projects for
unconventional gas. For example, the University of Queensland Centre for Coal Seam Gas (UQ CCSG, 2015) and the CSIRO's specific research entity, GISERA (Gas Industry Social and Environmental Research Alliance) investigate the impacts of unconventional gas (GISERA, 2015b). For example, the CSIRO investigates the impacts of unconventional gas in six research areas: surface and groundwater, greenhouse gas footprint, agricultural land management, terrestrial biodiversity, marine environment, and social and economic impacts and opportunities (GISERA, 2015b). However, such research models require a strict governance structure to ensure their independence. The research from GISERA is all peer reviewed and made publicly available. This means that research conducted through GISERA provides information to all concerned - from farmers through to gas developers, regulators and government departments through to concerned communities - so that informed discussions and decisions can be made (GISERA, 2015a). Building trust and credibility is key to conducting research in a contested space and ensuring that all stakeholders perceive the institution to be independent.

Access to information from all stakeholders becomes important for communities. For example, government information on plans, programs, policy, and monitoring mechanisms are important to stakeholders. Similarly, transparent and timely information from gas proponents is also necessary so that individuals and communities can respond accordingly. However, there is a need for the cumulative impacts and plans of government organisations, various gas proponents, and other stakeholders to be collected and compiled, made publicly available via an easily accessible format or service, and kept up-to-date to enable communities to better plan and respond to change. To partly address this need, the UQ CCSG is presently developing a set of key indicators for cumulative socio-economic impacts of coal seam gas development (UQ CCSG, 2015).

Despite its importance accessing information is only one step in creating effective relationships with the industry. Moreover, communities in their quest for information may also be indicating a need to ‘be heard’ or ‘listened to’, highlighting the importance of two-way communication that is underpinned by relationships based on trust and respect (Williams and Walton, 2013). The activities and interactions that form these relationships can broadly be grouped into community engagement.

4.2 Governance

Policy

Policy and regulation are important components of managing risk and building trust among stakeholders. Different levels of government develop policy in response to different political perspectives and aim to satisfy different social and economic objectives (Rahm and Riha, 2014). Adaptive management has emerged as a decision making framework for the management of many of our natural resources including water and land management, and appears to be the approach adopted in those areas of Australia with significant onshore gas development underway (Queensland Government, 2014; Victorian Government, 2013). Adaptive management is described as “a structured, iterative decision making process that can be well suited for environmental management challenges in which decisions are made in the context of significant uncertainty, limited scientific experience, and conflicting agendas of multiple stakeholders.” (Rahm and Riha, 2014, p 1401). It is essentially a learning-by-doing approach (de Rijke, 2013). However, for this approach to be effective multi-level processes of continuous improvement are required. Stakeholders need to agree on matters of risk and the issues at hand, roles of various levels of government need to be defined, understood and respected, and ongoing monitoring and analysis with subsequent adaption of policy and regulation are required. This cycle requires commitment from all stakeholders, and adequate resources (Rahm and Riha, 2014; Swayne, 2012) otherwise adaptive management may become ‘management on-the-run’.

Nevertheless, for many communities adaptive management does not address the uncertainty underpinning their worries and concerns since it is the operation of the industry when issues remain unclear that is grounds for their lack of acceptance; a position seen as going against the ‘precautionary principle’. This sentiment particularly applies to the management of water, which is considered by many as a ‘precious
resource’ in Australia (Mankad et al., 2015). This disparity in alignment between precautionary expectations and adaptive management as an approach to managing the onshore gas industry potentially accounts for many of the issues that are debated in relation to the industry. Communities may feel like they are ‘guinea pigs’ and that too much is ‘at stake’; these views underscore the need for high levels of trust, involvement of the community as an active stakeholder, and strong governance at multiple levels (Walton et al, 2013).

These sentiments have also been identified as important to Australians in their views towards mining more generally. A national study of attitudes to mining (including gas extraction), found that public confidence in governments to legislate and regulate to ensure that the mining industry acts appropriately, is important to the public’s acceptance of the industry. Moffat et al., (2014) found that when people had high levels of confidence in the government to hold the industry accountable they had higher levels of acceptance of the industry. They also found that governance was more important to acceptance when the environmental impact from mining was perceived to be high. Moffat and colleagues suggest that the more a government tries to streamline approval processes for mining the more the public potentially see this as an erosion of the government’s ability to hold companies accountable; thus reducing the public’s faith in the government to ensure that companies ‘do the right thing’, and in turn diminishing public acceptance of mining. The capacity of governments to ensure that companies operate appropriately in combination with fairness in how people feel they are treated and the fair distribution of the benefits all contribute to acceptance of the industry or its social licence to operate. Trust is critical to this process.

**Planning**

All stakeholders are at risk if the changes brought about by onshore gas development are not managed effectively. Not only are the social, economic and environmental aspects of a community potentially affected but also satisfaction with state and local government planning and the commercial operations and performance of gas companies if the social licence from a community is not achieved. Planning, leadership and good working relationships based on trust and respect are fundamental to achieving the changes (Moffat and Zhang, 2014; Schandl and Darbas, 2008; Walton et al., 2014). However, governments and companies operate differently. A case study of an onshore gas development in the Pilbara demonstrated that adverse impacts of the construction phase on the region were still experienced despite upfront planning and awareness of potential impacts and commitment from all parties to respect stakeholders different goals and perspectives (Haslam McKenzie, 2013). This breakdown was attributed to differences in the way that governments and companies operate in terms of timeframes and governance structures. This suggests that not only is good planning required but that the implementation of government and industry plans need to be better integrated in gas development projects. Integrated implementation matching the time frames and cumulative impacts of the new industry entails adequate resources, capabilities and capacities for the various agencies to implement the required infrastructure to meet the unfolding needs at the time it’s needed, for example, with respect to housing and roads. Alternatively, new governance structures may be considered like the Western Downs Housing Trust; however, any existing or new structures need to be responsive in the context of a rapidly developing onshore gas industry, especially for projects with longer lead times like additional housing and upgrading roads.

Planning for onshore gas development needs to cover the construction, operation and closure phases. Most of the activity from onshore gas development occurs during the construction phase, and planning may initially be focussed on this stage. However, planning for the construction phase also needs to incorporate planning for the drop in activity in the operational phase to avoid over investment in some areas like housing and facilitate more flexible strategies like temporary housing solutions. Some other investments like road upgrades or community infrastructure investments may leave lasting legacies which may serve to offset some unavoidable impacts in the construction phase. However, the most beneficial legacy projects should aim to building legacy projects building community capacity and regional infrastructure for the longer-term, including after the closure of onshore gas projects.

In particular, the pace and scale of the development has been identified as contributing to risk particularly in relation to water (Rahm and Riha, 2014) creating challenges for the many layers of governance surrounding the unconventional gas industry as policies to manage unfolding risk evolve. In a critical review
of water resource risk in the Marcellus Shale, Rahm and Riha found that although some risk can be reduced through policy and best practice other uncertainties are best addressed by research, assessment, and planning prior to gas development commencing. They identify the importance of monitoring and the need for data collection before activity begins, to provide a baseline, suggesting that data collection activities should commence during the planning phase. This type of monitoring requires appropriate resources for the governing agencies and emphasises the importance of adequate planning. Arguably the costs should be shouldered by stakeholders profiting from gas (e.g., gas companies and state governments). Further, there is no point in identifying problems through monitoring if processes and means for redressing them are not established, even if the evidence emerges well into the future. Complaints and compliance units allow the community as active stakeholders in the development to be part of the monitoring process.

4.3 Communities as active stakeholders

Local communities affected by coal seam gas need to be recognised as active stakeholders in any large scale development within their communities. When people are involved in the developmental process they are more likely to be happy with the process and then more accepting of the outcomes, even negative outcomes. In contrast, when the public feels excluded from the process they are likely to resist. A study of coal seam gas protesters has shown that the early community concerns were about inadequate community consultation, which later translated into fears regarding potential impacts on farmland and cumulative impacts on aquifers and future water supply. In addition, the economic, social, and environmental benefits of the industry were questioned. The protests can now be described as a social movement with a national debate linking community groups across and beyond Australia (Lloyd et al., 2013).

The reaction of the Queensland LNP Government seems to have further marginalised the public and local communities in their efforts to reduce ‘red’ and ‘green tape’ (Queensland Government, 2013). Comprehensive Social Impact Management Plans are no longer required for new operations in favour of more flexible guidelines (de Rijke, 2013) and only people directly affected by a mine are allowed to object in Queensland’s Land Court (ABC News, 2014). However, the coal seam gas companies are moving in the other direction, now working better with communities including supporting more active Community Consultative Committees, better controlling their employees’ behaviour, and offering more compensation for farmers. Coal seam gas employees volunteering in the community and the companies using their own resources to provide crucial help such as natural disasters increase their acceptance in areas that they operate (Williams, R. and Walton, 2014).

There are important differences within and between communities that suggest that a ‘one-size fits all’ solution is not going to successfully address the diversity of community concerns. Rather solutions need to be tailored to community segments and where necessary individuals within communities; for example a land owner negotiating with a gas company for access and compensation to his or her land. This need for a tailoring of solutions underlines the importance of community engagement, recognising that the ‘community’ is not a single and homogenous voice. Engaging successfully with diverse community segments is challenging and resource intensive but absolutely necessary for any new industry wishing to operate successfully within communities with pre-existing local economies and social mores. Well-staffed and resourced, community and regional development organisations that are independent from the coal seam gas industry and State government with capabilities to support local interests and build local capacities are one way to assist all sectors to act on their concerns. Once engaged with the issues, local communities can collaboratively develop additional ideas.

Any new systems of community engagement need to take into account the power imbalances between local communities and other stakeholders (e.g., gas companies and state government). Local communities and the general public are more likely to be reassured if they can see that more powerful stakeholders are taking their interests into account. Thus, the introduction of an unconventional gas industry needs to focus on good processes including community involvement in planning and decision-making, clear systems of monitoring and control, baseline measures, and systems for addressing complaints.
5 Conclusions

The review of community perceptions of on-shore gas development identified six main topics of public interest: water quality and quantity, health, the landowner, local infrastructure, economic effects, and community changes. These diverse topics reflect the breadth of the changes that occur when an onshore gas industry is developed. Regardless of the topic however the steps to address community concerns are similar. Communities want good planning, independent scientific knowledge of the likely effects of the industry, and careful monitoring of base-levels and any changes due to the industry so that either problems can be avoided or so industry, government, and communities can work together in addressing them. So, for community segments who are concerned about contentious issues such as hydraulic fracturing, they would need reassurance, not only, that there is clear scientific evidence that hydraulic fracturing does not necessarily have long term effects on the water table, but also, that monitoring is in place to ensure best practice, and that it is possible to remedy any problems that are identified in the future. Furthermore, communities want to be kept fully informed and “at the table” as acknowledged stakeholders when key decisions are made so local planning can be synchronised with industry developments.

The review also identified important differences in perceptions that arise from both different interests among community segments and different stages in the development. Thus it cannot be assumed that all Victorian communities would react in similar ways and that these reactions would stay stable throughout an unconventional gas development. The most stable views could be expressed either by those who strongly support the industry primarily because of the potential for economic growth from the industry itself or by those who oppose the industry due to the environmental risks and/or a commitment to renewable energy. However, most will be somewhere in-between. For others their attitude would depend more on their experiences, for example, farmers might receive more, or less, compensation than they expected for access to their land; local tradespeople might expect a boost to their businesses and be disappointed if larger more distant contractors are used or local trades may experience strong growth but be unprepared for the downturn at the end of the construction phase; local residents might be overwhelmed by the number of “glowworms” wearing high vis apparel in their town in the construction phase but then find their town settles down during the operations phase in ways that benefit from new residents. Because the operations stage is just commencing in the onshore gas fields in Queensland, there is as yet no Australian data on community reactions to this phase and certainly nothing about the closure phase. Caution would be needed in extrapolating from closures of other types of mining because of the distinctive way in which coal seam gas extraction co-exists with agriculture and other industries.

Although this review has produced some useful insights there is a clear need for specific studies of Victorian community perceptions. Our review has depended principally on studies in the US and the gas fields in Queensland, which may not directly translate to Victoria. Furthermore, as political debates surrounding onshore gas become more forceful, even recent results would need revisiting.

One particular issue for Victoria might be the location of gas reserves close to iconic tourist destinations. There seems no doubt that the construction phase with greatly increased road traffic, noise, dust and other signs of industry and also the potential shortage of accommodation could be detrimental to the tourist industry. In the operations phase, road use and demand for accommodation decrease and problems associated with an industrial landscape could potentially be ameliorated with regulation of the location and visual screening of industry sites.

Another consideration is the distance from the city to the gas fields. Closer proximity encourages DIDO (drive in drive out) arrangements rather than workers moving to the local region, including use of larger city based sub-contractors, thus local communities may lose stimulation to the local economy that comes with increased population and the sub-contracting of local tradespeople, but they also potentially avoid some of the problems in the construction phase associated with soaring house prices and overwhelming demands.
on local services. There needs to be a balance between DIDO arrangements; providing local housing, infrastructure and services; and enhancing local opportunities and capacities to benefit local communities.

A third key dimension for Victoria is whether the gas is principally for local use or export as the carbon footprint and infrastructure footprint are greater for LNG production and export than pipelines for domestic gas use. Whereas gas production in the US is for domestic consumption and reduces the import of petroleum, gas production in Australia to date has been principally for export. If gas production in Victoria were for the domestic market, then further research would be useful to see whether the end-use for the gas is important for broader Victorian community perceptions of unconventional gas development.

Finally we note that it takes time to implement the good planning, independent scientific knowledge, careful monitoring, and consultation that communities need to minimise any negative consequences and maximise the benefits of the industry. The timeframe communities require for reassurance is likely to be at odds with the timeframe that the industry might demand for commercial reasons. Much has been learnt from the Queensland experience which can assist Victorian decisions but there will be continual hard decisions with competing interests in on-shore gas development.
References


GasLand. (2010). Director Josh Fox, HBO Documentary Films, International WOW Company


http://www.marcellus.psu.edu/resources/PDFs/tncenergy.pdf


Parliament of the Commonwealth of Australia (2012). *Environment – Coal seam gas mining* (Journals of The Senate No.87 Thursday, 22 March 2012). Accessed 28/01/2015 Australian Government website: http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;adv=yes;db=CHAMBER;id=chamber%2Fjournals%2F20120322%5BS087%2F0033%3AorderBy=customrank;page=0;query=landholders%2Bright%2Bto%2Brefuse;rec=0;resCount=Default


Review of community concerns about onshore gas development

YOUR CSIRO
Australia is founding its future on science and innovation. Its national science agency, CSIRO, is a powerhouse of ideas, technologies and skills for building prosperity, growth, health and sustainability. It serves governments, industries, business and communities across the nation.

CONTACT US
 t 1300 363 400
   +61 3 9545 2176
 e enquiries@csiro.au
 w www.csiro.au

FOR FURTHER INFORMATION
CSIRO Land and Water
Andrea Walton
 t +61 7 3833 5675
 e andrea.walton@csiro.au

Energy/Onshore Gas
Jane Hodgkinson
 t +61 7 3327 4118
 e jane.hodgkinson@csiro.au