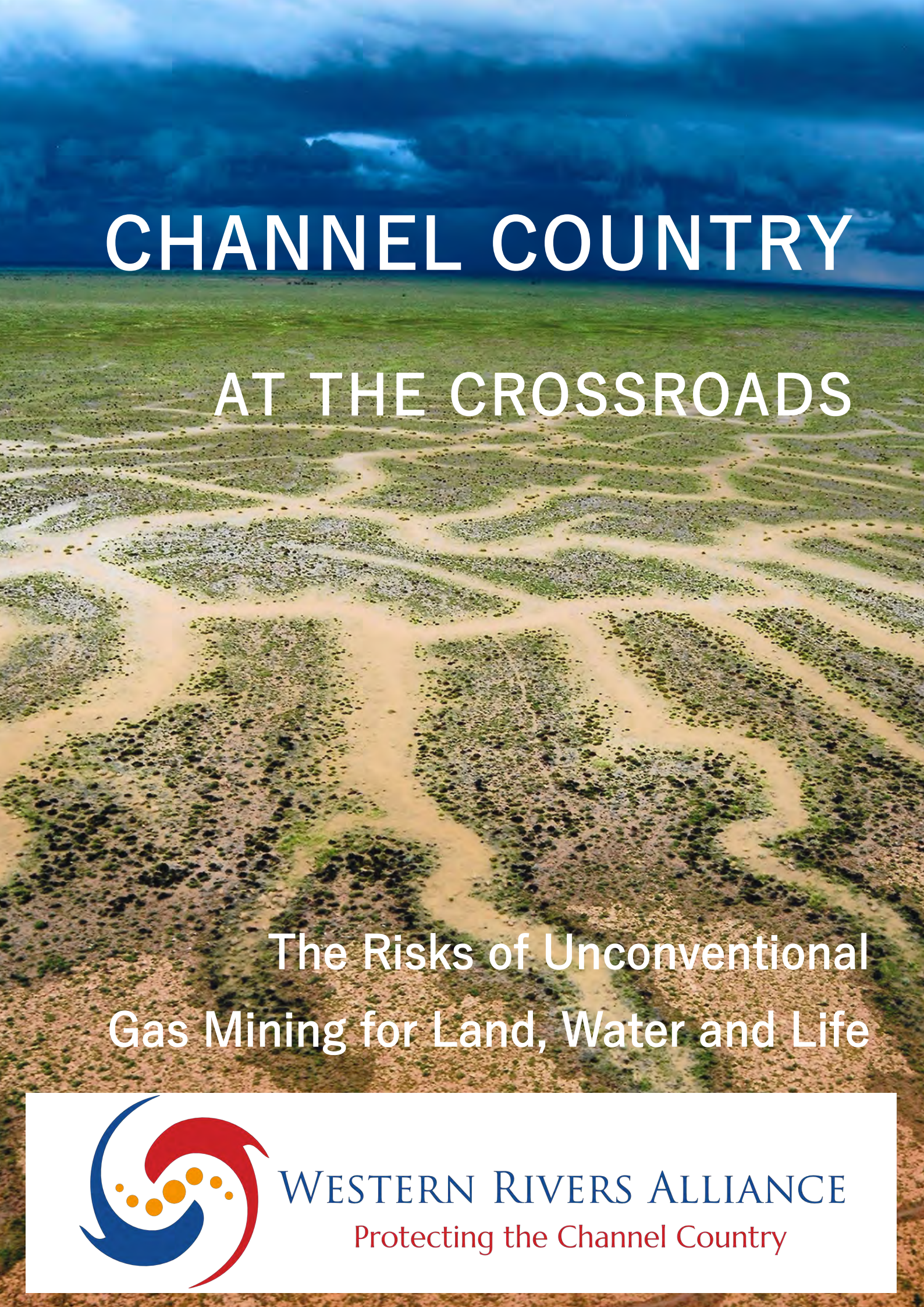

CHANNEL COUNTRY

AT THE CROSSROADS

The Risks of Unconventional Gas Mining for Land, Water and Life

WESTERN RIVERS ALLIANCE

Protecting the Channel Country

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Western Rivers Alliance acknowledges the Traditional Owners of Lake Eyre Basin.

Cover photo credit: Helen Kidd

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Dr Bob Morrish

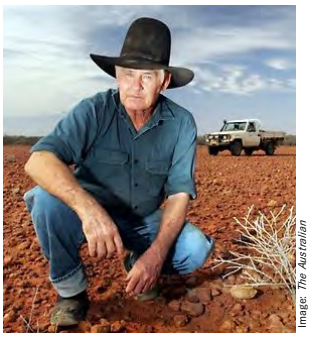

Image: *The Australian*

The Channel Country's rivers and wetlands and their surrounding landscapes have long been recognised for their ecological, scientific, aesthetic and cultural values, and for their superb natural contribution to a clean and green extensive pastoral industry.

They form the northern and eastern catchments of the Lake Eyre Basin, the last great unregulated and unpolluted desert river system – a magnificent and vast region of natural beauty in a world where nature has shrunk alarmingly as a consequence of human industrialisation, urbanisation and over-population.

Within the past 50 to 60 years, however, the hitherto largely undisturbed landscapes of the Channel Country have undergone continual encroachment by oil and gas exploration and production. This activity has so far been chiefly focused in the Cooper Creek floodplains and surrounding desert of northeast South Australia and far southwest Queensland.

CONVENTIONAL OIL AND GAS MINING IN THE CHANNEL COUNTRY

Pastoralists and scattered communities in the Cooper Creek Channel Country and the desert catchments of Lake Eyre are no strangers to the *conventional* oil and gas industry tapping the Cooper and Eromanga geological basins.

There have been disturbing incidents. The Santos Zeus Field oil spill of 2013 made national headlines, and the alarming Moomba explosion and fire of 1982 in the 'Corner Country' has become something of an Outback legend.

Oil and gas exploration and production have introduced an extensive spider web of roads, seismic lines, wells, pipelines and associated infrastructure to the Outback. A night flight over the region reveals a vast array of lights from the major production fields such as Moomba, Jackson and Ballera and numerous satellite fields. Seen from altitude in daylight, the regular crisscrossing of seismic lines is a stark contrast to the natural patterns of this landscape shaped by the actions of wind and water. Only the great distances between installations allow the natural landscapes for the most part to reassert themselves when viewed from ground level.

For the most part, the industry has generally coexisted with Outback communities, but this varies according to circumstances and the individuals involved.

Whether they are prospectors, miners or resource companies, non-pastoral leaseholders rarely seem concerned about their impacts on the surface but their activities can have far reaching consequences for sheep and cattle producers – and Traditional Owners. Important cultural sites have been damaged and even obliterated because no one was around to intervene when a seismic line was inadvertently bulldozed through an area of cultural significance.

FOREWORD

Coexistence with the oil and gas industry means the pastoralist has to learn to accommodate large volumes of traffic on property roads as well as the persistent presence of resource company personnel who are often strangers. However, it must be acknowledged that resource companies with permanent facilities on pastoral land often compensate for their intrusion with helpful assistance, such as access to water wells and supply of used materials such as drill stem, a valuable material for building stockyards.

Nothing, however, can compensate for damage to ecosystems or landscapes. The seismic exploration phase, involving disturbance to soil and vegetation over a large area, is often more disruptive to pastoral operations and sustainable land management than well drilling and eventual production, which are confined to specific locations. It takes a long time for native vegetation to recover. Many seismic lines cut before environmental codes of practice were established are now irreversibly eroding. Over time, creeks, channels and waterholes can accumulate huge amounts of erosion sediments carried along by the rare storms and the 'boom' season runoff. This reduces waterhole capacity and habitat values critical to life during the long 'bust' seasons.

The expansion of the *unconventional* oil and gas industry into the Channel Country is a relatively new development. It is becoming increasingly apparent that the proliferation of new oil and gas fields in the region will detract from its natural values. The proposed exploitation of shale and tight gas is particularly alarming. It is vital that residents of the region familiarise themselves with the potential scale of this new industry, its inputs and unconventional techniques such as hydraulic fracturing (fracking), so as to understand the risks for scarce water resources, vast floodplains and the natural ecosystems on which life and sustainable human industry depend.

This report outlines and summarises the nature and impacts of the unconventional gas industry and its likely effects on the Channel Country. It draws on the experiences of affected communities in the United States, where

UNCONVENTIONAL GAS MINING IN THE CHANNEL COUNTRY

unconventional gas exploitation is large-scale and has a much longer history than here in Australia, and puts it into a Channel Country and wider Lake Eyre Basin context.

The report also draws on the experience of Queensland communities where the coal seam gas industry has been established for about a decade. Readers will find disturbing parallels, and may be alarmed by the implication that extraction of deeper unconventional gas resources and more frequent use of fracking will pose even greater risks to the surface and underground water resources which are critical to the arid regions of the Lake Eyre Basin.

Earlier threats to the ecological integrity and pastoral sustainability of the Channel Country – in the form of a large irrigated cotton farm proposal for Cooper Creek – were met with fierce resistance from Channel Country pastoralists and local residents, allied with scientists, conservationists and concerned Australian citizens. An enlightened decision by the Queensland Labor government in 1999 prohibited any such large-scale irrigation development. Further levels of protection were provided by the *Wild Rivers Act 2005* and by wild river declarations for the Cooper, Diamantina and Georgina-Eyre Creek systems in 2011.

It is significant that the Wild Rivers Act was the only statute in Queensland that could not be overridden by the Coordinator General under the *State Development and Public Works Organisation Act 1974.* It should also be noted that there was extensive community consultation and an extremely high level of local landholder support for the Channel Country's wild river declarations.

The wild river declarations afforded strong protection against *any* development threatening the ecological integrity of the rivers and their associated floodplains and wetlands, while allowing some developments to continue as appropriate to the conditions in less sensitive areas. Sadly, the protection was short-lived.

FOREWORD

In the lead up to the 2012 Queensland election, LNP Leader Campbell Newman signalled his intention to revoke the Wild Rivers declarations over Cape York Peninsula where Traditional Owners opposed their listing. It wasn't until late 2013 that the new government revealed its plan to revoke the Channel Country declarations as well.

Resources Minister Andrew Cripps then vigorously promoted an unconventional oil and gas industry in the Channel Country, releasing *A Framework for the Next Generation of Onshore Oil and Natural Gas in Queensland* in July 2014 and the *Cooper Basin Industry Strategy* in December 2014. New and much weaker legislation was introduced to allow the oil and gas industry almost unfettered access to our cherished rivers and floodplains. A raft of legal amendments, notably including the *Water Act 2000,* ensured speedy assessments, a minimum of red tape and the rapid granting of licenses and approvals.

In spite of pre-2015 election promises by the now Labor government of Annastacia Palaszczuk to restore wild river type protections, current Resources Minister Anthony Lynham has granted even more concessions to the oil and gas resources industry in the form of 11,000 square kilometres of new exploration licences in the Cooper and Eromanga basins beneath the Channel Country. Some, but not all, of the worst of the LNP's legislative amendments have been 'wound back', but the government has not yet fulfilled its promise to protect our rivers.

It is noteworthy that there has been something of a 'revolving door' between senior government and party officials and highly placed resource industry executives in Queensland. Much of the process described above took place when this cross-fertilisation was in full swing. Significant political donations and payments for access to ministers were also being made by minerals and energy resources companies during this time. Both sides of politics were involved.

The risks identified in this report make the reinstatement of legislative protection for the natural values of the Channel Country a matter of urgency.

Dr Bob Morrish has spent 40 years living and working in the Channel Country. He chaired the Cooper's Creek Protection Group for 19 years and is an active member of the Western Rivers Alliance.

ABOUT THIS REPORT

This report is the result of a literature review undertaken between late 2015 and mid 2016 by Western Rivers Alliance coordinator Sarah Moles. Pastoralist Dr Bob Morrish contributed the foreword, and Angus Emmott, pastoralist and chairman of the Lake Eyre Basin Community Advisory Committee, wrote the section on the Lake Eyre Basin. The document was edited by science writer Dr Carol Booth. Spatial analysis, GIS assistance and mapping was provided by the Centre for Conservation Geography at the University of Newcastle, NSW.

The number of independent peer-reviewed studies on various aspects of the unconventional gas industry has increased dramatically in recent times. However, because the industry in Australia is relatively new, information is limited about the impacts here, particularly for shale and tight gas mining. The report draws mainly on Australians' experiences with coal seam gas mining, which has been occurring on a large scale over the past decade, and on data from the United States, which has had a large-scale, intensive shale gas industry in the Barnett shale basin in Texas for close to 20 years. The literature identifies a number of research gaps that are as relevant to Australia as they are to the United States.

This report also examines the Queensland policy context and provides comment on the economic and employment costs and benefits of unconventional gas mining to regional communities. Finally, steps needed to ensure long-term protection of the Channel Country's most previous natural resources are identified.

Several other related reports are under-way or planned. In preparation is a detailed assessment of the vulnerability of the Channel Country's water sources to large-scale unconventional gas mining. A guide for landholders about managing the risks to pastoral businesses is being produced on the basis of specialist legal advice obtained by Western Rivers Alliance about the inadequacies of insurance policies maintained by gas companies.

The Western Rivers Alliance also plans to examine the value of the beef industry in the Channel Country, options for value-adding, and alternative regional income-generating strategies that are compatible with existing, sustainable pastoral and tourism enterprises.

INTRODUCTION

The Channel Country is an iconic part of the Australian Outback. From the ill-fated Burke and Wills expedition to some of our best loved novels, songs, poems and artworks, Outback Australia's remoteness and rich heritage have become embedded in our national psyche. Although most Australians have never visited the Outback, it is a defining feature of our continent and informs our national character.

The Channel Country's rivers weave their way through western Queensland's vast deserts, stony gibber plains and almost limitless ephemeral swamps. They are among the last untamed rivers and they bring life to the dry heart of Australia. Below the sublime landscapes of the Channel Country lies the Great Artesian Basin, the only reliable source of water across 22% of Australia. Deeper still lies the Cooper Basin, rich in fossil fuels. Conventional oil and gas have been extracted from the Cooper Basin, mostly safely, for many decades.

As conventional fossil fuel resources deplete world-wide, the oil and gas industry has turned to the more difficult to extract unconventional fossil fuels. Unconventional gas mining is considered 'extreme' because of the high costs, scale of other resources required including water, its impacts on aquifers and the other techniques involved that negatively impact on the environment.

The purpose of this report is to provide a summary of the literature examining the impacts of the unconventional gas industry so as to assess its likely risks to the outstanding values of the Channel Country.

The revocation of the Channel Country's Wild Rivers Declarations and the repeal of the *Wild Rivers Act 2005* removed the certainty of river protection many pastoralists in the region had sought for almost two decades. Pre-election commitments by then Opposition leader Annastacia Palaszczuk to restore such protections were welcomed, but then dashed. In May 2015, the newly appointed Minister, Anthony Lynham announced that new areas of the Channel Country would be put out to tender for unconventional gas exploration.

In response to this announcement, Western Rivers Alliance members travelled through western Queensland during the winter of 2015. The purpose of this journey was to engage with pastoral communities and raise awareness of government plans to exploit unconventional deep oil and gas resources. During this visit it became clear that the differences between conventional and unconventional gas mining were not well understood in the general community. A need for practical tools became apparent.

This report is the first of those tools.

ABOUT THE WESTERN RIVERS ALLIANCE

In 2010 the Australian Floodplain Association initiated a process that led to the formation of a unique alliance between Channel Country pastoralists, conservation organisations and scientists with interests in the Lake Eyre Basin. This group became known as the Western Rivers Alliance (WRA).

The Western Rivers Alliance became a member of the Lake Eyre Basin Rivers Advisory Panel, which was formed by the Remote Area Planning and Development Board. Western Rivers Alliance membership recently expanded to include the Mithaka Traditional Owners, advocacy groups and environmentally-aware individuals concerned about the expansion of the unconventional gas industry into fragile Outback environments.

The Western Rivers Alliance advocates for protection of the rivers, floodplains and associated surface and underground waters of the Channel Country region. We believe the most effective way to do this is to restore protections such as those previously afforded by Queensland's *Wild Rivers Act 2005.*

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AUSTRALIA'S UNCONVENTIONAL GAS INDUSTRY

Australia possesses large reserves of unconventional gases – in coal seams (coal seam gas), shale rocks (shale gas) and dense sandstones (tight gas).[1] Unconventional gas differs from *conventional* gas in two key ways. Firstly, it is not found in a convenient and readily accessible rock reservoir but is spread thinly through rock layers. Secondly, it requires new, specialised (unconventional) techniques to extract it. These include horizontal drilling and hydraulic fracturing at very high pressure. It also generally requires thousands of densely spaced wells, vast networks of roads and pipelines, compressor stations, processing plants, wastewater holding dams and treatment plants. Unconventional gas extraction can lead to the industrialisation of entire landscapes.

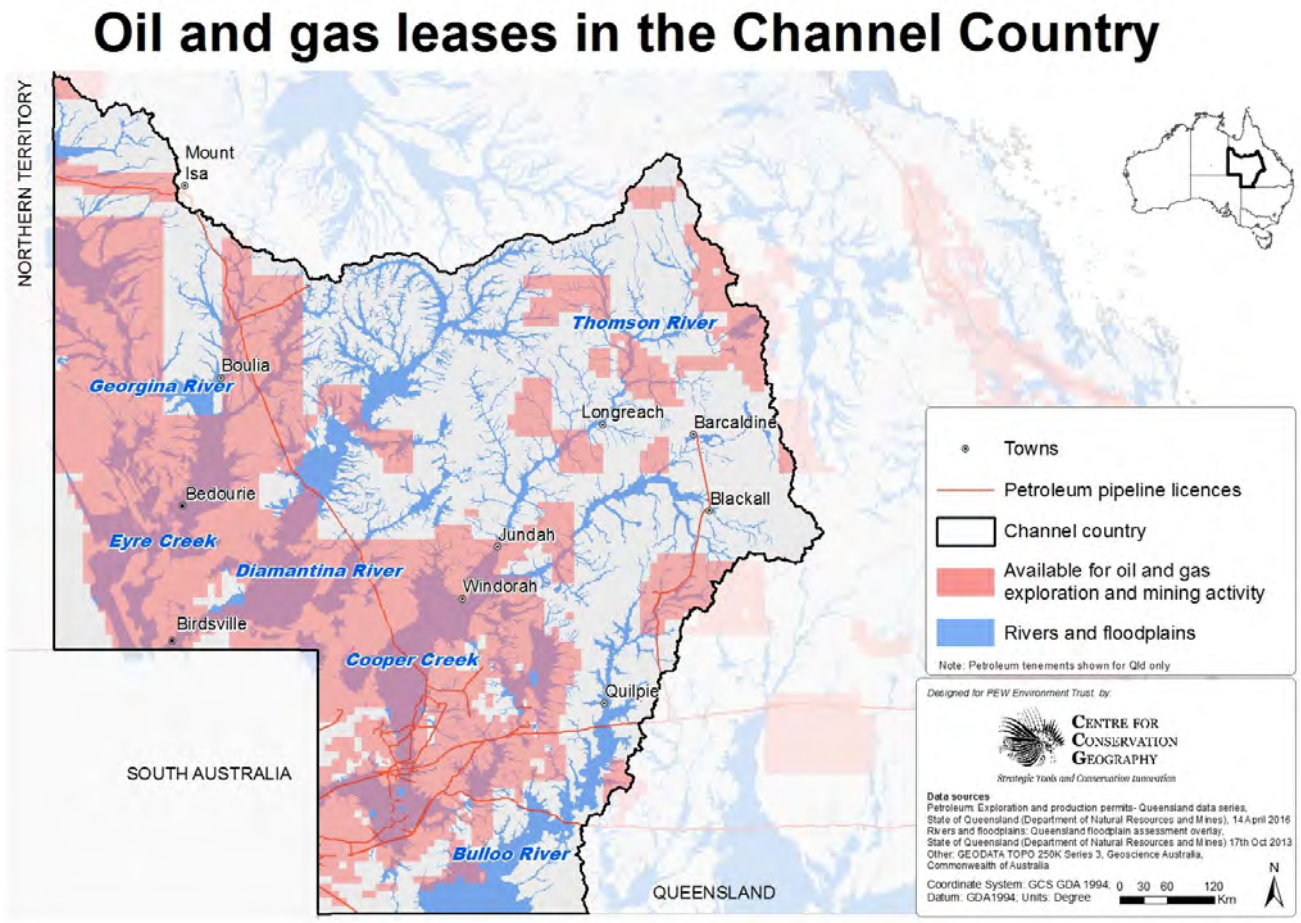
The Australian Petroleum Producers and Exploration Association estimates the Australia has CSG reserves totalling 203 – 235 trillion cubic feet.[2] The coal seam gas (CSG) industry is well established in Queensland, and CSG – in the form of liquid natural gas (LNG) – is being exported from Gladstone to Asian markets. The US Energy Information Administration has estimated that Australia could have up to 396 trillion cubic feet of shale gas. At current production rates, this is equivalent to about 185 years of total Australian gas production.[3]

The Australian Council of Learned Academies (ACOLA) is an independent, not-for-profit organisation that supports evidence-based interdisciplinary research. More than 2,000 of the nation's most eminent scientists, researchers, scholars and practitioners contribute to the ACOLA forum where Australia's four independent Learned Academies – Australian Academy of the Humanities, Australian Academy of Science, Academy of Social Sciences in Australia and Australian Academy of Technology and Engineering – come together to contribute to inform national policy and to develop innovative solutions to complex global problems and emerging national needs.

According to ACOLA, there are important differences between coal seam gas and shale gas mining. Shale gas wells are generally deeper – 1000-3000 metres compared to 300-1200 metres for CSG wells – and almost all shale gas wells require fracking, compared to 10-40% of CSG wells. Although shale gas mining produces smaller volumes of waste water, it is more saline, with more than three times the salt concentration of seawater. This and potentially harmful chemicals used in the fracking process limit the potential to treat and reuse this water.[4]

Like shale gas, tight gas is generally found at greater depths than coal seam gas and almost always requires fracking. A commercial unconventional shale and tight gas industry in Australia is almost a decade away, with the industry still in an exploration phase.[5,6] Companies have established in the major unconventional gas basins, but the focus of their current work appears to be proving up their reserves, understanding the nature of the gas resources, and perfecting the technology.

The scale of unconventional gas resources in Australia, including in the Cooper Basin:



The Channel Country bioregion in Queensland showing former Wild Rivers areas and current unconventional gas exploration tenements.

Queensland CSG field, 2015. *Photo: Sarah Moles*

Unconventional gasfields transform natural and productive agricultural landscapes into industrial zones. Wyoming. *Photo: EcoFlight*

UNCONVENTIONAL GAS MINING IN THE COOPER BASIN

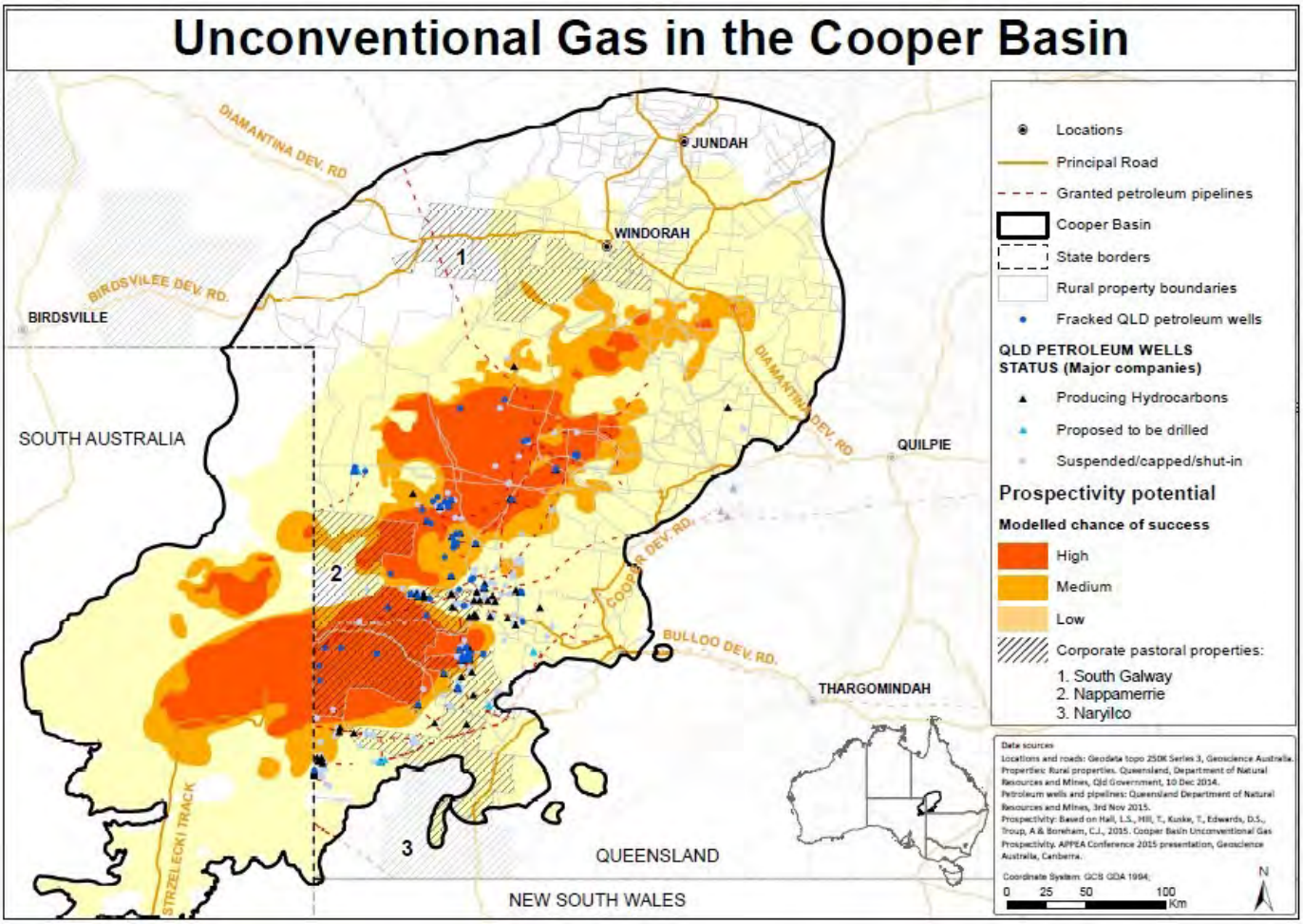
The Cooper geological basin spans about 130,000 square kilometres in south-western Queensland and north-eastern South Australia. It encompasses the Cooper Creek and Bulloo River catchments, and includes a small portion of the Diamantina and Georgina catchments. It underlies part of the Great Artesian Basin and part of the Lake Eyre Basin.

The Cooper Basin is recognised as a world class hydrocarbon province and the conventional gas industry is well established in both states. Gas (and oil) have been extracted from the Cooper Basin since the 1960s, particularly from the Nappamerrie Trough, which straddles the Queensland–South Australian border.

Unconventional techniques are now being used in the Cooper Basin and exploration is expanding. Geoscience Australia is conducting research to better define the nature and extent of its unconventional gas resources. The Australian Council of Learned Academies has estimated that the Cooper Basin could support more than 9,000 shale gas wells.[7]

Shale gas production rates decline very rapidly, about 60-80% in the first year.[8] This means more and more wells must be drilled each year to maintain production levels, fulfill pipeline contracts and satisfy shareholders. Within the gas industry this is known as the 'red queen' effect.

Since 2010, 36 wells have been drilled into unconventional gas reservoirs in the South Australian section of the Cooper Basin. Seventeen have been fracked and produced gas, but only one, Moomba 191, is connected by flowline to the Moomba processing plant and can be considered commercially productive. Another 16 wells have been temporarily flared for testing and evaluation.[9] It is unclear whether they were fracked. The status of the other three wells is unknown.



The Cooper basin in Queensland and South Australia, indicating the most prospective areas for unconventional gas extraction.

THE LAKE EYRE BASIN AND THE CHANNEL COUNTRY

A summary of the attributes and environmental values of the Lake Eyre Basin catchment and Queensland's Channel Country bioregion.

LAKE EYRE BASIN

The Lake Eyre Basin is the heart of Australia and covers 1.2 million square kilometres, about one sixth of the Australian landmass. Its natural, scientific and cultural values are globally significant. It is one of the last desert river systems on Earth that runs free and remains relatively unchanged by industrial interventions.[11]

This vast, remote area is characterised by extremes, and epitomises the idea of Australia as a land of drought and flooding rains. Tropical depressions deliver torrential downfalls to the headwater regions that flood the creeks and rivers. Weeks later, these floods spill over onto the expansive plains and fill gigantic wetlands. Sometimes, the water reaches Lake Eyre. On average, a large volume of water - 20 cubic kilometres or more - flows into Lake Eyre about once every 20-25 years.[12]

The explosion of life that follows is one of nature's remarkable spectacles. River-flows in the Lake Eyre Basin are extraordinarily variable. Cooper Creek and the Diamantina River have the most variable flows of any rivers in the world. They experience occasional massive floods and long periods of very low flows or no flow.

Natural Values

Much of the wildlife in the Lake Eyre Basin is adapted to exploit the rare 'boom' seasons that punctuate the much longer 'busts'. The few persistent waterholes are oases for aquatic life and the refuges from which the system is re-colonised the next time floodwaters arrive.

Eighty species of water birds have been recorded in the region. At times waterbird numbers are double or triple the populations in the Kakadu wetlands. The basin supports 35 native fish species, at least three of which (including the critically endangered red-finned blue eye) are found nowhere else. Fish populations are considered to be remarkably healthy. There are also 35 native frog species, three or four of which are unique to the region.

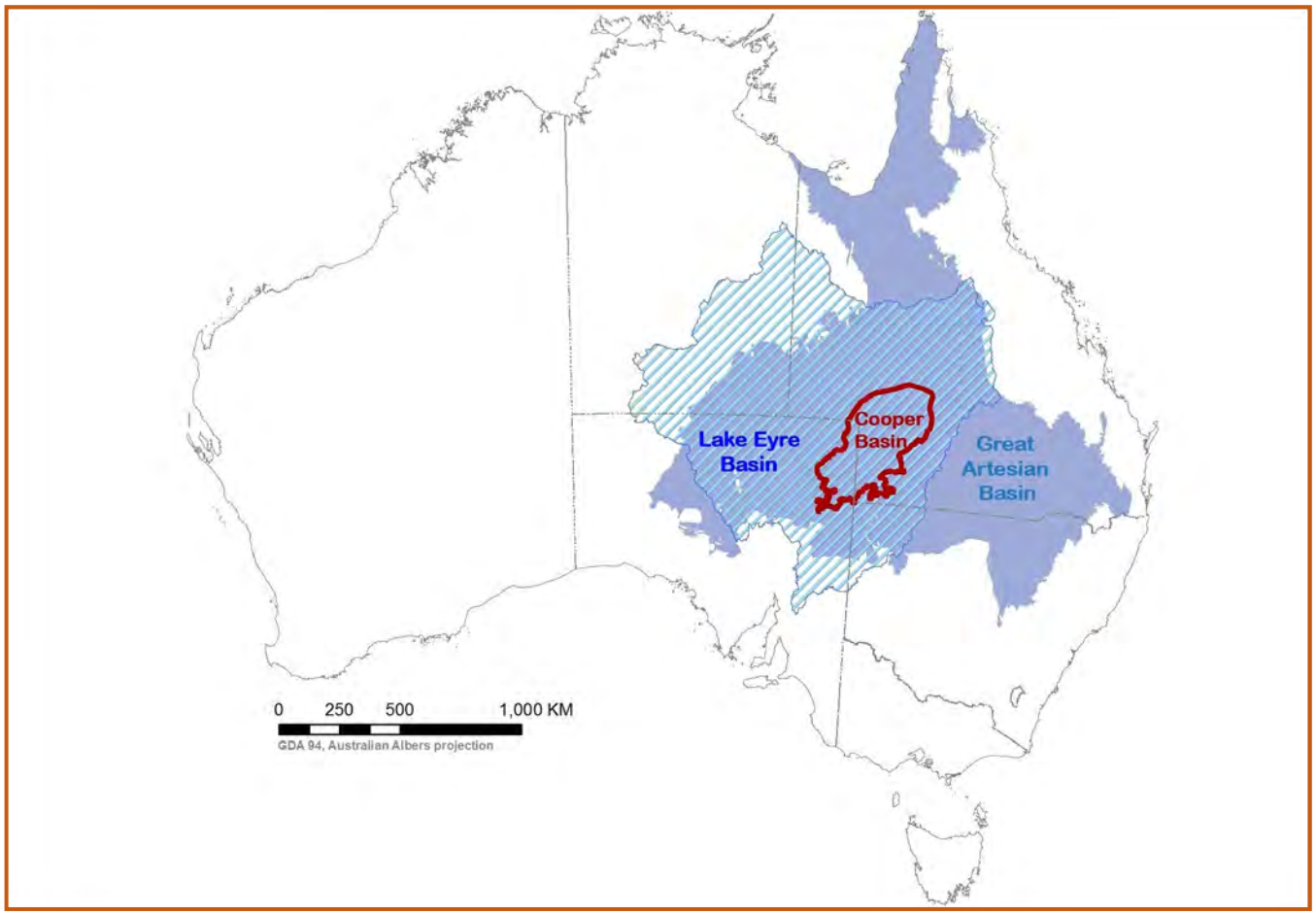
Two wetlands in the basin – Coongie Lakes and Lake Pinaroo – are recognised as Ramsar wetlands of international significance and 53 are listed as nationally important.

Due to the relatively undisturbed state of the Lake Eyre Basin, natural habitats are considered to be in good condition. Nevertheless, a total of 148 native plant and animal species are listed as threatened. [13]

Of 148 sites in the Lake Eyre Basin listed on the National Heritage List, 77 are recognised for Indigenous heritage, 21 for historic heritage, and 45 for natural values.

The world heritage values of the South Australian section of the Lake Eyre Basin were assessed in 1995. [14] The assessors concluded that Lake Eyre and the Cooper and Warburton drainage systems "are of sufficient importance to be assessed against World Heritage criteria". But the local community was not in favour of this, so no further action was taken.

The Lake Eyre Basin community was recognised in 2015 for its work in protecting the basin's values by being awarded the International Thiess Riverprize.



Lake Eyre Basin in relation to the Great Artesian Basin. The Cooper geological basin lies underneath the Great Artesian Basin.

People and Land Uses

About 60,000 people live in the Lake Eyre Basin. The most populous area is around Alice Springs, with about 26,000 inhabitants.

Most of the Lake Eyre Basin is pastoral leasehold (71%), and 12% is freehold. National parks and reserves cover about 10%, but some land under other tenures is also managed for conservation. Crown land covers about 5% and Aboriginal land about 2%. Grazing accounts for 82% of land use, and conservation for 11%.

Since 2000 the Lake Eyre Basin has been the subject of an intergovernmental agreement, with a ministerial forum comprising the Queensland, South Australian and Northern Territory government ministers and chaired by the federal environment minister facilitating a cooperative management approach. The aim is to develop policies and strategies about water and natural resources that avoid adverse cross-border impacts.[15] A community advisory committee and scientific advisory panel provide advice regarding research, policies and management.[16,17]

There is a wealth of literature about the Lake Eyre Basin. For those interested in learning more about its history, geography, natural resources, human activities, governance and scientific research, a list of further reading is provided on page 41.

THE CHANNEL COUNTRY

Most of the water that flows towards Lake Eyre falls as rain in the upper catchments of the Georgina and Diamantina Rivers and the Thomson and Barcoo rivers which combine to form the iconic Cooper Creek. These desert river systems are known as the Channel Country bioregion. It is remarkably flat, and the extensive floodplains cover about a third of the bioregion. Rainfall is scarce (the median is 168 millimetres/year) and unpredictable over the floodplains.

Natural Values

The rivers, waterholes, wetlands and floodplains of the Channel Country are of high conservation value. The desert wetlands complex is globally outstanding for the area of inundation and condition.[18] Seventeen wetlands are recognised as nationally important.

The bioregion is important for supporting many rare species, including the elusive night parrot *(Pezoporus occidentalis*). A total of 55 animal and 67 plant species listed as threatened under state laws, and 21 animal and 19 plant species listed federally have been documented. Twenty-nine bird species listed under international migratory bird agreements have also been recorded in the region.

The Channel Country floodplains are renowned as some of the best cattle-fattening country in the world. Because they rely on floods from rainfall in the upper catchments, good seasons can occur even when there has been little or no local rain. The climate and other factors mean that very few of the pests that plague many other cattle-producing areas are present. This has made possible a lucrative ($500 million/year) clean and green beef industry. Certified organic beef, much of which is exported to Asian, US and Middle East markets, is a growing part of this.

People and Land Uses

The Queensland section of the Lake Eyre Basin covers 509,933 square kilometres. The Channel Country bioregion accounts for 67% or 205,149 square kilometres of this area. For comparison, the state of Victoria covers 237,629 square kilometres.

Some 14,500 people are scattered across this vast, remote area. Longreach (population approx 3,600), is the major regional centre but it is located on the Mitchell Grass Downs, not in the Channel Country itself. The small towns of Windorah, Jundah, Birdsville and Bedourie lie within the Channel Country bioregion.

There is very little freehold land; pastoral leases cover almost all of the bioregion. Grazing is by far the dominant land use and grazing is the major contributor to the regional economy. About 50% of the land area is under a native title claim or indigenous management. National parks cover 21,300 square kilometres or 4.2% of the area while 12,000 kilometres of stock routes provide an important grazing resource for local pastoralists and travelling stock.

Like much of Outback Queensland, the population is ageing and has been in a slow but steady decline since the 1950s. The Channel Country has always been sparsely populated and is currently home to some 2,000-2,200 people. The average population density lies in the vicinity of 1 person per 90-100 square kilometres.

THE RISKS OF UNCONVENTIONAL GAS MINING

The risks of unconventional gas mining to geology, water, soil, human health, livestock and wildlife.

GEOLOGICAL RISKS

Well failures

The primary cause of groundwater contamination from unconventional energy production is well failure through blowouts and well leakage.[19] A range of industry standards for wells exists in Australia and abroad to prevent this and to maximise gas recovery. However, a study of chemical pollution from fracking in Pennsylvania found failure rates in newly drilled shale gas wells was 6.9 to 8.9% over three years.[20] Wells with horizontal underground arms were four times more likely to fail than vertical wells in the same area. Professor Tony Ingraffea, an expert on fracture mechanics from Cornell University, quotes industry figures that 6-7% of shale wells fail initially.[21] He says that over 20 years, 60% of wells fail, and eventually 100% will fail.

High water demand

Drilling and fracking of deep shale gas wells require huge volumes of water. In the South Australian part of the Cooper basin, water for these purposes may be stored on-site in steel tanks (approx 80,000 litres) or in larger (3-4.5ML or 3,000,000 – 4,500,000 litres) excavated earth pits.[22]

The Australian Council of Learned Academies has warned that a fully developed shale gas industry in an arid area has the potential to become a major user of groundwater.[23]

Figures on water use vary widely. The Australian gas industry says 11 million litres of water is needed for each frack in a shale gas well,[24] and each well may be fracked 10-15 times. A UN Report estimated 11 million to 34 million litres per frack (360 to 1100 tanker truck loads).[25] Tony Ingraffea, estimates 20 million litres of fluid per frack, per well. To achieve the necessary fluid pressure of 15,000 pounds per square inch requires the use of 25,000 horsepower pumps.[26]

Water and soil contamination

The composition of fracking fluids depends on the local geology. Water and sand (or ceramic beads) make up the largest proportion with small percentages but a large total volume of chemical additives. They include solvents, biocides (to prevent bacterial action underground), wetting agents (to ease pumping and removal of fluids), gels (to suspend the sand or ceramic beads in the fracking fluid) and stabilisers (to prevent

clays from expanding). Corrosion inhibitors, pH adjusting fluids and other chemicals may also be added.

Under normal conditions there is little risk of fracking chemicals or produced (waste) water contaminating aquifers. Shale gas tends to be well below the depth of aquifers exploited for human use and the high clay content of shales prevents water flow between aquifers. However, contamination may come from well failure, natural or man-made fractures or faults and poor handling of produced water.

A recent study in Texas on groundwater in more than 40 private water wells before, during and after nearby drilling and fracking for shale gas found that numerous contaminants in the water increased as the mining activity increased. They found increases in bromide, volatile chemicals (including dichloromethane, toluene, cyclohexane, acetaldehyde, xylene, ethyl benzene), and various alcohols as well as changes in total organic carbon and pH.[27] The researchers suspected that the chemical contaminants reached the groundwater either through leaky wells or via naturally occurring fault lines.

Produced water from deep shale rock is a highly saline mix of recovered fracking fluid and water from the shale (water which was trapped in pores in the rock as it was deposited). Typically 30-70% of injected fluids is recovered.[28] The fate and biological impacts of the unrecovered fracking fluid are highly uncertain.[29]

When “flow-back” water reaches the surface it must be stored, treated and disposed of properly to avoid damage to the environment, people and water supplies. The current practice in South Australia's Cooper basin (where the Australian shale gas industry is most advanced) is to store this waste as described above, in steel tanks or ponds excavated close to the well bore site. The ponds are lined with UV-stabilised plastic to prevent the recovered wastewater from seeping into the soil and the water disposed of by evaporation. Plastic liners are ultimately disposed of at an appropriately licensed waste disposal facility and the pond site rehabilitated.

In Queensland's CSG fields, disposal by evaporation is not permitted.

With rainfall in the arid zone a rare event, over-topping of these ponds is probably not a high risk. However, if drill sites and wastewater ponds are constructed on floodplains there is a risk of a spill from a bunded earth-wall being undermined or eroded by floodwaters. As mentioned elsewhere in this report, diversion of floodwaters from natural flow paths by infrastructure located on floodplains could have implications for pastoral leaseholders and local governments with responsibility for road maintenance.

The Concerned Health Professionals of New York have compiled several examples in the United States of fracking wastewater contaminating agricultural soils. They say that

"wastewater spills are a significant hazard in the current fracking boom". [30] For example, soils at sites in North Dakota where tens of thousands of litres of wastewater had seeped into the ground had chloride levels so high they were off the health department's measuring scale. Contaminated fields have not produced crops for decades. [31] In another case, US Forest Service researchers reported that the disposal of wastewater with high chloride levels in a West Virginia forest caused high rates of seedling death. [32]

Spills have also occurred in Australian CSG operations. A scalded area in NSW's Pilliga Forest has not recovered almost 10 years after a wastewater spill by Eastern Star Gas. [33,34] Wastewater leaking from a pond in the Pilliga (on tenements that Santos bought from Eastern Star Gas) resulted in the contamination of groundwater with uranium and arsenic. [35,36]

Gas leaks in the soil can also be deadly. Bacterial oxidation of the gas reduces oxygen to extremely low levels, which kills trees and other plants, and increases carbon dioxide concentrations. [37]

Earthquakes

Fracking can cause low level earthquakes if not done carefully. [38] An understanding of natural faults, fractures and stress directions is necessary to limit risks. According to the Australian Council of Learned Academies, there are few documented examples of earthquakes caused by the fracking process itself, but evidence is growing that re-injection of fracking wastewater can increase the frequency of earthquakes. [39,40]

Oklahoma once averaged fewer than two earthquakes of magnitude 3 or greater each year. In 2013 the Oklahoma Geological Survey (OGS) documented two earthquakes of at least magnitude 3 every *week*, and that number increased in 2014. [41] More recently the frequency of these earthquakes has increased to about two each day. On 13 February 2016 Oklahoma experienced a magnitude 5.1 earthquake, the third largest ever recorded in that state. [42] The OGS has indicated that this high rate of earthquakes is most likely due to the reinjection of fracking wastewater.

HUMAN HEALTH RISKS

The Union of Concerned Scientists has warned that because of the rapid expansion of unconventional oil and gas development, too little is known about the risks of groundwater pollution and potential environmental, health, and societal impacts. [43]

A recent assessment of scientific peer-reviewed papers from 2009-2015 of environmental and public health impacts of unconventional natural gas development in the United States found 685 relevant papers. Of those focused on public health, 84% found hazards, elevated risks, or adverse health outcomes; 69% of the water quality studies found potential or actual water contamination; and 87% of air quality studies

indicated air pollution. The authors concluded that “the weight of the findings in the scientific literature indicates hazards and elevated risks to human health as well as possible adverse health outcomes”. [44]

The Concerned Health Professionals of New York have raised concerns about the risks to water from drilling and fracking activities. [45] They cited a review of records held by the Pennsylvania Department of Environmental Protection, which found that 234 private drinking water wells had been contaminated by drilling and fracking operations during the prior seven years. They noted that the injection of liquid fracking waste into groundwater aquifers in California could contaminate large numbers of public drinking water supplies. They concluded that “growing evidence shows that regulations are simply not capable of preventing harm”. This is because the number of wells keeps growing and because some aspects of fracking, including the subterranean geological landscape, are not controllable.

In addition to claims of impaired quality and/or supply of groundwater, residents in Queensland's Surat Basin CSG fields have reported health effects arising from air pollution and difficulties sleeping due to noise and light pollution. The tragic suicide of Chinchilla farmer George Bender provides an indication of the relentless stress levels and mental health issues experienced by some members of this affected community.[46]

LIVESTOCK HEALTH RISKS

There is considerable anecdotal evidence from the United States that gas mining has detrimentally affected livestock and domestic animals. Two researchers (a professor of molecular medicine and a veterinarian) compiled 24 case studies of apparent harm to animals (and humans), mainly resulting from contamination of water wells, springs, ponds or creeks, some due to accidents or negligence, and others a consequence of normal operations. [47,48] On seven cattle farms studied in the most detail, half the herd, on average, was affected by death or failure to breed. [49]

In one case, of 60 cattle with access to a creek allegedly contaminated with fracking wastewater, 21 died and 16 failed to reproduce, while 36 cattle without access to the tainted water remained healthy. In another case, of 140 cattle exposed to fracking waste, about half died and many others bore stunted or stillborn calves while 60 others in another pasture had no problems. [50]

The Concerned Health Professionals of New York have compiled several other cases of affected livestock. For example, in Pennsylvania, one farmer whose cows were exposed to drilling wastewater in 2010 lost 8 out of 11 newborn calves. [51] In Pennsylvania the number of dairy cows declined where fracking was prevalent – in counties with more than 10,000 dairy cows and more than 150 shale gas wells, dairy cow numbers declined by 16% between 2007 and 2010. [52]

WILDLIFE RISKS

The United States has been “conducting a giant experiment without even collecting the important data on the water, air, land or wildlife impacts”, says ecologist Sarah Souther, who, with seven colleagues, reviewed the likely impacts of shale gas developments on wildlife in the United States. [53,54] The review found that shale gas mining can harm wildlife through contamination of surface water and groundwater, diminished stream flow, stream siltation, habitat loss and fragmentation, climate change and local air, noise and light pollution. [55]

Because of a lack of data collection and baseline studies, little is known about the impacts of fracking. The lack of data has been used by the gas industry to claim there is no proof linking fracking to water contamination. Although some impacts are likely to result from rare accidental events, the possibility of harm to wildlife can be great, due to the potentially toxic chemicals involved. [56]

Many of the threats extend beyond the immediate infrastructure footprint, cross land and water boundaries, and may interact to affect ecosystems in unexpected ways. Because the overall impacts are likely to outweigh that of any part of the process, it is important that risk assessments consider cumulative impacts. The few studies that consider cumulative impacts suggest that shale gas development will affect ecosystems on a broad scale. Although the specific impacts on wildlife have mostly not been assessed, shale gasfields have dramatically transformed landscapes, and turned extensive forest and grassland ecosystems into islands, fragmented by a dense network of roads, pipelines and well pads. Habitat fragmentation can interfere with the foraging, mating and dispersal of animals, and increase risks of local extinction.

In the locality of gas wells, the noise, lights, flaring of gas, and heavy vehicle movements, all of which occur around the clock, are known to have driven animals away from nesting sites and are likely to have affected migrating animals. [57] Shale gas flaring, to burn off natural gas produced as a by-product, produces an extremely noisy (120 decibels at the base) 200 metre tall flare, which can burn for months. [58] This has implications for nocturnal wildlife as well as tourism operators and visitors seeking star-studded Outback skies. Compressor stations, which pressurise the gas for transportation, also emit noise and light pollution as well as noxious fumes.

Aquatic wildlife is also at risk from shale gas mining due to the potential for contamination with toxic chemicals and sedimentation. The risk is enhanced in the US by the siting of many shale wells near rivers and streams because of their high water demand. [59] In one case investigated by the US Geological Survey and US Fish & Wildlife Service in 2007, a spill of fracking wastewater into a creek in Kentucky killed virtually all aquatic wildlife in a significant portion of the creek, including a threatened fish (Blackside dace). Many fish were found to have gill lesions and liver and spleen damage.[60]

THE NEED FOR MORE INDEPENDENT RESEARCH

Researchers of the impacts of unconventional gas mining have emphasised the need for much more research. As the examples above show, there is mounting evidence of harmful impacts and considerable uncertainty about its safety for the environment, agriculture or human health.

The authors of the 24 case studies on livestock and domestic animals (Robert Oswald and Michelle Bamberger) noted that the "most striking finding" of their study was how difficult it was to get solid information on the links between fracking and health effects.[61] They recommended comprehensive testing of the air, water, soil and animals prior to drilling and at regular intervals after drilling is completed, and full disclosure of the chemicals used in fracking.[62] Because little is known about the effects of fracking chemicals on meat and dairy products, food safety testing and research are needed. They recommend that non-disclosure agreements be prohibited when public health is at stake.

Reviewers of the ecological impacts of shale gas mining (Sarah Souther et al.) have recommended that any country considering full-scale shale gas development should conduct pilot projects and careful scientific studies on the impacts before allowing larger developments to proceed.[63] They say the top research priorities are impacts due to accidental or unplanned events that lead to contamination of fresh water, such as equipment failure, illegal activities, accidents, chemical migration and wastewater escape, as well as the cumulative ecological impacts of shale development.

Researchers emphasise the importance of studies being conducted independently of the gas industry. Industry funding of research has “left the science vulnerable to political and corporate interference.”[64] A 2015 report by the US Public Accountability Initiative, ‘Frackademia in Depth’, found that 76% of 137 studies investigated had some connection to the oil and gas industry.[65] Only 19 papers (14%) were peer reviewed and 10 of these were tied to the industry. Two were discredited and retracted due to poor scholarship and a false claim of peer review. The single peer-reviewed study that explicitly dealt with public health concerns was industry funded.

There are similar concerns in Australia regarding the lack of transparency and accountability, and conflicts of interest with industry-funded studies. Gas companies have funded universities and other research programs, including organisations such as the Gas Industry Social and Economic Research Alliance, leading to a perception of bias.[66]

RISKS FOR THE CHANNEL COUNTRY AND THE LAKE EYRE

The precautionary 'bottom line' advice from the studies summarised above is that shale gas has not been proven safe for the environment, agriculture or human health.

The Western Rivers Alliance holds the view that the potential impacts of a relatively short term unconventional gas industry on existing sustainable industries and the outstanding scientific, natural and cultural values of the Channel Country are significant and possibly irreversible.

The Channel Country rivers are among the last wild desert rivers on Earth.[67] Their ecological importance to the region, the nation and also to the rest of the world cannot be overstated.

It is important to remember that the Channel Country forms the headwaters of the Lake Eyre Basin and that any negative impacts will inevitably move downstream. As noted in this report, the South Australian section of the Lake Eyre Basin meets many World Heritage criteria which would also potentially be placed at risk.

A shale gas industry in an arid area has the potential to become a major user of groundwater.[68] The sustainable yield of groundwater in the Cooper Basin is low, and evaporation greatly exceeds rainfall, so the water demands of an unconventional gas industry need to be taken extremely seriously.[69] Alternatives to fresh water would need to be found. Options include recycled water or waterless fracking methods.[70]

While ACOLA has estimated the Cooper Basin resource could support 9,000 gas wells, analysis commissioned by the Queensland Department of Natural Resources and Mines put the figure at between 8,000 and 24,300 wells.[71] At an average of 15 ML of water per frack, the additional water demand therefore ranges between 120,000 ML and 364,500 ML to frack each well once. It is most likely that this will come from aquifers of the Great Artesian Basin. The Great Artesian Basin Water Resource Plan provides a current total annual average use of water from the Queensland part of Great Artesian Basin is 460,400 ML. The substantial increase needed to support a shale gas industry would be well in excess of the 10,000 ML state reserve for projects of state significance provided for in the Water Resource Plan. The implications for the health of the Great Artesian Basin and the impacts on existing users have not been assessed.

Recent research by CSIRO[72] found that the Great Artesian Basin is not in a steady state as previously assumed, but is, in fact, a declining resource. Long-term sustainability demands an emphasis on better protecting this storage of clean and unpolluted water rather than greatly increasing water extraction. Furthermore, the drilling of up to 23,400 gas wells (all of which will eventually fail and leak) right through the Great Artesian Basin is a potential risk to the integrity of the world's largest groundwater resource.

Globally and in Australia, fresh water supplies are under enormous pressure from encroaching development and over extraction, and there is no greater competition than that between food and energy producers. The Western Rivers Alliance considers practices that irretrievably degrade water quality to be unacceptable and unaffordable.

Unconventional gas development requires 10-20 times more truck movements than conventional oil and gas resources, large volumes of water, much larger well pads (so more clearing), and an extensive network of pipelines. If it was to operate year-round in the Channel Country, the industry would also require a substantial network of raised all-weather roads. Since it is most unlikely these would be sealed, run-off would increase the volume of sediment reaching the most biodiverse and highest value habitats in the entire bioregion - the creeks, channels and waterholes.

Shale gas fracking site in Haynesville, USA. *Photo: Frac Tech Services*

On the flat Channel Country floodplains even a 5 cm high structure can have major implications for overland flood flows. There is potential to increase flood heights in some areas and prevent beneficial flooding in others. Box culverts can be installed to allow floodwaters to pass under roads but they also lead to increased depth and velocity of floodwaters. This accelerates the process of erosion, adding to the sedimentation of drought refuges, the most critical habitats during the long bust sequence of years.

Floodplain areas deprived of water will not produce pasture grasses or herbage unless rain falls locally. However, rain produces far less pasture than a flood event. The foreword to this report noted the vigorous 1990s campaign to project the Cooper and its floodplains from intensive irrigation. Compared to the water demands of unconventional gas exploration and extraction that was a relatively modest proposal yet the risks to the viability of the pastoral industry galvanised the local community. The impacts on beef and wool producers of a much thirstier unconventional gas sector could be substantial.

From a biodiversity perspective, warnings about the increased rate of extinctions[73] must be heeded. Waterbird breeding events are useful indicators of ecosystem and environmental health. Waterbird numbers are in an alarming worldwide decline. Huge breeding events do still occur in the wetlands of the Lake Eyre Basin, including the 17 located in the Channel Country that are listed in the national Directory of Important Wetlands. The conservation values of these areas rely on the maintenance of their unaltered flow regimes and natural flooding patterns. Many of these habitats are also important to migratory birds listed under international agreements to which Australia is a signatory. If Australia is to take its biodiversity conservation responsibilities seriously, we must ensure that the natural pattern and extent of flood events is maintained and that these habitats are not contaminated with toxic chemicals.

Nature-based tourism is growing rapidly in the Channel Country and local governments and residents alike are keen to build on its growing popularity. “The Landscape” is already a highly marketable product that is popular among all those with a love of wide open spaces and unpolluted environments. Indigenous cultural heritage, European folklore and environmental and paleo-history are all regarded as exciting opportunities for new initiatives and can co-exist with the long-established pastoral industry.

Unconventional gasfields cannot easily co-exist with a clean and green beef industry and are likely to be incompatible with the aspirations of local people seeking to capitalise on their most important natural asset.

The Channel Country epitomises the notion of a land of droughts and floods. This report has not examined the greenhouse emissions of the unconventional gas industry but experts such as Cornell University's Professor Robert Howarth claim that fugitive methane emissions are substantial and that the shale gas industry has a greater greenhouse impact than burning coal. It has now been 4 years since the last major flood in the Channel Country. Locals say it is the longest flood-free period since records began.[74] Careful assessments and benefit-cost analyses are needed to ensure the best possible decisions are made for the future of the Channel Country, its communities and its rivers.

The political risks are arguably the most intractable. Both sides of politics are committed to the exploitation of unconventional gas resources and share a limited appetite for rigorous monitoring, compliance and enforcement, particularly in a region so remote from qualified staff. Of equal or greater concern is the 'revolving door' between governments and the resources sector and the influence of political donations in buying not just favourable policies but specific results. Beach Energy holds extensive exploration tenements in the Channel Country and is the subject of a case study documented in the recent ‘Greasing the Wheels’ report.[75]

Like much of the Outback, the Channel Country faces multiple challenges arising from a declining and aging population and the 'short-termism' that characterises government policies as applied to remote communities. This report has noted the negative socio-economic impacts of gas mining on local towns, businesses and the social wellbeing of their residents. For the emergence of a successful, modern Outback there is a need to unite members of remote areas, for them to re-evaluate the systems that are no longer working for them and design new ones that will facilitate resilient communities in sustainable environments. With its emphasis on a non-resident workforce and the purchase of goods and services from distant metropolitan centres or even overseas, the unconventional gas industry currently seems ill-placed to contribute to such a process.

LAWS, POLICIES AND POLITICS

This sections highlights the inadequacies of federal and Queensland laws, policies and compliance regimes under which the unconventional gas industry operates, and the Queensland politics that led to the demise of legal protection for Channel Country's declared wild rivers.

Federal laws

In 2013 a water trigger, negotiated by Tony Windsor MP, was added to the *Environment Protection and Biodiversity Conservation Act 1999* to allow for federal assessment of the impacts of proposed coal seam gas and large coal mining developments on water resources. An Independent Expert Scientific Committee was created to provide expert scientific advice on these proposals. The committee is also charged with identifying water resources that are research priorities due to their ecosystem significance or community concern and commission a bioregional water assessment.[76] However, the water trigger does not apply to mining of shale and tight gas, nor are these gases a focus in the terms of reference for the scientific committee.

In Australia, unlike the United States, gas companies list the chemicals used in fracking fluids. They imply these are safe by highlighting the everyday uses of these substances. However, at least 23 of the chemicals used in fracking have not been assessed by Australia's national regulator, the National Industrial Chemical Notification and Assessment Scheme, so claims about their safety cannot be justified. What is known about some of the other chemicals used in Australia indicates serious human health hazards.[77] NICNAS is participating in a national assessment of the health and environmental risks from chemicals used in drilling and hydraulic fracturing operations in the CSG mining industry. The report is due sometime in 2016.[78]

For almost 10 years it has been a policy goal of the Queensland government to encourage and support an unconventional gas industry.[79] The CSG industry is well established in the state, with almost 7,000 wells drilled by 2015.[80] However, the development of law and policy has not kept pace with the industry's expansion.

The Queensland government claims that its laws require thorough assessment of proposed projects; protect the Great Artesian Basin, local water supplies and areas of regional interest; provide fair conditions and compensation for landholders; ensure the CSG-LNG industry is safe and sustainable; and establish a strict compliance and enforcement regime.[81] However, the experiences of many people affected by the industry contradict these claims.

Queensland law and policy

Queensland's petroleum and gas industry is regulated under two Acts. The *Petroleum and Gas (Production and Safety) Act 2004* provides for the exploration, testing and production of petroleum with the broad definition of 'petroleum' including all the unconventional gases. Some petroleum tenures are administered under the *Petroleum Act 1923* which also authorises the exploration, testing and production of unconventional gas. The potential risks posed by the exploration and production processes are managed by conditions attached to an Environmental Authority granted under the *Environment Protection Act 1994*. The Minister cannot grant a petroleum tenure under either of these Acts until an Environmental Authority has been issued for the tenure. The current regulatory framework is described by the state government as an 'adaptive environmental management' approach.[82] They say this allows them to alter conditions placed on a project as new information becomes available. Given the scarcity of our water resources, the fact that Australia's geology is very different from that of the major US shale basins, and that much about the impacts of unconventional gas production remains uncertain, Western River Alliance believes a more precautionary approach should be in place.

In effect, the industry is largely self-regulated. Monitoring is a gas company responsibility with the data collected provided to government agencies, and the government's CSG Compliance Unit mainly responds to concerns brought to its attention by members of the public.

The GasFields Commission is a statutory body that is charged with facilitating the coexistence of rural landholders, regional communities and the coal seam gas industry in Queensland. Many Western Darling Downs landholders contend that the Gasfield Commission is biased in favour of the unconventional gas industry and that co-existence is imposed on them regardless of the impacts on, for example, prime farming land or critical water resources. They point to some Commissioners' close association with the resources sector as clear evidence of conflicts of interest.

Case Study: Western Downs Landholder Concerns

One example of affected communities having their concerns ignored was the government's slow and inadequate responses to widespread complaints since 2008 by residents in the Tara-Chinchilla area that their health has been affected by living near a gasfield. A Queensland Health study in late 2012 involved a literature review, and a medical examination or interview of just 17 people. No assessment was made of the air or water quality conditions at their homes. Queensland Health found no conclusive evidence of a link between residents' health problems and their exposure to the gas industry. [83]

General practitioner Dr Geralyn McCarron criticised the government for long trivialising and ignoring the residents' reports of ill health and then conducting a study "so inadequate and flawed that it has done little to alleviate concerns". [84] She conducted a survey of 113 people from 38 households, 58% of whom reported that their health was adversely affected by CSG mining, whilst a further 19% were uncertain. [85]

Incidents in Australia

There have been numerous reports of water contamination and health impacts by people living in close proximity to Australian CSG fields in Camden, NSW[86] and on the Western Darling Downs in Queensland. [87] They are similar in nature to reports in the United States. In Australia, as in the US, the lack of baseline assessments prior to the start of large projects means it is difficult for affected landholders to prove the impacts are due to CSG-related activities or to quantify them.

Some incidents (as well as breaches of approval processes and conditions) have come to light only because of whistle-blowers within government departments[88] and gas companies. [89]

The South Australian government provides annual publicly accessible Petroleum and Geothermal Energy Act Annual Compliance reports that detail the many incidents occurring in that state. [90] However, the reports do not state whether the wells involved are conventional or unconventional oil and gas wells.

In contrast, there is no transparency on monitoring and compliance activities in Queensland. Petroleum and gas compliance reports are not publicly available. [91] The Department of Environment and Heritage Protection has an online compliance and enforcement resource site that is restricted to *receiving* reports from the CSG/LNG industries. [92] In May 2013 some 240,000 litres of oil were spilled at a conventional well in Santos's Zeus field west of Thargomindah. [93,94] Despite clear evidence, the Queensland environment department chose not to prosecute Santos for this breach of conditions. [95] Critics of the industry and its relationship with governments point to the lack of resources for monitoring, compliance and enforcement of environmental authorities.

Queensland politics and the Channel Country's wild rivers

The foreword to this report notes the passing of the *Wild Rivers Act 2005* and subsequent wild river declarations over Cooper Creek and the Georgina and Diamantina Rivers in 2011. This law and the declarations provided a whole-of-river system management framework by bringing together regulations concerning vegetation management and water entitlements, access and use, as well as prohibiting or regulating activities in certain zones. For example, the declarations limited the petroleum industry's activities within areas mapped as 'high preservation' or 'special floodplain management' areas.

During the 2012 Queensland election campaign, the Liberal National Party committed to revoking the wild river declarations on Cape York Peninsula. No mention was made of the Channel Country declarations until a February 2012 media release from the Shadow Environment Minister, Andrew Powell, stating that "with the Western Rivers we will work with locals and other stakeholders about appropriate environmental protections for their region". [96]

After the election of the LNP government, the Natural Resources and Mines Minister, Andrew Cripps, established the Western Rivers Advisory Panel (WRAP) to seek community input into the development of "alternative strategies" for protecting the western rivers. The WRAP included local councils, agricultural groups, NRM bodies, a Traditional Owner representative, other stakeholders and the oil and gas industry. Environmental stakeholders were excluded (and removed from all committees and advisory groups within Minister Cripps' portfolio).

The final report of the WRAP supported substantial controls on unconventional gas mining in the region. [97] A majority of members agreed that "alternative strategies for the protection of natural assets and values in the Basin should take precedence over petroleum and gas decisions" and that decisions to protect natural assets "should not be able to be overridden by the Coordinator General".

Ministerial diaries from July 2013 to July 2014 show that while the WRAP process was under way, senior members of the petroleum industry were meeting with the highest levels of the Queensland government. In November 2013, a fortnight after meeting with Beach Energy representatives, the environment minister announced the Queensland government's intention to revoke the wild river declarations over the Channel Country.

The public notice stated that wild river regulations, such as those applying to mining and petroleum and gas operations, would no longer apply once the declarations were revoked. Beach Energy holds significant petroleum tenements and leases in the Channel Country.

Minister Cripps' diary shows that in February 2014 he visited the Cooper Basin with Beach Energy staff.[98] A month later, the *Regional Planning Interests Act 2014* and its regulation were progressed through the Queensland Parliament. Although 'strategic environmental areas' in the Channel Country are defined and identified in the regulation, it does little to protect them. Unconventional gas exploration or production are not among the 'unacceptable uses' listed for strategic environmental areas.[99]

The final step in the dismantling of wild river protections came in August 2014, with the passage of the *State Development and Infrastructure Planning (Red Tape Reduction) Act 2014*, which repealed the Wild Rivers Act.

The mining and petroleum industries are major donors to Queensland political parties.[100] Beach Energy's donations and contributions to the Queensland LNP from 2011-12 to 2012-13 totalled $110,000.[101,102]

One conclusion that may be drawn is that the majority recommendations of the community-based and scientifically informed WRAP process carried less weight than the influence wielded by the unconventional gas industry via donations and special access to decision makers.

THE ECONOMICS OF UNCONVENTIONAL GAS

The socio-economics of unconventional gas, including local economies, community well-being, employment and gas pricing.

Queensland's CSG boom has been one of the largest and most rapid industry expansions Australia has ever experienced but the promised job opportunities only materialised within the gas industry itself. Short-term jobs are created in the construction and professional services areas but the current evidence indicates no spill-over into local retail or manufacturing businesses as a result of the newly arrived CSG industry. In fact, for every 10 new jobs in the gas industry, seven were lost in the service sector. [103]

The gas industry's strong preference for a fly-in, fly-out workforce undertaking long shifts and usually housed in workers camps outside of towns means there are few opportunities for gas industry employees to support local businesses. The industry also prefers to source materials and supplies from overseas or metropolitan centres, so local suppliers and manufacturers rarely benefit from the construction boom.

The Surat basin in the western Darling Downs is Queensland's most mature unconventional gasfield. The impact of the CSG industry on the local economy has been studied by the mining industry-funded Sustainable Minerals Institute. [104]

The CSG industry representatives in the study claimed that the local economic impacts had been very positive. However, participants representing local businesses, farming, government services such as health and emergency services, and the community sector said that the CSG industry had led to a deterioration in financial, human, social and built capital. The loss of skilled labour to the gas industry, and higher costs for rent, transport and goods and services were contributing factors.

Similarly, another study of western Darling Downs by the Centre of Social Responsibility in Mining found that while CSG industry staff believed the local economy was "better" due to the gas industry, those in the local business, agriculture, government and community sectors believed it to be "worse." [105]

CSIRO's research also found the CSG industry was causing distress in local communities. While 6% of those surveyed felt their community was improving, almost half of the respondents to the CSIRO survey reported they were either 'only just coping' with or 'not coping' with or actively resisting the rapid rate of change that the unconventional gas industry had brought to their communities. Since social services, local retail and manufacturing businesses were declining and costs for rents and many basic products and services were increasing, it is little wonder that community and individual well-being suffered.

A CSIRO study funded by the CSG industry found that only 14% of Darling Downs locals approved of the CSG industry and only 6.1% felt the CSG industry would bring about positive changes for the community. [106]

Employment

Job opportunities are often prominent as justifications for the approval of unconventional gas projects. The US experience has shown that unless local residents have experience or are already highly skilled in the oil and gas industry, only low paid menial and often dangerous jobs are available. [107] Highly paid jobs are generally undertaken by a skilled fly-in, fly-out (or drive-in, drive-out) workforce.

The gas industry is capital intensive and highly mechanised, so is a very small employer. According to the Australian Bureau of Statistics in 2015, the entire oil and gas industry across Australia employed some 21,600 people or about 0.25% of the workforce and jobs have since been shed due to the falling oil price and company mergers. By contrast, on 31 December 2015, Bunnings hardware stores employed more than 40,000 people. [108]

Most jobs in the gas industry are in the construction phase, which lasts about two years. Since this phase in the Surat basin, Queensland CSG industry is now almost complete, it is likely that skilled jobs in new areas will go to those who already have industry experience. If skilled locals are employed, they will almost certainly come from another sector of the local economy. Replacing skilled workers in a remote area is often difficult, so the region may experience a net loss in skills and capacity.

Gas prices

Unconventional gas is considerably more expensive to produce than conventional gas. In 2012 conventional gas from Bass Strait cost $1.71/petajoule. According to the Australian Energy Market Operator, unconventional gas from the Cooper Basin would have cost $3.05/petajoule, almost twice as much to produce at that time. [109] This suggests that unconventional gas produced in a remote outback area may be economically unviable or only marginally so, particularly while oil and gas prices are low.

Since LNG exports began from Gladstone, Australia's gas price has been linked to Asian markets and the domestic price has increased. Consumers will continue to pay more for gas regardless of how much is produced.

In summary, unconventional gas mining in western and far south-western Queensland is likely to:

- employ few locals
- negatively impact on existing businesses and industries
- reduce well-being in affected communities
- have no significant impact on gas prices in Queensland

WHAT THE WESTERN RIVERS ALLIANCE CALLS FOR

The Western Rivers Alliance has significant concerns about the likely impacts of industrial-scale unconventional gas mining on the Channel Country's floodplains, rivers, wetlands and groundwater.

We also share the concerns of many Australians worried about recent changes to our democratic institutions, including the influence of corporations on government decision-makers.

The alliance shares many Australians' desire for regional economic development, new income streams and employment opportunities, particularly in Outback regions. While unconventional gas mining may provide some of these, we do not believe they should come at the expense of established industries, community health and the environment.

Policy-makers and decision-makers should not assume that the unconventional gas industry will deliver lasting economic benefits for the region.

The US experience leads us to believe that the risks to the Channel Country, its clean and unpolluted environment and the vital industries that depend on it, are far too great to allow the industry to establish on the floodplains.

With its low rainfall, highly variable streamflows, a high level of freshwater-dependent biodiversity, and outstanding scientific, ecological and cultural values, the risks of a fully developed unconventional shale gas industry in the Channel Country would appear to greatly outweigh the claimed economic benefits.

The Western Rivers Alliance calls for:

- The reinstatement of a binding legal framework that protects the rivers, floodplains, wetlands and natural flow patterns of the Channel Country as a matter of urgency;
- A comprehensive, independent and expert risk assessment of the likely impacts of an unconventional gas industry on the Channel Country, its natural resources, communities and economy;
- An expert review of legislation and policy to identify gaps in the existing framework and recommend amendments to ensure protection of land, water, ecosystem processes and human and animal health;
- An independent expert review of the experience of and impacts on individuals and existing businesses in unconventional gas producing regions;
- Amendments to the *Environment Protection and Biodiversity Conservation Act 1999* to include shale and tight gas projects in the water trigger; and
- The addition of shale and tight gas projects to the Independent Expert Scientific Committee's Terms of Reference.

GLOSSARY

Bioregion - A natural region defined by its geology, soil type and the native vegetation that grows in it.

Catchment - A surface water basin collecting water that flows to a terminal lake (such as Lake Eyre) or the sea.

Coal seam gas (CSG) - Unconventional gas extracted from coal seams.

Compressor station - Gasfield equipment that compresses gas to a pressure level sufficient to transport it by a pipeline.

Desert Channels Queensland - The regional natural resources management board responsible for the Channel Country region. Its work is focused on developing and delivering community – government partnership projects to improve the condition of natural resources and the sustainability of rural industries.

Horizontal drilling - Advances in technology now allow a drill-bit to be steered through 90 degrees so that the well bore can be extended horizontally through the rock layer in which the gas is distributed. Multiple horizontal 'arms' can be drilled from one vertical shaft.

Hydraulic fracturing (fracking) - A technique used to make gas flow through dense rock layers more easily. Initially developed to maximise oil recovery from wells nearing the end of their productive lives, the process has been modified to extract deeper oil and gas resources. It is now sometimes referred to as HVSW (high volume, slick water) fracturing. 'Slick water' refers to some of the chemical additives. It involves pumping very large volumes of water mixed with sand and chemicals into a well-bore under very high pressure. This opens a network of cracks that allows the gas to flow. An average fracking operation may need 15 million litres of water and 80 to 330 tonnes of chemicals. Some wells need 10 fracks over their productive lives.

Hydrology - The study of the distribution and movement of water resources.

ML - Megalitre. 1,000,000 litres.

NICNAS (National Industrial Chemical Notification & Assessment Scheme) - A statutory scheme administered by the Commonwealth Government Department of Health. NICNAS aids in the protection of the Australian people and the environment by assessing the risks of industrial chemicals and providing information to promote their safe use.

NRM - Natural resource management. Soil, water and vegetation are all natural resources.

LNG - Liquified natural gas. Unconventional gas is processed and exported as LNG.

Produced water- Water extracted from the gas-bearing rock seam. Also known as 'associated', 'product' or 'formation' water, this water is usually salty and contaminated with toxic substances held in the rocks such as heavy metals and naturally occuring radioactive materials. Larger volumes of produced water are brought to the surface with CSG mining than with shale or tight gas mining.

Shale gas - Unconventional gas extracted from layers of shale rocks.

Tight gas - Unconventional gas extracted from dense, low permeability sandstone.

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