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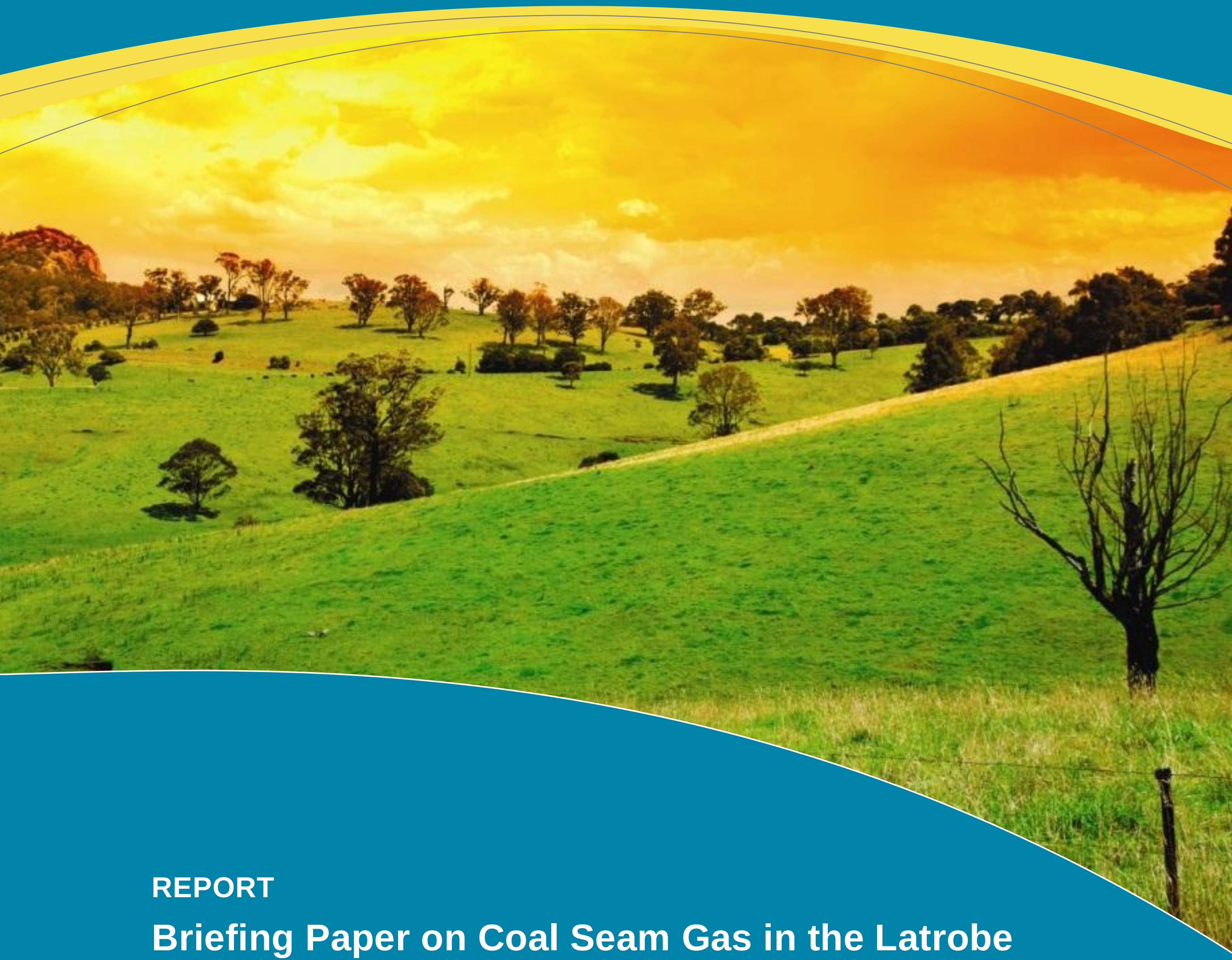

REPORT

Briefing Paper on Coal Seam Gas in the Latrobe Valley

Prepared for Latrobe City Council

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Latrobe City Council

Briefing Paper on Coal Seam Gas in the Latrobe Valley

CONTENTS

1 Introduction 1
1.1 Coal Seam Gas 1
1.2 Latrobe Valley Coal Reserves 2
2 Australian Policy on CSG 2
2.1 Federal Policy and Regulation 2
2.1.1 Future national framework for CSG project assessment 3
2.1.2 Interim Independent Expert Scientific Committee on Coal Seam Gas and Coal Mining (The Committee) 3
2.2 Victorian Policy and Regulation 4
2.2.1 Moratorium on Coal Seam Gas in Victoria 5
2.3 Local Government 5
3 Coal Seam Gas Technologies/Processes 5
3.1 CSG project lifecycle 5
3.2 CSG Extraction Techniques 6
3.2.1 Well drilling 6
3.2.2 Fraccing/Fracking 6
3.2.3 Gas processing 7
3.2.4 Produced water treatment and waste management 7
4 Issues and Benefits 8
4.1 Potential Issues 8
4.2 Potential Benefits 10
5 Feasibility of CSG extraction in Gippsland 12
6 Conclusion 13
7 Works Cited 14

Appendix A – Coal Seam Gas Exploration Licenses in Latrobe City
Appendix B – Other Coal Seam Gas Exploration Licenses in Vicinity of Latrobe City

1 Introduction

In recent times, a number of coal seam gas (CSG) exploration licenses have been issued in the Latrobe Valley. Latrobe City Council has commissioned this briefing paper to inform itself on the potential viability of CSG extraction from brown coal reserves located within Latrobe City and the region and on the potential issues and benefits associated with CSG extraction.

This paper is intended to provide a factual summary of the CSG process, based on publicly available information, and is not intended to present a case either in support or against development of the CSG industry in the municipality.

The paper includes:

- a brief, 'plain English' explanation of the CSG extraction process
- a summary of potential social, economic and environmental benefits and issues associated with CSG projects; and
- a commentary on the potential technical and economic viability of CSG in the Latrobe Valley.

1.1 Coal Seam Gas

Coal seam gas (CSG) is methane (CH_4) gas (often mixed with carbon dioxide, nitrogen and hydrocarbons) that exists in underground coal deposits. It is typically found in a semi-liquid state within the pores and fractures in the coal deposits. CSG is also known as coal seam methane, coal bed gas and coal bed methane. CSG has historically been seen as a waste gas produced during coal mining, particularly underground black coal mining, but is now being seen as a potential energy source. CSG has similar characteristics to natural gas and can be distributed to industrial and domestic customers through the natural gas pipeline network or, where facilities exist, exported as liquefied natural gas (LNG). (Australian Government Department of Climate Change and Energy Efficiency, 2012)

There are two main mechanisms through which CSG can be formed:

- Biogenically derived gas occurs in younger coals and is the result of bacterial conversion of coal into carbon dioxide (CO_2) or acetate, which is then transformed by organisms known as archaea (single celled organisms) into methane (CH_4)
- Thermogenic gas is formed as part of the coalification process (the process by which vegetable matter is converted to coal) and is purely a chemical process that releases methane into the coal seam and surrounding rock. (Moore, 2012)

The amount of methane in a coal seam generally increases with the age of the coal and the depth of the seam. Peat and the softest coals (e.g. lignites) are associated with high porosity, high water content, and biogenic methane. Higher temperature and pressure at increased depth accelerate the coalification process and the higher-rank coals[1], and associated thermogenic CSG, tend to be found at these greater depths. These higher rank coals have lower permeability and the CSG tends to be more tightly bound to the coal and surrounding rock. As a consequence, deeper underground mining will typically produce higher levels of coal seam gas methane than shallow underground mining. According to the World Coal Association, underground mines account for the overwhelming majority (up to 90%) of all measured methane emissions from the coal mining sector. (World Coal Association), indicating the general relationship between coal depth and gas content.

[1] Higher rank coals are typically harder, have low porosity, have a higher calorific (energy) value and less water than lower ranked, softer coals. The highest ranked coals are known as 'Anthracite' coals, medium ranked coals are 'bituminous and low rank coals are sub-bituminous, peat or lignite.

Table 1: World Coal Association - Methane content by depth

Depth Interval (metres)	Mean methane content (cubic metres per tonne of coal)
100	0.02
500	0.99
1000	3.73
1500	4.89
2000	7.09

Source: World Coal Association from IEA CCC 2005

Commercial production of CSG commenced in Australia in the Queensland Bowen coalfields in 1996. The Australian Department of Climate Change and Energy Efficiency (DCCEE) reports that in 2009-10 CSG accounted for approximately 10% of gas production in Australia and CSG production is continuing to grow. In Queensland, CSG provides approximately 90% of the domestic gas supply and a number of projects to convert CSG to LNG for export are underway. (Australian Government Department of Climate Change and Energy Efficiency, 2012)

1.2 Latrobe Valley Coal Reserves

The Gippsland Basin geological area is an area of approximately 40,000 km^2. Approximately 80% of this area is offshore, where much of Victoria's oil and gas reserves are found, while the remaining 20% is within the Gippsland Region of Victoria. Within this region of the Gippsland Basin, in an 800 km^2 area known as the Latrobe Valley Depression, extensive deposits of brown coal are found. (Gloe, C. S, 1984).

The brown coal in the Latrobe Valley is found near the surface in multiple seams, each up to 100 metres thick, often giving virtually continuous brown coal thickness of up to 230 metres. Seams are typically located under only 10-20 metres of overburden. (Victorian Government Department of Primary Industries (7), 2010).

As the deposits of Latrobe Valley brown coal are located in shallow deposits, open cut mining methods can be used to extract the coal. The coal is predominantly used in electricity generation, and provides 90% of Victoria's electricity requirements.

Ground water may be found in the sands above, and in aquifers below and between the coal seams and in surrounding rock. In some cases the coal seams act as aquitards (low-permeability zones that separate one aquifer from another). In the open cut coal mining process, groundwater may be extracted to depressurise the aquifer prior to mining so that the mine remains stable at depth.

2 Australian Policy on CSG

2.1 Federal Policy and Regulation

Mining licensing and regulation in Australia is governed under state or territory legislation and the Australian Government will normally only become involved in a CSG project if the project has potential to impact on matters protected under national environmental law; specifically, the *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act.) or the *Water Act 2007.* The EPBC Act is the legal framework designed to protect nationally and internationally important environmental and cultural values including nationally threatened and migratory species, wetlands of international importance (Ramsar wetlands) and national or world heritage places.

Projects that have potential to impact on matters of national environmental significance, identified under the EPBC Act, must undergo a thorough environmental assessment and public consultation process. The Australian Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) oversees the EPBC Act referral process and the Minister or Minister's delegate decides whether a project requires assessment under the EPBC Act and makes the final decision as to whether the project should proceed. (Australian Government Department of Sustainability, Environment, Water, Population and Communities, 2012)

A CSG or mining project may also fall under the Commonwealth *Water Act 2007.* Under this act, an independent, expert study is required prior to a license being granted for 'subsidence mining operations on floodplains which have an underlying groundwater system that is part of the Murray Darling Basin inflows.' (Australian Government Deparment of Sustainability, Environment, Water, Population and Communities, 2012)

2.1.1 Future national framework for CSG project assessment

The Council of Australian Governments (COAG) has established the Standing Council on Energy and Resources (SCER), made up of energy and resources Ministers from the states, territories and New Zealand. The SCER is responsible for "pursuing priority issues of national significance in the energy and resources sectors."

The SCER has agreed to develop and implement a harmonised regulatory framework for CSG to ensure that developments are undertaken in a responsible and sustainable manner and to address key areas of community concern based on four key themes:

- water management and monitoring (including hydraulic fracturing and chemical use; and well integrity and aquifer protection);
- multiple land use framework;
- best practice standards; and
- co-existence.

The work program has been publicly released and is available on the SCER website. The draft framework was due to be released in June 2012 with evaluation and consultation with stakeholders due to be completed in September 2012. The framework is to be finalised in December 2012. (Standing Council on Energy Resources (SCER), 2011)

Advice from SCER secretariat on the status of the framework is as follows: *"Ministers remain committed to this work and officials are progressing the Framework out-of-session, as outlined in the communiqué of the recent meeting of the Council in June 2012.... Any new details on the Framework will be made available on the SCER website at http://www.scer.gov.au/workstreams/land-access/coal-seam-gas/."*" (SCER Secretariat, 2012)

2.1.2 Interim Independent Expert Scientific Committee on Coal Seam Gas and Coal Mining (The Committee)

The Minister responsible for the Department of Sustainability, Environment, Water, Population and Communities the Hon Tony Burke MP, has appointed an Interim Independent Expert Scientific Committee (IIESC) on Coal Seam Gas and Coal Mining. The objective of the committee's work is to build confidence for communities where coal seam gas and coal mining projects are being undertaken, by providing independent scientific expert advice to governments on the impacts of proposed projects.

The role of the committee is to (IIESC, 2012):

- Provide advice to Government on CSG and coal mining projects: The IIESC will provide advice to Governments on proposed CSG or large coal mining developments with potential to have significant impact on water resources.
- Oversee bio-regional assessments where CSG and coal mining developments are underway or planned: The bioregional assessments will investigate the ecology, hydrology and geology of an area for the purpose of assessing the potential risks to water resources in the area as a result of the direct and indirect impacts of coal seam gas development or large coal mining development. The initial regions being studied are all located in NSW and Queensland and it is expected that additional regions will be announced following further advice from the interim committee.
- Oversee research on potential water related impacts of CSG and/or large coal mining developments: The research aims to build knowledge on the potential impacts of CSG and coal mining developments on water resources where the science is uncertain. The committee has identified six focus areas:
    - a risk assessment framework, to enable the bioregional assessments;

- knowledge projects and foundational science to better understand the impacts;
- capacity building - both infrastructure and people - to better enable the research to be done;
- data strategy and infrastructure (data availability and accessibility) to coordinate the information being accumulated;
- collaboration between major research agencies and institutions by fostering capacity and capability to ensure effective outcomes and processes; and
- basin scale modelling, which would provide data to support the understanding of risks and foundational research, including engaging with industry and state governments to enable currently collected data to be used effectively.

The Victorian Government is a signatory to the *National Partnership Agreement on Coal Seam Gas and Large Coal Mining Development*, and can therefore access IIESC scientific advice, risk frameworks and research on proposed CSG or large coal mining developments.

2.2 Victorian Policy and Regulation

The Victorian Government, through the Department of Primary Industries (DPI), has indicated that it does not want new sources of gas "at any price" and that it intends to ensure that the development of Victoria's resources is carried out in a sustainable manner. The Government has also stated that Victoria's gas demand is expected to double by 2030 and "*it makes sense to explore all possible new sources of gas in Victoria including unconventional sources like coal seam gas to keep gas prices affordable for Victorians and to ensure gas dependent industries stay in this State.*" There are no current or planned CSG facilities in Victoria, although a number of companies have obtained CSG exploration licenses. (Victorian Government Department of Primary Industries (4), 2012)

In Victoria, minerals and resources such as CSG, including those located under private land, are the property of the Crown. The Victorian Government, through DPI, regulates exploration, mining and development of resources under the *Mineral Resources (Sustainable Development) Act 1990 (MRSD Act).* Under this act, the DPI can issue licences for exploration, mining and development of mineral resources industries seeking to develop the resources. Under the MRSD Act, the industry is obligated to consult with the community, manage environmental impacts, consider public safety and land use concerns and negotiate and/or compensate landowners. (Victorian Government Department of Primary Industries (3), 2012)

Under the MRSD Act, DPI can issue the following licenses to CSG proponents:

- Exploration Licence: An exploration licence is valid for up to five years and allows the licensee to explore for minerals in an area of up to 500 square kilometres. The proponent is also required to seek additional approvals and agreements to register a compensation agreement with landholders and to obtain additional approval for work from DPI and, in cases, the Victorian Environment Protection Authority (Vic EPA). The proponent must enter into a rehabilitation bond with DPI and must also hold public liability insurance. An exploration licence does not allow commercial extraction or production of gas. If the proponent wishes to extract commercial quantities of gas, a mining licence is required.
- Mining Licence: A mining licence can be valid for up to 20 years, but normally the licence is granted for a shorter period of time. A mining licence transfers the ownership of minerals from the Crown to the holder of the licence and is a prerequisite to seek the approvals to mine under the MRSD Act. Approvals required to progress a CSG project under a mining licence include obtaining an approval for work from DPI, obtaining Vic EPA approval under the *Environment Protection Act 1970*, undertaking community consultation, entering into a rehabilitation bond agreement with DPI, obtaining public liability insurance, registering a compensation agreement with landholders and undertaking an Environment Effects Statement process.

While an Exploration License may be granted and resources found within the lease, there is no guarantee from the Government's issue of an Exploration Lease that a Mining Lease will be granted on the basis of the positive identification of a valuable resource.

2.2.1 Moratorium on Coal Seam Gas in Victoria

In the lead up to the finalisation of the national harmonised regulatory framework for coal seam gas described in Section 2.1.1, the Victorian Government announced reforms designed to provide greater certainty for communities and industries including:

- a hold on approvals to undertake hydraulic fracturing ('fraccing') and a hold on the issuing of new exploration licenses for CSG until the national framework has been considered by the Victorian Government; and
- a ban on the use of BTEX chemicals (benzene, toluene, ethylbenzene and xylene) in hydraulic fracturing in Victoria.

The Victorian Government also plans to strengthen resource policy and legislation to ensure better consideration of mixed land use issues during the application process for coal seam gas exploration activity, including using impact statements at the exploration stage for all minerals, including CSG, where there will be a significant material impact on the environment. The power to do this exists under section 41A of the *Mineral Resources (Sustainable Development) Act 1990* (Minister of Energy and Resources, 2012).

2.3 Local Government

Mining licensing and regulation in Australia is governed under state legislation as noted above. Local Government is likely to be a party to CSG project development as a key stakeholder in the Environmental Effects Statement process and as the agencies responsible for granting planning permit applications.

Local Government can also play a role advocating for its community and influencing the policy position of other levels of Government. As there is currently no current or approved coal seam gas production in Victoria and the viability of CSG extraction in Victoria is uncertain, CSG has not been a concern for Victorian communities, and hence their local governments, until recently. However, some Victorian, New South Wales and Queensland Councils have developed positions or resolutions on CSG development (e.g. City of Sydney, Muswellbrook Shire Council. Scenic Rim Regional Council, Moreland, South Gippsland, City of Yarra, Port Phillip Council, Bass Coast Council and Colac Otway).

3 Coal Seam Gas Technologies/Processes

3.1 CSG project lifecycle

CSG projects, like most resource exploration and definition projects, typically go through five stages (Moore, 2012):

- desktop study to identify the prospect for CSG;
- exploration drilling and sampling;
- establishment of pilot wells;
- development drilling ahead of full commercialisation; and
- full production with further drilling to maintain gas deliverability.

The decision as to whether to proceed from one stage to the next will depend on the scientific appraisal of the likely viability of commercial scale extraction based on the information collected at each stage. Commercial viability will normally depend on a number of factors including:

- gas price;
- capital and operating costs;
- coal seam gas flow rate from the well;
- total well reserve; and
- social and environmental considerations and management requirements.

3.2 CSG Extraction Techniques

3.2.1 Well drilling

Commercial extraction of CSG requires drilling and construction of a number of extraction wells spaced some distance (approximately 500m - 1500m) apart. The overall footprint of a CSG facility will depend on the number of wells and technologies and construction techniques used. Undergrounding of pipework and associated infrastructure and/or low density multi-lateral drilling, which targets a number of coal seams through one well head, can reduce the footprint and allow for multiple land uses to co-exist.

During establishment of the wells, steel pipe casings are installed in the wells and the area around the pipes is filled with concrete to reduce the chance of gas leaking into surrounding aquifers. Water is drawn from the coal seam and this reduces the pressure in the seam, releasing the methane that is adsorbed on the surface of the coal and surrounding rock so that it can flow from the well. (Figure 1) The production well may operate for 2-10 years. At the end of the life of the CSG extraction facility, the wells would be backfilled with concrete and, as required by Victorian law, the site surface would be rehabilitated. (Victorian Government Department of Primary Industries (6), 2012)

CSG production may also use horizontal wells which are drilled vertically into the coal seam and are then extended near horizontally into the reserve.

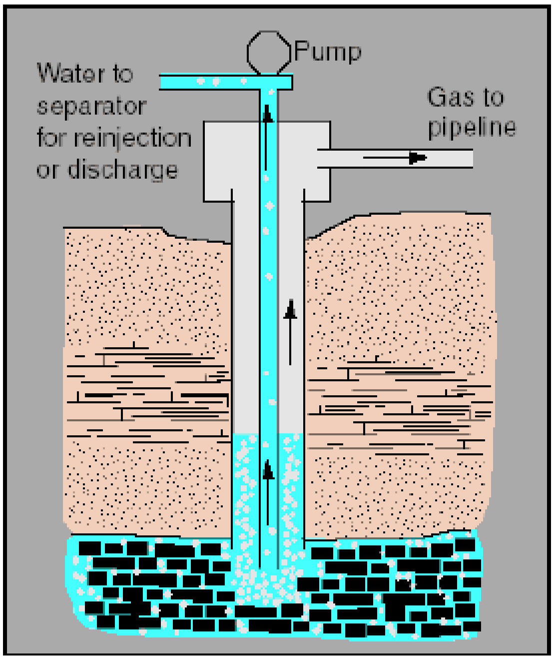


Figure 1: Coal Seam Gas Extraction (Source: DPI)

3.2.2 Fraccing/Fracking

Hydraulic fracturing (fraccing or fracking) is a process where a fluid (normally water, chemical additives and sand or ceramic beads) is pumped into the well under pressure to create fractures or cracks in the coal deposit. These cracks allow the gas to escape from the coal deposit and migrate to the well more readily and at a higher rate. The sand or ceramic beads are a “propping” agent, helping to hold the cracks open once formed. Chemical additives are used to help to suspend the proppant in the fluid, prevent the growth and build-up of bacteria and free the methane from the coal and rock.

Hydraulic fracturing is not always required for CSG production as explained by DCCEE (Australian Government Department of Climate Change and Energy Efficiency, 2012):

“In Australia, hydraulic fracturing is not as widespread as in the US in deposits exploited so far. This is because the coal deposits that contain CSG, which are relatively common in Australia, typically have a high permeability. This means that gas can migrate to wells more easily, even without fracturing, as well as allowing the use of “in seam directional drilling” techniques, which enhance the flow of gas but are only possible in reasonably permeable

seams. By contrast, shale deposits, which are a common source of gas in the US, are generally much less permeable, and therefore require hydraulic fracturing to create economic gas flows.

In Queensland, hydraulic fracturing is estimated to have been used in around 8% of CSG wells drilled to date. However, this proportion is expected to rise to 10% to 40% as the industry and production increase."

The chemical additives used in hydraulic fraccing overseas include potentially toxic chemicals such as benzene, toluene, ethylbenzene and xylene. The use of these chemicals has been banned in Queensland and New South Wales, where CSG production is underway and, as detailed in Section 2.2.1 the Victorian Government has also introduced a ban on the use of these chemicals in any future Victorian CSG projects. Chemicals typically used in place in Australian CSG fraccing operations include sodium hypochlorite and hydrochloric acid, cellulose, acetic acid and small amounts of disinfectants. (Australian Petroleum Production and Exploration Association, 2012)

Due to the physical nature and shallow depth of formation of lignite coal, fraccing is less likely to be required in the extraction of CSG from brown (lignite) coal,

3.2.3 Gas processing

Where a CSG production well meets the surface, the extraction companies will install a well pump for extracting water. In addition to the pump they will also install a system to separate the extracted water from the gas and a flow metering facility.

Once separated, the water and gas are typically piped, respectively, to a water treatment facility and a centralised gas compression facility. In some instances compressors may be used to move gas from the production well to the centralised compression facility.

3.2.4 Produced water treatment and waste management

In most instances of coal seam gas extraction in Australia, methane cannot usually be produced without a significant amount of water needing to be extracted. There are some exceptions to this, particularly in southern NSW, including the CSG fields near Camden south of Sydney, where AGL extracts CSG for domestic consumption in the NSW gas network. During CSG extraction the volumes of water (known as produced water or associated water) start off initially very high whilst very low rates of gas are extracted in the beginning of the well development. As the underground reservoir is de-watered over time and simultaneously de-pressurised, gas extraction rates begin to reach their maximum months or even years after de-watering of the well commenced.

The impacts of this water removal are two-fold with consideration needing to be given to both the potential depletion of ground water as well as impacts associated with the treatment and disposal of the extracted water. Volumes of water produced during CSG extraction can vary greatly but are dependent, to some extent upon the operation of the well and the size of the pump utilised for dewatering, but primarily the hydrological nature of the coal beds themselves.

The CSG extraction produced water typically contains sodium chloride, calcium carbonate and bicarbonates. Small traces of hydrocarbons, exuded from the coal, and other minerals can also be found.

The relative concentrations of these constituents will vary dependent on a number of factors including the nature of the coal chemistry, the coal seam depth, extractive process and aquifer recharge rates. The overall quality of this water will often require some element of treatment before the water can be reused beneficially.

The management and treatment of CSG produced water prior to discharge/reuse may be carried out utilising a variety of techniques including:

- <u>Evaporation</u>: The produced water is stored in an evaporation pond and is contained or evaporates over time. Construction of evaporative ponds typically uses large areas of land. This option of disposal is no longer permitted in NSW or QLD as the water is deemed wasted in this manner of treatment.
- <u>Thermal process</u>: Thermal processes use heat to separate treated water from salt and other constituents. The process requires significant energy inputs.
- <u>Reverse Osmosis</u>: Reverse Osmosis is a process for desalination or removal of salt from the associated water. The process is often used to treat brackish water/seawater to produce drinking water. In CSG production, water treatment using reverse osmosis produces desalinated water that can be beneficially reused, plus a concentrated brine stream that needs to be properly

treated and disposed of to avoid contamination of soil and ground water sources.. Options for management of the brine include chemical processing to produce salt, underground injection, disposal to ocean or disposal to a land waste disposal facility.

4 Issues and Benefits

There are both potential issues and benefits associated with CSG extraction. The significance of these issues and benefits will depend on the siting of the CSG facility, geology, environmental management/regulatory controls, underground water resources, the socio-economic situation and the processes used for extraction of CSG and treatment of wastewater

4.1 Potential Issues

Potential issues associated with the CSG extraction process will depend on the extraction and downstream processes used and on local site specific characteristics, particularly the local geology and groundwater depth and conditions. A detailed study of local conditions, geology and groundwater in the vicinity of CSG developments would be needed to fully understand issues associated with CSG development. However, some potential issues identified in literature of CSG processes and the measures typically used to manage these measures are described in Table 2 below.

Table 2: Potential issues with CSG production

ISSUES	CONSIDERATIONS AND MANAGEMENT
Water Use	If hydraulic fracturing is utilised, it may consume water from local sources. Depending on local water resource availability and use, this may create water use conflicts (e.g. between mining and agricultural activities). If there is a closed loop system, whereby water used in the CSG extraction process is treated and re-used at the site through either irrigation of crops (or other beneficial reuse) or reinjecting back into a target aquifer, then the impact of water use on local water resources may be reduced.
Water Discharge	Water is extracted from CSG wells during dewatering. Additionally, if hydraulic fracturing is used, wastewater is produced in the fraccing process. Volumes of wastewater (known as ‘production water’ or ‘associated water’) can be high and, depending on local groundwater conditions, the water may be saline. The water will generally need further treatment before disposing to surface water, reinjection into aquifers, use for agriculture or other beneficial reuse.
Groundwater Depletion	When the CSG well is established and the coal seam is dewatered (prior to CSG extraction), the pressure difference between the coal seam and surrounding aquifers can be changed. This can have a localised effect on natural groundwater levels. (John Williams, 2012) The potential for groundwater depletion will vary from site to site depending on the existing hydrogeology. Potential methods to manage groundwater effects include (Australian Petroleum Production and Exploration Association, 2012): • Deepening bore pumps in surrounding land areas

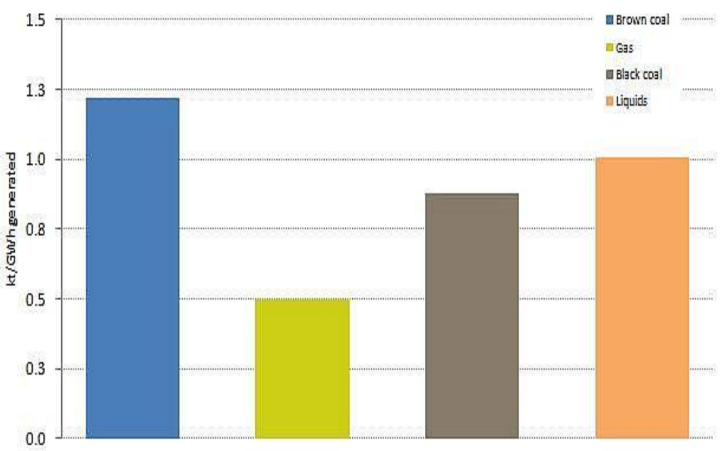
ISSUES	CONSIDERATIONS AND MANAGEMENT
	• Relocating bores into an alternative aquifer • Supplying water from alternative water sources
Groundwater Pollution	There is potential for contamination of groundwater from some chemical additives used in the hydraulic fracturing process. Note that in Victoria, New South Wales and Queensland the use of toxic additives such as benzene, toluene, ethyl-benzene and xylene has been banned. Additionally, groundwater bores can naturally contain methane (New South Wales Government Division of Resources and Energy) There are some reports of elevated levels of methane being found in groundwater wells close to shale gas fraccing facilities in the US (Scientific American, 2011). The accuracy of these reports has not been verified through this study.
Aquifer Contamination	Depending on local hydrogeological conditions there may be potential for previously separate aquifers to become cross connected either due to the coal seam dewatering process or due to the hydraulic fracturing process. If one aquifer is contaminated then it could potentially impact on the quality of the cross connected aquifer.
By-product Management	Treatment of saline wastewater using Reverse Osmosis, if required, produces treated water along with a concentrated brine stream. The brine is very saline and unsuitable for many reuse applications. Options for brine management include chemical processing to produce salt, underground injection, disposal to ocean or disposal to a waste disposal/managed landfill facility.
Greenhouse Gas Emissions	While CSG can provide a fuel with significant GHG emissions benefits (see Table 3), greenhouse gases can be emitted during the extraction and distribution of CSG. During production, methane can be released during the drilling and CSG production processes. During distribution, methane can be emitted through leaks in pipelines. Energy required during the drilling and production stages and energy needed to compress and pump the gas to consumers will also lead to greenhouse gas emissions. Assessing the greenhouse gas emissions impact requires consideration of the full greenhouse gas balance, encompassing extraction, production, distribution and consumption of CSG compared to the fuel it is replacing (e.g. brown coal).
Land Use/Agricultural Impacts	Commercial production of CSG extraction requires establishment of a number of wells typically spaced about 500m – 1500m apart. The footprint of the wells and associated road, pipe, cabling, ponds and other infrastructure can create potential for conflicts between CSG development and other land uses e.g. agriculture, public recreational areas. Opportunities to co-locate mixed land-uses will vary depending on the specific site, processes, construction (e.g.

ISSUES	CONSIDERATIONS AND MANAGEMENT
	undergrounding of pipework) and size of a CSG facility.
Traffic Impacts	Development of CSG extraction facilities could involve an increase in local traffic, due to vehicles involved in construction and operational activities. New roads and access tracks may need to be built to construct and service CSG facilities. Traffic impacts are most appropriately managed by considering these as part of site selection and planning processes.
Ecological Impacts	There is potential to affect both surface flora and fauna (including protected species and habitats) both as a result of the physical infrastructure of a CSG facility and the potential for groundwater contamination which may also subsequently affect sub-surface fauna communities. Again, ecological impacts are most appropriately managed as part of site selection and planning.
Noise Impacts	Development of CSG extraction facilities would potentially involve noise impacts due to an increase in the number of vehicles to construct the facilities and operation of the CSG facilities.
Property Prices	The potential exists for property prices to be impacted should neighbouring land be developed for the purposes of CSG extraction. Whether or not, and the extent to which, property prices are effected will depend on the siting and location of the CSG facility.
Hazards	As with the handling of any fuel, extraction and storage of CSG needs to be managed appropriately to minimise spill and fire hazards.

4.2 Potential Benefits

Table 3: Potential benefits of CSG extraction

BENEFITS	CONSIDERATIONS
Greenhouse Gas Emissions	Compared to other fossil fuels (e.g. brown coal) the emissions from the combustion of CSG, per megawatt-hour of energy produced, are much lower. CSG may therefore play an important role in assisting Australia's transition to a low carbon economy. As noted in Section 4.1, there are greenhouse gas emissions associated with CSG extraction, production, distribution and use. To understand the relative benefits of CSG compared to other fuels, a full greenhouse gas balance needs to be completed. However, it is likely that the balance will show greenhouse gas emissions reductions arising from the use of

	CSG in place of more emissions intensive fossil fuels (see Figure below showing average emissions intensity by fuel).  **Average emissions intensity of electricity generation, by fuel, 2009** *Source: SKM-MMA (2010), ACIL Tasman (2010), DCCEE analysis*
Economic Development and Energy Security- Victoria	The imperative to reduce greenhouse gas emissions, particularly related to electricity generation, will drive a transition to low/no emissions energy sources along with technologies for Carbon Capture and Storage (CCS). There will be a time lag while renewable energy and CCS technologies develop and become commercially viable. In the interim, generation of electricity from natural gas and other low emissions gas sources will play an important role. The DPI forecasts that Victoria's gas demand will double by 2030. Local reserves of gas to meet this demand have not been identified and if gas needs to be imported from other states then the price of gas to consumers will be significantly higher. (Victorian Government Department of Primary Industries (5), 2012). Having a local source of gas also improves Victoria's energy security.
Economic Development – Local	Any investment in a CSG industry would stimulate economic growth in the area. The development of the industry would create opportunities for local engineering, transport and service industries, particularly in construction of the wells and operation of gas and water processing facilities, leading to potential economic development and jobs growth in Latrobe City.
Industry Funded Initiatives	As part of the approvals process and also as part of the operating companies' Corporate Social Responsibility initiatives, the operator/owners of production facilities, such as CSG facilities, frequently contribute to the local communities in which they operate. Contributions may include education programs for local school children, the donation of equipment to local emergency services and volunteering/funding for community initiatives.

Tax Revenue	Any CSG industry within Victoria would be state approved and would provide additional tax and rates revenue to Victorian Government and Local Councils, providing funds for other projects to benefit the Victorian and Latrobe City communities.
Carbon Capture and Storage	Geological carbon storage (GCS) is the process of injecting carbon deep underground for long -term storage. GCS studies have not only looked at how carbon dioxide (CO_2) can be stored in coal but also employed to expel methane from the seam. (Victorian Department of Primary Industries, 2011) Coal deposits can absorb a high volume of CO_2 and there may be potential to use coal deposits that have had CSG extracted as storage for CO_2. The Victorian Government CarbonNet Project is investigating the potential of capturing carbon dioxide (CO_2) from electricity generation and new coal-based industries in the Latrobe Valley and moving it to Victoria's geological basins. In February 2012 The CarbonNet Project was selected by the Australian Government as a carbon capture and storage (CCS) Flagship project and awarded AU$100 million in joint Commonwealth and Victorian government funding for feasibility studies.

5 Feasibility of CSG extraction in Gippsland

There are no current coal seam gas production facilities operating in Victoria and there are no applications for new projects. The DPI website states that while the location of Victoria's coal resources is well known, the amount of associated CSG and the feasibility of extraction are uncertain. However, a number of companies have been granted exploration licences for coal seam gas. (Victorian Government Department of Primary Industries (4), 2012)

DPI data from GeoVic (online GIS database) shows that there are 5 current exploration licenses in Latrobe City and 4 applications for exploration licensees (see Appendix A).

In Australia, all CSG projects involve extraction of gas from **black coal** reserves and it has been assumed in this study that exploration in Latrobe City and vicinity is targeting CSG from brown coal reserves. It is less likely but possible that CSG could be extracted from brown coal, as there is at least one case where viable extraction of CSG from brown coal has been achieved on a large scale in the United States (Powder River Basin).

With its extremely large reserve of brown coal and the increasing incentive for low emissions gas-fired electricity generation, the potential exists for CSG to be present in the coal fields situated in the Latrobe Valley. The fact that organisations have applied for exploration licenses suggests that industry considers it possible that CSG is present. However, this study did not identify information in the public sphere that either confirms or disproves that sufficient quantities of gas exist to enable viable CSG extraction in the Latrobe Valley.

On its website, the DPI states *"Brown coal deposits in Victoria have potential for CSM (Coal Seam Methane) extraction but exploration is required to test the potential productivity of reservoirs. Issues including coal porosity and groundwater extraction need to be considered in new developments."* (Victorian Government Department of Primary Industries (2), 2011)

As noted in Section 1, older coal (e.g. black coal) found in deeper reserves, is usually of higher quality and contains greater quantities of CSG than younger coals (e.g. brown coal) in shallow deposits. Victoria has little useable, known black coal deposits but has significant reserves of shallow brown coal deposits in the Latrobe Valley.

The potential for viable quantities of CSG to be found in these younger brown coal reserves is likely to be much lower than would be the case if the reserves comprised deeper and older black coal. However, as noted earlier there are a number of factors that influence the viability of CSG extraction (including gas price) and, with the information available in the public sphere, it is not possible to come to a definitive conclusion as to whether or not CSG extraction is currently viable or likely to become viable in the future. However, given current market forces, gas supply characteristics and the limited development of CSG exploration in Victoria, it would seem unlikely that CSG production would be viable in the immediate future, which gives the region time to consider its position on the CSG industry, as the extent of CSG resources is better understood and in light of the national harmonised regulatory framework.

Factors that may influence the viability of CSG extraction in the future include:

- Gas price: Higher gas prices mean that more costly, less productive CSG projects may become viable
- Availability of gas: If alternative, local gas supplies are available (e.g. if new offshore reserves are identified and developed), then the driver for CSG development in the Latrobe Valley could be lessened.
- Technology developments: Future technologies may reduce CSG operating and capital costs or allow higher gas production rates improving the viability of CSG projects.

As the characteristics of any CSG reserves within the Latrobe Valley are not yet sufficiently understood, it is not possible to determine what processes might be used to extract the gas from the coal deposits. Brown coal tends to be more permeable/porous than black coal as explained in Section 1.1 and hydraulic fraccing is less likely to be needed to release the CSG from brown coal reserves.

6 Conclusion

The viability of CSG extraction in the Latrobe Valley is uncertain. A number or exploration licenses have been issued in the region, but the productivity of potential CSG wells is yet to be established.

There are potential issues and environmental risks associated with some CSG extraction techniques. However, the severity of these issues depends on the extraction and downstream processes used, on local site specific characteristics, particularly the hydrology and geology, and on the regulatory controls that are in place. For example, if hydraulic fraccing is not used, then water consumption and groundwater contamination risks are potentially lessened. The Victorian ban on toxic chemicals, used in the hydraulic fraccing processes overseas, also provides a level of protection against groundwater contamination.

There are potential benefits for Latrobe City and Victoria as a whole that could arise from CSG developments including economic development, energy security and the opportunity for affordable clean energy production. Again, the extent of these benefits will depend on the characteristics of the individual CSG production scheme.

The Standing Council on Energy and Resources (SCER) is developing a harmonised regulatory framework for CSG to ensure that developments are undertaken in a responsible and sustainable manner and to address key areas of community concern based on four key themes:

- water management and monitoring (including hydraulic fracturing and chemical use; and well integrity and aquifer protection)
- multiple land use framework;
- best practice standards; and
- co-existence.

This framework will provide a basis for evaluation and management of CSG developments and will be an important input to Latrobe City Council's consideration of its position on the CSG industry in the municipality.

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Appendix A - Coal Seam Gas Exploration Licenses in Latrobe City

Tenement	Renewal	Primary Owner	Address1	Address2	Address3	File Status	Expiry Date	Municipality	Area	Insp	Mineral/Stone Type
EL 4416	2	Ignite Energy Resources Pty Ltd	Level 9	267 Collins St	Melbourne VIC 3000	CURRE	11/04/2013	Latrobe City; South Gippsland Shire; Wellington Shire; East Gippsland Shire	3837.000 gr	GIPPS	Antimony; Base Metal (Cu, Pb, Zn); Coal Bed Methane; Coal (Brown or Black); Diamond; Mineral Sands; Gold/Silver/Platinum; Gypsum; Kaolin
EL 4877	2	Sawells Pty Ltd	Level 8	261 George St	Sydney NSW 2000	RENEW	09/08/2012	Latrobe City; South Gippsland Shire; Baw Baw Shire	170.000 gr	GIPPS	Coal (Brown or Black); Coal Bed Methane
EL 5081	0	Leichhardt Resources Pty Ltd	29 Woodland St		Ashgrove QLD 4060	CURRE	04/12/2012	Latrobe City; South Gippsland Shire	348.000 gr	GIPPS	Coal Bed Methane; Coal (Brown or Black)
EL 5210	0	Resolve Geo Pty Ltd	Level 8	46 Edward St	Brisbane QLD 4000	CURRE	02/06/2014	Latrobe City; Baw Baw Shire	46.000 gr	GIPPS	Coal (Brown or Black); Coal Bed Methane
EL 5274	0	ECI International Pty Ltd	352 Bay Rd		Cheltenham VIC 3192	APPLI		Latrobe City; South Gippsland Shire; Wellington Shire	309.000 gr	GIPPS	Coal Bed Methane
EL 5275	0	ECI International Pty Ltd	352 Bay Rd		Cheltenham VIC 3192	APPLI		Latrobe City; Wellington Shire	313.000 gr	GIPPS	Coal Bed Methane
EL 5322	0	ECI International Pty Ltd	352 Bay Rd		Cheltenham VIC 3192	APPLI		Latrobe City; South Gippsland Shire	97.000 gr	GIPPS	Coal Bed Methane
EL 5336	0	Mantle Mining Corporation Ltd	Suite 25	145 Stirling Hwy	Nedlands WA 6009	APPLI		Latrobe City; South Gippsland Shire; Wellington Shire	368.000 gr	GIPPS	Coal (Brown or Black); Coal Bed Methane
EL 5337	0	Mantle Mining Corporation Ltd	Suite 25	145 Stirling Hwy	Nedlands WA 6009	CURRE	19/04/2016	Latrobe City; South Gippsland Shire; Baw Baw Shire	198.000 gr	GIPPS	Coal Bed Methane; Coal (Brown or Black)

(Data from DPI from GeoVic – Provided by DPI 21st September, 2012)

Appendix B – Other Mineral Licenses in Vicinity of Latrobe City

Active	Tenement No	Tag	Type Description	Primary Owner	Application Date	Current Area	Status	District	Municipality	Mineral/Stone
Current	EL5428	EL5428	Exploration Licence	Mantle Mining Corporation Ltd	31/05/2012	25	Application	Gippsland	South Gippsland Shire	Coal (Brown or Black)
Current	EL5119	EL5119	Exploration Licence	Mecrus Resources Pty Ltd	31/10/2007	33	Application	Gippsland	South Gippsland Shire	Coal (Brown or Black);Kaolin;Base Metal (Cu, Pb, Zn)
Current	EL5429	EL5429	Exploration Licence	Mantle Mining Corporation Ltd	8/06/2012	29	Application	Gippsland	Latrobe City	Coal (Brown or Black)
Current	EL4683	EL4683	Exploration Licence	Loy Yang Power Management Pty Ltd	18/07/2002	34	Current	Gippsland	Latrobe City	Coal (Brown or Black);Gold/Silver/Platinum
Current	EL4684	EL4684	Exploration Licence	Loy Yang Power Management Pty Ltd	18/07/2002	1	Application	Gippsland	Latrobe City	Gold/Silver/Platinum;Coal (Brown or Black)
Current	EL4681	MP-EL4681	Exploration Licence	Monash Energy Coal Ltd	18/07/2002	100	Expired	Gippsland	Wellington Shire	Coal (Brown or Black);Antimony;Base Metal (Cu, Pb, Zn);Coal Bed Methane;Diamond;Gold/Silver/Platinum;Gypsum;Kaolin;Mineral Sands
Current	EL4860	MP-EL4860-24/09/2012	Exploration Licence	Sawells Pty Ltd	28/02/2005	88	Expired	Gippsland	Wellington Shire	Coal (Brown or Black);Coal Bed Methane
Current	EL5394	EL5394	Exploration Licence	Commonwealth Mining Pty Ltd	21/09/2011	170	Current	Gippsland	Wellington Shire	Coal (Brown or Black);Mineral Sands

(Data from DPI from GeoVic – Accessed 4th September, 2012)