From:	Keith Fleming
To:	IPCN Enquiries Mailbox
Subject:	Comment to add to Dr Keith Fleming" Written Submission for Santos" Narrabri CSG Project
Date:	Sunday, 9 August 2020 6:13:40 PM
Attachments:	2020 Written Submission from Dr Keith Fleming in support of my informed Objection to Santos" Narrabri CSG Project, August 9, 2020.pdf

INDEPENDENT PLANNING COMMISSION, NSW

Dear Commissioners

Please read my Additional *Comment* below in conjunction with my original submission dated August 7, 2020 (Dr Keith Fleming).

I had already submitted my written objection to the Independent Planning Commission for Santos' Narrabri CSG Project when inter-Departmental Correspondence from **Professor Peter Cook, Chair, Water Assessment Panel** (WAP) to **Stephen O'Donoghue, Director of Resource Assessment, NSW Department of Planning, Industry and Environment** (DPIE), entitled '*Post Production / Decommissioning Risks Associated with Long Term Well Integrity*', crossed my desk.

My comments on Cook's letter have explanatory relevance for my Equity considerations and Ecologically Sustainable Development (ESD) legislation, in my earlier *Submission.* Therefore, I request that you read this comment with my earlier submission. To assist you in this endeavour, **I have attached my earlier submission to this C*omment.***

I have attached a copy of my written submission to the Independent Planning Commission in strong opposition to Santos' Narrabri Gas Project, Friday, August 7, 2020.

Please forward my submission to the appropriate Commissioners for action.

Yours sincerly

Keith Fleming
(Dr Keith Fleming)

Dear Commissioners

Please read my Additional Comment below in conjunction with my original submission dated August 7, 2020. (Dr Keith Fleming)

I had already submitted my written objection to the Independent Planning Commission for Santos' Narrabri CSG Project (Fleming, 7 08 2020) when inter-Departmental Correspondence from **Professor Peter Cook, Chair, Water Assessment Panel** (WAP) to **Stephen O'Donoghue, Director of Resource Assessment, NSW Department of Planning, Industry and Environment** (DPIE), entitled '*Post Production / Decommissioning Risks Associated with Long Term Well Integrity'*, crossed my desk.

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Comment

In his letter, Cook plays down the risks of significant well failures for he is *'confident that they will be effective for many decades if not centuries'* (2020), to come. Cook's letter fails to consider long-term degradation of the wells as significant. He does not refer to the chemistry, engineering, or geophysics principles, which all foreshadow the breakdown of the concrete shielding, and well casing. Cook does not refer to overseas examples where CSG mining, and well capping have been conducted for much longer periods than the industry has been active in Australia. Cook does not refer to the NSW Equity and Ecologically Sustainable Development (ESD) Laws. These failings are unfortunate for his undue 'confidence' is indeed, misleading.

Council of Australian Governments' (COAG) Standing Council on Energy and Resources' National Harmonised Framework requires that well decommissioning and well abandonment must ensure the **environmentally sound and safe isolation of the well for the *long term*** (Cook, 2020). The phrase, **'long term'**, is significant, for CSG capping in Australia has generally only been for a 'short time'!

Cook claims that the NSW *Code of Practice for Coal Seam Gas Well Integrity* is consistent with COAG's *Code of Practice*. Although the NSW *Code of Practice* is intended to apply to all NSW CSG wells, it appears to be only formally applied to a CSG *Title* at the time of licence, or renewal (O'Kane 2014 a,b,c,). Current NSW *'legislation only requires a well to be plugged, or abandoned, and certified by the Regulator, for it to be classified as being satisfactorily abandoned. Once certified, the area is remediated and returned to the landowner, or the State' (Cook, 2020).* At present, **no ongoing monitoring by the CSG mining Company** is required.

Without monitoring data, it is not surprising that Cook can claim there is little NSW data on the long-term effects of plugged wells. This is consistent with his claim that there are very few well CSG failures in NSW, but he admits that '*potential does exist in a few instances for well failure to adversely impact on ground water quality, or*

flow' [rate] (2020). However, Cook postulates that '*the strategy cannot be to monitor every well for evermore'* (Cook, 2020). Cook did suggest a solution might be to monitor a small number of wells for 5 – 10 years, before reducing this number for monitoring for a further 10 – 15 years. If no leakages were detected he considers it would be reasonable to terminate monitoring all together.

Commissioners, the Water Assessment Panel's strategies appear to be **flawed**, for:

1 **Potential for well failure**

The WAP seem to ignore the potential for well failure following plugging.

2 **Time Scale**

15 to 30 years beyond the productive life of a well is less than a 'human generation', in time. This is far less than for a generation for most trees. A few wells may fail in 30 years, but 100% of plugged wells will fail given a sufficiently **long** period in which to decay.

3 **Concrete shielding**

Over time, the concrete shielding, and plug, both shrink.

The external shielding pulls away from the surrounding strata to which it was originally bonded.

The internal concrete plug pulls away from the internal wall of the well casing.

The concrete shielding and plug will crack with shrinkage.

The concrete shielding will crack with earth movements as strata settle following pressure reduction in the coal seam during CSG and water removal.

The concrete shielding will dissolve as a result of acid-secreting bacteria acidifying the aqueous fluids in which the external concrete shielding layer is imbedded:

$$CaCO_3 + 2H_3O^+ = Ca^{2+}\ H_2O + CO_2.$$

4 **Corrosion of the Well casing**

The well casing will corrode when in contact with an aqueous solution containing saline catalyst and oxygen. The rate of corrosion will increase in the presence of an acidic aqueous environment.

$$Fe = Fe^{2+}$$
$$Fe = Fe^{3+}$$

The Fe^{2+} and Fe^{3+} ions will form a mixture of salts, including iron oxides and carbonates ('rust').

5 **Result** The shrinking, cracking and dissolving of the concrete shielding and plug, together with the corrosion of the well casing, provide a funnel for gas and fluid movement from the targeted coal seam, to intermingle and contaminate other strata, including the atmosphere.

Given time, these natural occurrences will occur in 100% of wells. WAP's lack of data and preferred wishes have no bearing on the real long term outcome of a gas field. The problem is not in the chemistry, engineering and geophysics involved, but in NSW's own policies, and regulations for CSG mines, as well as present CSG monitoring policies and records that have led to the lack of reliable data over time.

Australia is signatory to a number of significant Environmentally Sustainable Development Conventions, including the 1983 World Commission on Environment and Development and the Rio Convention (1992). The NSW Government has enacted a number of ESD Laws. Yet, Cook makes no reference to these ESD Laws, or their implications, for CSG mining in NSW. (These ESD Laws are more fully discussed in my Written Submission, which is attached.) The three Principles of Equity include:

(eg ***INTRA*-GENERATIONAL EQUITY**
Equity within the present generation
e.g. *'People within the present generation having equal rights to benefit from the exploitation of resources and from the enjoyment of a clean and healthy environment.'* (Protection of the Environmental Administration Act (NSW) 1991.)

***INTER*-GENERATIONAL EQUITY**
Equity between present and future generations
Conservation of Options
Conservation of Quality
Conservation of Access
e.g.*'The present generation shall ensure the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.'* (Protection of the Environment Administration Act (NSW) 1991.)

***INTER*-SPECIES EQUITY.**
Ecological sustainability (Westra, L, Bosselmann, K, Soskolne, C, 2011)
Ecological Justice. (Westra, L, Bosselmann, K, Soskolne, C, 2011)

The outcomes from these three **Principles of Equity** provide for the **'***maintenance of a healthy, diverse and productive environment, now and in the future'* (Preston, 2017).

NSW Legislation also reflects outcomes from the 1983 World Commission on Environment and Development (**Brundtland Report, - *Our Common Future* (1987)):**

> ***Our Common Future*** *(1987)*
>
> e.g. Sustainable development is: *'Development that meets the needs of the present without compromising the ability of future generations to meet their own needs'.*

as well as the:

> ***Rio Declaration*** *on the Environment and Development (1992)*
>
> e.g. *'The right to development must be fulfilled so as to equitably meet development and environmental needs of present and future generations'.*

Surely these ESD Laws should be directing CSG Policies in NSW! Instead, we find:

1 **WAP and DPIE Policies** do not appear to reflect Equity and ESD Laws

2 **The 15 – 30 year monitoring period** for plugged wells suggested by Cook does not equate to Geological time of thousands, or millions of years. 30 years is less than one human generation, and a small fraction of the 'generation' period for most trees.

3 **Evidence for well leakage** is available if we care to look towards areas that have been CSG mined over many years. For example, Voltz (2011) acknowledges that there are tens of thousands of leaking wells in North America, not just a 'few' as claimed by Cook! The different time scales involved in the North American and NSW CSG fields, as well as the respective number of wells in the two Regions, will be major contributors to the differences in the claims of Cook and Voltz.

4 **Commissioners,** the worst scenario may not occur in our short lifetimes, but it **will occur!** It should not be the NSW Government's role to fund restoration of failed wells into the future. The **Polluter Pays Principle** identifies Santos to be the potential Polluter (if permitted to implement their unsafe proposal in the sensitive Narrabi Region) and therefore Santos is the responsible entity to fully clean up their below ground infrastructure so that it will not leak, **in the long term! The 'long term' is the operative variable, here!**

Conclusion

NSW's short term CSG monitoring policy is flawed, as is its Code of Practice for CSG mining. Lack of application beyond the CSG *Title* at the time of licence, or renewal is inadequate, and is inconsistent with NSW ESD Laws. Cook's letter demonstrates WAP's limited understandings of natural CSG well breakdown following plugging, for the **long term**. There appears a demonstrated need for research and learning from overseas CSG ventures to avoid reinventing known issues previously encountered.

Commissioners, as I see it, there appear three options:

1 Require the Department to develop meaningful regulations consistent with NSW ESD Laws, and the **long term** chemistry, engineering and geophysics principles operating for well decommissioning and well abandonment, which require environmentally sound and safe isolation of the well for the ***long term***.

2 Ignore the long-term chemistry and engineering effects as the DPIE and WAP appear to be doing and be responsible for the long-term destruction of the Narrabri CSG mining area, including the Great Artesian Basin's recharge aquifer, into the future.

3 Refuse Santos' application for CSG mining in its proposed sensitive Narrabri area, a decision which supports the retention of the area in a manner consistent with NSW's ESD Laws, and avoids the destruction of the Great Artesian Basin's recharge aquifer into the future.

Requested Action

Commissioners, acting in your roles, *in loco parentis,* for communities now and in the future, and here I refer to both human and non-human communities, I urge you to recommend to the Government in the strongest possible terms, the rejection of this unsafe, unfit for purpose, Santos' Narrabri Gas proposal and its associated EIS, which is clearly not in the 'long term' public interest.

REFERENCES

Brundtland Report 1987 *Our Common Future* United Nations, Oxford University Press.

Cook, P. 2020 *Post Production / Decommissioning Risks Associated with Long Term Well Integrity*, NSW inter-department correspondence, 07 08 2020.

Fleming, K. 2020 *Written Submission to the Independent Planning Commission in support of my Informed Objection to Santos' Narrabri CSG Project*, Submitted to Independent Planning Commission 8 08 2020.

NSW Department of Planning, Industry and Environment 2020 *Narrabri Gas Project*, dpie.nsw.gov.au

O'Kane (2014a) *Independent Review of Coal Seam Gas Activities in NSW - Managing environmental and human health risks from CSG activities,* September 2014. Office of the Chief Scientist and Engineer of NSW. http://www.chiefscientist.nsw.gov.au/__data/assets/pdf_file/0006/56922/140930-Final-Managing-Environmental-and-Human-Health-Risks.pdf

O'Kane (2014b) *Independent Review of Coal Seam Gas Activities in NSW - Study of regulatory compliance systems and processes for coal seam gas*, September 2014. Office of the Chief Scientist and Engineer of NSW. http://www.chiefscientist.nsw.gov.au/__data/assets/pdf_file/0006/56913/140930-Final-Compliance-Report.pdf

O'Kane (2014c) *Independent Review of Coal Seam Gas Activities in NSW* Information paper: Abandoned wells. Office of the Chief Scientist and Engineer 17p. https://www.chiefscientist.nsw.gov.au/__data/assets/pdf_file/0009/56925/141002-Final-Abandoned-Well-report.pdf

Preston, B (Chief Judge of the NSW Land and Environment Court) 2017 *What's Equity Got To Do With The Environment*, Sir Frank Kitto PC AC KBE KC Public Lecture, UNE.

Rio Declaration on Environment and Development 1992 *Conference on Environment and Development*, United Nations.

Volz 2011 Private Communication

Westra, L, Bosselmann, K, Soskolne, C 2011 *Globalisation and Ecological Integrity in Science and International Law,* Cambridge Scholars Publishing

Incl.

Written Submission to the Independent Planning Commission
in support of my Informed Objection to
Santos' Narrabri CSG Project
August 08, 2020

Dr Keith Fleming

Section 1 Reflections from David Kitto's *live Presentation*, 01 08 2020, 3.15pm.

Thank you **Independent Planning Commissioners (IPC),** for sharing David Kitto's (NSW Department of Planning, Industry, and Environment (DPIE) Executive Director, Resource Assessments and Business Systems) *live Presentation* through 'Zoom', Saturday, August 01, 2020, 3.15pm. Kitto's *Presentation* demonstrated that his Department is charged with carrying out the wishes and *Policies* of the NSW Government. Concern for the effects the project might have on people, other animals, plants, and non-animal or non-plant nature, *now* and *into the future,* appears not be part of the Department's brief. Without appropriate safeguards, many of Santos' Narrabri CSG proposed actions would appear to lie outside NSW's, and our Nation's Laws.

Most striking was Kitto's dismissal of previous *Presenters'* testimonies by his sweeping claim that *Presenters* had generally emphasised the science but nobody had shown what would happen to the aquifer (2020). Kitto's disregard for science began with the very first Question, when he appeared reluctant to agree that it might be possible for a flare to ignite combustibles in the surrounding environment. Let me assure you that this, and other unpredicted happenings, have occurred in the past.

For example, it was probably in the late 1950's when I was a child living in Port Kembla, that the 'unexpected' happened. One night, the BHP Steelworks' gas flare was unexpectedly extinguished. A strong stench of unburnt gas could be smelt for several kilometres to the south east of the BHP Steelworks' Gasometers, and flare chimney. Suddenly, there was an 'enormous' bang as a huge unburnt gas bubble, floating just above ground level, re-ignited. Considerable damage occurred to buildings and facilities for several kilometres down wind of the flare chimney! I was separated from the disaster zone by Green Hill, a small rise separating Port Kembla from Warrawong, which suffered most of the damage.

Commissioners, let me assure you, the risk of flare failure and localised combustion is REAL. Kitto's dismissal of the question as 'unlikely' indicates that the question had not been fully researched, and the possible consequences of such an emergency not fully considered! Based on the science, I would suggest a similar happening, wherever flares are used, is PREDICTABLE. Also PREDICTABLE is the result, should a flare outage/explosion occur. And this result is PREDICTABLY well beyond the capacity of most Companys' small fire offices to deal with, unaided.

Kitto's apparent ignorance of the science (as distinct from his knowledge of Santo's proposal) was surprising. Is Kitto, and the DPIE, required to downplay known Science Principles in favour of the Government's desired outcome? Many *Presenters*, have suggested the results of Santos' proposed actions will linger in the affected area for hundreds, or thousands of years beyond the lifetime of the project. This would include surface water drawdown (200 years) (Kitto, 2020) and the degrading of the

Great Artesian Basin (GAB) into the future. This would be long after Santos has gone from the area, should the Santos' Narrabri CSG proposal be approved. These long-term environmental changes would clearly breach the *Principles of Ecologically Sustainable Development (ESD) (Preston, 2017),* including *intra-generational, inter-generational and inter-species Laws,* enacted by our Governments. These include, among others, the *Precautionary Principle,* the *Polluter Pays Principle*, and *Conservation of Options*, *Conservation of Quality* as well as the NSW Occupational Health and Safety Laws, and Regulations. With such legal impediments, Santos' Narrabri CSG Gas Program cannot be 'fit for purpose' (NSW Department of Industry, Planning and Environment, 2020)! In stark contrast, Kitto appears to apply the *Precautionary Principle* as *the* lever to enable acceptance of Santos' incomplete methodology. Commissioners, surely any application for CSG mining development must fully address the NSW *OHS* and *Equity* Laws to eliminate ***pre****-determination*, all known and probable issues. The *Precautionary Principle* is an inclusion in the *Equity Principles* Laws, allowing for necessary adaptive changes and preventative measures to be taken, should they prove necessary in an **emergency**, **now**, and **in the future**. The NSW Government has enacted ESD Laws, but the Department appears to be ignoring these laws in its '*Narrabri Gas Project'* publication (NSW Department of Planning, Industry and Environment, 2020).

The manner in which Kitto is prepared to push nature conservation into small, available parcels of land with little or no continuum, shows Kitto's lack of understanding that all parcels of land are not equal, and that small interspersed parcels do not equate to a larger continuum of land destroyed for CSG development. Does Kitto understand how native species have evolved and survived on these lands? Again it is clear that DIPE has failed to address the three *Principles of Equity* in their preparation of their *'Narrabri Gas Project' Report (2020).*

I was staggered by Kittos' response to the possible problem of reduced water availability, which was simply to *'lower the bore'* (Kitto, 2020). At whose expense? Santos' may be long gone if we are to believe Kitto's suggestion that surface drawdown probably will not begin for 200 years after the life of the project (Kitto, 2020)! Where is the research that leads to this figure? How are the trees and other plants expected to extend their root systems to the changing water table depth if the roots are already at their maximum depth for their species? Where is the research for Santos to meet interspecies equity, now and in the future? Are Kitto and the DPIE ignorant of the need for scientific studies, to establish answers to these questions *before-determination,* and not *after-determination,* if Santos is to satisfy the Laws of this State and Nation. Extensive baseline studies are an essential part of this *before-determination* preparation!

Commissioners, thank you for disclosing the true colours of David Kitto and the NSW Department of Planning, Industry and Environment. I disagree with the DPIE's suggestion that the Santos' Narrabri CSG proposal is *'fit for purpose'* and their recorded *Conclusion* that *'the project is in the public interest and is approvable subject to strict conditions' (*NSW Department of Planning, Industry and Environment*, 2020).*

Please, I look forward to your Independent evaluation of Santos' Narrabri CSG proposal.

Section 2 Objection to Santos' Narrabri Gas Project

Introduction

Independent Planning Commissioners (IPC), your recent Santos' Narrabri CSG Proposal live *HEARING* highlighted many significant failings in Santos' Narrabri Gas proposal and its associated EIS. The NSW Department of Planning, Industry, and Environment's (DPIE) *'Narrabri Gas Project'* has been heavily criticised for its apparent lack of independence and unjustifiable scientific assessment.

My initial submission to the DPIE (attached) considered 6 pivotal issues and showed how each would pose unacceptable risks to humans, other animals and plants, as well as non-animal, and non-plant species, natural waters, land and air environments. **The Science Principles informed us that Santos' Narrabri CSG proposed extraction procedure is flawed and designed to fail. Planned sitings of wells and MSDS provisions are incomplete. Corrosion of proposed plant and infrastructure will ensure the failure of 100% of wells over time. Contamination of, and reduction in recharge capacity of the aquifer feeding the Great Artesian Basin, will occur. Drilling for the wells will fracture the coal seam's cap rocks, as well as higher strata, permitting fugitive gas to escape to the surface. Water and gas mixing, and contamination of all aquifers, will occur. The predicted small surface water drawdown appears non-justified in the EIS. *Any* drawdown will impose a future change in land use for this significant, Narrabri 'food bowl'. The Pilliga State Forest will itself be endangered, as will its already endangered species. High spill rates from the pilot project question Santos' competence in conducting a significantly extended gas field. The proposed Narrabri Gas field appears inappropriately selected, and researched and the EIS incompletely prepared.**

My *Presentation* to the IPC (July 24, 2020) considered only the corrosion issue and illustrated that with 100% of the iron and steel well casings and tubes failing over time, several Ecologically Sustainable Development Laws (ESD) would be breached. For example, the resulting contamination of the Great Artesian Recharge Aquifer, and higher aquifers, through the corroded well casings and tubes, would influence land uses of the mined region by the present and future generations' and would, therefore, breach our enacted Laws.

My present submission will illustrate that if the Santos' Narrabri CSG Project should be implemented, each of my 6 original *pivotal issues* will not only breach scientific principles, but will also fail our ESD Laws and OHS Laws and Regulations!

Expertise

My Ph.D. is in Chemistry. I have worked in industry, analysing boiler water for saline contamination, to identify boiler failure from corrosion, similar to what will occur with CSG well casings, and tubes. Tertiary teaching has included environmental and pollution studies. As the elected Chairperson for two large tertiary educational institutions' OHS Committees, I have considerable experience in risk management procedures.

Safety of Santos' Narrabri CSG Proposal
To be acceptable, an EIS must be scientifically **SAFE** in its operational environment. Implementation of the 'SANTOS NARRABRI CSG PROPOSAL' cannot be scientifically safe in its proposed sensitive Narrabri environment.

A mining proposal must be compliant with NSW and Australian Laws. Santos' Narrabri CSG proposal does not appear to meet existing NSW ESD and OHS Laws and Regulations.

Therefore, Santos' Narrabri CSG Proposal appears doubly flawed, firstly failing Scientific Principles, and secondly by failing our NSW Laws.

Objection
Santos' Narrabri CSG Gas Proposal and associated EIS does not appear to seriously consider established Scientific Principles, including the Chemical Principles involved. Santos' Narrabri CSG proposal does not appear to satisfy its ESD, and OHS Legal commitments at its proposed Narrabri site. These significant failings do not appear to have been flagged in the DPIE's *'Narrabri Gas Project' Report (2020).*

Therefore, I must **strongly OBJECT** to this unsafe, unfit for purpose procedure, and recommend to you that 'SANTOS' Narrabri CSG proposal be rejected.

Legal Considerations

Mining Development in Australia is controlled by National and State Laws.

Judge Brian Preston, Chief Judge of the Land and Environment Court of NSW (2017), identified **Equity** as *THE* principal consideration when the Land and Environment Court rules on development applications. The Laws of Equity to which Preston refers require **Evenness, Fairness and Justice in the sustainable development** of the environment.

Preston (2017) points out that in any environmental development decision, there will be 'winners' and 'losers', whilst many others will be bypassed. Preston points out that in legal terms, the winners and losers include people from the **present generation (intra-generational Equity)**, people of **future generations (inter-generational Equity**, as well as **non-human nature, both present and future (inter-species Equity)**. Achieving **Equity** among these communities involves:

***INTRA*-GENERATIONAL EQUITY**
Equity within the present generation
e.g. *'People within the present generation having equal rights to benefit from the exploitation of resources and from the enjoyment of a clean and healthy environment.'* (Protection of the Environmental Administration Act (NSW) 1991.)

***INTER*-GENERATIONAL EQUITY**
Equity between present and future generations
Conservation of Options

Conservation of Quality
Conservation of Access
e.g.'The present generation shall ensure the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.' (Protection of the Environment Administration Act (NSW) 1991.)

***INTER*-SPECIES EQUITY.**
Ecological sustainability (Westra, L, Bosselmann, K, Soskolne, C, 2011)
Ecological Justice. (Westra, L, Bosselmann, K, Soskolne, C, 2011)

The outcomes from these three **Principles of Equity** provide for the **'***maintenance of a healthy, diverse and productive environment, now and in the future'* (Preston, 2017).

Australian legislation also reflects outcomes from the 1983 World Commission on Environment and Development (**Brundtland Report, - *Our Common Future* (1987)):**

Our Common Future *(1987)*
e.g. Sustainable development is: *'Development that meets the needs of the present without compromising the ability of future generations to meet their own needs'*.

as well as the:

Rio Declaration *on the Environment and Development (1992)*
e.g. *'The right to development must be fulfilled so as to equitably meet development and environmental needs of present and future generations'*.

The Santos' Narrabri CSG Project and its associated EIS fail to reflect these Ecologically Sustainable Development Laws. This is demonstrated in Table 1 through a comparison of my *six pivotal issues*, submitted to the DPIE in May, 2017, with selected operative ESD and OHS Laws.

Table 1. Comparison of the *six pivotal issues* with their operative ESD Laws

#1	Corrosion of Iron and Steel	Comments / ESD Laws
	Iron and steel, in the presence of **water, oxygen and saline catalysts**, will readily oxidise the iron component of the steel alloys used in the well casings and tubes.	Basic Chemistry Principles. **Corrosion of iron and steel** is a **predictable, natural occurrence**.
	Protective coverings such as **paint, galvanising, concrete shielding and sacrificial electrodes**, without regular **maintenance, reapplication, and replacement**, will only **delay** corrosion failure.	Basic Chemistry Principles. Many industries (e.g. paint, sacrificial electrodes) exist to facilitate **delaying** iron corrosion, but only whilst **maintenance is active.**
	Corrosion of proposed plant and infrastructure, and this includes the CSG well casings and tubes, will ensure the	Basic Chemistry Principles. **Corrosion of iron and steel** is, a **predictable, natural occurrence.**

	failure of **100% of wells** over time.	
	Clean-up of the **below ground infrastructure** on the site appears left to future generations to deal with.	Out of sight does not mean corrosion stops and pollution transfer stops! **Leaving site clean-up for later generations to implement fails the Polluter pays Principle, inter-generational Equity, and interspecies Equity ESD Laws**.

Santos' failure to commit to **removing subsoil infrastructur**e (eg well casings and tubes) or **managing the Narrabri CSG mining area into the future,** following the active life of the gas field, is unacceptable, for it breaches the **Polluter Pays Principle** the **inter-generational Equity Principle, and interspecies Equity Principle)**! It is necessary, but by no means sufficient for Santos to fully clean up, seal, and manage into the future, all subsoil contamination and rock strata fractures.

#2	**Planned siting of wells incomplete**	**Comments / ESD Laws**
	The Narrabri Gas EIS does not include a **detailed well site plan for the entire field**.	Without a plan for the **entire field**, Santos is in no position to evaluate, *a priori*, **the personal, social and environmental, effects** of their proposed EIS. Other members of the community are also prevented from evaluating the array and effects it might impose on them, or their community. This uncertainty **fails the ESD precautionary Principle**, as well as the **intra- and inter-generational equity Principles**.

The **non-inclusion of a complete well site plan in Santos' EIS prevents** the DPIE from evaluating, *a priori,* the full Santos' proposal. Santos' failure to provide the complete well site plan also prevents the present community from **'fairly' assessing and commenting on the proposed complete plan. Equity** is therefore prevented as it is not possible to achieve a **'fair result reached by a fair process'**! The principles of equity are again compromised, failing the three Equity Principles (**intra-generational, inter-generational, and inter-species Equities), and** *'The right to development must be fulfilled so as to equitably meet development and environmental needs of present and future generations' (Rio Declaration, on the Environment and Development, 1992)*

#3	**Rock strata above the coal seam will be fractured**	**Comments / ESD Laws**
	The planned wells in the Narrabri Gas EIS will pass through several different rock strata. Each layer possesses different properties, porosities, water contents and pressures. All layers above the targeted coal seam will be breached to enable access to the desired coal seam. The integrity of each of these layers, including the capping layer retaining the gas within the coal seam, the significant recharge conduit for the Great Artesian Basin, and higher aquifers, as well as the intervening rock strata, will be fractured.	Basic geological, geochemical and hydrological principles.
	Faulting is present in the Jurassic and Permian deposits. Santos acknowledges the risk, although its significance is played down, in its Narrabri Gas EIS and Supplementary materials (Santos, 2017(a)).	Establishment of the extent of faulting is incomplete. The failure of Santos to determine the true extent of faulting, *pre-determination,* fails the necessary **baseline** requirements. As a result, the **Precautionary Principle** is compromised. **Fairness and justice cannot be obtained. intra-generational, and inter-generational Equities are not achieved.**
	When pressure is released from the coal seam, not only is the coal seam split further, liberating the adsorbed coal seam gas, but the **isolating cap rock** and the **rock layers it supports** will also **fracture**, permitting **interchange of liquids and gases** between the supra-rock layers, the ground surface and the atmosphere.	The contamination of strata, including aqueous layers, above the targeted coal seam fail the **ESD Principles of inter- and intra-generational**, and **inter-species equity,** the **Polluter Pays Principle**, and the **Precautionary Principle,** incorporated in our Laws
	Inadequate **Baseline data** in the Santos' initial EIS, and Supplementary materials prevents monitoring changes over time.	Recent work by the CSIRO has confirmed the region of Santos' Narrabri CSG Proposal lies entirely within the GAB 'intake' region (Currell, 2018). To check for contamination issues, a wide range of variables, including geochemical, microbiological, and hydrological controls, recharge

	a. Effect on liquid gurgitation Mixing of waters between the surface, subterranean aquifers and coal seams will occur as waters percolate through the fractured rock strata. **b. Effect on gaseous movement** The pressurised coal seam gas will be forced upwards through the fractured rock strata along the pressure gradient towards lower surface pressures. **c. Effect on surface environment** Fugitive gas and liquids, as well as solid and liquid spills, are spread by wind, rain and physical movements (e.g. truck tyres).	rates, water flow paths and rates, CO_2 concentrations, presence of other contaminants and their concentrations, and pressures, are only a few of the essential variables to be traced. These Baseline Data monitorings must be available *pre-determination* to ensure the **intra-, and inter-generational Equity Principles are observed.** **Contamination of the surface, each aquifer, and the coal seam will result.** The three **Principles of ESD, intra-, inter-generational and inter-species Equity**, as well as the **Precautionary Principle** and **Polluter Pays Principle**, will be violated. Physical Principles predict the movement of gases and liquids along existing pressure gradients. Without strategies to avoid contaminations from occurring, *pre-determination,* the three **Principles of ESD, intra-, inter-generational and inter-species Equity**, as well as the **Precautionary Principle** and **Polluter Pays Principle** will be violated. Contamination of the surface, each aquifer, and the coal seam by fugitive gas is a predictable and significant outcome. Without the identification of strategies to prevent the occurrence and dispersal of these contaminates the three, *pre-determination,* the **Principles of ESD, intra-, inter-generational and inter-species Equity**, as well as the **Precautionary Principle** and **Polluter Pays Principle will be violated**.

	d. Effect on environmental (including human) health The release of fugitive gas and waters from the coal seam will contaminate all subterranean and surface aquifers, soils and the atmosphere.	The release of fugitive gas and waters from the coal seam are predictable occurrences. Fugitive gas contains **carcinogens, teratogens and other poisonous substances**, which will affect humans, other animals, and plants, as well as non-human and non-plant species. Without strategies identified, *pre-determination,* to prevent dispersal of contaminates to subsurface strata and aquifers, and from entering the atmosphere, the three **Principles of ESD, intra-, inter-generational and inter-species Equity**, as well as the **Precautionary Principle** and **Polluter Pays Principle**, will be violated.

Santos' failure to acknowledge the significance of their proposed CSG extraction for humans, other animals, plants, and non-animals and plants species conflicts with our Government's Laws, particularly the **Principles of ESD inter- and intra-generational Equity**, **Inter-species Equity** and the **Precautionary Principle** and **Polluter Pays Principle**. The Rio Declaration *'The right to development must be fulfilled so as to equitably meet development and environmental needs of present and future generations'* will also be breached. Santos' proposed methodology is not only unsafe in terms of scientific Principles, but also unacceptable in the Narrabri operational environment in Legal terms.

#4	**High Spill Rates during pilot Study**	**Comments / ESD Laws**
	Santos has reported 20 spills from only 50 wells sunk during the pilot plant stage conducted in the Pilliga State Forest. (North West Alliance, undated). The escape of *'Produced Water'* from these spills contaminates the surface soils with foreign chemical substrates and concentrations. Some of these contaminates would be deliberately added to the well by the company during CSG extraction, others released from within the pressurised, fractured coal seam. These contaminates may include carcinogens, teratogens, and poisonous substances, such as benzene, toluene, xylene, ethyl benzene, uranium compounds, lead compounds and	If 5% of wells are predicted to leak in the first year, and all others to fail sometime in the future, the procedure cannot be safe. A failure risk of 100% over time is predictable and totally unacceptable in the sensitive Narrabri environment. Santos' spill rates **fail** the **Principles of ESD intra- and inter-generational Equity**, **and inter-species Equity,** as well as the **Precautionary Principle, the Polluter Pays Principle, and the Rio Declaration's** *'The right to development must be fulfilled so as to equitably meet development and*

	cadmium compounds.	*environmental needs of present and future generation'.*

Without regular maintenance into the future, the **failure of 100% of wells over time** is a **natural consequence** of corrosion of iron and steel in the presence of water, oxygen and saline catalyst. **Santos' projected procedure is designed to fail!** This is basic Chemistry!

This is not an acceptable risk. To expect present and future communities to accept these failures, and at the same time have the environment flourish, without deleterious feedback mechanisms, is naive.

The spill figures demonstrate that Santos does not have the competence to manage 50 wells safely. **How can Santos legitimately claim competence to manage an extended number of 850 wells, safely?**

Failure of the **Principles of ESD inter- and intra-generational Equity, inter-species Equity**, as well as the **Precautionary Principle** and **Polluter Pays Principle**, places the Santos' Narrabri Gas' unsafe proposal in conflict with our Governments' Laws.

#5	**MSDS**	**Comments / ESD Laws**
	The Narrabri Gas EIS lists a number of substances Santos proposes to use in its drilling programme. Only some of these substances have standard MSDS included in Santos' Narrabri CSG EIS. I have been unable to find MSDS for these and other substances when applied ***to their particular process*** for which they have been selected. Without appropriate 'active' MSDS details for each substance, **as used**, the **safety of each chemical in, and following its use, cannot be determined.**	**These chemicals cannot be assumed safe!** **The omission of selected MSDS from Santos' Narrabri CSG EIS breaches the State's OHS Act and Regulations**! The omission also fails the **intra-generational Equity Principle, probably the inter-generational Equity Principle, and the Precautionary Principle.** **Any company wishing to conduct an activity on campuses for which I was OHS Convenor would not have been permitted entry to the site!**

Without the provision of ***All* MSDS** in any company's EIS to support its project's proposal, and this includes Santos' Narrabri Gas EIS, the company's proposal is incomplete and **MUST FAIL** the **NSW OHS Act,** and its **Regulations**. These MSDS omissions would make the implementation of Santos' Narrabri Gas proposal illegal, and therefore Santos' Application totally unacceptable. In addition, to be applicable in the sensitive Narrabri Region, the MSDS must be relevant for their ***active* roles for which they were selected**. Without all active MSDS Santos is in no position to evaluate, *a priori*, **the personal, social and environmental, effects** of their proposed EIS.

#6	**Water draw-down**	**Comments / ESD Laws**
	Santos' Narrabri Gas EIS has acknowledged surface water drawdown will occur 'up to 0.5m' (*Santos, 2017*(a)), following produced water loss and the removal of CSG from the Narrabri Field. Santos (2017(b)) predicts a maximum Early Permian drawdown of 153m and Late Permian drawdown of 16.4m. Appendix F claims the Great Artesian Basin will experience a drawdown of <0.5m, similar to the water table prediction.	The water table and Great Artesian Basin figures seem inconsistent with the Permian strata predictions. I have been unable to justify these figures from the limited data available in Appendix F.
	Any lowering of the surface water table will affect agricultural use of the land as well as forest growth. When the water table drops below the depth required to support a plant's root system, all life dependent on that plant will be affected. The plant communities in the Pilliga State Forest, as well as dependant animals, some of which are critically endangered, will also be negatively affected. The EIS claims two endangered species will be affected but appears to ignore other species in the Pilliga State Forest, and elsewhere in the project area (Santos, 2017(c)).	It is predictable that such action would jeopardise the nationally significant Narrabri 'food bowl' in Santos's proposed project area. Pilliga State Forest will also be affected. If Santos' Narrabri Gas Proposal is approved, changes to established practices will be experienced in the Narrabri Region, throughout NSW, and our Nation!

The Nationally and State significant Narrabri food bowl, Pilliga State Forest and other animal and plant communities, which are dependent on these plants, and water for their survival, will be compromised. When the present water table drops as a result of Santos' CSG extraction, the **ESD precautionary Principle**, as well as the **intra- and inter-generational, and inter-species Equity Principles together with the Rio Declaration,** *'The right to development must be fulfilled so as to equitably meet development and environmental needs of present and future* generation', will be breached. If this occurs at 'some time in the future' beyond the life of the gas field (Kitto (2020) claims after 200 years), who will compensate for the failure under the Polluter Pays Principle?

Conclusion

David Kitto and his NSW Department of Planning, Industry, and Environment is a NSW State Government Department charged with carrying out the wishes and *Policies* of the NSW Government. The Department and its members are therefore not free to exercise independent judgement in their adjudications. The Department's publication, *(2020),* must be viewed as a **political publication**.

The procedure in the 'Santos' CSG proposal and EIS is, clearly **doubly flawed, firstly on scientific grounds, and secondly on legal grounds. Santos' Narrabri Gas proposal and its EIS, if implemented, will breach long established Scientific Principles. The proposed extraction procedure is, therefore, flawed and designed to fail. 100% of wells will corrode, providing contamination pathways between aquifers, rock strata, the earth's surface and atmosphere. With reduced pressures in the targeted coal seam, the supra rock strata will fracture, and land subsidence will occur, providing contamination channels for liquids and gases following pressure gradients. Any surface drawdown will impose a future change in land use for the Narrabri 'food bowl'. Pilliga State Forest will also be endangered.**

The occurrence of these scientifically predictable changes over time, will breach State and National Environmentally Sustainable Development Laws, including the 3 Principles of Equity, as well as the Rio Declaration, and *Our Common Future* based legislation.

Santos' proposed Narrabri CSG EIS is incomplete for the siting of all wells planned for the Narrabri gas field. All required MSDS are not listed in the EIS. Without the full compliment of MSDS Santos' Narrabri CSG Application, and EIS, would violate the NSW OHS Act and Regulations. Surely, the approval of the application would itself be illegal. The **Narrabri CSG Gas proposal is not immune to these equity and OHS considerations.**

Santos' Narrabri Gas proposal and EIS are unsafe in the sensitive Narrabri environment. They fail to present Equity, fairness, and justice towards intra-generational, or inter-generational, or inter-species communities. The lack of provision for the maintenance of an healthy, diverse and productive environment, now and into the future, confirms the Narrabri Gas EIS does not meet necessary National and State Environmentally Sustainable Laws and standards. I fail to understand how the Department of Planning, Industry and Environment can justify their *Conclusion* stated in the *'Narrabri Gas Project'* (2020) is 'Fit for Purpose', when the proposal does not work within established scientific Principles, and NSW Laws. To be 'Fit for Purpose' the Narrabri Gas EIS must meet all intra-generational and inter-generational and inter-species Equity Laws, and OHS Laws, which it clearly does not.

Requested Action
Commissioners, acting in your roles, *in loco parentis,* for communities now and into the future, and here I refer to both human and non-human communities, I urge you to recommend to the Government in the strongest possible terms, the rejection of this unsafe, unfit for purpose, Santos' Narrabri Gas proposal and its associated EIS, which is clearly not in the public interest.
REFERENCES

Brundtland Report 1987 *Our Common Future* United Nations, Oxford University Press.

Currell, **M.** 2018 *Review of Santos Narrabri Gas Project Response to EIS Submissions, School of Engineering, RMIT, Melbourne*.

Kitto, **D.** 2020 *Independent Planning Commission's Live Hearing* with the Department of Planning, Industry and Environment, NSW Government, 01 08 2020, 3.15pm.

North West Alliance (undated) The Spills – CSG Free North West NSW, *www.csgfreenorthwest.org.au/the_spills?utm_campaign=spea*

NSW Department of Planning, Industry and Environment 2020 *Narrabri Gas Project,* dpie.nsw.gov.au

Preston, B (Chief Judge of the NSW Land and Environment Court) 2017 *What's Equity Got To Do With The Environment*, Sir Frank Kitto PC AC KBE KC Public Lecture, UNE.

Rio Declaration on Environment and Development 1992 *Conference on Environment and Development*, United Nations.

Santos, 2017(a) Narrabri Gas EIS, Chapter 12, *Section 12.4.2*, page 12-23

Santos, 2017(b) Narrabri Gas EIS, Appendix F, *Sections 8-9*

Santos, 2017(c) Narrabri Gas EIS, Chapter 4, *Section 4.6.1*, page 31-32

Schwager, K, 2017 *Narrabri Gas Project Development Application and Associated EIS*, Santos.

Westra, L, Bosselmann, K, Soskolne, C 2011 *Globalisation and Ecological Integrity in Science and International Law,* Cambridge Scholars Publishing

Incl.

Fleming, K 2017 'Objection to Santos' Narrabri Gas EIS', May 4, 2017

submitted to: Executive Director, Resource Assessment
Department of Planning and Environment
GPO Box 39
Sydney NSW 2001

Objection to Santos' Narrabri Gas EIS
emailed to:
NSW Executive Director, Resource Assessment
Department of Planning and Environment
May 4, 2020

Dr Keith Fleming

May 4, 2017

Attention:
Executive Director, Resource Assessments
Department of Planning and Environment
GPO Box 39
Sydney NSW 2001

The target for my submission is the Narrabri Gas EIS.

I strongly OBJECT to this proposal and recommend that it should be rejected.

Background.

My Ph.D. is in Chemistry and I have worked in industry analysing boiler water for saline contamination, the presence of which would identify boiler tube failure.
I have been elected Chairperson of Occupational Health and Safety Committees for two major tertiary institutions and am experienced in risk management strategies.

Justification for my Objection

1. **Corrosion of Iron and Steel**

   Iron and steel, in the presence of water, oxygen and saline catalysts, will readily oxidise the iron component of steel alloys. (This was demonstrated recently when a local swimming pool was forced to close following boiler failure and more recently by the corrosion of its old steel filter bowl. Corrosion over time has predictably destroyed the integrity of the pool's infrastructure. Presently, the old plant is being replaced.)

   Corrosion of iron and steel is a predictable, natural occurrence. Protective coverings such as paint, galvanising, concrete shielding and sacrificial electrodes, without regular maintenance, reapplication, and replacement, will only delay corrosive failure. (i.e. **Iron and steel plant and its infrastructure will fail at some time in the future.)** The Narrabri Gas EIS contains no plan for maintenance of plant and replacement of equipment and infrastructure beyond the projected life of the project.

The limitation of the maintenance of plant, equipment and infrastructure for the projected extraction period of the Narrabri Gas EIS exemplifies the proposed procedure is flawed necessitating the project to be rejected.

2. Planned siting of wells is incomplete

The Narrabri Gas EIS does not include a detailed well site plan for the entire field. Without this plan Santos is in no position to evaluate, *a priori*, the personal, social and environmental, affects of their proposed EIS.

The Narrabri Gas EIS is incomplete and should be rejected.

3. Rock strata above the coal seam will be fractured

The planned wells in the Narrabri Gas EIS will pass through several different rock strata. Each layer possesses different properties, porosity, water content and pressures. All layers above the targeted coal seam must be breached to enable access to the desired coal seam. The integrity of each of these layers, including the significant recharge conduit for the Great Artesian Basin, and the capping layer retaining the coal seam gas within the coal seam, will be breached. Faulting is present in the Jurasic and Permian deposits. Santos acknowledges the risk, although its significance is played down, in the Narrabri Gas EIS (Santos, 2017(a).

When pressurised fracking occurs, not only is the coal seam split, liberating the adsorbed coal seam gas, but the isolating cap rock and the rock layers it supports will also fracture, permitting interchange of liquids and gases between the rock layers and the ground surface.

e. Effect on liquid retention

Mixing of waters between the surface, subterranean aquifers and coal seams will occur as waters percolate through the fractured rock strata. Contamination of the surface, each aquifer, and the coal seam will result.

f. Effect on gaseous movement

The pressurised coal seam gas will be forced upwards along the pressure gradient towards lower surface pressures. Contamination of the surface, each aquifer, and the coal seam by fugitive gas is a predictable and significant outcome.

g. Effect on surface environment

Fugitive gas and liquids, as well as solid and liquid spills, are spread by wind, rain and physical movement (e.g. truck tyres). Surface soil, water and aquifers will be contaminated. Fugitive gas will infiltrate and contaminate the local atmosphere.

h. **Effect on environmental (including human) health**

The release of fugitive gas and waters from the coal seam will contaminate all subterranean and surface aquifers, soils and the atmosphere. Fugitive gas contains carcinogens, teratogens and other poisonous substances, which will affect humans, other animals, plants, bacteria and viruses.

The methodology of the Narrabri Gas EIS is unsafe and should be rejected.

4 High Spill Rates during pilot Study

Santos has reported 20 spills from only 50 wells sunk during the pilot plant stage conducted in the Pilliga State Forest. The escape of 'Produced Water' from these spills contaminates the surface soils with foreign chemical substrates and concentrations. Some of these contaminates would be deliberately added to the well by the company, others would be released from within the pressurised, fractured coal seam. These contaminates may include carcinogens, teratogens, and poisonous substances, such as benzene, toluene, xylene, ethyl benzene, uranium compounds, lead compounds and cadmium compounds.

If 5% of wells are predicted to leak in the first year, and all others to fail sometime into the future, the procedure cannot be safe. A failure risk of 100% is totally unacceptable.

These spill figures demonstrate that Santos does not have the competence to manage 50 wells safely. One must question how Santos would be competent to manage an extended number of 850 wells, safely.

Santos' demonstrated management incompetence, confirms the Narrabri Gas EIS should be rejected.

5. MSDS

The Narrabri Gas EIS lists a number of substances Santos proposes to use in its drilling and fracking programmes. I have been unable to find MSDS for these and other substances when applied to their particular process for which they have been selected. Without appropriate MSDS details for each substance as used, the safety of each chemical cannot be determined. These chemicals cannot be assumed safe.

The Narrabri Gas EIS is incomplete and unacceptable and should be rejected.

6. Water draw-down

The Narrabri Gas EIS has acknowledged water drawdown will occur 'up to 0.5m' (*Santos, 2017*(a)), following produced water loss and the removal of CSG from the Narrabri Field. Santos (2017(b)) predicts a maximum Early Permian drawdown of 153m and Late Permian drawdown of 16.4m. Appendix F claims the Great Artesian Basin will only experience a drawdown

of <0.5m, similar to the water table prediction. The water table and Great Artesian Basin figures seem inconsistent with the Permian predictions. I have been unable to justify these figures from the limited data available in Appendix F.

Any lowering of the water table will affect both agricultural use of the land as well as forest growth. When the water table drops below the depth required to support root growth, all dependent plant life will be affected. It is predictable that such action would jeopardise the nationally significant 'food bowl' in Santos's proposed project area. The plant communities in the Pilliga State Forest, as well as dependant animals, some of which are critically endangered, will also be negatively affected. The EIS claims two endangered species will be affected but appears to ignore other species in the Pilliga State Forest, and elsewhere in the project area (Santos, 2017(c)).

The Nationally and State significant food bowl, Pilliga State Forest and other plant communities are dependent on water for survival. Without more stringent justification of a stable water table I urge you to reject the Narrabri Gas EIS application.

Summary

The proposed extraction procedure is flawed and designed to fail. Planned sitings of wells and MSDS provisions are incomplete. Corrosion of proposed plant and infrastructure will ensure the failure of 100% of wells over time. Contamination of, and reduction in recharge capacity of the aquifer feeding the Great Artesian Basin, will occur. The drilling and fracking process will fracture the cap rock and higher strata permitting fugitive gas escape to the surface. Water mixing and contamination of all aquifers will occur. The predicted small surface water drawdown is unjustified in the EIS. Any drawdown will impose a future change in land use for this 'food bowl'. The Pilliga State Forest will itself be endangered, as will its already endangered species. High spill rates from the pilot project question Santos' competence in conducting a significantly extended gas field. The proposed Narrabri Gas field appears inappropriately selected, and researched and the EIS incompletely prepared.

Executive Director, from within my area of expertise, I have addressed six pivotal issues and found each to propose unacceptable risks to humans, other animals, plants, water, land and air environments, the region, state and nation. Each is sufficient to demand refusal of the Narrabri Gas EIS proposal.

I urge you to recommend to the Government the rejection of the Narrabri Gas EIS.

References

Santos, 2017(c) Narrabri Gas EIS, Chapter 4, *Section 4.6.1,* page 31-32
Santos, 2017(a) Narrabri Gas EIS, Chapter 12, *Section 12.4.2,* page 12-23
Santos, 20 17(b) Narrabri Gas EIS, Appendix F, *Sections 8-9*

Cook, P 2020 *POST PRODUCTION/DECOMMISSIONING RISKS ASSOCIATED WITH LONG TERM WELL INTEGRITY,* June 5, 2020

From: peter.cook@pjcint.com.au
To: Steve O"Donoghue
Subject: Request for further advice - Narrabri Gas - Post Production - Decommissioning Risks
Date: Friday, 5 June 2020 7:38:06 PM

Mr Steven o'Donoghue,
Director Resources Assessment
NSW Department of Planning industry and Environment

Dear Mr o'Donoghue,

Thank you for your email of 2 June in which you request that the Water Expert Panel provide supplementary advice via a letter on the post production / decommissioning risks associated with long term well integrity related to the Narrabri
Gas Project.

I have consulted with the members of the WEP on the issue and the Panel is pleased to provide the following advice.

POST PRODUCTION/DECOMMISSIONING RISKS ASSOCIATED WITH LONG TERM WELL INTEGRITY

A number of stakeholders expressed concern about well integrity and suggested that the integrity of every well drilled by Santos should remain assured in perpetuity. This may not be exactly how they expressed these concerns, but
nevertheless it was how the WEP interpreted their various comments.

Clearly, there is no engineering activity, including drilling, completing and abandoning a well, that can be absolutely guaranteed to remain effective in perpetuity. The high standards required for the completion of wells, does provide
confidence that they will be effective for many decades if not centuries. But as pointed out eloquently by one landowner, with a century-long connection to his land, the average life of a CSG project is short compared to his family connection to the land. And of course, the connection of indigenous groups extends far beyond that.

The risks associated with abandoned wells have recently been described in the Northern Territory Report of the Scientific Inquiry Into Hydraulic Fracturing (NT, 2018, page 53):

"In common with operating wells, leakage or failure of decommissioned wells could occur by poorly cemented or deteriorating casing/hole annuli, faults in the interface between cement and the formation rock and casing failure. Additionally, for decommissioned wells, the interface between cement plugs and casing has been identified as a preferential pathway for gas/fluid flow. Migration of gas/fluid can also occur through fractures, channels, and the pore space
in the cement sheath. In the latter case, gas/fluid flow will only occur when the cement sheath is degraded or did not form properly during the cementing

process…."

The WEP believes that similar arguments can be mounted for CSG operations and supports the view of the NT Inquiry (NT 2018, page 54) that:

"*The combination of small cross-sectional areas, long vertical lengths of flow pathways and low driving pressure differentials means that overall, there is a low likelihood of substantial vertical movement of fluids post decommissioning."*

These conditions apply generally to the proposed NGP. In Appendix E of the WEP Report (WEP 2020) example calculations are given to illustrate the typical rate and quantities of leakage that might occur in a worst-case scenario. The overall leakage is very small and it should be noted that the conditions required to produce such upward leakage, such as the existence of an upward hydraulic gradient are highly unlikely to occur at the Narrabri site.

The Council of Australian Governments' (COAG) Standing Council on Energy and Resources (SCER) National Harmonised Framework (NHF 2013, page 30) requires that "*Decommissioning and well abandonment must ensure the environmentally sound and safe isolation of the well for the long term*" and the NSW Code of Practice for CSG Wells (NSW 2012) is consistent with this. The NSW Code is intended to apply to all CSG wells drilled in NSW but as pointed out in the O'Kane Review (O'Kane 2014a,b,c), it is only formally applied to a title at the time of licence issue or renewal, or at an activity approval on a Petroleum Exploration Licence (PEL).

In the case of the NGP area (O'Donoghue, pers comm), there are 2 State Significant Development planning approvals that cover construction and operation of exploration and appraisal wells – the Dewhurst and Bibblewindi pilot expansions. These approvals cover the more recent appraisal wells but include conditions that require design, construction, maintenance and abandonment in accordance with the Code of Practice for Well Integrity. The following conditions are included in both approvals for the construction and operation of petroleum wells:

"*The Applicant must ensure that all petroleum wells:*

a. *must be designed, constructed, maintained, and abandoned in accordance with the Code of Practice for Coal Seam Gas - Well Integrity (DTIRIS 2012)*

b. *ensure hydraulic isolation between the Upper Namoi and Lower Namoi alluvium and the Great Artesian Basin Southern Recharge during drilling activities*

c. *have all casing fully cemented from casing shoe to surface, leaving no open annuluses*

d. *have a blow-out prevention device on the well head secured to the steel casing, and*

e. *are sealed with cement from the total depth to 1.5metres below the surface when exploration is completed and the well is no longer required in order to protect the integrity of any underground aquifers, prevent gas escape and maintain groundwater quality."*

Under current NSW legislation, once a well is plugged and abandoned and certified by the Regulator as being satisfactorily abandoned, the area is remediated and handed back to the landowner or the State. There is no ongoing
requirement for monitoring the abandoned well. As O'Kane (2014c, page 5) points out "*Despite the abundance of information and research on petroleum well integrity (including design and cements), very little data exists about the longterm
(100 -1000 years) durability of abandoned petroleum wells."* There is no evidence that the vast majority of plugged and abandoned oil and gas wells have an adverse impact on the environment.
Nonetheless, the potential does exist in a few instances for well failure to adversely impact on groundwater quality or flow. Problems with well integrity may occur due to the breakdown over time of the materials forming the well casing,
cement or final well plug. These problems may manifest as the leakage of methane and/or saline groundwater from the target coal seams into and along the plugged well, with the potential to contaminate overlying aquifers. But it would
be quite impractical to put the onus on a Project or Government to monitor all plugged and abandoned wells indefinitely.
Therefore, the primary strategy must be to ensure that the wells are plugged and abandoned using the best available technology and to the satisfaction of the Regulator. The NSW regulations (NSW 2012, page 13) provide the basis for
doing just this and are designed to guarantee the safe and environmentally sound production of CSG by:

· "*preventing any interconnection between hydrocarbon-bearing formations and aquifers;*
· *ensuring that gas is contained within the well and associated pipework and equipment without leakage;*
· *ensuring zonal isolation between different aquifers and water bearing zones is achieved; and*
· *not introducing substances that may cause environmental harm."*

Bearing these regulations in mind, it could be deemed that the long-term risk of failure is so small, that the only strategy necessary, is to have a robust plan in place for dealing promptly and effectively with the rare case of failure as soon
as it happens. The problem with such a strategy is that, as pointed out earlier, little is known about long-term durability of abandoned wells. Additionally, such an approach may not imbue sufficient confidence in some stakeholders, if it is
perceived that there is no certainty that well failure was recognised.
What strategy might then provide landowners and other stakeholders with a greater degree of certainty that if well integrity problems do occur long after abandonment, the problems will be recognised in a timely manner and remediation
measures taken?

The strategy cannot be to monitor every well for evermore. If a system is to be put in place, it needs to be graded temporally and perhaps spatially, so that as the risk of well failure is progressively quantified, the extent of monitoring can
be adjusted to reflect that risk (an example of adaptive management.) This will require some practical means of assessing the likely performance of wells over time. One possible option might be for the Regulator to monitor a representative selection of wells for say 5-10 years after abandonment. At the end of that time a small number of sentinel wells could be selected for monitoring over a further 10-20 years. Provided no failures are encountered during that
time and the risk of well failure is better understood, then monitoring could reasonably be terminated at that point.

As noted by Dusseault (2014, page 212) *"Most jurisdictions have 'orphan well' funds, provided by a levy on production, that are used to fix wells for which an owner cannot be found*." It is the opinion of the WEP that similar plans should
be developed for ensuring long term on-going well integrity. If leakage is detected, then a plan for rectifying leaking wells will be required. It is the view of the WEP that establishing a legacy fund should be considered, as a mechanism to
meet future costs that may be incurred in carrying out necessary rectification works. The WEP considered that this is a policy issue that merits the attention and consideration of the relevant NSW government authorities.

According to the NSW Chief Scientist and Engineer: "*Land is a key issue and one that strikes an emotional chord due to the strong affinity Australians have with their land and its central role in the livelihood of rural communities. There is*
a perceived lack of support for rights of landowners in terms of access to their land. Lack of consultation, inadequate compensation, property value decreases, and potential legacy issues are also cited as major issues by landowners as
are the negative impacts on amenity and a lack of adequate benefits for their neighbours and their communities" (NSW 2014, page 7). Furthermore:

"*Legacy issues, including better understanding of inappropriately abandoned wells,*
need attention" (NSW 2014, page 10).

Accordingly, the Chief Scientist and Engineer made a recommendation in her report :

"*Recommendation 15 - That Government develop a plan to manage legacy matters associated with CSG. This would need to cover abandoned wells, past incomplete compliance checking, and the collection of data that was not yet supplied as required under licences and regulations. There will also need to be a formal mechanism to transition existing projects to any new regulatory system*" (NSW 2014, page 15). The WEP endorses this recommendation of the
Chief Scientist and Engineer, particularly in regard to abandoned wells.

In conclusion, the WEP recommends to Government that it develops policies

and procedures to monitor and inspect abandoned CSG wells, beyond the life of the NGP, for the purpose of detecting leakage of methane or saline groundwater, and the rectification of leaking wells should that be deemed necessary. Furthermore, the WEP suggests government should consider the establishment of a legacy fund to cover the costs of rectification work that may be
required in the future.

If you require further advice on this matter or clarification of any of the points raised, then do not hesitate to contact me.

Relevant references are provided below.

Peter Cook

Professor Peter J Cook CBE FTSE

Chair, Water Assessment Panel

References

Dusseault (2014) Chapter 7 Well Integrity - Report of the Nova Scotia Independent Panel on Hydraulic Fracturing.
https://energy.novascotia.ca/sites/default/files/Report%20of%20the%20Nova%20Scotia%20Independent%20Panel%20on%20Hydraulic%20Fracturing.pdf

NHF (2013) The National Harmonised Regulatory Framework for Natural Gas from Coal Seams.
http://www.coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/National%20Harmonised%20Regulatory%20Framework%20for%20Natural%20Gas%20from%20Coal%20Seams%20%28May%202013%29.pdf

NSW (2012) NSW Code of Practice for Coal Seam Gas – Well Integrity.
https://www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0006/516174/Code-of-Practice-for-Coal-Seam-Gas-Well-Integrity.PDF

NSW (2014) Final Report of the Independent Review of Coal Seam Gas Activities in NSW, September 2014. Office of the Chief Scientist and Engineer of NSW.
http://www.chiefscientist.nsw.gov.au/__data/assets/pdf_file/0005/56912/140930-CSG-Final-Report.pdf

NT (2018) Scientific Inquiry into Hydraulic Fracturing in the Northern Territory.
https://frackinginquiry.nt.gov.au/inquiry-reports/final-report

O'Kane (2014a) Independent Review of Coal Seam Gas Activities in NSW - Managing environmental and human health risks from CSG activities, September 2014. Office of the Chief Scientist and Engineer of NSW.
http://www.chiefscientist.nsw.gov.au/__data/assets/pdf_file/0006/56922/140930-Final-Managing-Environmental-and-Human-Health-Risks.pdf

O'Kane (2014b) Independent Review of Coal Seam Gas Activities in NSW - Study of regulatory compliance systems and processes for coal seam gas, September 2014. Office of the Chief Scientist and Engineer of NSW.
http://www.chiefscientist.nsw.gov.au/__data/assets/pdf_file/0006/56913/140930-Final-Compliance-Report.pdf

O'Kane (2014c) Independent Review of Coal Seam Gas Activities in NSW Information paper: Abandoned wells. Office of the Chief Scientist and Engineer 17p.
https://www.chiefscientist.nsw.gov.au/__data/assets/pdf_file/0009/56925/14

1002-Final-Abandoned-Well-report.pdf
WEP (2020) Report of the Water Expert Panel – Review of the Narrabri Gas Project.