

### Environmental risks arising from CSG operations

Environmental Risk	Likelihood of Occurrence	Consequences of Occurrence	Existing Legislation Controls	Primary risk control measures	Secondary control measures	Role for (a) Security Deposit (b) Insurance (c) Rehabilitation Fund
Pollution occurring above ground	Some examples have occurred in NSW of overflow/spillage of produced water / drilling fluids, being (typically brine solutions)  Total number of incidents not known	Effective make good and restoration normally possible by conventional methods with low risk of permanent environmental damage	(a) Breach of licence / lease conditions under PO Act and/or direction to make good  (b) Breach of CLM Act  (c) Breach of licence issued under the POE Act	(a) Requirement for prior approval of Water Management Plans approval detailing water management treatment and disposal methods as a condition of CSG activity approval  (b) Containment measures / bunding requirements limiting area of exposure  (c) Requirement to physically make good  (d) Risks reduced by banning of evaporation ponds  (e) Temporary ponds required to meet strict standards of construction and freeboard	(a) Verification and monitoring of primary control measures effectively in place prior to activity commencing  (b) Requirement of operator to regularly inspect and report status during CSG activities  (c) Ability to require cessation of CSG activity / elimination of risk by direction under PO Act if risk detected  (d) A final control provision is the imposition of substantial penalties as currently exist under any of the PO Act, the POEO Act and the CLM Act	(a) Extent of make good likely to be within financial capacity of operator to effect remediation, given NSW experience to date.  (b) All 3 measures potentially available if operator defaults.  (c) Directions to make good usually capable of compliance.
Aquifer contamination by CSG operations, typically by hydraulic stimulation (fracking)	Few proven examples of such contamination occurring in Australia or USA – likelihood diminished by:  (a) separation of alluvial aquifers from CSG aquifers, presence of aquitards  (b) elimination of toxicity in chemicals permitted in stimulation techniques	Depends on:  (a) maintenance of physical separation of aquifers; and  (b) toxicity of chemicals introduced by CSG operations – adverse consequences able to be limited by controls on toxicity of chemicals used and requirement for prior approvals.	Conditions attaching to either –  Lease or licence under PO Act  Licence under POEO Act	(a) Requirement for credible prior groundwater study and analysis  (b) Active monitoring and reporting of groundwater conditions during CSG operations  (c) Prohibition on use of any substance likely to cause adverse contamination  (d) Requirement for confidential communication of chemicals used in drilling	Prosecution and loss of title for breach, where coupled with requirement for prior vetting and approval of substances used, lessening the risk of the problems occurring	(a) All 3 measures potentially available if operator defaults.  (b) Issues for insurance will be:  (i) establishing causal link between CSG operations and aquifer flows (aquifer interruptions have many causes)  (ii) Unlike surface contamination,

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				and fracking fluids.		maybe no effective means of restoring/rehabilitating an aquifer.
Aquifer interference with available flow	Few proven examples of such contamination occurring in Australia or USA, at least where a sufficient degree of physical separation or aquitard barrier exists.	Consequences may depend on duration and extent of drawdown by CSG operations. Note flows may be also affected by variability of recharge flows and relativity of drawdown by other non CSG users of relevant aquifers	WM Act 2000 and Aquifer Interference Polices requiring compliance under that Act for potentially aquifer intervening activities.	Risk identification and assessment as part of planning process  Controls and detection of consequences by ground water monitoring by CSG operators and monitoring equipment in bores of other users.	Real time monitoring of aquifers and imposition of controls during operations.	Query if insurance is available, or if would adequately respond., as for aquifer contamination
Loss of productive land capacity	Low, given exclusion zones of SRLUP lands, Critical Industry Clusters, Residential Zone exclusion (with 2km buffer) and on land generally requiring preparation and assessment of Agricultural Impact Statements.	Significantly less than traditional mining and coal (open cut or subterranean) operations – may be more disruptive in semi permanent long term production fields.  Some degree of amelioration of consequences possible by careful planning of well head road and other facility installation referable to existing land use operations.	PO Act  SEPP (mining and petroleum) land use restrictions.	Strategic Land Use Policies, Critical Industry Clusters and CSG exclusion and 2km buffer zones as primary controls	Requirement for Agricultural Impact Statements on other land, to be assessed on a case by case basis	(a) Insurance available to cover costs of pollution at surface (eg failure of temporary water ponds)  (b) Fund and Security Deposit could also be available  (c) Major differences likely between mining and CSG operations in extent of land rendered unproductive, especially open cut mining including buffer zones.
Failure to rehabilitate sites (including water management facilities)	Need information from regulating Authorities.	Potential hazard from presence of well, likely to increase if well left in place.	PO Act and conditions of title	Condition of title, usually performed where directed	Security deposits available if title holder does not perform	(a) Potential role for retention fund and insurance if security fails and operator defaults for any reason, including insolvency  (b) Beneficial re-use of produced water from CSG or alternative re-use of storage facilities may reduce rehabilitation requirement and hence potential recourse to financial assurances

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Subsidence at surface	Given difference in volumes of water consistently extracted alluvial irrigation the more significant risk, but some risk of subsidence over area of aquifers possible.  Vaufly less risk than subsidence from underground especially long wall mining	Depends on location and extent of occurrence – studies available based on US data.	PO Act	Risk identification and assessment as part of planning process	Low probability of occurrence / attribution to CSG secondary control may not be necessary	Possibly new assurance fund may respond as might insurance, if compensable loss could be established
Loss of well control	Given pressure differential, much less likely in CSG wells	Fugitive emissions, potential fire risk	PO Act  WH&S Act (protecting workers)	Good oil field practice including widespread use of blow out preventers kill strings and well plug placements.	Provision of safety case and risk assessment required for each well approval	Insurance available and commonly taken out by drilling contractors, but tends to be limited to above ground contamination.  Cost per well of the order of \$10,000 approximately.
Fugitive emissions	Accurate assessments not available	Adverse consequences for green house gas control	Good oilfield practice and monitoring / reporting measures likely to be sufficient to control	Nite emissions occur naturally and distinguishing between background and CSG include levels of fugitive emissions would be required to measure increment.		Discharge of methane may not be a Pollution Condition within the terms of the proposed insurance, as methane (in small quantities) forms part of the atmosphere – query the extent of the discharge necessary for the policy to respond.
Triggering of adverse seismic activity	In Australia considered low probability, consistent with world wide experience (only one known occurrence to date, in UK)	Occurrence rates too low to quantify	Restrictions on areas imposed by SEPP as to where CSG activities can occur.	Breach of licence condition under PO Act, were it to occur.	Not Warranted <sup>1</sup>	Unlikely to be required.

<sup>1</sup> See for example papers such as:

- (a) Changing the language of gas-well induced seismicity – Mark Caslin, SLR Consulting Australia (2013)
- (b) Fracking in Hollywood – comprehensive environmental monitoring of two high volume fracturing projects Dr Daniel Tormey – Cardno Entrix Inc. (2013)