

Equities

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Coal Seam Gas Environment & Social Issues

Conference Call with Queensland Government

- **Conference Call** — Citi hosted a conference call with Andrew Brier, General Manager, Coal & CSG (Coal Seam Gas) Operations and Head of LNG Enforcement, Queensland Government, to discuss environmental and social issues facing the CSG industry. This note includes points from the call and some of our observations.
- **Replay Available Until 3 October** — Citi clients may contact us for replay details and presentation material.
- **Impacts on Water Bores is Likely** — All aquifers are interconnected, and the key issue is the degree of interconnection. CSG production is likely to result in drawdown of aquifer pressure and bore water levels in some local areas. “Make good” provisions appear manageable, and may include deepening bores or installing deeper pumps. Modelling is underway, and will be calibrated with monitoring data. The most significant early impacts appear likely in the Surat Basin.
- **Aquifer Contamination** — Large scale aquifer contamination may be an overstated risk, but we feel that it will take considerable time to prove this with confidence. Controversial BTEX chemicals are not used in Queensland fracking fluids.
- **Potential Impacts Vary Between Projects** — Aquifer impacts will vary with geology. In the eastern areas, the coal seams are shallower and lie adjacent to aquifers, maybe posing the most significant impacts to be managed. The STO and ORG operations may, in general, have fewer challenges than the Arrow/Shell and QGC/BG areas.
- **Salt Disposal** — Solutions to salt disposal are under investigation. Beneficial use is preferred. We see some risk of spillage in times of flood if large brine volumes accumulate in ponds.
- **Rebuilding Community / Landowner Trust** — There appears to be a significant lack of trust between the industry and affected communities. Apparently poor practices in the early days of CSG industry development have provided a platform for landowner and community opposition. Any problems or incidents appear to receive widespread media attention. Both Government and industry appear to be attempting to rebuild this relationship, but may have been late in recognizing the importance of the issue. Regaining community trust would seem to require minimizing landowner access disputes, minimizing water or gas leaks or other local environmental problems; and producing transparent credible data that demonstrates that aquifer impacts will not be detrimental to agriculture.

Elaine Prior

+61-2-8225-4891

elaine.prior@citi.com

See Appendix A-1 for Analyst Certification, Important Disclosures and non-US research analyst disclosures.

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CSG Conference Call with Queensland Government

Citi hosted a conference call with Andrew Brier, General Manager, Coal and CSG (Coal Seam Gas) Operations, within the Queensland Department of Environment and Resource Management. Andrew is also head of the new LNG Enforcement Unit.

This note provides a brief overview of some points from the call and our observations.

Replay Available

Citi clients may contact us for replay details (available until 3 October) and presentation material.

Impact on Aquifers

The main Coal Seam Gas production areas in Queensland are the Surat Basin and Bowen Basin. The industry involves four major projects for production of CSG for Liquefied Natural Gas (LNG) production for export, primarily to Asia.

The Surat is part of the Great Artesian Basin. The Bowen underlies the GAB. The GAB is a complex system of aquifer formations and impermeable layers.

Water is produced from CSG wells to reduce the pressure and allow the gas to flow out of the coal.

Water production from the Queensland CSG industry at peak (~2017 for 10 years) is estimated at ~125-280 Gigalitres pa. Production in the past year was ~8GL. Impacts are unlikely to be observed until higher production rates occur. The GAB holds ~65 million GL, so the scale of water production is negligible in a basin-wide context.

Local Water Pressure the Key Likely Impact

All aquifers are interconnected to some degree. The key issue is the degree of interconnection. Over time, water pressure will equilibrate between aquifers. Locally, water pressure is likely to be drawn down in some areas due to the CSG industry – probably by ~3-10 metres. This may affect water bores. For example, a bore with a current water level of 50m subsurface could see the water level drop to 60m subsurface.

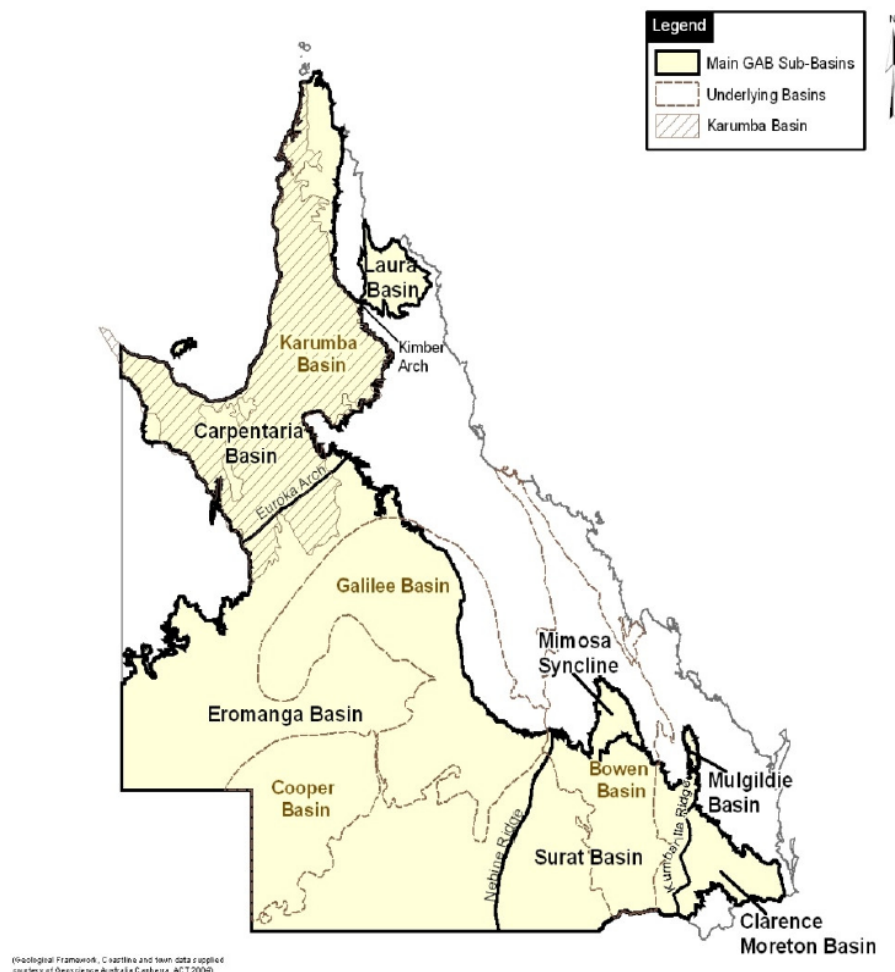
Companies are required to conduct a baseline assessment of all bores on their land and prepare Underground Water Impact Reports.

The Queensland Water Commission is developing a Cumulative Management Area groundwater model for the Surat, for completion by May 2012. This will identify bores likely to be affected by >5m over the next three years.

Modelling aims to predict where impact will occur over the next 3 years and longer term. Models will be calibrated and fine tuned as monitoring data becomes available. “Make good” provisions are likely to involve deepening some bores, installing deeper pumps in some bores, or drilling into a deeper aquifer. The aim is to implement corrective action before the impacts occur, for example so that pumps operate successfully without sucking air.

The greatest impacts are expected 10-20 years after the industry has ended, as water levels equilibrate. Reinjection of produced water is under consideration, and might alleviate these impacts.

Figure 1. Map of Great Artesian Basin and Sub-Basins



Source: Queensland Government; Geoscience Australia

Aquifer Contamination

There are three key sources of potential aquifer contamination: chemicals used in fracturing (fracking) fluids; movement of water between rock layers through natural connectivity; and flow of water between rock layers via wellbores.

Fracking Fluids – BTEX chemicals are effectively banned. Detection limits are set at a level that precludes adding BTEX to fracking fluids, but that accepts that BTEX can occur in coal seams or be detected due to minor contamination by grease or lubricants.

Underground Flow – Underground water quality and composition varies, and water contained in coal seams might contain minor hydrocarbons. When water is produced from coal seams, the pressure will tend to be reduced. Movement of underground water as a result of extraction would tend to be into the coal seams, rather than water (potentially containing contaminants) flowing out of coal seams into aquifers.

Wellbore Standards – Government is finalizing a construction standard for wells. Among other things, good well practices should minimise the potential for flow between formations via the wellbore.

Adaptive Management

CSG / LNG projects have been approved under an adaptive management regime. If unexpected / unpredicted impacts are seen, the conditions can be changed. New technologies may also be incorporated.

Risks Vary with Geography / Geology

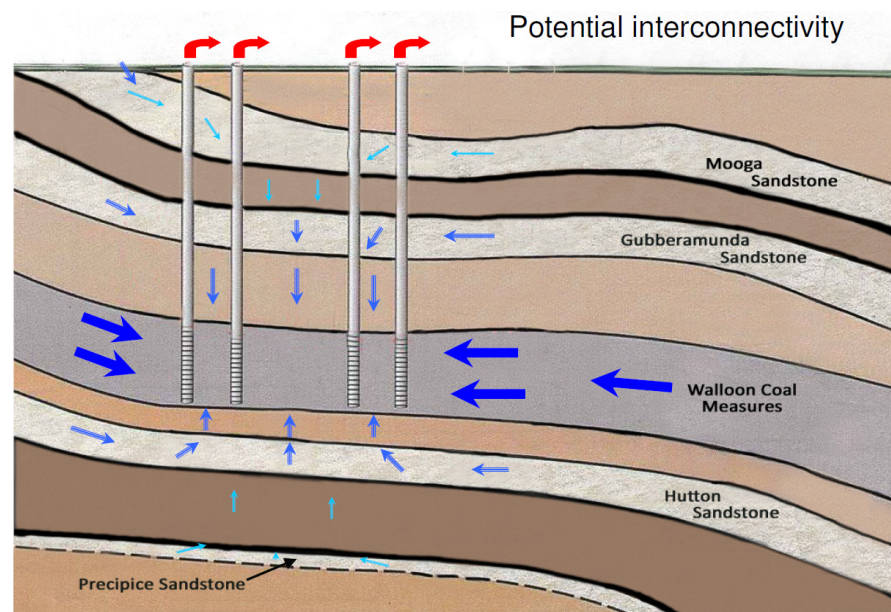
The potential influence of CSG production on aquifers will depend partly on geology.

Surat Basin - In the Surat, the Walloon coal measures are part of the Great Artesian Basin, with aquifers above and below the coal seams. The Surat includes the Arrow (Shell) and QGC (BG) tenements, and some Santos and Origin areas. Monitoring in this area will be important, as impacts are likely to be seen most quickly. In the Dalby area, the Condamine Alluvium aquifer directly overlies the Walloons. This aquifer is already overallocated, but may prove a suitable location for reinjection of treated produced water for future beneficial use.

Bowen Basin – In the Bowen, the coal seams underlie the GAB. Santos, Origin, Shell and AGL Energy have tenements in the Bowen.

Impacts are likely to be seen earlier in the Walloons. Early monitoring is particularly important here, in order to calibrate the models.

Figure 2. Managing Groundwater Impacts



Source: Queensland Government

Water Disposal

The Government is phasing out evaporation dams. Temporary water storage dams are allowed and must be lined. Preferred options for water disposal, in order of preference, are:

1. reinjection into depleted coal seams, use for irrigation (“virtual” reinjection), or replenishing other aquifers – chemistry must be appropriate to avoid impacts such as chemical reactions that clog pores;
2. beneficial use;
3. release to surface water courses or to land.

Consultation on water disposal options is underway, with the aim to have policy defined by the end of the year.

Salt Disposal

The industry is expected to produce ~30mtpa of salt at peak production. In the Walloons, produced water salinity is ~2000-8000 micro Siemens per cm ($\mu\text{S}/\text{cm}$), compared with sea water at 48,000 $\mu\text{S}/\text{cm}$ and drinking water generally at <300 $\mu\text{S}/\text{cm}$.

Where produced water is treated via reverse osmosis, ~5-15% of the original volume remains as concentrated brines.

Options for salt disposal, in order of preference, are:

1. use as a saleable product;
2. deep underground injection into isolated formations (Santos is doing this at Fairview, injecting at ~2000m depth);
3. solid salt disposal in suitable existing facilities, or in purpose built disposal facilities on freehold land owned by the CSG companies.

The government does not have a prescribed solution, but disposal must meet certain criteria that ensure there is no more salt in the landscape. There is optimism that the first option above will prove a commercially viable solution. Brine storage dams must have monitoring installed to detect any leakage, and a system to collect and dispose of any contaminants that move beyond the bounds of the dam.

Brine storage dams are designed so that they do not discharge, and do not fail in times of flood, including having manufactured spillways. During the recent floods, there were ~6 unauthorized discharges from CSG dams, compared with ~63 unauthorized releases from coal mines. During times of major floods, the salt concentration in a spill would be significantly diluted.

If salt is not converted into saleable product, and large quantities of salt or brines are accumulated, this appears to pose a risk of escape into the environment.

Interaction with Landowners

Some contentious and emotive issues relate to land access. We gained the impression that in the early days of the industry, some landowners were not treated well by some companies. This resulted in a major lack of trust by affected communities.

Industry pioneers Arrow Energy and QGC have since been taken over by Shell and BG respectively. The industry is now dominated by larger companies that appear conscious that they must repair this damage and rebuild the trust of the local and wider community.

[Our perception is that similar poor practices occurred in the early days of the US shale gas industry, and that this has provided further fuel for opposition to the Australian CSG industry.]

Compliance & Enforcement

Pro-active Government compliance includes a bore monitoring program (300 bores by end 2011). This compares with ~3700 wells drilled to date, of which roughly half are production wells. The intent is to validate company data and also provide confidence to the community.

The regulator sees the current period largely as a period of learning for the industry, ahead of production ramp up when LNG production starts. The aim is to rectify and learn from minor issues. More stringent action may be taken for repeated or deliberate non-compliance, negligence or neglect.

Most incidents to date have been resolved by negotiation, or resulted in warnings or minor fines. A few incidents remain under consideration for potential prosecution.

There may be a community perception that enforcement by government is not strong enough.

SBS Television Program & Skeptical Reaction

The "Insight" program on SBS TV on 20 September was on the topic of CSG. The program's Feedback website contains a plethora of comments, generally opposed to the industry. One theme running through the comments was fears about the long term impacts on aquifers and agriculture, and skepticism about the observation that most data from monitoring wells will come from the industry, rather than from an independent auditor / regulator.

Whatever the facts, we believe the industry has a long way to go to gain the broad confidence of affected communities, and to demonstrate that risks to aquifers are manageable and do not pose a significant or irreversible threat to agriculture.

Appendix A-1

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