



Coal seam gas production and groundwater supplies



Australia Pacific LNG Project

Australia Pacific LNG is the leading coal seam gas (CSG) producer in the Queensland natural gas industry. The joint venture between Origin, ConocoPhillips and Sinopec is currently undertaking a major CSG to liquefied natural gas (LNG) project that will supply natural gas to both the domestic and international markets. The Australia Pacific LNG Project involves developing CSG fields in the Surat and Bowen Basins, construction of a 520 km pipeline and a new LNG facility on Curtis Island, off shore from Gladstone.

CSG is a cleaner and greener alternative to many currently used fossil fuels, such as coal and petroleum. Power stations fired by CSG emit around half the greenhouse gases of coal-fired electricity generation and use only a fraction of the water. CSG is emerging as a preferred transition energy source as the world develops its renewable energy capacity. The CSG industry is set to provide Queensland and Australia with huge economic benefits.

CSG production relies on the extraction of water from coal seams to depressurise the coal measures to allow natural gas to flow. This water, referred to as CSG water or associated water, is unavoidably removed in the gas production process. Responsible management of CSG water and the impacts of CSG production on groundwater levels and water quality are critical to Australia Pacific LNG's business.

Water is a vital resource and an essential part of the environment and Australia Pacific LNG is committed to expertly managing and minimising the impacts of CSG production on groundwater.

Basic geology in the Surat Basin

The Surat Basin is one of three major sub-basins that make up the Great Artesian Basin, a vast underground water source that underlies one fifth of the Australian land mass in Queensland, northern New South Wales, the Northern Territory and northern South Australia.

The Surat Basin comprises many different geological layers including sandstone, mudstone and siltstone, one on top of the other (refer to diagram on page 3). Some of the layers, such as sandstones, are permeable and allow water to flow through them,



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these are called aquifers. The other layers, including mudstones and siltstones are relatively impermeable and do not allow water to pass through them freely, these are called aquitards. Aquifers are the layers that people tap with bores to access groundwater.

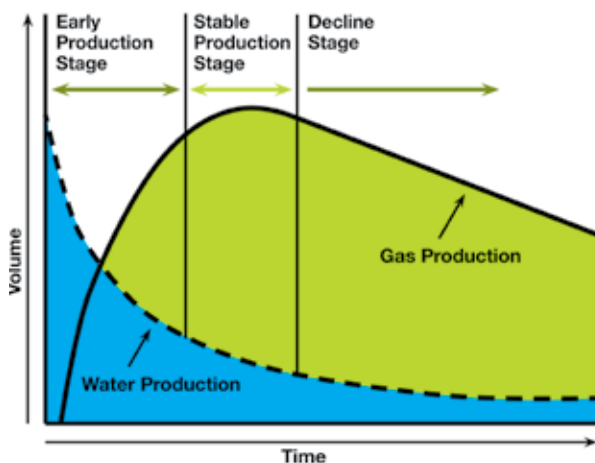
Coal Seam Gas Production and groundwater

CSG is a naturally occurring gas, mostly methane, found in the coal measures deep underground. These coal measures are geological layers that consist predominantly of impermeable mudstone and siltstone that have thin seams of coal running through them. These coal seams are discrete and not continuous over large distances; they generally form only 10% of the total thickness of the coal measures. Small amounts of gas collect in the many gaps, called cleats, within the coal deposits. The gas is bonded to the coal and held in place by water pressure.

CSG is extracted by removing some of the water and reducing the pressure holding the gas to the coal allowing the gas to flow.

CSG production only extracts water from the coal measures. It does not directly extract water from aquifers commonly used for local user's water supply. The rate at which each individual gas well produces water varies based on the geology at each well site. In addition, the rate at which water is removed from a CSG well drastically reduces over time as gas production increases.

Typical gas and water production rates



CSG production only removes enough water from the coal formations to depressurise the coal seams, it does not dewater (remove all of the water from) them. The required level of depressurisation reduces the water level in a CSG well to approximately 30 metres above gas producing coal seams.

There is concern that removing large amounts of water and depressurising the coal measures will impact on the water and pressure levels in the most commonly used GAB aquifers.

In the Surat Basin Australia Pacific LNG will be extracting CSG from the Walloon Coal Measures. These formations are generally located between 200 and 1000 metres underground in the project areas. There are many low permeability aquitards of significant thicknesses that separate the coal measures from the most commonly used groundwater supply aquifers. One aquitard example is the Westbourne Formation which is up to 250 metres thick in some places.

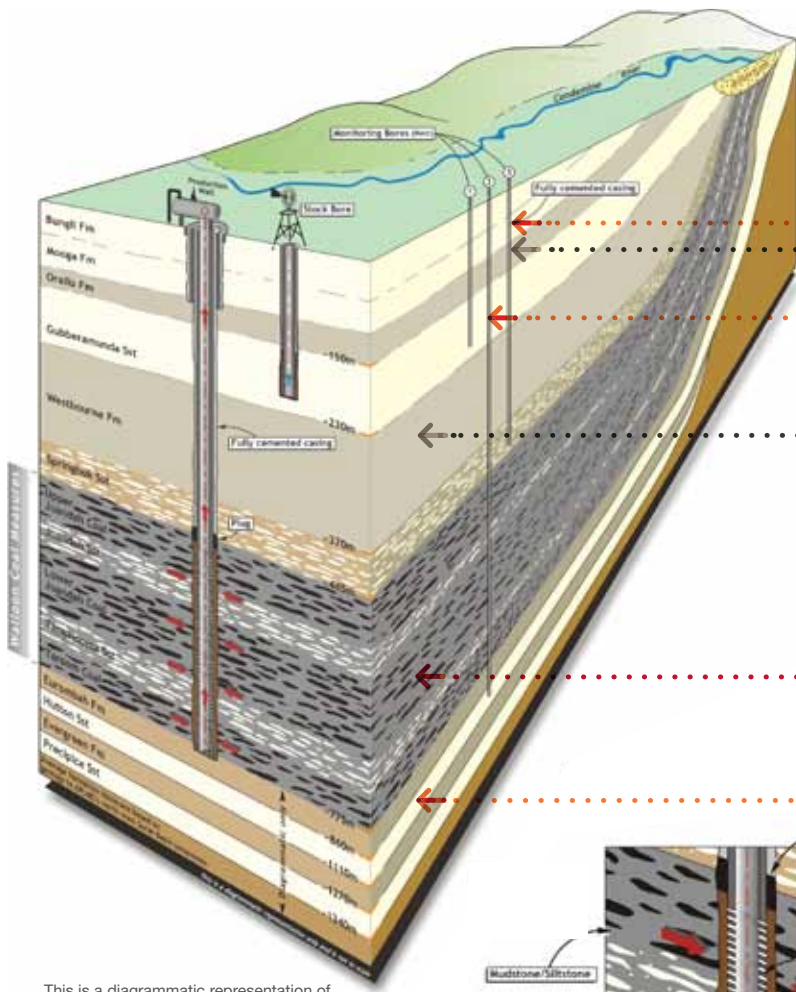
These aquitards create a high level of natural isolation between the coal measures and the commonly used aquifers. This means that there is limited potential for activity in one layer to directly impact the other and removing large amounts of water from the coal measures will not result in large reductions in water levels in aquifers.

However, there is some limited interconnectivity between layers, and as a result there is the potential for a drop in pressure in some aquifers as water slowly makes its way through aquitards towards the Walloon Coal Measures. Although permeable, the water flow in aquifers is very slow and it generally travels at a rate of between 1 and 5 m per year under natural conditions. This means that any potential impacts will be slow to develop and should be identified by the project groundwater monitoring program with sufficient time to implement mitigation measures.

Extensive computer modelling of the impact of depressurising the coal formations has been conducted. The results indicate that CSG activities may cause minor depressurisation in the geological layers directly above and below the coal measures, but in general will have insignificant impacts on groundwater pressure, and therefore bore water levels, in commonly used aquifers.

Australia Pacific LNG has designed an extensive groundwater monitoring program that will operate throughout the entire duration of production operations. This constant monitoring will be compared with the modelling developed by the independent Queensland Water Commission (and overseen by the Federal Government) to ensure any impacts measured are in line with predictions. Ongoing groundwater management decisions for the Project will be directed by groundwater monitoring results.

In some cases landholders directly access the Walloon Coal Measures, or aquifers near the Walloon Coal Measures, for groundwater supply. Where this happens close to proposed CSG operations, bore levels may be impacted by CSG production. In these instances it is the legal responsibility of the CSG operator to make good, or offset, any impacts. Australia Pacific LNG will work closely with landholders to make good any impacts to these groundwater supplies.



This is a diagrammatic representation of the Surat Basin only and is not to scale.

- The most commonly used aquifers are the Mooga and Gubberamunda Sandstones.
 - The Hutton and Precipice Sandstones are used to a lesser degree.
 - Aquitards restrict the amount of water transfer between geological layers and prevent cross-contamination of aquifers.
 - Australia Pacific LNG will access the Walloon Coal Measures to produce coal seam gas in the Surat Basin. These coal measures are typically located hundreds of metres below the most commonly used aquifers.
- For a more detailed view of the Walloon Coal Measures see figure 1.

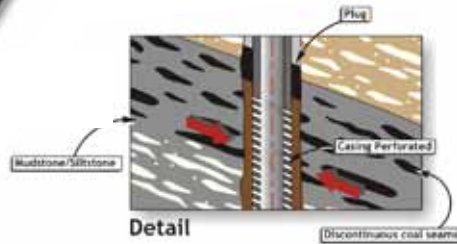
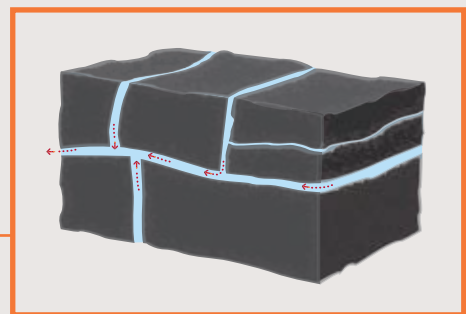
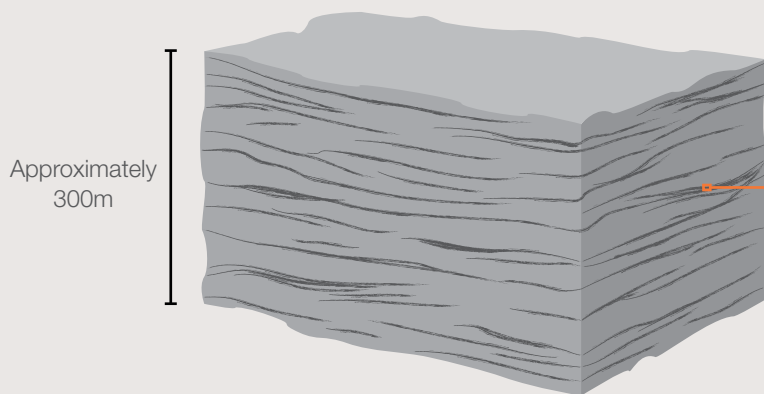


Figure 1



- Coal seams
- Siltstone
- CSG water
- ←•••• Coal seam gas (CSG)

The Walloon Coal Measures

Coal seams make up approximately 10% of the Walloon Coal Measures. The coal seams are discrete deposits of coal that are not continuous over long distances, and are encapsulated within largely impermeable siltstone. CSG water is effectively trapped within the coal deposits. The water extracted in CSG production is mostly removed from these 'pockets' of coal and not the surrounding siltstones. While some water is extracted from the coal measures, they remain fully saturated throughout CSG production.



Coal seam gas production and groundwater supplies

Is there any potential for groundwater contamination from coal seam gas wells?

Australia Pacific LNG is committed to minimising the impacts of CSG production on the environment. Best practise design and construction technology ensures that installed infrastructure, such as gas wells, is safe and prevents contamination of both land and water.

CSG wells are constructed in accordance with strict codes of practice, encased in both steel and cement, to prevent any substances used in drilling and completion activities, or removed in the production process from entering the surrounding rock formations and aquifers.

CSG wells are constructed in stages and thoroughly integrity tested before being brought into production.

A steel casing or tube lines the inside of the well, and fully isolates the well. Cement seals the gap between the borehole and the steel casing through to the depth of the coal measures. This cement prevents the movement of groundwater or gas between different geological layers which could lead to contamination.

In the coal measures the steel casing contains holes to allow water and gas to enter the well.

Australia Pacific LNG is confident that its wells and infrastructure are designed and constructed in a manner that prevents extracted gas or water from impacting on the surrounding environment.

However, Australia Pacific LNG will continue to monitor for changes in the levels of gas in groundwater conditions throughout the period of CSG production.

Summary

- CSG production in Australia Pacific LNG's project area does not extract water from commonly used aquifers. Water is removed from the coal measures, a geological layer that is not heavily used for water supply.
- Extensive computer modelling of the impact of depressurising the coal formations has been conducted. Results indicate that the impacts of CSG activities on groundwater pressure in the commonly used aquifers will not be significant, and that where local impacts occur they can be effectively managed.
- An extensive groundwater monitoring program will operate throughout the entire duration of production operations. The monitoring will be compared with independent modelling to ensure any impacts measured are in line with predictions. Ongoing groundwater management decisions will be directed by the monitoring results.
- CSG wells are constructed in accordance with strict codes of practice, encased in both steel and cement, to prevent any substances used in drilling and completion activities, or removed in the production process from entering the surrounding rock formations and aquifers.

Got a question about Australia Pacific LNG?

For enquiries about the gas fields or pipeline call 1800 526 369 or email contact@aplng.com.au

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Or visit our website at www.aplng.com.au