17 HAZARD AND RISK

17.1 INTRODUCTION

This chapter provides responses to submissions received on the draft environmental impact statement (EIS) related to hazards and risks of the Gas Field Component of the Queensland Curtis LNG (QCLNG) Project.

Where changes to the Project description, as detailed in *Volume 2, Chapters 7* and *11*, have altered the assessment of hazards and risks, these impacts, and measures to mitigate them, are described. Where required, additional information is provided on hazards and risks described in the draft EIS.

17.2 RESPONSES TO SUBMISSIONS

Table 3.17.1 provides a summary of the submissions received on hazards and risks of the Gas Field Component, and a response to those submissions.

Table 3.17.1 Response to Submissions on the Draft EIS

Issue Raised	QCLNG Response	Relevant Submissions(s)
QGC's activities may increase the risk to residents from, for example, bushfires or gas explosions	Refer to *Section 17.4* for bushfire risks and *Volume 3, Chapter 17* of the draft EIS for gas explosions.	7, 12, 11, 9
Rural firefighters have not been informed about potential fires at QGC facilities or trained in responding to such fires	QGC will liaise with rural fire brigades to assess the fire risks posed by Gas Field infrastructure, the methods to control any fires at Gas Field infrastructure and appropriate and safe procedures for QGC personnel to undertake for the protection of rural communities	7, 12, 11
QGC's infrastructure may be adversely impacted by a bushfire, further exacerbating an existing bushfire	Refer to *Section 17.5*	7, 12, 11, 9
CSG extraction may result in CSG migration, resulting in contamination of water supplies, risks to humans and loss of biodiversity	Refer to *Section 17.7*	7, 12, 19, 9
Organic coal chemicals and hydrogen sulfide may be released through CSG extraction Chemical exposure has not been adequately addressed.	Refer to *Section 17.6.* Potential exposure to chemicals is addressed in *Volume 3, Chapter 6* of the supplementary EIS	7, 19

Issue Raised	QCLNG Response	Relevant Submissions(s)
An effective separation distance/ exclusion zone is required between Gas Field infrastructure and residences. Proposals range from 1 km to 2 km. Clarify the potential fatality and injury risks to humans	Refer to *Volume 3, Chapter 17* of the draft EIS. QGC has developed a Draft Code of Conduct for Operations in a Rural Residential Area. A copy of this is provided in *Volume 8, Appendix 8.1*. This states that QGC will not carry out drilling operations, install aboveground infrastructure or construct access tracks within 200m of an occupied dwelling, except with the consent of the occupiers	7, 12, 11, 9
Describe the food management system proposed for worker camps and the relevant regulatory requirements	All food provided to personnel at camps will be in compliance with the *Food Act 2006*. QGC will let a contract inclusive of catering for the worker's camps. The contractor will provide a food management system as part of the tender process	10
All chemicals brought onto QGC tenements must be accompanied by a MSDS.	All chemicals brought onto QGC tenements will be accompanied by a MSDS.	36

17.3 SUPPLEMENTARY INFORMATION ON HAZARDS AND RISKS

The following hazards were identified in *Volume 3, Chapter 17* of the draft EIS:

- unplanned gas release with possibility of fire or explosion through introduction of an ignition source
- live and high-energy sources
- inappropriate/unauthorised infrastructure use or access
- infrastructure or equipment failure, other than gas-processing equipment
- natural disaster
- pollutant release to air, soils or water
- release of Associated Water
- traffic accidents involving multiple or single vehicles.

Hazards relating to the release of coal seam gas (CSG) and potential fires and explosions were assessed through a quantitative risk analysis (QRA). Other hazardous events, possible causes, consequences and proposed controls to address the identified hazards were assessed qualitatively.

The supplementary EIS identifies:

- additional hazards raised in consultation after the release of the draft EIS
- additional controls for management of hazards identified in the draft EIS.

The potential hazards considered in the Supplementary EIS are:

- potential to cause bushfire
- impacts on Project infrastructure from a bushfire
- gas migration and release to the atmosphere
- all gases within CSG.

17.4 POTENTIAL TO CAUSE BUSHFIRES

The supplementary EIS describes different flaring activities at wells which represent a potential risk of causing bushfires. Flaring will result from a combination of maintenance and emergency flaring. It is estimated that each well will flare 1 mmscf (28,300 m^3) of CSG per annum. There are a range of potential flaring scenarios occurring between once every four years and twice per year. Flaring events range between five minutes and six hours, except for flaring during pilot well testing and workover rig activities.

Pilot well testing will occur for six months (approximately 5 per cent or 300 wells) as part of the exploration and appraisal program for the QCLNG Project. Pilot wells are expected to flare approximately 95 mmscf (2.7 million m^3) per event.

Flaring during workover rig activities occurs once every two years for approximately three days. Each workover flaring event will flare approximately 0.5 mmscf (14,150 m^3) per day.

The following controls are proposed to reduce to as low as reasonably practicable the potential to cause bushfires from flaring at wells:

- to inform detailed design, a risk assessment will be conducted that includes thermal radiation modelling from flares
- based on thermal radiation modelling, a sterile radius will be constructed and maintained around wells
- the sterile radius (nominally 20 m) will be cleared of all vegetation so that no ignition sources are present
- the sterile radius will be fenced to prevent access
- flares will be elevated at a height of between 2 m and 6 m
- the flare will only ignite in a flaring event, and will not be continuously lit
- except for flaring from pilot wells, flaring occurs infrequently and for short durations (minutes to days)

- the flaring well will be visited by a Production Operator at least once every three days to check the wellsite and its immediate environment to ensure that the flaring operation can continue safely.

Under the *Fire and Rescue Service Act 1990* (Qld), the commissioner may, by notification published in the gazette, authorise the lighting of fires for purposes and in circumstances specified in the notification. This may include an exemption for petroleum activities. Nevertheless, QGC is considering control measures for flares at wells during a declared total fire ban in any areas of QGC tenements. The principle control mechanism proposed is to vent rather than flare CSG. This would be achieved by disengaging the pilot light manually or through the automated control system.

QGC will adhere to all local council mitigation measures to prevent bushfires and is committed to providing a safe working area for workforce. QGC acknowledges its responsibility to local community safety and will develop a comprehensive Fire Management Plan. QGC will maintain fire breaks around infrastructure such as field compressor stations (FCSs), central processing plants (CPPs) and accommodation camps. As an emergency measure, treated Associated Water could be used to fight bushfires.

17.5 IMPACTS FROM BUSHFIRES

The following controls are proposed to minimise to as low as reasonably practicable the potential impacts from a bushfire on QGC infrastructure:

- a detailed risk assessment (hazard and operability assessment) will be conducted for all facilities types and will include the scenario of bushfire
- the well pad will be cleared of all vegetation so that a bushfire does not have fuel up to the well pad equipment
- in an emergency, the choke valve on the wellhead at free flowing wells or the hydraulic downhole pump at pumping wells will be shut by an operator in the control room
- the separator vessel has a fire pressure relief valve that vents to atmosphere in order to prevent vessel overpressure and rupture.

As described in *Volume 3, Chapter 17* of the draft EIS, QGC will develop an Emergency Response Plan to determine the appropriate and safe response to a bushfire. This will include the role of local fire brigades.

17.6 CSG COMPOSITION

The composition of QGC's CSG, based on the average, maximum and minimum composition measured from various wells, is presented in *Table 3.17.2.* The composition of QGC's CSG has been compared to the Commonwealth Government's time weighted average exposure standards (TWAES) and short-term exposure limits (STEL).

Table 3.17.2 CSG Composition

Parameter[3]	Unit	Average	Maximum	Minimum[3, 5]	TWAES[1]	STEL[2]
Hydrogen Sulphide	ppm	<0.1	0.8	<0.1	10	15
Methane	mol %	97.6	99.7	88	n/a	n/a
Carbon Dioxide	mol %	0.22	1.21	<0.01	0.5	3.0
Nitrogen	mol %	2.18	5.8	0.11	n/a	n/a
Ethane	mol %	0.01	0.23	<0.01	n/a	n/a
Propane	mol %	<0.01	0.01	<0.01	n/a	n/a
iso-Butane	mol %	<0.01	<0.01	<0.01	0.08	none
n-Butane	mol %	<0.01	<0.01	<0.01	0.08	none
iso-Pentane	mol %	<0.01	<0.01	<0.01	0.075	none
n-Pentane	mol %	<0.01	<0.01	<0.01	0.075	none
Hexanes	mol %	<0.01	<0.01	<0.01	0.05	0.1
Heptanes	mol %	<0.01	<0.01	<0.01	0.04	0.05
Octanes plus	mol %	<0.01	<0.01	<0.01	0.03	0.0375

Notes:

1. Safe Work Australia
2. Safe Work Australia
3. The alkanes compositional data (i.e. all parameters excluding H_2S) were analysed using a gas chromatography machine
4. The detection limit for the gas content parameters is 0.01 mol per cent
5. The detection limit for the H_2S analysis is 0.1 ppm

Methane, nitrogen, ethane and propane are asphyxiant gases which when present in the atmosphere in high concentrations lead to a reduction of oxygen concentration by displacement or dilution. Exposure standards are not supplied for asphyxiants. The risk of asphyxiation is considered to be extremely low, as QGC activities are very unlikely to result in an increased concentration of asphyxiant gases in confined spaces.

When compared to the average CSG composition, none of the components of CSG exceed the TWAES or STEL. When compared to the maximum concentration of any one component of CSG, only carbon dioxide exceeds the TWAES, and no components exceed the STEL. CSG components are not expected to present a human health risk.

17.7 CSG MIGRATION

CSG is predominantly methane gas locked up in underground coal seams. The methane is held in place by a number of forces, including:

- the weight (head) of water above the coal seam
- adsorption, where methane is bound to the surface of the coal by physical and chemical attraction
- the presence of rock layers that are almost impenetrable by a gas.

These forces, under normal circumstances, keep the methane tightly attached to the coal and prevent it from escaping from the coal seams.

In the QGC tenement areas, the Walloon Coal Measures typically range in vertical thickness between 100 m and 460 m, and extend in depth from 170 m to over 900 m below ground level. The rock layers beneath the QGC tenement areas dip to the south and south-west, resulting in the deepest coal seams occurring to the south and south-west and the shallowest coal seams occurring to the north and north-east of QGC tenements.

17.7.1 CSG Migration Pathways

CSG can move through the ground through gaps (holes or pore spaces) and fractures (cracks or breaks) that occur naturally within rock and soils. The ease with which gas can migrate is controlled by the size and number of gaps and fractures and the interconnectedness of these gaps.

CSG movements can also occur through a reduction in groundwater pressure, including through bores and CSG extraction wells.

17.7.1.1 *CSG Extraction*

CSG extraction wells are purpose-built pathways to allow CSG to migrate. CSG will tend to migrate along paths of least resistance. When groundwater pressures are lowered, the path of least resistance is towards and within the CSG extraction well. Consequently, the potential for CSG to escape through the walls of the extraction well and migrate through the surrounding rock, where pressures are significantly greater, is negligible.

In some cases, to aid migration of CSG towards to an extraction well (rather than away from it), “fracing” (refer *Volume 3, Chapter 6*) is used to induce fractures in the coal seams. This process enhances the recovery of CSG under reduced pressure conditions, which further reduces the potential for CSG to escape through less conducive faults.

Following their operational life, the wells will be grouted into place to seal them off from the rest of the Surat Basin sequence and prevent the potential for preferential gas migration pathways to establish.

CSG extraction is designed to capture as much of the methane from the Walloons as possible. QGC operates in areas where the Walloon Coal Measures are so deep that the methane is held in place by very high groundwater pressures.

17.7.1.2 *Natural migration pathways*

In its natural state within the Walloon Coal Measures, the methane will not move until the pressure of the water is reduced to a specific level (less than approximately 70 m above the coal seams). Almost all of QGC's tenements occur in areas where the water pressure is greater than 70 m above the coal seams.

Natural CSG seepage from coal seams has been widely reported in the United States (e.g. the San Juan Basin in Colorado and New Mexico) and is typically associated with locations where the coal seams outcrop at the surface or where rivers have scoured through softer sediments close (<10m deep) to the underlying coal seams (Bureau of Land Management, 1999). In QGC's tenement areas, the coal deposits are typically at depths of more than 170 m.

The Walloon Coal Measures and other strata surrounding the Walloons are considered to have very low permeability. Gas movements between strata are highly unlikely unless there are natural breaks, such as fractures, bedding planes, joints and faults.

Gas migration along a bedding plane will occur only when the water pressure is low, which only occurs naturally where the bedding plane is shallow (i.e. north-east of QGC tenements).

Joints in the Walloon Coal Measures are often widely spaced and squeezed shut under the extremely heavy weight of overlying rock and so do not present a significant opportunity for the migration of CSG.

A number of faults are present within or close to QGC tenement areas. These are generally aligned in a north-south or north-east/south-west orientation parallel or sub-parallel to the direction in which the Walloon Coal Measures dip. In QGC tenement areas, they also do not usually penetrate through the full thickness of the rock layers present, and often do not reach the surface. The faults are squeezed under the heavy weight of rock above and do not readily permit gas migration, except in shallow outcrop areas approximately 20 km to the north-east of QGC's tenements.

Conditions resulting in CSG migration are more likely to exist (if at all) approximately 20 km to the north and north-east of QGC's tenement areas, close to the areas where the Walloon Coal Measures outcrop well outside of QGC's tenements.

17.7.1.3 *Man-made migration pathways*

Groundwater bores take groundwater from deep aquifers above, below and within the Walloons and from shallow alluvial aquifers. Only under certain, rare circumstances will CSG migrate through a deep groundwater aquifer. For this to occur, the column of water in the well above the coal seam needs to be less than approximately 70 m in thickness and the coal seam must be exposed in an open bore (i.e. the well is not screened though the overlying sandstone only). It is unlikely that CSG will migrate through groundwater bores located in shallow aquifers.

17.7.2 Potential to Cause CSG Migration

The potential lowering of groundwater bore pressure through extraction of CSG water may trigger the flow of CSG to other bores if:

- the bore pressure (head) is reduced to approximately less than 70 m above the coal seam
- the other bore is screened in the Walloons.

There are very few groundwater bores that may potentially meet the above criteria.

In a small number of areas (the fringe areas to the north and north-east and well outside of QGC tenements close to where the Walloons outcrop) it is possible that a very small quantity of CSG could escape the extraction process and migrate under natural conditions through the rock to the surface, or into a groundwater bore. However, this would only occur when the CSG extraction encroaches upon zones in the Walloons where methane is already migrating under natural conditions.

In the majority of QGC tenements, the Walloon Coal Measures are so deep that the weight of rock above the coal seams tends to squeeze bedding planes, joints and faults together, resulting in very low permeability. This will act to prevent or significantly slow the migration of methane through the ground, limiting the amount of methane which could migrate to the surface or into a groundwater bore. Given the very limited circumstances by which methane could escape from CSG extraction, and the difficulty methane would have migrating through low permeability rock, the possibility of methane migrating to a location where a groundwater bore is present is extremely unlikely.

17.7.3 Potential Impacts from CSG Migration

There is a very low risk of methane escaping from CSG extraction. Were CSG (predominantly methane) to migrate, the potential risks are considered to be low.

Methane is a colourless, odourless gas which is lighter than air and therefore tends to rise and disperse in the atmosphere. Methane is non-toxic, but at high concentrations (greater than 33 per cent) can result in asphyxiation due to displacement of oxygen in air. Methane may also be toxic to vegetation by displacement of oxygen in soil.

Methane is explosive in air at concentrations between 5 per cent and 15 per cent when exposed to an ignition source. There is a significant risk of ignition when methane is allowed to accumulate in poorly ventilated or confined spaces such as closed basements, small buildings and service pits.

In the unlikely event of methane migrating, it may accumulate if the migration occurs under a poorly ventilated building or in an enclosed groundwater bore. This is considered to be extremely unlikely. Monitoring of bores would identify any that are enclosed and may release methane.

17.7.4 Mitigation Measures

QGC will monitor existing groundwater bores as part of their CSG operations (a Groundwater Monitoring Plan, was submitted to DERM on 30 November 2009). Besides routine monitoring of water levels and water quality, monitoring will include an assessment of methane, both presence and concentration, at the bore head works. The monitoring will allow QGC to respond appropriately to instances where an increase in methane accumulation may be attributed to CSG extraction.

The Groundwater Monitoring Plan provides trigger levels for water levels and water quality parameters which, if exceeded, require increased monitoring and assessment of the cause. The trigger levels are conservative and, where water levels are concerned, are much less than the decrease in water level that may produce or enhance the release of methane. Therefore, forewarning of any potential increases in methane migration to the surface would be received through implementation of the Groundwater Monitoring Plan.

17.8 CONCLUSION

QGC has conducted further qualitative assessments of the hazards and risks posed by bushfires, the components of CSG and CSG migration.

Detailed risk assessments will be conducted to determine the potential to cause bushfires during detailed design. Well pads will be designed to minimise the risk of causing a bushfire from a wellhead flare to as low as reasonably practicable. An Emergency Response Plan will be developed to respond to bushfires.

The average gas content of CSG does not contain gases in concentrations in excess of Safe Work Australia guidelines.

There is a very low likelihood of CSG extraction resulting in methane migration. Even if methane migration was to occur, there is a very low probability of methane accumulating in sufficient concentration to pose an asphyxiation or ignition risk. QGC will monitor groundwater bores for methane emissions to establish a baseline for potential methane migration. This will assist in determining whether QGC activities contribute to methane migration, and the mitigation measures required if CSG extraction potentially causes methane migration.