

Chapter 7 Water

Environmental value 1: water quantity

Environmental objective 1: to ensure all surface and groundwater resources are used sustainably

Risk	Preliminary risk assessment	Mitigation measure	Residual risk
Excessive extraction from surface water	<i>Likelihood</i> - low, lack of permanent surface water in Beetaloo Sub-basin and other semi-arid and arid regions. <i>Consequence</i> - medium. <i>Risk</i> - low.	<ul style="list-style-type: none"> That a SREBA be conducted (Recommendation 7.5). That the use of surface water be prohibited (Recommendation 7.6). That WAPs be developed for the northern and southern regions of the Beetaloo Sub-basin (Recommendation 7.7). 	Low
Excessive extraction from groundwater - regional impacts	<p>Northern Beetaloo Sub-basin: <i>Likelihood</i> - low. <i>Consequence</i> - medium. <i>Risk</i> - low.</p> <p>Southern Beetaloo Sub-basin: <i>Risk</i> - cannot be assessed, lack of detailed knowledge on recharge rates in the region.</p>	<ul style="list-style-type: none"> That a SREBA be conducted (Recommendation 7.5). That the use of surface water be prohibited (Recommendation 7.6). That the Daly-Roper Water Control District (WCD) be extended south to include all of the Beetaloo Sub-basin and that Water Allocation Plans (WAP) be developed for the northern and southern regions of the Beetaloo Sub-basin (Recommendation 7.7). That use of water by the shale gas industry be restricted to less than that which can be sustainably extracted (Recommendation 7.7). That groundwater extraction be prohibited in semi-arid regions until there is sufficient information to demonstrate that there are no adverse impacts (Recommendation 7.7). 	Low for northern Beetaloo Sub-basin. Not able to be determined for southern Beetaloo Sub-basin.
Excessive extraction from groundwater - local impacts	<i>Likelihood</i> - low of an unacceptable aquifer drawdown further than 1 km from the gas company bore fields. <i>Consequence</i> - medium, if aquifers are drawn down excessively this could reduce the effectiveness of bores used by pastoralists and communities. <i>Risk</i> - low.	<ul style="list-style-type: none"> That a SREBA be conducted (Recommendation 7.5). That the extraction of groundwater for hydraulic fracturing be prohibited within at least 1 km of existing or proposed domestic or stock bores. (Recommendation 7.8). That WAPs include provisions to control the rate and volume of water extraction by the gas companies (Recommendation 7.8). That gas companies monitor drawdown in local water supply bores (Recommendation 7.8). That gas companies 'make good' and rectify any problems if the drawdown is found to be excessive (Recommendation 7.8). That groundwater modelling be undertaken to ensure there are no unacceptable impacts on groundwater (Recommendation 7.16). 	Low
Unacceptable changes to surface or groundwater flows from felt seismic activity caused by hydraulic fracturing	<i>Likelihood</i> - low, little evidence for hydraulic fracturing causing felt seismic activity, except in areas of active faults. <i>Consequence</i> - low. <i>Risk</i> - low.	<ul style="list-style-type: none"> That a traffic light system for measured seismic intensity be implemented (Recommendation 5.7). 	Low

Risk	Preliminary risk assessment	Mitigation measure	Residual risk
Unacceptable changes to surface and groundwater flow from seismic activity caused by reinjection of wastewater	<i>Likelihood</i> - low, evidence that this practice has cause seismic activity in US but no evidence for flow changes. <i>Consequence</i> - low to medium. <i>Risk</i> - medium.	<ul style="list-style-type: none"> That the reinjection of wastewater into deep aquifers and conventional reservoirs and the reinjection of treated or untreated wastewaters (including brines) into aquifers be prohibited (Recommendation 7.9). 	Low
Unacceptable changes to the surface water flow characteristics due to planned or accidental discharge of wastewaters	<i>Likelihood</i> - low to medium, based on historical data from the US. <i>Consequence</i> - low. <i>Risk</i> - low.	<ul style="list-style-type: none"> That the discharge of wastewaters (treated or untreated) to any surface water body be prohibited (Recommendation 7.17). 	Low

Environmental value 2: surface and groundwater quality

Environmental objective 2: to maintain acceptable quality of surface and groundwater

Risk	Preliminary risk assessment	Mitigation measure	Residual risk
Unacceptable groundwater contamination from leaky production wells	<p>Wastewater (salts and chemicals)</p> <p><i>Likelihood</i> - very low, little evidence of faulty contemporary wells. <i>Consequence</i> - medium, will depend upon the behaviour of contaminants in the groundwater (dispersion, transport, degradation). <i>Risk</i> - medium.</p> <p>Methane</p> <p><i>Likelihood</i> - low to medium, methane leakage more likely than leakage from bores of contaminated flowback or produced water. <i>Consequence</i> - low, little evidence that methane contamination of groundwater is harmful. Methane in water is considered non-toxic, but a possible explosion risk in drinking water bores or storage tanks if dissolved concentration exceeds 28 mg/L. <i>Risk</i> - low.</p>	<ul style="list-style-type: none"> That guidelines be developed for human and environmental risk assessments for all onshore shale gas developments (Recommendation 7.4). That information about hydraulic fracturing fluids, flowback and produced water be publicly disclosed (Recommendation 7.10). That all wells to be hydraulically fractured are constructed to at least Category 9 or equivalent and be tested to ensure well integrity before and after hydraulic fracturing, with the results certified by the regulator (Recommendation 7.11). That there is an offset of 1 km between well pads and water supply bores (Recommendation 7.11). That there is real-time groundwater quality monitoring around each well pad (Recommendation 7.11 and 7.13). That well pads are equipped with multilevel observations bores (Recommendation 7.11). That electrical conductivity and other water quality indicators are measured (Recommendation 7.11). 	Low (wastewater) Low (methane)

Risk	Preliminary risk assessment	Mitigation measure	Residual risk
Unacceptable groundwater contamination due to leaky abandoned wells	<p><i>Likelihood</i> - low, likely to be little produced water present and gas pressure will be greatly reduced at end of production life.</p> <p><i>Consequence</i> (wastewater) - low, since very low volumes of wastewater will be involved.</p> <p><i>Risk</i> (wastewater) - low.</p> <p><i>Consequence</i> (methane) - low.</p> <p><i>Risk</i> (methane) - low.</p>	<ul style="list-style-type: none"> • That a code of practice for well decommissioning be mandated (Recommendation 5.1). • That decommissioned and orphaned wells be monitored (Recommendation 5.2). 	Low (wastewater) Low (methane)
Unacceptable groundwater contamination due to spills of hydraulic fracturing chemicals and wastewater: on-site spills	<p><i>Likelihood</i> - medium, spills are typically small volume; the likelihood of the contaminants penetrating to the aquifer is low for most of the Beetaloo Sub-basin.</p> <p><i>Consequence</i> - medium, contamination could result in health issues for humans and stock using the aquifer for drinking.</p> <p><i>Risk</i> - medium.</p>	<ul style="list-style-type: none"> • That wastewater management plans and spill management plans be mandated (Recommendation 7.12). • That enclosed tanks be used for wastewater (Recommendation 7.12). • That well pads be banded to prevent run off and be treated by a geomembrane to prevent infiltration into the soil (Recommendations 7.12). • That groundwater be monitored (Recommendation 7.13). 	Low
Unacceptable surface and groundwater contamination due to off-site spills of hydraulic fracturing chemicals and wastewater from road and rail transport	<p><i>Likelihood</i> - medium, accidents are likely, particularly for road transport.</p> <p><i>Consequence</i> - medium, contamination of surface waterbodies could occur and result in adverse effects on aquatic ecosystem; in case of groundwater, will depend on where the accident/spill occurs and permeability of overlying soil/rock horizons at that location.</p> <p><i>Risk</i> - medium.</p>	<ul style="list-style-type: none"> • That a wastewater management framework be developed. The framework must include an auditable chain of custody that enables source-to-delivery tracking (Recommendation 5.5). • That restrictions be placed on the transport of fracking fluids and wastewater (Recommendation 7.14). • That rail be considered as a mode of transport (Recommendation 7.14). 	Not able to be determined
Unacceptable groundwater contamination due to off-site leaks of hydraulic fracturing chemicals and wastewater from pipelines	<p><i>Likelihood</i> - low, pipelines will be buried.</p> <p><i>Consequence</i> - medium, will depend on volume of the spill, type of wastewater and potential for contamination of groundwater.</p> <p><i>Risk</i> - low.</p>	<ul style="list-style-type: none"> • That a wastewater management framework be developed. The framework must include an auditable chain of custody that enables source-to-delivery tracking (Recommendation 5.5). • Ensure adequacy of construction guidelines and their enforcement. 	Not able to be determined
Unacceptable contamination of groundwater aquifers due to reinjection of treated or untreated wastewater into other aquifers	<p><i>Likelihood</i> - undetermined, cannot be assessed without detailed site-specific information and computer modelling.</p> <p><i>Consequence</i> - medium, if surface aquifer is contaminated.</p> <p><i>Risk</i> - undetermined.</p>	<ul style="list-style-type: none"> • That reinjection of wastewater into aquifers be prohibited (Recommendation 7.9). • That discharge of treated or untreated wastewater into waterways be prohibited (Recommendation 7.13). 	Low

Risk	Preliminary risk assessment	Mitigation measure	Residual risk
Unacceptable groundwater contamination due to induced connectivity between hydraulically fractured shale rock formation and overlying aquifers	<p><i>Likelihood</i> - remote to very low, provided that the hydraulic fracturing does not intersect with a fault.</p> <p><i>Consequence</i> - medium.</p> <p><i>Risk</i> - low.</p>	<ul style="list-style-type: none"> That details of known fault locations that could compromise well integrity be submitted to the regulator (Recommendation 7.15). 	Low
Unacceptable groundwater contamination due to changed groundwater pressures	<p><i>Likelihood</i> - low due to very large distance between shale formation and aquifers.</p> <p><i>Consequence</i> - medium.</p> <p><i>Risk</i> - low, provided that the fracturing operations avoid the proximity of existing faults.</p>	<ul style="list-style-type: none"> That modelling of the groundwater system be undertaken as part of a SREBA (Recommendation 7.16). 	Low
Unacceptable contamination of surface waters due to the intentional discharge of partially treated or untreated wastewater	<p><i>Likelihood</i> - low, provided that this practice is prohibited.</p> <p><i>Consequence</i> - medium, if during wet season when dilution is available and depending upon the concentrations of contaminants released.</p> <p><i>Risk</i> - low.</p>	<ul style="list-style-type: none"> That the discharge of hydraulic fracturing fluids and wastewater (treated or untreated) to drainage lines, waterways or temporary stream systems should not be permitted (Recommendation 7.17). 	Low
Adverse effects of linear infrastructure (roads, pipelines) on the quality and distribution of surface water across the landscape	<p><i>Likelihood</i> - medium, unlikely there will be problems with pipelines provided they are buried.</p> <p><i>Consequence</i> - low to medium, depending upon how they are designed and constructed.</p> <p><i>Risk</i> - medium.</p>	<ul style="list-style-type: none"> That landscape and regional impacts are considered in the planning phase of any development (Recommendation 7.18). That roads and pipeline corridors are constructed to comply with relevant guidelines (Recommendation 7.19). That regional and cumulative impacts be taken into account in decision-making (Recommendation 14.21 and 14.22). 	Low

Environmental value 3: aquatic ecosystems and biodiversity

Environmental objective 3: to adequately protect ecosystems and biodiversity that are dependent on surface water or groundwater

Risk	Preliminary risk assessment	Mitigation measure	Residual risk
Excessive extraction from surface waters	<p><i>Likelihood</i> - low, given the lack of permanent surface water in Beetaloo Sub-basin and other semi-arid and arid regions.</p> <p><i>Consequence</i> - medium, if volumes and flow regimes are altered.</p> <p><i>Risk</i> - medium.</p>	<ul style="list-style-type: none"> That a SREBA be conducted (Recommendation 7.5). That the use of surface water be prohibited (Recommendation 7.6). That WAPs be developed for the northern and southern regions of the Beetaloo Sub-basin (Recommendation 7.7). 	Low
Excessive extraction from groundwaters	<p><i>Likelihood</i> - low, for surface GDEs since none known in Beetaloo Sub-basin, undetermined for subterranean ecosystems (stygo fauna).</p> <p><i>Consequence</i> - undetermined for subterranean ecosystems.</p> <p><i>Risk</i> - undetermined, lack of detailed knowledge of impact of subterranean fauna (stygo fauna).</p>	<ul style="list-style-type: none"> That a SREBA be conducted (Recommendation 7.5). That the use of surface water be prohibited (Recommendation 7.6). That the Daly-Roper Water Control District (WCD) be extended south to include all of the Beetaloo Sub-basin and that Water Allocation Plans (WAP) be developed for the northern and southern regions of the Beetaloo Sub-basin (Recommendation 7.7). That use of water by the shale gas industry be restricted to less than that which can be sustainably extracted (Recommendation 7.7). That groundwater extraction be prohibited in semi-arid regions until there is sufficient information to demonstrate that there are no adverse impacts (Recommendation 7.7). 	Low for surface GDEs but undetermined for subterranean ecosystems
Unacceptable contamination of surface waters (aquatic ecosystems)	<p><i>Likelihood</i> - low.</p> <p><i>Consequence</i> - medium.</p> <p><i>Risk</i> - low.</p>	<ul style="list-style-type: none"> That the discharge of wastewaters (treated or untreated) to any surface water body be prohibited (Recommendation 7.17). That wastewater management plans and spill management plans be mandated (Recommendation 7.12). That enclosed tanks for wastewater be used (Recommendation 7.12). That well pads be bunded to prevent run off and be treated by a geomembrane to prevent infiltration into the soil (Recommendations 7.12). That groundwater be monitored adjacent to each well pad (Recommendation 7.13). 	Low
Unacceptable contamination of groundwaters (groundwater-dependent ecosystems)	<p><i>Likelihood</i> (leaky wells) - low, little evidence of faulty contemporary wells leaking solutes.</p> <p><i>Likelihood</i> (spills) - medium.</p> <p><i>Consequence</i> - undetermined, impact of contaminants on surface GDEs and subterranean fauna unknown.</p> <p><i>Risk</i> - undetermined.</p>	<ul style="list-style-type: none"> That a SREBA be conducted, including a baseline study of surface and subterranean ecosystems (Recommendations 7.5 and 7.19). 	Undetermined

Chapter 8 Land

Environmental value 1: terrestrial biodiversity and ecosystem health

Environmental objective 1: to ensure there is a low risk of impact on the terrestrial biodiversity values of affected bioregions and to ensure that the overall terrestrial ecosystem health, including the provision of ecosystem services, is maintained

Risk	Preliminary risk assessment	Mitigation measure	Residual risk
Unacceptable location of shale gas developments within a region	<p><i>Likelihood</i> - high, due to lack of region-wide biodiversity knowledge.</p> <p><i>Consequence</i> - high, significant threat to species that might occupy highly restricted ranges in development area.</p> <p><i>Risk</i> - high.</p>	<ul style="list-style-type: none"> • That a SREBA for all affected bioregions prior to any onshore shale gas production be conducted (Recommendation 8.1). • That areas with high conservation value be excluded from shale gas development (Recommendations 8.1 and 14.4). 	Low
Unacceptable increase in the spread or impact of weeds	<p><i>Likelihood</i> - high, given experience with onshore gas developments elsewhere.</p> <p><i>Consequence</i> - high, given severe potential impact on conservation and production values.</p> <p><i>Risk</i> - high.</p>	<ul style="list-style-type: none"> • That a baseline assessment of all weeds is undertaken (Recommendation 8.2). • That gas companies employ a dedicated weed management officer (Recommendation 8.3). • That gas companies have a weed management plan in place (Recommendation 8.4). 	Low
Unacceptable increase in the spread or impact of exotic invasive ants	<p><i>Likelihood</i> - medium, given that such species are established elsewhere in northern Australia and are readily spread by vehicles and machinery.</p> <p><i>Consequence</i> - high, major impacts on native species if introduced.</p> <p><i>Risk</i> - high.</p>	<ul style="list-style-type: none"> • That hygiene measures for vehicles and machinery are implemented (see discussion at Section 8.4.2.2 and Recommendation 8.4). 	Low
Unacceptable increase in the impact of feral animals	<p><i>Likelihood</i> - low, because onshore gas development is unlikely to have a significant impact on feral animal populations.</p> <p><i>Consequence</i> - low, as any increased impact of feral animals is likely to be local only.</p> <p><i>Risk</i> - low.</p>	<ul style="list-style-type: none"> • Gas companies must be aware of regional feral animal management obligations and programs (see discussion at Section 8.4.2.3). 	Low
Unacceptable changes to fire regimes	<p><i>Likelihood</i> - medium, increased human activity and hence sources of ignition.</p> <p><i>Consequence</i> - high, given the ecological importance of fire and its role in GHG gas emissions.</p> <p><i>Risk</i> - high.</p>	<ul style="list-style-type: none"> • That gas companies comply with regional fire management plans, which include requirements for baseline data, monitoring for any increase in fire frequency, and implementation of management actions as appropriate (Recommendation 8.5). 	Low
Unacceptable loss of native vegetation	<p><i>Likelihood</i> - high, given that substantial areas will be cleared of vegetation.</p> <p><i>Consequence</i> - low, because only small proportion of the landscape will be cleared, and fragmentation and edge effects are likely to be limited.</p> <p><i>Risk</i> - medium.</p>	<ul style="list-style-type: none"> • That a SREBA be conducted to identify any threatened species likely to be affected by cumulative effects of habitat loss and fragmentation and manage accordingly (Recommendation 8.6). • That vegetation clearing is minimised (Recommendation 8.7). • Progressively rehabilitate cleared areas (Recommendation 8.8). • Design and implement offsets to compensate for local vegetation and habitat losses (Recommendation 8.9). 	Low

Risk	Preliminary risk assessment	Mitigation measure	Residual risk
Roads and pipelines as ecological barrier or corridors	<p><i>Likelihood</i> - medium, given impacts of past construction of roads and pipelines.</p> <p><i>Consequence</i> - medium, given ecological importance of run-on/run-off dynamics in flat, semi-arid landscapes.</p> <p><i>Risk</i> - medium.</p>	<ul style="list-style-type: none"> • That corridor widths be kept to a minimum, with pipelines and other linear infrastructure buried, except for necessary inspection points, wellpads and other operation areas, and the disturbed ground revegetated (Recommendation 8.10). • That directional drilling under stream crossings be used in preference to trenching (Recommendation 8.12). • That roads and pipeline surface water flow paths minimise erosion of all exposed surfaces and drains (Recommendation 8.13). • That all corridors be constructed to minimise the interference with wet season stream crossings and comply with relevant guidelines (Recommendation 8.14). 	Low
Other impacts on wildlife	<p><i>Likelihood</i> - low, given management procedures already in place.</p> <p><i>Consequence</i> - low, given that any impacts will be local only.</p> <p><i>Risk</i> - low.</p>	<ul style="list-style-type: none"> • Implement existing management procedures. 	Low

Environmental value 2: landscape amenity

Environmental objective 2: to ensure that the perception by residents and tourists that the NT is a place of largely unspoiled landscapes is not diminished

Risk	Preliminary risk assessment	Mitigation measure	Residual risk
Unacceptable landscape transformation	<p><i>Likelihood</i> - medium, given experiences with onshore gas developments elsewhere.</p> <p><i>Consequence</i> - high, given the extremely high importance of the NT's unspoiled landscapes.</p> <p><i>Risk</i> - high.</p>	<ul style="list-style-type: none"> • That well pads are spaced a minimum of 2 km apart, and that long-term infrastructure within any development areas has little or no visibility from major public roads (Recommendation 8.15). 	Low
Unacceptable increase in heavy-vehicle traffic	<p><i>Likelihood</i> - cannot be assessed, lack of predicted traffic information.</p> <p><i>Consequence</i> - uncertain.</p> <p><i>Risk</i> - uncertain.</p>	<ul style="list-style-type: none"> • That the impact that all heavy-vehicle traffic associated with any onshore shale gas industry will have on the NT's transport system is assessed and managed (Recommendation 8.16). 	Low to medium

Chapter 9 Greenhouse gases

Environmental value 3: climate change

Environmental objective: to limit the emissions of methane and greenhouse gases to the atmosphere

Risk	Preliminary risk assessment	Mitigation measure	Residual risk
Excessive upstream fugitive emissions of methane during upstream extraction, processing, transport and distribution	<p><i>Likelihood</i> - high, given that methane emissions occur mostly on a continuous basis but with some episodic releases.</p> <p><i>Consequence</i> - low, given that upstream methane emissions (from any new shale gas field) will contribute a very low proportion of net global methane emissions.</p> <p><i>Risk</i> - medium.</p>	<ul style="list-style-type: none"> That the US EPA New Source Performance Standards of 2012 and 2016 be introduced (Recommendation 9.1). That a code of practice or other guideline for the ongoing monitoring, detection and reporting of emissions from wells be undertaken (Recommendation 9.2). That baseline monitoring of methane concentrations be undertaken for at least six months prior to the grant of any exploration approvals (Recommendation 9.3). That baseline and ongoing monitoring be undertaken (Recommendation 9.4). Monitoring results should be published on a continuous real-time basis (Recommendation 9.5). That once emission concentration limits are exceeded the problem is rectified (Recommendations 9.6). 	Methane levels reduced to a level consistent with the acceptability criterion for methane emissions (Table 9.9), but the risk remains medium (see GHG mitigation).
Excessive emissions of methane from post production wells	<p><i>Likelihood</i> - high, in the absence of monitoring and appropriate action.</p> <p><i>Consequence</i> - low, given that upstream methane emissions (from any new shale gas field) will contribute a very low proportion of net global methane emissions.</p> <p><i>Risk</i> - medium.</p>	<ul style="list-style-type: none"> That a code of practice be developed for decommissioned wells and that wells be implemented (Recommendation 5.1 and 5.2). That resources be available in the long term to ensure ongoing monitoring of wells and that problems will be remediated (Recommendations 14.13 and 14.14). 	Methane levels reduced to a level consistent with the acceptability criterion for methane emissions (Table 9.9), but the risk remains medium (see GHG mitigation).
Other (supplementary) risks may prevent lower levels of methane emission performance from being achieved	N/A.	<ul style="list-style-type: none"> That the action framework in Table 9.10 is implemented to manage and/or mitigate any supplementary risks that may prevent the achievement of lower levels of methane emissions (Recommendation 9.7). 	Risk is low and acceptable
Excessive emissions of lifecycle greenhouse gases, GHG (including methane)	<p><i>Likelihood</i> - high, given that GHG emissions occur mostly on a continuous basis but with some episodic releases.</p> <p><i>Consequence</i> - low (365 PJ/y production), given that GHG emissions (from any new shale gasfield) will contribute a very low proportion of net global GHG emissions and low/ medium (1,240 PJ/y production)</p> <p><i>Risk</i> - medium (365 PJ/y production) and medium/ high (1,240 PJ/y production)</p>	<ul style="list-style-type: none"> After mitigation of methane emissions the residual lifecycle GHG emissions are reduced slightly, but they remain medium or high. The lifecycle GHG emissions must have a low risk (Chapter 4). This can be achieved by fully offsetting the lifecycle GHG emissions. That the NT and Australian Government seek to ensure there is no net increase of GHG emissions in Australia as the result of any onshore shale gas produced in the NT (Recommendation 9.8). 	Risk is low and acceptable

Chapter 10 Public health

Environmental value 1: to prevent adverse impacts on public health by exposure to chemicals in contaminated water and air

Environmental objective 1: to assess and manage health risks associated with contaminated surface and groundwater

The risk estimates and risk mitigation measures for this objective are identical to those associated with water quality in Chapter 7.

Environmental objective 2: to assess and manage human health risks associated with the specific chemicals used in, or likely to result from, hydraulic fracturing processes

Risk	Preliminary risk assessment	Mitigation measure	Residual risk
Unacceptable human health effects caused by hydraulic fracturing and geogenic chemicals in flowback water	<p><i>Likelihood</i> - low, for hydraulic fracturing chemicals, unknown (at this time) for geogenic chemicals.</p> <p><i>Consequence</i> - medium, if inadequate knowledge of the concentration or presence of more toxic chemicals compromises the estimation of health risks via a formal HHRA.</p> <p><i>Risk</i> - low.</p>	<p>Require gas companies to prepare a site-specific HHRA that:</p> <ul style="list-style-type: none"> • uses contemporary knowledge of the chemicals proposed to be used specifically in formulating fracking fluids for operations in the NT; and • provides further details of the chemical composition of flowback and produced water specific to the geological features of the NT sites proposed for shale gas development, along with the proposed methods of treatment and/or disposal of this water (Recommendation 10.1 and 7.10). 	<p>Low - for hydraulic fracturing chemicals</p> <p>Unknown - (at this time) for geogenic chemicals</p>

Environmental objective 3: to ensure human health risks associated with airborne emissions from gas wells and associated infrastructure are acceptable

Risk	Preliminary risk assessment	Mitigation measure	Residual risk
Unacceptable impacts on the health of nearby communities from volatile or gaseous chemicals emitted from well heads, storage ponds, processing facilities or pipelines	<p><i>Likelihood</i> - medium for methane. Low for VOCs but highly dependent on the distance between source and potentially exposed humans.</p> <p><i>Consequence</i> - low for methane (relatively non-toxic gas). Medium for toxic gases and VOCs (such as NOx, BTEX), especially where associated with gas combustion events (flaring).</p> <p><i>Risk</i> - low to medium.</p>	<ul style="list-style-type: none"> • That wells are constructed and maintained to a high standard to ensure well head assemblies and pipelines are not leaking, coupled with regular monitoring to detect point source leaks (Recommendations 5.4 and 9.4). • That appropriate setback distances are set to minimise risks identified in HHRA reports, including potential pathways for waterborne and airborne contaminants. In the absence of local information, a default minimum setback distance of 2 km (based on US data) should be used (Recommendation 10.2). 	Low
Unacceptable impacts on the health of nearby communities from dusts and/or diesel exhaust fumes from shale gas site preparation activities	<p><i>Likelihood</i> - medium, but likely to be of relatively short-term impact during the pre-production phase of well head and facility development.</p> <p><i>Consequence</i> - low to medium, depending on controls over equipment movements and/or dust suppression measures.</p> <p><i>Risk</i> - low to medium.</p>	<ul style="list-style-type: none"> • That appropriate setback distances (based on scientific evidence) are set to protect landowners and local communities. In the absence of local information, a default minimum setback distance of 2 km (based on US data) should be used (Recommendation 10.2). 	Low to medium

Environmental objective 4: to ensure the human health risks associated with potential impacts on wellbeing are acceptable

The assessment of this objective is primarily covered in Chapter 9, together with the assessments contained in Chapters 11 and 12.