15. PRELIMINARY HAZARD AND RISK

This chapter summarises the findings of the supplementary preliminary hazard and risk assessment undertaken to address changes made to the project description since the Surat Gas Project Environmental Impact Statement (EIS) (Coffey Environments, 2012b) was finalised.

The Supplementary Preliminary Hazard and Risk Assessment, prepared by Planager Pty Ltd (Planager) is included in Appendix 12. The study supplements the Preliminary Hazard and Risk Assessment presented in Appendix S of the EIS, the main findings of which are summarised in Chapter 25 of the EIS.

The revised project description is provided in Chapter 3, Project Description, however aspects relevant to hazard and risk are also discussed in this chapter. In addition to the study findings, a list of key issues raised in submissions is presented, with responses to all issues provided in Part B, Chapter 19, Submission Responses. An updated list of commitments is also provided.

15.1 Studies and Assessments Completed for the EIS

The preliminary hazard and risk assessment provided an assessment of potential hazards and risks associated with project activities during the construction, operation and decommissioning phases. The study focused on hazards and risks to people and property from potentially significant incidents and was completed in accordance with the principles of AS/NZS ISO 31000:2009 Risk Management (Standards Australia, 2009b). Both qualitative risk profiles and quantitative risk contours and transects were developed to determine appropriate buffer zones between project infrastructure and neighbouring land uses for the protection of people and property. These buffer zones will inform the selection of suitable localities for project infrastructure. The contours and transects show the likelihood of fatality or injury to notional individuals occupying neighbouring land uses in the event of a fire or explosion due to a loss of containment of flammable gas.

The qualitative risk assessment undertaken as a part of the preliminary hazard and risk assessment found that the key project hazards and risks were associated with the operation of production wells and central gas processing facilities (CGPFs). These hazards and risks predominantly involved the handling and processing of flammable gas. Hazardous incident scenarios included the potential loss of containment of flammable gas or saline water and external events (such as bushfires or flooding). The study identified the highest risk across project activities as injury to drivers due to transportation risks. A series of mitigation measures were developed to reduce and manage the identified risks.

The risk contours and transects developed as a part of the quantitative risk assessment showed that low to tolerable risk levels would be achieved at neighbouring land uses with minimum buffer zones in place around project facilities. The assessment also found that the stringent risk management measures imposed through relevant codes and standards, and Arrow's own internal systems, meant that the likelihood of a major incident involving these facilities would be very low.

Table 15.1 presents the commitments to managing hazards and risks made by Arrow in the EIS and which were based on expert advice from Planager.

Table 15.1 Hazard and risk commitments presented in the EIS

No.	Commitment
C035	Apply appropriate international, Australian and industry standards and codes of practice for the handling of hazardous materials (such as chemicals, fuels and lubricants).
C079	Arrow will enforce a no hydraulic fracturing (fraccing) policy in the project development area.
C206	Subject each dam to separate approvals by the regulating authority. Each approval will require the incorporation of general and specific controls to avoid, mitigate or manage threats associated with flooding.
C207	Implement the dam operating plan.
C208	To reduce mosquito breeding in dams, dams and dam inner banks will be maintained so that they are as free of vegetation as practicable.
C209	Use an independent, suitably qualified, third party to certify that dams meet the dam design plan.
C210	Have in place a system for the collection and proper disposal of any contaminants that move beyond the bounds of the containment system of brine dams.
C211	Design and size dams to account for predicted flood conditions.
C215	Establish overflow and operational controls in accordance with the dam operating plan.
C216	Inspect and maintain dam integrity.
C223	Develop fire plans for production facilities.
C288	Implement an in-vehicle monitoring system for project vehicles.
C416	Prepare project safety management plans for the construction, operations and decommissioning of the infrastructure that form part of the present development.
C417	Implement Arrow's health, safety and environmental management system for all activities and phases of development.
C418	Conduct appropriate safety reviews during design of new and modified facilities, including the use of hazard and risk assessment processes. Base safety reviews on well-recognised methodologies, e.g., hazard and operability studies and AS 2885 (Standards Australia, 2008a) risk assessment (safety management studies).
C419	Select locations for project infrastructure with full consideration of and allowance for the minimum buffer zones indicated by the quantitative risk assessment.
C420	Design and construct project infrastructure and facilities in accordance with applicable codes and standards.
C421	Facilities will be designed with the ability to shut down and be isolated in preparation for impending bushfires.
C422	Design and install combustion sources (such as generators and gas-fired compressors) on Arrow facilities in accordance with engineering codes and standards, thus ensuring they will have safety mechanisms built-in.

Table 15.1 Hazard and risk commitments presented in the EIS (cont'd)

No.	Commitment
C423	Develop protocols for the control of construction activities during extreme fire danger periods.
C424	Arrow will develop emergency response plans in consultation with emergency services organisations that includes a list of required equipment, training and other resources, and foreseeable emergency and crisis situations (including escapes, blowouts, gas fire, bushfire, critical equipment failure, trapped or missing people, flooding, cyclones, power failure, security incidents and threats, and transport incidents). The plans should include safe evacuation procedures, communication protocols (internal and to emergency services, including the Petroleum and Gas Inspectorate), accounting for personnel and visitors, roles and responsibilities, and requirements for training.
C425	Design all pipes and vessels to cope with maximum expected pressure.
C426	Install pressure transmitters that remotely monitor high- and low-pressure alarms.
C427	Consider remote-control isolation on gas and water lines.
C428	Design equipment to withstand considerable heat load, e.g., through use of heat resistant (fire-safe) isolation valves on production facilities.
C429	Design radiation exclusion zones around flares according to API standard.
C430	Register pipelines and below-ground electrical services with Dial Before You Dig.
C431	Minimise enclosed spaces where flammable gas may accumulate.
C432	Consider installing flow and pressure instrumentation to transmit upset conditions and plant shutdown valves status, where necessary.
C433	Arrow will manage flooding risk through site location, drainage, etc., particularly for production facilities.
C434	Design appropriate drainages for waste spills within buildings.
C435	Apply dam safety guidelines, which will apply for all facilities forming part of the project development.
C436	Consider the Australian Pipeline Industry Association Construction Health and Safety Guidelines (APIA, 2008) for pipeline construction and development of Construction Health and Safety Plan.
C437	Conduct pre-job safety meetings prior to the start of and during construction activities.
C438	Perform blowout of pipes and equipment, to remove construction debris, using well-established procedures and under strict controls, including those detailed in risk assessments.
C439	Develop an integrated risk management plan (in alignment with the relevant NSW Department of Primary Industries hazardous industry planning advisory paper).
C440	Install, inspect and service fire-fighting equipment in accordance with risk assessments and relevant legislation and standards.

Table 15.1 Hazard and risk commitments presented in the EIS (cont'd)

No.	Commitment
C441	Implement transport-related safety programs, including driver training, journey management plans and preventive maintenance programs of vehicles.
C442	Develop and implement safety training programs for personnel and contractors, including induction training of new starters. Include supervision requirements for drilling and construction activities.
C443	Conduct pressure testing and inspection of equipment and pipelines in accordance with relevant legislative requirements and standards.
C444	Bury gathering lines at a minimum depth of 600 mm. Where gathering lines are present above the ground (at wellheads and at vents or drains), maintain a clear area. The size of the cleared area will be determined on a site-by- site basis with consideration of the site-specific risk of bushfire.
C445	Install isolation valves on pipelines in accordance with relevant standards and industry practices.
C446	Commission fire-safety equipment in the early phase of the construction period.
C447	Fit all buildings and production facilities with smoke or fire alarms.
C448	Fit pumps with automatic pump shutdown or other safety devices to prevent leak in case of pumping against a blockage.
C449	Install fire and gas detection systems to shutdown compressors.
C450	Implement security controls, e.g., fencing and locked gates.
C451	Install lightning mast and earthing grid to minimise risk of lightning strike at production facilities.
C452	Machine guard all rotating equipment in accordance with Australian standards.
C453	Where necessary, automate emergency shutdown systems at production facilities and, if necessary, include remote monitoring and control.
C455	Conduct systematic risk assessments (which include hazard identification, assessment, treatment and monitoring) in accordance with relevant legislation and standards during design, construction and operations.
C456	Implement a permit to work system that includes a job safety analysis process.
C457	Implement management of change processes, including protocols for communication of changes to appropriate levels of management.
C458	Implement internal and external (independent) hazard audit programs. Communicate results from audit to management.
C459	Barricade fall points and use personal fall-arrest equipment and wrist straps and lanyards to secure tools when working at heights.
C460	Use whip check or safety chain and tie downs (or equivalent) on all high-pressure lines and pressurised air hoses.
C461	Wear appropriate personal protective equipment on a site and duty-specific basis.

Table 15.1 Hazard and risk commitments presented in the EIS (cont'd)

No.	Commitment
C462	Where applicable, establish blowout preventer and other well control measures.
C463	Certify all equipment for drilling, where applicable.
C464	Ensure equipment and vehicle operators are licensed.
C465	Prepare a risk control action plan as part of the safety assessment process.
C466	Purge equipment of oxygen prior to introducing flammable gas.
C467	Purge equipment after shutdowns.
C468	Develop protocols for the control of operational activities during extreme fire danger periods, e.g., flaring or shutdowns.
C469	Use onsite waste treatment for such purposes as sewage, coal seam gas water and other specified wastes. Sewage will be treated in packaged sewage treatment plants. Sewage treatment plants will be located at production facilities and include settlement, digestion, aeration, clarification and disinfection equipment.
C470	Consider non-static protective clothing for operations personnel.
C471	Establish lone-worker protocols and communication.
C472	Conduct regular patrols and inspections of pipeline easements, including status of signposting subsidence and of fire breaks.
C474	Automate the chemical dosage system for water treatment at integrated processing facilities.
C475	Consider the use of non-toxic gases for water treatment if gases are used.
C476	Ensure operator supervision for unloading of hazardous materials at production facilities.
C477	Provide escape ropes and ladders at strategic locations within a dam.
C479	Use suitably trained and supervised staff or contractors to carry out depressurising and purging activities.

Table 15.1 Hazard and risk commitments presented in the EIS (cont'd)

No.	Commitment
C480	Ensure all personnel are familiar with Arrow's 12 Life Saving Rules, which embed safe practices in the day-to-day activities of the workforce. The rules encompass the following controls: • All staff to work with a valid permit where required. • Gas tests to be conducted where required. • Verification of isolation prior to work commencing and use of specified life-protecting equipment. • Authorisation to be obtained prior to entering a confined space. • Authorisation to be obtained prior to overriding or disabling any critical safety equipment. • All persons to protect themselves against a fall when working at a height. • No walking under a suspended load. • No smoking outside designated areas. • No alcohol or drugs while working or driving. • No phones to be used while driving and speed limits not to be exceeded. • Seat belts to be worn at all times. • Prescribed journey management plan to be followed.
C481	Train relevant personnel in the identification and avoidance of potentially hazardous wildlife. Use qualified handlers to move wildlife from project areas when encountered.
C483	Vegetation surrounding production facilities and wellheads will be maintained in a manner that limits the amount of will be maintained in a manner that limits the amount of combustible material in the area. The size of the cleared area will be determined on a site-by-site basis with consideration of the site-specific risk of bushfire.
C484	Install manual isolation valves at the production well and skid edge.
C485	Maintain facilities so that flammable and combustible material does not accumulate on site.
C486	Keep access tracks to well sites clear of dry grass and combustible material wherever practicable and where there is a higher risk of bushfire (to minimise the risk of dry grass being ignited by hot components of vehicles accessing the sites).
C487	Daily operations will be managed with consideration of the fire danger current at that time.
C488	Develop rig move plans.
C489	Depressurise and degas all plant and equipment in flammable-gas use prior to decommissioning.
C528	Monitor dam levels.
C532	Have a suitably qualified person routinely monitor the integrity and available storage of dams.
C537	Production wells will be designed and constructed so that the well is cased or concreted through aquifers other than the coal seam to prevent transmission of water and gas between strata.
C538	The State Planning Policy 1/03 for mitigating the adverse impact of flood, bushfire and landslide will be taken into regard.

15.2 Study Purpose

The supplementary preliminary hazard and risk assessment addresses changes to the project description since the EIS was finalised.

These changes arose as a result of further refinement of the field development plan and were identified as having the potential to affect (increase or reduce) some of the results of the preliminary hazard and risk assessment, as detailed in Chapter 25 and Appendix S of the EIS. The changes are summarised below.

15.2.1 Production Wells

The EIS described production wells as a single well located on one well pad. Wells will now be drilled as both single well pads and multi-well pads. The multi-well pads will comprise of an average of 9 but up to 12 wells per pad, approximately 8 m apart. Multi-well pads will comprise of a mix of vertical and deviated production wells. A likely configuration will be one central vertical production well, with the remainder of the wells being deviated production wells.

The multi-well pads consolidate a group of wells at one surface location, reducing the total number of well pad sites and increasing the distance between any two well pad sites. Approximately 30% of wells are expected to be single well pads and the remaining 70% will be multi-well pads.

15.2.2 Central Gas Processing Facilities

The layout of the CGPFs has changed from that presented in the EIS due to changes in the compression capacity and power generation.

Each CGPF will comprise of four-stage centrifugal compressors, each with the capacity to compress 75 TJ/d gas. The maximum gas compression capacity of CGPFs has increased to 225 TJ/d (with an n+1 sparing capacity resulting in up to four 75 TJ/d gas compression trains at a single facility). The EIS considered a maximum capacity of 150 TJ/d.

Centrifugal compressors are now Arrow's preferred option for the CGPFs, compared to the other compressor options presented in the EIS. Centrifugal compressors have a lower leak frequency, require less maintenance and are quieter than screw and reciprocal compressors. In addition, the number of compressors has reduced. The CGPF site layout also incorporates temporary power generation for the initial construction phases of the project. Note that changes to power options (inclusive of the high voltage distribution lines) and the flaring strategy were not identified as requiring re-assessment as a part of the supplementary preliminary hazard and risk assessment.

A typical CGPF arrangement is shown in Chapter 3 Project Description, Figure 3.4. Note that the specific orientation and layout of each facility will depend on site-specific factors.

15.3 Legislation and Standards Update

Since the EIS was finalised, the *Work Health and Safety Act 1995* (Qld) has been replaced by the *Work Health and Safety Act 2011* (Qld). The new act took effect on 1 January 2012.

The Australian Standard AS 2885 Pipelines Gas and Liquid Petroleum, 2008 (Standards Australia, 2008a) has been updated to AS 2885 Pipelines Gas and Liquid Petroleum, 2012 (Standards Australia, 2012).

These changes do not influence the findings of the preliminary hazard and risk assessment for the project. Similarly, the changes discussed in Section 15.2 do not alter the legislative context referred to in the preliminary hazard and risk assessment.

15.4 Study Method

This section describes the study methods used in the supplementary preliminary hazard and risk assessment. The risk assessment methods used are consistent with those used in the preliminary hazard and risk assessment and described in Chapter 25 of the EIS.

The supplementary preliminary hazard and risk assessment involved a review of project description changes and assessment of changes to the installations, materials, safeguards or systems proposed at the time of writing the preliminary hazard and risk assessment that could potentially influence the assumptions or conclusions made.

More specifically, the supplementary preliminary hazard and risk assessment involved:

- Systematic assessment of the project description changes to determine whether they could result in an increase (worsening) or a decrease (amelioration) of hazards and risks identified in the preliminary hazard and risk assessment.
- Update to the qualitative risk profile, the quantitative risk transects and contour figures to reflect the updated risk assessment and project description changes.
- Identification of any changes (or additions) to the design, safety controls and management measures, as detailed in the preliminary hazard and risk assessment, required to manage the potential hazards and risks.
- Identification of any changes to (or additional) recommendations of the preliminary hazard and risk assessment to accommodate changes to the project description.

15.5 Study Findings

This section outlines the findings of the supplementary preliminary hazard and risk assessment.

15.5.1 Qualitative Risk Assessment

The addition of multi-well pads for gas production triggered the need to update some of the hazard scenarios, causes and mitigation measures outlined in the qualitative risk assessment undertaken as a part of the preliminary hazard and risk assessment. Changes to the layout of the CGPF were not found to trigger the need for re-assessment as a part of the qualitative risk assessment.

While some of the hazard scenarios have been updated to take account of the multi-well pads, no new hazards or risks were identified with the introduction of multi-well pads. For instance, an incident involving flammable gas at a multi-well pad has the potential to lead to domino-effects involving neighbouring wells on the same pad. However, the supplementary preliminary hazard and risk assessment found that the risk of domino effects was small due to the proposed well spacing. The updates have not resulted in changes to the consequences, likelihood or residual risk ratings detailed in the preliminary hazard and risk assessment. All controls relevant for the single well pads remain relevant for the multi-well pads. Some additional measures have been identified to account for the potential cumulative hazards associated with more than one production well located on a pad.

Table 15.2 and Table 15.3 present the updates to the hazards and risks outlined in the supplementary preliminary hazard and risk assessment. Typical design and safety controls are listed as mitigation measures for managing the potential hazards. All other hazards and risks remain as presented in the EIS.

Table 15.2 Qualitative risk assessment for construction of multi-well pad facilities

Hazard Scenario and Potential Causes and Consequences	Summary of Updated Mitigation Measures	Consequence /Likelihood	Residual Risk
Hazard scenarios and potential impacts involving gas or pressure release or fire and explosion			
Fire or explosion due to ignition of flammable or combustible material resulting in injury or destruction of property. Incident involving gas released during well blowdown or blowout. For multi-well pads there is a potential for the incident to spread to more than one well. Consequences have been assessed as the same as a single well pad. All other causes and consequences remain as stated for the single well pad assessed in the preliminary hazard and risk assessment.	All controls listed in the preliminary hazard and risk assessment for the single well pad are applicable to the multi-well pad. Additional controls, as applicable for the drilling phase, include: • The wells are to be isolated at the surface with pressure rated / tested wellheads (American Petroleum Institute API 6A certification) before the drill rig is moved to the next well on the pad. • A full concurrent operations plan will be in place together with Arrow Energy's Emergency Response and Blowout Contingency Response Plans.	Moderate / Likely	Medium
Pressure burst resulting in operator injury or equipment damage. Causes and consequences remain as stated for the single well pad assessed in the preliminary hazard and risk assessment. Multiple wells on the same pad increase the potential exposure to injury of personnel working on a neighbouring well. Physical damage to wellhead equipment. Failure of well pressure control or blow out. Gas pockets are encountered due to free gas in the borehole. Failure of circulation piping during pressure testing.	All controls listed for the single well pad remain relevant for the multi-well pad. For multi-well pads, formalised site handover and detailed simultaneous operation plans will be in place as well as a Manual of Permitted Operations to detail operations that occur between production and drilling and completion activities.	Minor / Possible	Low

Table 15.3 Qualitative risk assessment for operation of multi-well pad facilities

Hazard Scenario and Potential Causes and Consequences	Summary of Updated Mitigation Measures	Consequence /Likelihood	Residual Risk
Hazard scenarios and potential impacts involving gas or pressure release or fire and explosion			
Pressure burst resulting in operator injury or equipment damage. Causes and consequences remain as stated for the single well pad assessed in the preliminary hazard and risk assessment. Multiple wells on the same pad increase the potential exposure to injury of personnel working on a neighbouring well. Physical damage to wellhead equipment. Failure of well pressure control or blow out. Gas pockets are encountered due to free gas in the borehole. Failure of circulation piping during pressure testing.	All controls listed for the single well pad remain relevant for the multi-well pad. For multi-well pads, formalised site handover and detailed simultaneous operation plans will be in place as well as a Manual of Permitted Operations to detail operations that occur between production and drilling and completion activities.	Moderate / Possible	Medium
Gas release and/or fire and explosion due to loss of containment of flammable gas from a wellhead or associated piping resulting in injury and equipment damage. Causes and consequences remain as stated for the single well pad assessed in the preliminary hazard and risk assessment. For multi-well pads, once an incident has been initiated there is a potential for domino-effects involving neighbouring wells on the same multi-well pad, leading to more severe consequences. Physical damage to wellhead or piping caused by impact with vehicle or machinery. Failure of flexible coupling. Leak from piping flange. Overpressure event due to control system failure or well shut-in/blocked outlet.	All controls listed for the single well pad remain relevant for the multi-well pad. Additional controls for multi-well pads include: • Wellhead spacing such that the risk of domino-effect from one well to a neighbouring well is reduced (as confirmed through quantitative risk assessment). • Wellheads are to be spaced such that the risk of collision with a well workover rig and any surface equipment is reduced. • Wellheads designed and constructed in line with API 6A, design rating exceeds requirements.	Major / Unlikely	Medium

Table 15.3 Qualitative risk assessment for operation of multi-well pad facilities (cont'd)

Hazard Scenario and Potential Causes and Consequences	Summary of Updated Mitigation Measures	Consequence /Likelihood	Residual Risk
Hazard scenarios and potential impacts involving external events such as bushfire and flooding			
External event such as bush fire, lightning or flooding prevents effective operation and maintenance of water treatment facility resulting in release of low quality water and harm to people. Causes and consequences remain as per the single well pad assessed in the preliminary hazard and risk assessment. The presence of multiple wells on the same pad increases the risk of exposure of personnel working on a neighbouring well. Lightning strikes or anthropogenic sources causing bushfire. Excessive rainfall in the same catchment as project infrastructure.	All controls listed for the single well pad remain relevant for the multi-well pad. Fire breaks will be designed around facilities based on the infrastructure present on the multi-well pad.	Severe / Rare	Medium

The potential cumulative risks identified in the EIS during the construction, operations and decommissioning phases of the project remain unchanged.

15.5.2 Quantitative Risk Assessment

The update to the quantitative risk assessment focused on project description changes specific to CGPFs and production wells in a multi-well pad arrangement. As for the preliminary hazard and risk assessment, the purpose of this assessment was to determine appropriate buffer zones between these facilities and neighbouring land uses, hence, the risk contours and transects have been updated to reflect the changes to the project description, detailed in Section 15.2. The revised contours and transects for multi-well pads and CGPFs are discussed below.

Multi-well Pad

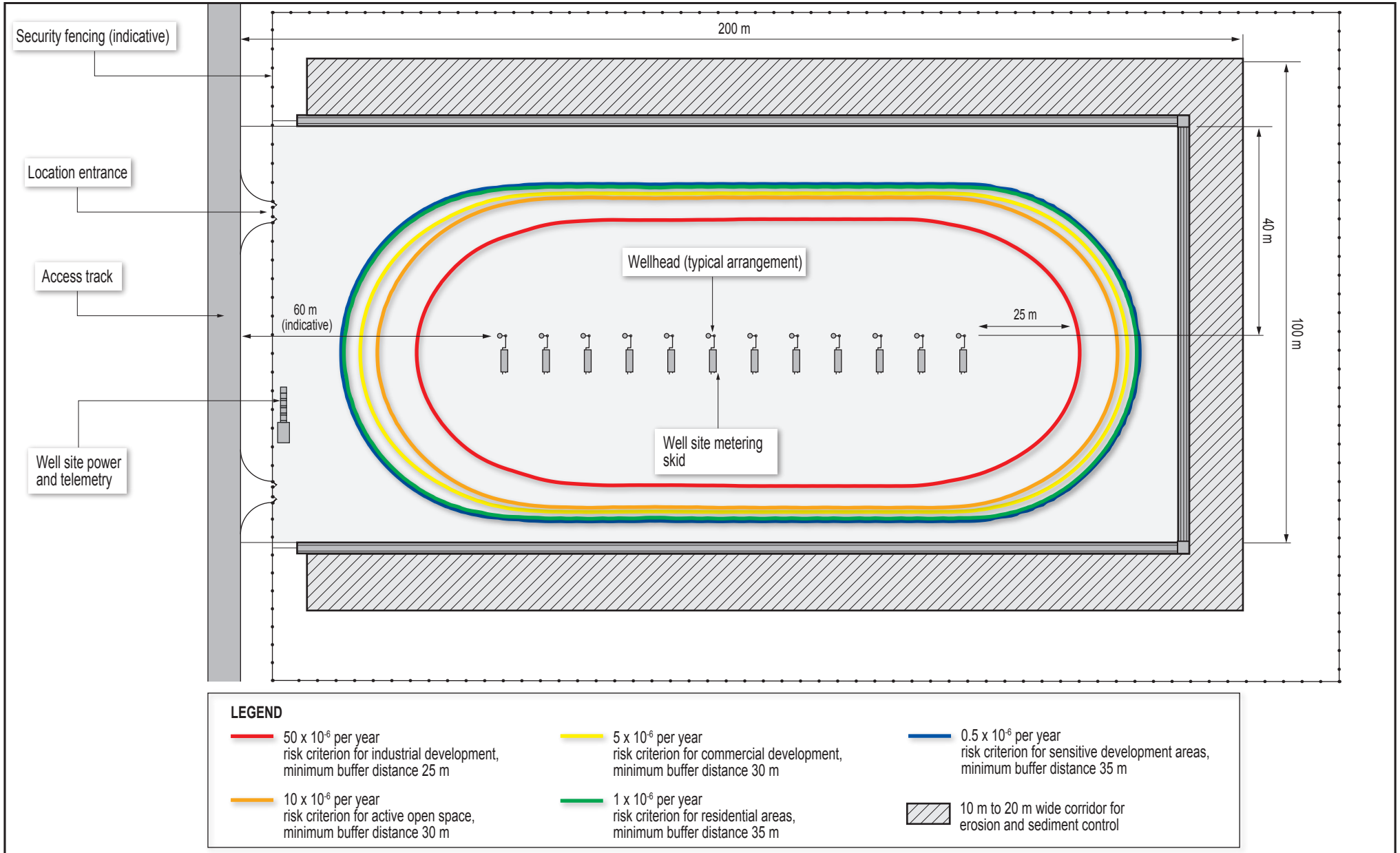
The individual fatality risk associated with multi-well pads is best represented as fatality risk contours, rather than as a risk transect (as presented for single well pads). Risk contours are best utilised for production facilities that are installed across an area such as multi-well pads. Single well pads are not considered facilities and have only a single point to determine their risk, meaning that it is appropriate that risks be represented through a risk transect rather than contour. The supplementary preliminary hazard and risk assessment presents buffer zones for multi-well pads. Buffer zones for single production wells identified in the preliminary hazard and risk assessment are presented for comparison purposes.

Figure 15.1 illustrates the individual fatality risk contours for multi-well pads, incorporating the maximum of 12 wells. Multi-well pads with fewer than 12 wells have the potential to have reduced risk contours. The minimum buffer distances for the multi-well pad arrangement have increased for the industrial, active open space and residential development land uses when compared to the single well buffer zones presented in the EIS. These are outlined in Table 15.4. The buffer distances in Table 15.4 represent the minimum buffer distances for neighbouring land uses. The contours show that the risks are less than the more stringent Arrow buffer distances, with production wells and associated wellhead infrastructure to be located no closer than 200 m from a sensitive receptor. The footprint of well pads will be reduced between workovers to accord with strategic cropping land standard conditions (DNRM, 2012a) or as agreed for multi-well pads.

The risk criteria presented in Table 15.4 have been sourced from recognised guidelines (DPI, 2011a and DPI, 2011b) and represent the peak individual risk to the most exposed individual located at a position for 24 hours a day, 365 days a year.

The controls outlined in the preliminary hazard and risk assessment were found to remain valid, with the addition of the measures outlined in Table 15.2.

Risk injury and propagation transects for the multi-well pad were both consistent with the transects for single well pads shown in the preliminary hazard and risk assessment (see Chapter 25 of the EIS).



Note: Not to scale.	coffey environments	Date: 05.06.2013 File Name: 7040_12_F15.01_HB	Arrow Energy Surat Gas Project	arrow energy go further	**Individual fatality risk contours for coal seam gas multi-well pad (12 wells)**	Figure No: **15.1**

Table 15.4 Minimum buffer distances for multi-well pad facilities

Type of facility	Minimum Buffer Distance (metres)				
	Industrial Buffer ($50x10^{-6}$/year)	**Active Open Space Buffer ($10x10^{-6}$/year)**	**Business Buffer ($50x10^{-6}$/year)**	**Residential Development Buffer ($1x10^{-6}$/year)**	**Sensitive Development Buffer ($0.5x10^{-6}$/year)**
Multi-well pads	25 m	30 m	30 m	35 m	35 m
Single wells, as reported in the EIS	10 m	25 m	30 m	30 m	35 m

The minimum distances have conservatively been rounded up to the nearest 5.

Central Gas Processing Facilities

Figure 15.2 presents the revised individual fatality risk contours for the CGPFs.

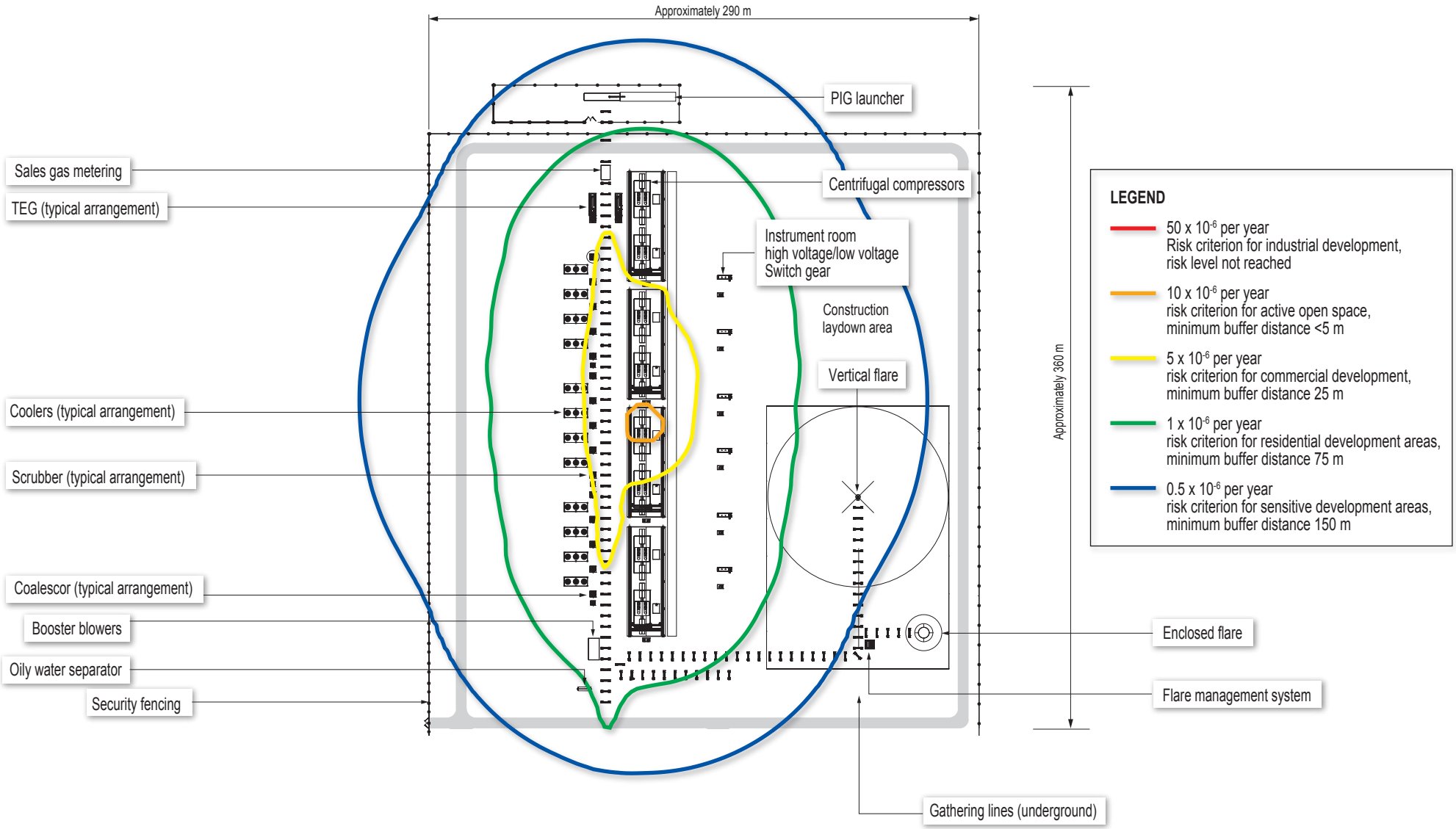
A comparison of the individual fatality risk results with the established risk criteria indicates that:

- The risk contour for industrial facilities, 50 x 10^{-6} per year remains contained within the boundary of the site.
- The risk contour for active open space, 10 x 10^{-6} per year remains contained within the boundary of the site.
- The risk contour for commercial development, 5 x 10^{-6} per year remains largely contained within the boundary of the site.
- The risk contour for residential areas, 1 x 10^{-6} per year remains largely contained within the boundary of the site and will not encroach into any residential areas. The property on which CGPFs are located will be owned by Arrow and no residential use is planned adjacent to the facilities.
- The risk contour for sensitive development, 0.5 x 10^{-6} per year remains largely contained within the boundary of the site and will not encroach into any residential areas. The property on which CGPFs are located will be owned by Arrow and no sensitive development is planned on these sites.

The risk contours presented in Figure 15.2 have reduced from those presented in the EIS. A comparison of the minimum buffer distances is provided in Table 15.5. The changes are due to the reduction in the number of compressors planned at each CGPF and a change in the type of compressor (to one with a lower leak frequency). The reduction in the risks means that the buffer zones have also been reduced.

Risk injury and propagation transects for the CGPF were both reduced compared to those shown in the preliminary hazard and risk assessment (see Chapter 25 of the EIS, Preliminary Hazard and Risk).

The typical controls identified in the preliminary hazard and risk assessment remain valid for managing the potential hazards and risks.



Note: Not to scale. Security fencing extends to remaining CGPF site - not shown here

coffey environments

Date: 07.06.2013

File Name: 7040_12_F15.02_HB

Arrow Energy

Surat Gas Project

arrow energy go further

Individual fatality risk contours for CGPF

Figure No: 15.2

Table 15.5 Minimum buffer distances for a CGPF

Type of facility	Minimum Buffer Distance (metres)				
	Industrial Buffer ($50x10^{-6}$/year)	**Active Open Space Buffer ($10x10^{-6}$/year)**	**Business Buffer ($50x10^{-6}$/year)**	**Residential Development Buffer ($1x10^{-6}$/year)**	**Sensitive Development Buffer $0.5x10^{-6}$/year)**
Outer edge of compressors at the CGPF for updated layout and compressors	Site boundary	<5 m	25 m	75 m	150 m
Outer edge of compressors at the CGPF, as reported in the EIS	Site boundary	55 m	75 m	210 m	290 m

The minimum distances have conservatively been rounded up to the nearest 5.

15.6 Conclusion

The supplementary preliminary hazard and risk assessment has taken into account changes to the project description to confirm the buffer distances required to meet established risk criteria for both production wells and facilities. Further detailed quantitative risk assessments and safety risk studies will be undertaken for the project during the front-end engineering design phase.

The addition of multi-well pads required some of the hazard scenarios outlined in the qualitative risk assessment (as presented in the preliminary hazard and risk assessment) to be updated. Some additional control measures were identified to manage these hazards and risks. No new hazards or risks were identified as a consequence of the project description changes and no changes are required to the consequences, likelihood or residual risk ratings detailed in the preliminary hazard and risk assessment. The risk contours for the multi-well pad, determined using quantitative risk assessment techniques, show that the risks are consistent with the single well design shown in the preliminary hazard and risk assessment. The updated fatality risk contours produced for the CGPF show a reduced risk with the risk contours being largely contained within the boundary of the site. The reduced risk has meant that the corresponding buffer zones have also reduced.

Overall, only minor changes have occurred to the hazards and risks identified in the preliminary hazard and risk assessment resulting from the project description changes associated with the CGPF and production wells.

No increases have occurred in residual or cumulative risks as a result of the project description changes.

15.7 Issues Raised in Submissions

Submissions on the EIS raised a range of issues relating to hazard and risk. The issues fall in broad topics which are listed below.

- Bushfires, flooding and landslides.
- Controlled burning and farming practices.
- Disease.
- Emergency response.

- Explosion risk.
- Gas leaks.
- Incident reporting.
- Legislation.
- Occupational health and safety.
- Project infrastructure.
- Risk assessment.

The topics list is provided to give an idea of the types of issues that have been raised in relation to hazard and risk and for which responses have been provided under the heading Hazard and Risk in Part B, Chapter 19, Submission Responses.

15.8 Commitments Update

Seven updated and three new management measures (commitments) relevant to hazard and risk have been identified in the course of the study and are presented in Table 15.6. The full list of commitments, including those that remain unchanged from the EIS and details on those that have changed, are included in Attachment 4, Commitments Update.

Table 15.6 Commitments update: hazard and risk

No.	Commitment	Revised / New
C424	Arrow will develop emergency response plans in consultation with emergency services organisations that includes a list of required equipment, training and other resources, and foreseeable emergency and crisis situations (including escapes of gas, blowouts, gas fire, bushfire, critical equipment failure, trapped or missing people, flooding, cyclones, power failure, security incidents and threats, and transport incidents). The plans should include safe evacuation procedures, communication protocols (internal and to emergency services, including the Petroleum and Gas Inspectorate), accounting for personnel and visitors, roles and responsibilities, and requirements for training.	Clarification of commitment intent.
C431	Reduce enclosed spaces where flammable gas may accumulate in accordance with relevant safety requirements.	Clarification of commitment intent.
C439	Develop an integrated risk management plan with consideration for relevant industry and Australian standards.	Amended to reflect adherence to Australian standards.
C444	Design, construct, maintain and rehabilitate the gathering system network in accordance with the APIA code of practice Upstream PE gathering networks CSG industry version 1.1 (APIA, 2011), or relevant Australian standards, as revised from time to time.	Amended to reflect legislative update and recognise relevant standards.
C447	Fit all buildings and production facilities (CGPFs and field compression facilities) with smoke or fire alarms.	Clarification of commitment intent.
C481	Train relevant personnel in the identification and avoidance of potentially hazardous wildlife. Use qualified spotter-catchers to move wildlife from project areas when encountered.	Clarification of commitment intent.
C484	Implement safety procedures to manage maintenance of wells including if necessary, isolation of infrastructure from gas flow.	Revised to allow for appropriate safety procedures to be developed through detailed design.
C544	Develop an Emergency Response and Well Control Contingency Response Plan.	New commitment

Table 15.6 Commitments update: hazard and risk (cont'd)

No.	Commitment	Revised / New
C545	Adopt appropriate safety procedures to manage simultaneous operations such as those activities undertaken at a multi-well pad.	New commitment
C547	Design multi-well pads to address the risk of propagation of an incident to adjacent wells.	New commitment