Macquarie Generation

Part 3A Environmental Assessment (Project Application 08_0061)

Gas Pipeline (North-South Route), Liddell Power Station

Appendix E

RISK SCREENING STUDY

CDB Environment Pty Ltd

Macquarie Generation

Liddell Power Station Gas Pipeline Development
North South Route
Screening of Potential Hazards

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Sleeman Consulting

Contents

1. Introduction and Summary of Findings

This Report has been prepared for and is addressed to Macquarie Generation ('MacGen') as part of the Environmental Assessment requirements associated with MacGen's application for approval to construct and operate a gas pipeline to the Liddell Power Station.

MacGen proposes to install infrastructure to allow gas to be transported for use in the generation of electricity, principally at the Liddell Power Station. This will in turn allow considerable quantities of gas that are routinely vented, or more commonly flared, in association with underground coal mining activities to be utilised in an environmentally beneficial manner. Gas that is drained from underground coal seams to ensure safe mining conditions, or which might escape to atmosphere after mining has taken place, may be collected by means of and transported through the proposed gas pipeline.

As part of planning for development of the gas pipeline system it is necessary to ascertain whether a Preliminary Hazard Assessment needs to be carried out in support of applications for project approvals.

This Report presents a preliminary, desktop based screening of potential hazards to identify whether off-site impacts are likely and determine whether a Preliminary Hazard Analysis is required.

It is concluded that:

- industry standard practices are available for management of hazards associated with the proposed gas pipeline;
- risks arising from development and operation of the system are low; and
- it is not necessary to undertake a Preliminary Hazard Assessment

2. Description of Supply System

The gas pipeline will be located within a corridor on Macquarie Generation land, private land and road easements. The pipeline will have a maximum diameter of 500 mm and may consist of dual runs in some sections for increased capacity if required.

Two alternative pipeline materials (namely, polyethylene and fibreglass) are being considered for use in construction of the mine-gas supply system. Key features of the alternative materials are summarised in Table 1.

The higher strength of glass reinforced epoxy (referred to as GRE or fibreglass) means that, for the same nominal size of pipe, the GRE options have greater flow capacity.

Final selection of the optimal pipeline construction material will be made during the detailed design and optimisation process.

The proposed gas pipeline will (with limited, specific exceptions as noted herein) be buried for its entire length, with a cover of not less than 750 mm.

The trench width required for installation of the pipeline is approximately 900 mm.

Table 1: Pipeline Material Options

	Material Option	
	Polyethylene	Fibreglass
Material description	High-density polyethylene PE100 pipe with	Filament-wound fibreglass reinforced epoxy ('GRE') pipe
Indicative Size Options (nominal external & internal diameters)	500 mm OD; 400 mm ID 450 mm OD; 360 mm ID 400 mm OD; 320 mm ID 355 mm OD; 287 mm ID 315 mm OD; 253 mm ID	495 mm OD; 482 mm ID 446 mm OD; 434 mm ID 405 mm OD, 394 mm ID 354 mm OD; 344 mm ID 323 mm OD; 314 mm ID 271 mm OD; 263 mm ID
Jointing Method	Butt-weld	taper - taper adhesive joint or (for 271 mm OD pipe) screwed joint.
Design Pressure	1,050 kPa	1,050 kPa
Pipeline Life	> 100 years	> 100 years
Maximum operating temperature*	35^0C	120^0C
Yield stress	25 N/mm^2	220 N/mm^2 (hoop)
Elastic modulus	900 N/mm^2 (tensile)	1,250 N/mm^2
Applicable Codes	AS 2430 Classification of Hazardous Areas AS 4343 Pressure Equipment - Hazard Levels AS 4041 Pressure Piping AS 4360 Risk Management AS/NZS 4645.3	

* Note: this refers to maximum operating temperature for the material. The system design will ensure that operating temperatures do not exceed these figures.

In addition to the Codes listed in Table 1, the following codes relate to the use of Polyethylene pipe and, where applicable, will be adopted:

- AS/NZS 4130 Polyethylene (PE) Pipes for Pressure Applications
- AS 4129 Fittings for PE Pipes for Pressure Applications
- AS 4131 Polyethylene (PE) Compounds for Pressure Pipes and Fittings
- AS 2033 Installation of Polyethylene Pipe Systems
- AS 3723 Installation and Maintenance of Plastic Pipe Systems for Gas
- AS 2566.1 Buried Flexible Pipes: Structural Design

The following Codes may be used for aspects of the GRE option, subject to and supplemented by the codes outlined above:

- AS 2885 Pipelines - Gas and Liquid Petroleum

Australian Standard AS 4564, which sets out gas quality requirements, is not applicable to the proposed gas pipeline since gas delivered through the pipeline will not be used for the purposes of distribution or vehicle fuelling. Gas transported through the gas pipeline will be used in the generation of electricity.

3. Pipeline Construction Activity

Construction activity will be confined to the pipeline corridor and adjoining land to which access is available for construction purposes. In areas where public access could be possible, public safety will be ensured by erecting temporary fencing to prevent access to construction activity or by carrying out construction in short sections with close supervision.

The process for construction of the gas pipelines will be industry typical. It will involve steps as set out below.

- The pipeline route will be surveyed and the centreline of the pipeline clearly marked.

- Vegetation along the pipeline route, within the corridor to be used for construction, will be removed and topsoil will be preserved for later use.

- The trench within which the pipeline will be located will be opened. Where possible this will be done using a trenching machine or excavator. In some areas it may be necessary to use a backhoe.

  Major road crossings required, will generally be by means of mechanical underboring. In the case of crossing the New England Highway, the existing services underpass will be used, through which the pipeline will remain buried.

In both cases there will be no interference with or interruption to normal traffic flows either during construction or during ongoing operations.

- The pipe material will be laid out beside the trench and individual lengths of pipe joined together.

- A layer of screened soil will be placed in the bottom of the trench (to protect the pipeline from external damage) and the pipeline will then be lowered into the trench.

- The structural integrity of the pipeline will be tested and confirmed by filling the pipeline with pressurised water. Pipeline testing will be carried out prior to the next step in order that problems (in the unlikely event there are any) will be readily locatable.

- The pipeline will be covered with screened soil and then the remainder of the trench spoil replaced.

- Topsoil will be replaced, the pipeline route restored and markers installed to clearly show the location of the pipeline.

Water required for the hydro-testing activity will be acquired from the Liddell Power Station water supply. After completion of hydro-testing the water will be returned to its source.

4. Screening of Hazards

This section presents the findings of a preliminary, desktop based screening of potential hazards to:

- identify whether off-site impacts are likely; and

- determine whether a more comprehensive Preliminary Hazard Analysis should be carried out.

4.1 Methodology

The preliminary screening of potential hazards was carried out using a methodology that takes into account the provisions of AS 2885.1-2007. This involved:

- identification of general and location specific threats to the integrity of the proposed pipelines; and

- assessment of the risk associated with each threat through consideration of the likelihood of occurrence and the consequences should they occur.

Consequences associated with each threat were considered from public, employee, environmental and economic perspectives taking account of risk mitigation methods that will be employed during design, construction and ongoing operation of the gas pipelines.

The preliminary screening process was carried out on the basis of information obtained from maps and photographs, complemented by input from personnel familiar with the area through which the pipelines will pass.

4.2 Overview of Pipeline Route

The gas pipeline will transport primarily methane gas that has been drained from underground coal seams. The gas pipeline will have a total length of approximately 50 km. The pipeline size will be kept to the minimum possible, but may be dual parallel runs of up to 500 mm nominal diameter.

With the exception of the beginning and end of each pipeline, where it connects to gas production infrastructure or power station pipework, the gas pipeline will be buried (with a minimum cover of 750 mm) for its entire length.

The land across which the gas pipeline will pass is rural in nature, with premises in and around Bulga and Jerry's Plains, and land accommodating large power station infrastructure and land subject to potential future mining activity.

Some of the land is subject to underground coal mining activities, the effects of which have been taken into account in the preliminary hazard screening process. Open-cut mining activities on land adjacent to the pipeline route have also been taken into account.

4.3 Risk Mitigation Measures

The following key (but not necessarily exclusive) measures will be adopted to mitigate risks associated with the gas pipeline system.

- The gas pipeline system will (apart from specific locations located on mining and Macquarie Generation land) be buried for its entire length. The depth of burial may vary from location to location, having regard for land use and the outcomes of risk assessments carried out during detailed design. The principles of AS 2885 will be applied in determining the appropriate depth of burial. Where no requirements specific to polyethylene or GRE pipelines exist, depth of burial indicated by AS2885 for steel pipeline will be used since the potential for damage to the covered pipe is primarily determined by the potential for third-party excavation activity at the depth the pipeline is buried, rather than the material of the pipeline itself.

- If necessary on the basis of risk assessments carried out during detailed design, sections of the pipeline in areas near residential and commercial premises may incorporate additional protection.

In the event this is required, mitigation will be addressed by adopting one or more of the following measures:

- substitution of a single pipeline;
- reduction in pipe diameter;
- concrete barriers laid above the pipeline;
- increased depth of burial; and/or
- increased wall thickness.

Specific measures, if necessary, will be selected during detailed design.

- The wall thickness of the pipe will be specifically selected to withstand not only internal pressure requirements but also external loads associated with burial depth, surface interference (such as vehicular loads), construction stresses and open-cut mining activities.
- Clear signage will be erected along the route of the gas pipelines. There will always be at least one sign visible from any location along the pipeline route. In addition, signs will be erected at each side of road crossings.
- Routine patrols of the pipeline route will be conducted.

The risk mitigation measures outlined above have been taken into account in the preliminary screening of potential hazards, set out in section 4.4.

4.4 Threats

Identified threats to the integrity of the proposed gas pipeline are reviewed below and are summarised in Attachment 1, together with an assessment of the level of risk (or 'risk ranking') associated with each threat. The basis for determination of risk rankings is outlined in Sections 4.5, 4.6 and 4.7.

i) Third Party Interference

Third party interference, whether accidental or intentional, is a recognised key threat to a gas pipeline. Examples of potential third party interference include:

- installation of new fixtures (eg, fences or sheds);
- installation of new services (eg water, phone, power poles etc.); and
- maintenance of, or within, the road reserve.

Burial of the pipeline (at a depth that takes into account surrounding land use), the positioning of pipeline markers, interaction with landholders and routine patrolling of the pipeline route are common measures to ensure risks associated with third party interference are minimised. In the case of the proposed gas pipeline, the following project specific factors are also significant:

- With the exception of land in the vicinity of Bulga and Jerry's Plains, the proposed pipeline is located well away from private developments.

- AS 2885 provides data for the calculation of the Radiation Contour Radius in the event of a full-bore failure of a single pipeline. Extrapolation of this data for a 4.7 kW/m^2 contour indicates around 16 m for a 250 mm nominal diameter pipeline increasing through approximately 65 m for a 350 mm nominal diameter pipeline, up to approximately 160 m for a 500 mm pipeline. During detailed pipeline design, where final selection of the pipeline system design will occur, the Radiation Contour Radius will be calculated for the system design and appropriate localised measures to protect against external interference (eg, concrete barriers, increased wall thickness and/or increased depth of burial) will be identified. These measures will be implemented during construction as required.

- Since the pipeline is buried along its entire route or, in locations where it is above ground, is within operational (power station or coal mine) areas, there is little risk of sabotage or vandalism.

- The proposed pipeline will be buried (by mechanical underboring) at major road crossings (unless existing services underpasses are available) with a minimum depth of cover (measured from the lowest point of the road reserve) of 1,900 mm.

Gas to be transported through the gas pipeline will not be dehydrated before it enters the pipeline system. As a result there may be potential for some condensation of water out of the gas stream. Should this occur the water will gather at low points along the pipeline route. During detailed design, facilities will be installed to allow water, if any, to be drained from the pipeline into a storage vessel. The drainage systems will be installed in locations where public access is not available and will, in any case, be enclosed (whether underground or within a fenced compound).

ii) Underground Coal Mining Activity and Subsidence

The proposed gas pipeline will traverse some areas that overlay current and probable future underground coal mining activities. Underground coal mining operations can lead to ground movements (ie, subsidence) that induce stresses within the material from which the pipeline is constructed. Subsidence, and the stresses induced by it, are predictable and can therefore be managed. Key mechanisms for dealing with the effects of subsidence include the following.

- In the course of detailed pipeline design appropriately qualified specialists will be engaged to prepare subsidence predictions. The predictions will be taken into account to design pipeline configurations that minimise the impact of subsidence. For example, 'snaking' of the pipeline across areas of subsidence (to reduce induced gradients and stresses) is possible.

- During the operating phase, if mining activity takes place below the pipeline and subsidence could occur, induced stresses will be monitored and management regimes implemented as necessary to ensure the integrity of the gas pipelines is not compromised. For example, should predetermined stress limits be reached during subsidence, action can be taken to prevent the limit from being exceeded. The most reliable approach to dealing with flexural strains is to expose and then raise or lower portions of the pipeline to reduce curvature[1]. This can be done without taking the pipeline out of service.

In addition, Macquarie Generation will confer with the Mine Subsidence Board to develop an ongoing pipeline management plan.

Risks associated with the impact of subsidence on the proposed gas pipeline are readily manageable through design and ongoing monitoring initiatives.

iii) Open-cut Coal Mining Activity

The key impact arising from open-cut coal mining activity in areas adjacent to the route of the pipeline will be blasting activity. Ground shock waves that result form blasting activities could cause deformation of or damage to a buried gas pipeline.

The effect of blasting upon a buried pipeline can be assessed through prediction of peak particle velocities[2] resulting from blasting activities.

During the detailed design process, planning information for open-cut coal mines adjacent to the pipeline route will be analysed to predict peak particle velocities to which the proposed pipeline will be exposed. The pipeline will then be designed, for example through material specification and sizing, to ensure pipeline integrity is not compromised.

In extreme circumstances, consideration will if necessary be given to temporary depressurisation of the pipeline while blasting takes place.

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[1] 'Pipeline Design Handbook', page 1060, Subsidence Strains, John F Kiefner.
[2] The peak particle velocity is a measure of the rate of ground movement resulting from blasting activity.

Areas that may be exposed to blasting influences are limited to land that is remote from residential or commercial property, and will as part of routine safety procedures, be vacated.

Risks associated with the impact of blasting activities on the proposed gas pipeline are manageable through design initiatives and operating regimes.

iv) Failure of Pipe Material

The materials from which the pipelines are manufactured and the processes employed in constructing the pipelines will be compliant with relevant codes and standards. In particular:

- For the polyethylene option:
  - The material used in pipeline manufacture will be compliant with AS 4131 - Polyethylene (PE) Compounds for Pressure Pipes and Fittings;
  - The pipeline will be compliant with AS/NZS 4130 - Polyethylene (PE) Pipes for Pressure Applications;
  - Pipeline fittings will be compliant with AS 4129 - Fittings for PE Pipes for Pressure Applications;
  - Installation procedures will conform with AS 4131 AS 2033 - Installation of Polyethylene Pipe Systems

- For the fibreglass reinforced epoxy ('GRE') option:
  - Materials and components will comply with API 15 LR
  - Pipeline shall be manufactured to comply with ASTM D2996;
  - Pipeline design will be in accordance with ISO 14692 Part 3;

- After construction, the integrity of the completed gas pipelines will be hydraulically tested to 125% of the design maximum working pressure in accordance with AS 2033 Installation of Polyethylene Pipe Systems (for the polyethylene option) or AS2885.5-2005[3] (for the GRE option).

Further, since the proposed pipeline is to be constructed from either polyethylene or glass reinforced epoxy they will not be susceptible to corrosion. Cathodic protection systems will not be required for prevention of external corrosion.

v) Over-pressure of Pipeline

The prospect that the pipeline could be over-pressured, leading to possible rupture and gas leak, is negligible. Inlet control systems (installed where gas enters the pipeline) will incorporate duplicate (active and standby) overpressure control systems. The pressure control systems will be fail-

[3] Although this standard is applicable for high pressure steel gas pipelines, the provisions are appropriate for hydrostatic testing of GRE pipelines.

safe. That is, should they fail they will automatically inhibit gas flow and prevent over-pressure.

vi) Static electricity build up on the inside surface of the pipe

Electrostatic build up may be present inside a gas pipeline where it is not a concern as the gas concentration is maintained well beyond the flammable/explosive range.

When combined with gas escape it is a potential hazard that will be controlled through system design and operating safeguards. The risk of ignition or explosion of escaping gas is dependant on the existence all three of the following conditions:

- a gas escape situation
- a gas/air mixture in the ignitable range (5-15% gas to air)
- a high energy static electricity discharge outside of the pipe

The most likely gas release conditions result from system maintenance, infrastructure failure or third party interference. Threats to pipeline integrity are addressed by adhering to industry standards.

The gas escape hazard is reduced to low by pipeline burial and limiting operating pressure to below the pipe rating. Further reduction comes from the use of complying materials and subjecting the pipeline to hydrostatic pressure testing after installation.

As the gas is lighter than air it is highly dispersible and the risk of a critical mixture occurring on release is very low.

Industry standard safety practices in accordance with the code, *AS/NZS 1020:1995 - The control of undesirable static electricity*, will apply to design and operation of the pipeline. This standard prescribes methods for eliminating this cause of ignition centred on measures for earthing the work area, tools and personnel.

At pipeline drainage points spark initiation opportunities will be avoided by use of low velocity discharge nozzles made from earthed conducting material.

vii) Explosive Pipeline Contents

Methane can be explosive when mixed with air in a concentration around 4% to 15% methane. Since the gas to be transported through the proposed gas pipelines will be primarily collected from coal mine pre-drainage and degasification activities there is a prospect that gas transported through the pipelines will contain a mixture of methane and air. However, the gas mixture within the pipeline is unlikely to be explosive since the gas is to be sourced from pre-drainage of future mining operations and GOAF gas (high concentration ventilation gas) associated with existing mines. As such the potential for gas to be within the explosive composition range is lower in the pipeline than in the mine operations (where mixing with air is more feasible). Any measures taken by the producers of the gas to alleviate this risk will consequently alleviate the risk in the pipeline.

The gas producers have indicated a methane content of gas to be transported will generally exceed 30% and will be normally be above 50%[4]. In any case:

- there will be no source of ignition within the proposed gas pipelines so an explosion will not occur; and

- in the event of a gas leak from a pipeline, the risk of explosion will be no worse than if the pipelines contained pure methane (which, upon release, would mix with surrounding atmosphere). Since methane is lighter than air, should a gas leak occur the methane will quickly disperse upward into the atmosphere and will fall to a concentration that is neither flammable nor explosive.

In the event that the pipeline's purpose is augmented during its lifetime to transport gas of potentially lower methane content (eg mine ventilation gas), monitoring and shutdown systems (for example, gas chromatographs) will be implemented to ensure gas compositions remain within safe limits.

viii) Road Crossings

The pipeline will cross several public and private roads.

The New England Highway will be crossed at one location. This crossing will be by means of a services underpass, where the pipeline will remain buried.

The RTA has been consulted in the course of preparing the Preliminary Assessment and has advised that a 1,900 mm minimum pipeline burial depth is required under road reserves. The New England Highway crossing engineering design will be submitted to RTA for approval prior to construction. The same minimum burial depth will be adopted for all other road crossings.

The land on each side of the highway is owned by Macquarie Generation. Macquarie Generation's facility operates as a secured site and access is only available to authorised personnel.

Methane is non toxic but can pose an asphyxiation risk if released into an enclosed space. There are no confined spaces along the pipeline route.

[4] By way of comparison, natural gas distributed for domestic, commercial and small industry use has a methane content of the order of 95%.

Should a gas leak occur the methane so released will (since it is lighter than air) rapidly dissipate upward into the surrounding atmosphere.

Where required to maintain pipeline integrity and address specific environmental issues for traversing other roads, a mechanically bored road crossing will be completed. The buried pipeline will align with and pass through a hole bored horizontally below the road base. Boring takes place at a location away from the roadway so there is no disturbance to normal traffic flows.

Minor private road crossings will be completed by open-trenching. To allow this, short-duration road closures will be negotiated with relevant parties. The crossing design will be engineered to avoid road subsidence and pipe stress.

Pipeline construction activities at road crossings and ongoing operational activities are low risk.

ix) Waterway Crossings

The proposed gas pipeline will cross rivers and creeks. Where required to maintain the pipeline's integrity and address specific environmental issues, a mechanically bored crossing be undertaken for these crossings. In these instances, the buried pipeline will align with and pass through a hole bored horizontally below the waterway. Boring takes place at a location away from the waterway so there is no disturbance to normal flows.

In addition, the proposed gas pipeline will cross several normally dry creeks. Crossings will generally be constructed using flow diversion techniques.

The flow diversion technique involves the use of dams and flumes (or sometimes pumps) to divert any creek flow while trenching takes place to allow pipeline installation.

The pipeline will be buried not less than 2 m beneath the creek bed.

Both the construction activity and ongoing pipeline operations are low risk.

x) Natural Phenomena

<u>Erosion of Pipeline Cover</u>

It is conceivable that erosion could occur at locations along the pipeline route where water flows are rapid during wet conditions. Avoidance of erosion across and along the route of the pipeline is however manageable through application of the following mechanisms:

- topsoil that is removed in advance of pipeline construction is replaced following construction to encourage regrowth of pre-existing vegetation, thereby binding the soil;

- erosion berms will also be used to direct runoff water so that it does not travel along the pipeline route; and

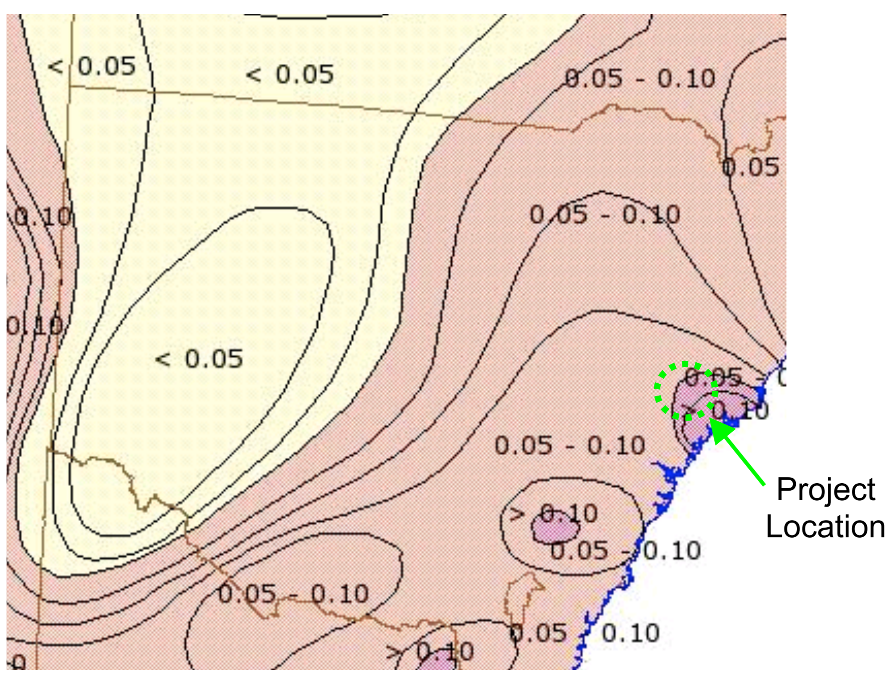
- where there is sloping terrain that could lead to water flow along the pipeline route, trench-breakers will be installed to prevent erosion;

Earthquakes

An extract from the Australian Geological Survey Organisations' earthquake hazard risk contour map is presented in Figure 1. The map shows acceleration coefficients[5] that have a 10% chance of being exceeded in the next 50 years. The coal seam gas supply system will be located in a region where there is a 10% chance that acceleration coefficients greater than 0.1 will be exceeded.

While the threat of an earthquake cannot be ruled out, it is of low probability and low consequence.

Figure 1: Earthquake Hazard Risk Contour Map



[5] The acceleration coefficient is a dimensionless coefficient of acceleration that can be used to estimate forces on structures. High values correspond with high risk. Damage to buildings can be expected to occur at a coefficient above 0.05. The soil surrounding pipelines helps to dampen the effects of earthquakes on them.

Bushfires

There is some potential for bushfires at isolated locations along the pipeline route. However, since the pipeline is buried for its entire length with no combustible material present above ground, bushfire related risk is low and of no consequence.

xi) Inadequate Maintenance

The gas pipelines will be operated in accordance with the requirements AS 2885.3 (a code generally applicable to high pressure gas transmission pipelines). Operations and maintenance activities will be carried out by properly qualified and trained personnel pursuant to formal procedures.

It is unlikely that operations and maintenance activities will be inadequate.

4.5 Frequency of Occurrence

The predicted frequency of each identified threat, as included in Attachment 1, has been assessed according to the classifications presented in Table 2.

Table 2: Frequency Classifications

Frequency	Description
Frequent	Expected to occur typically once per year or more
Occasional	Expected to occur several times in the life of a pipeline
Unlikely	Not likely to occur within the life of a pipeline, but possible
Remote	Very unlikely to occur within the life of the pipeline
Improbable	Have been known to occur, but not anticipated
Hypothetical	Theoretically possible, but not known to have occurred

4.6 Consequences

The possible consequences of each identified threat, should it occur, have been assessed taking into account the potential for:

- human injury or fatality;
- environmental damage; and
- economic impact resulting from loss of gas supply.

The severity of each identified threat has then been estimated (and included in Attachment 1) according to categories set out in Table 3.

Table 3: Severity Rankings

Severity	Description
Catastrophic	Only applicable where many fatalities would result
Major	Few fatalities, loss of supply, major environmental damage
Severe	Injuries, supply restriction, minor environmental damage
Minor	No injuries or supply problems

4.7 Risk Ranking

According to estimated frequencies of occurrence and consequences, the risk ranking of each identified threat has been determined and is included in Table 4. Risk rankings have been formulated on the basis of the basis of the following risk matrix.

Table 4: Risk Rankings

	Risk Rankings (by Severity Class)			
Frequency	Catastrophic	Major	Severe	Minor
Frequent	High	High	High	Intermediate
Occasional	High	High	Intermediate	Low
Unlikely	High	High	Low	Low
Remote	High	Intermediate	Low	Low
Improbable	High	Intermediate	Low	Low
Hypothetical	Intermediate	Low	Negligible	Low

5. Conclusion

Industry standard practices are available for management of hazards associated with the proposed gas pipeline system. Risks arising from development and operation of the system are deemed to be low. Therefore, it is not necessary to undertake a Preliminary Hazard Assessment.