Appendix E

Trans Territory Pipeline - Preliminary Risk Assessment in Accordance with AS2885 for the Trans Territory Pipeline prepared by OSD Energy Services



Preliminary Risk Assessment in Accordance with AS 2885 for the Trans Territory Pipeline

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1 SUMMARY

This document details the preliminary desktop Risk Assessment which has been carried out as part of the Trans Territory Pipeline (TTP) feasibility study to ensure that the route and pipeline construction parameters considered during that study did not involve any risks which could not be made acceptable by either design or procedural measures. It is not to be considered to be a definitive AS2885.1 Risk Assessment for the final pipeline design but it may be used as a guideline when preparing that definitive Risk Assessment.

The AS 2885 risk assessment methodology is a continuous process. This process requires a review of the risk assessment document, triggered by time or significant change of threats affecting the pipeline.

A preliminary risk assessment of the proposed TTP was undertaken in accordance with Australian Standard, AS 2885. A further 'team workshop' review of the risk assessment by experienced personnel will be prepared when the pipeline route has been refined during the process of detailed design. At least every five years during the life of the pipeline, in accordance with AS 2885, the risk assessment will be reviewed and revised to account for any changed conditions.

The Preliminary Risk Assessment is a desktop study based on information obtained from various site visits and surveys, and from maps and photos.

The Preliminary Risk Assessment is a qualitative risk assessment and has been completed to meet the requirements of Section 7.1 of the Final EIS Guidelines. With TTP transporting gas over approximately 940 km, there are many variations in the location classes and types through which the pipeline passes. The intention of the methodology outlined in AS 2885 is to ensure that all possible threats at the different location classes and types are identified, evaluated and managed at all stages over the life of the pipeline.

The location analysis has noted a series of features along the pipeline route and has identified threats associated with each feature. Where possible, risk has been minimised through route selection. Each threat has been systematically assessed and risk mitigation methods identified to reduce all risk to As Low As Reasonably Practicable (ALARP). The risk mitigation methods include both physical and procedural measures.

The pipeline will be constructed to Australian Standard 2885.1-1997 (incorporating Attachment No 1 - April 2001): *Pipelines - Gas and Liquid Petroleum Part 1 Design and Construction*. The Pipeline will be maintained and operated in accordance with AS 2885.3-2001: *Pipelines - Gas and Liquid Petroleum - Part 3 Operation and Maintenance*.

2 ROUTE DESCRIPTION

Alcan is proposing to convert its Gove Alumina Refinery to operate on natural gas, to be supplied from the Blacktip field in the Bonaparte Basin. The project will require construction of a natural gas pipeline from Wadeye to Gove to carry the gas from an onshore processing plant near Wadeye.

The project is a 940 km high pressure gas pipeline from Wadeye to Gove, via Katherine, and will have provision for installation of future compressor stations. The Trans Territory Pipeline will commence at a flange downstream of an onshore facility at Wadeye and will terminate at a flange downstream of the meter and pressure reduction station within the boundary of Alcan's alumina refinery on the Gove Peninsula.

A pipeline route alignment has been identified within a 10 km corridor of interest that traverses the Northern Territory, noting that this is being progressively reduced to a 100m survey corridor by field and aerial surveys. The pipeline route is being developed based on the outcomes of cultural heritage, environmental and engineering investigations.

Areas adjacent to the pipeline are sparsely populated and fall into the category of R1 – Broad Rural as defined by AS 2885, except in parts of the Nhulunbuy area which falls into the category T1 – Suburban, and an area north of the Katherine River near Katherine that falls in the category R2 – semi-rural.

3 RISK ASSESSMENT PROCESS

The Trans Territory Pipeline Risk Assessment was completed by assessing the pipeline for both location specific threats and general threats to the pipeline, their likelihood of occurrence and their effect if they were to occur. The effects from worst scenario cases of failure were considered with respect to:

- Safety of the public
- Safety of employees and contractors
- Environmental impact
- Economic loss

Risk mitigation methods to be employed were also assessed on the basis of reducing risk to ALARP (As Low As Reasonably Practicable) in accordance with Australian Standard 2885 requirements. Risk mitigation is detailed further in Section 5.

3.1 LOCATION ANALYSIS

Data gathered from aerial surveys, ground surveys and mapping of the route was used to perform a location analysis and feature identification of the pipeline. This documentation was used to correlate features identified during the route survey with locations.

3.2 RISK ANALYSIS

Risk analysis was performed on the threats identified in the location analysis process and on threats generally associated with pipelines. The risk analysis was performed in accordance with AS 2885.1-1997 and based on the guidelines of SAA HB105-1998. The AS 2885 risk assessment process is similar to that of AS 4360 so there is no differentiation made between natural hazard risks or any other risks within the risk analysis.

The standard prescribes a risk analysis process that assesses the frequency of occurrence of threats to the pipeline and the probability that each threat will result in a loss of integrity or containment of the asset. The consequence of the asset failing is then required to be assessed for the impact on the locality around the possible incident. Impact on the surrounding area is assessed with regard to safety, the environment and economic cost.

The aim of the risk analysis is to reduce the residual risk of an incident to a low ranking or ALARP, by applying physical design controls. In an operating pipeline situation, the risk assessment process may require additional procedural factors of protection to be applied if the pipeline does not fall into a safe enough operating regime through design above.

These requirements are considered in this risk assessment.

4 PIPELINE DESCRIPTION

4.1 PIPELINE DESIGN

The pipeline is a welded steel pipeline to be operated in accordance with Australian Standard AS 2885.3–2001.

The pipeline shall be designed to a MAOP of 15.3 MPag in accordance with AS 2885.1 – 1997 (incorporating amendment No 1).

Features along the pipeline route are detailed in Appendix A.

4.2 PIPE

The pipeline as currently selected shall be constructed from API 5L – X70 (482 MPa SMYS), 406.4 mm outside diameter pipe. In this case, pipe for R1 locations would have a wall thickness of 9.0 mm, and that for stations, road crossings and other special crossings would have a wall thickness of 10.8 mm. Manufactured bends would also use the thicker pipe to allow for wall thinning.

4.3 COATING

All linepipe shall be externally coated with a high integrity factory applied coating (dual layer Fusion Bonded Epoxy (FBE) or Trilaminate) coating in accordance with project specifications. The field joint coating system shall be compatible with the parent coating material and in accordance with a project specification.

The coating is the primary corrosion protection, with the cathodic protection providing secondary protection at any coating defects.

4.4 CATHODIC PROTECTION

The pipeline shall be protected from corrosion by impressed current systems located along the pipeline as required.

Provision has been made at each scraper facility and each mainline valve (MLV) for installation of cathodic protection anode beds.

4.5 COVER

The pipeline will be buried in accordance with the requirements of AS 2885 to a minimum of 750 mm in R1 locations, 1,200 mm in road, railway reserves and any other higher risk areas, as well as at least 2,000 mm below watercourses or areas subject to erosion.

4.6 VALVE STATIONS

The pipeline will be fitted with valve stations as indicated in the table below.

The stations at KP 0, 76, 234, 364, 485, 638, 797, 932 and 943 will be fitted with telemetry, instrumentation and with valve actuators, so that the main line valves can be operated remotely from the pipeline control room, in normal or emergency operation.

The valve station at KP 915 will be fitted with a pressure reduction valve to decrease the line pressure at the Gove end of the pipeline. This station will be

fitted with telemetry and instrumentation so it can be monitored and controlled from the pipeline control room

The valve spacings comply with the requirements of AS 2885 and provide for good control over the pipeline.

KP	Location	Facilities
0	Wadeye	Launcher, Metering + MLV
76	Tom Turners Crossing	Scraper + MLV
162	Wingates	MLV + Future Compression
234	Dorisvale	Scraper + MLV
282	Florina	MLV
322	Manbulloo Interconnect	Offtake
364	King River	Scraper, Compression + MLV
419	Beswick	MLV
485	Velkerri Creek	Scraper + MLV
533	Mainoru	MLV + Future Compression
638	Annie Creek	Scraper + MLV
728	Guluddy Creek	MLV
797	Gapuwiyak Road	Scraper + MLV
915	Giddy River	PRV + MLV
932	Nhulunbuy	MLV (Remote)
936	Nhulunbuy Offtake	Offtake
943	Gove	Receiver, Metering, Heating, Pressure Reduction + MLV

4.7 ROAD CROSSINGS

The pipeline depth of cover shall be at least 1,200 mm in road reserves. The NT Government has requested 1,000 mm minimum under table drains and 1,500 mm at the road shoulder of highways.

4.8 WATERCOURSE CROSSINGS

Watercourse crossings shall be buried deeper than 2,000 mm below the bottom of the watercourse.

4.9 RAILWAY CROSSING

The pipeline depth of cover shall be at least 1,200 mm below table drain of the Alice Springs-Darwin railway reserve and at least 3,000 mm below top of the rail.

4.10 OTHER UTILITY SERVICES

Adequate separation (300 mm minimum for crossings and 1,000 mm minimum for parallel) shall be kept between the pipeline and other utility services to ensure neither impacts on the other.

4.11 OPERATION AND CONTROL

Pipeline and station control systems shall all be fail safe.

The pipeline shall be protected from overpressure by pressure control and a second pressure limiting system at the pipeline inlet and at compressor stations.

The pipeline shall be fitted with telemetry, communications, instrumentation and SCADA to allow pipeline operations to reliably monitor, control and operate the pipeline.

4.12 PROCEDURES AND PLANS

The pipeline will be maintained and operated in accordance with a set of operating, maintenance and repair procedures.

These will be developed into a set of safety, operating and emergency response plans, which will take account of proper operation of the pipeline including environmental issues.

4.13 GAS DESCRIPTION

The gas transported in the pipeline will be non-toxic industrial quality natural gas. It will have a low water dewpoint and be non corrosive, thus providing corrosion protection to the internal surface of the pipeline.

Emissions of gas will be kept to a minimum, with the pipeline having high integrity from leakage and only minimal venting of gas taking place during operations.

5 RISK MITIGATION – PROTECTION MEASURES

The following risk mitigation measures are referenced in the pipeline location analysis, which can be found in Appendix A.

5.1 PHYSICAL MEASURES

5.1.1 Separation by Burial

The pipeline shall be constructed with a depth of cover of 750 mm or greater. In addition pipe within road reserves shall be buried to at least 1,200 mm.

This depth meets AS 2885.1-1997 requirement of burial not less than 750 mm for land designated R1 – Broad Rural. The majority of the land along the pipeline route falls within the category designated R1 – Broad Rural (ie larger than 5 ha lots).

API 5L-X70 pipe of 9.0 mm wall thickness buried at 750 mm is adequate to withstand a wheel loading in excess of 14 tonne, so the depth of burial is assessed as adequate (assessed in accordance with API 1102).

In road reserves, where there is greater possibility of third party impact from machine excavation, the pipeline will be buried with at least 1200mm cover to place it below any expected excavations.

Increased burial depth may also be required in some areas, if land use involves any deep ripping or extensive cultivation.

5.1.2 Resistance to Penetration

The pipeline shall be constructed from pipe with a wall thickness minimum of at least 9.0 mm. Pipe crossing roads will also have a thicker wall thickness of at least 10.8 mm.

Studies from France and England show that pipe with a wall thickness of 9.0 mm or greater is highly resistant to rupture from third party activity. A research project undertaken by the Australian Pipeline Industry through the CRC for Materials Welding and Joining in 2000, and a subsequent project in 2001 has verified overseas correlations.

5.1.3 Separation by Exclusion

The above ground pipework shall be protected by fencing.

This meets the SAA HB105 – 1998 pipeline risk assessment requirement of having at least one physical protection measure for a pipeline in located in an area designated as R1 – Rural.

Sections of the pipeline which may be at risk from routine activities (ditch clearing along roads for example) may require additional protection by concrete slabs.

5.2 PROCEDURAL MEASURES – MARKING

5.2.1 Dial Before You Dig

Trans Territory Pipeline will provide a Dial Before You Dig service. The service will be available 24 hours a day. Trans Territory Pipeline personnel will visit properties to locate the pipeline when required.

5.2.2 Signage

AS 2885.1-1997, Table 4.2.4.6, states the maximum sign spacing allowable is inter-visible but no more than 5,000 m in R1 reducing to 500 m in T1. Signage on the Trans Territory Pipeline shall be intervisible in both directions along the entire pipeline route and spacing shall not exceed 500 m. Signage will also be present on both sides of road crossings, both sides of railway crossings, both sides of significant river and stream crossings, at all fences, at all utility crossings and at all changes of direction (bends). An emergency contact number will be shown on the signs.

5.2.3 Marker Tape

In locations where additional protection is deemed necessary, marker tape may be installed above the pipe to warn third parties of the presence of the buried pipeline.

5.2.4 Patrols

Patrolling of the pipeline will occur at regular intervals not exceeding six monthly.

5.2.5 Landowner, Occupier and Other Authority Liaison

Third party awareness is an important protection measure. Correspondence will be posted to each landholder, occupier and other utility provider at least annually.

Landowners and occupiers shall also visit personally at least annually, and in any case regular contact will be made whenever patrols are conducted. Regular contact will also be made with the local superintendents of other utility providers.

6 RISK IDENTIFICATION

The AS 2885.1–1997 Risk Assessment Methodology was used for risk identification and evaluation. The area of influence examined during the risk assessment included facilities and features of note within 580 m of the pipeline route.

The area of influence was determined by looking at the furthest distance where a radiation level of 4.7 kW/m^2, which has the potential to cause injury, would result from full pipeline rupture resulting in a fire. Calculations used to determine the area of influence are based on a DN400 pipeline operating at a pressure of 15.3 MPa with maximum feed of gas to a fire. Maximum feed of gas to a fire is assumed to be equal to release of gas through a hole of equal size to the pipe diameter, with the pressure gradient between atmospheric pressure and 15.3 MPa driving the flow.

The same worst case scenario could potentially cause fatalities at 354 m, the distance where radiation intensity is 12.6 kW/m^2. The calculated area of influence is likely to be significantly less than this as there is only a low probability that third party damage will cause a full bore rupture, with the greater likelihood being a hole or pinhole with concomitant area of influence significantly smaller.

For example a 5 mm hole will cause a 12 m and 7 m distance respectively, versus the 580 m and 354 m for a full bore rupture.

Radiation intensity values of 4.7 kW/m^2 and 12.6 kW/m^2 correspond to the values where 30 seconds exposure will lead to at least second degree burns, and third degree burns with a possible fatality, respectively.

6.1 LOCATION ANALYSIS DISCUSSION

The location analysis was performed along the pipeline from a desktop analysis.

The location classification for the whole of the pipeline route was R1 - Broad Rural, other than the Gove end which is classified as T1 - Suburban.

6.2 THREAT ANALYSIS

The threat analysis was performed with two focuses: one focus on location specific threats (Appendix A), and the second on general threats found to apply

in many locations along the pipeline length, such as external interference. These general threats are considered further in Section 8 of this report.

6.2.1 Location Specific Threats

Location specific threats are tabulated in Appendix A.

The pipeline is divided into sections, or locations, for which threats specific to that location are identified. Each location is named in the table and protection measures mitigating against the threats provided. Protection measures are selected from a subset of the physical and procedural measures defined in AS 2885.1–1997 identified at Section 5. They are considered adequate if they meet AS 2885 requirements particular to the location classification and reduce the risk to ALARP.

A 'comments' column is included in the table to contain details of special interest features, irregular activities, or action items for identified risks requiring special interest.

6.2.2 General Threats

Issues considered include:

- external interference (third party activity)
- corrosion (internal, Stress Corrosion Cracking (SCC), Hydrogen Sulphide Cracking and external)
- electrical induction (lightning, power line induction)
- explosive atmospheres
- cyclones and strong winds
- flooding
- excessive vehicular load
- train derailment
- road maintenance
- earthquakes
- bushfire
- testing and inspection

- farming activities
- mining activities
- sabotage and vandalism
- erosion of cover
- failure of control and protective equipment
- inadequate or incomplete maintenance
- erosion and sediment control
- stream crossings

7 RISK EVALUATION

7.1 GENERAL

AS 2885 requires the frequency of a pipeline threatening event to be assessed according to the following classification.

Frequency of Occurrence	Description	Nearest Numerical Frequency for Guidance (per 1,000 km/yr)
Frequent	Expected to occur at least once per year	1 or greater
Occasional	Expected to occur several times in the life of the pipeline	0.1
Unlikely	Not likely to occur in the life of the pipeline, but is possible	0.01
Remote	Very unlikely to occur in the life of the pipeline	0.001
Improbable	Examples of this event have occurred historically, but it is not anticipated for the pipeline at this location	10^{-5}
Hypothetical	Theoretically possible, but has never occurred to date	10^{-6} or lower

AS 2885 also requires determination of the severity arising from an incident/event. The following definitions are used to categorise severity.

Severity Class	Description
Catastrophic	Applicable only in location classes T1 and T2 where the number of humans within the range of influence of the pipeline would result in many fatalities
Major	Event causes few fatalities or loss of continuity of supply or major environmental damage
Severe	Event causes hospitalising injuries or restriction of supply
Minor	Event causes no injuries or loss of supply

The frequency and severity are then considered together to determine a risk ranking. Risks are categorised as either HIGH, INTERMEDIATE, LOW or NEGLIGIBLE. Design criteria and operational procedures are put in place to shift the risk ranking towards the risk classifications of LOW and NEGLIGIBLE. A risk falling into the risk classification of INTERMEDIATE is acceptable according to AS 2885.1-1997, but only after recursive evaluation confirms this risk ranking and risk management actions have been applied to achieve a risk of ALARP.

Generally, according to AS 2885, a frequency lower than IMPROBABLE (10^{-5}) can be acceptable for all other than a CATASTROPHIC event (ie events that do not cause greater than a few fatalities, major loss of supply or major environmental damage).

Risks identified on the pipeline will be assessed in accordance with the SAA HB105 – 1998 guidelines for likelihood of impact against the frequency definitions defined above, during detail design.

7.2 CONSEQUENCE ANALYSIS

The upper bound of events, other than an explosion, is usually defined on a pipeline as a full-bore rupture of the pipeline with a fire. The intensity of any fire can be calculated from the diameter of the pipeline, the operating pressure and the size of the rupture. Intensity values of 4.7 kW/m^2 and 12.6 kW/m^2 are taken from document HB105–1998, and correspond to the values where 30 seconds exposure will lead to at least second degree burns, and third degree burns with a possible fatality, respectively.

Calculations used to determine the area of influence are based on a DN400 pipeline operating at a pressure of 15.3 MPa with maximum feed of gas to a fire. Maximum feed of gas to a fire is assumed to be equal to release of gas through a

hole of equal size to the pipe diameter, with the pressure gradient between atmospheric pressure and 15.3 MPa driving the flow.

The area of influence examined during the risk assessment included facilities and features of note within 580 m of the pipeline route. The same worst case scenario could potentially cause fatalities at 354 m. The calculated area of influence is likely to be significantly less than this as there is only a low probability that third party damage will cause a full bore rupture, with the greater likelihood being a hole or pinhole with areas of influence significantly smaller. Pressure within the pipeline is also likely to be less than the Maximum Allowable Operating Pressure (MAOP) at most points along the pipeline.

These intensity values can be used to place an upper bound on the consequence of a pipeline rupturing event.

7.3 RISK ESTIMATION MATRIX

The risk of an event is categorised using its likelihood and severity rankings in the risk estimation matrix from AS 2885.1 – 1997 shown below.

Frequency of Occurrence	Severity Class			
	Catastrophic	Major	Severe	Minor
Frequent	H	H	H	I
Occasional	H	H	I	L
Unlikely	H	H	L	L
Remote	H	I	L	L
Improbable	H	I	L	N
Hypothetical	I	L	N	N

Risk Classes:
H = High I = Intermediate L = Low N = Negligible

8 RISK EVALUATION

8.1 THIRD PARTY INTERFERENCE

Third party activity is recognised in the pipeline industry as one of the high risk threats to a pipeline. The pipeline wall thickness, depth of burial and procedural measures will reduce the risk to a low risk ranking.

Third party interference has been grouped under the following headings in order to facilitate this risk assessment.

8.1.1 Private Development

Typical threats associated with private development or maintenance include:

- fencing
- access roads
- installation of new services (ie gas, phone, sewerage, drainage)
- erection of structures such as sheds
- gardening/landscaping

Liaison with landholders and utility providers, and patrolling should almost eliminate this risk.

New services may be installed for domestic or industrial use. Domestic services are generally not installed at great depth or using equipment which could impact on the integrity of the pipeline. Industrial service lines are installed at a greater depth, and regular contact with utility providers is needed to reduce this risk. Any vehicular load risk will be minimised by the depth of burial, and pipe wall thickness.

8.1.2 Residential Developments

Residential development activity is unlikely to impact the pipeline as the location of the pipeline is away from any densely populated area.

Typical threats associated with new residential developments or residential maintenance include:

- building of houses
- building of garages, sheds, decks

- landscaping
- driveways and footpaths
- installation of new services (ie gas, phone, water, sewage, drainage, electricity, etc)
- power poles and lighting poles
- roads and table drains
- commercial centres

The rural routing of this pipeline is well away from farm buildings, making this threat low. No building structures were within 600 m of the pipeline, except for one house which was located approximately 200 m from the pipeline.

8.1.3 Public Developments and Maintenance

Threats from public developments and maintenance include:

- road and table drain maintenance (typically utilising 14 G grader or equivalent for resurfacing)
- maintenance of public facilities, such as power and lighting poles
- maintenance of public services (water, sewage, telecommunication cable and fibre optic, overhead and underground power, gas and oil pipelines, and drains)
- installation of new services (water, sewage, telecommunication cable and fibre optic, overhead and underground power, gas and oil pipelines, and drains)

It is possible that some of these activities may reach or exceed a depth of 750 mm. The pipeline will be buried to a depth of 1,200 mm within road reserves, thereby minimising any threat. Risks include those from installation of new services, especially if boring or directional drilling is used. Liaison with public utility providers associated with the above activities will reduce the risk of damage from third party activity.

8.1.4 Mining Development

A number of activities associated with mining in the areas in which the pipeline is located are assessed as possible threats to the pipeline.

These include:

- exploration drilling
- seismic surveying
- blasting
- crossing of the pipeline with heavy equipment
- test excavations
- new roads

It is likely that these activities will pose a threat to the pipeline. Signage, the cleared right-of-way (ROW) and liaison with mining companies will minimise any threat. Regular pipeline route inspections will provide an important measure to minimise the risk.

8.1.5 Rural Development

A number of activities associated with farming the land in which the pipeline is located are assessed as possible threats to the pipeline. These include:

- deep ripping
- fencing
- dams
- sheds
- contour banks

Some of these activities are likely to reach or exceed a depth of 750 mm. In any properties where deep ripping may take place pipeline will require additional depth of burial. Liaison with rural landholders will reduce the risk from third party activity.

The risk is assessed as having a severity class of MAJOR and a frequency occurrence rating of IMPROBABLE. This risk is reduced to INTERMEDIATE and is considered to be ALARP.

8.2 CORROSION

All pipeline steels can be affected by corrosion.

The Trans Territory Pipeline has been risk assessed for corrosion causing loss of integrity as follows:

- External Corrosion
  - The external surface of the pipeline is installed in a corrosive environment.
  - The pipeline will be operating in the pressure range of up to 72% SMYS. Stress corrosion cracking of the pipeline steel can take place at this pressure, particularly as the steel will be subjected to cyclic pressures.
- Internal Corrosion
  - The flowing gas has low sulphur and low water dewpoint. These gas qualities protect the pipe internals from corrosion.

The pipe will be coated with dual layer epoxy as the primary corrosion protection, and cathodic protection will be applied to protect any coating damaged areas.

Procedures will ensure that the pipeline cathodic protection levels are maintained to protect the pipeline from all types of corrosion.

The risk is assessed as having a severity class of SEVERE and a frequency occurrence rating of IMPROBABLE. This risk is reduced to LOW.

8.3 ELECTRICAL INDUCTION

Lightning striking the pipeline is capable of inducing significant voltages into the pipeline. There are no other high structures adjacent to the pipeline to attract lightning away from the pipeline.

There are powerlines paralleling the pipeline capable of inducing an electrical voltage in the pipeline from KP 932 through to the Gove Gate Station. Design techniques will be applied to protect equipment and personnel and to dissipate energy away safely.

The risk is assessed as having a severity class of SEVERE and a frequency occurrence rating of REMOTE. This risk is reduced to LOW.

8.4 EXPLOSIVE ATMOSPHERES

An explosive atmosphere exists when the natural gas in air concentration falls in the range of 4%-15%. Generally, this cannot occur for a leakage of natural gas in a freely ventilated area where gas can disperse. Natural gas is lighter than air and it will naturally disperse upwards away from the source of a leak, and therefore will not concentrate.

The risk is assessed as having a severity class of MAJOR and a frequency occurrence rating of HYPOTHETICAL. This risk is reduced to LOW.

8.5 CYCLONES AND STRONG WINDS

The Main Line Valves will be buried and not subject to cyclone damage.

The scraper stations will have some above ground pipe work. This pipe work is resistant to damage by impact from natural materials as the pipe steel will have a design factor of 0.6, and the main pipeline steel is 10.8 mm thick. Even manufactured materials (such as a vehicle) impacting the pipe would be unlikely to cause major damage to the pipe.

Smaller valves at a station could be broken off causing a smaller leak. This is likely to cause a small jet fire at worst.

All facilities will be fenced providing protection against wind driven debris (except for extra high velocity wind).

Control buildings (small) and compressor buildings shall be built to the Northern Territory building code to withstand the effects of cyclones and strong winds.

Most facilities and stations will be located more than 100 km from the coast where cyclone based effects are diminished.

The risk is assessed as having a severity class of SEVERE and a frequency occurrence rating of REMOTE. This risk is reduced to LOW.

8.6 FLOODING

The pipeline shall be buried at least 2,000 mm below rivers and watercourses.

Stations and facilities will be located on higher areas not subject to flooding.

In areas where pipeline flotation could occur such as rivers the pipe will have weight coating or some other means to provide negative buoyancy.

The risk is assessed as having a severity class of MINOR and a frequency occurrence rating of REMOTE. This risk is reduced to LOW.

8.7 EXCESSIVE VEHICULAR LOAD

The API RP 1102 equation was used to consider the loading effects on the pipeline from the combined effect of hoop stresses from internal pressure and external load. According to AS 2885.1-1997 the combined stress shall not exceed 90% of the yield stress.

The maximum wheel loading was found that 14 tonne per wheel remained below 90% of SMYS, at the pipeline's MAOP of 15.3 MPa.

This is considered a safe value which is not anticipated to be exceeded along the pipeline route by expected vehicles or farming equipment.

There are areas along the pipeline where mining could take place. There may need to be additional protection placed upon the pipeline, if these areas are developed, depending upon the loading from equipment proposed for the developments.

The risk is assessed as having a severity class of MAJOR and a frequency occurrence rating of HYPTOTHETICAL. This risk is reduced to LOW.

8.8 TRAIN DERAILMENT

The pipeline crossing of the Darwin to Adelaide railway is in a remote, straight section of track unlikely to cause a train derailment.

The pipe is buried deeper in the railway easement.

The risk is assessed as having a severity class of MAJOR and a frequency occurrence rating of HYPOTHETICAL. This risk is reduced to LOW.

8.9 ROAD MAINTENANCE

The pipeline is buried deeper in road reserves and thicker wall pipe is used for road crossings.

Concrete slabbing will be installed in table drains and marker tape elsewhere within road reserves.

Liaison with other utility providers to educate them on the pipeline's location will be conducted for the life of the pipeline.

The risk is assessed as having a severity class of MAJOR and a frequency occurrence rating of REMOTE. This risk is reduced to INTERMEDIATE and is considered to be ALARP.

8.10 EARTHQUAKES

Earthquake activity in Australia is low.

An Australian Geological Survey Organisation (AGSO) earthquake hazard map, which shows geological and risk contours was consulted. The earthquake hazard map shows acceleration coefficients, which have a 10% chance of being exceeded in the next 50 years. The Trans Territory Pipeline passes through areas that have a 90% chance that a ground acceleration coefficient will not be exceeded in the next 50 years of 0.09 near Wadeye, to areas of 0.065 around Katherine, to areas as low as 0.045 around Gove.

Damage to buildings generally starts to occur at a ground coefficient level of 0.05. Surrounding soil creates substantial damping for pipelines and tends to provide some protection. Pipelines with good weld integrity tend to survive minor earthquakes undamaged. A pipeline at Tennant Creek was buckled by an earthquake in 1988. This required shutdown of the pipeline to undertake repairs. The area around Tennant Creek has a ground acceleration coefficient rating of greater than 0.10.

The main factors affecting the ability of a pipeline to withstand the effects of an earthquake are wall thickness, good weld integrity and corrosion prevention. The Trans Territory Pipeline is to be made from high integrity pipe with good weld integrity and is expected to be resistant to the effects of earthquake levels that could be expected along its route.

The risk is assessed as having a severity class of SEVERE and a frequency occurrence rating of UNLIKELY. This risk is reduced to LOW.

8.11 BUSHFIRE

Bushfires will have no impact on the pipeline as the pipe is buried, and stations will be cleared and gravelled with no combustible material in proximity to above ground facilities.

Control buildings (small) and compressor buildings shall be built from materials and methods with resistance to catching fire from flying embers.

The risk is assessed as having a severity class of SEVERE and a frequency occurrence rating of UNLIKELY. This risk is reduced to LOW.

8.12 TESTING AND INSPECTION

The pipeline will be built to the AS 2885 standard. Pipes will be manufactured to the API – 5L standard.

This means the pipe, welds, construction, equipment and stations will be built to a high standard under well developed plans and procedures, and be subjected to a number of tests conducted by competent personnel, which will provide a high confidence in the suitability of selected materials and constructed integrity of the pipeline.

These tests will ensure that the pipeline, stations and controls do not hold any pipeline threatening faults.

The pipeline will also be maintained and operated under AS 2885 which will ensure that competent people will ensure the pipeline is maintained and operated in a safe manner, throughout its entire life.

The risk is assessed as having a severity class of SEVERE and a frequency occurrence rating of UNLIKELY. This risk is reduced to LOW.

8.13 FARMING ACTIVITIES

Farming activity is limited to grazing with some cropping. Cropping activity should generally be limited to ploughing of the soil to a maximum depth of 300 mm.

Deep ripping or blade ploughing is not anticipated along the pipeline route.

Land agreements will be entered into with landholders to limit their activities to non threatening activity on the pipeline ROW.

Post hole digging for fencing is likely to be the highest farming threat to the pipeline. Landholder liaison and ROW patrols will be conducted to reduce the risk to an acceptable limit.

The risk is assessed as having a severity class of SEVERE and a frequency occurrence rating of UNLIKELY. This risk is reduced to LOW.

8.14 HUNTING ACTIVITIES

The use of firearms near the pipeline will only present a threat to the pipeline at the facilities where there is above ground high-pressure pipework. These aboveground facilities are few and widely spaced.

Landholders will be advised of the risk and asked to limit hunting activities in the immediate vicinity of the facilities. The facilities will be fenced and have clear warning signs.

The risk is assessed as having a severity class of SEVERE and a frequency occurrence rating of UNLIKELY. This risk is reduced to LOW.

8.15 SABOTAGE AND VANDALISM

The pipeline will be buried along the entire route and is remotely located.

Above ground facilities will be fenced and buildings alarmed to indicate unauthorised access. Pipe wall thickness within facilities will be heavier wall.

The risk is assessed as having a severity class of SEVERE and a frequency occurrence rating of REMOTE, other than the case of terrorism which could cause an interruption of supply. This risk is reduced to LOW.

8.16 EROSION OF COVER

The pipeline will be buried deeper under watercourses and the pipeline ROW shall be maintained during the life of the pipeline to ensure cover is not reduced.

The risk is assessed as having a severity class of MINOR and a frequency occurrence rating of OCCASIONAL. This risk is reduced to LOW.

8.17 FAILURE OF CONTROL AND PROTECTIVE EQUIPMENT

The pipeline inlet control pressures will be designed in accordance with AS 2885 with two levels of overpressure control.

Pressure reduction stations will also have duty/standby configuration to protect downstream systems.

All systems will be fail safe.

The risk is assessed as having a severity class of MAJOR and a frequency occurrence rating of HYOPOTHETICAL. This risk is reduced to LOW.

8.18 INADEQUATE OR INCOMPLETE MAINTENANCE

The pipeline will be operated in accordance with AS 2885.3 which requires the implementation of a suite of operating, maintenance and repair procedures and the use of competent and properly trained operations personnel.

The risk is assessed as having a severity class of SEVERE and a frequency occurrence rating of IMPROBABLE. This risk is reduced to LOW.

8.19 EROSION AND SEDIMENT CONTROL

The pipeline ROW shall be a narrow strip and ground disturbance and vegetation clearing shall be minimised as far as practical to this strip.

Topsoil containing seeds shall be stripped off and stored on the edge of the pipeline ROW prior to construction taking place. Following pipeline construction this topsoil will be respread across the ROW, to encourage natural vegetation to restore and rebind the soil.

Erosion berms shall be constructed to ensure discharge runoff water does not lead to erosion or sedimentation.

Erosion control structures shall be routinely inspected and maintained during the life of the pipeline to ensure they remain effective.

The risk is assessed as having a severity class of MINOR and a frequency occurrence rating of OCCASIONAL. This risk is reduced to LOW.

8.20 STREAM CROSSINGS

Stream flow diversion techniques or horizontal directional drilling techniques are likely to be employed for stream crossings.

These involve stream flow diversion utilising dam and pump or fluming techniques utilising sand bagging or Aquadam™ with trenching taking place in the dry, or horizontal directional drilling techniques under the watercourse. The pipeline will be buried at least 2,000 mm below bottom of watercourses.

The risk is assessed as having a severity class of SEVERE and a frequency occurrence rating of IMPROBABLE. This risk is reduced to LOW.

APPENDIX A

LOCATION AND THREAT ANALYSIS

Appendix A – Location Specific Threat Analysis – Wadeye to Nhulunbuy (15.3 MPa)

KMP Location	Location Class	Land Use	Location Analysis	Threat Analysis	Protection	Comments
KP 0	R1	Wadeye Gas Plant	❑ Gas plant ❑ Launcher at KP 0	❑ Third party activity	**Physical Protection** ❑ Separation by Exclusion – Fencing around gas plant ❑ Separation by burial – Depth of burial 1,200 mm **Procedural** ❑ Within gas plant facility boundary ❑ Signage on fence ❑ Patrolling – Biannual inspection of pipeline and facilities ❑ Landholder liaison	❑ AS 2885 Physical and Procedural requirements met ❑ Monolithic Insulation Joint installed, and pipework earthed ❑ Lightning surge protector ❑ Two levels of overpressure protection. ❑ 10.8 mm wall thickness pipe
KP 0 – KP 50	R1	Natural Bushland	❑ Road crossings at KP10 and KP12 ❑ Annually dry catchment area of Kulshill Creek at KP 25 ❑ Fence crossing at KP 47 ❑ Road crossing at KP 48	❑ Third party activity at road crossings ❑ Erosion of cover at Kulshill Creek	**Physical Protection** ❑ Separation by Burial – Pipeline is buried with a minimum depth of cover of 750 mm, minimum 1,200 mm below roads and at least 2,000 mm below creeks ❑ Pipe wall thickness 9.0 mm. **Procedural** ❑ Signage with spacing of less than 500 m ❑ Patrolling – Biannual inspection of pipeline and facilities ❑ Landholder and other utility liaison	❑ AS 2885 Physical and Procedural requirements met ❑ Signage is clearly visible in both directions and located at both sides creeks and roads ❑ Relatively flat, no major erosion of soil ❑ Clear right-of-way ❑ 9.0 mm wall thickness pipe ❑ 10.8 mm wall thickness pipe at road crossings
KP 50 – KP 80	R1	Natural Bushland	❑ Road crossing at KP 53 ❑ Anopheles Creek at KP 55 ❑ Chalanyi Creek at KP 64 ❑ Fence crossing at KP 66 ❑ Moyle River at KP 75	❑ Third party activity at road and track crossings ❑ Third party activity unlikely as remote with some grazing ❑ Erosion of cover at Anopheles Creek, Chalanyi Creek and Moyle River	**Physical Protection** ❑ Separation by Burial – Pipeline is buried with a minimum depth of cover of 750 mm, minimum 1,200 mm below roads and tracks and at least 2,000 mm below creeks and	❑ AS 2885 Physical and Procedural requirements met ❑ Signage is clearly visible in both directions and located at both sides creeks, rivers and roads ❑ Relatively flat, no major erosion of

KMP Location	Location Class	Land Use	Location Analysis	Threat Analysis	Protection	Comments
			❑ Scraper station at KP 76 ❑ Track crossing at KP 62 and KP 66 ❑ Chalanyi Creek Fault line up ridge at KP 78		rivers ❑ Pipe wall thickness 9.0 mm. ❑ Scraper station cleared and fenced ❑ Pipe wall thickness 10.8 mm up range KP 78 to KP 79 **Procedural** ❑ Signage with spacing of less than 500 m ❑ Patrolling – Biannual inspection of pipeline and facilities ❑ Landholder and other utility liaison	soil ❑ Clear right-of-way ❑ 9.0 mm wall thickness pipe, with thicker wall across Chalanyi Fault line ❑ 10.8 mm pipe up steep range area and at road crossings
KP 80 – KP 200	R1	Natural Bushland	❑ Moyle River crossing at KP 93 ❑ Buried valve station at KP 162 ❑ Annually dry bed Fish River at KP 185	❑ Third party activity unlikely as remote inaccessible location ❑ Erosion of cover at Fish River	**Physical Protection** ❑ Separation by Burial – Pipeline is buried with a minimum depth of cover of 750 mm and at least 2,000 mm below creeks ❑ Valve station cleared and fenced ❑ Pipe wall thickness 9.0 mm. **Procedural** ❑ Signage with spacing of less than 500 m ❑ Patrolling – Biannual inspection of pipeline and facilities ❑ Landholder and other utility liaison	❑ AS 2885 Physical and Procedural requirements met ❑ Signage is clearly visible in both directions and located at both sides creeks ❑ Relatively flat, no major erosion of soil ❑ Clear right-of-way ❑ 9.0 mm wall thickness pipe
KP 200 – KP 282	R1	Natural Bushland some cleared for grazing at Dorisvale station	❑ Track crossing at KP 205 ❑ Dorisvale Fault line at ridge at KP 216 ❑ Approximately four fence crossings ❑ Bradshaw Creek at KP 231 ❑ Dorisvale Road crossing at KP 231 ❑ Crocodile Creek at KP 227 ❑ Scraper facility at KP 234	❑ Third party activity at road and track crossings ❑ Third party activity although remote with grazing ❑ Fencing activity ❑ Erosion of cover at Bradshaw Creek, Crocodile Creek and Daly River	**Physical Protection** ❑ Separation by Burial – Pipeline is buried with a minimum depth of cover of 750 mm, minimum 1,200 mm below roads and tracks and at least 2,000 mm below creeks and rivers ❑ Pipe wall thickness 9.0 mm. ❑ Scraper and valve station cleared and	❑ AS 2885 Physical and Procedural requirements met ❑ Signage is clearly visible in both directions and located at both sides creeks, rivers and roads ❑ Relatively flat, no major erosion of soil ❑ Clear right-of-way

KMP Location	Location Class	Land Use	Location Analysis	Threat Analysis	Protection	Comments
			❑ Number of annually dry creeks ❑ Daly River at KP 266 ❑ Florina Road at 279 ❑ Buried valve station at KP 282		fenced ❑ Pipe wall thickness 10.8 mm across Dorisvale Road at KP 231 **Procedural** ❑ Signage with spacing of less than 500 m ❑ Patrolling – Biannual inspection of pipeline and facilities ❑ Landholder and other utility liaison ❑ Marker Tape in Dorisvale Road Reserve	❑ 9.0 mm wall thickness pipe, with thicker wall across Dorisvale Fault line ❑ 10.8 mm pipe up steep ridge area and at road crossing
KP 282 – KP 322	R1 R2 between IP30250 to IP30500 and 4 km west along Florina Rd from IP 30250	Road Reserve, Mango farm, Natural Bushland	❑ Florina station front fence at KP 290 ❑ Florina Road reserve KP 290 to KP KP 307 ❑ Gum Creek at KP 305 ❑ Florina Road crossing at KP 307 ❑ Katherine River at KP 309 ❑ Chainman Creek at KP 315 ❑ Three fence crossings	❑ Third party activity in road reserve ❑ Third party activity, although along Mango farm fenceline and grazing east of Katherine River ❑ Fencing activity ❑ Erosion of cover at Gum Creek, Katherine River and Chainman Creek	**Physical Protection** ❑ Separation by Burial – Pipeline is buried with a minimum depth of cover of 750 mm, minimum 1,200 mm in road reserve and at least 2,000 mm below creeks and rivers ❑ Pipe wall thickness 9.0 mm. ❑ Scraper and valve station cleared and fenced ❑ Pipe wall thickness 10.8 mm across Florina Road and Katherine River **Procedural** ❑ Signage with spacing of less than 500 m ❑ Patrolling – Biannual inspection of pipeline and facilities ❑ Landholder and other utility liaison ❑ Marker Tape in Florina Road Reserve	❑ AS 2885 Physical and Procedural requirements met ❑ Signage is clearly visible in both directions and located at both sides creeks, rivers and roads ❑ Relatively flat, no major erosion of soil ❑ Clear right-of-way ❑ 9.0 mm wall thickness pipe ❑ 10.8 mm pipe crossing Florina Road and the Katherine River ❑ Ken Rayner's house approximately 350 m from pipeline alignment at KP 308
KP 322 – KP 366	R1	Natural Bushland some land cleared for grazing and cropping at Kam (KP345) and	❑ Victoria Highway crossing at KP 322 ❑ Manbulloo Interconnect at KP 322 ❑ Chinaman Creek at KP 322	❑ Third party activity at road and highway crossings ❑ Third party activity although remote with grazing	**Physical Protection** ❑ Separation by Burial – Pipeline is buried with a minimum depth of cover of 750 mm, minimum 2,000	❑ AS 2885 Physical and Procedural requirements met ❑ Signage is clearly visible in both directions and located at both sides

KMP Location	Location Class	Land Use	Location Analysis	Threat Analysis	Protection	Comments
		Maryfield (KP362) stations	❑ Approximately four minor road crossings in Manbulloo station ❑ Creek at KP 338 ❑ NT Gas pipeline crossing ❑ Railway crossing at KP 341 ❑ Railway Road at KP 341 ❑ Creek at KP 347 ❑ Creek at KP 353 ❑ Compressor Station at 364 ❑ Stuart Highway crossing at KP 366 ❑ Approximately ten fence crossings	❑ Cropping activity and possible deep ripping at Kam and Maryfield stations between KP 345 to KP 362 ❑ Fencing activity ❑ Erosion of cover at Chinaman Creek, three minor Creeks	mm below top of rail under rail tracks, minimum 1,200 mm below roads, highways and within rail reserves, and at least 2,000 mm below creeks and rivers ❑ Separation by Burial – Pipeline burial to a depth of 1,200 mm within Kam and Maryfield stations ❑ Pipe wall thickness 9.0 mm. ❑ Scraper and valve station cleared and fenced ❑ Pipe wall thickness 10.8 mm across highways, roads, rail reserve, pipeline crossing and within compressor compound. **Procedural** ❑ Signage with spacing of less than 500 m ❑ Patrolling – Biannual inspection of pipeline and facilities ❑ Landholder and other utility liaison ❑ Marker Tape in road reserves	creeks, rivers, roads and railways ❑ Relatively flat, no major erosion of soil ❑ Clear right-of-way ❑ 9.0 mm wall thickness pipe ❑ 10.8 mm pipe at road crossings ❑ 10.8 mm pipe within compressor compound
KP 366 – KP 424	R1	Natural Bushland, grazing at Sunday Creek station	❑ King River at KP 370 ❑ Road crossing at KP 372 ❑ Road crossing at KP 374 ❑ Roper Creek at KP 375 ❑ Approximately eight fences ❑ Central Arnhem Road crossing at KP 381 ❑ Maranboy Creek at KP 390 ❑ Beswick Creek at KP 401 ❑ Road crossing at KP 414 and KP 419	❑ Third party activity at road and track crossings ❑ Third party activity although remote with grazing ❑ Fencing activity ❑ Erosion of cover at King River, Roper Creek, Maranboy Creek and Beswick Creek	**Physical Protection** ❑ Separation by Burial – Pipeline is buried with a minimum depth of cover of 750 mm, minimum 1,200 mm below roads and tracks and at least 2,000 mm below creeks and rivers ❑ Pipe wall thickness 9.0 mm. ❑ Valve station cleared and fenced ❑ Pipe wall thickness 10.8 mm across roads	❑ AS 2885 Physical and Procedural requirements met ❑ Signage is clearly visible in both directions and located at both sides creeks, rivers and roads ❑ Relatively flat, no major erosion of soil ❑ Clear right-of-way ❑ 9.0 mm wall thickness pipe ❑ 10.8 mm pipe at road crossings

KMP Location	Location Class	Land Use	Location Analysis	Threat Analysis	Protection	Comments
			❑ Buried valve station at KP 419 ❑ Mataranka back road at KP 423 ❑ Water House Creek at KP 424		**Procedural** ❑ Signage with spacing of less than 500 m ❑ Patrolling – Biannual inspection of pipeline and facilities ❑ Landholder and other utility liaison ❑ Marker Tape in road reserves	
KP 424 – KP 500	R1	Natural Bushland	❑ Road crossing at KP 433 ❑ Chambers River at KP 441 and KP 444 ❑ Bukalorkmi Creek at KP 475 ❑ Scraper station at KP 485 ❑ Road crossing at KP 485 ❑ Velkerri Creek at KP 490 ❑ Maiwok Creek at KP 500 ❑ Approximately five fences	❑ Third party activity at road crossings ❑ Third party activity although remote with grazing ❑ Fencing activity ❑ Possible low depth mining activity from KP 465 to KP 500 ❑ Erosion of cover at Chambers River, Bukalorkmi Creek, Velkerri Creek and Maiwok Creek	**Physical Protection** ❑ Separation by Burial – Pipeline is buried with a minimum depth of cover of 750 mm, minimum 1,200 mm below roads and at least 2,000 mm below creeks and rivers ❑ Pipe wall thickness 9.0 mm. ❑ Scraper station cleared and fenced ❑ Pipe wall thickness 10.8 mm across roads **Procedural** ❑ Signage with spacing of less than 500 m ❑ Patrolling – Biannual inspection of pipeline and facilities ❑ Landholder and other utility liaison	❑ AS 2885 Physical and Procedural requirements met ❑ Signage is clearly visible in both directions and located at both sides creeks, rivers and roads ❑ Undulating possible erosion of soil. Higher maintenance area. ❑ Clear right-of-way ❑ 9.0 mm wall thickness pipe ❑ 10.8 mm pipe at road crossings
KP 500 – KP 600	R1	Natural Bushland	❑ Multiple channels of Flying Fox Creek at KP 506 ❑ Derim Derim Creek at KP 509 ❑ Valve station at KP 533 ❑ Central Arnhem Road crossing at KP 535 ❑ Ouibobikwi Creek at KP 538 ❑ Mainoru River at KP 550 ❑ Horse Creek at KP 570	❑ Third party activity at road crossing ❑ Third party activity although remote with grazing ❑ Fencing activity ❑ Possible low depth mining activity from KP 500 to KP 545 ❑ Erosion of cover at Flying Fox Creek, Derim Derim Creek, Ouibobikwi Creek Mainoru River, Horse Creek and Wilton River	**Physical Protection** ❑ Separation by Burial – Pipeline is buried with a minimum depth of cover of 750 mm, minimum 1,200 mm below roads and at least 2,000 mm below creeks and rivers ❑ Pipe wall thickness 9.0 mm. ❑ Scraper station cleared and fenced ❑ Pipe wall thickness 10.8 mm across roads	❑ AS 2885 Physical and Procedural requirements met ❑ Signage is clearly visible in both directions and located at both sides creeks, rivers and roads ❑ Undulating possible erosion of soil. Higher maintenance area. ❑ Clear right-of-way ❑ 9.0 mm wall thickness pipe

KMP Location	Location Class	Land Use	Location Analysis	Threat Analysis	Protection	Comments
			❑ Road at KP 593 ❑ Wilton River at KP 600 ❑ Approximately six fences		**Procedural** ❑ Signage with spacing of less than 500 m ❑ Patrolling – Biannual inspection of pipeline and facilities ❑ Landholder and other utility liaison ❑ Marker Tape at road reserve	❑ 10.8 mm pipe at road crossings
KP 600 – KP 701	R1	Natural Bushland	❑ Scraper at KP 638 ❑ Annie Creek at KP 641 and KP 685 ❑ Goyder River at KP 701	❑ Third party activity although remote ❑ Erosion of cover at Annie Creek and Goyder River	**Physical Protection** ❑ Separation by Burial – Pipeline is buried with a minimum depth of cover of 750 mm and at least 2,000 mm below creeks and rivers ❑ Pipe wall thickness 9.0 mm. ❑ Scraper station cleared and fenced **Procedural** ❑ Signage with spacing of less than 500 m ❑ Patrolling – Biannual inspection of pipeline and facilities ❑ Landholder and other utility liaison	❑ AS 2885 Physical and Procedural requirements met ❑ Signage is clearly visible in both directions and located at both sides creeks and rivers ❑ Relatively flat, no major erosion of soil ❑ Clear right-of-way ❑ 9.0 mm wall thickness pipe
KP 701 – KP 804	R1	Natural Bushland	❑ Valve station at KP 738 ❑ Central Arnhem Road crossing at KP 739 ❑ Badalngarrmirri Creek at KP 760 ❑ Central Arnhem Road crossing at KP 770, KP 773, KP 783, and KP 785 ❑ Buckingham River at KP 779 ❑ Scraper station at KP 797 ❑ Gapuwiyak Road at KP 797 ❑ Habgood River at KP 804	❑ Third party activity at road crossing ❑ Third party activity although remote ❑ Erosion of cover at Badalngarrmirri Creek, Buckingham River and Habgood River	**Physical Protection** ❑ Separation by Burial – Pipeline is buried with a minimum depth of cover of 750 mm, minimum 1,200 mm below roads and at least 2,000 mm below creeks and rivers ❑ Pipe wall thickness 9.0 mm. ❑ Valve and scraper station cleared and fenced ❑ Pipe wall thickness 10.8 mm across roads **Procedural**	❑ AS 2885 Physical and Procedural requirements met ❑ Signage is clearly visible in both directions and located at both sides creeks, rivers and roads ❑ Relatively flat, no major erosion of soil ❑ Clear right-of-way ❑ 9.0 mm wall thickness pipe ❑ 10.8 mm pipe at road crossings

KMP Location	Location Class	Land Use	Location Analysis	Threat Analysis	Protection	Comments
					❑ Signage with spacing of less than 500 m ❑ Patrolling – Biannual inspection of pipeline and facilities ❑ Landholder and other utility liaison ❑ Marker Tape at Road reserves	
KP 804 – KP 900	R1	Natural Bushland	❑ Habgood River at KP 810, KP 812, KP 816 and KP 817 ❑ Richard River at KP 830 ❑ Goromuru River at KP 839 ❑ Boggy Creek at KP 852 ❑ Cato River at KP 880 ❑ Buried valve station at KP 881 ❑ Central Arnhem Road crossing at KP 881 ❑ Wonga Creek at KP 895	❑ Third party activity at Central Arnhem Road crossings and adjacent to the road ❑ Third party activity although remote ❑ Erosion of cover at Habgood River, Richard River, Goromuru River, Boggy Creek, Cato River and Wonga Creek	**Physical Protection** ❑ Separation by Burial – Pipeline is buried with a minimum depth of cover of 750 mm, minimum 1,200 mm below roads and at least 2,000 mm below creeks and rivers ❑ Pipe wall thickness 9.0 mm. ❑ Valve station cleared and fenced ❑ Pipe wall thickness 10.8 mm across roads **Procedural** ❑ Signage with spacing of less than 500 m ❑ Patrolling – Biannual inspection of pipeline and facilities ❑ Landholder and other utility liaison ❑ Marker Tape at road reserves	❑ AS 2885 Physical and Procedural requirements met ❑ Signage is clearly visible in both directions and located at both sides creeks, rivers and roads ❑ Medium undulating, no major erosion of soil ❑ Clear right-of-way ❑ 9.0 mm wall thickness pipe ❑ 10.8 mm pipe at road crossings
KP 900 – KP 943	R1, T1 from KP 932 on	Natural Bushland to KP 932, then beside Alcan conveyor belt	❑ Giddy River at KP 912 ❑ Central Arnhem Road crossing at KP 915 ❑ Pressure reduction valve station at KP 915 ❑ Latram River at KP 922 ❑ Buried valve station at KP 932 ❑ Beside conveyor belt with other services from KP 932 to KP 943	❑ Third party activity at Central Arnhem Road crossings ❑ Third party activity particularly adjacent to other services along conveyor belt ❑ Erosion of cover at Giddy River and Latram River ❑ Alcan mining lease KP 922 to 928 ❑ Pipeline paralleling high voltage power lines inducing voltage in	**Physical Protection** ❑ Separation by Burial – Pipeline is buried with a minimum depth of cover of 750 mm, minimum 1,200 mm below roads and at least 2,000 mm below creeks and rivers ❑ Separation by Burial – Pipeline is buried to a minimum depth of 1,200 mm in T1 area from KP 932 onwards ❑ Pipe wall thickness 9.0 mm.	❑ AS 2885 Physical and Procedural requirements met ❑ Signage is clearly visible in both directions and located at both sides creeks, rivers and roads ❑ Medium undulating to flat, no major erosion of soil ❑ Clear right-of-way ❑ 9.0 mm wall thickness pipe

KMP Location	Location Class	Land Use	Location Analysis	Threat Analysis	Protection	Comments
			❑ Beside high voltage power lines KP 932 to KP 943 ❑ Melville Bay Road crossing at KP 941 ❑ Gate Station at KP 943	pipeline	❑ Valve stations cleared and fenced ❑ Pipe wall thickness 10.8 mm in T1 area from KP 932 onwards. ❑ Adequate earthing and surge protection at Gate Station **Procedural** ❑ Signage at less than 500 metre centres ❑ Signage at less than 250 metre centres from KP 932 onwards ❑ Patrolling – Biannual inspection of pipeline and facilities ❑ Landholder, mining lease holder and other utility liaison ❑ Marker Tape at road reserves	❑ 10.8 mm pipe at road crossings and in T1 area from KP 932 onwards

APPENDIX B

TYPICAL GAS COMPOSITION

Typical gas composition expected is tabulated below.

Component	Composition (Mole %)
H_2O	0.0153
CO_2	1.1001
Nitrogen	7.3882
Methane	87.9820
Ethane	2.2892
Propane	0.7378
I Butane	0.0894
N Butane	0.1683
I Pentane	0.0490
N Pentane	0.0389
Hexanes	0.0377
Heptanes	0.0438
Octanes	0.0390
Nonanes	0.0119
Decanes	0.0075
Undecanes	0.0019
$C_{12}+$	0.0000
Total	100.0000