Chapter 3
Project Alternatives

PACIFIC **ALUMINIUM**

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3 Project Alternatives

3.1 INTRODUCTION

This section describes alternatives to the KGGP Project considered in its design and construction, to demonstrate the central role that the environment performance has played in project planning. The following project alternatives are discussed:

- Not proceeding with the project.
- Alternative locations for project components.
- Design and construction alternatives.
- Alternative sources of services.
- Decommissioning and rehabilitation methods.

Discussion of the alternatives is intended to facilitate an understanding of the reasons some have been preferred over others and provides a basis for the NT EPA, in considering the KGGP Project, to satisfy its objectives of promoting ecologically sustainable development and protecting the environment (section 7 of the NT EPA Act).

A combination of environmental, economic and technical selection criteria were addressed in reviewing the feasibility of each alternative considered.

Alternatives were assessed in terms of:

- Cultural sensitivities and impacts to sacred sites.
- Logistical advantages and disadvantages.
- Positive and negative impacts.
- Impacts on matters protected under relevant Commonwealth and Northern Territory legislation.

3.2 NOT PROCEEDING WITH THE PROJECT

The implications of not proceeding with the KGGP Project include:

- The anticipated closure of the Gove alumina refinery.
- Loss of the economic benefit from construction of the KGGP and conversion of the Gove alumina refinery to gas.
- Avoided environmental impacts from the construction and operation of the KGGP.

The impact of each of these consequences is described below.

3.2.1 Closure of the Gove refinery

Continued reliance on fuel oil is not considered to be economically viable and it is anticipated would lead to the closure of the Gove refinery. Bauxite mining operations would continue, with the material exported rather than being predominantly used for onsite alumina production. This change in operations would arise because fuel oil is significantly more expensive compared to gas and is subject to greater price fluctuation. In conjunction with low aluminium and alumina prices, poor global market conditions and a high Australian dollar, this has adversely affected the current viability of the refinery operation.

The Gove refining and mining operations currently employ approximately 1,500 people (employees and contractors). The refinery provides the majority of employment, which would be lost if the refinery were closed. Gove has a narrow economic base and the majority of these employees would therefore be unlikely to find employment in Gove and most would be likely to leave the region, along with their families. The work completed during a Strategic Review of the Gove operation suggested that should refining operations be suspended, the population of Gove would decrease significantly from the present level of just over 4,000 down to approximately 1,500.

The Gove operations directly contribute approximately $375 million annually to the NT economy from local services and suppliers, pay wages and benefits of $160 million per annum and provide $30 million per annum to manage and operate Nhulunbuy Township. A closure of the refinery would see a considerable reduction in the direct contribution of the Gove operations to the NT and regional economy.

A significant consequence of not proceeding with the KGGP Project is therefore a direct reduction in the economic base of the region through less employment, lower population and less economic activity.

In addition to the direct economic effects on Gove, a closure of the Gove refinery would have significant broader economic and social impacts including:

- Loss of 'value adding' to the bauxite mining operations: the refinery currently produces 2.6 million tonnes of alumina per annum with an export value in the region of $800 million (this value is highly dependent on the alumina price) which compares to potential bauxite export value of less than half of this value.
- Loss of community infrastructure, sport and public amenities from a reduced workforce and lower population.
- A reduced capacity for Nhulunbuy to continue to act as a regional commercial, administrative and service centre for east Arnhem Land.
- The property market would be significantly diminished given the low demand and surplus supply of housing.
- A range of flow on social impacts could be expected including vandalism, an escalation of alcohol related social issues and higher incidence of domestic violence.

3.2.2 Loss of economic benefit from construction and plant conversion

Not proceeding with the project would mean that the construction of the KGGP and the conversion of the refinery to gas would not proceed. This would have the following consequences:

- Loss of expenditure benefits to the Northern Territory and Australia associated with the pipeline and associated infrastructure. The capital expenditure is expected to be over $600 million for construction of the KGGP and over $150 million for conversion of the refinery with a further $786 million in capital expenditure over the life of the project, compared with $350 million in capital expenditure through to the end of mine life for a mine only scenario.
- Loss of local, regional and national employment and business opportunities in both the short and longer term. Employment generated through KGGP construction in 2014 is estimated at an average of 780 persons.
- Loss of economic output to the regional economy. Over the period 2013 to 2036, conversion of the Gove refinery to gas is projected to increase real economic output to the region by $2,382 million (net present value).
- Loss of economic output to the Northern Territory and Australian economies. Over the period 2013 to 2036, conversion of the Gove refinery to gas is projected to increase the real economic output to the Northern Territory by $3,629 million (net present value) or an

equivalent of 19.5% of the Northern Territory's current Gross State Product (GSP). Over the same period, gas conversion is projected to add $3,667 million (net present value) or an equivalent of 0.25% of Australia's current Gross Domestic Product (GDP) (Appendix A).

These losses are likely to have significant flow-on effects to the Northern Territory and National economies.

3.2.3 Avoided environmental impacts from construction and operation

Not proceeding with the project would result in the avoidance of the physical disturbance and associated environmental impacts from pipeline construction, predominantly through not having to clear approximately 2,200 ha of native vegetation. The risks from vegetation removal can however, be acceptably mitigated, as set out in Chapters 6 to 11 and Chapter 17 in this Draft EIS.

Not proceeding with the project would also result in the avoidance of other impacts associated with construction and operation of the KGGP (see Chapter 5). These impacts can however, be acceptably mitigated as set out in Chapters 12 to 17.

3.3 ALTERNATIVE LOCATIONS FOR PROJECT COMPONENTS

3.3.1 KGGP pipeline route selection process

It is proposed that the KGGP follows the preferred alignment of a section of the earlier TTP proposal, commencing near Katherine and running east to Gove. Alcan Gove Pty Ltd made considerable effort to mitigate the potential environmental impacts of the previously proposed TTP through the selection of a pipeline route that avoided high value environmental and cultural assets. The planning process was undertaken at a broad scale, with a number of corridor alignments considered before the preferred alignment was identified. Minor deviations to the preferred route were identified at the 'finer' scale to avoid smaller patches of high value vegetation, wetlands or other sensitive sites, including sacred sites.

Due to the extensive effort involved in the pipeline route selection process for the TTP, it has not been considered necessary to conduct a new assessment of the alternative routes for the KGGP. Accordingly, the analysis of route selection for the KGGP presented below summarises the earlier assessment conducted for the TTP.

An assessment of alternative routes for the TTP was undertaken at an early stage in project conception and aimed to identify the most appropriate route based on social, economic, technical and environmental grounds. Both broad and finer scale options were considered. These options (as relevant to the KGGP Project) are summarised below and full details can be accessed at http://www.ntepa.nt.gov.au/environmental-assessments

3.3.2 Alternative routes (broad scale)

Four possible route options (at a broad scale) were considered during the development of the previous TTP proposal and assessed for potential environmental constraints using topographical maps (Table 3-1 and Figure 3-1)

Table 3-1: Alternative pipeline routes considered for the previous TTP and current KGGP

ROUTE	GEOGRAPHICAL DESCRIPTION OF ROUTE	JUSTIFICATION FOR SELECTION OR NON-SELECTION
Route A	Most direct route from the proposed Blacktip gas plant to Alcan Gove Refinery.	The route passes directly through Kakadu National Park and was immediately rejected on environmental grounds.
Route B	Passes approx. 2.5 km south of Kakadu National Park and directly through Nitmiluk National Park. Route passes approx. 49 km north west of Katherine.	Major deviations were required along the route to avoid undesirable geological conditions. Deviations added significantly to the overall length of the pipeline. This route was considered unfeasible and rejected on environmental, engineering and economic grounds.
Route C	Passes approximately 20 km south of Katherine.	This route offered the best balance between pipeline length, engineering feasibility and avoidance of high value environmental assets and was selected as the preferred route.
Route D	Passes approx. 46 km south of the Katherine township.	The route follows a direct line from Wadeye to Mataranka, and then follows a previously surveyed pipeline corridor from Mataranka to the Gove Peninsula. This route was considered feasible for construction, however, it was considered the longest route due to deviation requirements around surface rocks and was subsequently ruled out.

Route C was selected as the preferred route at the time of the TTP because it represented the best balance between pipeline length, engineering feasibility and avoidance of high value environmental assets such as national parks. The KGGP follows Route C from a point south of Katherine, where the pipeline would link to the NT Amadeus Gas Pipeline (Figure 2-1), for the same reasons this route was chosen for the TTP.

3.3.3 Pipeline deviations (finer scale options)

Bypasses

Following the selection of the preferred pipeline route (Route C, Table 3-1), detailed site surveys were carried out to further identify any minor deviations required around environmentally or culturally sensitive areas and sites at the finer scale. Based on the findings of these surveys and on technical grounds, refinements or deviations to the preferred pipeline route were made.

Two deviations (or bypasses) were considered during the assessment of the proposed alignment Table 3-2 and Figure 3-2. Although offering some advantages such as shortening the pipeline, neither of the bypasses were assessed as acceptable from a construction perspective.

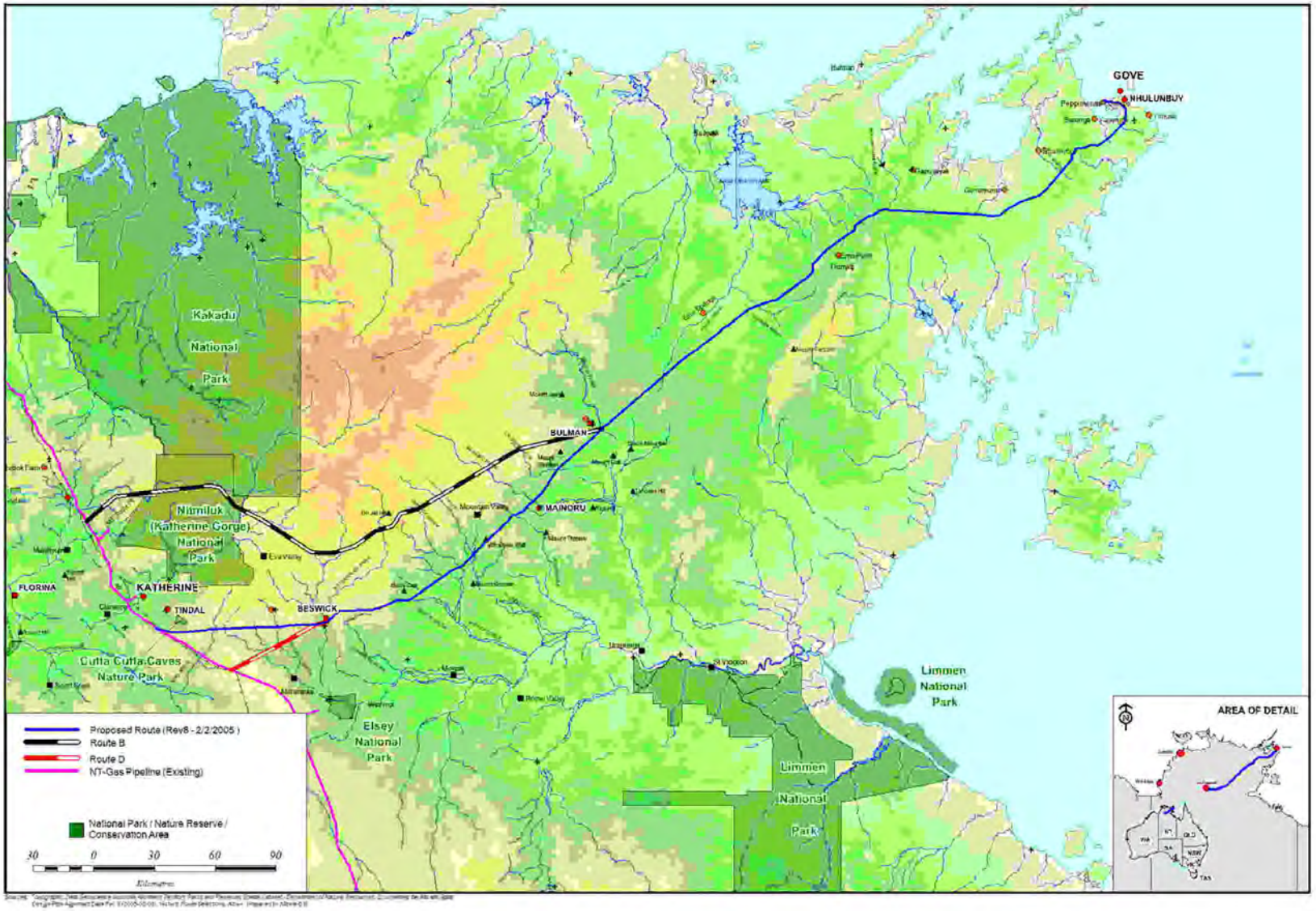

Figure 3-1: Alternative routes considered

Table 3-2: Pipeline deviations or bypass options considered

DEVIATION/BYPASS OPTION	GEOGRAPHICAL DESCRIPTION OF ROUTE	JUSTIFICATION FOR SELECTION OR NON-SELECTION
Bypass D2 (KP150 to KP180)	Passes through Maiwok, Flying Fox and Derim Creeks and the steep High Black Range escarpment.	This bypass would shorten the overall pipeline length, but was considered uneconomic from a construction point of view.
Bypass D3 (KP360 to KP510)	Crosses the Mitchell Ranges	Several routes across the Mitchell Ranges were considered. This route was rejected due to the difficult terrain encountered including large amounts of rocks. Following an aerial survey from Katherine to Gove in March 2004 it was considered that a northern crossing following the Central Arnhem Road would be the best option. This bypass was therefore rejected.

A small section of proposed route between KP399 and KP435 was not able to be specifically surveyed during the TTP studies or during the 2012 survey for the KGGP. This area lies near the northern extent of the Mitchell Ranges and, subject to Aboriginal traditional owner consent, the aim is for this area to be surveyed during the 2013 dry season to further inform final design and environmental management of construction. Any deviations in this section of the pipeline alignment would be determined following this survey.

Refinements to avoid sensitive environmental sites

During survey for the pipeline corridor small deviations in the alignment were made to avoid environmentally sensitive sites. These alternatives are summarised in Table 3-3 and expanded upon in Appendix C.

Table 3-3: Summary of action taken to avoid ecologically sensitive sites

SENSITIVE SITE	LOCATION	MANAGEMENT ACTION
*S*emi-permanent melaleuca swamp	KP289	Pipeline corridor moved 100 m north.
Permanent lagoon	600m north of KP371	Pipeline corridor moved 500 m south.
Semi-permanent swamp	KP394	Pipeline corridor moved south to minimise crossing distance.
Semi-permanent waterhole	100m south of KP446	Pipeline corridor moved 200 m north.
Semi-permanent waterhole	100m south KP448	Pipeline corridor moved 100m north.
Spring-fed rainforest – Boggy Creek	900m North of KP510	Pipeline corridor moved 800 m south to avoid.

3.3.4 Alternatives under current consideration

An alternative location for the tie-in of the KGGP with the NT Amadeus Gas Pipeline is under current consideration (Figure 2-2). Compared to the alignment proposed under the TTP, this alternative would make a more southerly connection to the NT Amadeus Gas Pipeline.

A decision on whether to pursue this alternative would be made in the design phase.

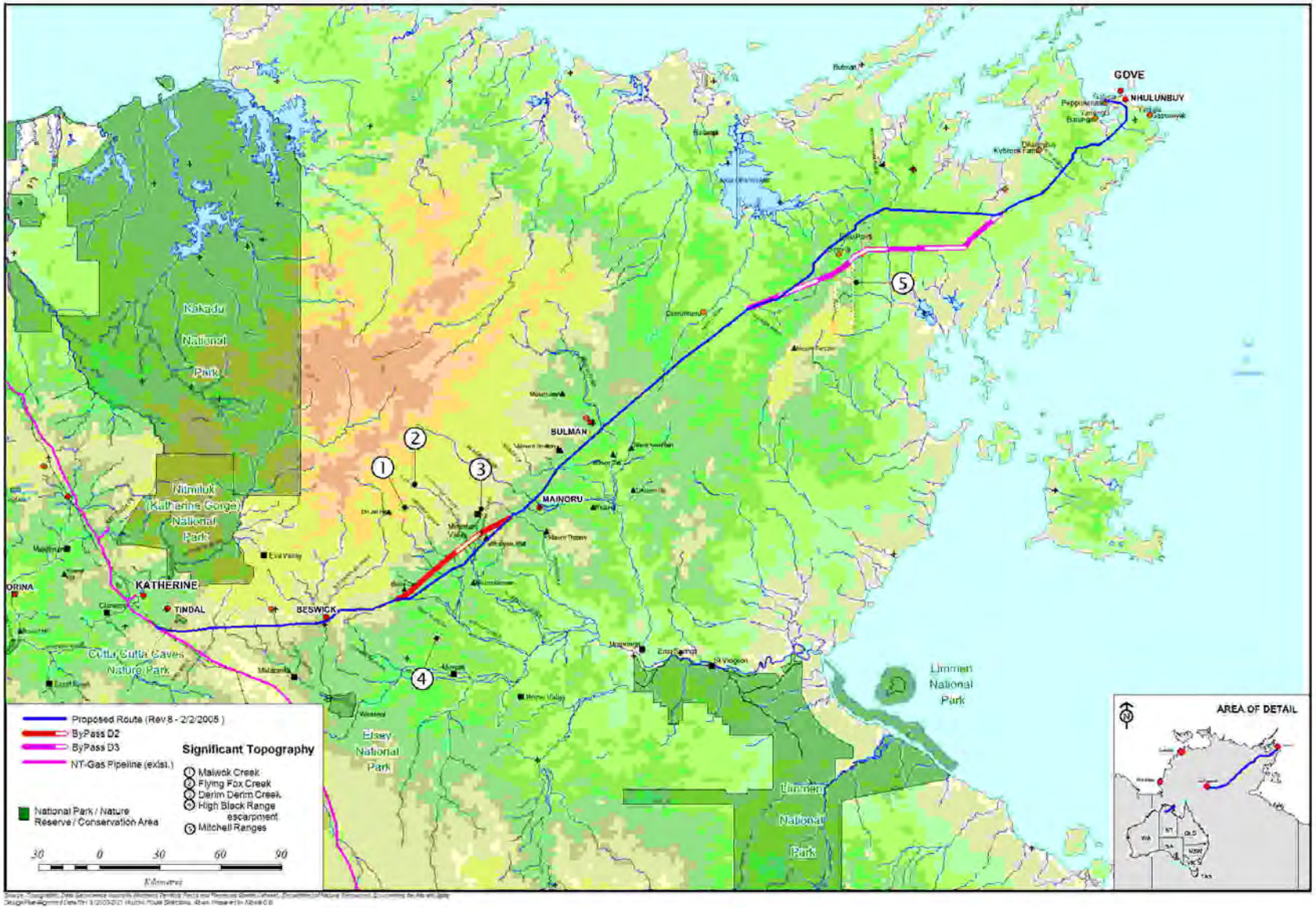

Figure 3-2: Alternative bypasses considered

3.4 DESIGN AND CONSTRUCTION ALTERNATIVES

There is limited scope for making changes to the specific design of high pressure gas pipelines. Pipelines are typically constructed using a universal, standard 'construction spread' technique (Section 2.6.2). There are however, opportunities for considering alternative construction techniques for pipelines crossing roads, rail and river crossings. The selection of the crossing technique could result in different levels of potential environmental impact. Potential crossing techniques considered as part of the design considerations include:

- Horizontal directional drilling (HDD).
- Open cut/trench methods.
- Horizontal boring utilising bell holes and railed thrust boring.

HDD has been selected as the preferred construction method for nine watercourse crossings (Section 2.6.5), which contain sensitive riparian habitats or which have cultural significance. Agreement on a crossing method involved a process of review by technical experts, followed by negotiation with landholders during the initial TTP surveys. Table 3-4 summarises the criteria considered by the technical experts in selecting the crossing technique.

Recent evaluation during the development of the KGGP Project has determined that HDD would additionally be used at any watercourse that is determined to have significant flow by the construction contractor at the time of constructing the crossing. This would further reduce disturbance to watercourses. Conventional trenching would be applied to watercourses that are dry at the time of construction and otherwise have no special environmental sensitivities. Detail on the location of these crossings and a detailed description of the various crossing techniques, is provided in Chapter 2 (Section 2.6.5).

Table 3-4: Selection criteria for watercourse crossings

ISSUE	ASPECT
Impact on environmental values	Type and integrity of riparian vegetation
	Susceptibility to erosion and potential to cause downstream sedimentation impacts
	Ability to stabilise and rehabilitate in short time frame between construction and the following wet season (dependent on various factors including soil type, vegetation, stream flow)
	Type and integrity of in-stream habitat
	Declared Beneficial Uses of water
	Threatened fauna and flora
Impact on archaeological and heritage sites	Significant archaeological sites or objects
	Significant historic heritage sites
Impacts on social values	Declared Beneficial Uses of water
	Landowner wishes
	Recreational and tourism use of waterways
Impact on cultural values	Aboriginal Sacred Sites
	Aboriginal cultural values
Engineering feasibility	Soil and rock type
	Bank profile
	Cost and logistics of construction

ISSUE	ASPECT
	Ability to stabilise and rehabilitate
	Water flow
	Feasibility of trenching

3.5 ALTERNATIVE SOURCES OF SERVICES

3.5.1 Alternate energy supply to the refinery

The existing Gove refinery currently uses imported fuel oil. Consideration was given to continued use of fuel oil, a scenario in which the KGGP would not be required. However, the continued use of imported fuel oil is no longer economically feasible in an environment of high fuel prices, low aluminium and alumina prices, poor global market conditions and a high Australian dollar.

Energy use at the Gove refinery comprises:

- 60% for process steam generation.
- 35% for calcination.
- 5% for electricity generation.

The capacity for energy supply to generate steam has therefore been the key technical factor in the evaluation of alternative energy sources for the Gove refinery. Renewable energy sources such as solar photovoltaic, wind and tidal were evaluated as unsuitable sources for steam generation. Geothermal energy was evaluated as unviable due to uncertainty around resource availability in the vicinity of Gove and the immaturity of the hot dry rock (HDR) technology. Small and large scale solar photovoltaic systems are however technically feasible and potentially cost effective to supplement the existing electricity supply to Nhulunbuy township. Pacific Aluminium will continue to explore such systems as an alternative when the electricity demands of Nhulunbuy township increases.

Energy alternatives that were capable of generating steam were the subject of investigation and analysis over the period 2009-2011 and evaluated (against the base case of continuing to use fuel oil) in respect of the following criteria:

- Capital expenditure.
- Fuel availability and price (as a key aspect of operating expenditure).
- 'Licence to operate' – including environmental and social considerations.
- Operability (given remoteness and access to skilled labour).
- Lead time.

A number of energy alternatives were considered including:

- Natural gas.
- Liquefied or compressed natural gas.
- Coal.
- Concentrating solar thermal power.

Each of these alternatives is discussed briefly below.

Natural gas

Gas is much cheaper than fuel oil and long term pricing stability can be negotiated. Gas is a considerably cleaner source of energy than fuel oil in terms of air emissions and would result in significant greenhouse gas emission reductions. A transition to gas would also substantially reduce the transport of significant quantities of fuel oil by tanker, lowering risks of spillage into the marine environment.

Liquefied or compressed natural gas

Delivery of LNG by tanker to the Gove refinery was considered. While technically feasible, commercial and logistic factors combined to make this an unattractive alternative. LNG is more expensive than natural gas and requires transport, traditionally by large tankers, which necessitate expensive storage facilities. Conversion to liquefied or compressed natural gas would also increase operational complexity at the Gove refinery.

Coal

Coal was considered as an alternative as it is considerably cheaper than fuel oil but is not suitable for the calcination process at Gove refinery. Also, conversion to coal would require an additional capital expenditure over gas alternatives and continued use of fuel oil for the calcination plant. Coal produces more greenhouse gas emissions and requires additional facilities for storage, handling and ash disposal. Accordingly coal was considered less favourably on both economic and environmental terms.

Concentrating solar thermal power

Four concentrating solar thermal power technologies were reviewed for suitability for replacing fuel oil for stream production (Central Receiver, Compact Linear Fresnel Receiver, Parabolic Trough, Parabolic Dish). Of these, Parabolic Trough is the most tested. Concentrating solar thermal power technologies were not considered technically viable at the Gove refinery due to the following drawbacks:

- Very high upfront capital costs.
- Inability for stand-alone plants to provide steam 24 hours a day. Energy storage solutions would be required to provide continuous steam and these systems have not yet been tested at scale. This would further increase capital costs.
- Cloudy conditions (particularly during the wet season) would limit solar energy availability and hence limit steam conditions achievable.
- Constrained land availability in proximity to the Gove refinery. Large areas of flat land would be required which are only available at distances of greater than 5 km, making it technically impractical to convey the steam back to the refinery.
- The systems would be prone to cyclone damage.

Conclusion

Construction of the KGGP and conversion of the Gove refinery to gas is the most cost effective and technically feasible energy alternative that also provides clear environmental benefits in terms of lower greenhouse gas and air emissions and reduced risks from marine transport, compared to other fuel alternatives. Renewable energy alternatives are not viable as they are either incapable of generating the required steam for the refinery or (in the case of concentrating solar thermal) constrained by land availability and very high capital costs.

3.5.2 Power generation along the pipeline during operation

Electricity would be required along the pipeline route to supply power to above ground facilities and the pipeline cathodic protection system during operational activities. Two main options have been examined for power generation:

- Diesel generation.
- Remote Area Power Supplies (RAPS).

Diesel generators can be used to charge batteries and supply power. Generators would require frequent delivery of fuel along the pipeline corridor during operation. Regular equipment maintenance would also be required and hydrocarbon spills would pose a potential environmental hazard. Noise and air emissions also result from the operation of diesel generators (Chapter 2).

RAPS systems provide an alternative to diesel generation and range from small petrol generators, able to power appliances directly, to more complex installations using only renewable energy. Combinations of both are possible. RAPS systems offer the following benefits:

- Reduction of fuel consumption and transport costs.
- Reduction of the risks associated with fuel storage and transport (for example spillage).
- Reduction of local impacts of fossil fuel generation (noise and air pollution).

RAPS systems have been identified as the preferred power supply for the KGGP. The alternative RAPS systems considered include:

- Solar powered (photovoltaic module).
- Thermal-electric generators.
- Closed cycle vapour turbogenerator.
- Wind turbines.
- Microhydro generators.

Solar RAPs provide environmental benefits of reduced greenhouse gas and air emissions and quieter operations compared to diesel, LPG and petrol alternatives. Operational benefits would include lower operational effort and cost.

3.6 DECOMMISSIONING AND REHABILITATION METHODS

The KGGP would be designed with an operational life of 50 years. Decommissioning of the pipeline at the end of this period would typically entail three options involved in the decommissioning of a pipeline. These are:

- Removal (involving excavation and land disturbance).
- Suspension (disconnecting and filling the pipeline with an inert material and maintaining as per an operating pipeline).
- Left *in situ* (disconnecting and leaving the pipeline to degrade).

Removal of the pipeline would not be environmentally preferable as it would involve excavation and considerably land disturbance. It is likely that the KGGP would remain buried (suspension or left *in situ*) at the end of the project life as discussed in Section 2.9 and the Provisional Decommissioning Plan at Appendix O.