

**Regional Minerals Program
Developing the West Kimberley's Resources**

Main Report

August 2005



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West Kimberley Resource Development Study August 2005

Prepared for the Department of Industry and Resources, Western Australia under the Australian Government's Regional Minerals Program

Prepared by ACIL Tasman Pty Ltd and WorleyParsons

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Executive summary

Study overview

The West Kimberley Resource Development Study was commissioned by the Government of Western Australia Department of Industry and Resources and has been undertaken within the framework of the Australian Government Regional Minerals Program (RMP) administered by the Department of Industry, Tourism and Resources. The objective of the RMP is to encourage a coordinated approach by industry and government to facilitate the regional development of mining and mineral processing activities (including petroleum) and promote regional employment opportunities.

The purpose of this study is to consider future minerals and energy development in the West Kimberley in order to facilitate processes for planning, infrastructure provision and local involvement. In particular, the study examined the requirements for infrastructure to support major resources projects.

The West Kimberley is a large area in the north west of Western Australia with significant but largely unexploited mineral and energy resources. The area is also a region of great aesthetic, environmental and cultural diversity and significance. Development therefore must be undertaken in a manner that protects the area's values as well as ensuring that the industries that utilise them are not compromised.

The study area includes the Shires of Broome and Derby-West Kimberley and the western portion of the Shire of Wyndham-East Kimberley.

Mineral and petroleum development potential

The most significant resources of the study area are the offshore gas resources of the Browse Basin and the bauxite reserves of the Mitchell Plateau, Cape Bougainville and Mt Leeming/East Kalumburu areas.

Both the gas and the bauxite reserves are significant by world standards. The gas reserves of the Browse Basin are currently estimated at 31 trillion cubic feet, compared to an estimated 22 trillion cubic feet remaining in the North West Shelf area. In addition, the area has significant deposits of other minerals and energy sources, including diamonds, iron ore, copper, lead, zinc, silver, nickel, uranium, coal, tin, mineral sands and on-shore petroleum.

Current minerals production is confined to diamonds and iron ore, but the region has also hosted a large zinc mining operation in the recent past.

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Other significant industries for the region are pastoral production, fishing including aquaculture, and tourism – especially eco-tourism, fishing and wildlife safaris and wilderness adventures – which draw on the natural beauty and remoteness of the region, and to an extent, its poor transport infrastructure.

While the resources of the West Kimberley region have been known for some time, the area is now being looked upon with renewed interest. While Australia has large reserves of natural gas, production is expected to be in decline in 10 to 20 years' time to the point where a new major source could find a fairly ready market in the south east of the country. Identification of a large foundation customer for the gas will be a necessary pre-requisite to its development.

The Western Australian (WA) and Australian Governments have taken a close interest in the future development of the Browse Basin gas fields. Their interest stems from the prospects that development of the gas field could underpin new LNG production for export, but also provide energy for development of the significant mineral wealth of the region, with downstream processing – and the attendant economic and social development opportunities of the whole region.

At the same time, it is recognised that this is a remote region, sparsely populated in the main, and with undeveloped infrastructure. The remoteness of the area brings special cost imposts for the establishment and ongoing operations of any new projects in the area. In addition, large new projects will require new built infrastructure especially for transportation of materials in and product out, but also for communications, accommodation and other social infrastructure. This can add further to the significant cost disadvantage compared with similar operations in more established areas of Australia.

Although the problems and costs of development in the region are well understood, there is a mood of cautious optimism that the initiation of major projects is becoming a realistic prospect, within a 10 to 20 year timeframe. This optimism is reflected in the actions of holders of mineral and gas tenements who have expended significant sums in recent years to better define the reserves and resources within their leases.

The study provides a detailed assessment of the prospectivity for the wide range of energy and mineral resources of the area. It examines market prospects for each so that development scenarios are seated in a realistic appraisal of the market as well as the size and quality of the prospective resource.

Study consultations

The study included consultation with project proponents, Traditional Owners¹ and their representatives, business and community organisations, and Local, WA and Australian Governments.

Prospective project developers have also committed to close consultation with the Traditional Owners, and see this as a standard part of the process. The Traditional Owners themselves also hold a positive attitude to these potential developments. While they hold an especially strong affinity with the land and their heritage, they increasingly look to new ways to establish a more certain economic future for their people, and especially their children.

Development scenarios

The study examined a number of possible development scenarios over a 20 year timeframe. These described possible mineral and energy developments and were used to illustrate possible development paths and to elicit community responses to them.

The base case for the development scenarios comprises current minerals and energy operations in the West Kimberley. The scenarios are:

- Scenario 1 – Modest Development
 - Developments that have been already publicly announced and that are generally considered by those in the petroleum and minerals industries as likely to go ahead.
- Scenario 2 – Medium Growth
 - Developments that could reasonably be achieved with some favourable change in markets and favourable policy settings.
- Scenario 3 – High Growth
 - An optimistic view of possible minerals and energy development in the West Kimberley under very favourable and sustained market settings.

The most likely development scenario is considered to be Scenario 2 – Medium Growth. It is constructed as an achievable outcome, on the presumption that market conditions remain attractive and governments take positive actions to facilitate the developments and these are identified in the recommendations. This scenario was agreed to by the Management Committee as a realistic view of potential development and forms the basis of the detailed analysis presented in this report.

¹ The term “Traditional Owners” as used in this report includes native title holders and claimants as well as traditional owners of land and/or sea who do not claim or hold native title.

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Within this scenario, the study identified a number of options for development locations for LNG production, bauxite mining and refining, and other resources developments.

The study concludes that major project development in the area within the next ten to twenty years is a realistic objective. It recognises, however, that there will be considerable difficulties and costs – especially for the first developers. These short and long term difficulties can be mitigated and the study recommends a comprehensive and coherent program by governments to enhance these future prospects.

The scenario and options defines the importance of bringing gas on-shore. This makes possible a range of value-adding activities such as minerals processing, as well as the prospect of domestic gas sales, possible gas to liquids projects, and a more conducive environment for support industries and supporting centres of population.

This “most likely” scenario is constructed as follows:

- A continuation of the existing operations for onshore oil, iron ore, and diamond production, with some additions to capacity, as well as the re-opening of the Lennard Shelf base metal operations;
- Development of Browse Basin gas including bringing gas on-shore. The primary reason for doing so would be to feed an on-shore LNG plant, with the possible later extension to a transcontinental pipeline designed to take gas to the Eastern States of Australia.
- A transcontinental pipeline would also service minerals and energy developments in the West Kimberley including an alumina refinery and a gas-to-liquids processing facility. Gas could also be used for electricity generation for nearby towns and communities, and other towns and developments along pipeline route.
- Increased development in the minerals sector including the mining of bauxite from Mt Leeming/East Kalumburu and/or Mitchell Plateau and/or Cape Bougainville and/ or the mine and refine option associated with the Mitchell Plateau, in line with agreements between the proponents and the WA Government.
- Development of the Admiral Bay lead and zinc deposit located south of Broome.
- A presumption that governments and the private sector would share a responsibility for the planning and provision of economic and social infrastructure.

Infrastructure and service needs

The study examined the needs for infrastructure to support the development of a gas processing and LNG plant, bauxite mining, alumina refining and other minerals projects. It also examined the social infrastructure required to support the increased population that such development would attract.

This report provides details of industrial infrastructure and ranges of costs.

It also provides information on the parameters and costs for a transcontinental pipeline.

The likely demand for government and business services is also examined.

Environment and heritage issues

Development of major resources projects inevitably will have some impact on the environment. The study examined environment and heritage issues that project proponents and governments will need to consider.

Strategies for development

The ultimate scenario and timetable for resources development in the West Kimberley will be dictated by:

- The market for the West Kimberley's commodities, notably LNG, bauxite/alumina, zinc and diamonds;
- For zinc and diamonds, continued exploration success;
- Agreement of Traditional Owners for access to land for development; and
- The economics of project development.

In this context, the principal role of Australian, WA and Local Governments is to create an environment which encourages and facilitates private sector project proponents to invest, and at the same time ensuring that worthwhile benefits flow to regional communities, the State and the nation. In this regard, priorities for governments should be to:

- Ensure an ongoing positive environment for minerals and petroleum exploration (all levels of government);
- Ensure efficient and effective planning and project assessment and approvals (all levels of government);
- Facilitate provision of the economic and social infrastructure required to support resources development, and to enable West Kimberley communities to attract and retain the skilled workers required for these projects (all levels of government);

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- Facilitate capacity-building of regional businesses and workers to enable them to participate in project development and operation through supply of goods, services and labour (all levels of government);
- Cooperate with project proponents and Aboriginal people and organisations to facilitate access to land for development (all levels of government); and
- Continue to support international marketing efforts for LNG (Australian and WA Governments).

Recommendations

The recommendations of the study target the major areas of difficulty for large scale project development in the West Kimberley area. They address the need:

- For more definitive studies of the resources of the area;
- To work towards meeting, or at least recognising and trying to accommodate, the needs of the different interest groups;
- To establish more efficient and effective planning and approvals processes;
- To facilitate development of physical and social infrastructure; and
- To help build the capacity of local businesses and workers.

Exploration climate

1. The Government of Western Australia, through the Geological Survey of Western Australia, should continue to give priority to pre-competitive exploration and data gathering, and to continue to package and market geoscientific information to the mineral exploration industry to encourage explorers to give the region high priority for investment.
2. Further development of relationships between the petroleum and mining industries and companies, and Aboriginal peoples and organisations should be facilitated through early and proactive engagement by proponents and all levels of government with Traditional Owner stakeholders and the Kimberley Land Council to provide a platform for successful project development and a sense of stakeholder ownership.
3. Project proponents should plan realistic time-frames for negotiating native title agreements, and should commence discussions as early as possible to address specific issues, establish certainty for all parties and building relationships for the long term.
4. Native title negotiations and heritage clearances should be facilitated through cooperation between companies, governments, traditional owner groups and the Kimberley Land Council to ensure that Aboriginal people and organisations have adequate resources and capacity. Native Title Prescribed Bodies Corporate need to be recognised as an emerging

commercial institutional layer within the Kimberley economy and land administration that needs to be resourced and to function effectively.

Support for gas marketing

5. The Australian and State Governments should cooperate with project proponents to provide support for marketing of Browse Basin gas.

Planning, and project assessment and approvals

6. Current and future planning processes and programs in the West Kimberley should be coordinated:
 - Within each level of government through coordination of the activities relevant departments and agencies;
 - Between Local, WA and Australian Governments to ensure coherence of programs and outcomes.
7. Australian, WA and Local Governments should continue to work to ensure that their own project assessment and approvals processes are effective and efficient, and well co-ordinated between government agencies.
8. Australian and WA Governments should continue to improve inter-government coordination of assessment and approvals processes to reduce complexity and duplication.

Economic and social infrastructure

9. Australian, WA and Local Governments should cooperate to develop a coordinated approach to infrastructure provision in the West Kimberley, including mechanisms for cooperation between governments and between the public and private sectors, to provide a framework to enhance the region as an attractive location for investment in major projects.
10. The WA Government, in consultation with Local Government should expedite development of a comprehensive, whole-of-government State Infrastructure Strategy with a key objective of identifying specific priorities for the allocation of resources to infrastructure projects over the long-term. Key elements of this policy should include:
 - Mechanisms to ensure that the mix of infrastructure throughout the State is complete, competitive and timely to support the State's key industries;
 - Identification and prioritisation of future infrastructure requirements in relation to transport, telecommunications, energy, water, industrial land, ports and related soft infrastructure (eg, Native Title and heritage clearances, training, skilled people and services);
 - Integration of the provision of all classes of social and economic infrastructure in support of development;

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- A consistent, integrated and systematic evaluation process to prioritise the assessment, planning and delivery of infrastructure;
 - Policies for government and non-government involvement, and mechanisms to identify opportunities for involvement of private sector and government business organisations;
 - Mechanisms to assess relative costs and benefits of infrastructure on a case-by-case basis; and
 - Implementation plans and regular reviews.
11. As a subset of the State Infrastructure Strategy, the WA Government, in cooperation with industry and other levels of government, should develop a West Kimberley Infrastructure Plan and this plan should be refined as potential resource development projects in the region become better defined.
- Within this plan, opportunities for a strategically located gas processing hub should be enhanced by forward planning for a location, and setting aside a suitable site for a heavy industrial estate.

Facilitating pipeline investment

12. The Australian, WA and Northern Territory Governments, through the Ministerial Council on Energy, should consider the recommendations of the Productivity Commission report on gas pipeline regulation as part of their efforts to enhance the investment climate for pipeline investment.

Participation of regional businesses and workers

13. At an early stage of planning specific projects, industry, local communities and all levels of government should co-operate to:
- Predict the requirements for goods, services and workers that may be able to be sourced from within the region;
 - Develop workforce training programs;
 - Implement business capacity-building programs; and
 - Implement programs to develop community capacity to engage with projects.
14. Within Australian Industry Participation Plans, project proponents should include measures to facilitate regional business participation in projects.
15. Local, WA and Australian Governments should give particular attention to mechanisms that facilitate greater participation by Aboriginal people and businesses in the mainstream economy, for example, through
- Education and workforce training programs;
 - Support for Aboriginal businesses; and
 - Aboriginal employment programs.

Planning for implementation

16. Local, WA and Australian Governments should co-operate to develop a plan and multi-stakeholder process for consideration and implementation of the recommendations of this study, in particular the recommendations on a cooperative approach to planning for and provision of infrastructure (see recommendations 9 and 10).

1 Introduction

1.1 Study overview

The West Kimberley Resource Development Study (the study) has been commissioned by the Department of Industry and Resources (DoIR) on behalf of the Government of Western Australia and the Australian Government Department of Industry, Tourism and Resources (DITR) through the Regional Minerals Program. The study is also supported financially by a number of stakeholders including petroleum, mining and exploration companies, local government authorities and regional government agencies.

DoIR is the Western Australian Government agency responsible for encouraging and facilitating development of the State's natural resources – particularly mineral and petroleum resources – by the private sector for the ongoing benefit of the Western Australian community.

Recognising that the resources sector is critical to the Australian economy and way of life, DITR supports exploration and mining, encourages the efficient use of energy, monitors our oil and gas resources and ensures they are extracted and used safely and in environmentally responsible ways. DITR works closely with industry to identify new opportunities for growth.

The purpose of the West Kimberley Resource Development study is to consider future minerals and energy development in the West Kimberley and requirements for infrastructure and services in order to facilitate processes for planning, infrastructure provision and local involvement.

Both the Australian and Western Australian Governments give a high priority to the development of the Browse Basin gas fields. The gas could facilitate development of gas- and minerals-based processing in the West Kimberley region, establishing a new strong export base in the region and generating regional growth and employment. The high ethane content of the gas also provides potential for petrochemical developments.

There will also be impacts on the Western Australian and national economies through investment flows, labour market impacts and the balance of payments and exchange rates. Development of the region's natural resources will have revenue implications for both the Australian and State Governments. The development of large offshore gas reserves will also provide another option for the supply of gas to the Eastern States when current supplies begin to decline in the near future.

Recent discussion about petroleum and minerals development in the West Kimberley has shifted from long-term discussion by governments to serious study by companies and others.

This study therefore represents a timely opportunity to examine the development potential of the West Kimberley, the aspirations of stakeholders, infrastructure and other needs for development, and how development may occur in a manner consistent with sustainability objectives.

1.2 The Regional Minerals Program

1.2.1 Program history, objectives and aims

The Regional Minerals Program (RMP) was established by the Australian Government in 1996 to encourage a coordinated approach by industry and government to facilitate the regional development of mining and mineral processing activities, and to promote regional employment opportunities. In 2002, the program's scope was broadened to extend, inter alia, the definition of minerals to include petroleum.

The aims of the program are to:

- Provide an overview of the mineral and petroleum resources and the potential for extraction and processing development in selected regions;
- Assess the infrastructure and government services of a region and develop proposals to overcome impediments; and
- Facilitate a coordinated approach to the regional minerals and petroleum development.

The program provides competitive grants to sponsor projects with industry and government to identify infrastructure (hard and soft) requirements and ways to remove any regional impediments to the economic development of the minerals industry, particularly by encouraging enhanced levels of exploration, mining and processing activity. These projects may also identify wider policy issues that warrant further attention such as research and development needs, native title and environment issues.

The RMP project reports make recommendations on ways to:

- Reduce cost to industry;
- Encourage value added processing;
- Encourage enhance levels of investment and exploration;
- Improve the potential to expand existing operations;
- Identify potential development projects;
- Address and implement best environmental practices;

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- Enhance communication and consultation between the minerals and petroleum industry and all levels of government;
- Help to clarify industry needs and priorities for infrastructure with significant gains to industry competitiveness;
- Bring forward projects earlier than might be the case; and
- Bolster regional employment opportunities.

Since the inception of the RMP, 22 widely geographically dispersed projects have been approved. Information about all of these projects can be found at: www.industry.gov/regionalminerals

1.2.2 Regional Minerals Studies in Western Australia

The Department of Industry and Resources and its predecessor Department of Mineral and Petroleum Resources have managed a number of regional minerals studies in Western Australia including:

- Central Pilbara Infrastructure Planning Study, 2000
- Mid West Regional Minerals Study, 2000
- Southern Cross Esperance Regional Minerals Study, 2000
- East Kimberley – Tanami Regional Minerals Study, 2003
- Study of the Petroleum and Minerals in the Pilbara Coast Region of Western Australia, 2004
- Energy for Minerals Development Study, South West Coast of Western Australia: Certainty of supply for the future growth, 2004
- Water and the Western Australian Minerals and Energy Sector: Certainty of Supply for Future Growth, 2004

Similar studies undertaken in Western Australia outside this program include:

- North Eastern Goldfields development and infrastructure study, 1998
- Pilbara Strategic Industry Areas Study, 2004

1.3 Purpose of the West Kimberley Resource Development Study

The West Kimberley Resource Development Study examines the development potential and infrastructure and service needs of the mineral and petroleum industry of the West Kimberley.

In particular, the study focuses upon identifying development scenarios for the offshore Browse Basin, based upon the potential needs of international and national gas markets. The study also identifies possible development scenarios

for onshore minerals industries and examines the synergies between these and gas developments.

The broad objectives of this study are:

- To encourage a coordinated approach by industry, Local, State and Australian Governments to facilitate the cost efficient and effective development of gas and mineral processing activities, and promote regional employment opportunities;
- To examine long term multi-user industrial and social infrastructure, and associated services required to stimulate the development and potential processing of gas and mineral resources at strategic locations within the West Kimberley region;
- To assess the economic viability and impact of connecting known and expected gas reserves in the Browse Basin to the mainland and eastern Australian gas markets; and
- To recommend appropriate means for the funding and delivery of such infrastructure in a coordinated and equitable manner.

The assessment of infrastructure needs is not necessarily aimed at specific uses but provides scenarios from which multi-user infrastructure requirements can be assessed. Stand-alone developments for gas processing and minerals will differ and thus have varying port and land area requirements. The siting of specific projects will be sensitive to technical, commercial, environmental and community considerations and their detailed investigation is outside the scope of this study.

The prospect of infrastructure development on offshore islands is outside the scope of this study. The reason for this is that the offshore developments are unlikely to involve multi-user infrastructure and are therefore regarded as the sole cost and benefit of the project operator.

1.4 Terms of Reference and Scope of the Study

The Terms of Reference and Scope of the Study, as reported here, are taken directly from the Tender issued by the Western Australian Department of Industry and Resources on 5 April 2004.

Objective

The objective of this study is to identify strategic infrastructure and services required to develop the petroleum and mineral resources of the West Kimberley area. It will also examine the impacts on other potential interests, for example, environmental, tourism and Aboriginal/native title.

Scope of Study

The Study Area has been defined to encompass the petroleum resources off the West Kimberley coast, in particular the Browse Basin, most of the Shires of Broome and Derby—West Kimberley, plus the western portion of the Shire of Wyndham—East Kimberley covering the Mitchell Plateau.

This is a strategic planning study. If particular issues are identified that require investigation beyond the scope of this study, the Management Committee may decide to commission more focused, smaller scale studies separately.

Terms of Reference

1. Resource and Demand Assessment

Using publicly available information and through consultation with industry representatives, provide an overview of gas, petroleum and mineral resources within the study area.

Develop low, medium and high “development scenarios” based on regional and world market demands and likely future trends in processing and technologies over the next 20 years.

This section of the report will be reviewed by the participating industry representatives before infrastructure planning proceeds. It will be a key section of the report.

2. Infrastructure and Support Services

Utilising development scenarios from the previous section, identify multi-user industrial infrastructure, and associated services required to stimulate the development of gas and mineral resources, including:

- *offshore supply bases*
- *land for industrial development*
- *deep water ports*
- *water availability and supply*
- *workforce source and accommodation*
- *energy supply at competitive prices*
- *aviation issues (air services, airports and helicopter support base)*

Compare existing versus required infrastructure (based on the development scenarios above) and identify any deficiencies. Provide cost estimates for upgrades or for any new facilities required.

Identify who is responsible (private, State or Australian Government) for the provision of new or upgraded infrastructure, taking into account Commonwealth/State constitutional arrangements and scope for private provision. Investigate ways to overcome impediments to

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infrastructure funding. This assessment is to include an analysis of whether costs can be fully met on a commercial basis and any market failures.

3. Transcontinental Pipeline Feasibility

Using desk top methodology, determine the economic and technical feasibility of linking the Browse Basin gas reserves with the eastern Australian gas markets via a transcontinental pipeline. Identify an optimal conceptual pipeline route. Utilise the market and pipeline route analysis already undertaken for the Pilbara Coast Petroleum and Minerals Study.

4. Gas processing hubs

Determine the economic and technical feasibility of developing gas/resource processing hubs at strategic locations along the West Kimberley coast. Identify potential locations that minimise transport costs and risks (include buffer zones) and aim to accommodate a diverse range of industries. Identify potential costs in terms of related infrastructure and the most appropriate means for funding such infrastructure. Consider the competitiveness of such sites compared with other international locations for resource processing investment.

5. Social Infrastructure

Identify land requirements and social infrastructure required to support the optimal or most likely development scenario, for example:

- *Land for residential expansion*
- *Education facilities*
- *Hospital facilities and health services*
- *Local Government community services*
- *Police, fire and emergency services*
- *Recreation facilities*
- *Workforce accommodation*

Examine existing and planned social infrastructure, identifying any deficiencies. Provide cost estimates for any upgrades or new facilities that may be required.

Identify potential future nodes of population growth maximising utilisation of existing settlements and associated infrastructure. The roles of the respective townsites (Broome, Derby, Wyndham/Kununurra and other settlements) to service the mining industry should be determined.

6. Other Development Issues

Identify other possible impediments to development, including environmental, heritage, native title and policy issues.

Consideration should be given to possible implications arising from the proposed location of a space launch facility in the study area, possible conservation areas (including marine parks) and other Government policy and planning documents including the State Sustainability Strategy, the Natural Resource Management Initiative and the Department for Planning and Infrastructure's North Kimberley Briefing Paper.

Identify the environmental, social and economic benefits to the region including regional employment opportunities and strategies or policies needed to maximise these benefits.

7. Consultation

In undertaking this work, the Management Committee will be the primary reference group. Effective key stakeholder consultation will be critical to a successful outcome, but broader community consultation will not be required. Refer to key stakeholder list:

1.5 Priority issues

Matters that the study has examined include:

- Prospectivity of the region;
- Market opportunities for development of a West Kimberley gas processing hub;
- Market opportunities for use of gas for minerals processing;
- Market opportunities for development of a transcontinental pipeline;
- Infrastructure needs for processing of gas and minerals;
- Maritime service and support base requirements;
- Social infrastructure impacts and needs;
- Other strategic considerations to assist in optimising development;
- Development aspirations and concerns of the West Kimberley community;
- Environmental and cultural considerations; and
- Native title and land tenure matters.

2 Conduct of the study

2.1 The study area

The West Kimberley study area occupies about one third of the Kimberley Region of Western Australia. The study area is shown pictorially in Figure 1. The study area includes the Shires of Broome and Derby-West Kimberley and has been extended to include part of the Shire of Wyndham – East Kimberley (indicated on the map), as this area contains the Mt Leeming and West Kalumburu bauxite deposits and is being actively considered for mining development. The study area also includes adjacent offshore areas.

2.2 Study management

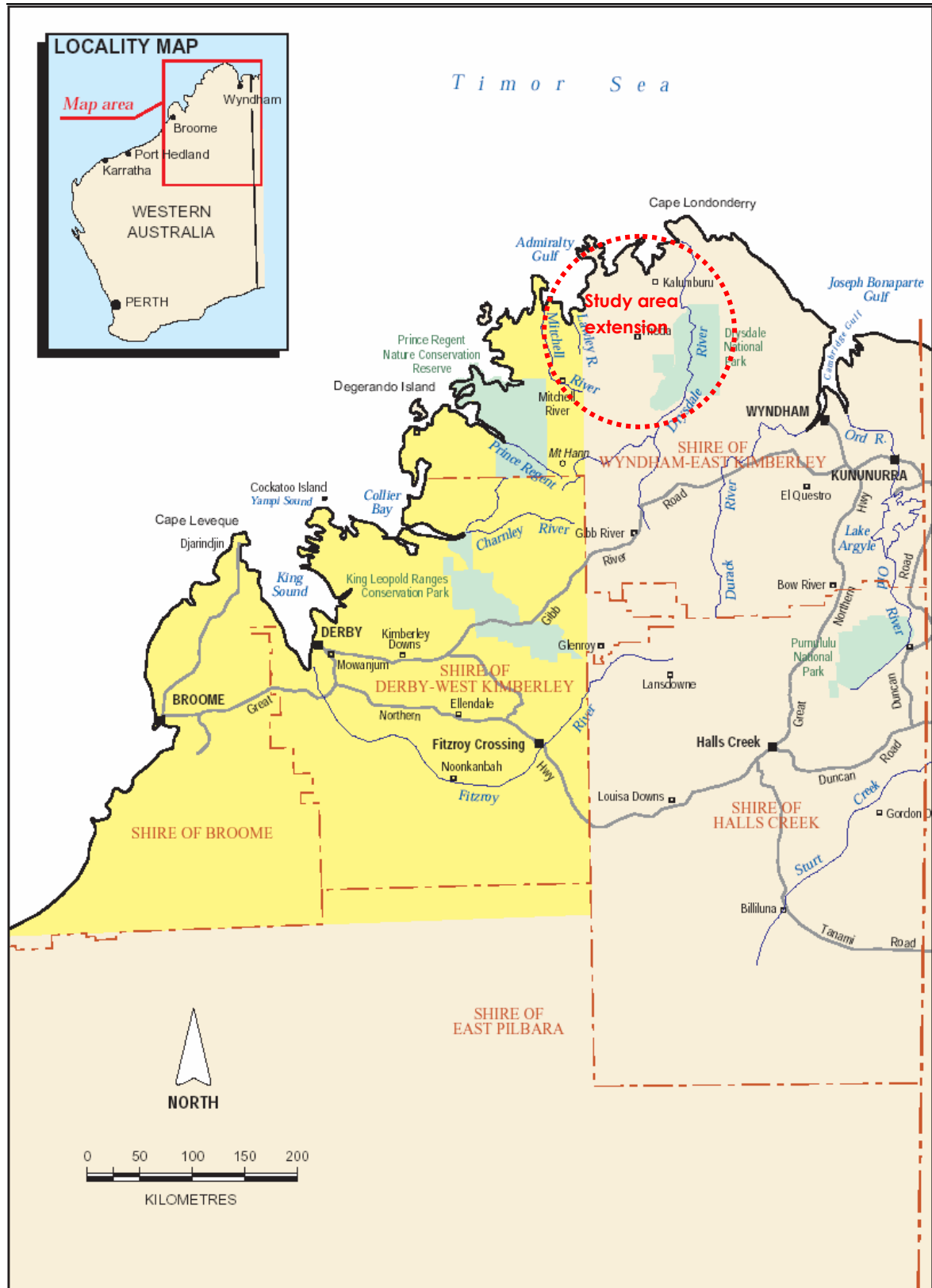
This study was overseen by a government-industry Management Committee. Members are listed in Table 1.

Table 1 **Management Committee members**

Don Sanders	Director WA and NT, APPEA – Chairman
Sean Kildare	External Affairs Advisor, Inpex Browse Ltd
Andy Munro	Manager External Affairs, Rio Tinto
Marcelle Anderson	General Manager, Aldoga Aluminium
Tim Reynolds	Principal Advisor, Strategy, Epic Energy
Andrew Leibovitch	Browse Business Development Manager, Woodside Petroleum
Brian Philp	Supply Base Manager, Mermaid Marine
Ron Johnston	President, Broome Chamber of Commerce and Industry
Tom Vinnicombe	President, Shire of Broome
Elsia Archer	President, Shire of Derby – West Kimberley
Jonathan Throssel	CEO, Shire of Derby – West Kimberley
Kevin Pettingill	Executive Manager Technical Services, Shire of Derby – West Kimberley
John Durant	Executive Officer, Kimberley Area Consultative Committee
Jake Zahl	President, Derby Chamber of Commerce and Industry
Don Langdon	Finance and Administration Manager, Port of Broome
Mike Allen	Director Strategic Planning and Policy, Department for Planning and Infrastructure
Kelvin Barr	Assistant Director, Kimberley Development Commission
Mary Durack	Project Manager, Department of Industry and Resources
Leigh Mathieson	Project Manager, Department of Industry and Resources
Ian Foster	Assistant Manager, Australian Government Department of Industry, Tourism and Resources
Kylie Stocks	Assistant Manager, Australian Government Department of Industry, Tourism and Resources
Bill Sashegyi	Director Industry Policy, Chamber of Commerce and Industry WA
Richard Mehan	General Manager Iron Ore, Portman Ltd
Mike Sutton	Operations Manager, Henry Walker Elfin
Ted Graham	General Manager Development, Mermaid Marine
Andrew Freeman	Manager – Project Development and Marketing, Santos
David Parker	Director, External Affairs, WA Chamber of Minerals and Energy

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Figure 1 West Kimberley study area, with extension to part of North Kimberley



Data source: Department of Industry and Resources

Consultant team

The consultant team undertaking the study comprised:

- ACIL Tasman Pty Ltd – economics, policy and strategy consultants;
- WorleyParsons – engineering, infrastructure and environment consultants; and
- Bevan Stott – Indigenous development consultant.

2.3 Study timing

The study commenced in May 2004 and this report was finalised in June 2005.

2.4 Methodology

The study is set within a sustainability framework. In considering petroleum and mineral development potential and the needs of these sectors, this study sought to consider all of the values of the West Kimberley (environmental, social, cultural and economic), as well as the aspirations of the region's people. The Western Australian Government State Sustainability Strategy provided a guide to this approach.

Information gathering for the study involved substantial consultation with stakeholders, including Indigenous groups, which have an increasing interest in development issues in the West Kimberley.

The methodology for the study comprised the activities described in the following sections.

2.4.1 Economic analysis

A general economic review of the study area and the surrounding region was prepared. The analysis identified the major economic drivers in the study area, patterns of employment and the demographics of local communities.

2.4.2 Resource availability and market assessment

The aim of this assessment was to identify the available and potential mineral and energy resources of the West Kimberley and the likely market outlook for each commodity or product. The primary reference source for the mineral resource assessment was the report *Mineral Occurrences and Exploration Potential of the West Kimberley (2004)* produced by the Geological Survey of Western Australia. The information presented in this document was supplemented by first hand knowledge of the area as well as discussions with mining and exploration companies who have or are currently operating in the area.

The primary reference sources for the energy assessment were ACIL Tasman's gas and LNG market databases, supplemented by ACIL Tasman analysis.

ACIL Tasman undertook broad 20 year market assessments for each relevant commodity and product. These assessments investigated the current and expected global demand and supply conditions for each.

2.4.3 Scenario and option development

Three scenarios were developed to describe potential patterns of development for the West Kimberley over the next 20 years. The scenarios took into account the resource availability and demand assessment, economic review and an appraisal of existing and planned economic infrastructure in the West Kimberley.

The **low development scenario** consisted primarily of existing and planned developments as well as developments that were considered by industry as possible given the current market and investment climate.

The **medium development scenario** consisted of existing and planned developments as well as developments that were considered by industry as possible given a buoyant market and investment climate.

The **high development scenario** consisted of existing and planned developments as well as developments that were considered by industry as possible given a bullish market and investment climate.

The scenarios are detailed in Chapters 7 and 8.

The medium development scenario was considered the most likely and was accepted by the Management Committee as the basis for assessment of infrastructure needs.

Options for resources development

Within the medium development scenario, a series of development options were specified. These options provide principally for different development locations within the region to enable assessment of infrastructure requirements and costs for each location. The development options are detailed in Chapter 9.

The options are conceptual and were selected to demonstrate the infrastructure needs and provide a base for order of magnitude costing. For any particular development, a detailed siting study would dictate final site selection, project configuration and infrastructure requirements.

2.4.4 Infrastructure and services overview

Infrastructure specialists from WorleyParsons undertook an appraisal of the existing infrastructure in the study area. WorleyParsons then assessed of the infrastructure required to support each of the minerals and energy development options under the medium scenario.

The review was undertaken in a regional context and examined strategic linkages with the rest of the Kimberley, Northern Territory and other parts of Western Australia.

Current business and community services were also examined and summarised, and assessments were made of additional services to support the demand generated by large scale resource development.

2.4.5 Aboriginal review and consultation

Aboriginal people in the West Kimberley have a major stake in future development of the region. The study involved significant consultation with Aboriginal representative bodies, backed by first hand knowledge of the issues at hand. Consultation included field visits and meetings with representatives of key Traditional Owner groups² and the Kimberley Land Council to identify issues from their perspective.

The study team also undertook consultation with petroleum and mining companies, and State Government agencies in the Kimberley and Perth to examine ways to encourage and facilitate an increased level of training and employment of Aboriginal people – and development of Aboriginal businesses – in both resource industry activities and associated services.

The development scenarios discussed in this report do not necessarily represent the views of the region's Traditional Owners.

A summary of outcomes of the consultation is presented in Chapter 4.

2.4.6 Consultation with other stakeholders

An extensive consultation program with representatives of stakeholder groups was undertaken in the study area, the wider Kimberley and elsewhere. Field trips were made to Broome, and Derby. Face-to-face meetings and telephone interviews were held with people representing all key stakeholder groups.

In addition, emailed surveys were sent to other interested stakeholders.

² Throughout this report traditional owner(s), Traditional Owners (s) means native title holders (determined) native title claimants (where applications have registered or have potential to be made) or traditional owners who do not claim or hold native title.

2.4.7 Development issues

In the light of the information derived from the preceding steps, issues relating to future development were identified. These included regional development, aspirations of stakeholder groups, environmental and amenity issues, Aboriginal cultural issues, issues relating to economic and community infrastructure, and project economics and feasibility.

3 West Kimberley region overview

3.1 Increasing focus on development potential

During the past two years, discussions about petroleum and minerals development in the West Kimberley have shifted from long-term discussion by governments to serious study by companies and others. For example:

- Recent discoveries by Inpex Browse Ltd (Inpex) and Woodside Petroleum have extended the known gas reserves in the Browse Basin to about 30 million cubic feet;
- Woodside is discussing the prospect of an LNG plant, gas hub and transcontinental pipeline based on Browse Basin gas;
- Studies of the feasibility of developing bauxite and iron ore deposits are being undertaken;
- Mineral exploration has increased markedly in the past three years; and
- The Traditional Owners of the region are examining options for achieving greater economic self-determination as well as how to preserve cultural and natural values.

3.2 Local conditions and infrastructure limitations

The West Kimberley is located in a remote and relatively inaccessible area. Whilst infrastructure in some parts of the study area is good to excellent, infrastructure is virtually non-existent in other parts. This contributes to the difficulty in developing minerals and energy resources in the area, as well as other economic activity.

For example, whilst air services to Broome are good and air services to Derby and Fitzroy Crossing are adequate, there are limited services to the rest of the study area. There are very few all-weather and night landing airstrips and most remote airstrips that are suitable for light aircraft only. Apart from the Great Northern Highway, there are no major sealed roads and large portions of the study area have no road access. There are limited port facilities at Broome and Derby.

The climate of the West Kimberley and the lack of infrastructure mean that large parts of the study area are inaccessible in the wet season. Many roads become impassable due to flooded crossings and damaged surfaces, and access by road to certain areas is blocked. In addition, off-road travelling (eg for mineral exploration) is impossible as much of the area becomes flooded or boggy. During the "dry" season, unsealed roads become hard and rough and result in a high level of wear and tear on vehicles.

The meteorological conditions of the region and the potential impact of cyclones on onshore and marine facilities require particular attention to risk management in design and operation of both resources projects and infrastructure. The oceanographic conditions of the region require consideration of the large tides typical of the area along with associated currents.

3.3 Values of the area

The West Kimberley is a region of great aesthetic, environmental and cultural diversity and significance. Much of the region is essentially unchanged by European settlement.

Traditional owners of the West Kimberley wish to preserve the values of the region and to ensure that they uphold cultural responsibilities for their land. At the same time they wish to explore opportunities for greater economic self-determination. Whilst the development of petroleum and mineral resources could provide one pathway to achieve this aim, other economic activities are also important. In particular, the growing popularity of high value eco-tourism and adventure tourism represents a valuable economic opportunity as does sustainable pastoral activities and aquaculture developments.

The other inhabitants of the West Kimberley also wish to ensure that the current environmental, social and economic values of the area are protected while new activities occur.

It is therefore vital that development of the West Kimberley's resources occurs in a way that is consistent with and protects existing values. This means that development in the region needs to take place within the framework established by the State Sustainability Strategy.

3.4 Geography and climate

The West Kimberley includes the Shires of Broome and Derby - West Kimberley and the western part of the Shire of Wyndham - East Kimberley.

The region has a tropical monsoon climate, made up of two seasons – the “Dry” and the “Wet” – separated by short transitional periods. The “Wet” season generally lasts from early December to early April and is characterised by heavy rainfall and high humidity. The region receives around 90 per cent of its rainfall over this period when intense low pressure systems (and sometimes cyclones) and unstable air characterise weather patterns.

The remainder of the year is the “Dry” season during which little rain falls and the climate is sunny and warm during the day and cooler during the night. This pattern of high pressure systems and a predominantly south easterly airflow

from Australia's interior create a much more comfortable environment than is experienced in "The Wet".

3.5 Geology overview

The Kimberley region boasts a complex and diverse geology containing a wide range of mineralisation styles. The region is divided into four distinct landforms:

- North Kimberley
- Ordland and Fitzroyland
- Sandland
- Dampierland.

The North Kimberley is the largest of the four landforms taking up the north-west corner of the Kimberley region stretching from Wyndham through to the Buccaneer Archipelago. Streams and river systems flowing north and north-west drain through this area. It is characterised by a large plateau country comprising sandstone with some shales and volcanic areas.

The Kimberley Foreland is situated at the south of the North Kimberley landform. It is a relatively small area that is characterised by intensely folded and faulted landscapes. Iron ore and bauxite deposits are found in the area.

The Ordland and Fitzroyland landforms make up the area's two major drainage systems with the Ordland draining to the north and the Fitzroyland draining to the west. Minerals found in this area include gold and diamonds. Fitzroyland encompasses the towns of Fitzroy Crossing and Derby. It is characterised by the Devonian reef system which is a 350 million year old marine reef system that contains lead and zinc deposits and petroleum accumulations.

The Sandland landform is situated in the southern most part of the Kimberley region and contains a portion of the Great Sandy Desert and the Tanami Desert. Gold deposits are found in the area especially towards the Northern Territory border.

Dampierland is characterised by the red Pindan country and includes Broome and the Dampier Peninsula. This area is not as rich in minerals as the remainder of the region.

A technical description of the geology of West Kimberley is presented in section 5.1.

3.6 Human settlement

Aboriginal people are believed to have lived in the Kimberley region for around 40,000 years, although some archaeological evidence suggests human habitation for a considerably longer period.

Aboriginal peoples' belief systems, social organisation, cultural law and customs, language, land tenure, technology, subsistence economy and exchange systems developed and evolved overtime shaped by and within sustainable limits of their environment and natural resources.

Sustainability of subsistence society relied on continuity of Aboriginal knowledge systems of natural bounty, natural forces (e.g. weather, sea, water, fire), indicators (seasonal and abundance), land tenure, ritual, creation law and relationships (internal and external).

Traditional Owners experienced profound change, dislocation and disruption to their traditional way of life when Europeans commenced settlement in the West Kimberley. Many traditional Owner groups were forced to relocate to mission stations and government depots and reserves, worked on European pastoral stations and in industry, such as pearling, with little or no economic reward.

Recent Aboriginal settlement has seen the growth of community housing and services built around mission stations (e.g. Kalumburu, Beagle Bay), pastoral homesteads or within or near growing European towns (Broome, Derby). Larger settlements have populations of over 200 people.

Traditional owner aspirations have been to develop outstations and enterprise on traditional land for year-round or seasonal occupation. These settlements allow Traditional owners to connect with country and develop enterprise - (pastoral, tourism), as demonstrated by the many emerging outstations on Dampier Peninsula and along the Gibb River road.

Traditional Owners today, through native title applications, seek recognition and enjoyment of their traditional (pre-European) land interests, resource, settlement, cultural systems and connections so that the intrinsic linkages of natural and cultural values can be passed to future generations.

The region has had regular coastal visits by Macassan trepang fishermen, which have taken place annually for hundreds of years. The first Europeans in the area are believed to have been the Portuguese who sailed down the coast as far as Shark Bay and, later on, the Dutch also charted parts of the coast. The first of the British arrivals to the Kimberley was William Dampier who sailed into King Sound in 1688 and again in 1699. There were no other known European visitors until 1801 and 1803 when French explorers sailed the coast.

The first land-based exploration took place from 1837-38 when George Grey led an expedition to the Kimberley. Alexander Forrest followed in 1879. His reports on the pastoral quality of the area led to settlers from the south west of Western Australia, Queensland and New South Wales moving to the area. By 1883, some 20 million hectares had been leased for cattle and sheep grazing purposes and in November 1883 Derby was declared a townsite. By 1887, the pastoral area had declined and stabilised at 6 million hectares.

The pastoral development coincided with the first discovery of gold in Western Australia at Halls Creek in 1885 by Hall and Slattery. At the peak of the rush, Halls Creek swelled to accommodate 10,000 miners. But the boom was short lived and by 1887 the rush was all but over. The flow of prospectors travelling along the Fitzroy River track led to the development of Fitzroy Crossing as a supply base in 1886. When the gold rush subsided, Fitzroy Crossing remained to service the pastoral industry.

Broome was also established in the 1880s as a pearling port. It also experienced a massive influx of people from Europe, Malaysia, China and Japan who came to the area to work in the industry.

3.7 Demographics

The 2001 Census reported nearly 32,000 people living in the Kimberley region. This represents around 1.6 per cent of Western Australia's total population and 6 per cent of the people living in regional Western Australia, as illustrated in Table 2. The Kimberley is one of the fastest growing regions in Western Australia with high birth rates within the Aboriginal population, and people being drawn to the area for lifestyle reasons and as a result of growing economic opportunities.

The region has a high Indigenous population with just under a half of the population of Aboriginal or Torres Strait Islander origin. This represents one quarter of the State's total Indigenous population. A large proportion of the Indigenous population lives in remote communities and outstations throughout the Kimberley region.

The majority of people in the Kimberley live in the centres of Broome (population approximately 12,000), Derby (5,000) and Kununurra (6,000) with most of the remainder in the smaller towns of Wyndham, Fitzroy Crossing and Halls Creek.

Table 2 **Estimated resident population: Kimberley region 1991 – 2001, with projections to 2016**

Local Govt Authority	1991	1996	2001	% Indigenous (2001)	2006*	2016*
Broome	7,887	9,766	13,239	23.5	13,500	17,000
Derby-West Kimberley	7,019	6,512	8,285	45.9	8,600	9,800
Halls Creek	2,679	2,910	3,921	71.3	4,100	4,700
Wyndham – East Kimberley	5,790	6,484	7,255	24	8,000	8,900
Kimberley region	23,375	25,672	32,700	47.3	34,222	40,402
Regional WA	455,549	480,391	518,403	-	571,355	624,639
Western Australia	1,636,067	1,765,256	1,906,114	3.2	2,096,247	2,264,763

Source: Australian Bureau of Statistics, *WA Planning Commission³

3.7.1 Shire of Broome

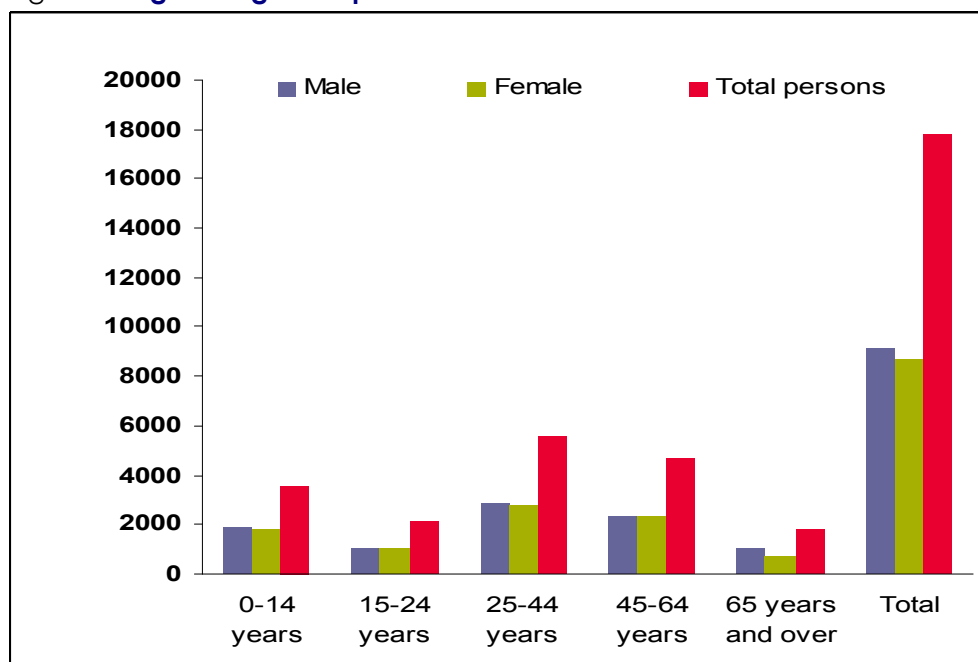
At 30 June 2002, the Shire of Broome had a population of 13,673. The Shire of Broome's population represents only 2.6 per cent of the people living in regional Western Australia and 0.71 per cent of the population of Western Australia. However its population growth rate of 3.6 per cent is the second highest of any Local Government Area in Western Australia. The population growth rate for regional Western Australia is 1.1 per cent whilst for Western Australia as a whole it is 1.4 per cent.

The majority of the Shire's population lives in the town of Broome but there are also a number of Aboriginal communities located throughout the Shire.

Figure 2 shows the age and gender profile of the population in the Shire of Broome. The chart highlights the lack of population in the 15-24 age group compared to the 0-14 and 25-44 age groups. This is a reflection of high school and university aged people leaving the Shire to pursue their education and early careers elsewhere.

³ Note: Census data includes visitors to the region and may also reflect temporary movement of people within the region.

Figure 2 Age and gender profile: Shire of Broome



Data source: 2001 Census

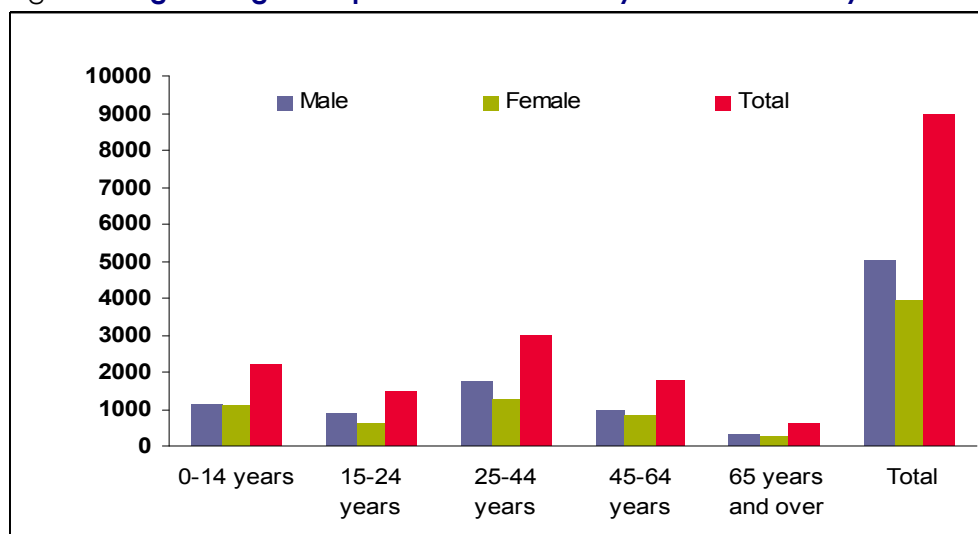
People of Aboriginal or Torres Strait islander descent comprise 23.5 per cent of the Shire population. Whilst this percentage is high compared to that of the State, it is relatively low compared to other Shires in the Kimberley.

3.7.2 Shire of Derby - West Kimberley

The Shire of Derby - West Kimberley had a population of the 8,517 as at 30 June 2002. This represents 1.6 per cent of the people living in regional Western Australia and 0.44 per cent of the State's population. The majority of people live in Derby (4,800) and Fitzroy Crossing (1,120), which are the two major towns in the Shire. There are also a number of Aboriginal communities within the Shire, some of which have substantial populations.

Figure 3 illustrates the age and gender profile of the Shire of Derby - West Kimberley. The profile shows a similar pattern to that of the Shire of Broome with a lack of people in the 15-24 age group. Unlike the Shire of Broome, the number of males is noticeably greater than the number of females. This is especially so in the 25-44 age group which suggests that this imbalance is partially due to the presence of mine and defence workers, the majority of which are young, male and single.

Figure 3 Age and gender profile: Shire of Derby – West Kimberley



Data source: 2001 Census

The Shire of Derby - West Kimberley has the largest Indigenous population of any of the Kimberley Shires with around 4,127 Indigenous people living in the Shire at the time of the 2001 Census. This represents around 46 per cent of the total population.

3.8 Economic profile

Economic profiles of the Shire of Broome and the Shire of Derby-West Kimberley are described in the following sections. The economic base of the West Kimberley comprises the agricultural (pastoral, fishing and aquaculture), minerals, and government service industries as well as an important and growing tourism sector.

There is also a growing focus on conservation and arts industries.

3.8.1 Conservation of environment and heritage

The conservation of the West Kimberley environment and both Aboriginal and non-Aboriginal heritage is important for reasons of culture, biodiversity conservation and preservation of aesthetic values. It is also important to sustaining and growing the West Kimberley's economy through further development of high-value industries such as adventure tourism and aquaculture.

The uniqueness of the West Kimberley environment and heritage, and measures to conserve them, are discussed in detail in Chapter 12.

3.8.2 Aboriginal economic development

The Aboriginal people of the West Kimberley are generally supportive of economic development, subject to cultural, social and environmental safeguards. In particular, they feel that development must respect the cultural responsibilities of Traditional Owners for their land. As discussed in Chapter 4, this support is also conditional on implementation of measures to enable:

- Participation in discussions and negotiations on development and land use;
- Participation in economic development itself.

Aboriginal people in the region are increasingly involved in economic development through employment and ownership of businesses. The tourism industry in particular is a high growth source of income. Some 30-35,000 tourists are estimated to have visited the Dampier Peninsula during 2004 season, serviced by about 10 local operators in accommodations and attractions⁴. Traditional Owners are understandably concerned to ensure that resource development does not compromise further growth of high value tourism, particularly adventure tourism in remote areas.

The Kimberley economy is imbalanced in terms of relative participation of Aboriginal people in the production side of the economy. Aboriginal people comprise 50 percent of the working age population. The 2001 census records Aboriginal unemployment of 5.6 per cent – similar to the non-Indigenous rate. Within the study area, however, 60 per cent of the Indigenous workforce was employed on Community Development Employment Projects (CDEP), the Indigenous work for the dole scheme. This is reflected in relative incomes: 60 percent of Indigenous people in the workforce earned an average wage of \$200 or less per week (ABS 2001), whilst the average wage in the West Kimberley was more than \$700 per week.

Another measure of current imbalances in the regional economy is the number of dependants on each person in the workforce. A recent study in the north east Kimberley (including Kalumburu) considered a comparable measure in other Kimberley sub-regions, nine people depend on each Aboriginal income earner in mainstream employment (not including CDEP), compared with 0.5 dependents per non-Aboriginal income earner.⁵

3.8.3 Shire of Broome

The economy of the Shire of Broome is built around the tourism, retail, agriculture and aquaculture industries. Pearling in particular provides significant

⁴ The Dampier Peninsula Marketing Strategy, Ray Bird and Associates 2002 p25

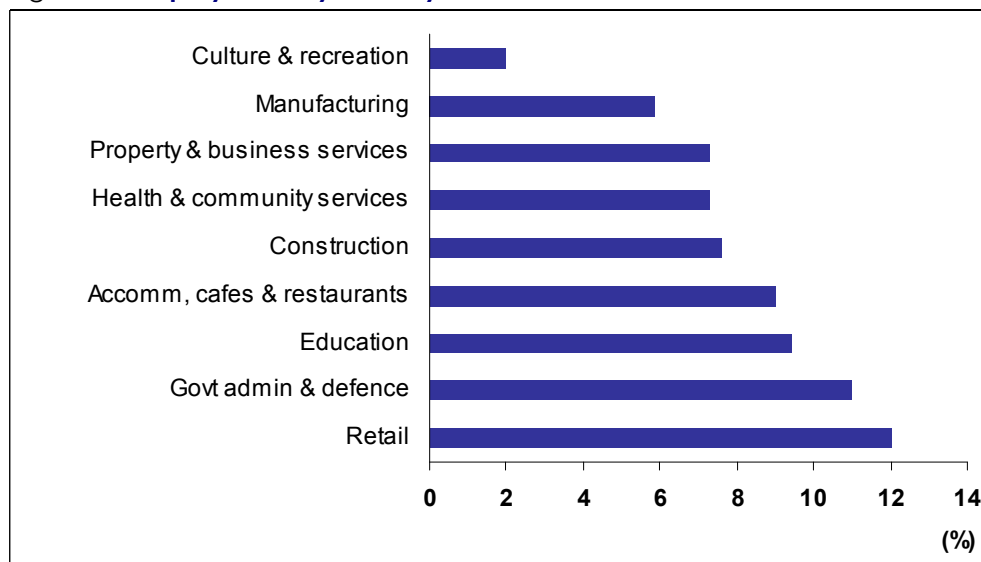
⁵ Aboriginal population profiles for development planning in North East Kimberley: J Taylor CAEPR Research Monograph No. 23 2003

employment and provides flow-on benefits to other sectors, including the tourism industry. Other industries that provide an economic contribution to the Shire include horticulture, transport, minerals and energy servicing and construction industries.

Total employment in the Shire of Broome in the June 2003 quarter was 6,644 people, with an unemployment rate of 6.7 per cent. This is slightly higher than the unemployment rates for regional Western Australia (5.6%) and for the State (5.9%).

Figure 4 shows the major industries of employment in the Shire of Broome and the percentage of its population employed in that industry. It highlights the importance of the retail and tourism industries in creating jobs for local people.

Figure 4 **Employment by industry: Shire of Broome**



Data source: Australian Bureau of Statistics, 2001 Census

The average taxable income for all individual taxpayers in the Shire of Broome for 1999/00 was \$36,541, which is higher than the \$33,958 for regional Western Australia and \$35,406 for Western Australia as a whole. The cost of living in the Shire of Broome, however, is higher than the Perth metropolitan area. Average prices in the Shire of Broome in 2000 were 3.2 per cent higher than in Perth and a similar difference is expected to exist in 2005. The price index covers food, clothing, housing, household equipment and operation, transportation, tobacco and alcohol, health and personal care, and recreation and education.

The following sections outline the more important industries in the Shire of Broome in detail.

Aquaculture

The aquaculture industry is a major contributor to the economy of the Shire of Broome. Pearl oysters, prawns, and aquarium fish are the primary products farmed but there are also some niche industries including crocodiles. Broome Crocodile Farm produces skins, meat and other products for the medicinal, clothing, smallgoods and fertiliser industries.

The pearling industry is the most important component the aquaculture industry. It has been in operation since the 1880s and is primarily based around Broome. Several pearling companies maintain significant operations in Broome.

A significant education industry has developed around the aquaculture industry, including the Broome Tropical Aquaculture Park that undertakes research and education. This is a joint venture between the Department of Fisheries and the Kimberley College of TAFE. The facility is a pearl and multi-species hatchery to produce trochus, giant clams and tropical abalone.

Adjacent to the aquaculture park is Manbana, a commercial aquaculture hatchery, and an aquaculture and Aboriginal cultural discovery centre. The hatchery produces a range of species including trochus, giant clam, tiger prawn, cherabin prawn, and Barramundi. It is operated by MSH Pty Ltd - a company wholly owned by the Kimberley Aquaculture Aboriginal Corporation (KAAC). KAAC represents Aboriginal communities which have an interest in developing aquaculture enterprises in the tropical north of Western Australia.

Agriculture

The main agricultural industry is the pastoral sector, which supplies cattle primarily for the live export trade. Most cattle from West Kimberley are exported through the Port of Broome but some are exported through the Port of Wyndham. Stockyard facilities at the Port of Broome are capable of holding 4,500 animals prior to ship loading.

In 2002/03 78,400 head of cattle were exported through the Port of Broome to overseas market destinations including South East Asia. In the same year, only Darwin (251,600), Townsville (143,750) and Fremantle (131,250) exported greater numbers of cattle.

Horticulture is also a thriving and growing industry in the Shire with mangoes, melons, bananas, sweet potatoes and cut flowers grown on irrigated land on the outskirts of Broome.

Tourism

Broome's tourism industry is largely seasonal with peak visitor activity between April and October each year. In 2003 there were 3,505 beds in a range of tourist establishments plus an additional 1,399 sites in the town's five caravan parks⁶.

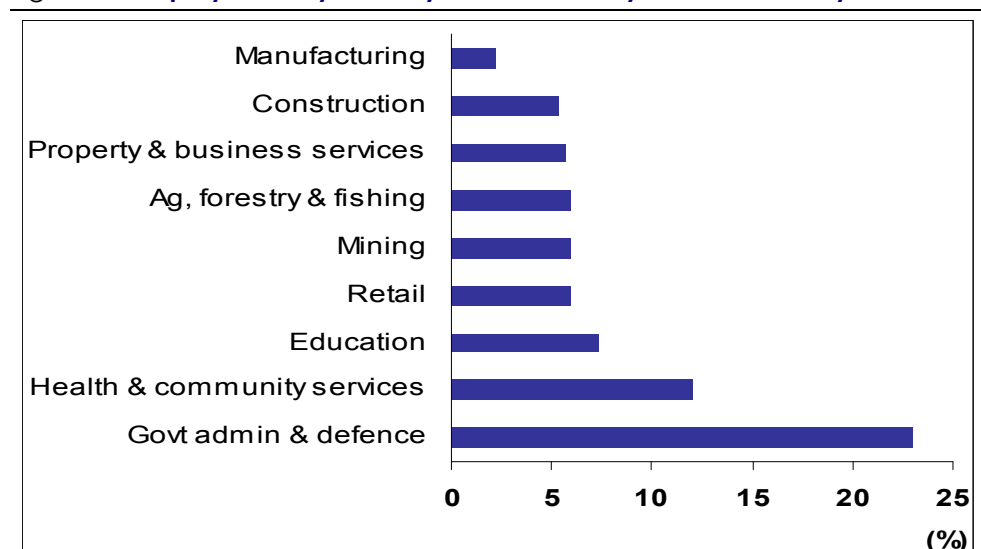
In 2002 there were 244,000 visitors to the Shire of Broome. Over 80 per cent were domestic visitors and the remainder tended to be young international visitors.

3.8.4 Shire of Derby-West Kimberley

The economy of the Shire of Derby-West Kimberley is built around the pastoral industry and the government sector, including health, education, and government administration and defence. Other industries that play an important role in the economy include the mining industry.

Total employment in the Shire of Derby-West Kimberley in June 2003 was 3,360 people with the majority of people being employed in the government sector, as illustrated in Figure 5. The unemployment rate for the Shire was 9 per cent compared to 5.6 per cent for regional Western Australia and 5.9 per cent for the State.

Figure 5 **Employment by industry: Shire of Derby-West Kimberley**



Data source: Australian Bureau of Statistics, 2001 Census

Figure 5 shows the major industries of employment for the population of the Shire of Derby-West Kimberley. It shows the significant role the government sector has in employing local people.

⁶ WA Planning Commission, (2004), Broome 2004 Country Land Development Program, p 10

Developing the West Kimberley's Resources

The average taxable income for all individual taxpayers in the Shire of Derby-West Kimberley for 1999/00 was \$37,896 which is higher than the \$33,958 for regional Western Australia and \$35,406 for Western Australia as a whole.

Mining

Mining production in the Shire of Derby-West Kimberley in 2000/01 was valued at \$173.4 million or 0.7 per cent of total Western Australian production. Iron ore and diamonds are the only minerals currently mined in the Shire but lead and zinc were mined at Lennard Shelf as recently as 2001. The mineral prospectivity of the Shire is medium to high with identified deposits of, and potential for diamonds, lead and zinc and gold. There are also deposits of bauxite in and around the Mitchell Plateau and Cape Bougainville. Until recently these deposits were considered uneconomic to develop due to their remote location and lack of access to supporting infrastructure and energy. There is now greater interest in developing the deposits due to a global growth in aluminium demand and the possibility of development of the Browse Basin offshore gas fields.

The closure of the Western Metals Lennard Shelf lead and zinc operations in 2001 was a setback for the Shire as it lost a major employer and major user of the Port of Derby. Rising prices for both lead and zinc could mean that the mine and processing plant will re-open in the medium term, provided the new owners Teck Cominco are successful in defining sufficient new ore reserves and project economics prove to be robust. The Ellendale Project, operated by the Kimberley Diamond Company, provides good employment and business prospects for the Shire. It currently employs 172 people. Construction of a new 2.2 million tonne per annum diamond production plant adjacent to the current operations was completed during the second quarter of 2004 as part of a major expansion of the Ellendale operations.

Agriculture

The value of agriculture in the Shire of Derby-West Kimberley in 2000/01 was \$35.9 million or 0.8 per cent of state output.

There are some small scale horticultural activities near Derby that produce crops such as mangoes, melons, bananas and sweet potatoes. A private developer was until recently investigating the commercial viability of a two-stage irrigated cotton growing and processing industry on the Fitzroy River. The main contributor to agriculture is the pastoral industry, which services the live cattle export market.

Defence

The Australian Defence Force is a large land holder in the Shire. The RAAF Curtin Airbase is located 30 km from Derby and there are training sites at Yampi and Oombalal north of Derby.

The Curtin Airbase has a large sealed runway that is capable of landing all types of aircraft. It has been used in the past to deliver heavy equipment for the mining industry and provides an important infrastructure option for future resource developments in the area.

Yampi Training Area north of Derby is an important area for conservation. The site is 5,660 sq km and contains important flora and fauna, which has led to the area being placed on the Australian Government Heritage list and the Register of the National Estate.

Oombalal Area north of Derby is a 400 sq km defence exercise area that is also on the Australian Government Heritage list and contains an Aboriginal heritage site.

3.9 Planning for development and conservation

There are several State and Australian Government planning processes currently underway in the West Kimberley that have major implications for future development in the region. These include:

- Local planning by the Department for Planning and Infrastructure;
- Planning by Local Government Authorities;
- Examination by the Western Australian Department for Conservation and Land Management of future reserves and protected areas;
- Examination by the Australian Government Department of Environment and Heritage of conservation options for areas of high biodiversity;
- Planning for roads by State and Local Government;
- Road funding plans by the Australian Government;
- Kimberley Natural Resource Management Strategy planning by both Australian and State Governments; and
- This study – the West Kimberley Resource Development Study.

In order to achieve optimal economic, social, cultural and environmental outcomes, there is clearly a need for all levels of government to coordinate such activities both within their respective governments and between levels of government.

4 Aspirations of West Kimberley communities

As part of the research for this report, consultations were undertaken with government, business and community leaders in the West Kimberley to develop an understanding of economic, social, cultural and environmental aspirations. Particular emphasis was given to consultation with leaders of Aboriginal groups that represent the Traditional Owners in the region.

A list of organisations that were consulted is presented in Table 38 in Appendix A. This study did not include consultation with the general community and therefore the commentary below cannot be regarded as indicative of community-wide views. Project-specific approvals processes will necessarily require extensive community and other consultation by project proponents.

4.1.1 Resources industry

The proponent of the Mt Leeming - West Kalumburu bauxite project, Aldoga, is currently planning all approvals and investment decisions to be in place for a start to mining in 2007. The holder of the Mitchell Plateau bauxite leases, the Mitchell Plateau Joint Venture (MPJV), believes that 2013 is the earliest likely start-up date for mining of those resources. The MPJV is due to submit a detailed proposal to develop the Mitchell Plateau bauxite resource by 30 April 2005. Other proponents have also been invited to submit proposals.

Petroleum proponents have very positive views on the prospects of future petroleum development. Inpex is examining a range of development offshore, onshore and combined development options, while Woodside is investigating options for LNG development.

Kimberley Diamond Company has strong expectations of continued expansion of its West Kimberley operations. Teck Cominco and Noranda are undertaking work to produce a redevelopment plan for the Lennard Shelf assets. A decision to recommence operations will depend on the outcome of these studies, as well as zinc market conditions and exchange rates.

Aztec Resources Ltd has the potential to be a significant iron ore producer in the area, following the identification of high grade ore reserves at its Koolan Iron Ore project. Resources have been estimated at 24.9 million tonnes grading at 66.95 per cent iron.

4.1.2 Derby stakeholders

Derby stakeholders who were consulted were keen to explore development opportunities, subject to being satisfied about protection of environmental values. They highlighted the development potential of the region, including the potential heavy industrial location of Point Torment, light industrial land in Derby, community facilities, transport infrastructure and the availability of housing land.

4.1.3 Broome stakeholders

Broome stakeholders who were consulted were also amenable to resource development in the West Kimberley. Several stakeholders expressed concerns about possible negative impacts of industrial installations on the environment, community amenity and the tourism industry.

Stakeholders highlighted the existing community, housing, port and transport infrastructure in the Broome area as a facilitator of resource development.

4.1.4 Regional development organisations

State and Australian regional development organisations are very supportive of resource development in the West Kimberley region. They highlighted the need to broaden and deepen the West Kimberley economy. They also pointed out the imbalance in the economy between Indigenous and non-Indigenous people and communities. They felt that if resource development occurs there is a need to take action to fill out the potential 'hollow economy' by maximising local participation in development.

Protection of the West Kimberley environment and heritage has a high priority amongst all stakeholders.

4.1.5 Traditional Owners

There is general support amongst Aboriginal groups for economic development, subject to a number of issues identified by the organisations consulted and discussed below. Location-specific issues raised by traditional owner representatives are outlined in Chapter 14.

Consultation, negotiations and participation

There is a need for 'proper arrangements' with interest holders. This includes an inclusive process for development of agreements, careful design of the content of agreements, attention to implementation of agreements, and resourcing of the negotiation process.

Developing the West Kimberley's Resources

Realistic lead-times are required for negotiations to enable Traditional Owners to engage with project proponents after thorough preparation. There must also be adequate lead time for getting people ready to participate in development.

Co-operative efforts are needed between the community, government and industry to achieve this.

Aboriginal interest groups consistently identified the need for resources to be provided to Aboriginal interest holders (including representative body and traditional owner groups) to participate in negotiations. These groups typically have very limited capacity to sustain lengthy negotiations.

Aside from lack of resources, Aboriginal people typically lack the experience and negotiation skills needed to engage in commercial negotiations with corporations. Capacity-building is required in addition to resources to hire advisers.

Similarly, capacity-building is needed by Aboriginal people and businesses to enable them to take up the opportunities that are presented by major development. These opportunities include employment and business development.

Aboriginal groups identified the need for support from government and business needed to enable them to participate in the possible new industrial phase of West Kimberley development. This support includes:

- Appropriate recruitment programs;
- Training and skills development;
- Support to travel to and from worksites; and
- Culturally-friendly shift arrangements.

Aboriginal stakeholders identified a need for a cooperative approach between industry and government to provide infrastructure and services.

Culture, environment and planning

Traditional Owner stakeholders all identified the need for development to have respect for the Traditional Owners' cultural responsibility for land.

In this context, concerns about the environmental and cultural impact of mining of Cape Bougainville were identified, while assessments of all values of Mitchell Plateau area and the impact of mining are required to enable informed decision-making. Values identified included: biodiversity, high value-low impact tourism, cultural heritage, mineral resources, other natural resources (including carbon credit potential), social issues and economic opportunities.

Developing the West Kimberley's Resources

In some areas, the use of islands for development is a sensitive issue. Some islands and parts of islands have high cultural value.

Some Aboriginal stakeholders also had concerns about pressures on land use that might arise from intensive development. They were concerned that sufficient land be available for when they have capacity for initiating development, and for their children.

5 Petroleum and mineral resources

5.1 Geology overview

The two primary physiographic areas of the region are the Fitzroyland and the North Kimberley Division. Fitzroyland is further divided into the Fitzroy Uplands Province, the Fitzroy Plains Province and the Sand Plain Province whilst the North Kimberley Division is divided into the Kimberley Plateaux Province and the Kimberley Foreland Province. The area also includes a small area of the Dampierland Province on the western boundary.

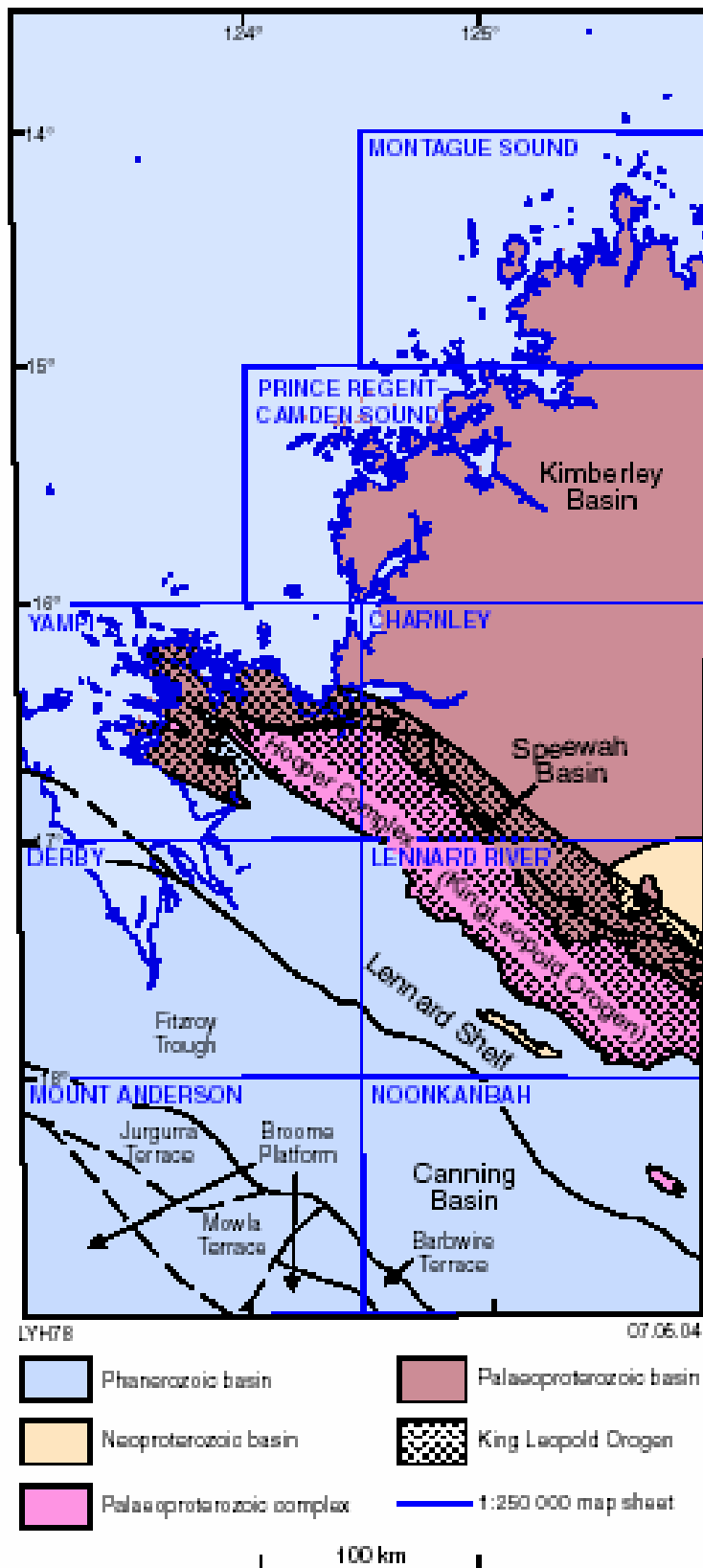
From a geological perspective, the land area of the West Kimberley is divided into a number of provinces. These divisions are illustrated in Figure 6. The West Kimberley includes most of the King Leopold Orogen and parts of the Palaeoproterozoic Speewah and Kimberley Basins and the Phanerozoic Canning Basin. The Canning Basin lies to the south of the study area and the Kimberley Basin lies to the north. These Basins are divided by the King Leopold Orogen which is a 50 to 60 kilometre wide west-northwest belt in the King Leopold Ranges and the Speewah Basin.

An orogen is a major tectonic belt which is also affected by metamorphism and abundant plutonic intrusions and, in the case of the King Leopold Orogen, includes younger tectonically related volcanic and sedimentary rocks and reworked material from older cratons.

The Kimberley and Speewah basins are comprised of sedimentary and volcanic rocks. Both basins are thought to have been deposited separately. The Speewah Basin contains fluvial sands passing into or alternating with shallow-marine facies and then back into fluvial sands whilst the Kimberley Basin has been deposited within a broad, semi enclosed, shallow marine basin.

The study area includes the north eastern portion of the Canning Basin. The Basin is a large intracratonic basin covering north western and central Australia. In the West Kimberley it includes sedimentary rock of the Fitzroy Trough, the Lennard Shelf and the Broome Platform.

Figure 6 Tectonic sketch of the West Kimberley



Data source: Department of Industry and Resources; Report 88

5.2 Summary of mineral deposits of the region⁷

The prospectivity of the West Kimberley region can be gauged by the variety of mineral deposits which have already been discovered. There are 819 known mineral occurrences in the West Kimberley. Currently, the Lennard Shelf and the Fitzroy Trough form, economically, the most important geological entities in the area. They contain the diamond deposits at Ellendale, and zinc, lead and silver deposits at Lennard Shelf.

These mineralisation styles are discussed in the following sections.

5.2.1 Diamonds

Nearly all diamond occurrences are found within lamproites of the Fitzroy Volcanics. They include the Ellendale, Eastern Lennard Shelf, Calwinyardah and Nookanbah fields as well as some other fields in the study area. The Ellendale 4 and 9 deposits have been under production by the Kimberley Diamond Company since 2002. The deposits are located in pipes and are returning around 60 per cent gem quality. As at 2002, 79 lamproites had been found in this field and ongoing exploration continues to uncover new lamproites. At the Ellendale mining operations, an additional 18 lamproite occurrences have been discovered (to August 2004) since mining began.

To the east of Ellendale is the Lennard Shelf field which contains the Big Springs deposit where small diamonds and micro diamonds have been discovered. Similar results have also been discovered at the Calwinyardah field. The Nookanbah field includes the Walgidee Hills deposit but, to date, no economic concentrations of diamonds have been found.

5.2.2 Base metals

Base metals (copper, lead, zinc and nickel) are found in several mineralisation styles in the West Kimberley. Deposits include:

- Copper and nickel occurrences at Limestone Springs;
- Copper, lead, zinc, silver deposits at Chianti which contain low base metal content, and at Turtle Creek in the Hooper Complex;
- Copper and lead from the Carson Volcanics at Brecknock Harbour in the Camden Sound and Precipice Range north of Fitzroy Crossing;
- Copper is found at Mangrove, Wilsons Reward north of Derby in the Little Tarraji River area.

⁷ Data for this section sourced from: Geological Survey of Western Australia, Mineral Occurrences and Exploration Potential in the West Kimberley; Report 88, 2004

Significant limestone-hosted lead and zinc mineralisation is found in the Lennard Shelf. The largest resource is at Pillara and there are smaller resources at Kutarta, Kapok West, Fossil Downs and Wagon Pass as well as several deposits in the East Kimberley. The Cadjebut and Goongewa deposits have been exhausted along with the Narlarla deposits. Until its closure in 2003, the Lennard Shelf project was Western Australia's largest producer of zinc and lead.

There is good potential for the discovery of additional base metal deposits in the Lennard Shelf and Fitzroy Trough.

5.2.3 Iron ore

The largest deposits of iron ore are found on Koolan Island which is currently undergoing a mining feasibility study, and Cockatoo Island, which is in production. Both deposits have been mined at various times since 1951. The ore from both these islands is of high grade with low impurities. Iron ore is also found on a number of other islands in Yampi Sound including Irvine Island.

Mainland deposits are found at Grant Range, Shore Range and Jemberlura all to the south of the Great Northern Highway near Fitzroy Crossing.

5.2.4 Uranium

A medium sized sandstone type uranium deposit has been defined near Oobagooma, and there are also prospects at Myroodah.

5.2.5 Gold

Gold is found in several mineralisation styles including deposits north of Fitzroy Crossing including the Richenda River, Turtle Creek, Mount Bell, Mount Behn and Mount Broome deposits. To date, only small amounts of gold have been returned from this area.

Gold has been collected intermittently in the study area for most of the last century with most finds unreported. These include several historically reported deposits near the coast north of Derby at Mt Heytesbury in the Yampi Sound and at Camden Harbour. Similar finds have occurred in the Mount Broome Creek – Richenda River area.

These finds along with recent exploration efforts indicate there are good potential for gold discoveries elsewhere in the Kimberley Basin.

5.2.6 Bauxite

The bauxite deposits at Mt Leeming and West Kalumburu are being assessed by Aldoga. The bauxite deposits at Mitchell Plateau and Cape Bougainville are

substantial and have commercial potential. The resource at Mitchell Plateau is estimated to total 230 million tonnes (Mt), with 980 Mt at Cape Bougainville. However, the average grade of bauxite at Mitchell Plateau is 47 per cent Al_2O_3 , compared to 36 per cent Al_2O_3 at Cape Bougainville.

Low grade bauxite is also present further south at Sharp Hill.

5.2.7 Tin

Tin is found at Richenda River north of Fitzroy Crossing as well as King Sound. Taylors Wolfram Reward is an abandoned open-cut mine located at King Sound where tungsten was mined. There is no recorded tin production from this mine.

Low grade mineralisation deposits have been found at Silent Valley, Dysons Creek and elsewhere.

5.2.8 Coal

Coal is found in a number of places in the Kimberley Basin. Deposits with varying qualities have been found at Liveringa Ridge, Myroodah, Mount Fenton and others.

There are also significant deposits of coal in the Canning Basin that are currently being reviewed.

At this early stage, no potential markets have been identified for the possible development of these coal resources.

5.2.9 Heavy mineral sands

Heavy mineral sands are found at King Sound where an inferred resource of more than 100 Mt assaying nearly 35 per cent titanium dioxide was found. Subsequent drilling did not confirm this assessment and additional investigation is needed to confirm the extent of the resource. Other deposits have been found nearby at the mouths of the May River and Robinson River as well as at Secure Bay.

5.2.10 Onshore petroleum

The Canning Basin, which is prospective for petroleum, extends from the coast around Broome to the western part of the Tanami region. In the past, exploration focussed on the northern and central basin areas, and several exploration wells had hydrocarbon shows, especially of oil. Some have yielded commercial hydrocarbons. The Fitzroy Trough is considered the most prospective area. The Department of Industry and Resources in 2003 released

exploration acreage and called for bids for Fitzroy Basin tenements adjacent to, and intersecting the Tanami area.

5.2.11 Other minerals

There are a number of other minerals present in the study area which comprise small deposits. These include a kaolin deposit at Thangoo near Broome which was considered for development before environmental concerns associated with the development halted plans in 2002. In addition there are deposits of fluorite, barite, beryl, mica, corundum, kyanite, rutile, garnet, glauconite, phosphate, bentonite, ochre, salt, limestone and dimension stone.

5.3 Mineral production

In the past, a number of minerals have been produced in the West Kimberley, including small quantities of copper, tungsten, tin, and gold. In addition, Western Metals mined significant quantities of zinc and lead from the Lennard Shelf before commercial difficulties forced the closure of the mine and operating plant in 2003. Significant quantities of diamonds and iron ore are also mined in the study area.

Current production is confined to Kimberley Diamond Company's diamond operations at Ellendale and Portman Mining's iron ore mine on Cockatoo Island.

A feasibility study is currently underway by Aztec Resources to develop the iron ore deposits on Koolan Island and mining could start as early as 2005.

The new owner of the Lennard Shelf operations, Teck Cominco, is undertaking a study of the feasibility of recommencing production.

5.4 Mineral exploration and resources

The West Kimberley hosts a wide range of mineral commodities in a variety of mineralisation styles. There is potential for further discoveries of all currently known commodities. In particular, there is a high potential for further discoveries of base metals, diamonds and gold.

5.4.1 Pre-competitive exploration and data provision

The West Kimberley region has been highlighted by the Geological Survey of Western Australia (GSWA), a Division of the Department of Industry and Resources, as an important area for further assessment by the mineral exploration industry. GSWA has recently completed a number of prospectivity studies and geoscientific programs and has several others in progress.

A key role of the State Government in relation to mineral exploration is to research, collect and provide pre-competitive exploration data to stimulate exploration leading to mineral discovery. GSWA is responsible for providing government and industry with the basic geological data necessary to understand the potential for mineral and petroleum resources throughout the State. In this role GSWA carries out field geological mapping, limited regional geochemical surveys and regolith studies, and coordinates regional geophysical surveys such as airborne magnetics and radiometrics.

Part of GSWA's major function in the Department is to provide immediate access to pre-competitive exploration data and much is now accessible via the GSWA website www.doir.wa.gov.au/GSWA/index.asp

GSWA programs focus on regions of the State which are perceived to have high potential for mineral or petroleum resources, but which are relatively poorly understood geologically. Recent work programs have centred on the Pilbara, Gascoyne and Eastern Goldfields regions, and during the past two years, GSWA teams have been undertaking detailed studies in the Kimberley. Relevant GSWA research publications are:

- GSWA Report 88, *Mineral Occurrences and Exploration Potential of the West Kimberley*, published 2004. This is a mineral prospectivity package that includes a report of 88 pages, a 1:500,000 scale geology and mineralisation map, and a CD-ROM containing several digital datasets.
- GSWA Report 58, *Subsurface Facies Analysis of Devonian Reef Complexes Lennard Shelf, Canning Basin, Western Australia*, published 2000. This is a report of 128 pages providing details of the relationship between Mississippi style lead-zinc-silver deposits and the depositional setting and reef-building processes of their host rocks.
- GSWA Bulletin 143: *The Geology of the King Leopold and Halls Creek Orogens*, in progress. This is a major study of geological history, tectonic development, geochronology, and petrology of these extensive tectonic units.
- GSWA Bulletin 144: *Geology of the Lennard Shelf*, in progress. This is a major study of its geological history, depositional environment and development, and sedimentary facies, highlighting their importance to lead-zinc mineralisation.

Airborne magnetic surveys are planned to commence in 2006/07 over the Lennard Shelf and parts of the adjacent King Leopold Orogen.

The GSWA has already, or is planning to, package and market geoscientific information to the mineral exploration industry to differentiate the geological provinces, various mineralisation styles, and potential for further discoveries in the region to encourage explorers to give the region higher priority for private sector exploration investment. All publications and datasets for all regions of Western Australia are available to be downloaded from the GSWA website.

5.4.2 Gold

Exploration for gold in the West Kimberley has been intermittent since gold was first discovered in the area in 1856. Recent exploration from the 1970s to the 1990s was limited and confined to the Mount Broome – Richenda River area where small discoveries were made at Turtle Creek and Robinson River.

Exploration by Striker Resources and De Beers in 2001 for gold has uncovered an epithermal gold province in the north Kimberley suggesting that there is potential for gold mineralisation in the Kimberley Basin. This find was buoyed by another find near Oombulgurri in 2002 from which Striker Resources reported soil assays of up to 16.7 grams of gold per tonne.

These discoveries signalled the potential for a new style of gold deposits in the Kimberley and led to a big increase in application for exploration tenements by a number of companies in 2002. While much of these tenements have since been relinquished, gold exploration activities remain much higher than in past years.

5.4.3 Base metals

The closure of the Western Metals' Lennard Shelf operations and its purchase by Teck Cominco Ltd in 2004 has resulted in renewed exploration in the vicinity to assess the resource and exploration potential. The reopening and long term future of these operations depends on Teck Cominco being able to define long-term ore reserves. In turn, this requires access to land near to the current deposits and permission from Traditional Owners to explore and subsequently mine.

5.4.4 Diamonds

Good production results from Kimberley Diamond's Ellendale deposit have resulted in further exploration activity in the area. A number of companies hold promising tenements which they plan to investigate further.

Conquest Mining holds the Ellendale 17 pipe as well as several diamond targets in the Napier Range. The company reports that Ellendale 17 is the same size as Kimberley Diamonds' Ellendale 9 pipe and is expected to contain diamonds of similar value.

Paramount Mining holds tenements in the Ellendale field and the Napier Ranges. The Company believes that the Ellendale tenements have significant potential to host economic diamond deposits and intends to conduct an intensive ground survey and drilling programme to investigate further. Further investigation is also planned for the Napier Range deposits.

Developing the West Kimberley's Resources

Kimberley Diamonds' spin-off exploration company Blina holds varying interests covering the centre core of the Ellendale field including a number with 'near mine' status. The company intends a number of surveys in the area.

Table 3 **Summary of current advanced exploration activity: West Kimberley**

Company	Current and planned exploration
Base metals	
Teck Cominco	Subject to the reopening of the Lennard Shelf operations, the Kutarta deposit is likely to supplement production from Kapok and Pillara when output from the latter reduces. The Fossil Downs deposit has been earmarked for future development when the Kapok orebody is depleted. Exploration tenure around the Lennard Shelf Operations covers an area in excess of 2200 square kilometres.
Teck Cominco / Noranda	Noranda signed an agreement with Teck Cominco to earn a 50% interest in the Lennard Shelf mineral properties, plant and equipment and infrastructure. Under the agreement, Noranda will be required to invest approximately A\$26 million in exploration, operating, capital expenditures or other advances in Lennard Shelf.
Diamonds	
Blina (Kimberley Diamonds)	Ongoing exploration near current mine resulted in two new discoveries in Dec 2003 at the northern section of the Ellendale field. Ellendale Lease covers an additional 35 known diamondiferous pipes, plus 13 newly identified pipes.
Conquest Mining	Conquest Mining has been exploring in the West Kimberley since 1994. Conquest's leases cover an area of 330 km ² straddling the Lennard Shelf to the immediate north of Kimberley Diamond's Ellendale operations and adjoin exploration tenements held by Kimberley Diamonds' newly listed exploration arm, Blina. The area is also prospective for world class Mississippi Valley style silver-lead-zinc mineralisation.
Paramount	The Ellendale Project consists of 3 Prospecting Licences 04/196-198, totalling approximately 340 hectares and one Exploration Licence 04/1391, approximately 70 square kilometres in area. The Company can earn a 90-95% interest in the tenements through farm-in agreements. The Company believes that its Ellendale tenements have significant potential to host economic diamond deposits. It will conduct an intensive ground survey and drilling programme to determine the size of the lamproite bodies, the nature of the magnetic anomaly and DEM targets, and the alluvial potential of the area. If results are encouraging, a bulk sampling programme to test for diamond grade will follow.
Iron ore	
Aztec	Aztec Resources Limited has commenced drilling on Koolan Island as part of a bankable feasibility study to recommence mining. Significant high grade iron ore up to 67% Fe and up to 36 metres wide has been found at the Eastern and Barramundi deposits. The study is due for completion in early 2005.
Gold	
Various companies	Various companies are currently exploring for gold including AngloGold Australia, Striker Resources NL and De Beers Australia Exploration formed a joint venture in 2003 for East Kimberley including the Oombulgurri area.

Source: Various company websites and Department of Industry and Resources⁸

5.5 Onshore petroleum exploration and resources

Petroleum exploration began in the Canning Basin in the early 1920s when the Freney Oil Company encountered asphaltic flows in drill holes on the Lennard

⁸ Geological Survey of Western Australia, Mineral Occurrences and Exploration Potential in the West Kimberley; Report 88, 2004, pp 15-19.

Shelf, in the west of the study area and beyond. Minor exploration activity followed, but intensified when the Australian Government and WAPET conducted gravity, magnetic and seismic reflection surveys. Since then, nearly 250 wells have been drilled in the Canning Basin, mostly in the West Kimberley region. Oil is produced commercially in the West Kimberley in small quantities (about 30,000 barrels a year). The fields are 80 km east of Derby at the West Kora, Blina/Boundary and Sundown/West Terrace/Lloyd sites.

The Department of Industry and Resources has released petroleum acreage in the east Canning Basin. To the north-east of the study area, the Bonaparte Basin (which extends into the Northern Territory) was first drilled in 1964. Since then, mine wells have been drilled onshore in the Kununurra – Wyndham area.

5.6 Offshore petroleum exploration and resources

The Browse Basin off the coast of West Kimberley contains significant reserves of hydrocarbons, especially gas. Figure 7 compares the anticipated resources of the major gas basins in North Western Australia and highlights the remoteness of these reserves from centres of population and domestic markets. Access to international and domestic markets is required to monetise these resources.

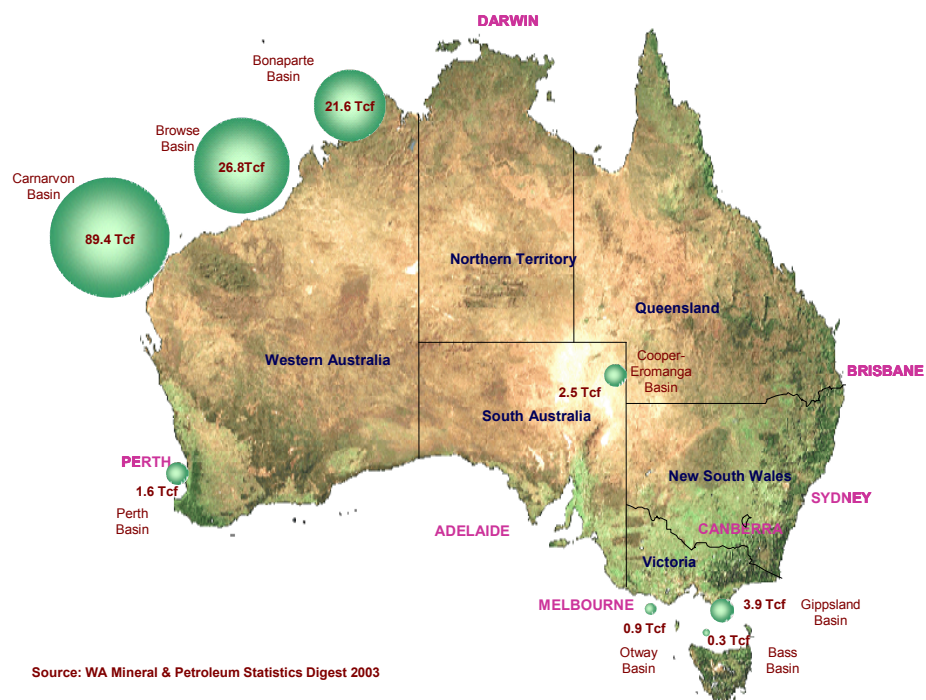
The Browse Basin reserves are considered to contain about 30 Tcf⁹ of gas and 588 million bbls¹⁰ of condensate, at a P50 level of confidence (and potentially far more), compared to an estimated 22 Tcf in the remaining reserves in the North West Shelf area. In addition, much of the Browse gas has relatively high associated condensate volumes, which can help the revenue stream if the gas and LNG sales contracts can be concluded. Commercial accumulations of oil have yet to be found in the Browse Basin.

The Carnarvon Basin reserves are considered to contain 22 Tcf of gas, 95 million bbls of condensate and 470 million bbls of crude oil. The non commercial reserves for the Carnarvon Basin are considered to be 62 Tcf of gas, 545 million bbls of condensate and 468 million bbls of crude oil.

⁹ Trillion cubic feet – glossary of terms and acronyms in Attachment B.

¹⁰ bbls: Barrels.

Figure 7 Gas resources in Australia



Data source: Australian Petroleum Production and Exploration Association

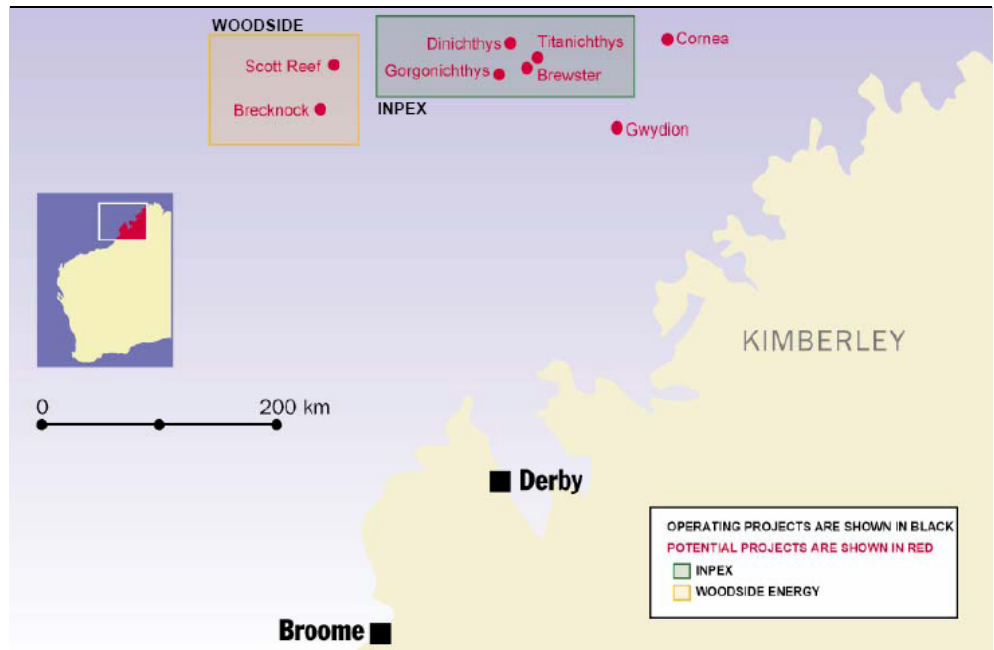
5.6.1 Significant gas and condensate discoveries in the Browse Basin

Many exploration wells have been drilled in the Browse Basin area and these have led to the discovery of three main significant hydrocarbon accumulations so far:

- Gas/condensate at Scott Reef/Brecknock area – Woodside operated;
- Gas/condensate at Ichthys area (previously Brewster) – Inpex operated;
- Oil at Cornea area – previously Shell operated – now relinquished.

Major oil and gas discoveries in the Browse Basin are shown in Figure 8.

Figure 8 Major oil and gas discoveries in the Browse Basin



Source: Department of Industry and Resources

Scott Reef/Brecknock area

The Scott Reef/Brecknock area lies 425 km north of Broome in water depths ranging from 400 to 800 metres. The initial exploration in this area was carried out by Burmah Oil in 1971 when the successful Scott Reef-1 exploration well was drilled. Since then the nearby Brecknock and Brecknock South gas fields were discovered by Woodside in 1979 and 2000 respectively. The scope for hydrocarbons recovery from these discovered reservoirs in this area is considered to be around 20 Tcf of dry gas and 310 million barrels of condensate.

Ichthys area

The Ichthys area within the WA-285-P permit lies 440 km north of Broome and 800 km south-west of Darwin. Water depths range from 90 to 340 metres.

Between March 2000 and February 2001, Inpex drilled three successful wildcat wells named Dinichthys-1, Titanichthys-1 and Gorgonichthys-1 that flowed between 21.3 million and 40.6 million cubic feet per day of gas, as well as between 292 and 2,305 barrels per day of condensate. The Ichthys reserves are considered to be six Tcf of gas and 232 million bbls of condensate.

Inpex has not released reserves numbers based on the three discovery wells to date, but the expectation is that the reservoirs contain at least 10 Tcf of recoverable gas and 600 million barrels of condensate, making it nearly double

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the size of Conoco Phillips' Bayu Undan field to the north-east that is currently producing oil and will supply gas to the Darwin LNG plant from late 2005.

Cornea area

In 1998 Shell secured the WA-265-P and WA-266-P Browse Basin blocks. Subsequent drilling discovered a promising oil column at the Cornea field. However, further appraisal of the Cornea reservoir found that the reservoir was highly fractured and not suitable for commercial development using current technology. The Cornea permit area has since been relinquished by Shell.

6 Markets for petroleum and mineral products

6.1 Global economic overview

6.1.1 The global economy: the short term (2004 – 05)

The upturn in global economic activity from 2004¹¹ as illustrated in Table 4, is expected to result in a growth in demand for all minerals and energy commodities. Increased global demand combined with Australia's reliance on minerals and energy exports will result in an increase in the volume of these exports. The strong Australian dollar is expected to weaken over the year as currencies such as the US dollar recover. An increase in demand for Australian commodities is expected as a result.

Table 4 Real GDP growth estimates

	2002	2003	2004	2005
US	2.4	3	4.25	3.5
EU	1.1	0.75	2	2.5
Japan	0.2	2.25	2.5	2.25
China	8	8.25	7.75	7.5
Other East Asia	4.6	3.75	5	4.75
Australia	4.5	2.75	4	3
World	2.8	3.25	4.25	3.75

Source: ANZ

Global economic growth is expected to weaken in 2005 as a result of more moderate expected growth rates in the key markets of China and the US. Despite this decline, the global economy is expected to remain buoyant in the short term period of 2004 – 2005.

China

The rate of economic growth in China has been extremely high in recent years. This is driving a rapid rise in demand for minerals and energy products, including from Australia. There is some doubt about the ability of the Chinese economy to sustain such growth, however. A deceleration of economic growth in China could see a slowing of demand growth for the iron ore, alumina and energy products from Australia. Whilst Chinese economic growth in 2004 is forecast to be slightly lower than that experienced in 2003, it is expected to

¹¹ United Nations, LINK Global Economic Outlook, April 2004, p 4

remain high at around 8 per cent. The Asian Development Bank identified signs of the economy overheating in 2003 including the high investment growth rate, rising prices of raw materials, and shortages in some sectors including oil, electricity, and coal¹². As a result of these the concerns, the Chinese Government took measures to control growth in late 2003 and this has had some impact in slowing investment growth.

Despite uncertainty surrounding the rate of Chinese economic growth, ABARE¹³ has forecast that Australia is expected to experience an increase in export revenue in 2004 and 2005 caused by buoyant global demand coupled with a lower Australian dollar.

Japan

Economic recovery in Japan in 2002 and 2003 is expected to continue in the short term, albeit at a more modest pace. Nevertheless, improved growth in one of the world's largest economies will have a significant impact on other economies such as Australia and the rest of Asia. GDP growth in Japan was 2.5 per cent in 2003 and has been forecast at around 4.0 per cent for 2004 and 1.8 per cent in 2005, reflecting some uncertainty as to whether Japan's economy is entering a period of sustained recovery.

However, there are concerns¹⁴ that, although the tempo of Japanese economic growth will continue during 2004, it is based on a relatively buoyant export performance. Recovery will gradually weaken in 2005 due to the expected slowdown in 2005 in the key markets of the US and China which take 40 per cent of Japan's exports. The concerns of declining growth are already evident. Whilst corporate and consumer confidence was high at the beginning of 2004 it began to decline in mid 2004 with retail sales and industrial production falling.

Europe

The economies of Europe are expected to recover in 2004 and 2005. However by world standards they continue to remain sluggish with growth rates hovering around two per cent.

Growth in the major European countries is expected to be variable. While economic growth in Germany continues its modest improvements, it remains at a relatively low 0.5 per cent. This compares with France, which is expected to

¹² Asian Development Bank, Development Outlook 2004

¹³ ABARE, Australian Commodities: forecasts and issues, Vol 11 No 3 September Quarter 2004, p 382

¹⁴ various including Research Centre for Policy and Economy, Mitsubishi Research Institute, Japan's Economy, p 1

improve moderately to two per cent in 2004 but lag behind the economies of the UK and Spain who are expected to grow at around three per cent¹⁵.

USA

In the first quarter of 2004, US economic growth was 4.5 per cent and in the second quarter 3.0 per cent. Although these growth rates are slightly below the forecast rate of 4.25 per cent annual growth, they reflect the strength of the domestic US economy. In particular, productivity remains strong¹⁶ and unemployment is beginning to ease which are having a positive impact on consumer and business confidence.

Growth is expected to decline slightly to 3.5 per cent in 2005, as illustrated in Table 4, as inflationary pressures, fed by higher oil prices, dampen the domestic economy.

6.1.2 The global economy: the long term (2004 – 24)

Over the long term, global economic growth is expected to moderate as countries currently experiencing high growth rates settle into a more sustainable pattern of growth. Global economic growth is expected to continue to be influenced by the current economic powers including the US, China and Europe. The Asian region is expected to become more important, however, as its economy recovers and India is expected to play a greater and more influential role in the world economy.

Demand for minerals will be led by those that are used in the construction sector and in the industrial sector, especially in new and emerging technologies. The major influences on the world economy in the long term are expected to be:

- The price of energy which has a direct impact on the industrial sector; and
- Political risks which could have an unsettling impact on global consumer and business confidence.

6.2 Minerals markets

The following sections outline the current global demand and supply of the major minerals found in the West Kimberley. Table 8 presents a summary of the major mineral deposits in the West Kimberley including their mine life, value and proponent.

¹⁵ Price Waterhouse Coopers, European Economic Outlook, June 2004

¹⁶ OECD, OECD Economic Outlook 75, June 2004 p 5. Also ABARE, Australian Commodities: forecasts and issues, Vol 11 No 3 September Quarter 2004, p 380

6.2.1 Lead

Australian and global production

Australia is the world's largest miner and exporter of lead. The bulk of Australia's production is exported in the form of lead bullion to the United Kingdom, with a smaller amount to South Korea. Lead in ore and concentrate is also exported to Japan for further processing, while refined lead is sent to Taiwan, South Korea, Indonesia, India and Malaysia.

Lead is commonly a by-product of zinc/polymetallic mines. Almost all of Australia's lead-zinc mines¹⁷ are underground operations and are highly mechanised. Ore is drilled and blasted in large volumes, transferred to underground rock crushers by large loaders and trucks before being hoisted to the surface in skips or driven directly to the surface by truck via a spiral access tunnel (decline).

Falling prices for base metals over the 2001 - 2003 period contributed to the closure of a number of Australian lead operations including the Western Metals operations at Lennard Shelf. The largest lead and zinc miner in the world, Pasmaico, also went into administration, causing the temporary closure of a number of operations including the Century zinc mine in Queensland, the Rosebury zinc-lead-silver mine in Tasmania, the Risdon zinc smelter, the Budel zinc smelter and the Port Pirie lead/zinc smelter. The result of these closures was a reduction in the global supply.

Before the closure of the Lennard Shelf, the Shire of Derby-West Kimberley produced nearly all of the lead in Western Australia. In 2002, this was valued at \$30.4 million.

There are also lead deposits in the Shire of Broome at Admiralty Bay, which are undeveloped but have recently been purchased by Kagara Zinc, indicating that there may be plans to develop the deposit.

Demand for lead

The most common uses of lead are in batteries. Lead is also used as a fuel additive but as this outdated technology is replaced, the demand for lead based products is falling. This gradual fall in demand over time has had an impact on the supply of lead and has resulted in a fall in the number of lead projects coming on line. New battery technologies using lead may lead to a resurgence in demand, however.

¹⁷ Only the Century mine in North West Queensland is open cut.

This general reduction together with the recent closure of some significant lead operations in 2001 and 2003 has caused an under supply in the lead market in 2003 and 2004. This has been exacerbated by a marginal increase in demand for lead caused by increased global industrial activity, particularly in China and the US.

Pressure on supply has accelerated prices for lead in the first quarter of 2004. This price increase should be maintained as economic growth is forecast to remain high and additional lead projects are not expected to be established for some time. However, there is a possibility that the Pasmaenco and Lennard Shelf operations will come into production again under new ownerships. These developments are expected to occur in late 2004 or 2005 and would alleviate the pressure on lead stocks.

After then, prices are expected to remain stable as demand continues to outstrip supply. However, the forecast moderation of economic growth in the longer term could cause prices to dampen.

6.2.2 Zinc

Australian and global production

The development of the large, world-class zinc-lead-silver deposits at McArthur River in the Northern Territory and Cannington and Century in Queensland has resulted in Australia becoming one of the world's largest producers of zinc and a leader in zinc mining and processing technology. Other major producers include China and Canada.

Australia exports zinc as refined metal to a number of markets primarily Indonesia, Hong Kong, Chinese Taipei and Malaysia. Zinc ore and zinc concentrate is also exported primarily to Japan and South Korea but also to Europe.

Zinc production in the West Kimberley in 2002 was valued at \$123.8 million, which is 72 per cent of the value of Western Australia's total zinc production. Production was confined to the Western Metals' Lennard Shelf operations near Fitzroy Crossing in the Shire of Derby-West Kimberley. These operations have now been closed following the company going into voluntary administration on 18 July 2003 as a result of falling prices in 2002 and 2003. The Lennard Shelf operations ranked in the world's top five zinc mining operations and their closure is having a significant impact on global supply.

The Lennard Shelf closure, together with the closure of the Cockle Creek smelter in New South Wales, is expected to cause Australia's zinc mineral and metal output to fall in 2003-04. Production is not expected to recover until 2005

and producers have time to respond to the expected increasing demand, as illustrated in Table 5. There is expected to be short term increases in total Australian production as existing mines increase production rates. Longer term recovery will depend on when the expansion of Consolidated Broken Hill's Elura mine comes into production and whether the Lennard Shelf operations come back into production.

Table 5 **Global outlook for zinc**

	Unit	2002	2003	2004	2005	2006	2007	2008	2009
World									
Zinc production	Kt	9725	9780	9840	10050	10600	11050	11300	11600
Zinc consumption	Kt	9374	9570	9980	10260	10540	10840	11200	11570
Price	US\$/t	779	828	1025	990	1020	1000	950	1050
Australia									
Mine output	Kt	1490	1529	1410	1497	1647	1662	1682	1682
Exports									
- Ores and conc.	Kt	1849	1913	1809	2012	2312	2342	2382	2262
- Refined	Kt	496	486	433	419	420	420	420	480
- Total value	Kt	1529	1427	1287	1490	1679	1681	1697	1860

Note: a In 2004 US dollars. b In 2003-04 Australian dollars. f ABARE forecast. z ABARE projection.

Note: Values are in nominal dollars

Data source: ABARE

Global supply of zinc is also expected to remain flat as a result of mine closures and reduced exports from China. This situation is expected to continue until 2005 when new developments come into production, as illustrated in Figure 9. Table 5 shows ABARE's forecast for the global market for zinc for the remainder of this decade and indicates that demand and supply will grow only marginally causing prices to remain high.

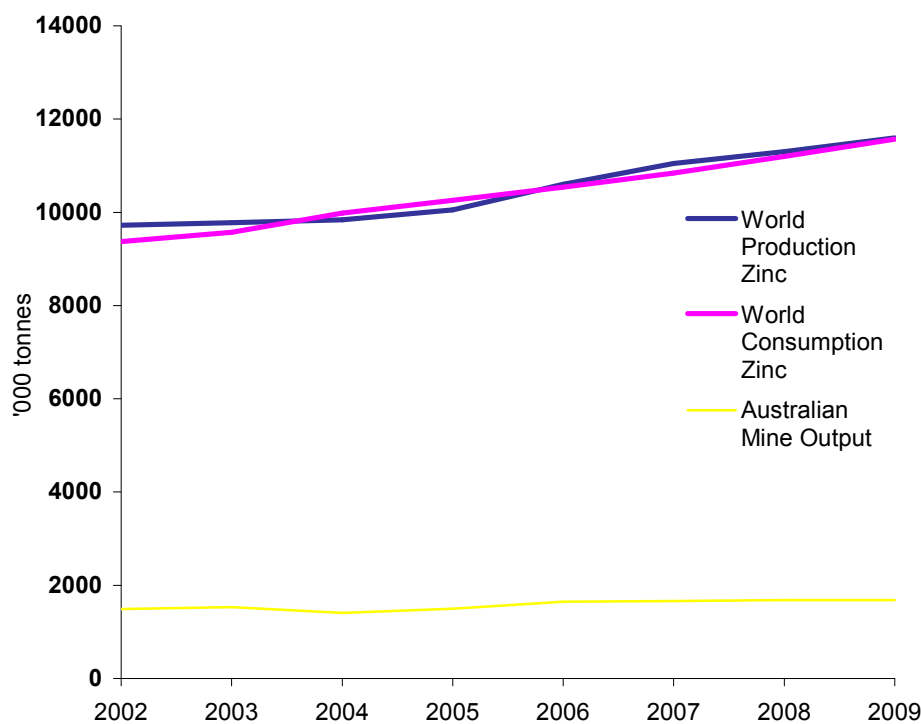
Demand for zinc

Zinc is used for galvanising iron and steel to protect it from rusting. Almost half of the total global zinc production is used in the construction sector and around one third is used in the transport and machinery sectors. Demand for zinc is therefore dependent on activity in the construction and industry sectors.

A substantial fall in global zinc prices as a result of the declining world economy in 2002 caused a subsequent decline in zinc supplies over 2002 and 2003 as various operations around the world were forced to close. An improvement in the global economy and speculative buying activity in the face of falling supplies resulted in a strengthening of the world price for zinc in the last quarter of 2003.

Prices rose above US\$1000 a tonne (US45c/lb) in December 2003 for the first time since March 2001 and remained above that level into the early part of 2004¹⁸.

Figure 9 Global demand and supply of zinc



Data source: ABARE

Continued growth in world industrial output in the short term, especially in the US and China, will result in higher consumption of zinc and will assist in maintaining the current high price level. On the supply side, significant closures of both mine and smelting capacity, particularly in 2003, will cause the shortage of supply to continue into the future and will maintain the upward pressure on prices.

The demand for zinc from Australia and Canada is expected to increase as continued industrial growth in China places pressure on domestic stocks and reduces the supply of zinc for export. Demand is therefore expected to come from Europe and the US in line with their expected higher economic growth.

ABARE has forecast that world zinc prices will grow strongly in 2004 to average around US\$1025 a tonne and are expected to fall to average US\$990 a tonne in 2005¹⁹.

¹⁸ ABARE, Australian Commodities: forecasts and issues, op cit, p 443

¹⁹ Ibid p 443

Beyond 2005, zinc prices are projected to decline as world economic and industrial production growth moderates and global supply increases.

6.2.3 Iron ore

Supply of iron ore

Iron ore resources occur in all the Australian States and the NT²⁰, but 80 per cent of the identified resources occur in the Pilbara region of Western Australia. Iron ore is the largest selling product in the Western Australian minerals and energy industry after petroleum, accounting for a record 194 million tonnes or 19 per cent (by value) of total minerals and energy sales in 2003.

Table 6 Global outlook for iron ore and steel

	Unit	2002	2003	2004	2005	2006	2007	2008	2009
World									
Production Steel	Mt	902	961	1010	1039	1069	1100	1132	1166
Production Iron Ore	Mt	1131	1196	1255	1279	1310	1340	1372	1401
Australia									
Production Iron and Steel	Mt	8.31	9.4	9.78	10.1	10.18	10.26	10.84	11.92
Production Iron Ore	Mt	185.3	198.9	227	237	245	253	260	267
Exports Iron and Steel	Mt	3.3	3.59	4.29	4.69	4.56	4.45	4.89	5.82
Value	A\$ m	1484	1855	1958	2217	2165	2066	2112	2275
Exports Iron Ore	Mt	156.1	181.5	206.2	222.3	231.8	239.8	245.8	250.4
Value	A\$ m	5160	5342	5415	6612	7480	7808	7838	8126

Note: a Includes all steel items in ABS, Australian Harmonized Export Commodity Classification, Chapter 72, 'Iron and steel', excluding ferrous waste and scrap and ferroalloys. b In 2003-04 Australian dollars. f ABARE forecast. s ABARE estimate. z ABARE projection.

Note: Values are in nominal dollars

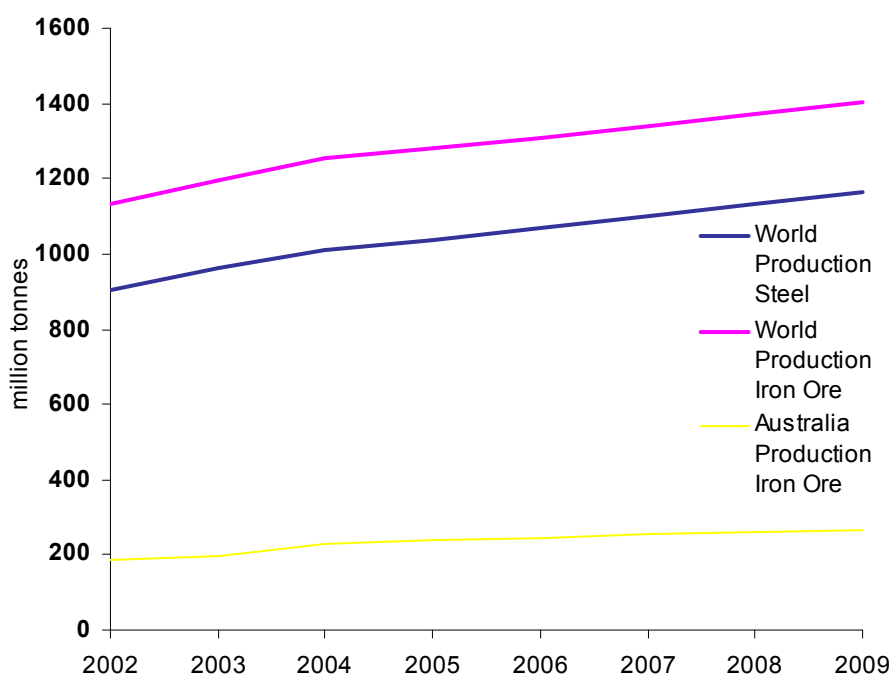
Data source: ABARE

Forecasts of an increase in global steel demand have led to an increase in actual and planned investment in the iron ore industry in Australia. Many of these investments are currently under construction and are expected to come on line over the 2004 to 2006 period. Figure 10 and Table 6 show the global production of iron ore and steel compared to Australian iron ore production. They show global production increasing post 2005 largely as a result of increased Australian production.

²⁰ Minerals Council of Australia, <http://www.nationalminesatlas.gov.au/info/factsheets/iron.jsp>

Examples of this increased capacity include the expansion of BHP Billiton's Mining Area C and the Koolan Island iron ore mine development. Other planned developments include the proposed Fortescue Metals Group iron ore mine, rail and port development which is still in the early proposal stages and, Hope Downs iron ore development. Between them, these planned and proposed projects represent over \$5 billion in investment.

Figure 10 **Global demand and supply of iron ore and steel**



Data source: ABARE

Demand for iron ore

The demand for iron ore is a direct reflection of the demand for steel. Steel is the main structural metal in engineering and building projects, which means that demand for steel is normally a reflection of industrial growth.

ABARE reported that in 2003 global crude steel output was an estimated 961 million tonnes, a rise of 59 million tonnes on the previous year. This increase was on the back of a similar rise during 2002 and was a response to higher prices created by strong economic growth in China creating an increase in demand for steel.

As a result, China now consumes around 260 million tonnes per annum of steel, which is around 26 per cent of world steel consumption. As a whole, Asia accounts for 43.5 per cent of global steel production. In 2003, total steel production in Asia was 393 million tonnes or 11 per cent higher than the

previous year²¹. Growth in production of steel in Asia is expected to moderate in the near future because of lower growth rates in China and India. Growth in steel consumption in the rest of the world remains steady.

China is expected to lead the continued increase in demand for steel for the remainder of the decade with demand from China expected to reach around 300 million tonnes per annum by 2010²².

6.2.4 Bauxite/alumina

Australian and global production

Australia is the world's largest producer of bauxite and alumina, accounting for about 40 per cent of world's bauxite and over one third of the global supply of alumina. In Australia, bauxite is mined from open cut operations at Weipa (Qld), Gove (NT) and the Darling Range (Western Australia). Alumina refineries are located at Gladstone, Gove and the South West region of Western Australia.

In addition, there are the undeveloped bauxite deposits in the Mt Leeming – West Kalumburu area as well as the Mitchell Plateau and Cape Bougainville deposits. As discussed, studies are currently underway to reassess the feasibility of mining in the region.

In Australia there are a number of plans for expansion of alumina refineries that are either currently underway or are planned for after 2005, which will increase Australia's alumina production by over 4 million tonnes each year. These include efficiency upgrades at Alcoa's Pinjarra refinery and the Worsley refinery – both in Western Australia. In addition, Alcoa is currently seeking approval to expand its Wagerup refinery and Alcan is seeking approval to expand its Gove operations. Worsley proposes to expand its refinery from late 2005.

There are also several aluminium smelters in Australia, including the Comalco Gladstone smelter in Queensland and Bell Bay smelter in Tasmania, the Alcoa Portland and Point Henry smelters in Victoria, and the Tomago and Kurri Kurri smelters in New South Wales.

²¹ The Chamber of Minerals and Energy of Western Australia, *Bedrock of the Economy* 2004, p 53

²² The Chamber of Minerals and Energy of Western Australia, *op.cit.*

Table 7 **Global outlook for bauxite and alumina**

	Unit	2002	2003	2004 ^f	2005 ^z	2006 ^z	2007 ^z	2008 ^z	2009 ^z
World									
Production									
Primary Aluminium	kt	26,145	27,635	28,724	29,833	30,996	32,081	33,060	33,903
Consumption									
Primary Aluminium	kt	24,925	27,243	28,864	29,903	30,890	31,801	32,723	33,934
Prices^b									
World Aluminium	US\$/t	1,352	1,433	1,633	1,613	1,535	1,460	1,395	1,468
Alumina Spot	US\$/t	140	280	340	278	211	190	181	191
Australia									
Production									
Primary Aluminium	kt	1,809	1,855	1,887	1,937	2,192	2,440	2,471	2,504
Production Alumina	kt	16,417	16,413	16,834	17,462	18,577	19,364	20,348	20,776
Production Bauxite	Mt	54	54	57	59	64	66	70	72
Exports									
Primary Aluminium	kt	1,490	1,551	1,559	1,598	1,851	2,098	2,125	2,153
Value	A\$/m	3,965	3,696	3,340	3,503	4,160	4,859	4,809	5,094
Exports Alumina	kt	13,091	13,168	13,617	13,684	14,303	14,606	15,529	15,893
Value	A\$/m	4,114	3,660	3,677	3,695	3,856	4,058	4,216	4,512
Exports Bauxite	kt	5,429	7,445	6,860	7,377	10,422	9818	12,118	12,919
Value	A\$/m	136	186	172	184	261	245	309	336
Total Value	A\$/m	8,214	7,542	7,189	7,383	8,276	9,162	9,334	9,941

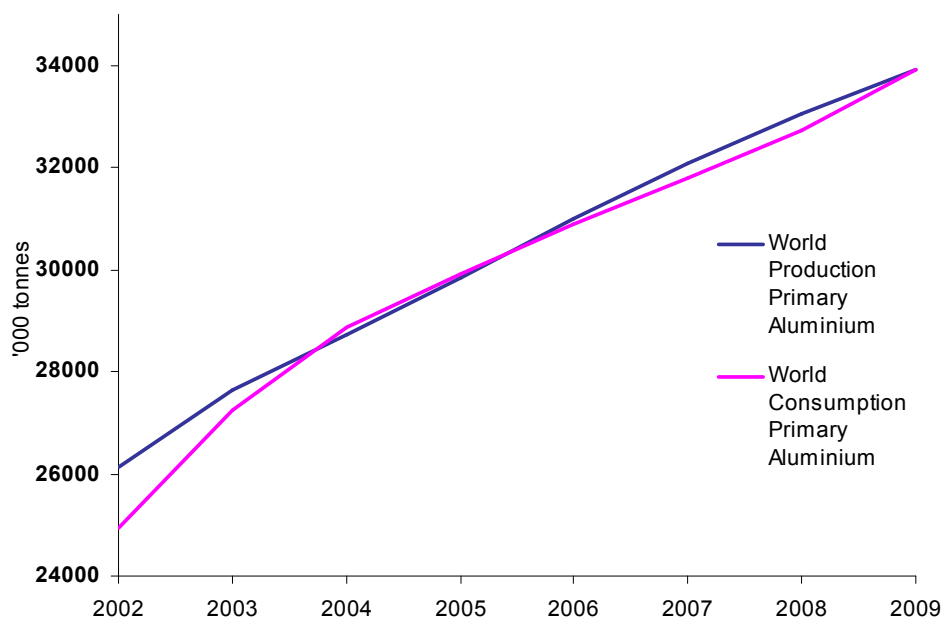
Note. b LME cash prices for primary aluminium. F ABARE forecast. z ABARE projection.
Data source: ABARE

At the end of 2005, significant new aluminium smelting capacity is expected to commence in Bahrain, India, Canada, Norway, Mozambique and South Africa. Beyond 2005, further capacity is expected to come on line with some analysts²³ forecasting that as much as 30 million tonnes of new capacity could impact the world market by 2008. This will drive a continuing strong demand for alumina.

²³ MiningNews.net, Alumina Refineries Looming, 28 May 2004

The global outlook for aluminium market is presented in Table 7 and shown pictorially in Figure 11. They illustrate the dramatic increase in production of aluminium after 2004.

Figure 11 **Global demand and supply outlook: aluminium**



Data source: ABARE

Recently announced smelting expansion plans outside of Australia include:

- Russian Aluminium, which has signed a memo with the Government of Kazakhstan to build a new 1.5 Mt per annum refinery and associated aluminium smelter.
- Brazilian iron ore producer, CVRD and the Aluminium Corporation of China have announced plans to build a 1.8 Mtpa refinery with 2007 as the proposed production start-up date.
- Russian Aluminium has also announced a feasibility study into a 600,000 tonne aluminium smelter in Siberia that could begin production as early as 2009.
- Alcoa Inc plans to build a \$1 billion aluminium smelter in Trinidad to take advantage of nearby natural gas reserves.
- Alcan Inc and Alcoa Inc have signed a memorandum of understanding to assess the feasibility of a 1.5 million-tonne a year alumina factory in Guinea, which could be up and running by early 2008.
- Dubai Aluminium has announced it is expanding the capacity of the Jebel Ali smelter to 761,000 tonnes per annum.
- Guinea Aluminium Products Corp Ltd is planning a 2.6 million tonne-per-year alumina refinery.

Despite this activity, production in China is expected to fall as a result of power shortages and government measures to curb over-investment in key industrial sectors. In the last four months of 2003 China closed about 350,000 tonnes of aluminium capacity, covering 25 smelters, and construction of 2.37 million tonnes of planned aluminium capacity had been stopped or delayed. For example, Aluminium Corp of China Ltd's Pingguo plant announced that it has cut aluminium production by more than one-third because of power shortages.

Demand for bauxite and alumina

Bauxite is a low value resource of which nearly all is refined to form alumina. Alumina is then smelted to form aluminium. The demand for aluminium is closely tied to industrial growth as the primary uses are in the manufacture of electrical equipment, cars, ships, aircraft as well as domestic and industrial construction, packaging (aluminium foil, cans) and general household goods.

Global demand for aluminium in the near future is expected to be driven by growth in the construction and transport industries in China. China's recent high rate of economic activity has created an unprecedented growth in demand for aluminium which is expected to lead to it becoming the world's largest consumer of aluminium during 2004. There is also expected to be increased demand from Europe and India in 2004 in line with strong economic growth in these countries.

ABARE has forecast global aluminium prices to average US\$1,633 a tonne in 2004, 14 per cent higher than in 2003, as a result of increasing demand. Demand is expected to outstrip supply until the second half of 2005 when significant new aluminium capacity becomes available. Aluminium prices are therefore forecast to remain relatively high into the first half of 2005²⁴.

Demand for alumina should therefore remain strong in the near term.

After 2005, aluminium prices in real terms are projected to decline, as smelting capacity increases. In the long term, the growth in demand for alumina is expected to slow as growth in the world economy begins to cool.

6.2.5 Diamonds

Australian and global production

Australia is currently the largest supplier of diamonds by volume in the world. The Argyle operation in the North Kimberley region is the world's largest diamond mine. Not only does it produce nearly all of Australia's diamonds but

²⁴ABARE, Australian Commodities: forecasts and issues, Op cit., p 436

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it contains a very large proportion of small brown to yellow diamonds and a smaller amount of rare pink diamonds.

Western Australia currently produces six per cent by value and 22 per cent by volume of the world's rough diamonds, with Botswana, Russia, South Africa and Canada the other major producers. The lower US\$ per carat value of Argyle's production is driven by the nature of the diamonds it produces, which comprise five per cent gem, 70 per cent near gem, and 25 per cent of industrial quality.

In 2002, Kimberley Diamonds commenced production from the Ellendale Operations in the West Kimberley. Mining operations were expanded in 2003-04. The Ellendale processing plant near Derby is now capable of producing around 200,000 carats per annum. The Kimberley Diamonds' expansion and the current buoyant exploration activity in Australia, including in the Kimberley, driven by growing demand could lead to additional deposits being developed.

Demand for diamonds

The primary use for diamonds is in jewellery. The US is the world's largest consumer of diamonds and is expected to remain so for some time, currently accounting for around half of global retail diamond jewellery sales.

Recent economic growth in Asia and the US resulted in strong growth for rough diamonds in 2003. This growth is expected to continue to strengthen in 2004 and 2005 as strong economic growth in these regions continues and as the size of the consumer middle class, especially in Asia, expands.

Improved demand was reflected in strong prices for rough diamonds in 2003. Prices are expected to remain strong until at least 2005 as a result of continued demand in the US. After 2005, it is possible that additional supply could cause prices to flatten out. However, the development of new markets in China and India, where economic growth is rapid and diamond consumption is likely to rise faster than in established western markets, is expected to grow demand over time and ensure that prices remain strong.

Table 8 Summary of selected mineral deposits in the West Kimberley

Name of mine/deposit	Proponent/ Operator	Product	Description of processing and extraction	Volume	Market	Mine life	Infrastructure
Cockatoo Island	Henry Walker Elfin (50%), Portman Mining Limited (50 %)	High-grade premium sinter fine iron ore	2000 – 2002 mining of low grade dumps using a beneficiation process. 2002 – sub sea level extraction of previously worked mine.	Current = 50,000-75,000tpm. After seawall completion = 100,000-130,000tpm.	China and Japan	Once the seawall is built, the expected ore body will be 3.5 million tonnes with a mining life of over 3 years.	Berth at Cockatoo Island for vessels of up to 50,000 DWT
Pillara mine and processing plant.	Teck Cominco	Lead and zinc	All mining on the Lennard Shelf is carried out underground with Company owned and operated equipment. At the Kapok mine ore is crushed underground and transported to the surface by belt conveyor from where it is loaded into contractor operated road trains and hauled to the Pillara concentrator.	2.4 mtpa	Global	Commenced 1997, closed 2003	Exported through Derby Port from a dedicated export facility built by Western Metals. Transported from processing plant along Gt Northern Highway to Port by road train.
Cadjebut processing plant and camp	Pilbara Mines (Purchased from Teck Cominco in May 2004)	Lead and zinc	Resource exhausted. Mine closed.	Na		Commenced July 94 – resource exhausted 97.	Resource exhausted. Mine closed.
Kapok	Teck Cominco	Lead and zinc	As above	Na	Global	Commenced '95	As above

Name of mine/deposit	Proponent/Operator	Product	Description of processing and extraction	Volume	Market	Mine life	Infrastructure
Goongewa	Teck Cominco	Lead and zinc	Resource exhausted. Mine closed.	0.6 mtpa		Commenced Oct 94 – resource exhausted March 2001.	Resource exhausted. Mine closed.
Mitchell Plateau	Mitchell Plateau JV - Comalco (65.62 %), AngloGold (12.5 %) and Alcoa (21.88 %)	Bauxite	Currently undeveloped.	Indicated resources of 230 mt (Mineral Occurrences and Exploration Potential of the West Kimberley, GSWA 2004)	China		Nil
Cape Bougainville	Mitchell Plateau JV - Comalco (67.5 %), AngloGold (10 %) and Alcoa (22.5 %)	Bauxite	Currently undeveloped.	Indicated resources of 980 mt (Mineral Occurrences and Exploration Potential of the West Kimberley, GSWA 2004)	China		Nil
Ellendale	Kimberley Diamond Company (100 %)	Diamonds	2002 - current = 600,000 tpa production plant, recovery unit, cap and infrastructure at Ellendale 9. Ellendale 9 expansion = 2.2 mta production plant now in production. Plans for a mining and production centre at Ellendale 4, from mid-2005. Mining = large hydraulic excavators with 85-tonne haul trucks and support equipment. Mining is	5 million tonnes per annum or 2.8 million carats	Antwerp (Belgium)/ global	Total identified resources for Pipe 9 and 4 = 90.4 mt or 5.6 million carats with an 8 year mine life.	The Ellendale Mining Lease includes the operating plant and infrastructure of the Ellendale Diamond Project.

Name of mine/deposit	Proponent/Operator	Product	Description of processing and extraction	Volume	Market	Mine life	Infrastructure
			suspended during the "Wet" season but the plant, processes ore all year. Wet concentrates are transported to a final recovery plant containing two x-ray flowsort separation units.				
Admiral Bay	Kagara Zinc	Zinc and lead	Undeveloped – acquired from Rio Tinto in May 2004 for 2.5 million shares. Plans include a mine with a dedicated smelter. Expected to seek a joint venture partner to develop.	Drilling returned intercepts of 3m grading 8.2 % zinc and 62 grams/tonne silver; 41m at 9.72 % lead and 35.5gpt silver; 69m at 7.24 % lead and 15.57gpt silver	Global	A large deposit with a substantial mine life.	Nil

Sources: Various, including company reports, Department of Industry and Resources

7 Browse Basin natural gas development potential

7.1 Gas resource commercialisation options

Options for commercialisation of natural gas resources can be categorised according to the products produced and sold and the method used for transporting the natural gas to market, as follows:

1. Natural gas delivered by pipeline;
2. Natural gas delivered as Liquefied Natural Gas (LNG); and
3. Other products derived from natural gas.

Quite often, more than one of these options is used, and many world class gas operations, including the North West Shelf, use all three.

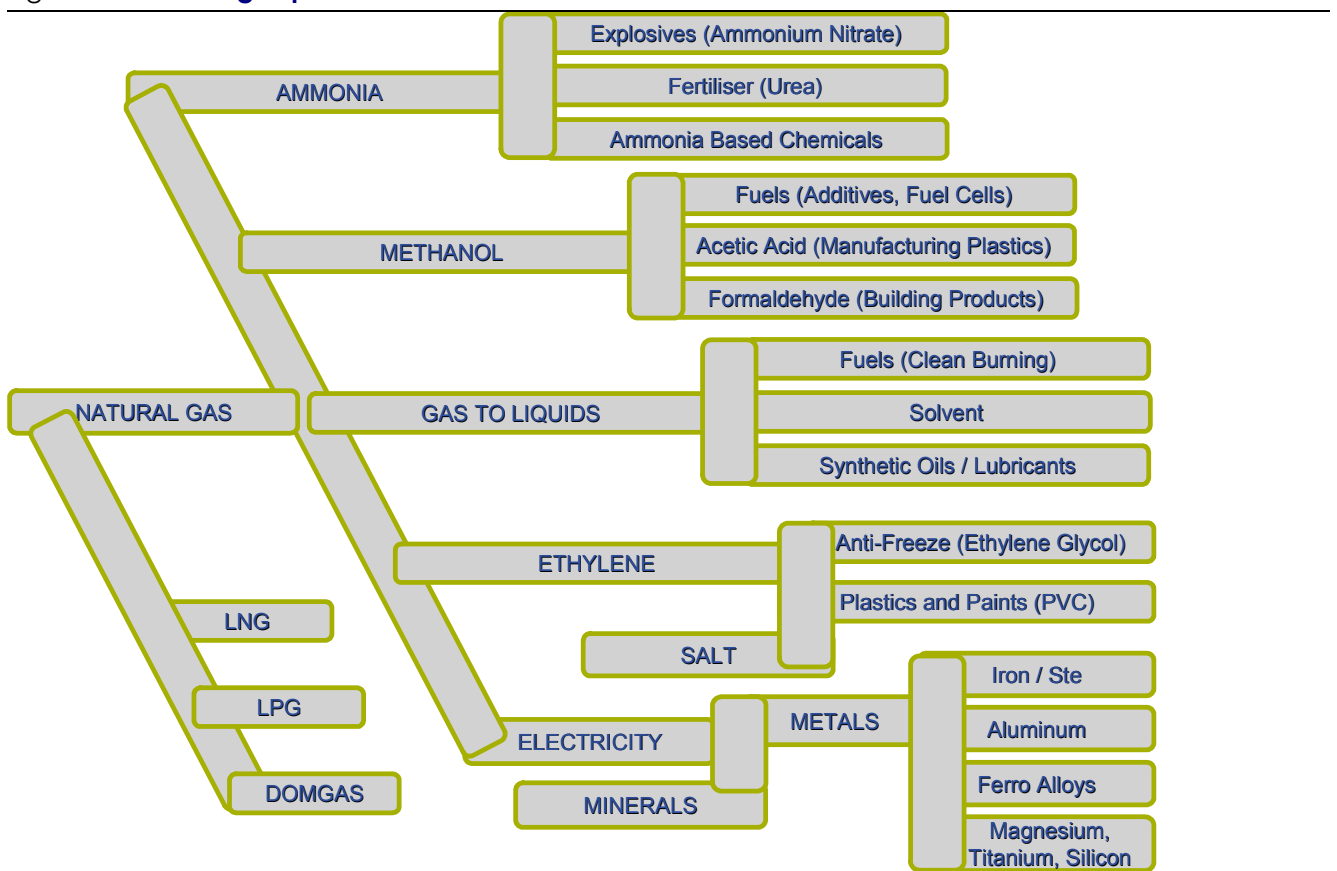
For any of the development options, a significant gas processing facility is required. For pipeline gas, a relatively small plant is necessary to remove impurities and separate and store liquids that may be sold separately. For LNG, a large complex cryogenic plant is required to convert the gas to a liquid state for shipping. The other products, for example GTL and petrochemicals, are also produced in specialised chemical process plants.

The first two options relate to the method of transportation. Owners of remote natural gas resources around the world typically face a difficult challenge because of the high cost of transporting natural gas to distant markets. Whether by pipeline or LNG, the transportation cost can be well over half of the delivered cost of the gas. Pipeline transportation is usually the lower cost option for short to medium distances, up to 2500 to 3000 km. LNG is competitive for longer distances, or in situations where pipeline construction costs are unusually high. For LNG the cost of transportation is the sum of the liquefaction, shipping and regasification costs, which may amount to as much as 80% or more of the delivered cost of the gas.

In most cases, a large gas resource will not be developed unless it is competitive in the natural gas market itself, either via pipeline or LNG delivery. The third option, production and sale of other products derived from natural gas, usually arises only after the resource has been developed for sale of the natural gas itself. However, in some cases, gas resources have been commercialised purely through the production and sale of one of the secondary products that can be derived from gas. These products include methanol, ammonia and urea, synthetic petroleum liquids, and associated natural gas liquids. The potential products from Browse Basin gas are illustrated

in Figure 12. They are discussed in more detail in Section 7.3. A stand-alone development for production and sale of methanol, ammonia/urea, or synthetic liquids could be feasible in remote situations where there is no gas market accessible by pipeline, production costs are very low, and the resource is not large enough to be developed for sale of LNG. Standalone natural gas liquids production is feasible in situations where the associated liquids content of the gas is relatively high. In this case, the liquids are removed and the gas is reinjected into the reservoir where it is stored for later production and sale.

Figure 12 **Natural gas product chain**



Source: Department of Industry and Resources and ACIL Tasman

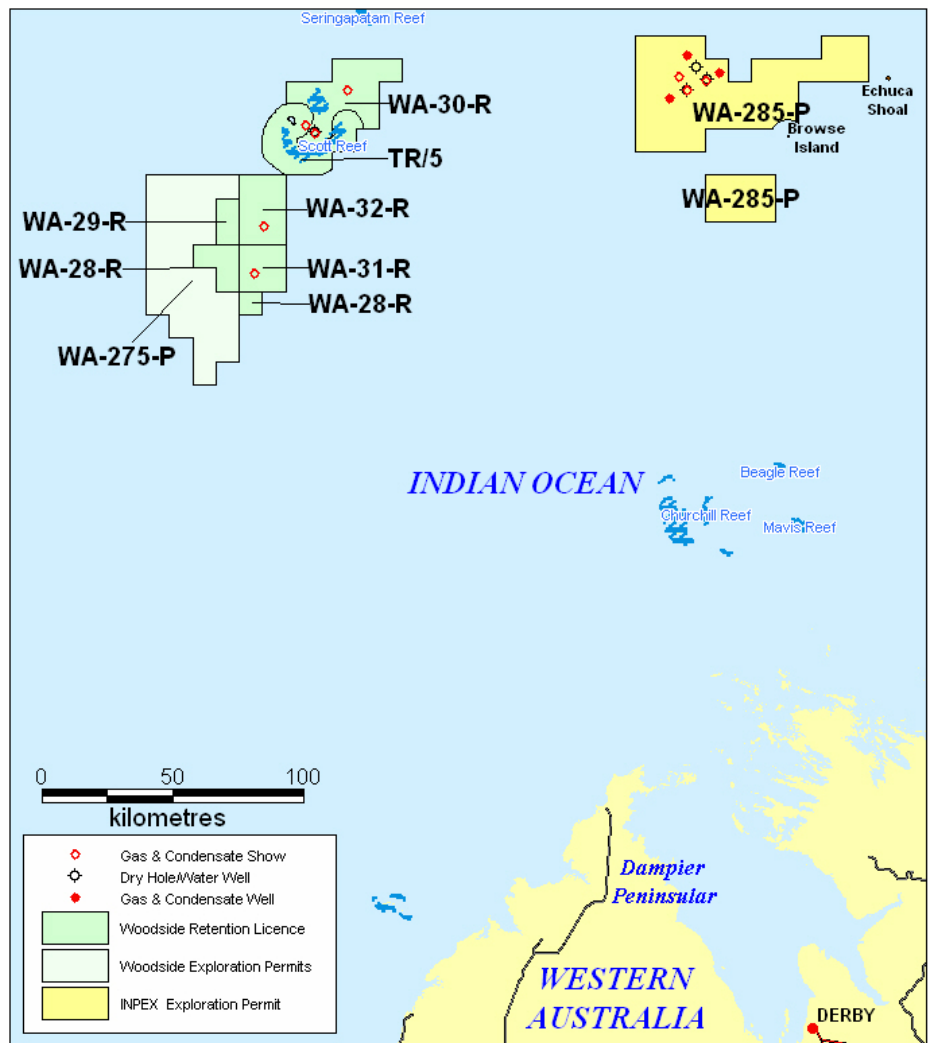
In ACIL Tasman’s opinion, the most likely option for initial development of Browse Basin gas is for LNG. This option is discussed in Section 7.2. The pipeline gas option - sale of gas to the eastern states via transcontinental pipeline - is discussed in Section 7.5.

7.2 LNG: Likely driver of Browse gas development

In all likelihood, a major LNG project will be necessary to drive Browse Basin gas development, if such a development is to occur within the next 10 to 15 years. Development of other gas-based industries prior to LNG cannot be ruled out, but LNG is the most likely lead development.

In most cases, LNG projects must be very large to achieve the economies of scale necessary to be competitive. The Scott Reef-Brecknock partners are considering different LNG development options, conceptually with an initial 7 mtpa onshore LNG train. Appraisal drilling and initial design work is planned for 2005. Figure 13 indicates the locations of the fields.

Figure 13 **Scott Reef, Brecknock, Brecknock South and nearby leases**



Source: Woodside

An LNG project of this size requires a very large quantity of gas. One million tonnes of LNG contains about 55 petajoules (PJ) of energy, and requires at least another 5 PJ of energy in production operations. Therefore, a 10 mtpa LNG project would require gas production of about 600 PJ per year. To give an indication of the magnitude of such an operation, this amount of gas production is about the same as the total gas consumption of all of the Eastern Australian states combined.

A project of this magnitude should have the necessary economies of scale to make Browse gas development commercially feasible, and Browse LNG competitive in international markets. ACIL Tasman's analysis of the global LNG market, outlined in this section, indicates that there is a strong possibility that 10 mtpa of Browse gas could be utilised in the Asia Pacific LNG market within 10 to 15 years.

A transcontinental pipeline could eventually see similarly large volumes of Browse Basin gas flowing to markets in the South East. However, ACIL Tasman's analysis of the domestic markets, outlined in Section 7.5, suggests that the available market for a transcontinental pipeline development is not likely to exceed 400 PJ until well after 2020.

Furthermore, because of the relatively small size of the Eastern Australia market, the build-up of production volume to maximum levels will be slower than in the case of an LNG project, making it more difficult to achieve a comparable return on the upstream investment. If an LNG project is already in place when the pipeline project gets underway, the investment necessary for the pipeline gas supply is much more likely to be commercially feasible.

Timing of development of Browse Basin LNG will be driven by market conditions and competition. With expected strong growth in the LNG markets of the Asia Pacific region, particularly in China, and LNG buyers' desire to diversify suppliers to ensure security of supply, greenfield projects in Australia will be well positioned to contribute to Australia's LNG exports.

However, these new Australian suppliers will face strong competition from other suppliers, in particular from Qatar and in the longer term from Iran. These two countries have access to almost unlimited supplies of gas from a single, liquids-rich, non-associated gas field. The North Field, as it is called in Qatar, extends from the tip of the Qatari Peninsula well into the waters of Iran, where it is called South Pars. The combined North Field/South Pars reserves are estimated to be over 1.3 million PJ, or about 65 times the reserves of Scott Reef/Brecknock. The cost of delivery of LNG from Qatar or Iran to any location in Asia is significantly lower than the delivered cost of LNG from any new field in Australia.

There is potential for development of two major gas projects based on Browse Basin gas between 2010 and around 2020.

There is a wide range of uncertainty in the various factors that will determine the timing of entry of Browse gas into the LNG and other product markets. It is probable that conditions could arise that would bring Browse gas into the market sometime between 2010 and 2015. It is also possible, however, that Browse development may not take place until the 2020s, or later. Section 7.4 summarises the potential for development of an LNG industry and describes three scenarios illustrating the range of possibilities for LNG development and necessary conditions.

7.3 Opportunities for other gas-based industries

Other industries that use gas as feedstock are typically considered wherever low cost gas supplies are available. While LNG is the most likely initial and “enabler” industry, it is possible that another gas-based industry could be developed first in response to a market window. It is more likely that one or more gas-based industries apart from LNG would be developed following an LNG development. Summaries of each of the principal gas-based industries that could be based on Browse Basin gas are provided in the following sections.

7.3.1 Liquefied Petroleum Gases (LPGs)

The industry that is most likely to be developed in conjunction with an LNG facility is the Liquefied Petroleum Gas (LPG) industry. LPG refers to two basic light petroleum products - propane and butane. LPGs are used as fuels in a wide variety of industrial, commercial and residential applications and as motor vehicle fuels. Propane and butane may also be used as feedstocks for production of propylene and butylene, which are in turn used as the basic feedstocks in the manufacture of a wide variety of petrochemical products including tires, plastics, solvents, adhesives, acrylic fibres and polyesters.

Feasibility of LPG development depends on the composition of the gas stream and the volume of gas available. Most natural gas production operations around the world produce LPGs as by-products, as the extraction of LPGs is a relatively simple distillation process and is often necessary to meet pipeline or LNG specifications. LPGs can be readily shipped in specialised trucks, rail cars, and tankers to fuel distribution, refining and petrochemical centers. This is preferred in most instances to development of propylene and butylene plants on site, except in locations where major petrochemical centers can be developed specifically to take advantage of the availability of very large volumes of low cost LPGs.

7.3.2 Ethane based petrochemicals

Unlike LPGs, ethane is not widely used as a fuel, and because it is lighter, it is more expensive to transport. Consequently, a natural gas stream that is rich in ethane can be a problem for LNG operators, because the gas specifications in the LNG markets typically impose a constraint on the heating value of the gas, which in turn limits the ethane content. Based on advice from Woodside, it is our understanding that this will not be a problem for their Browse Basin gas. Its ethane content is lower than that of the North West Shelf, which does not have to remove ethane to meet the LNG specifications in Japan or China.

Even if ethane removal is not a requirement, it may be done in situations where its value as a feedstock for ethylene production is greater than its energy value. This is sometimes the case with remote gas resources where the netback energy value of natural gas is relatively low. Cracking of ethane is a cost effective method of producing ethylene. Although liquid feedstocks can also be used, ethane is preferred wherever it is available at low cost. Ethylene is the basic feedstock for a wide range of petrochemicals including polyethylene and polyvinyl chloride, which are in turn in the manufacture of films, bottles, solvents, pipes, detergents and various household and plastic products.

Ethylene production may be considered if there is a sufficient volume of ethane available to support a competitively sized ethylene plant of 500,000 to 600,000 tpa or larger. A plant of this size would require about 20 PJ per year of ethane feedstock. It is our understanding that the ethane content of the Browse Basin gas is around 5%. Thus at least 400 PJ of annual gas production would be necessary to support an ethylene plant. Since a 10 mtpa LNG plant would require around 600 PJ of natural gas for feedstock and fuel, there would be a sufficient volume of ethane to support a world-scale ethylene plant.

Once the ethylene is available, further processing of ethylene to make polyethylenes on site would be a possibility. However, such processing is more typically carried out in large petrochemical centres. Ethylene can be economically shipped in specialised carriers that are similar in design to LPG tankers, thus export of ethylene may be the preferred option.

7.3.3 Methanol

Production of methanol by oxidation of methane is a relatively straightforward method of converting gas to an easily transportable product with a sizeable world market. The world methanol market is in the order of 30 mtpa. North American consumption is in the range of 25 to 30 per cent of the world total, but the expected growth rate is between 3 and 4 percent per year-end will be driven largely by Asia, and China in particular.

Methanol is used in the manufacture of various chemical products, including formaldehyde, acetic acid, MTBE for motor fuel oxygenation, and a variety of intermediary chemicals used as feedstock for a range of consumer products.

Methanol plants on the U.S. Gulf Coast and in Canada are the marginal producers. Because of the expectation of continued high gas prices in North America, methanol producers are closing plants in North America and planning new plants in locations where there are large reserves of low cost gas, in order to be more competitive. New plants in the Middle East are now the low cost producers. Other favoured existing or potential plant locations include Trinidad, Chile, Indonesia, West Africa and Malaysia.

A modern world scale plant typically produces 1.0 to 1.5 mtpa. A 1 mtpa plant would utilise about 35 PJ of natural gas feedstock.

7.3.4 Di-methyl ether (DME)

The world DME market is of the order of 150 ktpa and hence for the moment it ranks only as a specialty product, being used mainly as a propellant for spray cans (cosmetics, paints, agricultural chemicals etc). In recent years there have been proposals to convert natural gas to DME in large quantities and to utilise it as a substitute for diesel and for power generation fuel. DME is a clean energy form that has low toxicity and is easy to handle and it is expected that if it can be economically manufactured at large-scale then it could come into extensive use. However, these markets are yet to be developed.

One drawback to DME as a fuel is its relatively low energy density, only about 31.7 GJ/Tonne, HHV, about 70% of the value of conventional premium diesel fuel. Therefore, on an energy equivalent basis, the price of DME would be only about \$140 per tonne when conventional diesel is at \$200 per tonne, or \$27.40 per barrel. Japanese Government support or mandated environmental premiums may help to overcome this disadvantage for industry pioneers, but in long run DME will have to compete head to head with other premium fuels.

DME is currently manufactured from natural gas in a process similar to the well-established methanol conversion process but with an additional dehydration step. If the entire methanol is converted to DME in the conventional process, the ratio of DME production to methanol feed is about 0.76 to 1, i.e. a 1 mtpa methanol plant using 35 PJ per annum of gas produces enough methanol to manufacture 760,000 tonnes of DME.

7.3.5 Ammonia and urea

Ammonia is the basic source of nitrogen for fertilisers and a large majority of the 100 million tonne per year world consumption of ammonia is the fertiliser

market. Other major uses are in the production of ammonium nitrate for explosives and as a feedstock for specialised petrochemicals containing nitrogen.

A significant portion of the ammonia produced for fertilisers is converted to urea. Urea is a solid and is considerably easier to handle and transport than ammonia, which is a gas at atmospheric temperature and pressure. While refrigeration is required to store ammonia, urea is a solid that can be converted to pellets or granules for storage, shipping, and application.

World demand has been growing steadily, with demand growth in Asia offsetting declines in Europe. However, the market suffered during the 1990's from an excess capacity overhang that remained from a boom in new plant development during the 1980's. Continued plant closures in locations where feedstock costs are high, notably North America, will tend to bring supply more into balance with demand. To the extent that new capacity is needed, it will continue to be built in large scale increments in locations where natural gas prices are low. Favoured locations for new plants are the same as for methanol – the Middle East, Trinidad, Indonesia, West Africa and Malaysia.

Ammonia is produced by reacting nitrogen with hydrogen produced from the natural gas feedstock. Urea is produced by reacting liquid ammonia with carbon dioxide.

A large single train ammonia plant would produce in the order of 750,000 to 800,000 tonnes per year. If all of the ammonia output is converted, urea production for a plant this size would be about 1.3 mtpa. Natural gas feedstock for a 750,000 tpa ammonia plant would be about 30 PJ per year.

7.3.6 Synthetic petroleum liquids (GTL)

The Fischer-Tropsch (F-T) process has been in use since the 1930's for conversion of coal based synthesis gas to liquids. More recently, the process has been adapted for conversion of gas to liquid (GTL) products, and in recent years there have been a number of new gas to liquid hydrocarbon conversion projects proposed, as advances in production technology have reduced costs. Only a few of these have actually progressed to construction, as the cost remains relatively high. However, proponents promise continuing improvements in technology and related cost reductions. These improvements, in combination with continuing strong crude oil prices, are likely to provide sufficient incentive to bring more of these projects into the market over the next several years.

F-T technology is attractive because it opens up a much larger market for the gas producer. F-T products are typically a mixture of high boiling point wax

and olefinic naphtha. Conventional refining processes can be used to convert these raw feedstocks into a variety of refined petroleum products, including diesel, jet fuel, kerosene, LPG's and lubricants. The world diesel fuel market alone is over 600 million tonnes per year and the market for all middle distillates is over 1500 million tonnes. F-T diesel characteristics make it especially attractive as a blending feedstock used with conventional heating oil stock to produce a premium quality diesel fuel.

Several companies, including Sasol, Shell, Syntroleum, ExxonMobil, Rentech, Williams and BP have developed their own proprietary technologies utilising the F-T process for GTL production.

One reason that F-T plants require very low cost gas feedstock is their high level of energy consumption. Gas feedstock is typically in a ratio of at least 10 GJ per barrel of liquid product, or almost 1.7 units of input energy per unit of output energy. Plants with capacity of 130,000 to 200,000 barrels per day are currently being planned in Qatar. A 100,000 barrel per day plant would consume over 365 PJ of gas, about the same volume as a 6 mtpa LNG plant.

7.4 Potential for development of a LNG industry in the West Kimberley

As has already explained, LNG is typically the primary target product for development of a remote gas resource like the Browse Basin because of its relatively large market. Once an LNG project has been established, additional gas-based industries utilising various components of the gas stream often become feasible, if the price of the gas or its by-products is competitive.

Experience with North West Shelf gas at the Burrup Peninsula is instructive in assessing the likelihood of development of other gas-based industries in conjunction with Browse Basin development for LNG and domestic gas supply. Over the years there have been a variety of proposals for methanol, ammonia/urea, and GTL plants on the Burrup Peninsula, but so far, only the Burrup Fertilisers ammonia plant has gone ahead. Two of the key factors that determine the economic feasibility of such projects are the capital cost of the plant and the cost of the gas supply. In recent years, many of the new world scale plants have been built in the Middle East, where both capital costs and gas costs are lower than in Australia. Markets for these products are relatively small compared to the size of the LNG market. The world methanol market, for example, is about 25 million tons per year, less than half the size of the LNG market in Japan alone. Consequently, only the lowest cost gas producers are in a position to supply them. The current rule of thumb in the industry is that the price of gas must be less than US\$1.00 per GJ in order to be considered as a competitive location.

7.4.1 Basis for LNG market projections

The LNG market outlook presented below is a compilation developed by ACIL Tasman for this report. Sources for the Base Case demand forecast include publicly available presentations by ABARE, Australia LNG, Woodside and Exxon Mobil, reports by the International Energy Agency and US Energy Information Agency and ACIL Tasman's own research and internal data base. The supply forecast has been developed based on project announcements and ACIL Tasman's assessment of likely timing and competitiveness of future projects.

The projections provided are those prepared by ACIL Tasman for the purposes of this study and report and do not necessarily represent the views of gas project proponents in the region or government agencies.

7.4.2 Asia Pacific LNG market overview

LNG supply in the Asia Pacific region comes from seven countries: Australia, Brunei, Indonesia, Malaysia, Oman, Qatar, and the UAE. Indonesia and Malaysia are the largest suppliers, but Qatar has by far the largest reserves of the LNG producing countries and will soon surpass Indonesia as the largest LNG producer.

LNG consumption in 2002 and estimates for 2004 are set out in Table 9 whilst Table 10 shows LNG production capacity of each country that is supplying the Asia Pacific region as at 2004.

Table 9 **Asia Pacific LNG consumption, million tonnes (2002 and 2004)**

Country	2002 Actual	2004 Estimate
Japan	54.3	58
Korea	17.3	21
Taiwan	5.2	6
India	0.0	2
Total	76.8	87

Data source: 2002 Actual – OECD, International Energy Agency; 2004 Estimate – ACIL Tasman

Table 10 **Asia Pacific LNG supply capacity, million tonnes (2004)**

Country	Project	Location	Capacity, mtpa
Abu Dhabi	Adgas	Das Island	5.7
Australia	Northwest Shelf	Dampier, WA	7.8
Brunei	Brunei LNG	Lumut	7.2
Indonesia	Arun	Lhokseumawe, Aceh	5.0*
Indonesia	Bontang	Bontang, Kalimantan	22.6
Malaysia	Satu	Bintulu, Sarawak	8.1
Malaysia	Dua	Bintulu	7.8
Malaysia	Tiga	Bintulu	6.8
Oman	Oman LNG	Qalhat	7.3
Qatar	Qatargas	Ras Laffan	8.0
Qatar	Rasgas I	Ras Laffan	6.9
Qatar	Rasgas II	Ras Laffan	4.7**
USA	Kenai	Cook Inlet, Alaska	1.5
Total			99.4

Notes: * Originally 6 x 2.1 mtpa, current plan is for 2 train operation from late 2004 onward.

** First of two 4.7 mtpa trains to start second half 2004

Data source: Various sources including owner /operator websites, IEA, others

While the large majority of the capacity in Table 10 is used to supply LNG to the Asia Pacific region, it should be noted that Qatar and Oman use a significant portion of their capacity for sales to Europe.

World LNG consumption is expected to continue to grow rapidly for the foreseeable future, driven by the attractiveness of natural gas as an increasingly competitive, clean fuel. Demand growth in Japan and Korea may be slower than in the past, but overall growth in the Asia Pacific region will be maintained with rapid growth in China and India.

Recently, Asia Pacific suppliers have taken a great deal of interest in the US west coast market, and several suppliers are involved in re-gasification terminal developments there. Although approvals are difficult, it seems likely that one or more terminals will be built there within the next 10 years. Some Asia Pacific suppliers will eventually have the opportunity to sell a significant portion of their gas into the U.S. west coast market and the west coast market price will begin to have an impact on Asia Pacific supplier decisions.

While the US west coast has been a significant focus for the Australian suppliers and others in this region, developments in the Atlantic markets may have a much greater impact on the Asia Pacific market. The Californian market is only about 10 per cent of the total US market. There will be a much larger market play in the eastern US markets which will be accessed via terminals on the Atlantic and Gulf of Mexico coasts. At the same time the European market appears to be set to grow dramatically. Middle Eastern producers are presently gearing up to supply these markets. They will face strong competition from producers in North and West Africa and the Caribbean. Thus, the rate

of growth of the Atlantic market and the Middle East producers' success in capturing a solid share of that market could have a significant impact on supply and price in the Asia Pacific markets.

7.4.3 Key LNG market uncertainties

There are a large number of key issues that will impact the timing of entry of new Australian LNG suppliers into the market. Some of the most important issues are listed below.

Demand side factors

Important demand side factors include the following

- China economic and energy consumption growth, and pace of LNG terminal development;
- Development of the Indian economy and ability of suppliers to obtain sufficient levels of commitments from creditworthy buyers to underpin investment in new LNG supply;
- The pace of economic recovery in Japan, in combination with energy and regulatory policy;
- The extent of development of greenhouse gas policies that have substantive impact on energy consumption and investment in all gas consuming countries;
- Rate of growth of natural gas demand in the mature markets of the U.S. and Europe; and
- Buyers' diversification and supply security strategies, in particular the degree of acceptability of Middle East LNG in buyers' supply portfolios.

Supply side factors

Supply side factors that will have a major impact include:

- The extent to which suppliers build spare capacity to position themselves to stay ahead of new entrants;
- New discoveries and reserves extensions in Indonesia, Malaysia and Brunei
- The timing of entry of Iran into the LNG market;
- Extent of focus of Qatar and other Middle East suppliers on the Atlantic markets;
- The rate of increase in development of pipeline gas supplies from major producing areas in North Africa and Western Siberia; and
- The rate of increase (or decline) in gas production from the mature producing regions of North America

Significant uncertainties are associated with all of the above factors. Consequently, although world gas supplies are plentiful, and market forces will ultimately bring supply and demand into balance, the market configuration even five to ten years into the future is very difficult to predict.

The three scenarios described below consider some of the potential combinations of these key factors that could lead either to the early development of Browse LNG, or that could defer development beyond the 20 year horizon of this study.

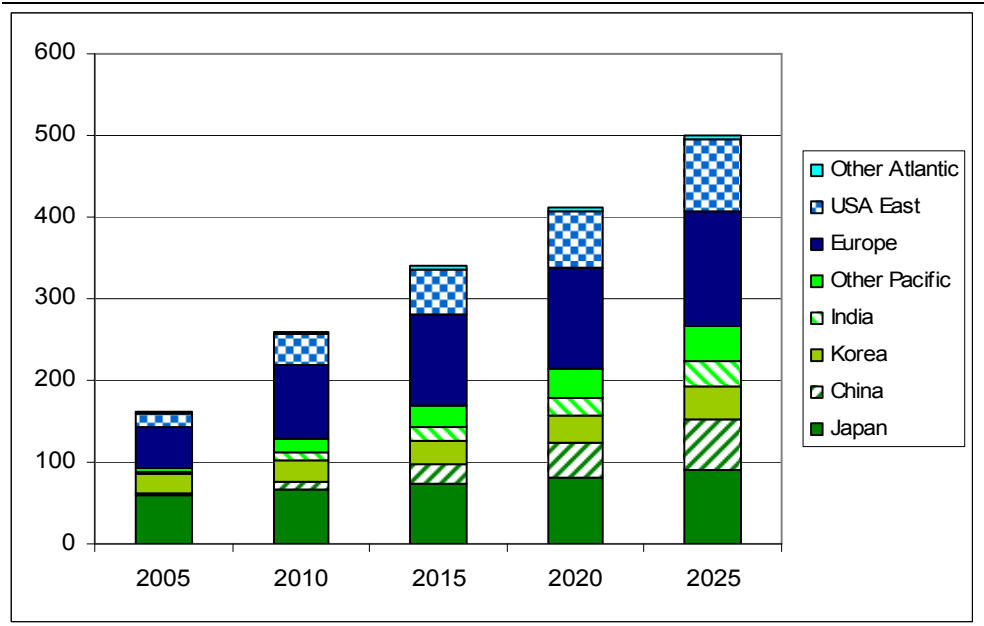
These scenarios have been developed by ACIL Tasman for the purpose of this study and report, and are not predictions of actual market conditions. ACIL Tasman however believes that the scenarios are plausible representations of the range of potential market outcomes relevant to Browse Basin LNG development.

7.4.4 LNG market scenarios

Scenario 1 – Solid Market Growth (medium development scenario)

Scenario 1 is the Base Case. It assumes a robust global economy and generally solid growth in demand for LNG in all major markets, which brings substantial new supplies into the market. Global demand is assumed to grow as illustrated in Figure 14. Long term growth in the Asia Pacific market is driven by China, which is importing about 25 mtpa by 2015 and over 60 mtpa by 2025. The size of the European market surpasses that of Japan by 2010, and continues to expand rapidly, mainly with the construction of new terminals in Spain, France and the UK. The US market grows rapidly as well, particularly after 2010, as domestic production is unable to keep pace with demand.

Figure 14 Global LNG demand: Scenario 1, mtpa



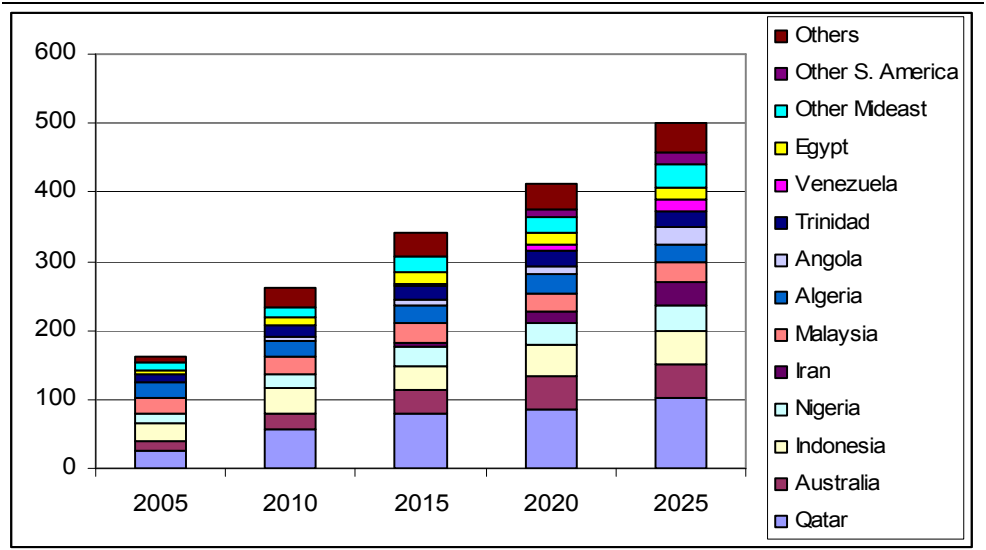
Data source: ACIL Tasman estimates

Indonesia also increases production significantly, with a new train at Bontang, and greenfield developments at Tangguh and in Sulawesi. Iran enters the market around 2015 and expands to over 30 mtpa by 2025.

In spite of the strong competition from other producers, given the relatively high demand growth in this case, new production from Gorgon, Browse and the Timor Sea, in addition to the North West Shelf Train 5 expansion, are all needed to meet the market demand by 2020. With all of these projects in place Australia is the second largest LNG producer at that time.

Atlantic Basin suppliers expand dramatically. Nigeria, Angola, and Trinidad all join the ranks of very large LNG producers with over 20 mtpa of production.

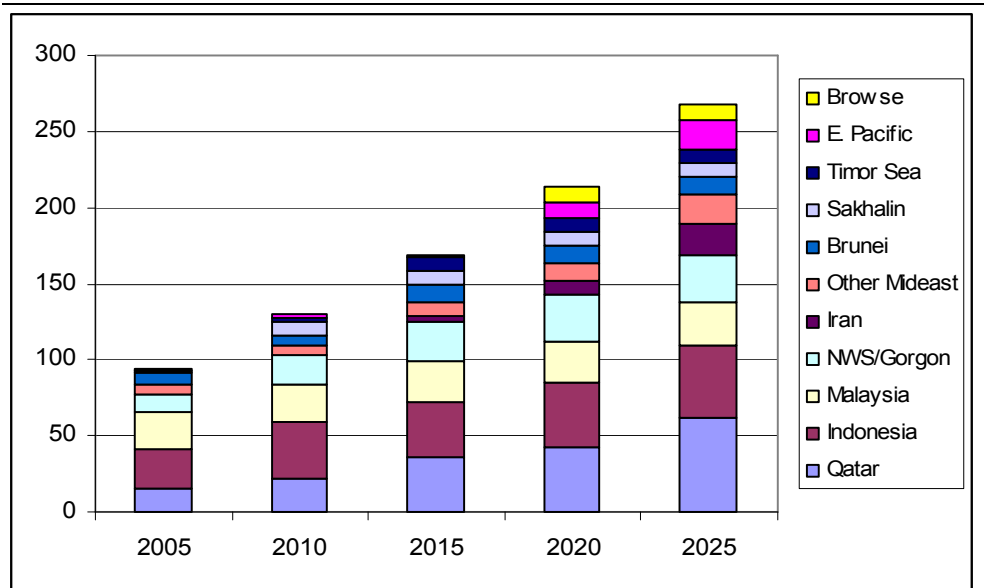
Figure 15 **Global LNG supply: Scenario 1, mtpa**



Data source: ACIL Tasman estimates

Supply for the Asia Pacific region is shown in Figure 16. With new Qatari developments targeting the Atlantic market, Qatar's deliveries to Asia Pacific remain almost constant between 2005 and 2010. Asia Pacific takes only about 40 per cent of Qatar production in 2010, versus 60 per cent in 2005. However, after 2010, Middle Eastern supply to Asia Pacific increases from about 21 per cent to over 35 per cent by 2025.

Figure 16 **Asia Pacific LNG supply: Scenario 1, mtpa**

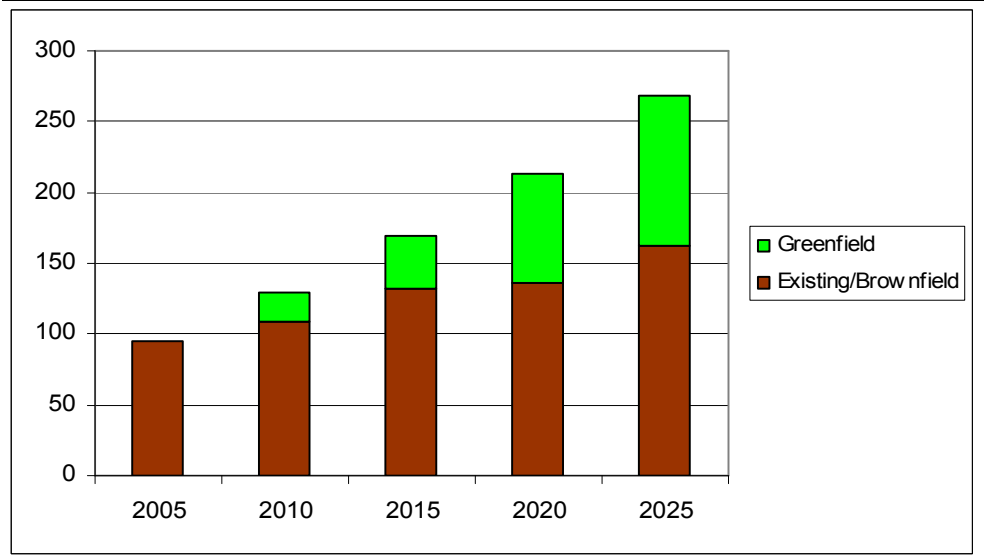


Data source: ACIL Tasman estimates

The portion of Asia Pacific supply from greenfield projects is shown in Figure 17. Brownfield projects, including North West Shelf, Bontang, Brunei,

Malaysia, and Abu Dhabi, in addition to Qatar, are able to provide the large majority of required new supply through 2015.

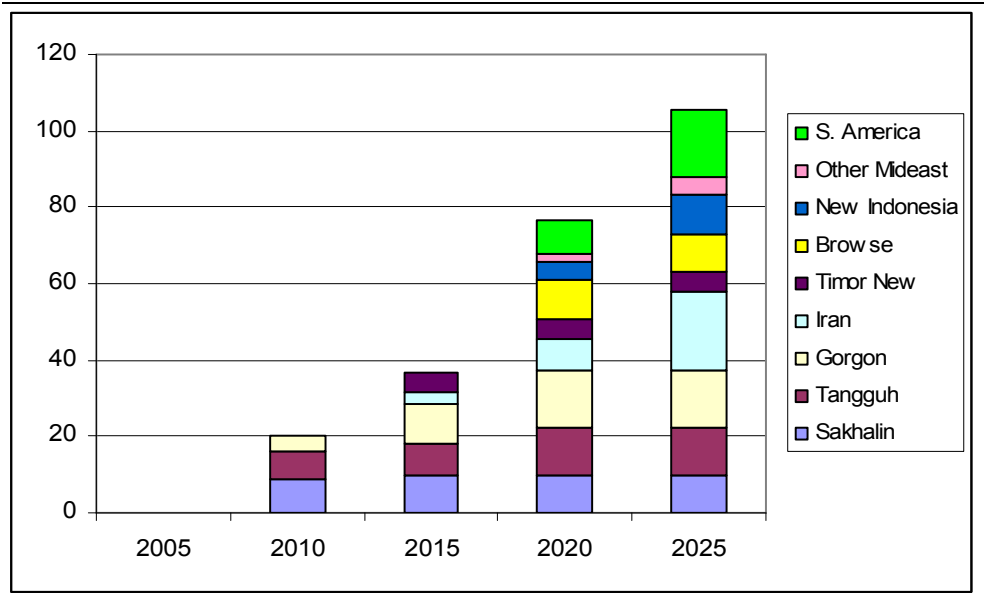
Figure 17 **Asia Pacific brownfield and greenfield supply, Scenario 1, mtpa**



Data source: ACIL Tasman estimates

Entry of greenfield suppliers is illustrated in Figure 18. The Sakhalin and Tangguh projects, which are both well advanced in development, are assumed to be the next two projects to come on-stream. In this scenario, the first Gorgon train is up and running by 2010. Between 2010 and 2015, Gorgon expands to two trains, Iran enters the China market, and Sunrise gets underway. Iran expands quickly, but Browse is still able to secure sales necessary to start production in around 2017, and ramps up quickly to 10 mtpa by 2020. Donggi, Yemen, Peru and Bolivia are also assumed to be in the market by 2020. South American production would be expected to go primarily to the U.S. west coast.

Figure 18 Asia Pacific greenfield supply: Scenario 1, mtpa

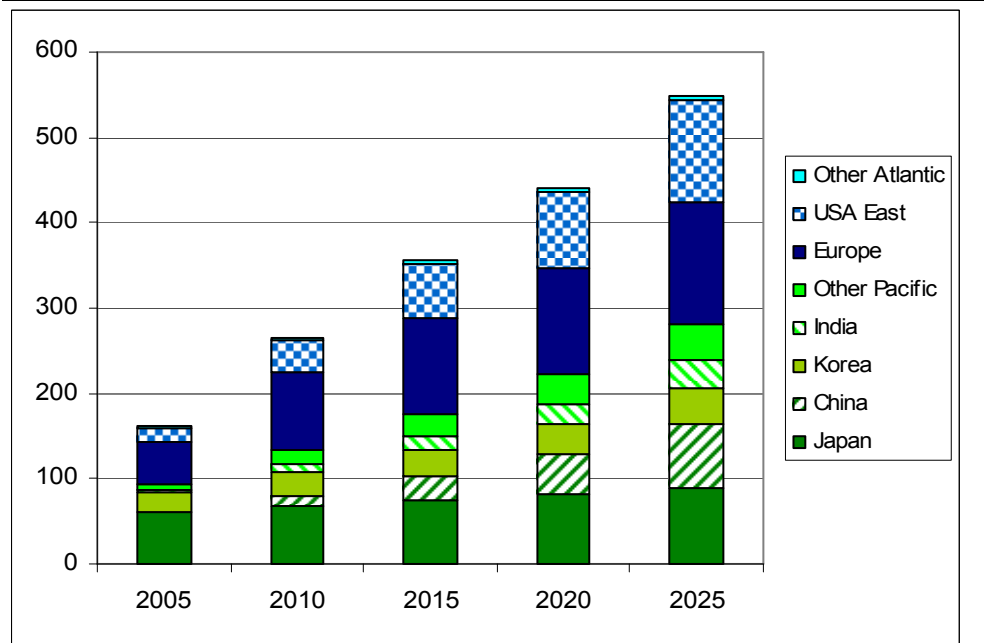


Data source: ACIL Tasman estimates

Scenario 2 –Australia Preferred (high development scenario)

Market growth in this scenario is as shown in Figure 19. The overall growth rate in LNG consumption is somewhat higher than in the Base Case, particularly in North America. Asia Pacific consumption grows slightly faster than in the Base Case, mainly due to a faster pace of terminal development in China.

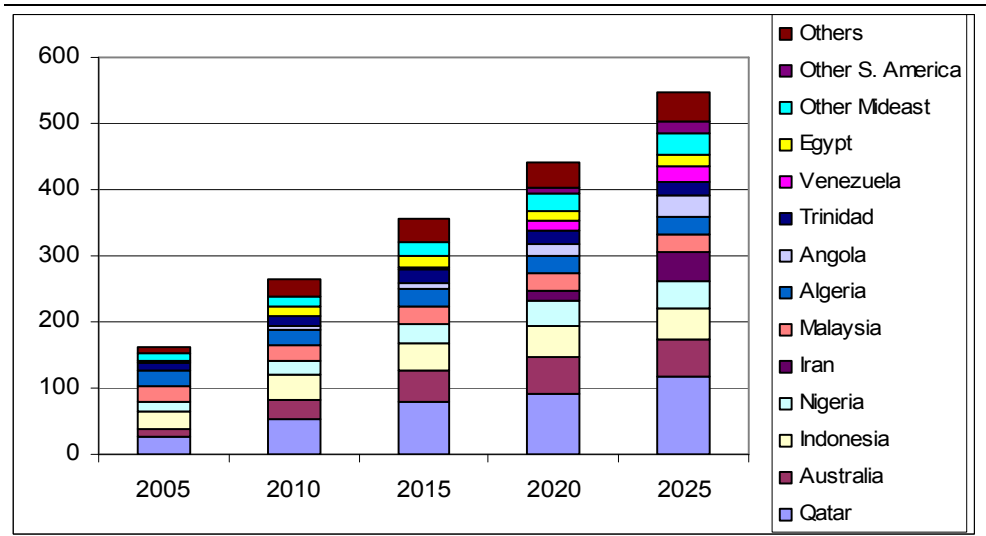
Figure 19 **Global LNG demand: Scenario 2, mtpa**



Data source: ACIL Tasman estimates

The global supply configuration for the “Australia Preferred” Scenario 2 is shown in Figure 20. Middle East producers aggressively pursue the Atlantic market while Asia Pacific buyers show a strong preference for maximising supply from regions other than the Middle East, and particularly from Australia. Buyers recognise that they will eventually need to purchase a substantial share of their LNG from the Middle East, so they buy as much as possible from other producers as long as such supplies are available. The Middle East suppliers are willing to give up markets in Asia Pacific, since they have a good alternative in the Atlantic. Qatar’s total production volume in 2015 through 2025, for example is actually higher than in Scenario 1 because increased Atlantic sales more than offset the reduction in Asia Pacific sales.

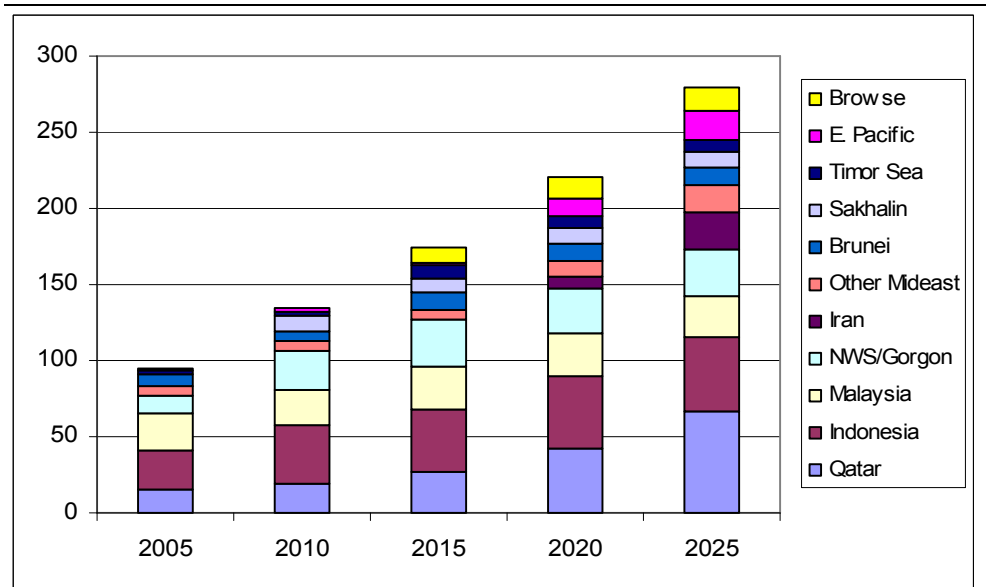
Figure 20 **Global LNG supply: Scenario 2, mtpa**



Data source: ACIL Tasman estimates

As a result, the Middle East suppliers lose market share in the Asia Pacific region, as shown in Figure 21. Qatar sells only 34 per cent of its production to Asia Pacific in 2015 as compared to 45 per cent in the Base Case. Middle East suppliers have a total of only 19 per cent of the Asia Pacific market in 2015 as compared to 28 per cent in the Base Case.

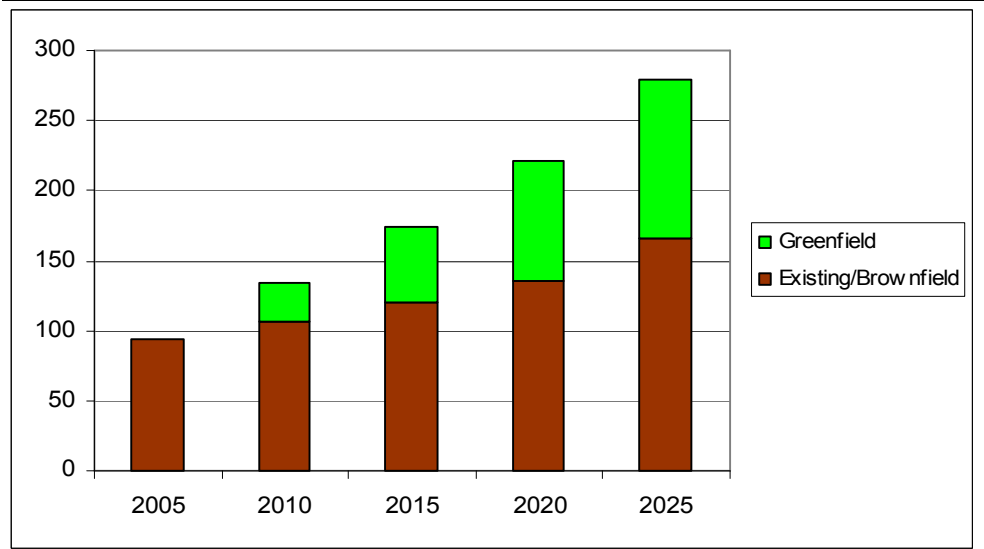
Figure 21 **Asia Pacific supply: Scenario 2, mtpa**



Data source: ACIL Tasman estimates

Considerably more greenfield supply is needed in Asia Pacific by 2015 relative to the Base Case, as can be seen by comparing Figure 22 with Figure 17.

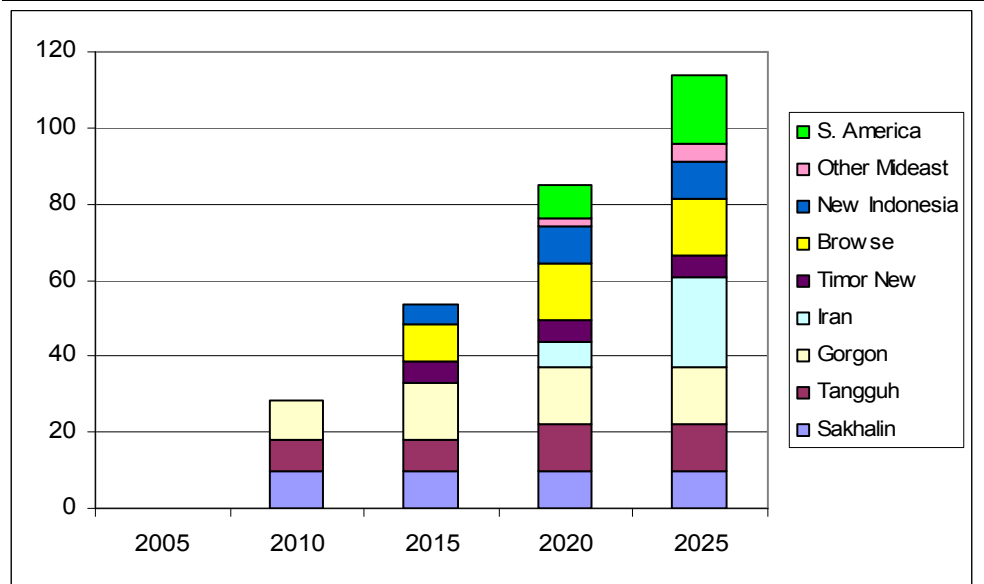
Figure 22 **Asia Pacific brownfield and greenfield supply: Scenario 2, mtpa**



Data source: ACIL Tasman estimates

This enables Browse LNG to enter the market in 2011 or 2012, with production ramping up to 10 mtpa by 2015.

Figure 23 **Asia Pacific greenfield supply: Scenario 2, mtpa**



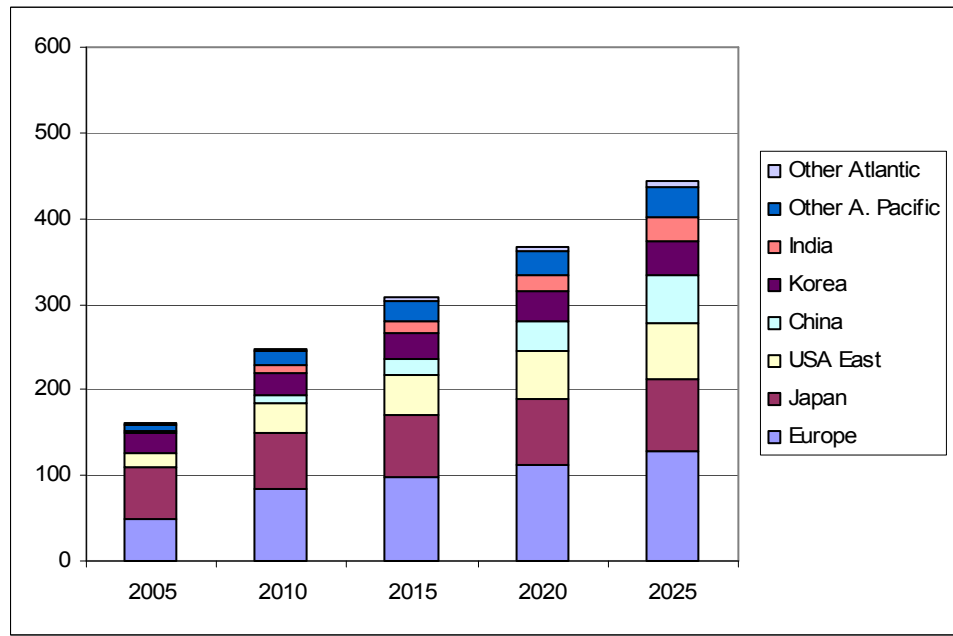
Data source: ACIL Tasman estimates

Scenario 3 – Slow Growth, Low Price (low development scenario)

Global demand for Scenario 3 is shown in Figure 24. In the near term the market grows at a reasonable pace in this scenario, but not quite as quickly as hoped for. Atlantic demand growth is less than anticipated, well below the

Base Case. In particular, US terminal development is slow, gas prices remain high and pipeline supplies continue to grow.

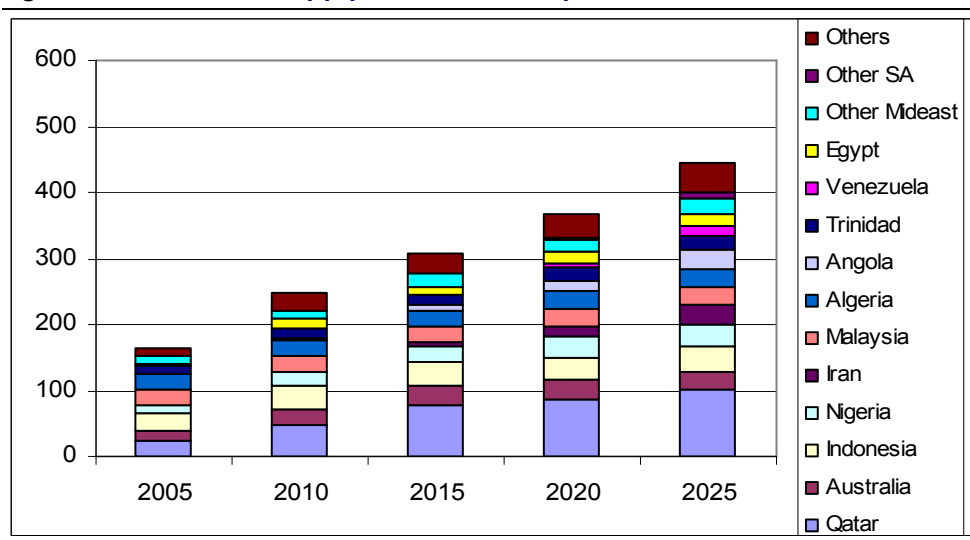
Figure 24 **Global LNG demand: Scenario 3, mtpa**



Data source: ACIL Tasman estimates

Middle East producers are unable to find markets to match their aggressive development aspirations, consequently, they offer more attractive prices to buyers in the Asia Pacific and capture a larger share of the market. Consequently, new suppliers have fewer opportunities to enter the market. The supply configuration for Scenario 3 is shown in Figure 25. A key feature of this case is Qatar's production. From 2015 on, Qatar's production is about the same as in the Base Case, even though global demand is lower.

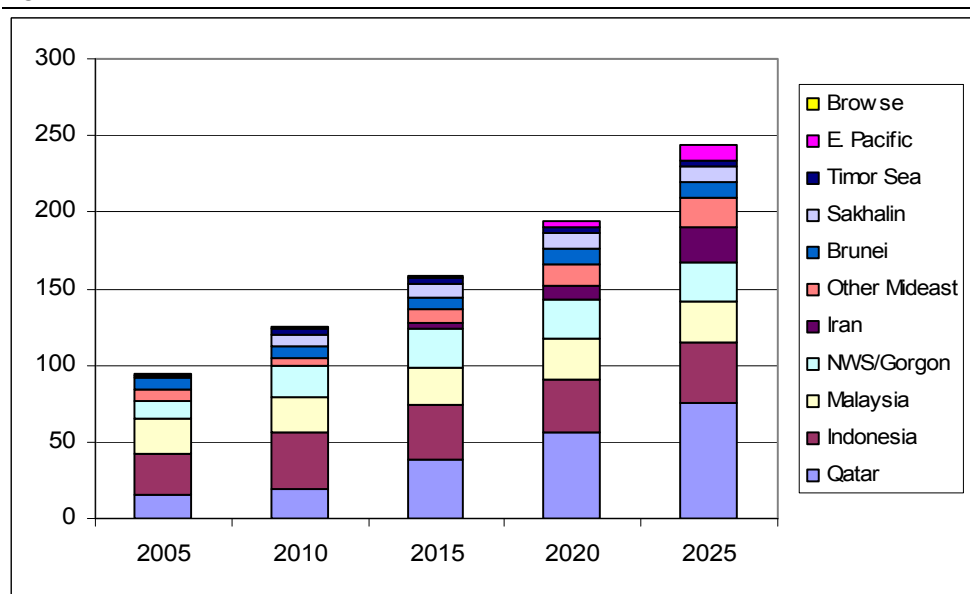
Figure 25 **Global LNG supply: Scenario 3, mtpa**



Data source: ACIL Tasman estimates

Supply going to Asia Pacific is shown in Figure 26. Middle East supply has a much larger share of the market in the later years in this case. In 2020, for example Middle Eastern LNG supplies about 40 per cent of the market, as against 29 per cent in the Base Case.

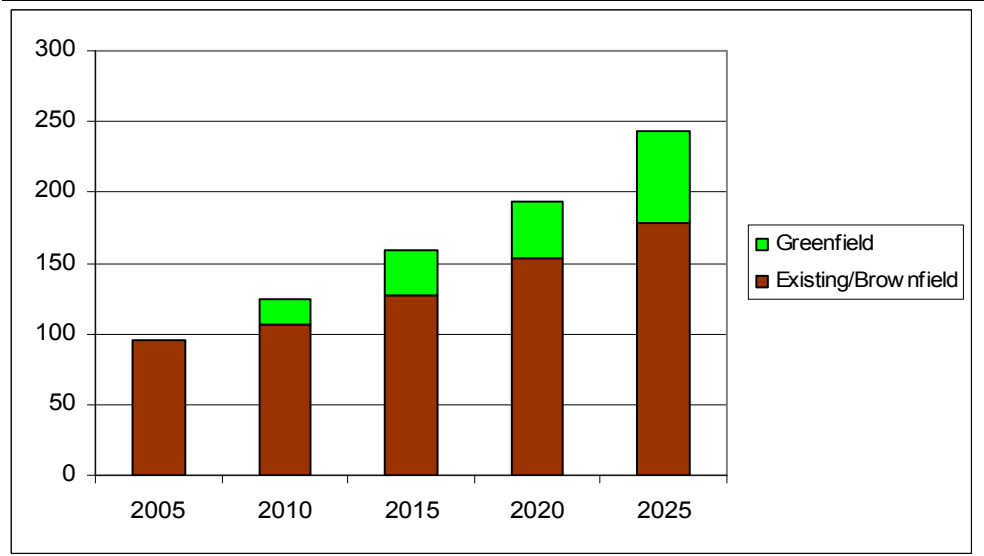
Figure 26 **Asia Pacific LNG supply: Scenario 3, mtpa**



Data source: ACIL Tasman estimates

Greenfield supply requirements for Asia Pacific are considerably lower than in the Base Case, especially in the later year, as can be seen by comparing Figure 27 with Figure 17.

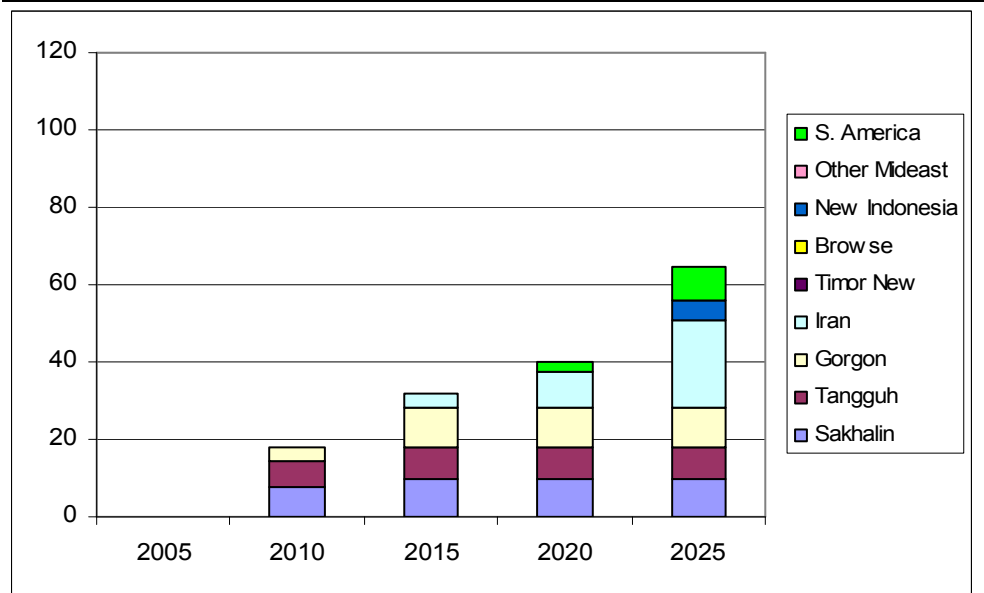
Figure 27 Asia Pacific brownfield and greenfield supply: Scenario 3, mtpa



Data source: ACIL Tasman estimates

Browse LNG does not enter the picture during the 20 year time horizon in this case. The new suppliers serving Asia Pacific in this scenario are shown in Figure 28. With about 23 mtpa sold into the region in 2025, Iran is by far the largest of the new suppliers.

Figure 28 Asia Pacific greenfield supply: Scenario 3, mtpa



Data source: ACIL Tasman estimates

7.5 Transcontinental pipeline potential

7.5.1 Basis for Eastern Australia market outlook

The gas market outlook and scenarios discussed below derive from ACIL Tasman's knowledge and analysis of the gas market's functioning and structure, and realistic assumptions about available reserves, production capability of existing and new fields, transmission pipeline developments and demand for gas in different market sectors. ACIL Tasman maintains an extensive database covering all aspects of the Australian gas market and uses a proprietary model of the market (*GasMark*TM) to generate projections of future market conditions based on a particular set of assumptions. The "medium development scenario" described here was developed using *GasMark* with assumptions that ACIL Tasman considers to be a reasonably likely base case. The two alternate scenarios were also developed using *GasMark* with altered assumptions as indicated.

Assumptions regarding gas demand for electric power generation — an area expected to be a key driver of growth in the gas industry — have been formulated to reflect the results of ACIL Tasman's modelling of the Australian electricity market using our proprietary model of the National Electricity Market in Eastern Australia (*PowerMark*TM).

7.5.2 Eastern Australia market overview

Gas consumption in Queensland, New South Wales, Victoria, and South Australia presently amounts to about 580 PJ. About 50 per cent of the gas consumed is for industrial and cogeneration use, while the electricity generation and residential/commercial sectors use about 25 per cent each. Power generation has the potential to be a much larger component of total gas consumption, but in the current competitive environment, particularly in areas where significant quantities of low-cost coal are available, penetration of gas is expected to be gradual.

The large majority of the gas supply comes from two producing basins, the Gippsland Basin offshore Victoria and the Cooper/Eromanga Basin in South Australia and Queensland.

7.5.3 Future supply options

Eastern Australia has ample reserves of natural gas to supply its markets in the near term. Total proved and probable reserves in the developed conventional gas fields amount to roughly 12,000 PJ, or over 20 years of supply at the current production rate of around 580PJ/a. However, since production from

conventional fields begins to decline long before reserves are fully depleted, without new discoveries the current rate of production could not be supported for much longer than 10 to 12 years. With production increasing to meet growing demand, production could begin to decline in less than 10 years.

Considerable potential remains to develop new reserves that could maintain production at higher rates for a longer period of time. The Gippsland Basin producers have recently embarked on an exploration program and initial results have been promising. New discoveries in the Otway Basin are also encouraging. Furthermore, given the large coal resources in Eastern Australia, Coal Seam Gas (CSG) represents a promising new source of gas for the future. New developments are underway in Queensland and CSG production there has already reached a level of about 15 PJ/a. Given planned developments and supply contracts that are already in place, it is expected that CSG production in Queensland will ramp up quickly to at least 75 PJ over the next several years.

Nevertheless, local supplies will eventually reach their limits, and when this happens, it will be necessary to tap the much larger resources in north west Australia and/or the large fields in the Timor Sea or Papua New Guinea to continue to support the market. The largest potential market for a new northern pipeline are the New South Wales and South Australian markets, therefore Moomba is likely to be the primary connection point for any northern pipeline development. ACIL Tasman's analysis indicates that supplies from any of these resources could be delivered to the South East via Moomba in the Cooper Basin of South Australia at a price that would be competitive with existing supplies, assuming foundation markets are sufficient to provide the critical mass necessary to underpin the large investments involved in major field developments and large long distance pipelines.

A transcontinental pipeline is an attractive option for providing the necessary supply for the long term. Such a pipeline would have a much longer life than a pipeline from PNG or the Timor Sea, because it would be supported by a much larger resource. Reserves in the Browse and Carnarvon Basins amount to over 115,000 PJ, enough to supply the LNG export market and the transcontinental pipeline market for several decades. The concept of a transcontinental pipeline from the Carnarvon Basin off the Pilbara coast has been studied by interested parties on various occasions over the past several years. Recently, there has been renewed interest in the potential for a pipeline from the Browse Basin, partly due to the shorter distance to Moomba.

As is the case with LNG, timing of a transcontinental pipeline will be dictated by the market. It is highly likely that the pipeline will ultimately be built, but the actual timing at this stage remains highly uncertain. It will depend on the pace of demand growth and the extent of success of further exploration and

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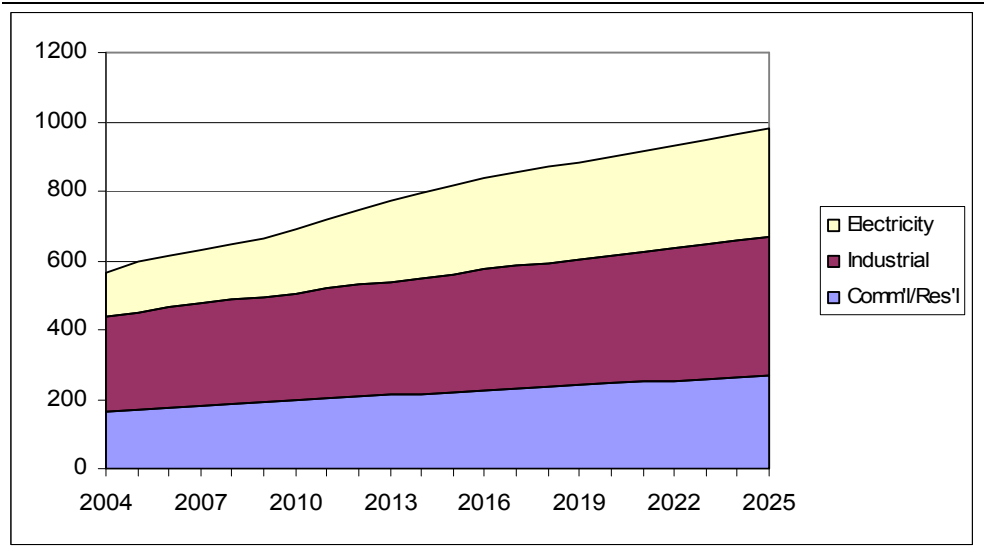
development in the mature fields in the South East. It will also depend on the development of competing pipelines from the other possible sources.

Aside from the uncertainty of the future supply and demand balance, there is also a high degree of uncertainty with regard to the timeframe necessary to put in place the commercial and financial arrangements necessary to underpin the pipeline and upstream investment. The fundamental requirement will be for a major buyer or group of buyers to perceive a supply shortfall and make a commitment to a long term, high volume purchase. Experience with attempts to commercialise PNG and Timor Sea gas by developing markets in the east has shown the difficulty, uncertainty and long time frame of such developments. In the case of PNG, resource owners spent significant money in preliminary engineering, land access, and marketing since 1996 and are only now getting close to obtaining sufficient commitments. Eastern Australia market scenarios

Scenario 1 – Steady Growth (medium development scenario)

Scenario 1 is the Base Case. Demand continues to grow at an average rate of just over two per cent in the commercial and residential sectors, consistent with population growth. Industrial demand increases at about the same rate with occasional step increases from major new industrial plants, mostly in the minerals processing sector. Electricity generation demand grows more rapidly, with significant increases in years when major new base load gas-fired plants come on-stream. Modest incentives supporting generation technologies with lower greenhouse gas emissions are introduced over time where necessary to allow gas-fired generation to be competitive with gas at slightly higher prices than in the past. Total gas usage for electricity generation increases from about 125 PJ in 2004 to over 300 PJ in 2025. Total gas consumption grows from around 580 PJ in 2004 to about 980 PJ in 2025.

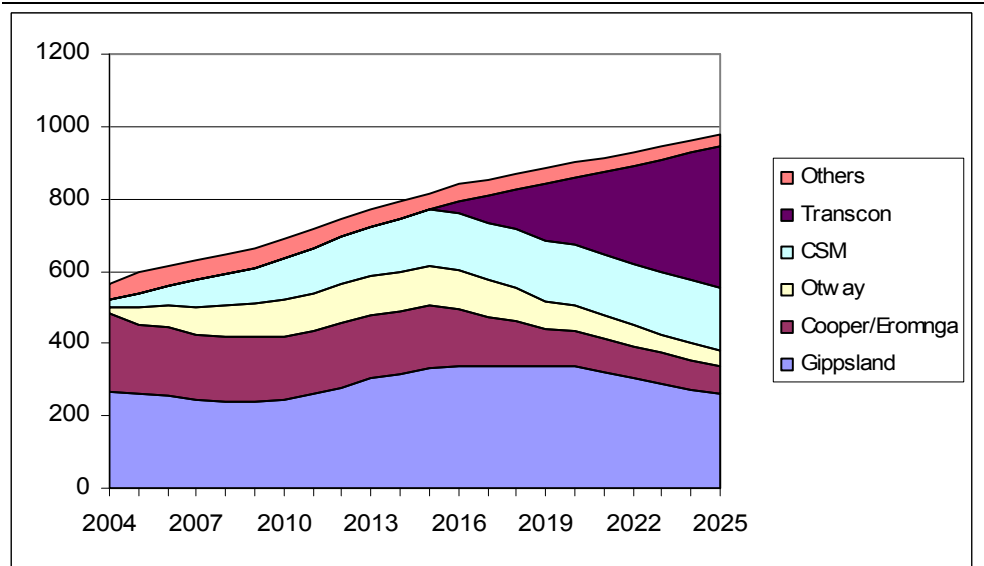
Figure 29 Eastern Australia demand: Scenario 1, PJ/a



Note: gas consumption for cogeneration is allocated between the electricity and industrial sectors
 Data source: ACIL Tasman modelling

Gas supply for Scenario 1 is shown in Figure 30. Increasing demand is initially supplied by new production in the Otway Basin and in the coal seam methane fields of Queensland. The new Otway production displaces both Gippsland gas in Victoria and Cooper/Eromanga gas in South Australia. Cooper/Eromanga gas is also displaced by the new coal seam methane production. Once Otway production levels off, more gas from Gippsland is required to supply market growth. It is assumed that exploration success in the Gippsland area is sufficient to support production expansion to an average level of about 335 PJ/a, and this is adequate to supply market growth until about 2015. Aggressive development takes CSG production to about 145 PJ by 2015, and production continues to grow after 2015 at a more gradual pace. Once Gippsland production reaches a plateau, new supplies from remote sources are needed, as there are no further large supply increments available in the South East. For this scenario, it is assumed that the PNG gas project has not been successful and the Transcontinental Pipeline supplies the market growth and replaces declining production in the mature fields through 2025. Transcontinental Pipeline deliveries reach almost 400 PJ/a by the end of the 20 year period.

Figure 30 Eastern Australia gas supply: Scenario 1, PJ/a

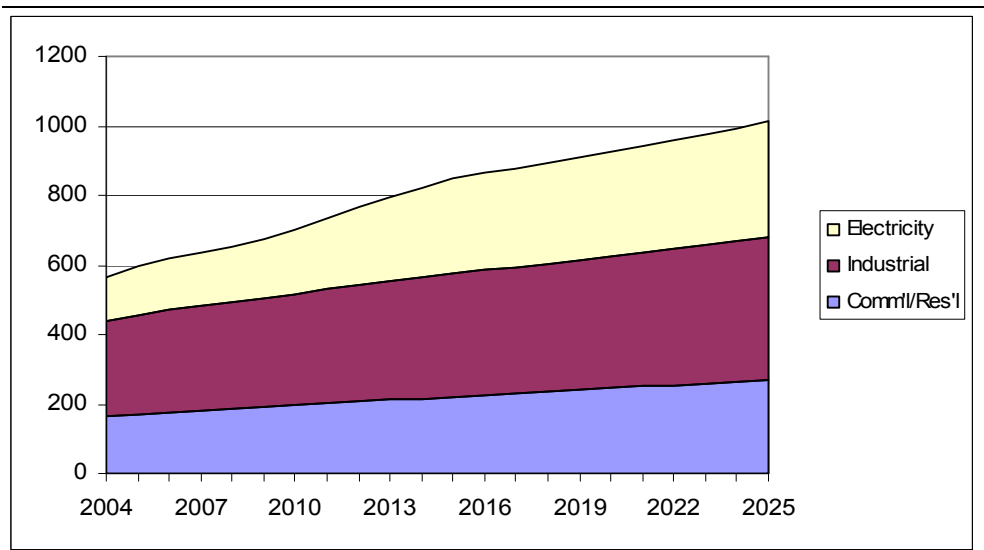


Data source: ACIL Tasman modelling

Scenario 2 – Eastern Supply Shortfall (high development scenario)

Demand in Scenario 2 grows at a somewhat higher rate than in Scenario 1 in the early years. The main difference is in the electricity sector, where incentives favouring gas are offered somewhat earlier than in Scenario 1. Industrial demand also grows at a slightly higher rate. Demand in 2025 reaches over 1000 PJ.

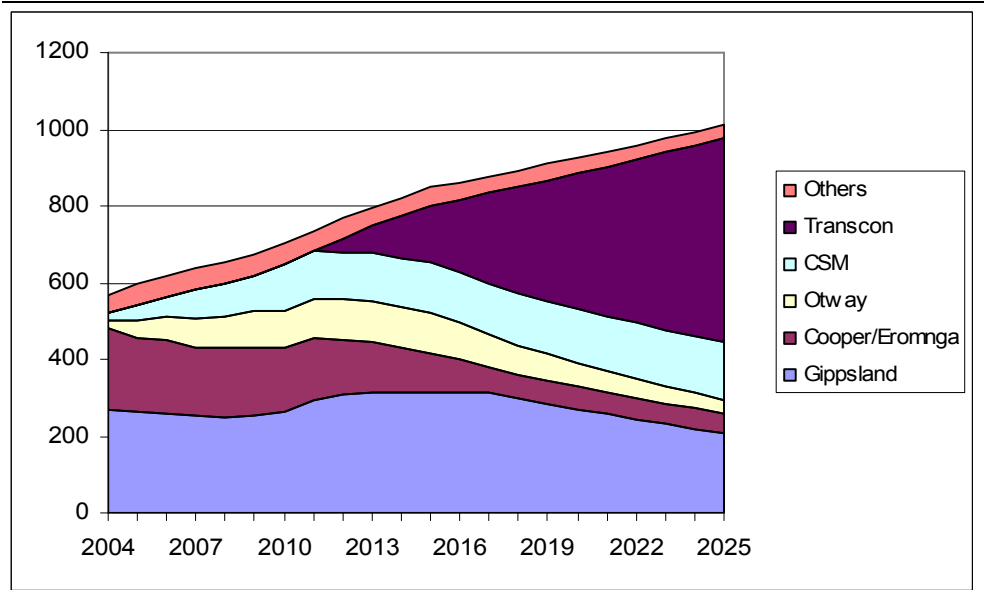
Figure 31 Eastern Australia demand: Scenario 2, PJ/a



Data source: ACIL Tasman modelling

In the early years, supply for Scenario 2 is essentially the same as in Scenario 1. Gippsland and Cooper/Eromanga production both fall off while Otway and CSG production increase. However, exploration in Gippsland is less successful, and sustainable annual production capacity is limited to about 315 PJ. CSG development also progresses at a slightly slower pace than in Scenario 1. As a result of the combination of these relatively minor differences, the new pipeline to Moomba is needed earlier. Transcontinental Pipeline deliveries start in 2012 and increase to over 500 PJ by 2025.

Figure 32 **Eastern Australia gas supply: Scenario 2, PJ/a**

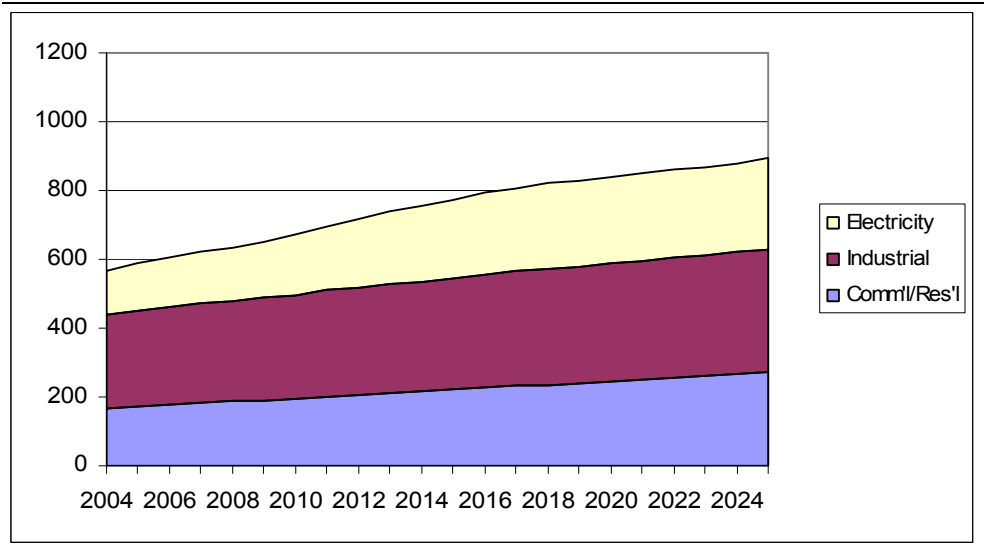


Data source: ACIL Tasman modelling

Scenario 3: PNG First (low development scenario)

On the demand side, this scenario illustrates the potential impact of a somewhat slower rate of demand growth, which could be the result of a number of different factors, including slower economic growth and higher gas prices. Total gas demand reaches only about 775 PJ in 2015 as compared to about 820 PJ in the Base Case. About two-thirds of this difference is in electricity generation.

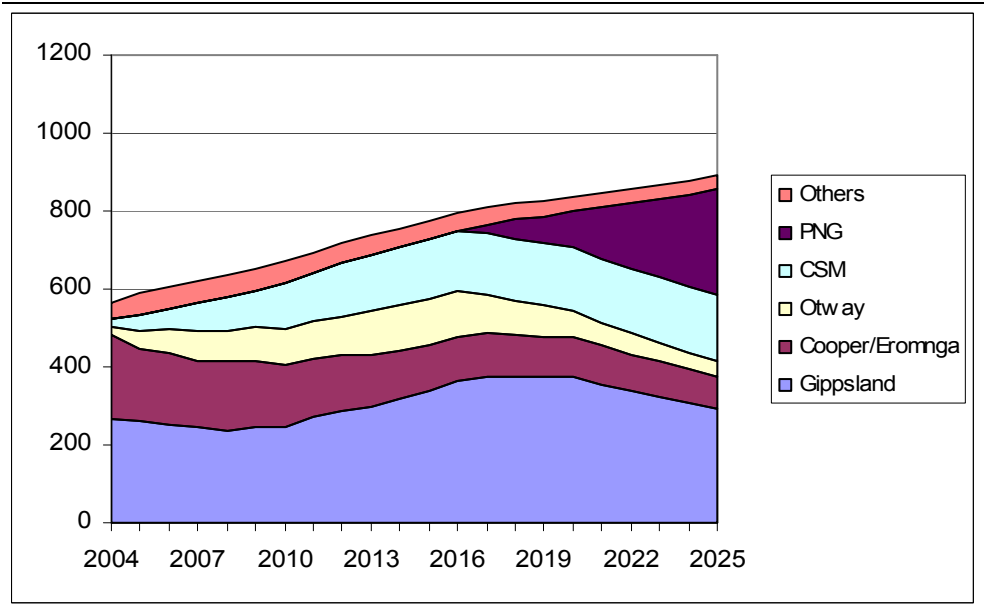
Figure 33 Eastern Australia demand: Scenario 3, PJ/a



Data source: ACIL Tasman modelling

Eastern Australian gas supply in this case is more plentiful than in either of the other two scenarios. Sufficient new reserves are discovered in Gippsland to support expansion to 375 PJ. Coal seam methane production also reaches moderately higher levels than in the other scenarios. The combination of higher production and lower demand postpones the need for new supply until 2017. In this case the new supply comes from PNG rather than from the Transcontinental Pipeline. It should be noted that in January 2005, the PNG Gas Project operator, ExxonMobil, will commence front end engineering and design studies for the PNG component of the project. This is expected to be completed by January 2006. Separate FEED studies are to be undertaken for the Australian pipeline component by APC.

Figure 34 Eastern Australia supply: Scenario 3, PJ/a



Data source: ACIL Tasman modelling

7.6 Economics of potential developments

7.6.1 Options for development of Browse Basin reserves

Remoteness from centres of population and industry means that the key to the commercialisation of these gas and condensate reserves lies in the economic transportation of the gas to the market. This transportation can take place basically in four modes:

4. Off shore gas recycling, with condensate being extracted for direct export and the gas being re-injected into the reservoir for the time being.
5. Pipeline to shore, then conversion to another form (eg LNG, gas-to-liquids [GTL]) then export shipping to market.
6. Export via pipeline to shore, domestic gas treatment then further pipelining either to local towns and alumina and zinc refineries and smelters. A further possibility would be pipelining into the domestic grid to reach the South East cities market (Sydney, Melbourne, Adelaide).
7. Conversion offshore into another form, with the assumed technology being for a floating LNG plant, then export shipping to market.

At present there is no infrastructure providing an obvious route to commercialisation involving onshore facilities. Therefore, commercialisation may occur by the application of technology such as FLNG (Floating Liquid Natural Gas) production, or a similar production technique whereby the gas is not piped to shore via a pipeline but is converted to another form at the

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offshore site and then transported by vessel to a distant market place is an option in the medium term.

Bringing the gas ashore might be the first stage of development, or might follow on from the earlier development of an offshore processing platform, which could be for either gas re-cycling with condensate extraction or even a floating LNG plant.

If an off-shore processing platform(s) is the first stage, it would probably continue to operate even after gas were brought to shore because of the committed investment. In this case, gas to shore would require only a pipeline to shore – and maybe a gas gathering manifold at the gas fields.

If bringing the gas ashore for processing is undertaken as the first stage of development, the principal infrastructure requirements are well completions (probably subsurface), gas gathering manifolds and submarine pipeline(s) to shore.

8 West Kimberley development scenarios

Given the prospectivity of the West Kimberley and the current market outlook for the minerals²⁵ and energy products particular to the region, three scenarios describing possible minerals and energy development were assembled. The scenarios described low, medium and high minerals and energy development possibilities.

The discussion in this section of options for development of the Browse Basin gas is limited to mainland areas. Offshore developments, including on islands, is beyond the scope of this report because such developments would most probably not involve multi-user infrastructure.

8.1 Base case

The base case for the development scenarios is comprised of current minerals and energy developments in operation in the West Kimberley. These are:

- Iron ore mining at Cockatoo Island;
- Diamond mining and processing at Ellendale near Fitzroy Crossing; and
- Onshore oil extraction.

The time scale for each scenario is 20 years. Developments are only included if they are expected to occur within the 20 year period.

A summary of each of the development scenarios is presented in Table 11. The most likely development scenario is considered to be the medium development scenario. This scenario was agreed to by the Management Committee and forms the basis of all of the remainder of the analysis presented in this report.

8.2 Development Scenario 1 – modest development

The Modest Development Scenario represents a very conservative view of the outlook for development in the West Kimberley. It is comprised of the developments that have been already publicly announced and that are generally considered by those in the petroleum and minerals industries as likely to go ahead.

²⁵ Despite promising prospectivity for gold in the West Kimberley, gold development has not been included in these scenarios as many mineral exploration tenements have not yet been granted and any economic deposits not yet discovered.

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The modest development scenario assumes minimal development and therefore little to no additional infrastructure requirement from government and the private sector, beyond that required for “business as usual” economic growth and maintaining the existing infrastructure. It assumes continued onshore oil, iron ore, and diamond production, with some additions to capacity, as well as the re-opening of the Lennard Shelf base metal operations.

Additional energy development would be confined to an offshore gas processing facility that would come into production by 2012 and a floating LNG facility late in the scenario timeframe. It is considered that in the absence of any onshore gas development, it becomes more likely that offshore facilities could be developed late in the timeframe.

Figure 35 **Infrastructure for modest development scenario**



8.3 Development Scenario 2 – medium growth

The Medium Growth Scenario is presented as a “likely” view of the outlook for resources development in the West Kimberley. It is comprised of developments that could reasonably be achieved with some favourable change in markets and favourable policy settings.

The medium scenario assumes:

- The same mineral development as the low scenario: continued onshore oil, iron ore, and diamond production, with some additions to capacity, as well as the re-opening of the Lennard Shelf base metal operations;
- Increased development in the minerals sector including the mining of bauxite from Mt Leeming/West Kalumburu and/or Mitchell Plateau.

It is assumed that bauxite initially will be shipped via a load out facility for processing outside Western Australia. In line with requirements of the State Agreement Act covering the Mitchell Plateau deposit, the scenario assumes an alumina refinery will be established in Western Australia within three years of mine development. The location of the refinery will be close to a competitive source of energy (gas). If located in the Kimberley, then the most likely locations are assumed to be near Derby or Broome, but the refinery could be located outside of the study area including in the Pilbara or the Mid West.

This scenario also includes the development of the Admiral Bay lead and zinc deposit located south of Broome.

The scenario assumes the development of Browse Basin gas including bringing gas to the mainland. The primary reason for doing so would be to feed an on-shore LNG plant, plus a transcontinental pipeline designed to bring gas to the Eastern States of Australia. This pipeline would also service minerals and energy developments in the West Kimberley including the alumina refinery and a gas-to-liquids processing facility assumed under this Scenario. Gas could also be used for electricity generation for nearby towns and communities, and other towns and developments along the pipeline route. It is assumed that gas would come onshore somewhere in the region of Dampier Peninsula and Yampi coastline because they are the closest mainland location to the Browse Basin. This minimises sub-sea pipeline capital costs.

Offshore processing would be limited to gas processing platform(s) that would operate at the producing field(s) prior to gas coming onshore.

Under the medium growth scenario, onshore gas extraction would increase over time due to new discoveries and producing fields or changes in technology that allow additional extraction for existing fields.

The medium scenario would require economic and social infrastructure planning and provision from both government and the private sector.

8.4 Development Scenario 3 - high growth

The High Growth Scenario is constructed as an optimistic view of possible minerals and energy development in the West Kimberley. It is not a “blue sky” view, but an assessment of the developments that could occur if policy settings and markets are favourable. It would require a greater level of infrastructure planning and provision from government and the private sector than the other scenarios.

The High Growth Scenario assumes the same minerals and energy development as the Medium Growth Scenario (likely) but in most cases assumes an accelerated timeframe. For the minerals sector, it assumes the development of an aluminium smelter in the vicinity of the alumina refinery and a zinc smelter close to the Admiral Bay development.

Additional gas development would include the alumina smelter and zinc smelter as customers in addition to the development of a GTL and ethylene industry. It also assumes a floating LNG facility from 2015 (in addition to the onshore plant) but no other offshore gas facility as gas is assumed to come onshore earlier than in the other scenarios and condensate is extracted at an onshore facility.

Table 11 Summary of development scenarios

DEVELOPMENT	LOW SCENARIO 1 (MODEST DEVELOPMENT)	MEDIUM SCENARIO 2 (LIKELY DEVELOPMENT)	HIGH SCENARIO 3 (OPTIMISTIC DEVELOPMENT)
Bauxite/alumina			
Bauxite is mined and crushed at Kalumburu and Mt Leeming and exported elsewhere for processing via a basic load out facility close to the mine. Subject to agreement between proponents and State Government. Workers are sourced locally and fly-in, fly-out (FIFO) and housed in camps.	No	2008	2006
Bauxite is mined and crushed at Mitchell Plateau and exported elsewhere for processing via a basic load out facility close to the mine. Workers are sourced locally and FIFO, and housed in camps.	No	2013	2010
Bauxite is refined to form alumina and exported elsewhere for smelting from a purpose built ship loading facility close to the mine/transported by road to the Port of Wyndham/Derby. Refinery is located close to onshore gas pipeline near Derby or Broome but possibly the Pilbara (Port Hedland) or Mid West (Oakagee). Some workers are FIFO, some sourced from the Kimberley but most are encouraged to live with families in town close to refinery.	No	2016	2013
Alumina is smelted close to refinery and exported via a sophisticated port facility close to Derby or Broome direct to overseas customers. Smelter is located close to gas pipeline. Few workers are FIFO with most living in town close to smelter.	No	No	2020
Lead/zinc			
Lennard Shelf operations are re-opened. Lead and zinc is mined and processed on site before being transported via the Great Northern Highway to the Port of Derby for refining/smelting elsewhere. All workers sourced from the Kimberley with some FIFO.	2006	2006	2006
Admiral Bay deposit is developed with lead and zinc mined and processed on site before being transported via the Great Northern Highway to the Port of Broome for refining/smelting elsewhere. Most workers sourced from the Kimberley with some FIFO.	No	2010	2010
Zinc is smelted on site before being shipped via a purpose built ship loading facility close to mine. Most workers sourced from the Kimberley with some FIFO.	No	No	2012
Diamonds			
Ellendale continues to expand. Product is mined and processed on site	2004	2004	2004

DEVELOPMENT	LOW SCENARIO 1 (MODEST DEVELOPMENT)	MEDIUM SCENARIO 2 (LIKELY DEVELOPMENT)	HIGH SCENARIO 3 (OPTIMISTIC DEVELOPMENT)
and flown to market from local airstrip. Some workers sourced from the Kimberley and others FIFO.			
Additional diamond mine established. Product is mined and processed on site and flown to market from local airstrip. Some workers sourced from the Kimberley and others FIFO.	2008	2008	2008
Iron ore			
Cockatoo Island mine continues with subsea mining and initial processing on site. All ore exported for processing elsewhere. All workers FIFO.	2004 – 2007	2004 - 20070	2004 2007
Koolan Island mine established with mining of existing dumps and expansion of existing mine. Initial processing on site. All ore exported for processing elsewhere. All workers FIFO.	2006 – 2013	2006 - 2013	2006 - 2013
Onshore oil			
Oil extraction continues. Oil transported by Great Northern Highway and/or through the Port of Broome.	2004	2004	2004
New technologies allow greater extraction of oil from Canning Basin and elsewhere. Oil transported by through the Port of Broome.		2004	2004
Gas onshore			
LNG/Liquids. Gas bought onshore and processed to form LNG and liquids before being transported elsewhere by sea. Sophisticated processing plant and port facility required similar to Burrup Peninsula. Workers sourced from the Kimberley and FIFO.	No	2016	2012
Private customer. Gas is bought onshore for electricity generation to service one or more significant energy users such as an alumina refinery, aluminium smelter or lead smelter. Remote operation or FIFO.	No	2016 (alumina refinery)	2012 (alumina refinery)
Transcontinental pipeline. Gas is brought onshore by one or more users for processing before being transported via a transcontinental pipeline to the Eastern States. Customers along the way could include a lead smelter and alumina refinery/smelter in the West Kimberley but could also link into towns and resource developments further inland. Pipeline could link into Amadeus pipeline in the Northern Territory. Pipeline operated from a remote location. Processing plant requires minimal supervision and could possibly be operated from a remote location. All workers FIFO.	No	2016/17	2012
GTL. Gas bought onshore to service a lean gas-based industry. Products are then transported elsewhere through a sophisticated port facility. Workers sourced from the Kimberley and FIFO.	No	No	2012
Ethylene. Gas bought onshore to service a petrochemical industry. Products are then transported elsewhere through a sophisticated port	No	No	2016

DEVELOPMENT

	LOW SCENARIO 1 (MODEST DEVELOPMENT)	MEDIUM SCENARIO 2 (LIKELY DEVELOPMENT)	HIGH SCENARIO 3 (OPTIMISTIC DEVELOPMENT)
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facility. Workers sourced from the Kimberley and FIFO.

Gas offshore

Offshore gas processing (recycling and condensate extraction) platform with all products processed at sea and shipped elsewhere directly from platform. All workers FIFO.

2012

2012 (prior to onshore gas)

No

Floating LNG facility with all products extracted and processed at sea and shipped elsewhere directly from platform. All workers FIFO.

2018

No

2015

9 Options within most likely development scenario

A detailed discussion on the Medium Resource Development Scenario is contained in the following sections. Summary tables comparing the sub options, infrastructure considerations and their advantages and disadvantages are provided in Appendix A. Note that for ease of understanding, each option is described in its entirety, which has resulted in some repetition of descriptions.

9.1 Development options overview

The development options presented are based on the examination of existing and potential oil fields, gas fields, and mineral deposits and their relative location to existing infrastructure in the West Kimberley area.

The areas identified for potential development have not been assessed in terms of technical, environmental, social and economic criteria as being suited for development. Such assessments are outside the scope of this study.

To determine the location for resource project development requires further investigation, including siting studies. This is the responsibility of the project proponents. Extensive consultation would be required with Traditional Owners and the wider community and studies would also need to take into account factors such as land tenure.

Gas development options

The development options considered for the natural gas resources in Browse Basin are:

1. Gas plant – Coastal areas north-east of Derby;
2. Gas plant – Area of northern Dampier Peninsula; and
3. Gas plant – Area on the western side of Dampier Peninsula.

Figure 36 indicates the mainland areas closest to the Browse Basin, which are therefore considered the most likely for an onshore gas pipeline.

The development options considered for the bauxite resources in the vicinity of Mitchell Plateau are:

1. Bauxite mining at Mt Leeming/Kalumburu and Mitchell Plateau.
2. Alumina refining either:
 - a) Near the mine sites at Napier Broome Bay or Admiralty Gulf;

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- b) North-east of Derby; or
- c) On the Dampier Peninsula.

It is recognised that an alumina refinery could be developed elsewhere in Western Australia, possibly in the Pilbara or the Mid West, or other parts of the State. However, the purpose of the study is to focus on development of the West Kimberley region. Therefore only areas in the Kimberley are considered in this report.

Scenario for other resource development

The development scenario considered for other resources such as lead, zinc, diamonds, iron ore and onshore oil fields are:

- Lead and zinc mining recommencing at Lennard Shelf and new mine development at Admiral Bay;
- Continuation and expansion of diamond mining at or near Ellendale;
- Iron ore mining continuing at Cockatoo Island and re-commencement of mining at Koolan Island; and
- Ongoing production from and development of new fields in the Canning Basin.

9.2 Gas development options

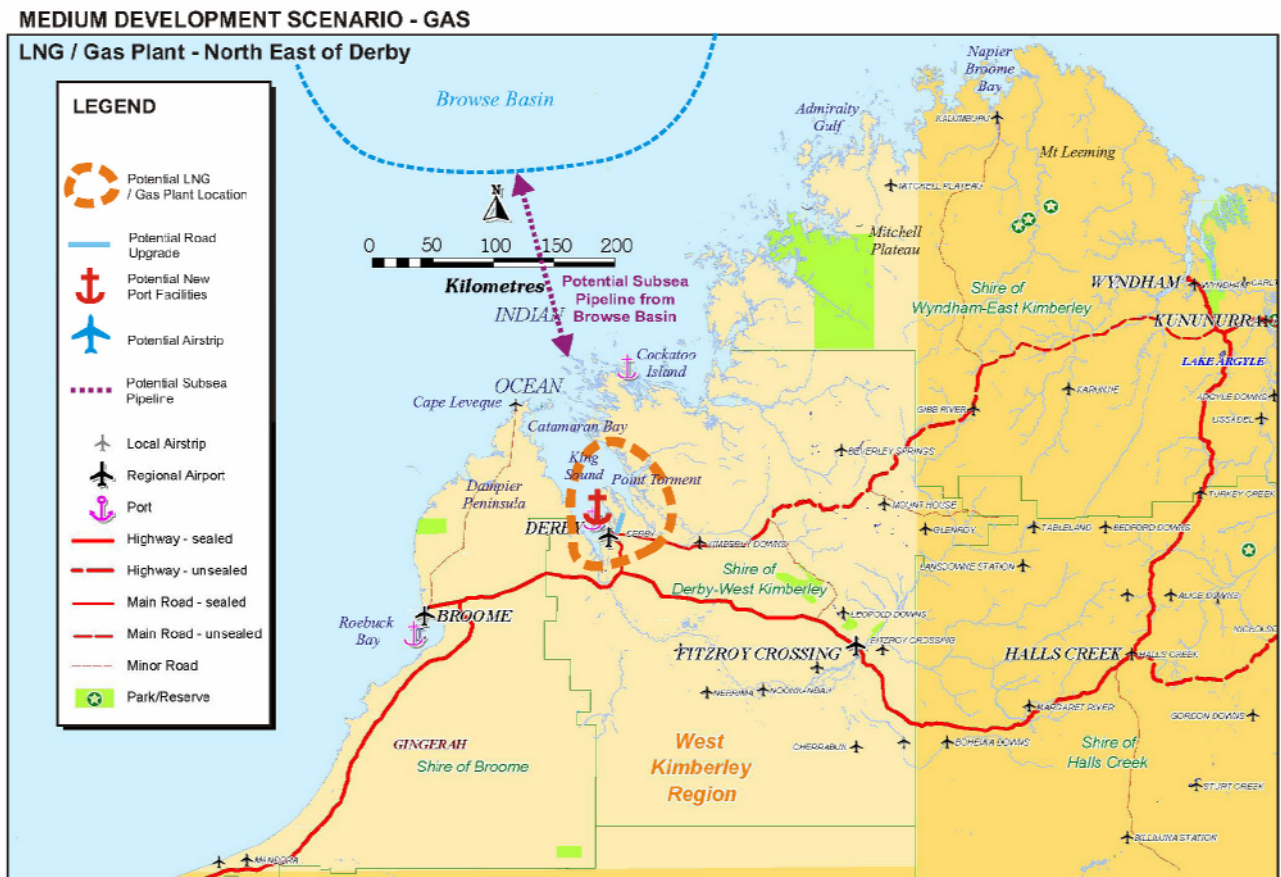
Three gas development options are presented in detail in the following sections and summarised in Table 11.

9.2.1 Option 1 – LNG and domgas plant north east of Derby

This section describes the infrastructure required to progress the development of an onshore gas receiving terminal, gas processing plant, ship loading terminal and associated facilities north-east of Derby.

Figure 36 illustrates the infrastructure requirements for this option.

Figure 36 Infrastructure needs for LNG and domgas plant north east of Derby



Transport infrastructure

Port

The new ship loading facility would be sited and developed by the project proponent. There is potential for the port of Derby to be upgraded for resource development in the region. The particular upgrade requirements would depend on the infrastructure needs of the project. It should be done in consideration that the conditions in King Sound present significant challenges for large scale shipping.

The new ship loading terminal will require safe navigational access and berthing for LNG tankers such as the “Moss-Rosenberg” design LNG carriers that are in service between the North West Shelf Venture gas shipping facility in Karratha and the various gas receiving terminals in Japan. These vessels, carrying a cargo of 125,000 m³ of LNG, have a deadweight tonnage of 93,000 t and a loaded draft of 11.5 m. Larger vessels with a capacity of up to 250,000

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m³ may be used with a deadweight tonnage of 170,100 t and a loaded draft of approximately 14 m.

There is potential for port development north east of Derby, co-located with an onshore LNG facility. The channel from King Sound to the Indian Ocean is bordered by the Buccaneer Archipelago consisting of small islands, shoals and reefs that require careful navigation by vessels. King Sound is capable of accommodating large sea-going vessels. However, low water depths at the Port of Derby restrict ship berthing to shallow draft vessels. Port development north east of Derby would have to consider dredging to enable large scale shipping.

The existing navigation channel into King Sound is the Sunday Strait between East Sunday Island and Tree Island. This channel is characterised by strong currents requiring pilot assistance to ensure safe navigation. Risks to ships can be managed by selecting specific tidal windows for passage through the Sunday Strait. However, this could compromise the regular LNG shipping schedules that would be required. The channel delineation will require upgrading with additional buoys and beacons.

Depending on the specific location chosen for a new ship loading berth, dredging works will be required to create the berthing pocket and approach channel. The berth would be a piled steel jetty structure with loading pipelines and facilities installed on top.

If strong currents are encountered at the berth, then regular maintenance dredging will be necessary to assist in berthing and prevent siltation of the channel and berth pocket. The large tidal range in King Sound would require specially designed LNG loading facilities of a type not before used in the industry.

Further consideration of development north east of Derby is required on a project by project basis.

Roads

Many roads in the areas are unsealed. The road network north east of Derby is largely undeveloped. Major developments in the area will require the improvement of roads to all-weather standard. The stretch of the Derby-Gibb River Road that runs to the south of this area is sealed.

All weather access from north east of Derby and the Derby-Gibb River Road could be provided by 25 km to 100km of sealed road running north of the existing road. Given the relatively flat nature of the terrain and small watercourses, the road construction would not require major crossing

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structures. However, it will need to be designed to withstand high rainfall that is associated with cyclonic events.

Air transport

The nearest airport facilities are Derby Airport and RAAF Curtin Airbase is approximately 55km to the south of Derby. Both airports have sealed runways and passenger transit facilities. Therefore a gas plant development north east of Derby would not require its own airstrip for personnel transport during the construction and operation phases.

The Derby Airport runway is capable of receiving medium size passenger jet aircraft such as Fokker F100 and British Aerospace BAe-146.

The Curtin Airbase is capable of handling large passenger jet and heavy transport aircraft with heavy wheel loads. This would allow the transport of heavy equipment components using specialist aircraft such as the Antonov AN-124.

Site development

The topography north east of Derby varies from gently undulating to low rocky hills with the ground sloping down to the waterline.

The project will need to be sited at an elevation to withstand the combined effects of storm water and storm surge for a recurrence interval of 100 years. This can be achieved by siting the plant on elevated land or by building up the low-lying coastal areas with cut to fill material from surrounding areas and spoil from dredging operations.

The geotechnical conditions in the Kimberley also offer some challenges including occurrences of reactive clays and identification of suitable construction materials. These need to be addressed on a case by case basis and some of these opportunities are identified below.

The anticipated footprint area of the LNG plant could need a minimum of 100 ha for the permanent facilities listed below:

LNG process plant (2 trains) and domgas plant	60 ha
Plant utilities	20 ha
Administration and workshop buildings	20 ha

The construction phase will require an additional 100 ha of land for construction-related facilities: a construction camp and laydown areas for the storage of materials and assembly of steelwork and piping as follows:

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Buffer and laydown areas	60 ha
Construction camp	40 ha

A development north east of Derby has the potential to take advantage of existing infrastructure and support services within the township of Derby. This would also enhance opportunities for local businesses to provide catering, accommodation and other facility management services during the construction phase.

Construction materials

Construction materials in the Derby area are currently sourced from a number established sources operated by local earthmoving and cartage contractors. These sources are presented in Table 12.

Table 12 **Construction materials: Derby**

Source Name	Materials	Location
Langey Crossing	Sand, Gravel	40 km south of Derby
May River	Sand, Gravel	33 km east of Derby
May River	Sand	25 km east of Derby
Yeeda-Kimberley Group	Rock, Aggregate, Gravel	80 km south of Derby

Data source: *Minedex, Department of Industry and Resources, 2004*

Energy

The nearest energy facility is the Derby Power Station, a diesel-fired station designed to service the residential and light commercial requirements of consumers in the town and surrounding area. This facility will be replaced in 2005 by an LNG-powered plant. However, neither is technically and economically suitable to supply the electrical needs of an industrial project some 30 km distant. Any operation located north east of Derby would have to be self-reliant for electrical energy supply.

Gas to the LNG plant could be supplied by a sub-sea pipeline from the offshore Browse Basin. Pipeline configuration would be subject to technical and economic assessment of each route.

The incoming gas would be processed at the plant to remove water and impurities and produce LNG, and possibly gas for domestic use (domgas), and saleable by-products such as condensate.

Should a plant be developed north east of Derby, the potential for it to provide power to Derby should be assessed. On completion and commissioning of the plant and the gas-fired power station, the transmission line could be used to supply electricity to Derby.

Water supply and wastewater

Groundwater extraction is the prevalent form of water supply for the town of Derby and surrounding pastoral stations.

An LNG plant operation north east of Derby is likely to be supplied from a borefield in the vicinity of the plant site, subject to further hydrogeological investigations to determine the capacity and suitability of the groundwater aquifers.

There is potential to install a desalination plant within the LNG plant site to supplement the groundwater supply and produce industrial-grade water for cooling and blow-down purposes.

Wastewater from the gas plant could be treated on-site using a standard “package” treatment plant.

Telecommunications

There is potential to connect the gas plant by cable or microwave with the existing telecommunications facility at Derby, which would have to be upgraded to provide a service to the wider north east area.

The existing Derby GSM and CDMA mobile telephone coverage area has limited coverage to the north east of Derby. If development is needed, the existing service could be upgraded and/or extended.

The Derby Telephone Exchange is connected by optic fibre cable to the National Optic Fibre Network that facilitates fast voice and data communications between capital and regional centres.

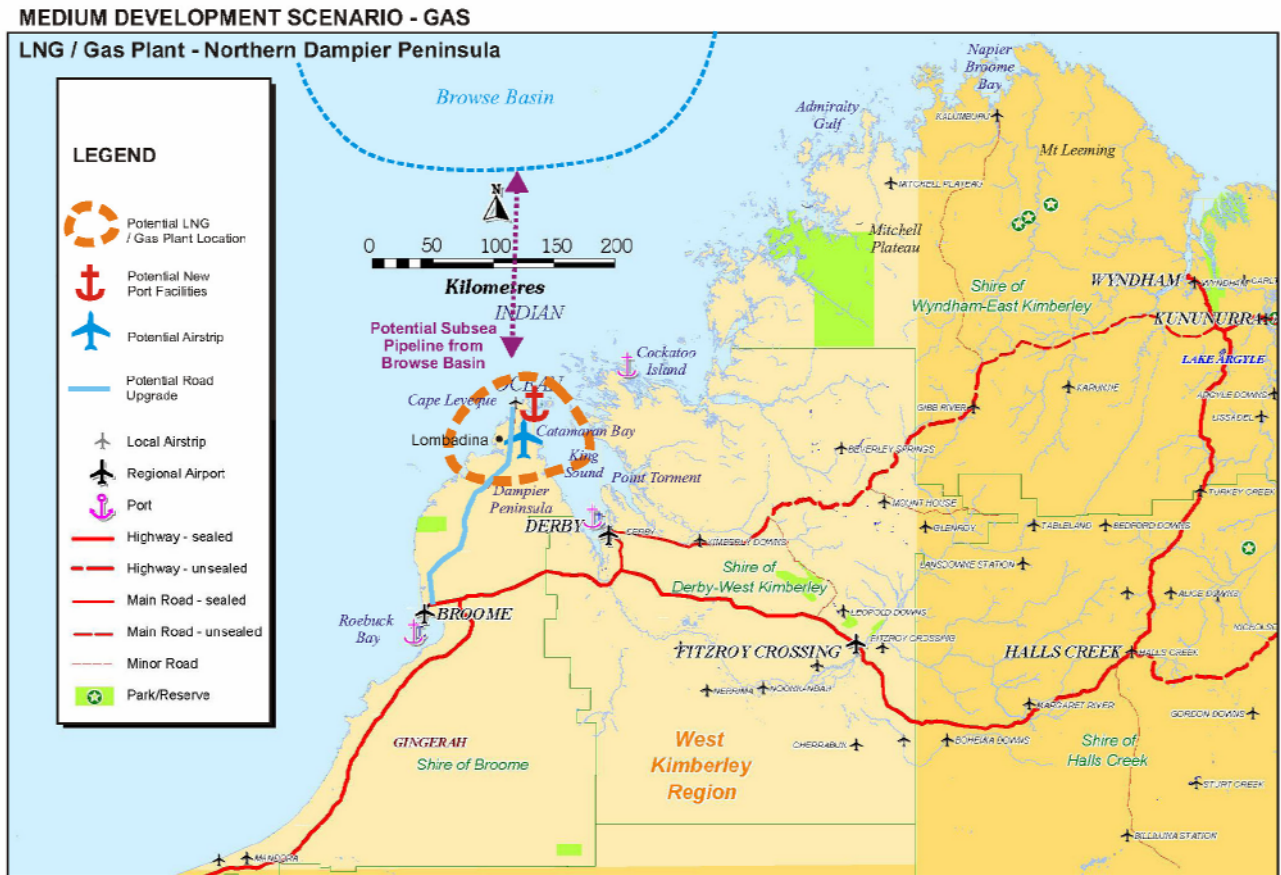
9.2.2 Option 2 – LNG and domgas plant at Northern Dampier Peninsula

This section describes the infrastructure required to progress the development of an onshore gas receiving terminal, LNG plant, domgas processing plant, ship loading terminal and associated facilities along the northern areas of the Dampier Peninsula. This area is one of the closest mainland locations to the Browse Basin.

It would be the responsibility of the project proponent to undertake appropriate consultation with traditional owners about any development in this area.

Figure 37 illustrates the infrastructure requirements for this option.

Figure 37 Infrastructure needs for LNG and domgas development on the northern Dampier Peninsula



Transport infrastructure

Port

There is a range of locations that could be considered for port development in the northern area of the Dampier Peninsula. As described under option 1, the entrance of King Sound to the Indian Ocean is bordered by the Buccaneer Archipelago consisting of small islands, shoals, reefs and rocks that require judicious navigation by vessels. Port development will have to consider a requirement for careful navigation due to sections of shallow water and shell banks, plus strong tidal currents. In addition, the north west coast is subject to strong storm surges associated with cyclones.

Navigation and port requirements are assessed as similar to requirements for Option 1.

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Depending on the specific location chosen for the new ship loading berth, dredging works will be required to create the berthing pocket and approach channel. The berth would be a piled steel jetty structure with loading pipelines and facilities installed on the deck. If strong currents are encountered at the berth then tugs and regular maintenance dredging will be necessary to assist in berthing and prevent siltation of the channel and berth pocket.

Operational constraints due to currents and tides will require consideration in the design of marine facilities. Charts identify high currents for the area and these require further investigation.

It needs to be noted that currently the eastern coastline of the Dampier Peninsula is contains numerous pearling leases.

Due to the isolation of the area from other regional centres in the West Kimberley it may be necessary to construct a new barge landing for the delivery of construction materials and equipment close to the project site.

In this case, a supply base with a substantial lay-down area and barge landing would need to be constructed at a location with good road access. Derby is one option.

Road transport

The northern Dampier Peninsula Aboriginal communities of Lombadina, One Arm Point and Cape Leveque are accessible by a 200 km long unsealed road from Broome. This road is gazetted as a main road and maintained by the Shire of Broome on behalf of Main Roads WA.

Due to the lack of suitable road construction materials and difficult terrain sections, the road can be closed between Broome and Lombadina in the Wet season due to flooding and poor surface conditions. The current upgrade program will improve the situation.

North of the Lombadina community, the roads to Cape Leveque and One Arm Point have been sealed to facilitate all-weather access and transport between these communities and tourism developments at Cape Leveque.

Provision of reliable road transport would require considerable upgrading of the existing access road to Lombadina to a minimum of an all-weather unsealed standard with creek crossings and grades suitable for heavy transport vehicles.

Air transport

A sealed airstrip at Lombadina services the needs of the Aboriginal communities and tourism ventures in the northern Dampier Peninsula area. This airstrip is located 15 km south-west of One Arm Point. However, use of this facility associated with an LNG and gas plant development would require agreement with community members.

The existing sealed airstrip would require upgrading in the form of runway and parking area widening, lengthening and strengthening to accommodate medium size passenger turbo-prop passenger aircraft or small to medium jet aircraft, up to 737 size, dependent upon proposed transport strategy and personnel requirements.

Site development

Potential sites are on sloping terrain with small creeks feeding into the sea. Preparation of a level site elevated above flood and storm surge levels could require considerable earthworks.

The preparation of a project site would require clearing of vegetation and changes to surface drainage.

The anticipated footprint area of the LNG and domgas plant is approximately 100 to 200 ha for the permanent facilities as listed below:

LNG process plant (2 trains) and domgas plant	60 ha
Plant utilities	20 ha
Administration and workshop buildings	20 ha

The construction phase would require an additional 100 to 200 ha of land for construction-related facilities: a construction camp and laydown areas close to the barge landing facility for the storage of materials, and assembly of steelwork and piping.

The construction support areas are:

Buffer and laydown areas	60 ha
Construction camp	40 ha

Due to the isolated location of the site, a permanent accommodation camp would be required to accommodate operations personnel with fly-in fly-out transport from Broome or other population centres in Western Australia.

The northern Dampier Peninsula is mostly Aboriginal reserve land and the construction of a purpose-built town to accommodate operations personnel for the plant may be at odds with the social objective of the isolated

communities. An accommodation camp would house fly-in, fly-out workers. It is not envisaged that a residential town would be developed for this project.

Construction materials

There are limited identified construction materials sources in the northern Dampier Peninsula. Small borrow pits and scrapes are used by the Main Roads WA and the Shire of Broome to extract road-building materials for the Cape Leveque access road.

To construct the LNG plant, earthworks materials may be able to be sourced locally, subject to investigation for suitability as engineered fill. Rock and aggregate required for coastal and concrete works, respectively, may be identified and could be sourced from either of the following:

- Established quarries in the vicinity of Broome;
- The nearest suitable construction material maybe found at mine sites, such as Cockatoo and Koolin Islands.

The haulage distance for construction materials from the Broome area would exceed 300 km. A materials search would need to be undertaken over the area to determine options as this may influence site selection.

Energy

An LNG - domgas plant would be self-sufficient for electrical energy with power generation provided by gas-fired turbine generators and diesel-fired back-up system. A local distribution system would supply the plant and associated facilities.

There maybe an opportunity for the State Government to assess the feasibility of providing power to local communities from the LNG plant.

Water supply and wastewater

Groundwater bores and surface catchment dams would need to be constructed to service the water requirements of the plant site and accommodation camp. A package treatment plant would be required to improve water quality

A desalination plant within the plant site may be required to supplement the groundwater supply/surface catchment if adequate supply is not obtainable from these sources. The desalination plant would produce water for consumption, cooling, blow-down and other purposes.

Wastewater from the gas plant could be treated on-site using a standard “package” treatment plant.

Telecommunications

The Cape Leveque community is serviced by optic fibre connection to the Broome telephone exchange and the national network. This means that a project may be able to tap into this infrastructure for fast and efficient voice and data communications.

The plant site connection to the optic fibre cable could be either through a direct cable connection or by microwave relay stations. Some work may be required at the connection point as well as the Broome exchange to ensure that the cable transmission capacity is optimised.

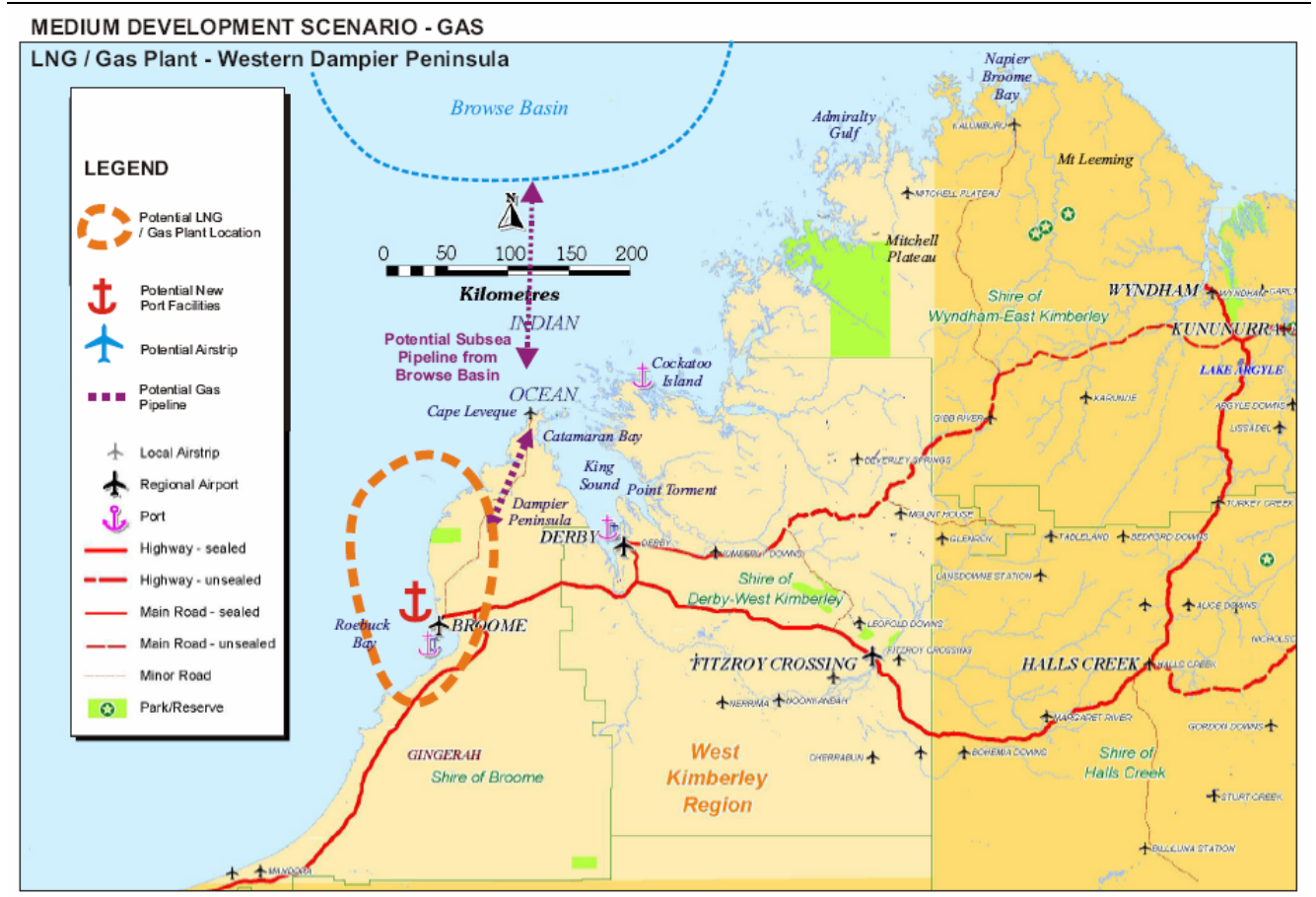
Access to broadcast media for personnel employed at the plant would require a receiving station. This would provide analogue television and radio signals that are broadcast to the regional centres.

9.2.3 Option 3 – LNG gas plant in the western side of Dampier Peninsula

This section describes in detail the infrastructure required to progress the development of an onshore gas pipeline receiving terminal at Cape Leveque, an onshore pipeline on the Dampier Peninsula connecting with a gas processing/LNG plant, ship loading terminal and associated facilities on the western side of the Dampier Peninsula, north of Broome, or south of Broome.

Figure 38 illustrates the infrastructure requirements for this option.

Figure 38 Infrastructure requirements for LNG and domgas plant on the western side of the Dampier Peninsula



Transport infrastructure

Port

The development of a port facility on the west coast of the Dampier Peninsula or south of Roebuck Bay would require marine works at a suitable location that would offer a degree of protection for the port facility from large swells and storm action.

The western coastline of the Dampier Peninsula is exposed to the open waters of the Indian Ocean with scattered reefs and shoals in some locations. In general, access to this section of coastline is affected by navigational hazards that will need to be investigated and addressed prior to final selection of a suitable port development site.

The outer approaches to existing Broome Port and any future development and port sites will require potentially significant dredging to accommodate

vessels with drafts exceeding 10 metres. The impact of tides and currents will also require assessment.

The existing Port of Broome is located on Roebuck Bay with deep water accessed by a jetty structure. The port entry inner channel allows ships up to 40,000 DWT to access the Port. The berthing pocket at the jetty is currently limited to 10m depth at chart datum.

Roebuck Bay offers slower currents and in some areas good shelter from cyclonic conditions. It would provide less operational constraints than other locations.

Road transport

Broome is located close to the junction of the Great Northern Highway with the eastward section providing a connection to Derby, Fitzroy Crossing and Wyndham/Kununurra, and the southward section connecting with the Pilbara regional centres of Port Hedland and Karratha/Dampier.

The Great Northern Highway is the primary road transport artery and the plant site would be connected via a sealed all-weather access road for personnel and material transport from Broome and other areas of Western Australia. All road access to the Port of Broome is currently through the town. Any significantly greater use of the port area would necessitate construction of the proposed town bypass road.

Air transport

Broome is serviced by a high standard airport facility capable of handling medium passenger and freight jet aircraft as well as small aircraft and helicopters. For a plant site located in close proximity to Broome, all personnel transport needs would be met by the existing airport.

There are medium to long term plans to construct a new airport north of Broome and to redevelop the existing site for residential and commercial use.

In the case of a plant site located more than 100 km from Broome Airport, consideration may need to be given to the construction of a small airstrip to provide landing capacity for small commuter aircraft to provide the connection with Broome Airport.

Site development

The terrain in the vicinity of Broome is undulating near the coastline with a gently sloping interior north-east of Broome. The coastal areas have clay pans, tidal areas and low-lying flood plains with small watercourses.

The key criterion for the preparation of the plant area is to elevate the plant site above storm surge and flood levels and this is of greater emphasis in the low lying coastal areas.

The anticipated footprint area of the gas/LNG plant development is approximately 100 ha for the permanent facilities listed below:

LNG process plant (2 Trains) and domgas plant	60 ha
Plant utilities	20 ha
Administration and workshop buildings	20 ha

The construction phase will require an additional 100 ha of land for construction-related facilities: a construction camp and laydown areas for the storage of materials and assembly of steelwork and piping as follows:

Buffer and laydown areas	60 ha
Construction camp	40 ha

The construction camp may be located close to Broome, subject to government and Traditional Owner approval. The camp residents would be close to existing social and entertainment infrastructure and local businesses would benefit from extra trade and services supplied.

Construction materials

Construction materials in the Broome area are currently sourced from a number of established sources operated by local earthmoving and cartage contractors. These sources are presented in Table 13.

Table 13 **Construction materials: Broome area**

Source	Materials	Location
12 Mile Quarry	Gravel	16 km east of Broome
Deep Creek	Sand	55 km east of Broome
Roebuck Plains	Sand, Gravel, Rock	65 km east of Broome
Roebuck Plains	Rock, Aggregate	86 km east of Broome
Nillibubbaca	Aggregate	100 km east of Broome

Data source: Minedex, Department of Industry and Resources, 2004

Energy

Gas from the Browse Basin would be brought onshore via a sub-sea pipeline to a landfall site in the vicinity of Cape Leveque (the closest mainland landfall to the Browse Basin) and from there by a buried pipeline to the onshore gas processing facility. The pipeline would most likely be constructed within existing infrastructure easements where available to minimise disturbance and ensure access for maintenance and to avoid native title difficulties.

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The gas/LNG plant will be self-sufficient for electrical energy with power generation provided by gas-fired turbine generators and diesel-fired back-up system. A local distribution system will supply the plant and associated facilities with a possible high voltage transmission line to the existing Broome sub-station.

Broome is currently supplied by a diesel-fired power station. This power station has capacity suited to supply residential, commercial and light industrial requirements for the town. It will be replaced in 2005 by a new LNG gas-fired plant with LNG being supplied by truck from a new facility on the Maitland Industrial Estate near Karratha. The development of a gas/LNG plant in the vicinity could provide a viable alternative source of gas and/or electrical energy for the town and region's ongoing development.

Water supply and wastewater

The supply of water to the gas plant site could be accommodated from two potential sources subject to capacity:

- Existing Broome water supply by Water Corporation;
- Borefields in groundwater extraction areas;
- A reverse osmosis desalination plant.

Any water extracted from groundwater sources would require treatment in the on-site treatment/chlorination plant and distributed locally.

Depending on the distance of the site from Broome, wastewater from the plant operations could be piped to the existing Broome treatment plant, subject to system capacity, but more likely would be treated on site prior to discharge.

Telecommunications

The proximity of the potential gas/LNG plant site to Broome will determine the telecommunications and broadcast media requirements. The most basic infrastructure item would be a direct cable connection to the Broome telephone exchange or microwave radio signal stations.

If the plant site is located in proximity to Broome transmitter stations, then signal quality can be improved for the longer distance by installing a booster or repeater station. Fibre optic cable connection of Broome to the rest of Australia should provide adequate for plant telecommunications and data needs.

9.3 Bauxite mining and alumina refining development options

The following bauxite development options are described in detail in the following sections and summarised in Table 34 and Table 35 on page 190.

9.3.1 Option 1: Bauxite mining at Mitchell Plateau/Mt Leeming and West Kalumburu

This option envisages bauxite mining only, with refining done outside the Kimberley. The Mitchell Plateau, Mt Leeming and Kalumburu in the remote north west of the West Kimberley is characterised by limited economic and social infrastructure, an extreme climate, and sensitive environmental and cultural heritage issues. The remoteness of the area increases during the Wet season when access by road virtually ceases.

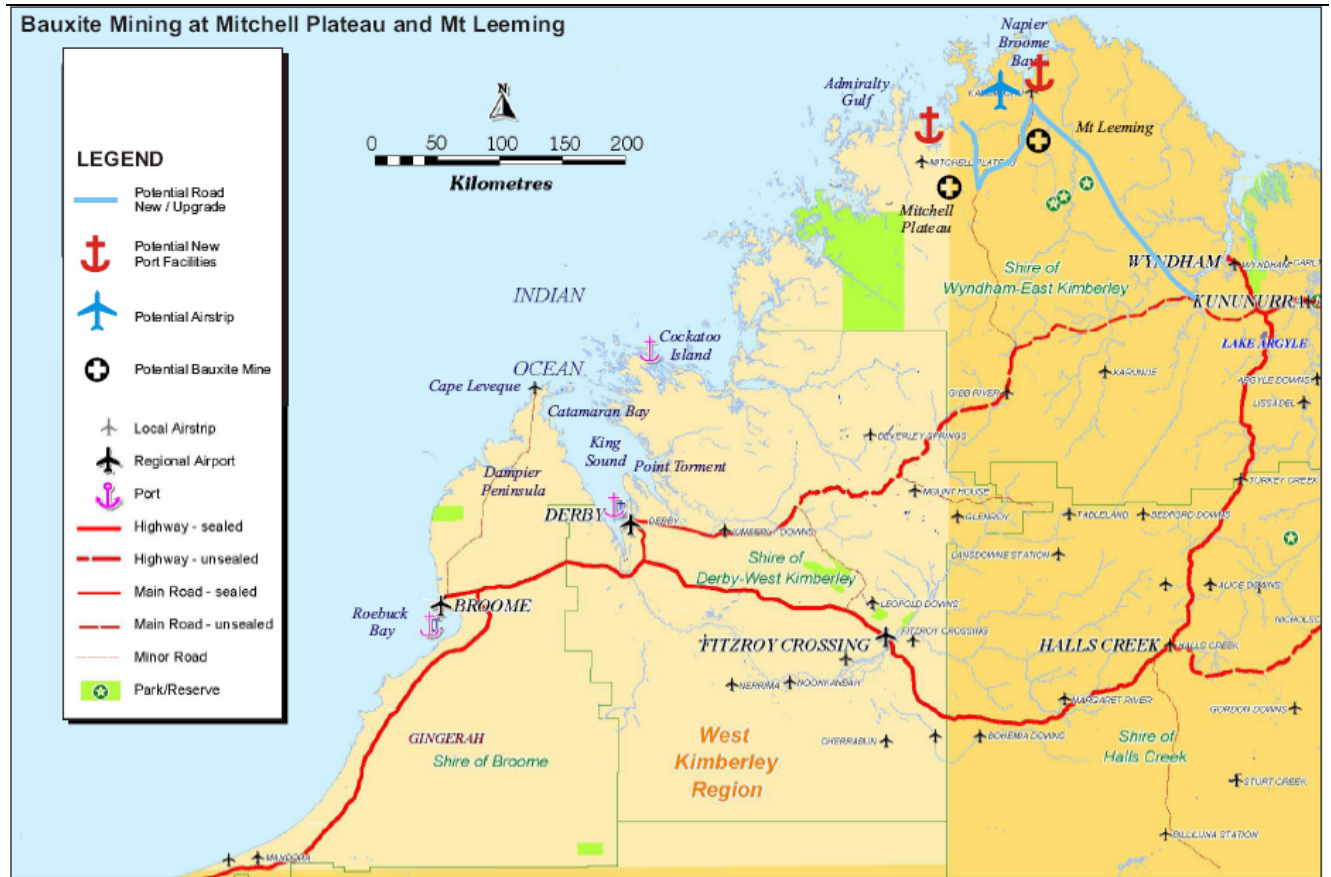
Mine sites would be located some 700 km by road from Derby, approximately 850 km from Broome and 550 km from Kununurra and the Port of Wyndham.

The sites are in reasonably close proximity (approximately 100 km) to the coast of either Napier Broome Bay or Admiralty Gulf – Port Warrender where access by shipping is possible. No ports exist in these areas.

The Mungalalu-Truscott airfield on Anjou Peninsula provides a sealed airstrip and offshore helicopter transit facilities. Unsealed airstrips exist at Mitchell Plateau and Kalumburu.

Figure 39 shows the infrastructure requirements for this mining-only option.

Figure 39 Infrastructure requirements for bauxite mining only



Transport infrastructure

Roads

The Gibb River Road – an adventure tourism route – runs from Derby to intersect the Great Northern Highway between Wyndham and Kununurra. The road access north of the Gibb River Road known as the Kalumburu – Gibb River Road is a 250 km 4WD track. Both roads would require significant upgrading to ensure a good Dry season access road. All-weather road access would require further significant works in the form of creek crossings, drainage, raising and sealing the road pavement in certain sections to reduce dust and improve reliability.

Road access would be required for the construction period which would be limited to the Dry season due to access problems during the Wet. It is expected that the difficulties associated with road access will necessitate much of the construction effort being serviced by barge.

Haul road – mine to port

A haul road or conveyor with access tracks would be required to transport the crushed ore from the mine to the port site. It is proposed that this route would follow the existing tracks as much as possible, subject to some modification and alignment.

However for safety, security and operational reasons this corridor would be separate from the existing access tracks.

Port facilities

Considering the distances by road involved and the need for a port facility to export bauxite, it would be beneficial to include a materials off-loading facility at the port. This would provide a way to import essential supplies for the local communities and developments, and provide another form of construction access for the mine development and operations.

Port facilities for the mine would require berthing of Panamax class vessels up to 75,000 DWT for export of bauxite. A storage area for stockpiling bauxite will be required with associated materials handling systems, maintenance and workshop facilities.

Kalumburu/Mt Leeming

There is deep water access from Cape Talbert south-west to Napier Broome Bay east of Sir Graham More Island. The 30 km channel would require navigation aids to delineate the approaches. Water depth of 15m exists at the start of Deep Bay which is some 15 km from north of King Edward River.

A possible site for a port is off Bluff Point on the east side of Deep Bay 21 km from Kalumburu Community. This site is more easily accessible by road than sites on the west side of the Bay, which have steep terrain and require crossing the King Edward River, Monger Creek to reach Guy Point at West Bay.

The site at Bluff Point is close to 10m of water. A bauxite load-out berth for Panamax carriers would require at this location approximately:

- 6 km channel 160 m wide to 15 m depth.
- Turning basin of 750 m to 11 m depth.
- Single berth pocket of 50 m by 350 m to 15 m depth.
- Jetty length of approximately 500 m.
- A sheet piled material off-loading facility could be dredged locally onshore to depth of 7 m south of the site.

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Bluff Point varies in width from 4 km to 1 km. An existing access track runs 10 km south of the point and extends some 7 km to the port site.

Mitchell Plateau port site

Possible locations for port sites exist on the west side of Port Warrender at Walsh Point and MacGregor Point. These points are characterised by elevated bluffs of approximately 180 m and 120 m respectively.

Channel approaches are some 70 km east of Long Reef or via Oyster Reef passage to the south. Deep water exists, running south past the west side of Osborne Islands to Crystal Head. From there the channel for deep water narrows to less than 1 km.

Dredging would be required off Walsh Point to provide a turning basin and sufficient width of channel. This is less so at MacGregor Point some 3 km to the North. Site preparation works for stockpile storage limited at MacGregor Point due to the very high and steep terrain. This is similar at Walsh Point.

Preparation of a site area in the bay between Walsh Point and MacGregor Point using reclamation from dredging and earthworks could be possible.

A jetty would need to be located some 350 m from either point.

Air transport

The Mt Leeming – West Kalumburu bauxite mine could be serviced either by a new airstrip in the vicinity of the mine site or Napier Broome Bay or by upgrading the existing Kalumburu Airstrip by sealing it to handle medium size turboprop or jet aircraft. The sealed Mungalalu-Truscott airfield on Anjou Peninsula could be a further consideration

The existing Mitchell Plateau airstrip will be upgraded to provide all-weather landing and access to the mine site for personnel transport.

Site development

Site development adjacent to the port area would include a materials off-loading facility and road access.

The port facilities would need to include land area sufficient for storage stockpiles of bauxite ore with associated materials handling equipment, facility buildings for the port operations and separate facilities for materials off-loading facility and laydown areas.

The port facility area will require an area of approximately 20 hectares.

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The bauxite mine development area is dictated by the extent and depth of the ore deposit. Generally the materials handling, maintenance and administration facilities will occupy an area of approximately 10 hectares. The mine personnel will be housed in an accommodation camp close to the mine, with all mine and camp deliveries by road from the port facility.

Construction materials

Due to the lack of established construction material sources in the vicinity of the potential mine sites at Mt Leeming and Mitchell Plateau, the construction material requirements could be sourced from the following alternatives:

- Rock and aggregate produced from screened and crushed waste material at mine site;
- Rock and aggregate produced from screened and crushed material at new quarry site close to development area; or
- Rock and aggregate transported by ship from existing quarries to port facility.

The development of construction materials sources for the development of the mine site and port facility will be done using transportable screening and crushing equipment that will be removed on completion of the works.

Energy

Each bauxite mine would be supplied with electrical energy from a diesel-fired power station located at the mine site or from a diesel-fired power station and high voltage transmission line from the port facility. In comparison to a refinery, a mine site requires considerably less energy as the primary equipment consists of crushers, screens and conveyors.

The port facility would require a power generating facility to provide power for conveyors, stackers, reclaimers and the ship loader, and the associated administration and maintenance facilities.

Diesel fuel will be shipped in to the port and stored in tanks prior to transport to the mine site tank farm, where it will be used in refuelling mining equipment and potentially on-site power generation.

Water supply and waterwater

The mine site and port facility will be supplied by water from two potential sources:

- Groundwater, or
- Surface catchment water.

Water would require treatment in a filtration and chlorination facility, with surface catchment water generally requiring more rigorous treatment than water extracted from bores. Due to the separation distance, the mine and port facilities would be supplied by separate stand-alone systems instead of using pipeline to distribute water between sites from a central facility.

Wastewater treatment and discharge would occur on a similar basis to water supply, with separate treatment plants and lagoons servicing the individual sites.

Telecommunications

The existing telecommunications station at Kalumburu would be used to extend the telecommunications network to the mine sites at Mt Leeming and Mitchell Plateau, located south and south-west from Kalumburu. The additional demand placed on the Kalumburu station would necessitate upgrading to provide adequate transmission capacity from Kalumburu to the closest exchange located on the National Optic Fibre Network.

Broadcast media coverage could be supplied to the mine sites at Mt Leeming and Mitchell Plateau by installing radio repeater stations in conjunction with the microwave radio sites.

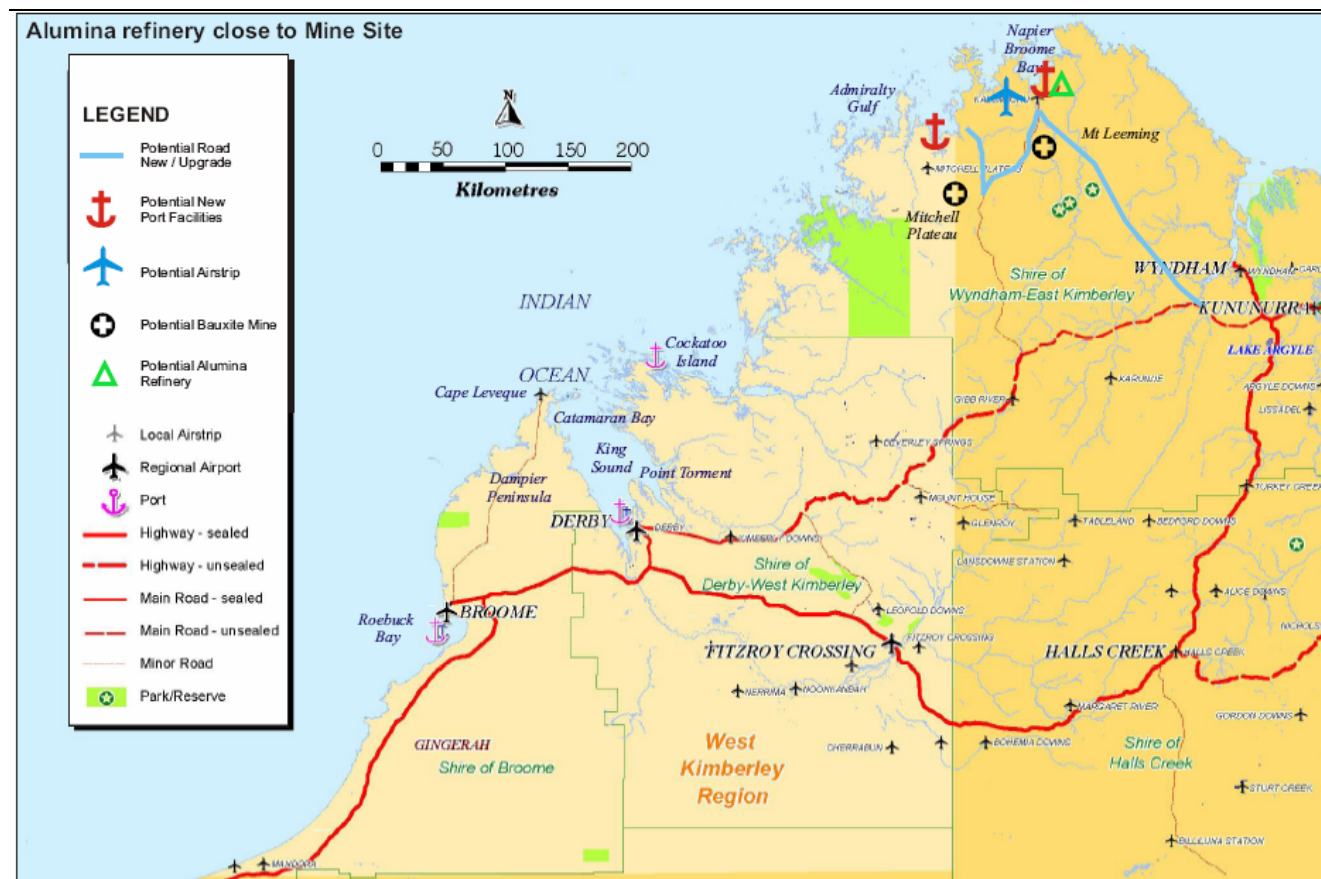
9.3.2 Option 2a: Bauxite mine and alumina refinery near Mitchell Plateau and Kalumburu

The infrastructure requirements for the potential bauxite mines at Mt Leeming and Mitchell Plateau are as listed and described in Option 1 of this section.

The infrastructure requirements and potential synergies associated with the location of an alumina refinery and port at Napier Broome Bay are discussed below.

Figure 40 illustrates the infrastructure requirements for this option.

Figure 40 Infrastructure requirements for bauxite mine and alumina refinery near Mitchell Plateau and Kalumburu



Transport infrastructure

Road

Mine to refinery

All-weather road access from the mine to the refinery would be required to transport materials, personnel and diesel fuel from the port to the refinery and to the mine site. Crushed ore may be transported from the mine site by road trains or conveyor belt. It is proposed this route will follow the existing tracks as much as possible subject to some modification and alignment.

However for safety, security and operational reasons this corridor would be separate from the existing tracks used by the community.

Port facilities

Port facilities for the alumina refinery would require berthing of Panamax class vessels up to 75,000 DWT. A berthing pocket and turning basin would be required in addition to an approach channel as discussed in Option 1.

The port facilities would provide the following functions:

- Materials off-loading facility and 20 ha materials storage area
- Loading of bauxite to ships
- Loading of alumina to ships

The port facility would also be used for receiving and storing the following materials required by the alumina refinery using the Bayer Process:

- Caustic soda
- Bulk lime
- Specialty chemicals

Air transport

An alumina refinery and a Mt Leeming mine could be serviced either by a new airstrip in the vicinity of the mine site or Napier Broome Bay or by upgrading the existing Kalumburu Airstrip by sealing it to handle medium size turboprop or jet aircraft.

Site development

The refinery would require a prepared site of up to 700 hectares that is elevated above the anticipated storm surge and flood levels. The large area requirement is driven by the need to provide water storage dams as well as process residue storage areas.

Construction materials

As described for the mine site development, construction material requirements for the refinery could be sourced from the following alternatives:

- Rock and aggregate produced from screened and crushed waste material at mine site;
- Rock and aggregate produced from screened and crushed material at new quarry site close to development area; or
- Rock and aggregate transported by ship from existing quarries to port facility.

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The development of construction materials sources for the development of the mine site and port facility would be done using transportable screening and crushing equipment that would be removed on completion of the works.

Energy

An alumina refinery has considerable electrical energy requirements that would necessitate the construction of a power station with capacity exceeding 60 MW. The power station would also supply process steam to the refinery. The power station would be either gas-fired direct from a gas supply pipeline or oil-fired using bulk oil shipped in to the port.

An oil-fired station is likely to be expensive to operate and would be subject to often volatile fuel costs.

A gas-fired station would require a gas treatment plant to remove impurities and possibly condensate prior to being used in power generation. There would be a high cost associated with the construction of a supply pipeline and gas plant to the refinery site due to the distance from the Browse Basin gas reserves. The shipping of natural gas from existing LNG operations is unlikely to be economic as it involves only a short transport distance via ship. LNG transport by road train would require a sealed road to protect the specialised cryogenic tankers. An LNG option would also require a receiving terminal and re-gasification plant.

Water supply and wastewater

The refinery would require considerable water resources for use in the refining process as well as a cooling/heat exchange medium. This requirement would be met either through a new surface catchment dam or desalination plant with treatment facilities.

The refinery will produce liquid waste that would require treatment and some storage prior to discharge into the environment.

Telecommunications

The existing telecommunications station at Kalumburu would be used to provide the basis of communications between the refinery, mine sites and the rest of Australia and the world. The additional demand placed on the Kalumburu station would necessitate upgrading to provide adequate transmission capacity from Kalumburu to the closest exchange located on the National Optic Fibre Network.

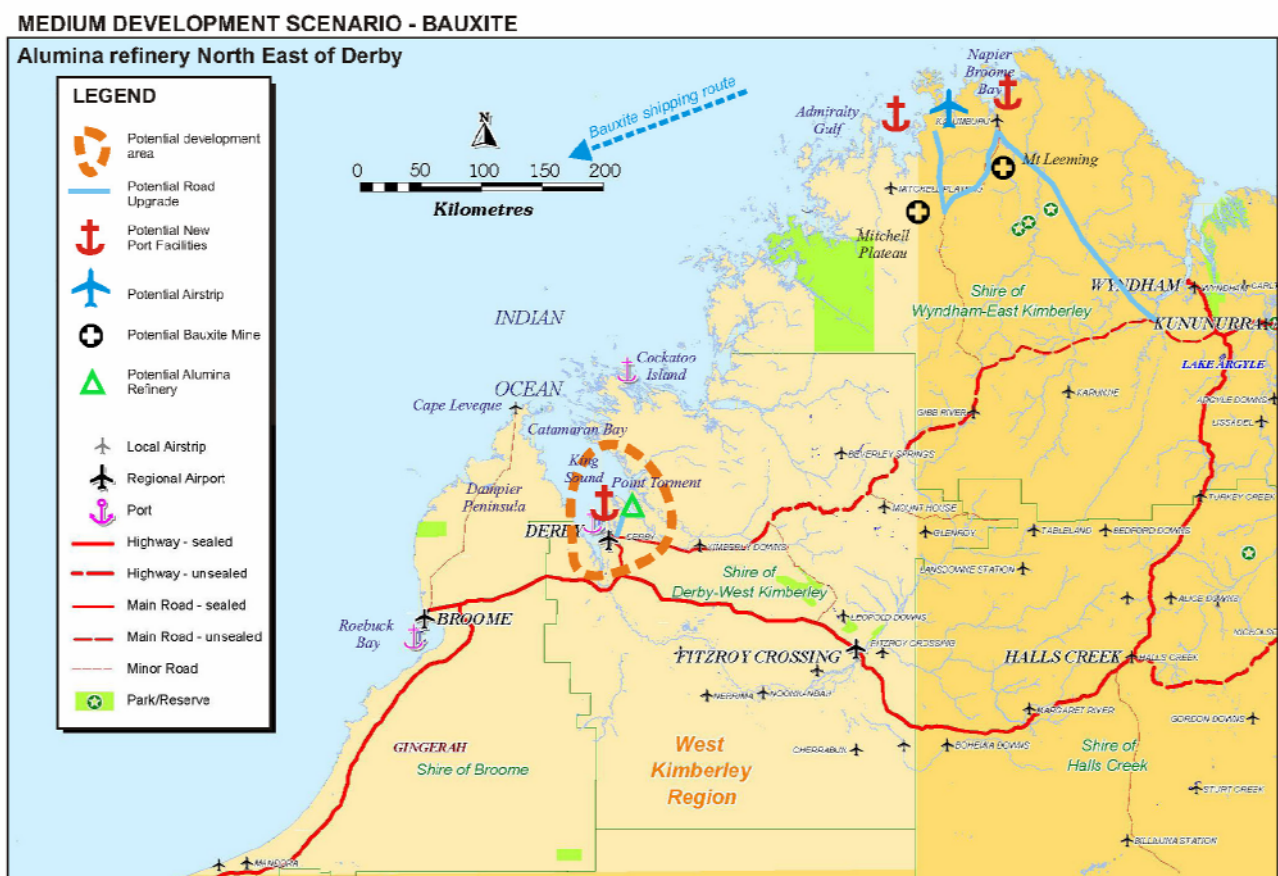
Broadcast media coverage to the refinery site would be provided by the existing repeater station at Kalumburu with some upgrading to boost signal quality.

9.3.3 Option 2b: Bauxite mine at Mitchell Plateau, alumina refinery near Derby

The infrastructure requirements for the potential bauxite mines at Mt Leeming and Mitchell Plateau are as listed and described under Option 1 in this section.

The infrastructure requirements and potential synergies associated with the location of an alumina refinery and port at Point Torment north of Derby are discussed in the following sections. Figure 41 illustrates the infrastructure requirements for this option.

Figure 41 Infrastructure requirements for bauxite mine at Mitchell Plateau, alumina refinery at Point Torment near Derby



Transport infrastructure

Road

Point Torment is located north of the Derby town and is separated from it by the waters of King Sound and the mud flats of Doctors Creek. The stretch of the Derby-Gibb River Road that runs to the south of this area is sealed. An 8 km gravel road runs from the Derby-Gibb River Road to Bungarun. From this location there are several unsealed tracks to One Tree Well and Point Torment, suitable for four wheel-drive access only.

All weather access between Point Torment and the Derby-Gibb River Road would be provided by a 25 km sealed road running north of the existing road. Given the relatively flat nature of the terrain and small watercourses, the road construction would not require major crossing structures.

Port facilities

Point Torment is located in King Sound, a water body of varying depth subject to large tidal movements and associated currents. The entrance of King Sound to the Indian Ocean is bordered by the Buccaneer Archipelago consisting of small islands, shoals and reefs that require careful navigation by vessels. The shipping servicing the Port of Derby is restricted to shallow draft vessels (eg. Barges) which are used for transferring loads to larger vessels anchored in the Sound.

Port facilities for the Alumina Refinery will require berthing of Panamax class vessels up to 75,000 DWT. A berthing pocket and turning basin will be required.

The port facilities at Point Torment will provide the following functions:

- Unloading of bauxite from bulk carriers;
- Loading of Refined Alumina to bulk carriers.

Bauxite would be unloaded using grab-type gantry cranes and conveyed to open stockpiles. Alumina would be loaded from enclosed storage silos using a travelling shiploader.

The port facility would also be used for receiving and storing the following materials required by the alumina refinery using the Bayer Process:

- Caustic soda
- Bulk lime
- Specialty chemicals.

The operational constraints arising from the tidal range and currents need to be considered in the design of in-loading and out-loading facilities.

Air transport

Point Torment is located within 30 km of Derby airport and the RAAF Curtin Airbase approximately 55 km south of Point Torment. Both airports have sealed runways and passenger transit facilities. It is therefore not likely that a gas plant development at Point Torment would require its own airstrip for the transport of personnel during the construction and operation phases.

The Derby Airport runway is capable of receiving medium size passenger jet aircraft such as Fokker F100 and British Aerospace BAe-146.

Site development

The refinery would require a prepared site of up to 700 hectares that is elevated above the anticipated storm surge and flood levels. The large area requirement is driven by the need to provide water storage dams as well as storage areas for process residue.

Due to the proximity of the plant site to Derby there is potential to locate the construction camp facilities closer to the town to take advantage of the local social and recreational facilities. This would also provide an opportunity for local businesses to provide catering, accommodation and other facility management services during the construction phase.

Construction materials

Construction materials in Derby are sourced at a number of established locations operated by local earthmoving and cartage contractors. These sources are listed in Table 14.

Table 14 **Construction materials: Derby**

Source Name	Materials	Location
Langey Crossing	Sand, Gravel	40 km South of Derby
May River	Sand, Gravel	33 km east of Derby
May River	Sand	25 km east of Derby
Yeeda-Kimberley Group	Rock, Aggregate, Gravel	80 km South of Derby

Data source: Minedex, Department of Industry and Resources, 2004

Energy

An alumina refinery has considerable electrical energy requirements that would necessitate the construction of a power station with capacity exceeding 60

MW. The power station would also supply process steam to the refinery. The power station would be gas-fired with gas from the supply pipeline originating in the gas plant/LNG plant, where raw gas from the Browse Basin would be treated to remove impurities, condensate and hydrocarbons not required for power generation.

An existing transmission line connects Derby and Bungarun and this line could be utilised to provide electricity during the construction phase. On completion and commissioning of the refinery and gas-fired power station, the line could be used to supply the Derby town.

Water supply and wastewater

The refinery would require considerable water resources for use in the refining process as well as a cooling/heat exchange medium. This requirement would be met either from groundwater sources or a desalination plant.

The refinery would produce liquid waste that will require treatment and some storage prior to discharge into the environment.

Telecommunications

Due to the proximity of the site at Point Torment to the existing telecommunication facility in Derby there is potential to connect the gas plant by cable or radio relay with the Derby telephone exchange and signal station. Point Torment is within the existing Derby GSM and CDMA mobile telephone coverage area.

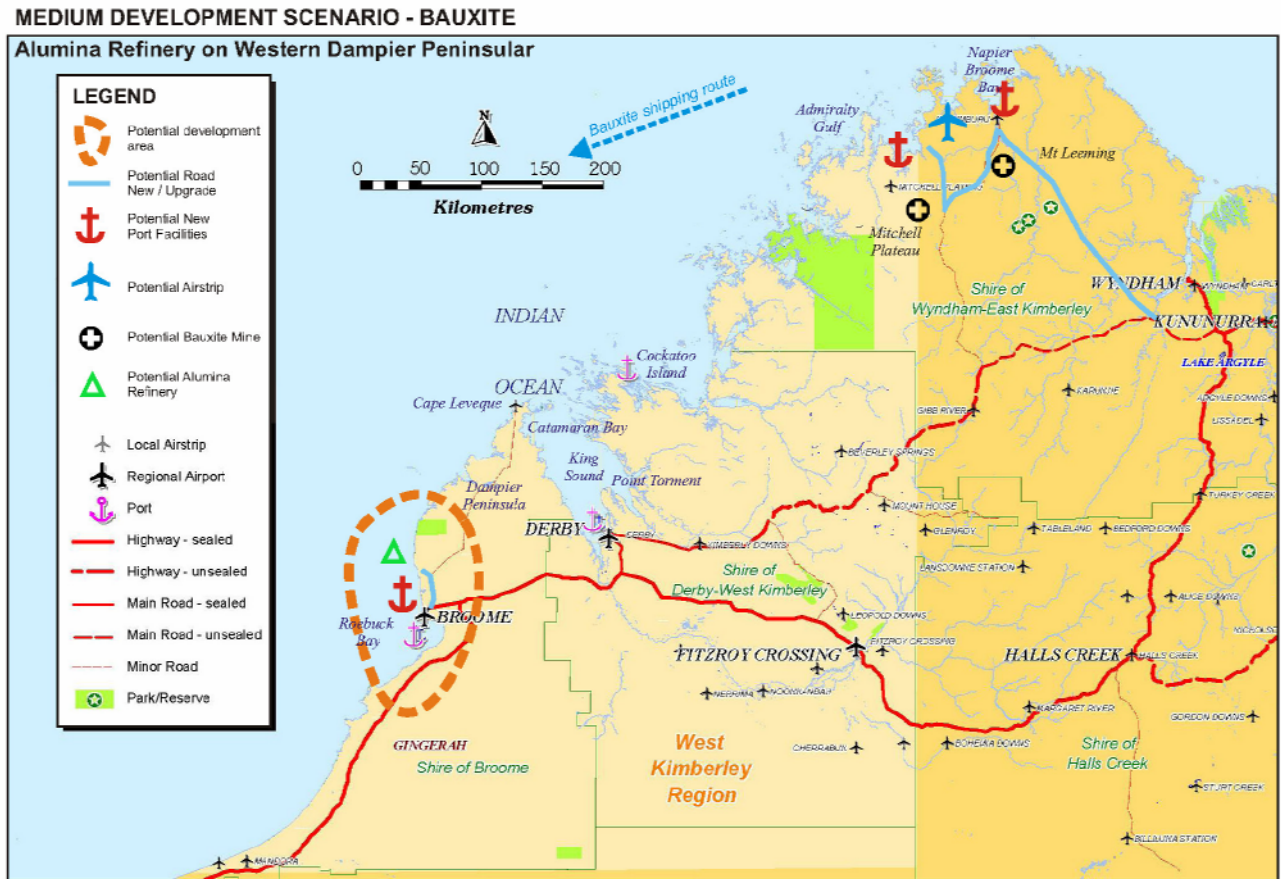
The Derby Exchange is connected by Optic Fibre Cable to the National Optic Fibre Network that facilitates fast voice and data communications between capital and regional centres.

9.3.4 Option 2c: Bauxite mine at Mitchell Plateau, alumina refinery in vicinity of Broome

The infrastructure requirements for the potential bauxite mines at Mt Leeming and Mitchell Plateau are as listed and described under Option 1 in this section.

The infrastructure requirements and potential synergies associated with the location of an alumina refinery in the vicinity of Broome and the potential gas plant/LNG plant are discussed in the following sections. Figure 42 illustrates the infrastructure requirements for this option.

Figure 42 Infrastructure requirements for bauxite mine at Mitchell Plateau, alumina refinery in vicinity of Broome



Transport infrastructure

Road

Broome is located close to the junction of the Great Northern Highway with the eastward section providing a connection to Derby, Fitzroy Crossing and Wyndham/Kununurra, and the southward section connecting with the Pilbara regional centres of Port Hedland and Karratha/Dampier.

The Great Northern Highway is the primary road transport artery and the plant site would be connected via a sealed all-weather access road for personnel and material transport from Broome and other areas of Western Australia.

Road access to the Port of Broome is currently via the town of Broome. Any substantial increase in transport activity associated with the port would require construction of the proposed access road bypassing the town.

Port Facilities

The development of a port facility on the west coast of the Dampier Peninsula or south of Roebuck Bay would require marine works at a suitable location that would offer a degree of protection for the port facility from large swells and storm action.

The Western coastline of the Dampier Peninsula is generally exposed with scattered reefs and shoals in some locations. However access to this section of coastline is not hampered by significant navigation hazards that would present a serious risk to shipping.

The existing Port of Broome is located on Roebuck Bay with deep water accessed by a jetty structure. The port entry channel depth of 13 m at Chart Datum (zero tide) allows ships over 40,000 DWT to access the Port, although the berthing pocket at the jetty is limited to 10 m depth at Chart Datum.

The port facilities for the alumina refinery would require berthing of Panamax class vessels up to 75,000 DWT with adequate depth berthing pocket and turning basin.

The port facilities in the Broome area will provide the following functions:

- Unloading of bauxite from bulk carriers;
- Loading of refined alumina to bulk carriers.

Bauxite would be unloaded using grab-type gantry cranes and conveyed to open stockpiles. Alumina would be loaded from enclosed storage silos using a travelling shiploader.

The port facility would also be used for the receiving and storing of the following materials required by the alumina refinery using the Bayer Process:

- Caustic soda
- Bulk lime
- Specialty chemicals.

Air transport

Broome is serviced by a high standard airport facility capable of handling medium passenger jet aircraft as well as small aircraft and helicopters. For a plant site located in close proximity to Broome, all personnel transport needs would be met by the existing airport.

There are medium to long term plans to construct a new airport north of Broome and to redevelop the existing site for residential and commercial use.

Should the refinery site be located more than 100 km from Broome Airport, consideration may need to be given to the construction of a small airstrip to provide landing capacity for small commuter aircraft to provide the connection with Broome Airport.

Site development

The refinery would require a prepared site of up to 700 hectares that is elevated above the anticipated storm surge and flood levels. The large area requirement is driven by the need to provide water storage dams as well as storage areas for process residue.

Due to the proximity of the plant site to Broome there is potential to locate the construction camp facilities closer to the town to take advantage of the local social and recreational facilities. This would also provide an opportunity for local businesses to provide catering, accommodation and other facility management services during the construction phase.

Construction materials

Construction materials in the Broome area are currently sourced from a number of established sources operated by local earthmoving and cartage contractors. These sources are presented in Table 15.

Table 15 **Construction materials: Broome area**

Source	Materials	Location
12 Mile Quarry	Gravel	16km east of Broome
Deep Creek	Sand	55km east of Broome
Roebuck Plains	Sand, Gravel, Rock	65km east of Broome
Roebuck Plains	Rock, Aggregate	86km east of Broome
Nillibubbaca	Aggregate	100km east of Broome

Data source: Minedex, Department of Industry and Resources, 2004

Energy

An alumina refinery has considerable electrical energy requirements that would necessitate the construction of a power station with capacity exceeding 60 MW. The power station will also supply process steam to the refinery. The power station would be gas-fired with gas from the supply pipeline originating in the gas plant/LNG plant where raw gas from the offshore Browse Basin is treated to remove impurities, condensate and other hydrocarbons not required for power generation.

A local distribution system would supply the plant and associated facilities with a high voltage transmission line to the existing Broome Sub-station.

Water supply and wastewater

The refinery would require considerable water resources for use in the refining process as well as a cooling/heat exchange medium. This requirement will be met either from groundwater sources or a desalination plant.

The refinery would produce liquid waste that would require on-site treatment and some storage prior to discharge into the environment.

Telecommunications

The proximity of the potential alumina refinery to Broome would determine the telecommunications and broadcast media requirements. The most basic infrastructure item required will be a direct cable connection to the Broome Telephone Exchange or microwave radio signal stations.

If the plant site is some distance from the Broome transmitter stations, signal quality could be improved by installing a booster or repeater station.

9.4 Other resources development options

This section describes the infrastructure required to facilitate the development, continuation and expansion of:

- Lead and/or zinc mining at Lennard Shelf and Admiral Bay;
- Diamond mining at Ellendale and nearby;
- Iron ore mining on Cockatoo Island and Koolan Island; and
- Onshore oilfields.

9.4.1 Lead and zinc mining development

This section describes the infrastructure requirements over and above existing infrastructure to facilitate the re-commencement of mining at the Lennard Shelf lead/zinc mining operations, and the greenfield development of the Admiral Bay lead/zinc deposit 120 km south of Broome.

Transport infrastructure

Port

When in operation, the Lennard Shelf mining operations produced lead/zinc concentrate that was transported by road to the Port of Derby for storage prior

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to loading onto a 4,500 tonne barge that transferred the bulk cargo to ships anchored approximately 30 km offshore from the Port of Derby.

The Admiral Bay deposit is located south of Broome and it is anticipated that the product will be processed into concentrate for road transport to either the Port of Broome or Derby.

The Port of Derby is equipped with storage and barge loading facilities for transfer to sea-going vessels offshore.

The Port of Broome does not have bulk handling facilities. The Broome Jetty would require extension and installation of a bulk shiploader and conveyor system for concentrate loading. The existing bulk storage shed has the potential for conversion to handle mineral concentrate. These operations could be in conflict with some of the other port users and careful design may therefore be required. Facility design needs to be investigated further.

Roads

The Lennard Shelf operations are located in close proximity to the Great Northern Highway. This road is undergoing upgrading and maintenance to reduce the incidence of closure due to flooding. Potential new and existing operations will require the construction and maintenance of all-weather access roads.

Admiral Bay is located to the east of the Great Northern Highway, south of Broome and will require the construction of an all-weather access road to the mine site and process plant.

Road transport into the Port of Broome is restricted by the current route that uses the town centre thus leading to congestion and amenity issues for residents and visitors. Construction of the proposed heavy vehicle bypass road would be required to improve road access to the port.

Air transport

The Lennard Shelf operations are located in close proximity to Fitzroy Crossing Airport capable of handling prop-jet aircraft in most weather and at night. In addition, a sealed airstrip was constructed at the Pillara operations site east of Fitzroy Crossing and this can be used as a transport hub for personnel at nearby mine operations.

Admiral Bay is located in the vicinity of unsealed airstrips east of the deposit and at Nita Downs station. A new airstrip will be required for personnel transport between the mine site and the towns of Broome and Derby. The size

and type of airstrip will be dictated by the type of aircraft required to convey the required number of personnel and the frequency of such movements.

Site development

The existing Lennard Shelf operations are located in the vicinity of the Fitzroy River floodplain in the Pillara Range. Due to previous history of flooding of this major watercourse the existing operations are located above expected flood levels. Potential new developments and re-established process plant and accommodation camp facilities will need to be located at an elevation above the expected flood levels.

Admiral Bay is located in undulating sandy terrain with few watercourses however the mine, plant site and accommodation facilities will need to be elevated to avoid localised flooding.

Construction materials

Construction materials (sand and gravel) for the Lennard Shelf operations could be supplied from quarries in the vicinity of Fitzroy Crossing. There is also potential to obtain rock and aggregate material from mine waste with a small screening and crushing operation.

The Admiral Bay operations would require the establishment of an on-site quarry to produce construction materials or transport materials from the existing Roebuck Plains quarry south of Broome.

Energy

It is anticipated that the Lennard Shelf operations will generate electricity on-site from a diesel-fired power station and with a local distribution system for the process plant, camp and satellite mines. Fuel for the station would be delivered by road transport from the Port of Broome and stored on site in tanks. The previous power plant, like the process plant, has been sold and removed from site.

Admiral Bay will require an on-site diesel-fired power station with diesel fuel transported by road via the Great Northern Highway from the Port of Broome. All mine site, process plant and accommodation camp requirements would be supplied by this power station.

Upgrades to the power generation capacity required at Lennard Shelf and Admiral Bay will be dictated by changes to the mine and process plant throughput.

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The new gas-fired distributed generation system in the West Kimberley and at Halls Creek will be supplied by LNG road tankers from a new plant (eventual capacity 180 tpd) at Maitland Industrial Estate near Karratha. This provides an opportunity for future generation at mine sites to be gas-fired, with an expected substantial fuel cost saving.

Water supply

The Lennard Shelf operations are supplied by groundwater that is treated on-site in stand-alone plants. To recommence mining, the existing plant would require re-commissioning and possibly upgrading. The treatment plant may require similar works to ensure adequate capacity is available.

Admiral Bay would require a stand-alone water treatment plant as well as a treatment and handling facility.

Telecommunications

Lennard Shelf operations are located in close proximity to telecommunications facilities in Fitzroy Crossing with microwave radio stations for voice and data transmission. The Fitzroy Crossing exchange is connected to the National Optic Fibre Cable Network and any expansion of communications capacity will focus on upgrades to the microwave radio system. Broadcast media signal from Fitzroy Crossing can be boosted at the transmitter or a repeater station installed at the operations sites.

Admiral Bay would require a microwave radio link to existing transmitter stations located along the Great Northern Highway. The capacity of the existing communications network is dependent on the installed capacity of the microwave system. Any upgrade required to service the new mine site voice and data transmission needs may affect the microwave network up to the closest exchange in Broome. A new repeater station would need to be installed to provide broadcast media coverage.

9.4.2 Diamond mining development

This section describes the infrastructure requirements to ensure the continuation and expansion of mining at the Ellendale Diamond mine and possible new diamond mine 140 to 160 km east of Derby.

Transport infrastructure

Port

The Port of Broome is the key fuel receiving terminal from which diesel fuel is transported to Ellendale and other mines in the surrounding region. Product from the mine does not require port access, but expansion projects have the potential to use the port for the transport of processing equipment and structural materials.

Roads

The Ellendale mine operations are located in close proximity to sealed section of the Derby-Gibb River Road, but with some unsealed road to negotiate. This road is a vital transport link for the delivery of supplies and consumables to this operation.

A new mine would require an access road, most likely to the Gibb River Road.

Air Transport

An existing airstrip serves the needs of the Ellendale mine site and process plant with regular flights using small turbo-prop aircraft for personnel movement between the mine and the residential centres of Broome and Derby.

Upgrading of the airstrip will be needed should production expansion require increased personnel movements using larger aircraft.

A new mine may require its own airstrip.

Site development

The Ellendale mine site is located in the vicinity of watercourses and areas prone to flooding as a result of rainfall and storms. Expansion of the site and associated facilities will require elevation above flood levels, as would development of a new mine.

Construction materials

Construction materials can be sourced from sand and gravel quarries in the vicinity of Fitzroy Crossing to the south-east of the mine site, with a rock and aggregate source at Yeeda Station south of Derby. There is potential to screen and crush suitable mine waste on-site if large volumes of construction materials are required.

Energy

Electrical energy requirements are currently met by diesel-fired on-site power generation with fuel delivered to site by road transport. A local electrical distribution system is used to meet the needs of the mine site, process plant and accommodation camp.

The new gas-fired distributed generation system in the West Kimberley and at Halls Creek will be supplied by LNG road tankers from Maitland Industrial Estate. This provides an opportunity for future generation at mine sites to be gas-fired, with an expected substantial fuel cost saving.

Water supply and wastewater

The water supply for the mine, process plant and accommodation camp is provided by groundwater with a standard package treatment plant. The potential expansion of production at the site will require modular expansion of the treatment plant to service increased water consumption.

Wastewater is treated in a small stand-alone plant prior to discharge into the environment in specially constructed lagoons. Any increase in flows arising from expansion will require upgrading of the treatment plant capacity and the lagoon storage area.

A new diamond mine will require similar facilities.

Telecommunications

The Ellendale mine site is serviced by microwave radio. The site is in the proximity of the optic fibre cable linking the Derby and Fitzroy Crossing telephone exchanges and is part of the National Optic Fibre Network. This provides access to fast and efficient voice/data communications that can be expanded by increasing the capacity of the microwave radio connection with the cable connection station.

Radio repeater technology is used to provide broadcast media coverage for the site. Expansion of coverage can be provided by upgrading the repeater station or installing additional stations.

9.4.3 Iron ore mining development

This section describes the infrastructure required to continue iron ore mining at Cockatoo Island and re-commence mining at Koolan Island in the Buccaneer Archipelago, 130 km north-east of Derby.

Transport infrastructure

Port

Cockatoo Island and Koolan Island are located in Yampi Sound with deep water access to the Indian Ocean from the north and north-west. The islands were previously developed by the Broken Hill Proprietary Company (BHP) for their rich iron ore resources in the 1950s and 1960s.

The developments on Cockatoo and Koolan islands included the construction of jetties and wharves to allow the loading of ships up to Panamax Class (70,000 DWT). Due to the steep coastline, the wharves were constructed relatively close to the coastline and in deep water.

The wharf at Cockatoo Island has been refurbished and re-commissioned by current operator Portman Mining/Henry Walker Eltin and has been utilised to load ships to various markets in the Asia/Pacific region. The existing wharf at Koolan Island has been removed.

Navigational access to Yampi Sound is well proven and does not require additional navigational aids, dredging or turning basins.

Roads

Roads on both Cockatoo Island and Koolan Island are unsealed tracks and haul roads designed to service the mining operations and residential camps.

Apart from basic maintenance to mine haul roads and existing service tracks, road upgrades are not considered a necessity to ensure the continuation of operations at Cockatoo Island and the re-commencement of operations at Koolan Island.

Air transport

Cockatoo and Koolan islands have existing unsealed airstrips capable of handling small turbo-prop aircraft. The mine operations on each island do not require large personnel numbers and rostered movements between the islands and Derby or Broome could be accommodated using small charter aircraft.

However, increased mining and processing rates may potentially require additional personnel and subsequently increase the personnel movements that will be best accommodated with larger size aircraft. If this is the case, the airstrip will need to be improved by lengthening and widening the runway to suit the specific type of aircraft.

Site development

The existing processing facilities at both Islands are located on prepared areas close to the ship loading facilities and mine areas.

The need for additional site development will be dictated by changes to the crushing and processing plants, and the direction of the mine pits.

Construction materials

There are no established construction materials sources on Cockatoo and Koolan islands. However, waste material from the mining operations has the potential for use in earthworks and construction subject to the material's suitability and physical properties meeting engineering criteria.

Energy

The existing operations at Cockatoo Island are supplied by electricity generated by a diesel-fired power station and distributed by a local system. Fuel for the station is delivered by ship and stored on site in tanks to provide sufficient supply for a defined period of time with an emergency supply for periods when fuel cannot be delivered due to adverse weather or shipping delays.

Upgrades to electrical energy supply will be dictated by changes to the mine and process plant throughput that will require additional energy if additional equipment is installed or power demand expanded.

Water supply and wastewater

The existing operations are serviced by small package-type water extraction and treatment plants providing potable water for the mine workforce at Cockatoo Island.

The Koolan Island mine will require the re-commissioning of the water treatment system to provide water for the mine operations. The existing

Wastewater is treated by a stand-alone plant on and its capacity is sized in line with the personnel numbers and anticipated flows.

Telecommunications

The existing operations are serviced by microwave radio towers providing voice and data communications between Cockatoo and Koolan islands and the mainland. Broadcast media is received via radio concentrator system.

Upgrades to improve the speed and capacity of the telecommunications system can be implemented by upgrades to the receiving radio towers and the network transmitting between the islands and the Derby telephone exchange.

9.4.4 Onshore oil and gas development

This section describes the infrastructure requirements to assist in the ongoing production and further development of the Canning Basin oil fields located up to 120 km east of Derby. Due to current low production volumes, all transport is now direct by road to the BP Refinery at Kwinana.

Transport infrastructure

Port

Broome Port is equipped with petroleum product in-loading, storage and out-loading facilities that allow for the transfer of products from road transport to ships berthed at the Broome Jetty.

The loading and un-loading operations for petroleum products require the closure of Broome jetty to other shipping due to the hazardous nature of the operations. The proposed extension of the Broome jetty in the southern direction will allow for the loading and un-loading of petroleum products without effecting closure of the jetty by providing the necessary separation distance from other activities.

The operational requirements may conflict with existing operations and require separate facilities and this would need to be investigated further.

Roads

The oil operations are located in the vicinity of the sealed section of the Derby-Gibb River Road that links the operations with Derby and the Great Northern Highway. Oil from the Blina well is piped to the product storage and road transport terminal located at Erskine. This terminal on the Great Northern Highway is used for the loading of road tankers destined for the Port of Broome and other locations within Western Australia.

Air transport

A small airstrip is located at Blina Station, 12 km south of the existing Blina oilfield. Derby Airport is located approximately 120 km east of the Blina oil field.

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Increased personnel movements to the site can be accommodated by upgrading the Blina airstrip or utilising existing facilities in Derby with road transport to the site.

Site development

Due to the relatively small footprint of the oil field operations the site development requirements are correspondingly low. The key requirement for new developments is to ensure that production wells and associated facilities are located above flood levels and adequate drainage is provided for storm water.

Construction materials

Construction materials sources are located at May River 90 km west of Blina. Rock and aggregate is available from Yeeda Station, 80 km south of Derby.

Energy

The scattered nature of the operations means that energy requirements are met by small diesel-fired generation units at wellheads, storage tanks and the Erskine transport terminal.

New developments will be serviced by modular diesel-fired generation units at the site or by expansion of existing generating unit capacity.

Water supply and wastewater

Groundwater sources are used to supply water to the operations with small on-site treatment units. Larger treatment units and additional extraction bores will be required for increased water demand.

Wastewater is handled in small systems to remove impurities with basic treatment and this will require expansion to provide capacity in line with the processing and operating requirements.

Telecommunications

The operations are located in close proximity to the Great Northern Highway and the optic fibre cable linking the Derby and Fitzroy Crossing telephone exchanges. This cable is part of the National Optic Fibre Network providing access to fast and efficient voice/data communications that can be expanded by increasing the capacity of the microwave radio link with the corresponding exchange.

9.5 Development of a gas processing hub

As indicated in Scenario 2, onshore gas development is most likely dependant on establishing an LNG plant to provide the base load necessary to develop gas supply infrastructure from offshore fields. The location of the LNG plant and associated gas supply and infrastructure (principally a port, roads and a nearby town) will dictate the location of other major gas-using industries. Section 9.2 discusses the most likely mainland locations for an onshore gas processing facility.

Environmental and social considerations, too, will most likely dictate the co-location of industries in one area.

The location of an alumina refinery and any subsequent gas processing industries (eg methanol, GTL diesel, petrochemicals) will therefore most likely be close to the LNG plant. Eventual development of a gas processing “hub” will need to be considered by the State Government in initial planning for the potential location of an LNG plant.

Opportunities for a strategically located gas processing hub could be enhanced by forward planning for a location, and setting aside a suitable and large site for a heavy industrial estate.

9.6 Offshore gas-gathering

The Browse Basin fields could be operated by several companies. In the case of onshore development, project economics and efficiency considerations are likely to militate against the construction of two pipelines to shore, although this could occur.

Economics would suggest a single pipeline to shore as more viable than multiple pipelines. However, the distance between the likely fields to be developed is large (about 150km) and the costs of feeding into a common pipeline for the Browse Basin gas fields are very high. A final decision on pipeline configuration would depend upon detailed engineering and economic evaluation. Only after this analysis could operators agree to share a single pipeline and to install submarine manifolds that gather gas from several fields before it is piped to shore. This is done in both onshore and offshore contexts in the USA and elsewhere.

9.7 Transcontinental pipeline and associated pipelines

This section describes the technical, environmental and economical factors that affect the potential for the development of:

- Offshore pipelines to transport gas to the mainland;
- Onshore pipelines connecting to gas processing plants and other major customers; and
- The possible transcontinental pipeline to transport gas from the Browse Basin to other parts of Australia.

9.7.1 Gas demand considerations

As discussed in Section 7.5, in order to justify the development of a pipeline there needs to be a suitable aggregate demand and some form of commitment from potential customers to take a gas supply.

In the case of the transcontinental pipeline, total demand for Browse Basin gas from the Eastern States would need to be in the order of 200 PJ per annum within about one year of pipeline commissioning – with good potential for growth – to justify pipeline construction.

Once demand and purchase commitments are established, the pipeline design and route can be investigated in conjunction with an assessment of the need for laterals from the main pipeline to supply other customers along the route. The size and location of other gas customers could have a significant impact on the final pipeline route.

Gas will only be brought to shore from an offshore gas field if there is an initial demand of some 600 PJ to justify the costs of field and pipeline development. As discussed in Chapter 7, such demand is likely to come only from an LNG development. All other potential gas customers are secondary in justifying gas development and would be highly unlikely to justify it in the absence of an LNG plant.

9.7.2 Route options

In selecting a suitable pipeline route the primary concerns are large areas of rock and major river crossings as these require special treatment and hence involve additional cost. The pipeline route can also be heavily influenced by the land tenure arrangements as land access must be arranged before a pipeline licence can be issued.

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One of the more significant land tenure considerations is native title. Dealing with the necessary native title processes can add considerable duration to the overall pipeline development schedule. State Governments do have the powers resume land for infrastructure easements, but they are reluctant to do this and prefer to gain access through negotiation.

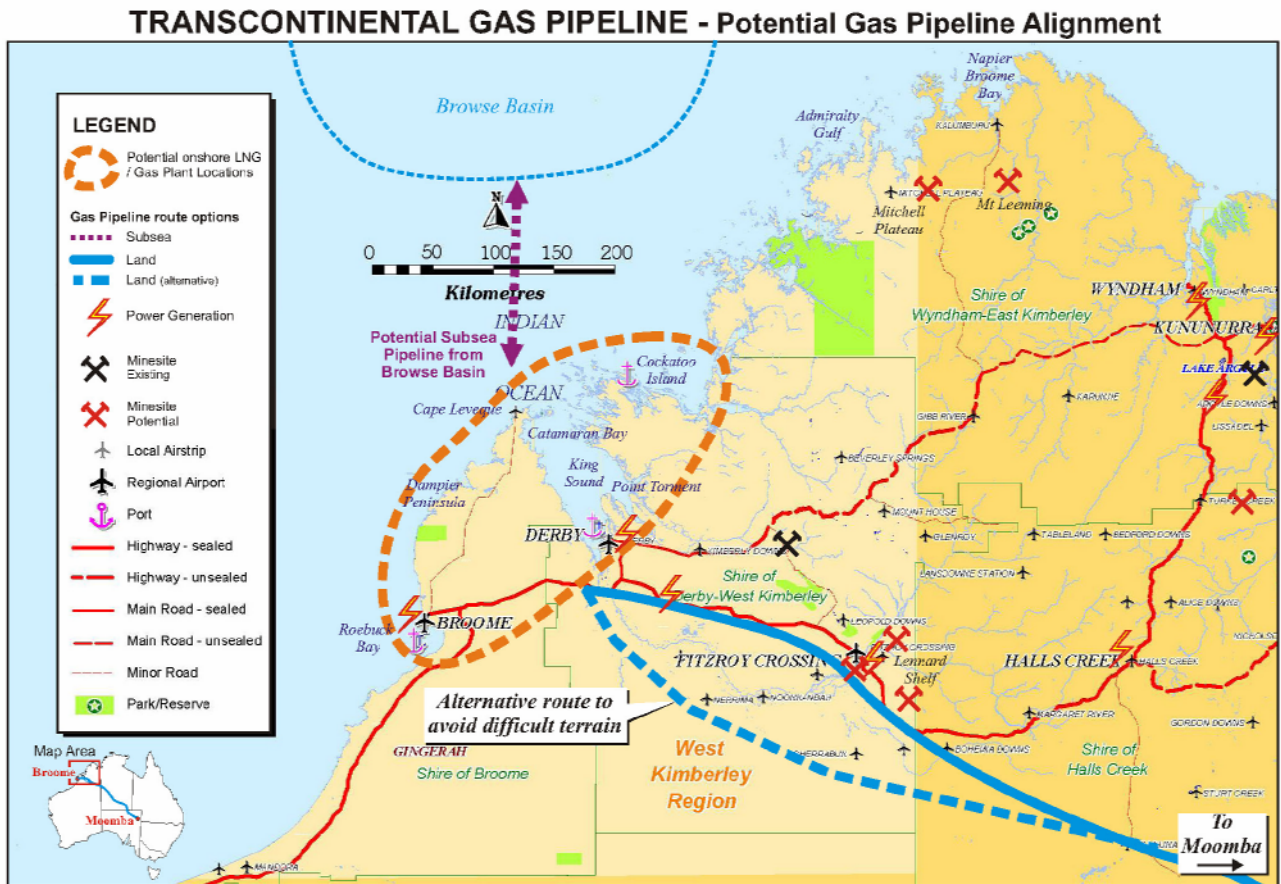
The most attractive location for a pipeline is often within an existing road reserve. Main Roads WA is usually quite sympathetic to these applications and local shires are also generally supportive of pipelines within shire road reserves. Traditionally native title is extinguished on previously gazetted road reserves. New road easements may only suppress native title, which means that the full native title process will need to be addressed. In any event, a transcontinental pipeline could practically utilise only short sections of road reserve relative to the length of the whole pipeline.

Regardless of native title considerations, Traditional Owner heritage considerations must be dealt with for each pipeline easement. The interests of other landholders must also be considered. Other significant regions to be avoided are environmentally sensitive areas, such as nature reserves and any other locations of restricted land access.

The key to selecting a suitable pipeline route is the early identification and understanding of all stakeholders and their specific requirements. Provision of information and close consultation will be needed.

Figure 43 depicts potential sub-sea and onshore pipeline routes in the study region and locations of potential customers in the Kimberley.

Figure 43 Route options for subsea and transcontinental pipelines in the Kimberley



9.7.3 Shore crossings

The location where the pipeline comes ashore from the Browse field must be carefully selected so that the pipeline can easily be constructed, cultural and environmental impact is transitory and minimal.

Ideally it would be a stable beach area without excessive rock and a steep beach so the pipeline deepens quickly.

Shore crossings are often now installed using horizontal directional drilling techniques which are least invasive and minimise damage to the stable beach surroundings. Steep embankments onto the land would be beneficial as they provide a solid barrier to the sea and result in a shorter drilling length. The location would also need to consider the route options detailed above in particular reserves and native title issues.

If direct drilling is not feasible (eg, in the case of a gently shelving beach) then excavation of the beach will be necessary to create a pipeline trench, which would be backfilled and rehabilitated. With careful management, the shore crossing point should not be apparent following rehabilitation.

9.7.4 Design and approvals

Pipelines must be designed to Australian Standard AS2885, including all the requirements of the risk assessment process to mitigate against possible risks to the pipeline integrity. The main approvals mandatory to construct the pipeline are defined within the Australian Government pipeline licences (for pipelines in Australian Government waters) and State pipeline licences (for State waters and onshore). These include environmental approval processes, development of a Safety Case, third party design validations and various approvals required to secure pipeline easements.

Specific agreements will usually be required with local authorities, Main Roads WA, Department of Land Information (DLI) for Crown Land and any other land holders and stakeholders that may be affected by the pipeline.

9.7.5 Construction

For onshore pipelines, a construction corridor must be established along the pipeline easement to build the pipeline. A typical construction corridor for large diameter pipelines would be 30 – 50 m wide. The corridor provides access for materials and equipment. In particular, a major activity is delivering the numerous lengths of pipe onto the easement. The pipe delivery demands good access roads into the pipeline easement which is an additional benefit of the pipeline route following existing roads and highways. Depending on the length of the pipeline and the time available several construction spreads may be used along with adequate camps and messing facilities to support the construction teams. The camps are located at carefully selected sites along the pipeline route.

9.7.6 Cost estimates

Without any details of the pipeline size, route or location, a general rule of thumb for estimating the budget cost of a new onshore pipeline is \$30,000/inch of pipeline diameter/km of length (installed in ground), assuming cost of pipe at \$1,250. These figures are order of magnitude only to plus or minus 50 per cent.

9.7.7 Pipeline development scenarios

The Browse Basin is being explored and development options are being investigated by Woodside, Inpex, Santos and others. Their development decisions will influence the potential for transcontinental pipeline options for the area.

Development options include the potential for offshore gas processing facilities as well as onshore gas plants.

Under the Scenario 2 medium growth case, each option involves a pipeline to shore to supply an LNG plant in the general area shown in Figure 43. An alumina plant is assumed to be located nearby, with gas processing plant(s) to follow later.

The shore crossing for a pipeline requires a suitable location and preferably the shortest offshore pipeline route. The identified options are:

1. Coastal areas north east of Derby;
2. Area of northern Dampier Peninsula; and
3. Area on the western side of Dampier Peninsula.

Of these, only the northern Dampier Peninsula option has been subject to assessment in any detail.

The additional offshore pipeline required for a western side of Dampier Peninsula crossing is likely to be prohibitively expensive compared with the cost of an onshore pipeline running close to Broome from a northern Dampier Peninsula shore crossing.

The coast line the northeast of Derby is a tidal flat area, and is likely to result in a difficult and expensive shore crossing. King Sound experiences tides of up to 11 m creating strong currents, which would result in the need to anchor the pipeline to the bottom with high installation expenditure. The King Sound option is difficult to assess without further studies. However, from an engineering and economic perspective, this option may not be viable.

The options of bringing the pipeline ashore at places in Admiralty Gulf to Mitchell Plateau or Napier Broome Bay near Kalumburu is not appropriate as the distance from Browse Basin is much greater and the coastline in this area is very broken up. Once on the land in these areas there are no major population centres to support a plant or other major infrastructure for a gas pipeline.

Any gas brought ashore will have to be treated to remove water, condensate, CO₂ and any impurities before being utilised for LNG or sent to other local customers and the wider market.

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Once the gas is treated it can be used for any of the following options:

- LNG production at or within proximity to the landing site;
- Electricity and steam production for an alumina refinery;
- Manufacture of GTL products.
- Transport through a Transcontinental Pipeline to:
 - Moomba, and from there through existing pipelines to Eastern States customers;
 - Customers near to the pipeline route.

The pipeline route raises issues concerning native title and detailed engineering which are beyond the scope of this report and are not considered here. Later, detailed studies will identify the most appropriate route. The route shown here is indicative only so as to enable an early assessment of infrastructure costs.

The pipeline to Moomba may be able to take advantage of an existing pipeline corridor from Tanami to Alice Springs. The route would sweep around the south west corner of Queensland to stay in North Territory and South Australia. Figure 44 illustrates a potential pipeline alignment from the West Kimberley to Moomba.

Figure 44 Possible alignment of a transcontinental pipeline

TRANSCONTINENTAL GAS PIPELINE - Potential Gas Pipeline Alignment



Potential en-route customers

Some customers are more likely to materialise than others, due to a range of factors, but principally to distance from the Transcontinental Pipeline and volume of gas demand. Economics deteriorate with lower demand and long distances. Pipeline supplies will compete with trucked LNG and compressed natural gas (CNG) supplies. There is also the possibility of small scale development of a gas field near Kununurra. The following users could be considered as potential gas customers that would require offtakes from the main pipeline.

- Power generation at the following towns:
 - Broome,
 - Derby,
 - Fitzroy Crossing,
 - Halls Creek,

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- Camballin-Looma,
- Kununurra (currently supplied principally by hydro electricity).
- Mining
 - Zinc and Lead;
 - ... Lennard Shelf operations located between 30 and 80 km east of Fitzroy Crossing;
 - ... Future Admiral Bay operations.
 - Nickel
 - ... Sally Malay Nickel deposit, located near the Bungle Bungle Ranges 200 km south of Kununurra (assuming mine life is extended through additional discoveries).
 - Bauxite
 - ... Mitchell Plateau and Mt Leeming/East Kalumburu.
 - Diamonds
 - ... Ellendale Operations;
 - ... Other future operation nearby;
 - ... The Argyle Diamond Mine and village in the North Kimberley (currently supplied principally by hydro electricity).

A pipeline route to the South of the Fitzroy River has also been proposed to try to reduce the number of river crossings, but the land tenure in this area will be more of an issue than for a northern route as there is no road reserve to use as a pipeline corridor.

Possible onshore gas production

Oil production currently occurs in the Canning Basin, 80 km east of Derby at the West Kora, Blina/Boundary and Sundown/West Terrace/Lloyd sites. The Canning Basin is a highly prospective area for onshore petroleum and remains one of the most under-explored sedimentary basins in the world.

The Waggon Creek gas field located 50 km north of Kununurra in the onshore Bonaparte Basin was discovered in 1995. Further drilling is required to prove economic viability.

Gas produced in the region close to the Transcontinental Pipeline could be transported through laterals to connect with the pipeline. However, large volumes of gas would have to be produced to make such a project feasible.

Nevertheless, the existence of a pipeline is likely to stimulate greater exploration of the Canning Basin.

River crossings

The locations of the river crossings have not been selected and it is beyond the scope of this report to provide engineering solutions. Many crossing methods are utilised in the pipeline industry, which can meet most environmental requirements.

In cases where particular concerns cannot be resolved by a conventional method, a Horizontal Directional Drilling (HDD) could be employed. This method allows the crossing to be constructed without disturbance to the river banks and bed. This is the least intrusive method but it is a more costly solution with some risks to other buried services if they are located in the immediate area. It is a method often employed by pipeline construction companies.

Indicative pipeline costings

Table 16 summarises the cost of the pipeline option being considered. The pipeline is an assumed size and the estimate an order of magnitude at this stage based on data provided in the previous section.

Table 16 **Indicative cost of a transcontinental pipeline**

Diameter and length	DN750, 2400km
Number of compressor stations	12
Capex - pipeline	\$2,160 million
Capex - compression	\$1,150 million
Total capex	\$3,310 million

9.7.8 Commercial considerations

The primary obstacle to development of a transcontinental pipeline is the need for a large volume of foundation shippers and a rapid build-up in the pipeline throughput to achieve an acceptable return on investment for its owners.

A comparison with the 1,500 km Dampier to Bunbury Natural Gas Pipeline (DBNGP) provides an indication of the pipeline tariff that would be necessary. The tariff for delivery of gas to the South West on the DBNGP is just over \$1.00 per GJ. This is based on a valuation of just over half of the estimated cost of the transcontinental pipeline, with full haul deliveries on the DBNGP amounting to over 200 PJ.

The tariff on the transcontinental pipeline would have to be considerably higher, even if the foundation volume were as high as 200 PJ. Assuming the volume profile shown previously for Scenario 2 in Figure 30, a tariff of at least

\$1.50 would be necessary to yield an acceptable return on the \$3.3 billion investment. Gas prices at Moomba would have to be considerably higher than at present to achieve an acceptable netback at the pipeline inlet with the tariff at \$1.50.

9.7.9 Regulation and pipeline investment

The proposed transcontinental pipeline and associated regional pipelines are high-cost, potentially high risk that will require very large investment by private sector proponents. However, in recent years, there has been under-investment in pipelines in Australia. This is principally due to increasing market risks and the effects of the Australian Gas Access regime against investment in high cost, high risk pipelines.

The recent report of the Productivity Commission review on the Gas Access Regime²⁶ for pipelines found that the current gas access regime, in effect, is a form of cost-based price regulation. While generating benefits, the regime has significant costs, including a potential to distort investment in favour of lower risk projects. This could result in a greater reliance than otherwise on building capacity that is essentially fully contracted, expanding capacity incrementally and delaying pipeline construction until forecast demand is more certain.

The Commission also found that:

...the effect of the Gas Access Regime on future investment might also arise through its indirect effect on foundation customers, even though the regime only applies to third party access and excludes foundation customer contracts in place prior to coverage. New transmission projects generally require simultaneous large, long-term investments to be made by gas producers in production facilities, by service providers in pipelines and by foundation customers in large industrial processes or power generation. Foundation customers play an important role in the development of transmission pipelines, providing a way to share the risks across all those involved. The regulator could set regulated access prices (reference tariffs) that are below the prices agreed to by foundation customers of the pipeline. The third party access seekers might also be competitors of the foundation customers and receive a competitive advantage by way of being a third party access seeker. In this environment, it is reasonable to expect future foundation customers to include clauses in their contracts that ensure they are not commercially disadvantaged by third party access and are able to share in any future cost reductions arising from the exploitation of economies of scale.²⁷

Distortion of investment in favour of lower risk projects could result in a greater reliance than otherwise on building capacity that is essentially fully

²⁶ Review of the Gas Access Regime, Productivity Commission Inquiry Report No. 31, 11 June 2004

²⁷ Ibid, p XXXII

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contracted, expanding capacity incrementally and delaying pipeline construction until forecast demand is more certain.

This situation could well arise in relation to the transcontinental pipeline.

To reduce the potential chilling effect of regulation on greenfield pipeline investments, the Commission proposed that there be scope in the Gas Access Regime for a binding ruling of 'no coverage' for 15 years, on a case-by-case basis. The Commission also recommended considerable streamlining of the current regime.

It said that:

Adoption of the Commission's recommendations would deliver more efficient outcomes, particularly in relation to investment in the gas sector and the development of a competitive energy market. The recommendations would reduce regulatory risk, potential for regulatory error and the time and cost of regulatory procedures and improve regulatory accountability. The recommendations are designed to achieve the benefits of the existing regime while reducing many of its costs.²⁸

²⁸ Ibid, p XL

10 Infrastructure assessment and needs

The West Kimberley is well served by infrastructure in some areas and not in others. This is a function of the location of population centres and also a lack of industry activity, long distances, and the cost of infrastructure provision in this rugged region with an extreme climate.

This chapter describes the main infrastructure that currently exists in the West Kimberley as well as what is currently planned and proposed in the area and who will provide it. Table 17 summarises this infrastructure.

It also describes the main infrastructure that is required given the resource development potential of the area under medium growth Scenario 2.

It includes comment on the West Kimberley and the adjacent regions to examine possibilities for the co-ordination of infrastructure across the region. It also includes comment on the opportunities for multi-user infrastructure.

10.1 Existing Infrastructure

10.1.1 Economic infrastructure

This section provides a discussion of existing economic infrastructure in the West Kimberley area, in terms of its type, responsible authority/agency, existing condition and proposed future works/improvements.

Roads

The road network in the West Kimberley comprises the following:

- Sealed National Highways
- Sealed State Highways
- Sealed Main Roads
- Unsealed Main Roads
- Sealed Local Roads
- Unsealed roads and tracks

The National Highway network in the West Kimberley was constructed to sealed highway standard in the 1980s to complete the road link between Western Australia and the Northern Territory. The whole network has suffered damage as a result of frequent use by heavy vehicles serving the general transport, mining and pastoral industries within the region, as well as interstate freight traffic. Further damage from floods during the “Wet” season has

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resulted in road closures that have caused considerable delays and loss of perishable products.

Main Roads WA has identified sections of the highway network that need to be upgraded to minimise delays by replacing floodway type crossings with bridges and culverts that allow the road to be open at times of heavy stream and river flows. Several bridges in the East Kimberley section of the Great Northern Highway are under construction with joint Australian and State Government funding. Numerous other roads are being progressively upgraded by State and Local Government using both Australian and State Government funds.

The Broome Port Bypass Road is a planned key road project that will allow the port to increase its trade capability without heavy traffic impacts on the Broome Township.

Energy

The energy supply and distribution network in the West Kimberley is fragmented with each population centre relying on a stand-alone power station for electricity supplies.

The responsible agency is Western Power Corporation with private operators servicing mining operations and pastoral stations.

Gas is supplied as LPG in containers to consumers through local distribution agencies. There is no integrated electrical or gas supply network and due to the sparse population separated by considerable distance it is unlikely that an investment will be made in providing such as system in the short to medium term.

Western Power has contracted Energy Developments to establish four new LNG-fired power stations at Broome, Derby, Fitzroy Crossing and Halls Creek. They will replace the existing old and operationally expensive diesel stations. Energy Developments will build a small (up to 180 tpd) LNG plant at the Maitland Industrial Estate near Karratha. LNG will be transported by triple road trains with cryogenic tanks to the power station storage tanks. Operations will be fully commissioned from 2006 and will run for 20 years under the current contract.

There has been a proposal for development of a tidal power station at Derby. Derby and the surrounding area currently obtain their electric power from diesel generators that are nearing the end of their useful life. The tidal power proposal was to use the large tidal range, almost 12 metres, to create a renewable energy source. Despite strong community support the government

has chosen not to develop the proposal and it is likely that the new power source will be gas fuelled power generators.

Sea transport

The region is serviced by two ports in Derby and Broome as well as an iron ore port on Cockatoo Island. The Port of Broome has undergone considerable investment to improve its infrastructure, resulting in offshore oil exploration supply facilities being established there and increasing shipping activity in the port. The port has potential to expand its services to mineral bulk cargo shipping and increased sea freight trade. This port is able to accommodate Handymax sea-going vessels at the jetty without restriction by tidal movements. Future works are planned to improve the infrastructure of this port so that it can better service the needs of the pastoral and mining industries in the interior of the region.

The Derby Port was modified and augmented in 1997 to provide for shipments of lead-zinc concentrates from the Lennard Shelf Operations. This port is restricted by tidal movements and existing facilities to shallow-draft vessels only. As a result, the shipping of concentrates required the loading of sea-going vessels at anchor 35 km from the port using a barge. The suspension of mining activity at Lennard Shelf has considerably reduced activity in this port. Considerable investment would be required to improve facilities in this port to allow the direct-loading of ships at the jetty.

Construction of enhancements to the Derby wharf are planned to commence soon, with preliminary modelling and design work already underway. The planned enhancements include the construction of a floating breakwater, a tidal flow dissipation barrier, replacement of wooden fenders at the jetty face and construction of a new barge landing facility,

Air transport

Principal airports in the region are located in Broome, Derby and Fitzroy Crossing. Commercial jet flights from Perth terminate in Broome with local operators providing connecting flights to the other centres. Unpaved airstrips have been constructed at most pastoral stations and communities to provide for emergency access during the "Wet" season when roads are closed by flood waters.

The North Kimberley and offshore oil and gas operations in the Timor Sea are serviced from Mungallalu-Truscott Airfield. This airfield is a former RAAF airfield used in World War II and is located on the Anjou Peninsula approximately 50 km north-west of Kalumburu. The airfield is capable of handling turbo-prop aircraft and helicopters with planned upgrading to handle

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medium size jet aircraft for more efficient commuting offshore oil workers to major population centres.

Telecommunications

The major population centres of Broome, Derby and Fitzroy Crossing are serviced by the optic fibre telecommunications network providing access to reliable and reasonably efficient voice and data communications. Communities and mining operations outside of the towns are serviced either by radio or satellite communications with somewhat lesser capacity, reliability and utility.

Water

Water supplies in the West Kimberley are provided by the development of local sources. The circumstances vary enormously from location to location. While some areas have an abundance of water, the development of other areas is limited by access to suitable water supplies.

The northern two thirds of the West Kimberley has significant water resources with most of the area receiving high rainfall. The Fitzroy is a major river system by any standard. However, the river flows are very seasonal, with periods of extended "Dry" and a "Wet" that is characterised by heavy peak flows and flooding for short periods.

The southern parts of the West Kimberley are dry and surface water is difficult to obtain.

The water needs of the area are met by local infrastructure. Each of the towns, mining projects and settlements has its own water source, which are based on the exploitation of local resources. In the main these are groundwater solutions, such as those that provide water supplies to Broome, Derby, and Fitzroy Crossing. Some of the remote settlements, such as Kalumburu, use surface catchments and draw water from natural or enhanced pools in local rivers.

Table 17 **Existing and currently planned/proposed infrastructure**

Infrastructure type	Relevant authority / agency	Infrastructure sub-type	Description of existing infrastructure	Description of future proposed infrastructure
Roads	MRWA	Major Arterial Roads (eg Highways)	<p>National Highway Network. Federal funds used for maintenance of road. Asset of WA State Govt. Network comprises of:</p> <ul style="list-style-type: none"> (a) Great Northern Highway (b) Victoria Highway <p>The Highway network is sealed to 6.8m width with majority of single-lane bridges and floodways in East Kimberley.</p> <p>State Highway Network. Asset of Main Roads WA maintained with MRWA funds. Network Comprises of:</p> <ul style="list-style-type: none"> (a) Broome Highway (b) Derby Highway (c) Wyndham Road <p>Main Roads:</p> <ul style="list-style-type: none"> (a) Gibb River Road (Derby - Wyndham Road) <p>This road used by pastoralists and tourism as well as for access to Aboriginal communities. Partly sealed east of Broome. Impassable during "Wet" season due to poor drainage and flooded river crossings.</p>	<p>Bypass Road Design and Construction:</p> <ul style="list-style-type: none"> (a) Broome Bypass: Close to starting detailed design. Preliminary design and route alignment completed. Looking to commence within 2 years due to increasing heavy traffic through Town Centre. (b) Kununurra Bypass: Preliminary planning only. (c) Wyndham Bypass: Route selection completed and land acquisition to commence. <p>Highway Upgrades:</p> <ul style="list-style-type: none"> (a) Pavement reconstruction and sealing to 8m width in specific sections damaged by floods. (b) Halls Creek section: Replacing floodways with dual lane and single lane bridges (c) Gogo section: Replacing floodways with 2 lane bridges. <p>Main Roads:</p> <ul style="list-style-type: none"> (a) Gibb River Road: Ongoing drainage and pavement grading. Sealing of steep sections and floodways (\$1m p.a.). Estimated cost of total reconstruction and sealing - \$70m.
		Minor Roads (eg paved urban roads)	<p>Road systems within the following towns maintained by Local Government Authorities:</p> <ul style="list-style-type: none"> Broome Derby Fitzroy Crossing <p>Road systems within Aboriginal Communities maintained on behalf of ATSIC by Local Government.</p>	

Infrastructure type	Relevant authority / agency	Infrastructure sub-type	Description of existing infrastructure	Description of future proposed infrastructure
		Tracks (eg unsealed tracks)	<p><i>National Park Access Roads</i> Windjana Gorge Tunnel Creek Mirima Drysdale River</p> <p><i>Local Government Access Roads/Tourist Roads:</i> Cape Leveque Road - maintained by Shire of Broome at \$10m p.a. Popular tourist road. Kalumburu Road - community access road. Tanami Road - Alternative Route to Alice Springs for Truck transport. Access route to Gold Mining Operations in WA and NT.</p> <p><i>Mining Operation Roads/Tracks:</i> Lennard Shelf Lead/Zinc - Pillara, Kapok Panton Sill Platinum Project Sally Malay Nickel/Cobalt Mine Argyle Diamond Mine Ellendale Diamond Mine Blina Oilfield access.</p>	Sealing of sections to improve access during wet weather.
Electric Power	Western Power	Transmission Lines	No transmission lines in the West Kimberley Area.	No proposed transmission lines in the West Kimberley Area.
		Distribution Lines	Islanded distribution systems exist for local networks in Broome, Derby, Fitzroy Crossing and Camballin.	The islanded distribution systems in Broome, Derby, Fitzroy Crossing and Camballin are intended to be taken over by private providers in late 2005 and early 2006.

Infrastructure type	Relevant authority / agency	Infrastructure sub-type	Description of existing infrastructure	Description of future proposed infrastructure
		Power Stations	<p>Diesel Power stations currently supply power to local networks in Broome, Derby, Fitzroy Crossing and Camballin.</p> <p>HydroPower station located at Lake Argyle Dam south of Kununurra. Power supplied to Argyle Diamond Mine, Kununurra and Wyndham via transmission lines.</p>	<p>The islanded distribution systems in Broome, Derby, Fitzroy Crossing and Camballin are intended to be taken over by private providers in late 2005 and early 2006. The power stations are intended to be replaced with natural gas spark ignition generating stations. Note that there is a possibility that Camballin may remain as a diesel power station. Locations of new power stations are not finalised, however they will be within the boundaries of the townships.</p>
				<p>A Derby Tidal Power Station has been under consideration. Despite strong local community support, the government has chosen not to proceed with the proposal.</p>
Gas distribution	Alinta	Gas distribution network	No gas mains infrastructure in West Kimberley Area.	No plans to construct pipelines in the future.

Infrastructure type	Relevant authority / agency	Infrastructure sub-type	Description of existing infrastructure	Description of future proposed infrastructure
Ports	Broome Port Authority	Port of Broome	<p>Steel Piled wharf with concrete deck and spring fendering.</p> <p>Outer berth is 183m long and inner berth is 170m long</p> <p>Maximum vessel capacity is 40,000 DWT.</p> <p>Maximum vessel draft is 10.0m at Chart Datum (Zero Tide).</p> <p>100 tonne mobile crane facilities.</p> <p>Petroleum Inloading/ Outloading and Storage facilities.</p> <p>Total Port Reserve of 206 Ha free of NT and Aboriginal Heritage encumbrances.</p> <p>Port has land holdings for lease from 500 m² to 10,000m² or more.</p> <p>- Bulk storage facilities on wharf for trans shipment of cement and bentonite to oil and gas exploration rigs and vessels.</p>	<p>Extension of Broome Jetty in Southerly direction by 148m to increase working area by 80% (subject to funding). This will allow for:</p> <p>berthing of long cruise vessels</p> <p>loading and unloading of petroleum tankers without total wharf closure</p> <p>berthing of two 40,00 DWT trade vessels or four oil rig supply vessels</p> <p>Potential for shipping of Lead/Zinc concentrate from re-opened Lennard Shelf Operations. Allows for direct loading of Panamax class vessels from wharf using bulk shiploader. Existing grain storage shed and truck unloading facility can be converted to bulk mineral storage.</p> <p>Extensive port reserve can be developed to provide storage and laydown facilities for :</p> <p>Oil and gas supply vessels</p> <p>Beef Cattle Exports</p> <p>(c) Mining consumables and equipment</p>
	Shire of Derby/West Kimberley	Port of Derby	<p>Part of port was originally leased to Western Metals (who have since been taken over by Teck Cominco) for exporting lead/zinc concentrates from Lennard Shelf mining Operations.</p> <p>Wharf facility has a 40,000 tonne concentrate storage shed and a covered conveyor designed to load 4,500 tonne barges.</p> <p>Teck Cominco has suspended mining operations and port is not in use.</p> <p>Port operations restricted due to large tides and shallow berthing draft.</p> <p>Ships unable to berth at wharf - all loading is done approx 35km from shore.</p>	<p>Extensive works required to allow trading vessels > 10,000 DWT to berth at the jetty for loading/unloading</p> <p>Significant enhancements to the Derby Port are in the modelling and design stage. The works include a floating breakwater, a tidal flow dissipation barrier, replacement of wooden fenders at the jetty face and construction of a new barge landing facility.</p>

Infrastructure type	Relevant authority / agency	Infrastructure sub-type	Description of existing infrastructure	Description of future proposed infrastructure
	Portman Mining/Henry Walker Eltin	Cockatoo Island Port	- Jetty with shiploader for loadout of iron ore to 40,000 DWT ships and barge landing facility for supplies and mining equipment.	
	Ord River District Cooperative	Wyndham Port	Piled Structure with concrete deck and spring fendering with 342m long berthing face. Maximum vessel capacity is 26,000 DWT. Maximum vessel draught is 8.0m at Chart Datum (Zero Tide). Maximum LOA is 150m and Beam 25m. Shiploader at Southern end of wharf for loading of bulk sugar. - Petroleum inloading and storage facilities (Mobil)	Potential for shipping of Nickel and Cobalt concentrate from Sally Malay project.
Airports and Airstrips	Broome International Airport	Broome Airport	Broome Airport has one runway. Runway is paved, with a paved length of 2368m and width of 45m. No control tower.	Original concept of moving the Broome International Airport 12km out of the township along the Broome-Derby Highway. Plans were abandoned in 2002 due to the inability to obtain land rights to the proposed location. Future plans for relocation have been delayed by 15-20 years.
	Shire of Derby/West Kimberley	Derby Airport	Derby airport has two runways. The first runway is paved, with a paved length of 1736m and a width of 30m. The second runway is unsealed red gravel, with a paved length of 1158m and width of 18m. No control tower.	
	Shire of Derby/West Kimberley	Fitzroy Crossing Airport	Fitzroy Crossing Airport has one runway. Runway is paved with a paved length of 1300m and a width of 30m. No control tower.	
	Shire of Derby/West Kimberley - Department of Defence	Curtin Aerodrome	Airport is shared between the Department of Defence and the Shire of Derby/West Kimberley. Airport has one runway. Runway has a length of 3049m with a width of 45m. No control tower.	

Infrastructure type	Relevant authority / agency	Infrastructure sub-type	Description of existing infrastructure	Description of future proposed infrastructure
		Mungalu-Truscott Airfield	Transit base for offshore helicopter services Runway ha a length of 1700 m paved length of 1500m and width of 15m. NDB navigation	Current planned runway upgrade to sealed length of 1800m and width of 30m
		Cape Leveque Airstrip	Part of Ibis Aerial Highway for Tourism purposes. No further information was collated.	
		Mt Hart Airstrip	Part of Ibis Aerial Highway for Tourism purposes. No further information was collated.	
		Windjana Gorge National Park Airstrip	Part of Ibis Aerial Highway for Tourism purposes. No further information was collated.	
Railways			No Railway infrastructure in West Kimberley.	
Telecommunications	Telstra / NDC Optus Vodafone	Broome	<ul style="list-style-type: none"> - Telephone exchange connected to National Network with optical fibre - Telstra GSM coverage in town area - Optus GSM coverage in town area - Vodafone GSM coverage in town area - Telstra CDMA coverage around town area - Telecentre provided by WA Government for internet access and videoconferencing - Commercial and National TV Coverage - Analogue - Commercial and National Radio Coverage 	
	Telstra / NDC	Derby	<ul style="list-style-type: none"> - Telephone exchange connected to National Network with optical fibre - Telstra GSM coverage - Telecentre provided by WA Government for internet access and videoconferencing - Commercial and National TV Coverage – Analogue - Commercial and National Radio Coverage 	

Infrastructure type	Relevant authority / agency	Infrastructure sub-type	Description of existing infrastructure	Description of future proposed infrastructure
	Telstra / NDC	Fitzroy Crossing	<ul style="list-style-type: none"> - Telephone exchange connected to National Network with optical fibre - Telstra GSM coverage - Internet connection using telephone system - Commercial and National TV Coverage – Analogue - Commercial and National Radio Coverage 	
		Cape Leveque Aboriginal Communities	<ul style="list-style-type: none"> - Fibre Optic cable connection - Internet/Data connection using Satellite system 	
		Looma Aboriginal Community	<ul style="list-style-type: none"> - Telephone connection via Radio concentrator system 	
		Pillara Mine Site	<ul style="list-style-type: none"> - Telephone connection using Microwave Radio - Internet/Data connection using Satellite system 	
		Cockatoo Island	<ul style="list-style-type: none"> - Telephone connection using Microwave Radio - Internet/Data connection using Satellite system 	
Water	Water and Rivers Commission	Various	Local source developments for towns, communities and developments	

10.1.2 Social infrastructure

Social infrastructure and services for the Shires of Broome and Derby-West Kimberley are presented in Table 18. Services in the Shire of Wyndham East Kimberley are shown for comparison.

While both Shires have good levels of government and private sector services available, the Shire of Broome offers a more cosmopolitan standard of living. The following sections provide a brief description of the towns of Broome, Derby and Fitzroy Crossing.

Broome

Broome is the largest of the Kimberley towns and its high level of social infrastructure reflects the cosmopolitan make-up of the town and its role as a major tourist destination. There is a wide range and availability of restaurants, cafes and other social recreation facilities including shopping, movie theatres and so on. There is a good range of sport and recreation facilities including an aquatic centre, race course, oval, tennis courts and so on.

Accommodation provision is excellent with a variety of accommodation styles available. However during the peak tourist season (the “Dry”) high demand can result in a shortage of all accommodation styles.

Many State Government departments have an office in Broome and some use the town as a base for the region.

Education facilities in the town are excellent with pre-primary through to year 12 schooling available, as well as a range of tertiary courses on offer.

The quality of housing in Broome is excellent and on a comparable level with the metropolitan area, but there is a shortage of land which could impact housing availability and affordability. The Shire of Broome is seeking to remedy this situation.

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Table 18 **Summary of social infrastructure in the West Kimberley**

Services	Broome (B – Broome)	Derby - West Kimberley (D - Derby, FC - Fitzroy Crossing)	Wyndham - East Kimberley (W - Wyndham, K - Kununurra)
Business	Transport operators (B)	Transport operators (D & FC)	Transport operators (W & K)
	Business/economic services (B)	Business/economic services (D)	Business/economic services (W & K)
	Postal & telecommunication services, bank, agencies (B)	Postal & telecommunication services, bank, agencies (D & FC)	Postal & telecommunication services, bank, agencies (W & K)
	Home, building supplies & contractors (B)	Home, building supplies & contractors (D & FC)	Home, building supplies & contractors (W & K)
	Mechanical trades & supplies (B)	Mechanical trades & supplies (D & FC)	Consulting engineers & engineering services (W & K)
	Electrical contractors & appliances (B)	Electrical contractors & appliances (D & FC)	Real estate agents (K)
	Consulting engineers & engineering services (B)	Consulting engineers & engineering services (D & FC)	Mechanical & electrical trades & supplies (W & K)
	Real estate agents (B)	Real estate agents (D)	Food & other general supplies & services (W & K)
	Food & other general supplies & services (B)	Food & other general supplies & services (D & FC)	Petrol & service stations (W & K)
	Fuel & service stations (B)	Fuel & service stations (D & FC)	General shopping (W & K)
	General shopping (B)	General shopping (D & FC)	Agriculture equipment, supplies & services (W & K)
	Agriculture equipment, supplies & services (B)	Agriculture equipment, supplies & services (D)	
	Mining equipment, supplies/services (B)	Mining equipment, supplies/services (D)	
	Community	Family & human services (B)	Family & human services (D & FC)
Community & Health services (B)		Community & Health services (D & FC)	Community & Health services (W & K)
Recreation, sport & hobby (B)		Recreation, sport & hobby (D & FC)	Recreation, sport & hobby groups & supplies (W & K)
Education (B)		Education (D & FC)	Education (W & K)
Libraries (B)		Libraries (D & FC)	Libraries (W & K)
Arts & Religion services (B)		Arts & Religion services (D & FC)	Arts & Religion services (W & K)
Government	Airport terminal services (B)	Airport terminal services (D)	Department of Indigenous Affairs (K)
	ATSI (B)	ATSI (D)	ATSI (K)
	Department of Agriculture (B)	Department of Agriculture (D)	Department of Agriculture (K)
	Centrelink (B)	Centrelink (D)	Education Department of WA (K)
	Disability Services Commission (B)	Disability Services Commission (FC)	Department of L& Information (K)
	Health Department of WA (B)	Health Department of WA (D)	Centrelink (K)
	Department Health & Aging (B)	Kimberley Health Service (D & FC)	Kimberley District Education Office (K)
	Broome Health Services (B)	Public Utilities providers (D & FC)	WA Department of Training (K)
	Public Utilities (B)	Main Roads Western Australia (D)	Dept of Industry & Resources (K)
	Main Roads Western Australia (B)	Police Department (D & FC)	Dept for Planning & Infrastructure (W)
	Police Department (B)	Ministry of Justice Court House (D & FC)	Disability Services Commission (K)
	Ministry of Justice Court House (B)	C.A.L.M (D & FC)	DETYA (K)
	C.A.L.M (B)		Department of Employment, Workplace Relations & Small Business (K)
	Dept for Planning & Infrastructure (B)		Public Utilities providers (K)
Other	Tourist operators & bureau (B)	Tourist operators & bureau (D & FC)	Tourist operators & bureau (W & K)
	Hotels & accommodations (B)	Hotels & accommodations (D & FC)	Hotels & accommodations (W & K)
	Restaurants, food outlets (B)	Restaurants, food outlets (D & FC)	Restaurants, food outlets (W & K)
Emergency Services	Police (B)	Police (D & FC)	Police (W & K)
	Ambulance (B)	Ambulance (D & FC)	Ambulance (W & K)
	Fire Brigade (B)	Royal Flying Doctor Service (D)	Fire Brigade (W & K)
	Bush Fire Services of WA (B)	Volunteer Fire Brigade (D & FC)	Bush Fire Services of WA (K)
	SES (B)	Buccaneer Archipelago Rescue Club (D)	SES (K)
		SES (D & FC)	

Data sources: Yellow Pages, local business directories and personal communication

Derby

Derby is the government administrative centre of the Kimberley and as such is the base for a number of services including the Royal Flying Doctor Service, the Health Department, Kimberley Public Health Unit, Department of Agriculture and others.

Education facilities are provided from preschool up to year 10 and there are also adult education services.

The town supports a range of accommodation, restaurants, and other small businesses. There is a light industrial area which houses the Shire depot as well as other businesses that are capable of servicing the resources industry.

There are a range of sport and recreation facilities in the town including a swimming pool, a civic centre, netball, basketball and tennis courts, a golf course and a race course.

There is a good range of housing quality and availability as well as land for building purposes.

Fitzroy Crossing

The relatively proximity of Fitzroy Crossing to Derby and its small population base of around 1,120 people means that the town has a level of infrastructure expected of a small town.

There are good sport and recreation facilities including tennis courts, an oval and a rodeo ground. Education facilities are also good. There is a pre school, primary school, a high school which caters for students up to year 10, and an adult education office.

Fitzroy Crossing District Hospital provides ambulance, community health, home and community care, general medical, outpatient, paediatric, pharmacy, and radiology services.

Visitor accommodation is limited to several caravan parks and a hotel/motel.

The quality of housing is adequate.

10.1.3 Services for business and industry

Business services in the West Kimberley are quite comprehensive adequate for the current level of business activity. Table 19 to Table 22 summarise what services are available in and near to the West Kimberley. Kununurra is included as it may provide services to the northern part of the West Kimberley.

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Under the medium growth scenario for resources development, demand for additional services will be generated. The market will deal with most needs, with existing and new businesses expanding and establishing, principally in Broome and Derby.

There may be some specialised and very large supply requirements generated by the resources industry that are difficult for local businesses to supply without some form of assistance. In this case, existing government programs, generally accessed through the Small Business Development Corporation and Area Consultative Council will be useful in helping businesses develop capacity.

Project proponents may need to implement targeted regional business development programs in conjunction with government to encourage and assist businesses to participate in supply to major projects. Such programs are best implemented as part of projects' Australian Industry Participation Plans.

Table 19 **Business services in Broome**

Category	Services
Aviation services	Charter services, aero-mechanics, flight training, helicopter services
Residential construction and maintenance	A wide range – plumbing, gas, electricians, construction contractors, landscaping, lawn mowing, paving, bricklaying, painting, roofing, glass, airconditioning / refrigeration, fencing
Legal services	Aboriginal legal service, legal firms, sole practitioners
Human resources	Personnel services, recruitment, education and training, TAFE, University of Notre Dame, child care
Health care	Range including dentists, GPs, physiotherapy, alternative medicines, Red Cross blood bank, psychology and counseling
Business support services	Accounting/tax, bookkeeping, banking, couriers, printing/marketing/promotion, consulting, computing, insurance, fire protection, pest control, industrial cleaning, industrial linen, transport/freight, storage/removals
Engineering	Range of engineering companies
Industrial construction and maintenance	Sheet metal, bitumen, concrete, kerbing, hire services (bobcat, crane, car/boat, grader, scaffold, tractor, truck), welding
Automotive	Wide range of mechanics and auto-electricians, smash repairs, panel/paint, spare parts and salvage, tyre services, wheel alignment and suspension, diesel servicing
Media	Local radio, local television, local newspapers
Other	Car/boat hire, travel agencies, translation services, locksmith, security, Centrelink

Source: *Shire of Broome 2004 Directory*

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Table 20 **Business services in Derby**

Category	Services
Aviation services	Air maintenance, airlines
Residential construction and maintenance	Wide range of services – airconditioning/ refrigeration, building supplies, construction contractors, plumbing, gas, roofing, landscaping, electricians, fencing, carpet, tiling, paint, glass
Legal services	Aboriginal legal service
Human resources	TAFE, employment services and training
Health care	Hospital, ambulance, doctors, dentists
Business support services	Accounting/tax, bookkeeping, freight and transportation, consultants, cleaning, storage, computing, office equipment
Engineering	Engineering service and consultancy
Industrial construction and maintenance	Welding, kerbing and concrete, hire services (bobcat, bulldozer, forklift, truck)
Automotive	Mechanics, auto-electrician, tyre services, exhaust, spare parts
Other	Car/boat hire, Centrelink

Source: Derby and Fitzroy Crossing West Kimberley Information Directory

Table 21 **Business services in Fitzroy Crossing**

Category	Services
Aviation services	Helicopter services, air charter
Residential construction and maintenance	Airconditioning/ refrigeration, construction contractor, paint, glass, concreting, kerbing, gas, plumbing
Legal services	Aboriginal legal service
Health care	General practitioner
Business support services	Accounting, tax agents
Automotive	Service station and garage

Source: Derby and Fitzroy Crossing West Kimberley Information Directory; Yellow Pages

Table 22 **Business services in Kununurra**

Category	Services
Aviation services	Transportation/freight, helicopter charter, aero mechanics
Residential construction and maintenance	Construction contractors, earthmoving, electrical, plumbing, gas
Legal services	Aboriginal legal service, community legal service, private lawyers
Human resources	Training, TAFE
Health care	A range of services including Aboriginal medical service, GP's, dentists and complementary medicines (physiotherapists etc)
Business support services	Banking, Bookkeeping, internet, computing, cleaning, freight
Engineering	General engineering, road contractors and construction
Industrial construction and maintenance	Industrial machinery hire, backhoe hire, crane hire, mechanics
Automotive	Auto-electrician, mechanics, spare parts, hydraulics, panel and paint
Other	Translation services

Source: Yellow Pages

10.2 Required infrastructure

In order to support a medium growth resource development scenario, there is a requirement for further infrastructure development. The following sections consider the additional economic, social and business infrastructure required in the West Kimberley under Scenario 2 in addition to the current level of infrastructure (existing and planned) outlined in Section 10.1.

Economic infrastructure requirements are considered for each development option whilst social and business infrastructure requirements are considered generally.

10.2.1 Economic infrastructure

This section identifies required infrastructure for each development option over and above that already in place or planned. Infrastructure items are selected on the basis that they will be of benefit to both the initial project, to other projects and/or the local community. Forms of cost-sharing of the capital expenditure are likely to be required and this is discussed in Chapter 12.

The cost figures provided are order of magnitude estimates only to approximately $\pm 50\%$ for the purpose of allowing assessment of funding requirements for the various infrastructure components of the respective development scenarios. The estimates are based on current and available high-level information for the region rather than specific site information.

Specific developer costs such as offshore/onshore pipelines are not included in the estimates.

The estimates for port facilities are indicative only and are based on a range of values that are likely to be encountered at each of the development sites for the various development scenarios. These are taken as cost neutral for each option.

Gas/LNG Option 1: LNG / gas plant north-east of Derby

Table 23 presents cost estimates for required infrastructure of an LNG/gas plant north east of Derby.

The required infrastructure for the LNG/Gas Plant listed in Table 23 includes the following:

- Port facility works comprising:
 - Dredging of channel in soft sediment (rock dredging and blasting not included in estimate);
 - Barge landing and materials offloading facility;
 - Navigational aids in King Sound.

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- New wastewater treatment plant;
- Upgrade of roads in the region to sealed standard to Bungarun to sealed standard;
- Preparation of elevated site;
- New 40 km 33 kV transmission line from Derby (if required);
- Water supply pipeline from Derby (if required);
- Fibre optic cable from Derby (if required);
- Microwave repeater for voice/data and upgrade of microwave network capacity.

Table 23 **Cost estimates for required infrastructure: Option 1: LNG/gas plant north east of Derby**

Item description	Requirement	Unit Cost	Min Est Cost (\$m)	Max Est Cost (\$m)		
Port facility	1	Berth		\$300	\$400	
Upgrade Unsealed Road	25	km	\$250,000	/km	\$6	\$9
New Road	30	km	\$450,000	/km	\$14	\$20
Site Development of Plant site and Laydown areas ¹	120	Ha	\$450,000	/Ha		
Airstrip	Not required					
Energy – Power Generation			\$1,500,000	/ MW		
Energy – Power Distribution	40	km	\$35,000	ea	\$1	\$2
Water – Supply and Treatment	500 person cap		\$400,000	ea		
Water – Pipeline from Derby supply	50	km	\$350,000	/km	\$18	\$26
Wastewater – Treatment	500 person cap		\$600,000	ea		
Pipeline to Derby WWTP	Not required					
Telecommunications – Cable	50	km	\$200,000	/km	\$10	\$15
Telecommunications – Microwave	1	ea	\$250,000	ea	\$1	\$1
ESTIMATED TOTAL COST OF MULTI-USER INFRASTRUCTURE				\$350	\$474	

Data source: *Cost Estimation Handbook, AusIMM, 1990 with prices indexed for inflation to 2004*

Notes:

1. Site development is project proponent cost as it is not multi-user infrastructure, but laydown areas could be used by subsequent projects.
2. Power generation to meet plant electrical energy requirements is project developer cost.
3. Water supply for plant process requirements only is project developer cost.
4. Treatment plant for plant requirements is a project developer cost.
5. Costs estimates are plus or minus 50 per cent.

Gas/LNG Option 2: LNG /gas plant at northern Dampier Peninsula

Table 24 Cost estimates for required infrastructure: Option 2: LNG/gas plant at northern Dampier Peninsula

Item description	Requirement	Unit Cost	Min Est Cost (\$m)	Max Est Cost (\$m)		
Port facility	1	Berth		\$300	\$400	
Upgrade Unsealed Road	200	km	\$250,000	/km	\$50	\$100
New Road to Plant Site	10	km	\$450,000	/km	\$5	\$9
Site Development of Plant Site, Laydown and Construction Camp	150	Ha	\$600,000	/Ha		
Airstrip upgrade	1		\$3,600,000		\$4	\$7
Energy – Power Generation			\$1,500,000	/ MW		
Energy – Power Distribution to communities	50	km	\$35,000	/km	\$2	\$4
Water – Supply and Treatment	500 person cap		\$400,000	ea		
Wastewater – Treatment	500 person cap		\$600,000	ea		
Telecommunications – Cable	10	km	\$200,000	/km	\$2	\$4
Telecommunications – Microwave	1		\$250,000	ea	\$1	\$1
ESTIMATED TOTAL COST OF MULTI-USER INFRASTRUCTURE				\$363	\$525	

Data source: Cost Estimation Handbook, AusIMM, 1990 with prices indexed for inflation to 2004

Notes:

1. Site development is project proponent cost as it is not Multi-User Infrastructure.
2. Power generation to meet plant electrical energy requirements is project proponent cost.
3. Water supply for plant process requirements only is project developer cost.
4. Treatment plant for plant site and construction camp facilities is project developer cost.
5. Costs estimates are plus or minus 50 per cent.

Table 24 presents the required infrastructure over and above infrastructure that is already in place in the northern Dampier Peninsula area.

The required infrastructure listed in Table 24 includes:

- Port facility includes:
 - Dredging of channel in soft sediment (rock dredging and blasting not included in estimate);
 - Barge landing;
 - Navigational aids in King Sound.
- Upgrade of road from Broome to Lombadina Community to sealed standard;

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- New road to gas/LNG plant from Broome-Cape Leveque Road;
- Extension of runway at Cape Leveque airstrip to accommodate turbo-prop and/or jet aircraft;
- Electrical power distribution system to One Arm Point, Lombadina and Cape Leveque communities;
- New fibre optic cable to gas plant from existing trunk cable to Cape Leveque areas;
- Microwave repeater for voice/data.

Gas/LNG Option 3: LNG/gas plant in the western Dampier Peninsula locality

Table 25 **Cost estimates for required infrastructure: Option 3: LNG/gas plant in western Dampier Peninsula locality**

Item description	Requirement	Unit Cost	Min Est Cost (\$m)	Max Est Cost (\$m)
Port facility	1 Berth	\$150,000,000 ea	\$300	\$400
New Road	60 km	\$450,000 /km	\$27	\$41
Site Development of Plant Site and Laydown areas ¹	113 Ha	\$450,000 /Ha		
Airstrip	Not Required			
Energy – Power Generation ²		\$1,500,000 / MW		
Energy – Power Distribution	60 km	\$35,000	\$3	\$5
Water Supply pipeline from Broome	60 km	\$350,000	\$21	\$32
Water – Supply and Treatment ³	500 person cap	\$400,000 ea		
Waste Water Treatment ⁴	500 person cap	\$600,000 ea		
Telecommunications – Cable	60 km	\$200,000 /km	\$12	\$18
Telecommunications – Microwave	1	\$250,000 ea	\$1	\$2
ESTIMATED TOTAL COST OF MULTI-USER INFRASTRUCTURE			\$364	\$496

Data source: *Cost Estimation Handbook, AusIMM, 1990 with prices indexed for inflation to 2004*

1. Site development is project proponent cost as it is not Multi-User Infrastructure.
2. Power generation to meet plant electrical energy requirements is project proponent cost.
3. Water supply for plant process requirements only is project developer cost.
4. Treatment plant for plant site and construction camp facilities is project developer cost.
5. Costs estimates are plus or minus 50 per cent

Table 25, presents the required infrastructure over and above infrastructure that is already in place in a western Dampier Peninsula locality.

The required infrastructure listed in Table 25 includes:

- Port facility comprising:

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- Dredging of channel in soft sediment (rock dredging and blasting not included in estimate);
- Jetty structure and wharf;
- Navigational aids in channel to wharf.
- New road to gas plant;
- Electrical power distribution system to Broome Substation;
- Water supply pipeline from Broome;
- New fibre optic cable to gas plant;
- Microwave repeater for voice/data at plant site/port facility and upgrade of microwave network capacity.

Table 26 Summary of cost estimates (\$ millions) for required infrastructure: LNG/gas plant

	OPTION 1 – North east of Derby				OPTION 2 – Northern Dampier Peninsula				OPTION 3 – Western Dampier Peninsula			
			Min	Max			Min	Max			Min	Max
Port facility	1	Berth	\$300	\$400	1	Berth	\$300	\$400	1	Berth	\$300	\$400
Upgrade Unsealed Road	25	km	\$6	\$9	200	km	\$50	\$100				
New Road	30	km	\$14	\$20	10	km	\$5	\$9	40	km	\$27	\$41
Site Development of Plant site and Laydown areas	120	Ha			150	Ha			120	Ha		
Airstrip	Not required				1	Airstrip	\$4	\$7	Not Required			
Energy – Power Generation												
Energy – Power Distribution	40	km	\$1	\$2	50	km	\$2	\$4	40	km	\$3	\$5
Water – Supply and Treatment	500	p cap	\$0	\$0	500	p cap			500	person cap		
Water – Supply pipeline from exstg source	50	km	\$18	\$26					40	km	\$21	\$32
Water – Treatment pipeline to exstg WWTP	500	p cap	\$0	\$0	500	p cap			500	person cap		
Telecommunications – Cable	50	km	\$10	\$15	10	km	\$2	\$4	40	km	\$12	\$18
Telecommunications – Microwave	1	ea	\$1	\$1	1		\$1	\$1	1		\$1	\$2
TOTAL COST OF MULTI-USER INFRASTRUCTURE (\$m)			\$350	\$474			\$363	\$525			\$364	\$496

Cost estimates are all plus or minus 50 per cent.

Bauxite/Alumina Option 2: Bauxite mining at Mitchell Plateau/Mt Leeming and West Kalumburu

Cost estimates for bauxite mining at Mitchell Plateau / Mt Leeming – West Kalumburu with a coastal port facility are presented Table 27. Alumina refining is not included.

Table 27 **Bauxite mining at Mitchell Plateau / Mt Leeming with coastal port facility**

Item description	Requirement		Unit Cost		Min Est Cost (\$m)	Max Est Cost (\$m)
Port facility	1	Berth	\$150,000,000	ea	\$150	\$375
Upgrade Unsealed Road	100	km	\$250,000	/km	\$25	\$50
Site Development of Bauxite stockpiles at port facility ¹	20	Ha	\$500,000	/Ha		
Site Development at Port Facility	5	Ha	\$500,000	/Ha	\$3	\$6
Site Development of Mine Site ²			\$500,000	/Ha		
Airstrip	1		\$3,600,000	ea	\$4	\$8
Energy – Power Generation ³			\$1,500,000	/MW		
Energy – Power Distribution	100	km	\$35,000	/km	\$4	\$8
Water – Supply and Treatment ⁴	500 person cap		\$400,000	ea		
Water – Waste Water Treatment ⁵	500 person cap		\$600,000	ea		
Telecommunications – Microwave Repeater	4	ea	\$250,000	ea	\$1	\$2
Telecommunications – Upgrade Kalumburu Station	1	ea	\$500,000	ea	\$1	\$2
Telecommunications – Signal Booster	1	ea	\$500,000	ea	\$1	\$2
ESTIMATED TOTAL COST OF MULTI-USER INFRASTRUCTURE					\$189	\$453

Data source: *Cost Estimation Handbook, AusIMM, 1990 with prices indexed for inflation to 2004*

Notes:

1. Site development of bauxite stockpile areas at port facility is project proponent cost
2. Site development at mine site is project proponent cost
3. Power generation to meet mine site and port facility electrical energy requirements is project proponent cost
4. Water Supply for mine site and port facility requirements is project developer cost
5. Waste Water Treatment plant for plant site and construction camp facilities is project developer cost
6. All cost estimates are plus or minus 50 per cent.

The required infrastructure for the mine site and coastal port facility listed in the table includes:

- Port facility comprising:

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- Approach channel (dredging in soft sediment);
 - Berthing pocket and turning basin;
 - Wharf and jetty;
 - Navigational aids;
 - Barge landing.
- 20 hectare cleared port area for general cargo, materials laydown and freight transport requirements;
 - Upgrade of road access from the Derby-Gibb River Road to Mt Leeming / Mitchell Plateau site and coastal port and township for “Dry” season access only;
 - Upgrade of existing airstrip to include sealed runway and basic aircraft handling facilities;
 - 70 km HV transmission line from coastal port and refinery to mine site;
 - Construction of sealed airstrip for personnel transport for mine;
 - Construction of microwave repeater stations connected to existing station at Kalumburu with upgrade to existing station to increase capacity;
 - Installation of signal booster for broadcast media re-transmission to mine site from existing telecommunications facility at Kalumburu.

Bauxite/Alumina Option 2a: Bauxite mines at Mitchell Plateau and Mt Leeming – West Kalumburu, and alumina refinery nearby

Infrastructure costs for mines and an alumina refinery are provided separately.

Bauxite mines

The required infrastructure for the bauxite mine site as listed above includes:

- Upgrade of road access from the Derby-Gibb River Road to Mt Leeming / Mitchell Plateau site and to coastal port and township;
- 70 km HV transmission line from coastal port and refinery to mine site;
- 4 microwave repeater stations for voice/data communications between mine site and port/refinery;
- Signal booster at mine site for broadcast media signal received from coastal township and port.

The following assumptions were made with regard to the required infrastructure for the mine site:

- Port facility for bauxite export shared with the refinery for alumina export;
- Airstrip for refinery, port and township is shared with bauxite mine for personnel transport;

Table 28 **Cost estimates for required infrastructure: Option 2a: Bauxite mines at Mitchell Plateau / Mt Leeming**

Item description	Requirement		Unit Cost		Min Est Cost (\$m)	Max Est Cost (\$m)
Port facility					Refinery Cost	Refinery Cost
Upgrade Unsealed Road	100	km	\$250,000	/km	\$25	\$50
Site Development of Bauxite stockpiles at port facility ¹	20	Ha	\$500,000	/Ha		
Site Development at Port Facility			\$500,000	/Ha	Refinery Cost	Refinery Cost
Site Development of Mine Site and Construction Camp ²			\$500,000	/Ha		
Airstrip – sealed airstrip	1	ea	\$3,600,000	ea	\$4	\$8
Energy – Power Generation ³			\$1,500,000	/MW		
Energy – Power Distribution	100	km	\$35,000	/km	\$4	\$8
Water – Supply and Treatment ⁴			\$400,000	ea		
Water – Treatment ⁵			\$600,000	ea		
Telecommunications – Microwave Repeater	4		\$250,000	ea	\$1	\$2
Telecommunications – Upgrade Kalumburu Station	1		\$500,000	ea	\$1	\$2
Telecommunications – Signal Booster	1		\$500,000	ea	\$1	\$2
ESTIMATED TOTAL COST OF MULTI-USER INFRASTRUCTURE					\$36	\$72

Data source: *Cost Estimation Handbook, AusIMM, 1990 with prices indexed for inflation to 2004*

Notes:

1. Site development of bauxite stockpile areas at port facility is project proponent cost
2. Site development at mine site is project proponent cost
3. Power generation to meet mine site and port facility electrical energy requirements is project proponent cost
4. Water Supply for mine site and port facility requirements is project developer cost
5. Waste Water Treatment plant for plant site and construction camp facilities is project developer cost
6. All cost estimates are plus or minus 50 per cent.

Alumina refinery

Cost estimates for required infrastructure for an alumina refinery in vicinity of Mt Leeming – West Kalumburu/ Mitchell Plateau are presented in Table 29.

Table 29 **Cost estimates for required infrastructure: Option 2a: Alumina refinery in vicinity of Mt Leeming – West Kalumburu / Mitchell Plateau**

Item description	Requirement		Unit Cost		Min Est Cost (\$m)	Max Est Cost (\$m)
Port facility		Berth	\$200,000,000		\$200	\$500
Upgrade Unsealed Road					Mine Site Cost	Mine Site Cost
Site Development at Port Facility	5	Ha	\$500,000	/Ha	\$3	\$6
Site Development of Refinery Site ¹	700	Ha	\$500,000	/Ha		\$0
Airstrip – sealed airstrip					Mine Site Cost	Mine Site Cost
Energy – Power Generation for Refinery and Mine Site ²			\$1,500,000	/MW		
Energy – Power Distribution	100	km	\$35,000	/km	Mine Site Cost	Mine Site Cost
Water – Supply and Treatment	500 person cap		\$400,000	ea		
Water – Treatment	500 person cap		\$600,000	ea		
Telecommunications – Microwave Repeater	4		\$250,000	ea	Mine Site Cost	Mine Site Cost
Telecommunications – Upgrade Kalumburu Station	1		\$500,000	ea	Mine Site Cost	Mine Site Cost
Telecommunications – Signal Booster	1		\$500,000	ea	Mine Site Cost	Mine Site Cost
ESTIMATED TOTAL COST OF MULTI-USER INFRASTRUCTURE					\$203	\$506

Data source: *Cost Estimation Handbook, AusIMM, 1990 with prices indexed for inflation to 2004*

Notes:

1. Site development of port facility is project proponent cost
2. Site development at refinery site is project proponent cost
3. Power generation to meet refinery and port facility electrical energy requirements is project proponent cost
4. All cost estimates are plus or minus 50 per cent.

The required infrastructure for the alumina refinery and port site listed above includes:

- Port facility comprising:
 - Approach channel (dredging in soft sediment);
 - Berthing pocket and turning basin;
 - Navigational aids;
 - Barge landing.
- Construction of sealed airstrip for personnel transport for mine, refinery and port facility;

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- 10MW power station for township electricity supply;
- Basic water supply system (filtration and chlorination type) for township development;
- Treatment plant for township;
- Construction of microwave repeater stations connected to existing station at Kalumburu with upgrade to existing station to increase capacity;
- Installation of signal booster for broadcast media re-transmission to mine site from existing telecommunications facility at Kalumburu;
- Housing and serviced land for township residents;
- Community recreation and sport facilities for township residents;
- Commercial and retail facilities for residents;
- Light industrial area for contractors servicing the bauxite mine, refinery and port.

The following infrastructure items are not included in the above list:

- Sub-sea pipeline and onshore terminal for delivery and treatment of natural gas from offshore gas fields;
- Onshore gas pipeline from terminal/gas plant to refinery;
- Development of lime resources required in Bayer Process for alumina refining;
- Receiving and storage of caustic soda required in Bayer Process for alumina refining;
- Receiving and storage of specialty chemicals and other consumables required by the Bayer Process.

The total cost of providing infrastructure to support the mine site at Mt Leeming / Mitchell Plateau and an alumina refinery and port development at a coastal location north of the potential mine sites is estimated at:

Min Estimated Cost (\$m)	Max Estimated Cost (\$m)
\$239	\$578

Bauxite/Alumina Option 2b: Bauxite mine at Mitchell Plateau / Mt Leeming – West Kalumburu, alumina refinery at north east of Derby

Bauxite mines

Cost estimates for required infrastructure for a bauxite mine at Mitchell Plateau / Mt Leeming – West Kalumburu with a coastal port facility are presented in Table 30.

Table 30 Cost estimates for required infrastructure: Option 2b: Bauxite mines at Mitchell Plateau / Mt Leeming with coastal port facility

Item description	Requirement	Unit Cost	Min Est Cost (\$m)	Max Est Cost (\$m)		
Port facility	1	Berth	\$150,000,000	ea	\$150	\$375
Upgrade Unsealed Road	100	km	\$250,000	/km	\$25	\$50
Site Development of Bauxite stockpiles at port facility ¹	20	Ha	\$500,000	/Ha		
Site Development at Port Facility	5	Ha	\$500,000	/Ha	\$3	\$6
Site Development of Mine Site ²			\$500,000	/Ha		
Airstrip	1		\$3,600,000	ea	\$4	\$8
Energy – Power Generation ³			\$1,500,000	/MW		
Energy – Power Distribution	100	km	\$35,000	/km	\$4	\$8
Water – Supply and Treatment ⁴	500 person cap		\$400,000	ea		
Water – Treatment ⁵	500 person cap		\$600,000	ea		
Telecommunications – Microwave Repeater	4	ea	\$250,000	ea	\$1	\$2
Telecommunications – Upgrade Kalumburu Station	1	ea	\$500,000	ea	\$1	\$2
Telecommunications – Signal Booster	1	ea	\$500,000	ea	\$1	\$2
ESTIMATED TOTAL COST OF MULTI-USER INFRASTRUCTURE					\$189	\$453

Data source: *Cost Estimation Handbook, AusIMM, 1990 with prices indexed for inflation to 2004*

Notes:

1. Site development of bauxite stockpile areas at port facility is project proponent cost
2. Site development at mine site is project proponent cost
3. Power generation to meet mine site and port facility electrical energy requirements is project proponent cost
4. Water Supply for mine site and port facility requirements is project developer cost
5. Treatment plant for plant site and construction camp facilities is project developer cost
6. All cost estimates are plus or minus 50 per cent.

The required infrastructure for the mine site and coastal port facility listed in the table includes:

- Port facility comprising:
 - Approach channel (dredging in soft sediment; rock dredging and blasting not included in estimate);
 - Berthing pocket and turning basin;
 - Navigational aids;
 - Barge landing.
- 20 hectare cleared port area for general cargo, materials laydown and freight transport requirements;
- Upgrade of road access from the Derby-Gibb River Road to Mt Leeming / Mitchell Plateau site and coastal port and township for “Dry” season access only;
- 70 km HV transmission line from coastal port and refinery to mine site;
- Construction of sealed airstrip for personnel transport for mine;
- Construction of microwave repeater stations connected to existing station at Kalumburu with upgrade to existing station to increase capacity;
- Installation of signal booster for broadcast media re-transmission to mine site from existing telecommunications facility at Kalumburu.

Alumina refinery at north east of Derby

There is potential for a alumina refinery to be located in the vicinity of an LNG plant from Browse Basin, north east of Derby. The co-location of these facilities creates opportunity for cost-sharing of infrastructure between the two projects as listed in Table 31.

The required infrastructure for the alumina refinery and port sited at north east of Derby includes:

- Port facility comprising:
 - Berthing pocket and turning basin;
 - Wharf and jetty.
- 10MW power station for Derby town expansion or stand-alone township in the vicinity of Derby shared with gas plant/LNG plant;
- Basic water supply system (filtration and chlorination type) for expanded Derby town or township development shared with gas plant/LNG plant;
- Treatment plant for Derby or stand-alone township shared with gas plant/LNG plant;
- Housing and serviced land in Derby or in the vicinity of Derby with connection to existing services maximised shared with gas plant/LNG plant;

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- New or expanded community recreation and sport facilities in Derby or new township shared with gas plant/LNG plant;
- New or expanded commercial and retail facilities in Derby or new township shared with gas plant/LNG plant;
- Light industrial area for contractors servicing the bauxite mine, refinery and port in the vicinity of industrial area with gas plant/LNG plant;
- Existing airport at Derby shared between alumina refinery and gas plant/LNG plant for personnel transport. Proximity of RAAF Curtin airbase may reduce the need to upgrade aircraft capacity of Derby Airport;
- Telecommunications costs to be shared between alumina refinery and gas plant/LNG plant to maximise use of common-user infrastructure.

Table 31 **Possibilities for cost sharing between alumina refinery and LNG/gas plant north east of Derby**

Item description	Requirement		Unit Cost		Min Shared Cost (\$m)	Max Shared Cost (\$m)
Port facility	1	Berth			\$300	\$400
Upgrade Unsealed Road	25	km	\$250,000	/km	\$5	\$7
New Road	30	km	\$450,000	/km	\$10	\$15
Site Development at Port Facility	5	Ha	\$400,000	/Ha	\$1	\$2
Site Development at Refinery Site 1	700	Ha	\$400,000	/Ha	\$0	\$0
Airstrip	Not required				\$0	\$0
Energy – Power Generation			\$1,500,000	/MW	\$0	\$0
Energy – Power Generation Multi-User	10	MW	\$1,500,000	/MW	\$11	\$16
Energy – Power Distribution	40	km	\$35,000	/km	\$1	\$2
Water – Supply and Treatment	500 person cap		\$400,000	ea	\$0	\$0
Water – Treatment	500 person cap		\$600,000	ea	\$0	\$0
Telecommunications – Cable to Derby	50	km	\$200,000	/km	\$7	\$11
Telecommunications - Microwave Repeater. 50% cost share of 1 station	1	ea	\$250,000	ea	\$1	\$1
Township Land Development	50	Ha	\$3,000,000	/Ha	\$105	\$158
Township Social Housing	25	ea	\$250,000	ea	\$5	\$7
Township Community Facilities	1	ea	\$3,000,000	ea	\$2	\$3
Township Commercial / Retail Facilities	0.2	Ha	\$8,000,000	/Ha	\$1	\$2

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Light Industrial Area	5	Ha	\$400,000	/Ha	\$1	\$2
ESTIMATED TOTAL COST OF MULTI-USER INFRASTRUCTURE					\$451	\$626

Source: Cost Estimation Handbook, AusIMM, 1990 with prices indexed for inflation to 2004

Notes:

1. Site development at refinery site is project proponent cost.
2. Power Generation at Refinery Site is project developer cost.
3. All cost estimates are plus or minus 50 per cent.

The total cost of the required infrastructure for the mine site at Mt Leeming / Mitchell Plateau and port facility, with bauxite shipped to potential alumina refinery site north east of Derby is estimated at:

Min Estimated Cost (\$m)	Max Estimated Cost (\$m)
\$640	\$1,079

The numbers shown in the table above are the combined totals of Tables 31 and 32.

Bauxite/Alumina Option 2c: Bauxite mine at Mitchell Plateau / Mt Leeming – West Kalumburu, alumina refinery in vicinity of western Dampier Peninsula

Cost estimates for required infrastructure associated with a bauxite mine at Mitchell Plateau / Mt Leeming with a coastal port facility is presented in Table 32.

Table 32 **Cost estimates for required infrastructure: Option 2c: Bauxite mines at Mitchell Plateau / Mt Leeming with coastal port facility**

Item description	Requirement		Unit Cost		Min Est Cost (\$m)	Max Est Cost (\$m)
Port facility	1	Berth	\$150,000,000	ea	\$150	\$375
Upgrade Unsealed Road	100	km	\$250,000	/km	\$25	\$50
Site Development of Bauxite stockpiles at port facility ¹	20	Ha	\$500,000	/Ha		
Site Development at Port Facility	5	Ha	\$500,000	/Ha	\$3	\$6
Site Development of Mine Site ²			\$500,000	/Ha		
Airstrip	1		\$3,600,000	ea	\$4	\$8
Energy – Power Generation ³			\$1,500,000	/MW		
Energy – Power Distribution	100	km	\$35,000	/km	\$4	\$8
Water – Supply and Treatment ⁴	500 person cap		\$400,000	ea		
Water – Treatment ⁵	500 person cap		\$600,000	ea		
Telecommunications – Microwave Repeater	4	ea	\$250,000	ea	\$1	\$2
Telecommunications – Upgrade Kalumburu Station	1	ea	\$500,000	ea	\$1	\$2
Telecommunications – Signal Booster	1	ea	\$500,000	ea	\$1	\$2
ESTIMATED TOTAL COST OF MULTI-USER INFRASTRUCTURE					\$189	\$453

Data source: *Cost Estimation Handbook, AusIMM, 1990 with prices indexed for inflation to 2004*

Notes: project proponent costs include

1. Site development of bauxite stockpile areas at port facility
2. Site development at mine site
3. Power generation to meet mine site and port facility electrical energy requirements
4. Water Supply for mine site and port facility requirements
5. Treatment plant for plant site and construction camp facilities
6. All cost estimates are plus or minus 50 per cent.

Table 33 **Cost estimates for required infrastructure: Alumina refinery in west Dampier Peninsula area**

Item description	Requirement		Unit Cost		Min Shared Cost (\$m)	Max Shared Cost (\$m)
Port facility	1	Berth			\$300	\$400
New Road	60	km	\$450,000		\$19	\$28
Site Development at Port Facility	5	Ha	\$400,000	/Ha	\$1	\$2
Site Development at Refinery Site ¹	700	Ha	\$400,000	/Ha		
Airstrip	Not Required					
Energy – Power Generation			\$1,500,000	/MW		
Energy – Power Generation Multi-User	10	MW	\$1,500,000	/MW	\$11	\$16
Energy – Power Distribution	60	km	\$35,000	/km	\$2	\$3
Water – Supply and Treatment	500 person cap		\$400,000	ea	\$0	\$0
Water – Treatment	500 person cap		\$600,000	ea	\$0	\$0
Telecommunications – Cable to Broome	60	km	\$200,000	/km	\$8	\$13
Telecommunications - Microwave Repeater. 50% cost share of 2 stations	1	ea	\$250,000	ea	\$1	\$1
Township Land Development	50	Ha	\$3,000,000	/Ha	\$105	\$158
Township Social Housing	25	ea	\$250,000	ea	\$5	\$7
Township Community Facilities	1	ea	\$3,000,000	ea	\$2	\$3
Township Commercial / Retail Facilities	0.2	Ha	\$8,000,000	/Ha	\$1	\$2
Light Industrial Area	5	Ha	\$400,000	/Ha	\$1	\$2
ESTIMATED TOTAL COST OF MULTI-USER INFRASTRUCTURE					\$457	\$635

Data source: *Cost Estimation Handbook, AusIMM, 1990 with prices indexed for inflation to 2004*

Notes:

1. Site development at refinery site is project proponent cost.
2. Power Generation at Refinery Site is project proponent cost.
3. Costs estimates are plus or minus 50 per cent.
4. All cost estimates are plus or minus 50 per cent.

The required infrastructure for the mine site and coastal port facility listed in the table includes:

- Port facility comprising:
 - Approach channel (estimate based on dredging in soft sediment; rock dredging and blasting not included in estimate);
 - Berthing pocket and turning basin;
 - Navigational aids;

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- Barge landing.
- 20 hectare cleared port area for general cargo, materials laydown and freight transport requirements;
- Upgrade of road access from the Derby-Gibb River Road to Mt Leeming / Mitchell Plateau site and coastal port and township for “Dry” season access only;
- 70 km HV transmission line from coastal port and refinery to mine site;
- Construction of sealed airstrip for personnel transport for mine;
- Construction of microwave repeater stations connected to existing station at Kalumburu with upgrade to existing station to increase capacity;
- Installation of signal booster for broadcast media re-transmission to mine site from existing telecommunications facility at Kalumburu.

Alumina refinery in west Dampier Peninsula

The potential alumina refinery location is in the vicinity west Dampier Peninsula, near the potential gas plant/LNG plant processing gas from the Browse Basin.

The co-location of the industrial facilities allows for cost-sharing of infrastructure between the two projects as listed in Table 33.

The required infrastructure for the alumina refinery and port sited in the vicinity of west Dampier Peninsula includes:

- Port facility shared with potential gas plant/LNG plant comprising:
 - Berthing pocket;
 - Wharf and jetty.
- The expansion of Broome town or development of a stand-alone township in the vicinity of Broome and the plant site with development costs shared with the gas plant/LNG plant development. This includes the following services:
 - 10 MW power station;
 - Basic water supply system (filtration and chlorination type)
 - treatment plant;
 - Housing for expanded population and serviced land;
 - New or expanded community recreation and sport facilities;
 - New or expanded commercial and retail facilities;
 - Light industrial area for contractors servicing the alumina refinery and gas plant/LNG plant.
- Existing airport in Broome shared between alumina refinery and gas plant/LNG plant for personnel transport;

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- Telecommunications costs and facilities are shared between alumina refinery and gas plant/LNG plant to maximise use of common-user infrastructure and increase public benefits.

The total cost of the required infrastructure for the mine sites at Mt Leeming / Mitchell Plateau and port facility, with bauxite shipped to potential alumina refinery site in western Dampier Peninsula area is estimated at:

Min Estimated Cost (\$m)	Max Estimated Cost (\$m)
\$426	\$808

Table 34 Summary of bauxite development options: mine site costs

MINE SITE COSTS	OPTION 2 - Mine in NW Kimberley				OPTION 2a - Mine and Refinery in NW Kimberley				OPTION 2b - Mine in NW Kimberley and Refinery north east of Derby				OPTION 2c - Mine in NW Kimberley and Refinery west Dampier Peninsula			
			Min	Max			Min	Max			Min	Max			Min	Max
Port facility	1	Berth	\$150	\$375			Refinery Cost	Refinery Cost	1	Berth	\$150	\$375	1	Berth	\$150	\$375
Upgrade Unsealed Road	100	km	\$25	\$50	100	km	\$25	\$50	100	km	\$25	\$50	100	km	\$25	\$50
Site Development of Bauxite stockpiles at port facility	20	Ha			200	Ha			20	Ha			20	Ha		\$0
Site Development at Port Facility	5	Ha	\$3	\$6			Refinery Cost	Refinery Cost	5	Ha	\$3	\$6	5	Ha	\$3	\$6
Site Development of Mine Site												\$0				\$0
Airstrip	1		\$4	\$8	1	ea	\$4	\$8	1		\$4	\$8	1		\$4	\$8
Energy – Power Generation												\$0				\$0
Energy – Power Distribution	100	km	\$4	\$8	100	km	\$4	\$8	100	km	\$4	\$8	100	km	\$4	\$8
Water – Supply and Treatment		500 person capacity				500 person capacity				500 person capacity				500 person capacity		
Water – Waste Water Treatment		500 person capacity				500 person capacity				500 person capacity				500 person capacity		
Telecommunications – Microwave Repeater	4	ea	\$1	\$2	4		\$1	\$2	4	ea	\$1	\$2	4	ea	\$1	\$2
Telecommunications – Upgrade Kalumburu Station	1	ea	\$1	\$2	1		\$1	\$2	1	ea	\$1	\$2	1	ea	\$1	\$2
Telecommunications – Signal Booster	1	ea	\$1	\$2	1		\$1	\$2	1	ea	\$1	\$2	1	ea	\$1	\$2
SUB TOTAL (\$m)			\$189	\$453			\$36	\$72			\$189	\$453			\$189	\$453

1. All cost estimates are plus or minus 50 per cent.

Table 35 Summary of bauxite development options: refinery site costs

	OPTION 2 - Mine in NW Kimberley	OPTION 2a - Mine and Refinery in NW Kimberley	OPTION 2b - Mine in NW Kimberley and Refinery north east of Derby	OPTION 2c - Mine in NW Kimberley and Refinery in western Dampier Peninsula
REFINERY SITE COSTS				
Port facility		2 Berth \$200 \$500	1 Berth \$100 \$200	1 Berth \$80 \$120
New Road			25 km \$5 \$7	60 km \$19 \$28
Upgrade Unsealed Road		Mine Site Cost Mine Site Cost	30 km \$10 \$15	
Site Development at Port Facility	5 Ha	\$3 \$6	5 Ha \$1 \$2	5 Ha \$1 \$2
Site Development of Refinery Site	700 Ha		700 Ha	700 Ha
Airstrip – sealed airstrip		Mine Site Cost Mine Site Cost	Not required	Not Required
Energy – Power Generation for Refinery				
Energy – Power Generation for Public	100 km	Mine Site Cost Mine Site Cost	10 MW \$11 \$16	10 MW \$11 \$16
Energy – Power Distribution			40 km \$1 \$2	60 km \$2 \$3
Water – Supply and Treatment		500 person capacity	500 person capacity	500 person capacity
Water – Waste Water Treatment		500 person capacity	500 person capacity	500 person capacity
Telecommunications – Cable	4	Mine Site Cost Mine Site Cost	50 km \$7 \$11	60 km \$8 \$13
Telecommunications – Microwave	1	Cost Cost	1 ea \$1 \$1	1 ea \$1 \$1
Township Land Development	1		50 Ha \$105 \$158	50 Ha \$105 \$158
Township Social Housing			25 ea \$5 \$7	25 ea \$5 \$7
Township Community Facilities			1 ea \$2 \$3	1 ea \$2 \$3
Township Commercial / Retail Facilities			0.2 Ha \$1 \$2	0.2 Ha \$1 \$2
Light Industrial Area			5 Ha \$1 \$2	5 Ha \$1 \$2
SUB TOTAL (\$m)		\$203 \$506	\$251 \$426	\$237 \$355
Total cost of multi-user infrastructure (mine and refinery) (\$m)	\$189 \$453	\$239 \$578	\$440 \$879	\$426 \$808

1. All cost estimates are plus or minus 50 per cent.

10.2.2 Social infrastructure

Social infrastructure in the West Kimberley is generally adequate to service the current population and expected business-as-usual growth. Any substantial increase in population as a result of resources development will require expansion and augmentation of the existing social infrastructure. There are several areas of social infrastructure provision that could be improved to better service development of resources in the West Kimberley. These have been identified as:

- A lack of available land for housing and other development in Broome;
- A concern amongst residents of the West Kimberley that secondary education facilities are lacking compared with those in the Perth metropolitan area and elsewhere in Western Australia; and
- The possibility that medical facilities in the West Kimberley could be improved to specifically meet the needs of the resource industry, as well as the needs of a growing population.

Land shortage in Broome

The shortage of available land in Broome could impact the availability of housing to meet a possible increase in population as well as the affordability of housing. Broome currently has the highest median house prices outside the inner Perth metropolitan area²⁹. High housing costs have been attributed to a range of factors including lack of available land, high building and construction costs and uncertainty surrounding the resolution of Native Title claims.

It is expected that the population of Broome will increase at around 5 per cent per annum³⁰ for the foreseeable future – without any major resources projects nearby. The Department for Planning and Infrastructure and the Shire of Broome have estimated that this increase equates to a demand for new housing of around 200 lots per annum. This need is not able to be met by the current rate of land development.

Education and training

Despite the area being well serviced by primary, secondary and post secondary facilities (see Box 1) there is a noticeable trend for families to leave the area once their children reach secondary school age (see Section 3.7 on demographics). A similar phenomenon exists in the Pilbara.

²⁹ Department for Planning and Infrastructure, Planning for Broome: Population and Housing, Information sheet 4

³⁰ Ibid

There is a need for a review of secondary education in the West Kimberley to investigate how this trend could be reversed. The retention of workers with secondary school aged children to the area will be of particular concern for companies who wish to employ local people or attract workers and their families to the West Kimberley.

In Karratha, the campuses of the Karratha Senior High School, Karratha College (Pilbara TAFE) are being combined to offer better curriculum choices and a seamless transition to TAFE. A campus of Curtin University will also be established on the same site. Similar campuses exist in Kalgoorlie and Mandurah and will shortly be established in Busselton and Bunbury.

Major resources development will result in both increased population and a demand for educated and trained workers. The State and Australian Governments will need to respond with appropriate education and training facilities and curricula.

Box 1 **Education facilities in the West Kimberley**

Primary education

Provided in government and other schools.

Secondary education

Government schools accommodate students up to Year 10 in all West Kimberley towns at district high schools. Broome Senior High School offers Year 11 and 12 also. Distance education is offered at district high schools and for home schooling.

The Catholic Education Office of WA provides schooling up to Year 12 at St Mary's College in Broome.

There are a number of Aboriginal Independent Community Schools operating in remote communities some of which offer education up to Year 10.

Post-Secondary Education

The Kimberley College of TAFE has centres in Broome and Derby whilst the University of Notre Dame and Edith Cowan University have campuses in Broome.

University of Notre Dame offers bachelor degrees in Education, Commerce, Indigenous Australian Studies, Counselling and Nursing. Postgraduate and Masters programs are also available in some subjects. Vocation, Education and Training programs for Aboriginal people are available to undertake at the Diploma level for Education, Management (Indigenous Organisation) as well as the Certificates 2 and 3 in Public and Community Administration.

Edith Cowan University has a School of Indigenous Studies in Broome which offers courses in Business, Education, Social Sciences, Indigenous Services, and Arts. It also offers an Indigenous University Orientation Course designed for Indigenous students seeking access to tertiary studies.

Medical facilities

Medical facilities in the Kimberley are good for a regional location, with Kununurra, Broome and Derby hospitals all providing accident and emergency services as well as other services generally expected of a hospital including radiography, maternity, general medical and so on. Derby District Hospital is the only facility in the Kimberley that provides intensive care services.

Upgrades may therefore be required to cater for specific industrial accidents and emergencies. It is expected that these needs would be assessed to meet specific requirements as resources development progressed.

In addition, the growing population will require increased health capacity and possibly some extra health services. The availability of such services are, with education, a key determinant of whether a region can attract and hold workers with families.

10.2.3 Other service needs

Government services

The services available in the West Kimberley are on a par with the services provided in other regional areas of Western Australia, although distance tends to reduce accessibility to such services.

As the population of the region continues to expand, the demand for government services is likely to increase. This is likely to be met within current government planning parameters.

Major resources development is likely result in a step change in population, and all levels of governments will need to respond with expanded and additional services.

10.2.4 Cost of living and doing business in the Kimberley

A major factor discouraging people from living and operating businesses in the Kimberley is the high cost of living. The Commonwealth's Taxation Zone Allowance Scheme provides for offsets to individuals living in rural and remote areas in recognition of the disadvantages that taxpayers are subject to because of the:

- Difficult climatic conditions in the Wet season;
- Remoteness; and
- Higher costs of living in comparison to the metropolitan areas.

The zone tax offset arrangements recognise two zones – Zone A and Zone B – as well as “special areas” within these zones. In general, Zone A comprises those areas where the above factors are more pronounced, and Zone B comprises areas that are affected to a lesser extent.

The State Government says that the real value of zone rebates has fallen by 15 per cent since 1993³¹. It says that restoring the real value of zone tax rebates would encourage more families to make a permanent commitment to regional living. It would also assist small and medium-sized businesses to better compete with city-based businesses.

In concert with the Queensland and Northern Territory Governments, Western Australia has made representations to the Australian Government for:

- Indexing of zone rebates so that they maintain real value over time; and
- An inquiry into zone rebates and other mechanisms to encourage regional living.

The National Farmers' Federation in 2001 issued a discussion paper which proposed a new personal income and company tax zone rebate scheme for people and businesses residing and operating in country Australia.

The Regional Business Development Analysis Panel³² in June 2003 also proposed changes to the Taxation Zone Allowance Scheme

³¹ Zone Allowance Rebates: a submission by the Minister for State Development, 2002.

³² Regional Business Development Analysis Panel, *Regional Business: a Plan for Action*, June 2003 (report of the RBDA commissioned by the Deputy Prime Minister and Minister for Regional Development)

11 Impacts on other business sectors

Minerals and energy development will impact other industries in the West Kimberley. These impacts could be positive or negative. Positive impacts include the opportunity for shared infrastructure, complementary training and education possibilities, and greater economies of scale in business and service provision. Negative impacts could include visual and perceived impacts from greater development in the area that could affect other industries such as tourism.

Other significant land users in the West Kimberley that could be impacted by resource development include the tourism industry and the agribusiness industry, including irrigated agriculture and aquaculture. The impacts on each of these industries are discussed in greater detail in the following sections.

11.1 Tourism

The unique culture, history and environment of the West Kimberley have resulted in a high level of tourism development and the potential for further development.

Provision of good quality accommodation is one area in which the tourism and resource development sectors can complement each other. There is an excellent range of accommodation facilities in the Shire of Broome. However, despite 2,766 beds and 933 guest rooms³³ available in the Shire of Broome with another 308 units planned, many in the industry consider that there is an under investment in the industry. Whilst there are ample beds to accommodate visitors in the low tourist season, there is a shortage of beds available in the peak tourist season. Lack of available land for development is a major factor in preventing further development.

The Shire of Derby-West Kimberley currently has 398 accommodation beds³⁴ in 170 guest rooms. Future supply of accommodation is good with 24 units under construction and a further 54 planned including 48 units planned at Fitzroy Crossing³⁵.

Whilst industrial tourism can offer a complementary tourism experience, there is a general concern in the industry that resource developments could impact

³³ Australian Bureau of Statistics, March Quarter 2004 (provided by WA Tourism Commission)

³⁴ Ibid

³⁵ WA Tourism Commission, Tourism Development Register Western Australia: Kimberley Region, December 2003 pp 7 - 10

the tourism potential of the area. This is particularly so for those involved in the eco tourism or wilderness tourism areas. High value adventure tourism is a growing sector in which Indigenous people are becoming increasingly involved. Indigenous and non-Indigenous adventure tourism proponents desire to ensure that the sector is not compromised by developments in the region.

11.2 Agriculture

There have been several large agriculture developments proposed for the West Kimberley. Whilst none of these developments have yet gone ahead, it is worth considering the impact if a similar project were to go ahead.

Some of these developments are listed below and include the Fitzroy River cotton project that was rejected by the State Government in July 2004:

- Beagle Bay tropical timber plantation. Product harvested and partial processing on site before being transported by road to the Port of Broome.
- Fitzroy River irrigated agriculture. Two-stage irrigated cotton growing and processing industry was to be located south of Broome. Phase One would have used groundwater supplies from the La Grange sub-basin of the Canning Basin, near Broome whilst Phase Two would have used surface water supplies in the Fitzroy Valley.

Water resources from the Fitzroy River were to be used to irrigate cotton and other products including sugar, leucaena, hemp, a range of horticultural products, exotic hardwoods, freshwater aquaculture and viticulture. Harvesting and initial processing was to be undertaken on site. Products were to be transported via the Great Northern Highway to the Ports of Wyndham, Derby, Broome or Fremantle for the overseas or domestic markets.

The Beagle Bay development is expected to employ a small workforce, and have little impact on social or economic infrastructure. The Fitzroy River development would have required a large workforce surpassing 2,000 at its peak. The additional population created by the additional workforce and their families would have placed pressure on the existing social and economic infrastructure in the nearby town of Broome.

It would also have required new economic infrastructure including the upgrade or creation of access roads, possible upgrade of the Port of Broome, and the construction of new power supplies to service processing. It is possible that the upgrade of infrastructure under a medium growth resource development scenario could complement new infrastructure requirements as a result of such a development.

11.3 Aquaculture

The aquaculture industry provides a valuable economic contribution to the economy of the West Kimberley. In particular, there are a number of pearl farms along the coast. There are plans to build additional aquaculture developments including 650 ha black tiger prawn development near Derby³⁶.

While upgrades to access tracks and port facilities could benefit the industry, there are also concerns that the development of the resources industry could adversely impact the aquaculture industry. These concerns lie primarily with the development of offshore oil and gas. In particular, increased wave movement caused by ships, possibility of increased pollution (including spills) and so on could impact the aquaculture industry.

11.4 Air services

The development of major resources projects in the West Kimberley will result in a large rise in air transport requirements both within the Kimberley region and to other locations, particularly Perth. Major projects will require both regular passenger transport (RPT) and charter air services. As has been demonstrated in the East Kimberley, there are potential synergies between charter and RPT demands in building overall supply of regional air services. The additional demand for air transport from major projects would be likely to result in additional services for all air transport users within the region and those wishing to travel to and from the region.

Resource developments in the region have a most beneficial impact on the availability of air services for the local communities. Resource developments are generally heavy users of air services and this has a positive impact on the level of services that become available to other users.

11.5 Defence

There are considerable Australian Defence Force land holdings north of Derby. This area lies on the north side of King Sound and extends from Stokes Bay to Collier Bay. The area is used for Defence Force training using live ammunition.

Defence activities are seen as a desirable economic activity in the region, adding importantly to the level of business activity and services available to the local community.

³⁶ Kimberley Development Commission,
<http://www.regional.wa.gov.au/perspectives/kimberley/fishing.asp>

The existence of this land and the purpose for which it is used could have some impact on the development of energy resources in the area. In particular, it could impact the location of an LNG/gas plant or the landfall for a gas pipeline.

The Defence land is still actively used. Its function and location will need to be considered as part of the necessary risk assessment that will be a part of any siting studies for major developments in the area.

11.6 Space launch facility

The Asia Pacific Space Centre Pty Ltd (Asia Pacific) is an Australian company that plans to build, own and operate a commercial satellite launch facility known as the Asia Pacific Space Centre (APSC). The facility is planned to be located on the Australian Territory of Christmas Island, and to comprise a Technical Complex, Launch Complex and Mission Control.

The petroleum industry has expressed its concerns about the risks to installations in the north and north-west of Australia from falling launch debris.

APSC is yet to secure funding to construct the facility.

12 Environmental and heritage issues

This section examines the potential environmental and cultural impacts on the West Kimberley region of the Medium Development Scenario described in Chapter 8.

12.1 Greenhouse gases

Greenhouse gases are gases in the Earth's atmosphere that absorb and re-emit infrared (heat) radiation causing a warming of the Earth's surface temperature. Activities such as combustion of fossil fuels release greenhouse gases (principally carbon dioxide, methane and nitrous oxide). Increases in greenhouse gas production have raised concerns that the natural warming effect will be "enhanced" and could result in global climate change.

Greenhouse gas emissions are one of the key issues confronting the LNG industry in Australia as LNG plants are major producers of greenhouse emissions, principally in the form of CO₂. The sources of CO₂ are the incoming native gas stream, the burning of gas in the turbine drivers, and from flaring. Other developments under the Medium Development Scenario will also unavoidably contribute to Australia's greenhouse emissions at a time when the Australian Government is committed to controlling such emissions.

A positive outcome is that the development of LNG will provide a more greenhouse-efficient fuel than oil and coal. In addition, alumina is used to manufacture aluminium, which is used preferentially to other materials in most applications because of its lightness. The aluminium intensity of vehicles for example has increased very substantially during the past decade as designers have sought to make vehicles lighter and more fuel efficient.

Thus, while greenhouse gases may be emitted in increased quantities within the Kimberley, Western Australia and Australia when LNG and alumina are produced, their end uses – mostly in other countries – lead to emission reductions relative to using other fuels and materials.

Implications for future developers

The Australian Government's LNG and Light Metals Action Agendas, its Energy White Paper and the Western Australian State Greenhouse Strategy all recognise the issues and encourage such industries to establish and operate in Australia.

Unfortunately, the operation of the Kyoto Protocol does not take Australia's unique situation fully into account.

Nevertheless, Australian and State Government policies require that all measures to minimise greenhouse gas emissions should be investigated as part of the approval and ongoing operational phases of projects. Proponents should also deal specifically with ongoing measures to reduce greenhouse emissions. This should include mechanisms for continual review of new technologies and opportunities to reduce emissions, and benchmarking against other facilities with a view to achieving international best practice in terms of greenhouse gas emissions per unit of production.

The Western Australian Environmental Protection Authority (EPA) provides guidance advice to new or expanding developments that have the potential to create greenhouse gas emissions (such as the energy industry) to assist proponents with addressing ways of managing such emissions. These include estimating and benchmarking, minimising emissions and sequestering carbon.

12.2 Fauna, vegetation and flora

The Kimberley has a huge variety of habitats which support very diverse animal and plant communities, many of which are endemic, protected and/or of particular conservation significance. The extreme seasonality of rainfall and permanently high temperatures which characterise the wet/dry tropics of the Kimberley drive much of the population dynamics and ecosystem complexity of the region. Endemism of freshwater fishes, frogs and lizards is high in the ecological refuges harboured within the Kimberley region. These fascinating areas often contain large numbers of endemic species, or species or ecosystems which do not occur in the broad sweep of the surrounding environment.

The Australian Government's recognition, in the Australian Terrestrial Biodiversity Assessment 2002³⁷, of the North West Kimberley, (including Mitchell Plateau area) as a least stressed Bio-diversity Hotpot region in Australia emphasises the high environmental values within the study area and raises awareness of need for strategic action to conserve endemic diversity.

In terms of vegetation, the coastal, saline and freshwater wetlands are the most recently formed and the simplest in terms of biological diversity. In scenic contrast, the widespread eucalypt-dominated communities of the well-drained lowlands are more complex and contain a diverse assemblage of species of mixed origin. The sandstone, often forming spectacular escarpments and cliffs, supports a flora which has features in common with other sandstone floras of Australia and contains relict elements. Cool, dappled monsoon forest pockets or 'jungles' also have many floristic similarities with vegetation types further eastwards in the Australian tropics and in the tropical Indo-Malesian region to

³⁷ www.audit.deh.gov.au

the north. A distinctive feature of the monsoon forest pockets is their small, disjunct nature. Essentially, they are islands of mixed origin, semi-evergreen vegetation in a sea of sclerophyll forest.

The Kimberley is relatively weed-free as a result of it remaining relatively undisturbed, having a total of approximately 167 known weeds (compared to over 795 in Perth). Future developments in the West Kimberley will need to prevent the introduction of such weeds into unaffected areas by careful management of disturbance activities.

The greatest structural diversity in the habitats of terrestrial vertebrates in the Kimberley occurs in the open forests and woodlands; these habitats are richest in species of reptiles, birds and mammals. At least 32 threatened fauna species and 62 migratory species occur within the West Kimberley region.

Stygofauna are a category of subterranean fauna, in particular obligate, ground-dwelling, aquatic animals and have been found to be present within the alluvial deposits and karstic landforms in the Devonian reef complexes which now make up the Limestone ranges and within the West Kimberley region. Stygofauna is significant for its value to biodiversity, evolutionary studies, ecosystem processes, maintaining water quality and groundwater threat indication. Recent surveys have suggested that relatively localised impacts such as mining have the potential to cause the extinction of locally endemic subterranean fauna species (Eberhard and Humphreys 1999) and further study is required.

Developments in the West Kimberley are likely to result in a range of environmental disturbances. Loss of native vegetation through clearing for development may impact on both the biodiversity of plant communities and the conservation of fauna species that rely on a particular vegetation species as habitat. Any sizeable development in the West Kimberley will inevitably affect some fauna during construction and operation activities. Some may move, and survive, within adjacent conservation areas. Others may be displaced and may later succumb to predators, stress or territorial conflicts during attempts to re-establish a home range. Interaction with newly arrived human populations may also impact adversely on local fauna, and clearing of vegetation can impact on fauna by reducing available habitat.

Implications for future developers

The *Wildlife Conservation Act 1950* and Regulations administered by the Department of Conservation and Land Management (CALM), sets out requirements for the protection of flora and fauna in Western Australia. Clearing of vegetation during ground disturbing activities associated with mineral exploration and mining are regulated under the *Environmental Protection*

(Clearing of Native Vegetation) Regulations 2004, provided for under Section 51C of the *Environmental Protection Act 1986*. Before the commencement of operations, the tenement holder must first obtain approval of the Department of Industry and Resources (DoIR). Consent from the Minister for the Environment must be obtained before any person can remove, damage or take any flora listed as Declared Rare.

Fauna surveys for mammals, birds, invertebrates, reptiles, amphibians and/or stygofauna (see below) may need to be undertaken by proponents of developments in the region as part of the environmental impact assessment and protection process. Comprehensive flora and fauna surveys prior to development will assist in identifying any rare and priority species that may be present in the proposed development area. A proposal will also need to be referred to the EPA or the Department of Environment and Heritage if it has the potential to impact on Specially Protected (threatened) flora or fauna protected under the *Environmental Biodiversity and Conservation Act*. A permit may be required for activities in or on Australian Government land that may affect a member of an EPBC listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Rare and priority species will also need to be incorporated into the project Environmental Management Plan and may affect the total area that can be developed.

The existence of stygofauna has become an issue in relation to obtaining permission for future mining (and any other projects with the potential to affect the groundwater). It is usually the case that if rare species are identified within a project area, development approval is obtained only following evidence that the development will not negatively impact on the species survival.

12.3 Marine and coastal environment

Coastlines are the transition zone between the marine and land environments. They are periodically immersed by the sea, exposed to the air and are subjected to high salinity. The West Kimberley has a diverse range of coastal areas including long sandy ocean beaches, rocky headlands, coral reefs, sheltered bays and estuaries with extensive muddy and sandy tidal flats and mangrove areas. These areas play an important role: as habitat for a variety of marine, terrestrial and birdlife; as buffer areas between the marine and land environments; and hold rich traditional food resources for Aboriginal community subsistence.

The coast is prone to large tidal variations that, together with summer river discharges, dramatically influence the coastal environment. Much of the coast

remains uninhabited. Long stretches of isolated coastline provides wilderness attraction, but at the same time presents issues of management.

Future offshore or coastal developments in the region have the potential to substantially alter marine and coastal environments and processes and impact on aspects of the marine environment such as marine flora and fauna, coral reefs, the seafloor and water quality. There is the potential for marine degradation and pollution to occur during the construction and operation of shipping, offshore or port developments as a result of associated activities such as dredging, ballast water discharge, oil spills, runoff from shiploading wharves etc.

Environmental issues associated with marine dredging works that could be of concern include:

- The extent and quality of turbid water resulting from the dredging operation. Turbidity creates a visual impact, which could upset the local population. Of more importance are the possible detrimental impacts on seagrasses or coral, by blanketing or restricting the quality of light getting to the plants.
- Impacts on marine life parks.
- Possible impacts on local industry such as fishing.
- Protection of sea life such as dolphins, sea lions and whales. In all cases the dredges need to ensure that they do not disturb these animals, e.g. during the whale migratory season.
- Possible impacts on Aboriginal subsistence food resources

To avoid detrimental and possibly costly effects to “the project” the environmental issues should be fully addressed before project commencement.

With respect to potential environmental impacts, a necessary task is to obtain government approvals for the work (Federal approval for offshore disposal and State approval for all other aspects of the work, both near-shore and onshore).

Implications for future developers

Approval may be required for a proposed activity that is likely to have a significant impact on the environment in a Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the Australian coast.

An offshore gas pipeline near Derby or Broome, a bauxite mine loadout facility, an alumina smelter port facility close to Derby or Broome, subsea mining proposals and dredging and marine construction works and associated

support facilities are all examples of the types of industry/activity this impact is relevant to.

12.4 Wetlands

There are many different types of wetlands, including lakes, rivers, lagoons, mangrove forests etc. Wetlands are important ecosystems for the following reasons; they support many different types of plants and provide a home for many types of fauna including migratory birds, they usually have high recreational value, they aid in reducing the severity of floods, they can help keep water clean and are important to Aboriginal cultural systems.

The West Kimberley contains two Wetlands of International Significance (Ramsar Sites); Eighty Mile Beach and Roebuck Bay. A third, Ashmore Reef, is situated 610 km offshore north of Broome. Ramsar wetlands are sites that are recognised under the Convention on Wetlands of International Importance (Ramsar Convention) as being of international significance in terms of ecology, botany, zoology, limnology or hydrology. As well as Ramsar wetlands, the West Kimberley contains a large number of Wetlands of National Importance.

Wetlands have the potential to be placed under threat by future developments, particularly if they result in any of the following: alteration of natural water regimes, loss of vegetation, salinisation and excessive inundation, water pollution or the introduction of invasive species.

Implications for future developers

An action that will, or is likely to, have a significant impact on a Ramsar wetland will be subject to a rigorous environmental assessment and approval regime under the *EPBC Act*. Also relevant to proposals that have the potential to impact on wetlands and migratory waterbirds are the Convention on Migratory Species (Bonn Convention) and international treaties such as the Japan-Australia and China-Australia Migratory Bird Agreements (JAMBA and CAMBA).

Many of the Kimberley's nationally important wetlands occur in existing or proposed conservation reserves which are managed by the Department of Conservation and Land Management, however, some occur on private property or pastoral lease or lands for other purposes so their conservation depends on land owner and community attitudes towards conserving wetlands.

Any industry has the potential to impact on wetlands either directly (e.g. via clearing or draining) or indirectly (e.g. via contamination of water source, increased visitation).

12.5 Soils and landform

The Kimberley region can be divided into four distinct landform divisions, three of which are represented within the West Kimberley region; the North Kimberley Division, the Fitzroyland Division and the Sandland Division as discussed in Section 3.5. The North Kimberley Division is predominantly plateau country comprising sandstone with some shales and volcanic. The Fitzroyland Division contains the Fitzroy River and its tributaries. It also contains the Devonian reef system that harbours 350 million year old marine fossils. The Sandland Division comprises the southern parts of the West Kimberley region and contains a portion of the Great Sandy Desert.

Degradation can occur as a consequence of inappropriate pastoral or agricultural activities. This can also result from the effects (such as erosion) of mining, clearing and other such ground disturbing activities.

Implications for future developers

Proponents of future developments will need to assess the impact of their project on the soils and landforms of the project area. Baseline studies may be required as a part of this process. Measures will then need to be taken by the proponent to ensure that landforms in the area are kept stable, sustainable and consistent with the surroundings. To do this, proponents will need to develop management and mitigation strategies with objectives relating to avoiding impacts from erosion, flooding, other changes resulting from surface and groundwater changes, effects on nearby vegetation communities, salinity etc.

Any activity involving clearing or landform disturbance e.g. mining can have an impact on soils and landform.

12.6 Conservation reserves and other environmentally sensitive lands

Conservation reserves comprise almost two million hectares of the Kimberley. These consist of CALM reserves, national parks, nature reserves and conservation parks (some Class 'A'), EPA Redbook recommended areas and proposed reserves and other areas considered to be environmentally sensitive areas. The location of Conservation Reserves and other Environmentally Sensitive Lands within the West Kimberley is shown in Figure 45.

12.6.1 National Parks and Nature Reserves

National Parks are for wildlife management and landscape conservation, scientific study, preservation of heritage or natural features, together with

recreational enjoyment by the public. They are of national or international significance. National Parks within the West Kimberley region include Mount Hart, Geikie Gorge, Tunnel Creek, Windjana Gorge and Rowley Shoals (marine park).

Nature Reserves are specifically for wildlife and landscape conservation, scientific study and preservation of heritage or natural features.

12.6.2 EPA Redbook Recommendation Areas and Proposed Reserves

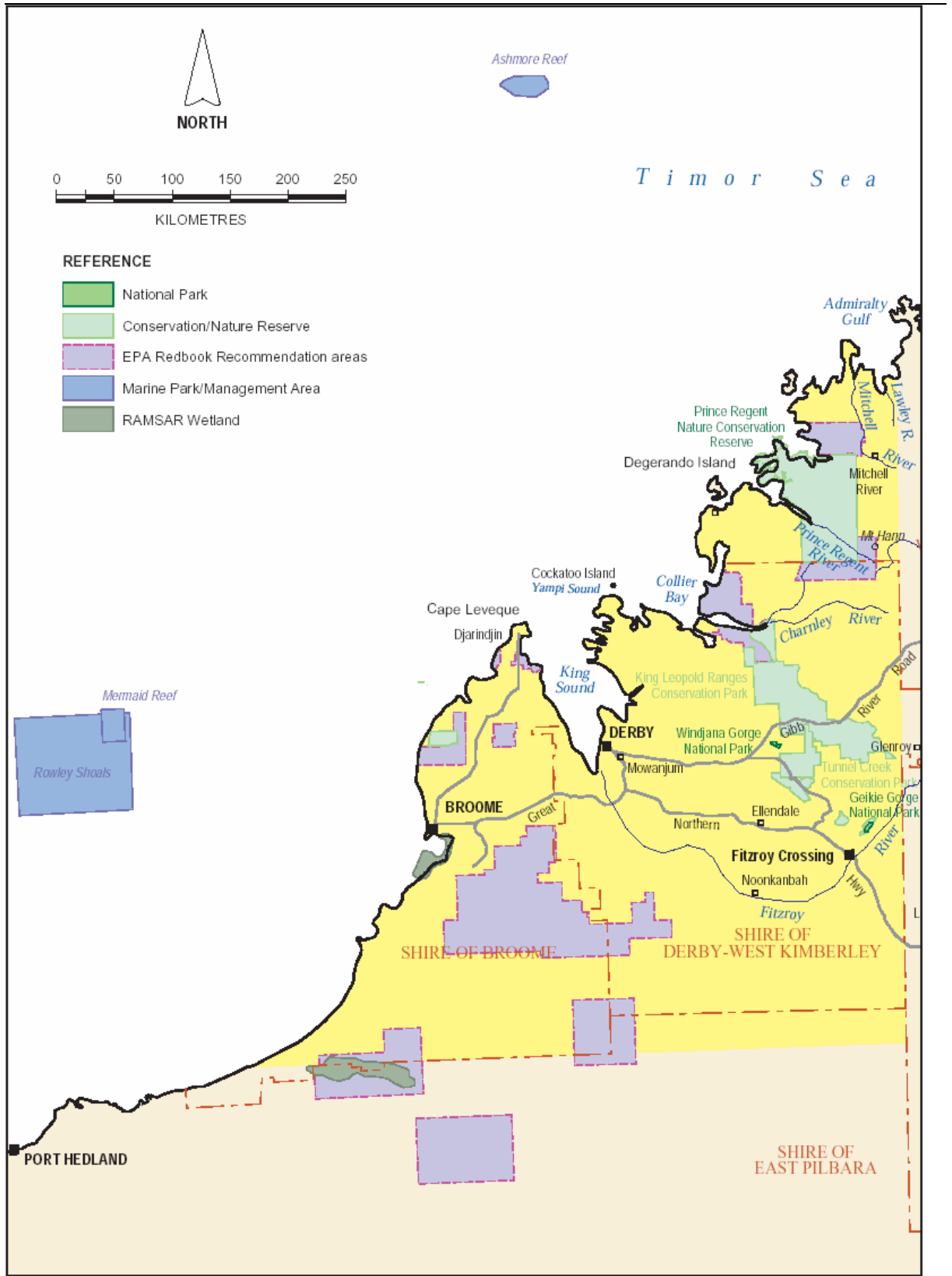
Redbook Recommendations are a range of areas recommended by the EPA to become Conservation Reserves. Proposed reserves are reserves under consideration that have been endorsed by Cabinet or the Minister for the Environment.

Environmentally Sensitive Areas are special areas that the Department of Minerals and Energy, CALM, and the Department of Environment have agreed warrant environmental protection. They include rainforest areas, areas of declared rare flora, mangrove communities and important wetlands. There are numerous environmentally sensitive areas scattered throughout the West Kimberley region.

Implications for future developers

Where development proposals occur within Conservation Reserves and Other Environmentally Sensitive lands, the proposal will need to be referred to the EPA and CALM for impact assessment. These referrals ensure that the State government agencies responsible for land management and environmental protection are consulted and advice sought prior to tenements being granted or operations being approved where such activities have the potential to create significant disturbance. The Minister for the Environment is also required to give his/her recommendation for activities in nature reserves and conservation parks.

Figure 45 **Areas of particular environmental sensitivity in the West Kimberley**



Source: Department of Conservation and Land Management

12.7 Aboriginal culture and heritage

12.7.1 Aboriginal Heritage sites

Heritage sites of significance and importance to Aboriginal people exist throughout the study area in many forms: in physical presence such as rock art paintings, burial places; in natural features (waterfalls, reef structures, soaks, springs, waterholes, landscape formations) and in spiritual and totemic association with creation beliefs and living things in the environment.

Aboriginal cultural heritage and Native Title are often closely connected. For example, the Wanjina and Gwion (“Bradshaw”) rock art images throughout the North-West Kimberley are intrinsic to Wanjina Wungurr laws and customs and cultural values of the Wanjina Wungurr native title holders. The evidence that native title claimant can rely on to support their applications for determination of Native Title may include the Aboriginal cultural material and/or sites that may impact or be located in the vicinity of a proposed development or exploration activities.

Protection of Aboriginal heritage sites is currently afforded through Commonwealth and State Acts. These are the *State Aboriginal Heritage Act 1972* (WA) and the *Commonwealth Aboriginal and Torres Strait Islander Heritage Protection Act 1984*.

Under both the State and Commonwealth Acts, proponents must take steps to identify and protect Aboriginal cultural heritage sites.

Implications for future developers

Exploration or development activity in the West Kimberley has the potential to impact on Aboriginal sites. Whether an Aboriginal heritage site is registered on the State Register of Aboriginal Sites is not conclusive indication of the presence of an Aboriginal heritage site in any particular location.

Western Australian Aboriginal Heritage Act (1972)

To ensure compliance under the *Aboriginal Heritage Act 1972*, proponents of future developments should endeavour to undertake heritage surveys before any ground disturbing activities proceed to ensure all Aboriginal heritage sites are identified and protected. The Act was developed to protect and preserve Indigenous Heritage and it is an offence to knowingly damage an Aboriginal site. There is also a requirement, under Section 15 of the Act, for any person who becomes aware of an unrecorded site to report the existence of that site to the Registrar of Aboriginal Sites at the Department of Indigenous Affairs. Examples of sites and objects protected under the Act can include burial

grounds, symbols, paintings and engravings (in caves or on rock faces), stone structures or arrangements, carved trees and specific tracts of country and/or water.

Disturbance of an Aboriginal heritage site should only take place after consultation with appropriate Traditional Owners and in accordance with the Act. Under Section 18 of the State Act, the Minister for Indigenous Affairs can consent to disturbance if development is likely to impact a site. The Minister considers the recommendations of an advisory committee (the Aboriginal Cultural Materials Committee – APMC) and the general interests of the community when making a decision on such matters. In practice the APMC will only make a recommendation to the Minister once it is satisfied that sufficient consultations have been undertaken by the proponent.

Also, under Section 16, the Registrar can authorise excavation and removal of anything from an Aboriginal heritage site, and this is generally used for research purposes after consultation with Indigenous people.

The Australian Government's Department of Environment and Heritage administers the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984*. The law's purpose is to preserve and protect areas and objects of particular significance to Aboriginal people. The law complements Western Australian legislation and is intended to be used only as a last resort where the State law and the heritage protection process prove to be ineffective.

Native title process and relationship to Mining Act process of grant

In 2004, the State Government introduced a new policy whereby applicants for Exploration Licences and Prospecting Licences are required to enter into a *Standard Heritage Agreement* or satisfy the State that an existing Alternative Heritage Agreement is in place before the applications will be submitted to the *Native Title Act 1993* (NTA) Expedited Procedure. In the absence of such an agreement the applications will be processed under the more lengthy NTA Right to Negotiate regime.

A standard heritage protection template agreement has been negotiated and is in place with each of the Native Title Representative Bodies in Western Australia except the Kimberley Land Council. The standard heritage agreement template contains minimum Aboriginal heritage protection standards. In return, Native Title claimant groups are asked to agree to the grant of exploration tenements and to provide a clear picture of the ethnographic landscape to tenement holders.

In the Kimberley, the State Government continues to apply the expedited process to all Exploration Licence and Prospecting Licence applications

without requiring a *Standard Heritage Agreement* or an Alternative Heritage Agreement to be in place. Introduction of the new policy in the Kimberley will depend on whether a *Standard Heritage Agreement* is negotiated by the Kimberley Land and Sea Council and Industry or whether the State imposes a *Standard Heritage Agreement*.

Heritage assessments in the Kimberley Region

Traditional Owners in the Kimberley utilise a heritage impact assessment methodology that centres on the proponent seeking clearance from the Traditional Owners of the project area of specific activities identified in the proposed work program. Agreement to adopt this methodology is usually negotiated with the proponent during the native title expedited procedure that applies to the grant of exploration and prospecting licences.

Under the methodology, a proponent provides the resources for a field survey team comprising relevant Traditional Owners and their advisers accompanied by a proponent representative. Advisers may be of anthropology, archaeology or any other technical discipline. Proponents are provided with a clearance report for the work program, detailing what activities can and cannot be undertaken within the area of the proposed work program. The Kimberley Land Council assists the Traditional Owners in the assessment process as requested.

Explorers have expressed concern that the process addresses only activities identified in the proposed work program without Traditional Owners divulging any information regarding the location of Aboriginal heritage sites or any cultural information. Explorers maintain that this approach does not provide the level of certainty, particularly in instances when a project has a real prospect of progressing to mining.

12.7.2 European and Asian heritage

The West Kimberley has a rich European and Asian heritage as outlined in Section 3.6. The value of this history is recognised by the Register of the National Estate which lists at least 14 places in the West Kimberley as significant. The Estate is Australia's national inventory of natural and cultural heritage places which are considered worth keeping for the future.

Implications for future developers

The way in which private, State Government and Local Government owners manage their National Estate properties is not directly affected by listing as entry on the Register does not place any direct legal constraints on the actions

of owners of private property. Also, listing on the Register does not give the Australian Government any rights to acquire, manage, or enter places which are private property. The Australian Government is the only body whose actions are constrained as a result of listings in the Register of the National Estate. Future developers in the region should however give consideration to proactively conserving sites of European heritage and natural significance.

12.7.3 Managing environmental and heritage impacts of development

The Kimberley region contains some of the last wilderness areas of Western Australia. It is a remote and sparsely populated area that is nonetheless feeling the effects of human impacts through changed land management, grazing, tourism and industry. In order to help conserve the region's high environmental and cultural values, careful planning and consideration must be given when attempting to manage existing land uses and fully realise the region's potential value, including the development of the tourist industry as well as its petroleum, minerals and agriculture potential.

Each individual development carries its own specific impacts, both positive and negative. The environment and the social and cultural needs of all interests in the region must be integrated into the planning, construction and operational phases of every development.

In addition to the impact assessment and management requirements of individual projects, the cumulative environmental and heritage impacts of possible development scenarios in the West Kimberley region need to be properly investigated. This way, better design, management and mitigation strategies can be established by proponents, planning bodies and government agencies.

The development options currently under consideration for the West Kimberley have the potential to result in a combination of locally, regionally and/or internationally significant impacts. The development scenarios discussed in this report will result in local impacts such as noise, dust, waste, destruction of flora and fauna and affect Aboriginal, and European and Asian heritage. Many of these impacts can also be classed as regional impacts. For example, impacts to flora and fauna, wastes, development within reserves etc. The impacts of petroleum and minerals processing industries will also be of international significance because of their potential to result in production of substantial quantities greenhouse gases. Operations that have the potential to impact adversely on wetlands are also considered to be of international significance because of their protection under international agreements on migratory birds.

Proponents of future developments within the West Kimberley region will need to conduct project and scenario specific environmental, heritage and community planning and impact assessments, for assessment by the relevant government bodies as part of their obligations to comply with State and Australian legislation. Such approaches, which include thorough community consultation, are also necessary to obtain broad community support for proposed developments – the so-called “community licence to operate”.

13 Native title issues

13.1 What is native title?

Native title is a pre-existing interest that is 'recognised' by Australia's common law and, since 1 January 1994, the *Native Title Act* (NTA). Since 1 January 1994 acts affecting native title have been regulated by the Native Title Act.

Native title can exist over both land and waters (onshore and offshore). Government, industry and private individuals must take native title rights into account in the same way as other property rights.

The source of native title rights and interests is the traditional laws and customs of the native title holders. This means that the nature of native title rights and interests may vary from community to community of Traditional Owners.

Native title can be exclusive or non exclusive. Exclusive native title rights and interests may include a right to exclude others from an area of land, or may mean that native title holders have an exclusive right to do something.

Native title rights can also be non-exclusive (that is, they can co-exist with other types of rights such as a pastoral lease). Other types of native title rights and interests may include rights to fish, hunt, gather or conduct ceremonies in certain areas.

The NTA provides for a right to compensation for the loss or impairment of native title arising from the validation of certain future acts (see Section 13.3).

13.2 Determination of native title

Determinations of native title are made in the Federal Court either as a result of a litigated process or a consent determination. Determinations are registered on the National Native Title Register managed by the National Native Title Tribunal.

There are presently three determinations of Native Title and 13 applications for determination (native title claims) in the West Kimberley region. The native title determinations are:

- Karajarri People 2002,
- Karajarri People 2004,
- Rubibi Community #6, and
- Wanjina Wunggurr Wilinggin Native Title Determination No1.

All determinations and claims are summarised in Table 35. A map of areas in the Kimberley under native claim or determined is shown in Figure 46.

Determination of the Wanjina Wungurr Willinggin application was handed down in the Federal Court in August 2004. Determination of the Rubibi Community's claim was handed down in November 2001. One other application, Bardi Jawi, has been heard by the Federal Court. Judgement is reserved.

In principle agreement has been reached between the Yungngora people, WA Government, Shire of Derby West Kimberley and other parties over the Nookanbah claim, situated south west of Fitzroy Crossing and covering an area of 1811 square kilometres. It is expected that parties to the proposed determination will seek the Federal Court's approval shortly.

The Shire of Derby West Kimberley reports that it has been negotiating with the Nyikina Managala Native Title Claimant group and the Kimberley Land Council on the Nyikina Mangala People's native title claim over the past 18 months with a view to entering into an Indigenous Land Use Agreement (ILUA). More details are contained in section 14.5.3.

The majority of land and waters within the West Kimberley study area is already subject of native title claims.

13.3 Future Act process

Future acts are acts done after 1 January 1994 (the date of commencement of the NTA) which 'affect' native title. In the main, future acts are acts done by governments or statutory authorities, rather than individuals. For instance, the granting of a right or permit to mine, rather than the mining activity itself, will be an act which 'affects' native title.

The NTA establishes a procedural framework within which future activity impacting on native title may be undertaken. The 'future act' regime in the NTA ensures that native title rights are taken into account by laying down procedures that must be complied with before acts affecting native title can be done.

13.3.1 Right to negotiate

The NTA provides that certain acts done by governments require them to negotiate with the native title holders. The right to negotiate is confined to land above the high water mark and covers a future act that:

- is done by government;
- and involves:

- the creation or variation of a right to mine (other than for infrastructure);
- the compulsory acquisition of native title rights and interests for third parties (other than in towns and cities);
- certain permissible renewals or extensions of leases and licences; or
- an act approved by the Commonwealth Minister.

The right to negotiate provisions of the Act apply to all Crown lands, with the exception of certain leases identified in Schedule 1 of the NTA. Mining Lease or General Purpose Lease applications attract the Right to Negotiate under s29 of the NTA. Interests in minerals are reserved to the Crown.

13.3.2 Expedited procedure

Some future acts might have minimal impact on native title rights and interests and therefore qualify for fast-tracking, or the 'expedited procedure'. This enables some minimal-impact applications to be granted if there are no objections while native title claims are under way.

The expedited procedure may apply to some exploration licences, prospecting licences, amalgamation applications, retention licences, and certain miscellaneous licences if these are:

- Not likely to involve any major disturbance to any land or waters concerned; and
- Not likely to interfere directly with the carrying out of community and social activities of native title holders; and
- Not likely to interfere with areas or sites of particular significance to native title holders.

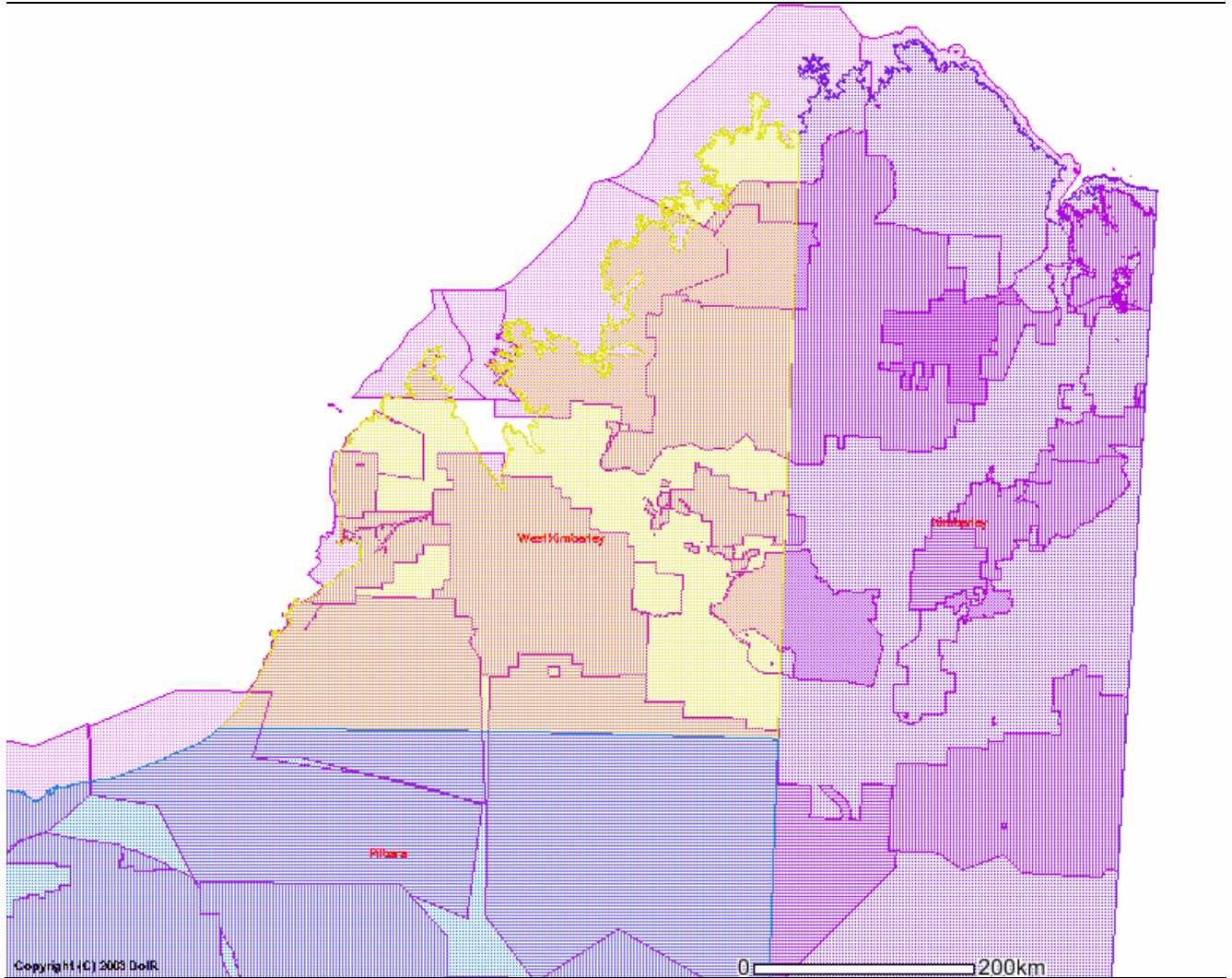
The expedited procedure does not apply to tenement applications that might have a more significant effect on native title rights and interests. In these instances, miners are required from the outset to enter into negotiations with any registered native title parties whose native title rights and interests might be affected by the proposed grant.

Table 36 **Native title claims in the West Kimberley**

Claim	Location	Shire	Status/Number
Bardi Jawi	Nth Dampier Peninsula	Broome	Federal Court Hearing WG49/98 Judgement reserved
Bardi and Jawi People-Brue Reef	North of Sunday Island	Broome	Refer Bardi Jawi
Djabera Djabera	Mid-west Dampier Peninsula	Broome	Application WG6124/98
Goolaraballoo – Jabirr Jabirr Peoples	Lower west Dampier Peninsula	Broome	Application WG6002/98
Rubibi #6	Broome region	Broome	Determination – Native title exists
Rubibi	Broome region	Broome	Federal Court Hearing WG6006/98
Karajarri 2002	South of Broome	Broome	Determination Native title exists
Karajarri 2004	South of Broome	Broome	Determination Native title exists in parts of the determination area
Mayala	North of King Sound	Derby/WK	Application WG6255/98
Nykina and Mangala	East of Broome south of Derby	Broome Derby/WK	Application WG6099/98
Ngurrara	Great Sandy Desert	Broome Derby/WK	Application WG6077/98
Nookanbah	South west of Fitzroy Crossing	Derby/WK	Application WG6229/98
Bunuba	North of Fitzroy Crossing	Derby/WK	Application WG6133/98
Gooniyandi Combined #2	West of Fitzroy Crossing	Derby/WK	Application WG008/00
Kurungal	South west of Fitzroy Crossing	Derby/WK	Application WG6217/98
Wanjina Wunggurr Willinggin, (Ngarynin)	Central North Kimberley	Derby/WK and Wyndham/EK	Federal Court Hearing W6015/99
(Wanjina-Wunggurr) Dambimangari	North-west Kimberley	Derby/WK and Wyndham/EK	Application WG6061/98
(Wanjina Wunggurr) Uunguu	North Kimberley, west of Kalumburu	Wyndham/EK	Application W6033/99
Balanggarra (Combination)	North east Kimberley	Wyndham/EK	Application WG6027/98

Source: Derived from NNTT www.nntt.gov.au/applications/claimant

Figure 46 Area of determined native title and under claim in the Kimberley



Note:

Source: Geoview, WA database http://www.doir.wa.gov.au/aboutus/geoview_launch.asp

13.4 Native Title Bodies Corporate

When the Federal Court makes a positive determination of native title, it must also determine the body that will hold the native title in accordance with s56 or s57 of the NTA. These bodies are known as Prescribed Bodies Corporate (PBCs) and must be incorporated under the Commonwealth *Aboriginal Councils and Associations Act 1976*. PBCs either hold native title on trust or act as agents for the native title holders. Once determined by the Court, PBCs are registered on the National Native Title Register and become Registered Native Title Bodies Corporate (NTBCs). NTBCs manage affairs relevant to native title rights and interests, including future act processes, with the informed consent of native title holders.

Native Title Representative Bodies (NTRBs)³⁸ may use their funding to expressly assist with the establishment, incorporation and registration of PBCs up to and including the holding of the first annual general meeting of the PBC. After the first annual general meeting of the PBC, NTRBs may use their funding to perform the functions of an NTRB in respect of PBCs (eg, facilitation and assistance functions, which include assisting NTBCs in consultations, mediations, negotiations and proceedings relating to future acts and ILUAs). PBCs are not funded by government other than through NTRBs, which themselves have limited resources relative to the tasks that they need to undertake. This situation is particularly apparent in the West Kimberley, where the Kimberley Land Council has limited its engagement in certain native title discussions and processes, which have been delayed as a result.

PBCs in the Kimberley are likely to number less than 50 corporate entities holding and/or managing the native title rights and interests of about 50 percent of the Kimberley population. However, each will be small and have limited capacity to undertake their roles. They will find it almost impossible, without finances and resources, to undertake and comply with governance obligations; develop capacity, be strategic and pro-active; meet land-holder expenses (fees, insurances); and discharge NTA functions and responsibilities.

PBCs are a unique stakeholder that governments and proponents will need to interact with in many future developments. PBCs need to be a functional institutional layer within the regional economy for the land tenure system and its administration to work efficiently.

³⁸ NTRBs are funded by the Australian Government to provide professional services to native title claimants and holders in accordance with the NTA. The NTRB for the study area is the Kimberley Land Council.

Each sector of the economy, from large scale developers to small business enterprises, including Aboriginal enterprises, will have varying capacity to transact with PBCs.

It is likely that most PBCs in the Kimberley would locate and operate registered offices in their community or nearby town. Remoter locations are generally expensive to conduct business from; overhead and administrative costs are high; markets for and margins from potential enterprise incomes and commercial opportunities can be uncertain as may be revenues from potential future act agreements. The nature of the communal interests will most likely preclude their use as collateral for any capital raising.

13.5 Aboriginal Reserves

In the West Kimberley study area there are some substantial parcels of land dedicated as Aboriginal Reserves, with management orders vested in The Aboriginal Lands Trust (ALT) and proclaimed under Part III of the WA *Aboriginal Affairs Planning Act* (AAPA). Table 37 lists the larger reserves and the relevant native title claim.

Table 37 **Aboriginal Reserves in the West Kimberley**

Major Part III Reserves	Reserve Number	Area Ha	Location	Native Title Status
Kalumburu Reserve	21675	166,000	Drysdale River-Kalumburu	Balanggarra Combination application
Cape Bougainville	24705	111,531	West of Kalumburu	Wanjina Wunggurr Uunguu application (Wunambal Gaambera)
Admiralty Gulf	30643	202,343	West of Mitchell Plateau	
Kunmunya	15530 23079	238,000 421,900	South of Prince Regent River	Wanjina-Wunggurr Dambimangari - application Wanjina Wunggurr Wilinggin (S-Ecorner) - determination
Wotjalum	30674	120,900	North of King Sound	Wanjina-Wunggurr Dambimangari - application
Sunday Island	25106	1,619	Entrance to King Sound	Bardi Jawi - application
One Arm Point	20927	14,339	Dampier Peninsula	
Beagle Bay Carnot Bay	1834 22615	315,250 60,298	Dampier Peninsula	Most presently unclaimed South west portion in Djabera Djabera application

Source: *Aboriginal Lands Trust*

For many reserves, the ALT has leased parts, portions or all of a reserve to traditional owner or Aboriginal community corporations. Access by non-indigenous people and grant of interests in Part III Reserves require consent of the Minister for Indigenous Affairs after consultation with the ALT and relevant Traditional Owners or community corporation (if lessee).

13.6 Indigenous Land Use Agreements

The NTA incorporates provisions for flexible, voluntary agreements between native title and other parties and, as such, should hold some appeal for those wishing to negotiate mining agreements. The provisions do not limit parties from negotiating agreements outside the provisions of the NTA.

ILUAs are flexible agreements, with the parties determining their main features and timeframes for negotiation. They are also voluntary, meaning that parties are not obliged to negotiate an agreement.

ILUAs can provide an alternative to the formal native title process, proponents may enter into an Indigenous Land Use Agreement (ILUA) with Traditional Owners for an agreement concerning grant of statutory interests and any other matters related to a project. Where an agreement proposes the extinguishment of Native Title (such as a grant of freehold title) the Western Australian Government must also be a party.

The NTA prescribes three forms of ILUA:

- Body corporate agreements – these are restricted to areas where one or more registered native title bodies corporate hold native title over the entire area subject to an agreement. Such bodies corporate may make agreements with any other person.
- Area agreements – these may be applicable in situations where there are no native title bodies corporate for the whole area.
- Alternative procedure agreements – these may apply in any situation where there is no native title body corporate for the whole area, although there must be a Native Title Representative Body (NTRB) or body corporate for the area. In addition to the wide range of matters that may be covered by the other types of ILUAs, an alternative procedure agreement may provide a framework for other agreements about native title rights and interests, and, because it is not a requirement that native titleholders are parties to such an agreement, cannot provide for the extinguishment of native title.

The common features of all three types are:

- Agreement may be given by native titleholders or native title applicants in relation to consideration, and subject to any lawful conditions;
- Any person may request assistance from the NNTT, not just native title parties;
- An application for registration of an ILUA may be by any of the parties; and
- Any party may appeal a decision to register an ILUA.

ILUAs may have application in a variety of contexts in areas where a determination has been or is likely to be made that native title exists. These include:

- To provide for practical resolution of land use and management issues in a native title context;
- As a framework for compensation applications;
- In order to bypass the right to negotiate provisions of the NTA;
- As an alternative agreement in relation to future acts;
- To facilitate approvals for mineral titles, including prospecting, exploration and mining applications;
- As regional or local agreements which may specify relationships between native title and other parties, including grantees; and
- To operate as framework agreements within which other substantive agreements may be reached.

14 Aboriginal stakeholder arrangements in the West Kimberley

A consistent message from community consultation is the need for developers/proponents to engage with Traditional Owners and community institutions in an inclusive and certain process, sooner rather than later. This chapter suggests processes and a framework of possible agreements between Traditional Owners, project proponents and governments.

Proponents should plan for sufficient project lead times to provide opportunities for Traditional Owners and the proponent to identify each other, develop sound relationships, understand proposed change, understand each other's needs and aspirations and the framework/timeframes to fulfil those aspirations and objectives.

A common vehicle to build relationships and provide certainty in the Kimberley is for Traditional Owners and the developer to conclude an agreement arrangement as early as possible. Proponents should make contact with the Native Title Representative Body, Kimberley Land Council in the first instance.

The process may be a set of agreements recognising the stages and complexity of development such as outlined but not limited to those set out in sections 13.1 to 13.4.

14.1 Exploration or Feasibility Agreement

The scope of this type of agreement may cover such activities as mineral exploration, design and feasibility study surveys including impact assessments.

This agreement may be initiated by the State's stipulation that an exploration licence application will only enter the fast-tracked Expedited Procedure of the NTA if it is accompanied by a heritage survey agreement. This type of agreement would most likely incorporate issues such as a heritage assessment clearing a proposed work program, work area or outlining a clear picture of the ethnographic landscape. A heritage agreement for an exploration tenement would also likely include survey budgets, traditional owner participation, liaison and implementation as well as outlines for consultation.

Traditional Owners and the proponent may take the opportunity to incorporate into such an agreement a process and conditions to streamline the grant of additional similar interests, as an alternate to the formal future act process.

Standard form or model mineral exploration and heritage protection agreements suited to the Kimberley and the traditional owner approach to heritage impact assessment and protection described earlier, have been developed by the KLC over the past years. Whilst circumstances and issues to be negotiated between each traditional owner group and proponent are unique and particular, standard agreements may assist to focus and reduce negotiation costs.

This type of agreement may also be suitable for proponents seeking access to traditional owner land and waters to undertake initial feasibility studies where no statutory interest is required to be granted at that stage.

14.2 Negotiation Protocol Agreement

A negotiation protocol agreement can cover arrangements and issues for negotiating a comprehensive mining or project development agreement between the Traditional Owners and the proponent. In most instances the NTRB (KLC) represents and provides assistance to the Traditional Owners in negotiations; as such it could be expected to be a party to a Negotiation Protocol Agreement.

The scope of a protocol agreement would conceivably include:

- Identifying parties to the comprehensive agreement – such as the inclusion of government parties for the grant of statutory interests and possible public investment requirements in an ILUA;
- Identify resources for negotiation – Traditional Owners will need to be adequately resourced by the proponent to: participate in negotiations, to engage adequate expertise to assist Traditional Owners to make informed decisions and to be properly advised (legal, corporate and technical issues) and to settle agreements;
- Establish negotiation protocols – “rules for talking” – such as where, who, negotiator roles and responsibilities, in-principle approvals and timeframes;
- Define (as far as possible) the issues and principles to be negotiated;
- Define the agreement structure - will an ILUA be registered, are some issues to be comprised in an ILUA whilst other issues are contained in an ancillary agreement; and
- NTRB certification and ILUA registration as required under the NTA.

The Negotiation Protocol Agreement should be seen as an interim document to define and provide a measure of certainty to relationships between Traditional Owners and the proponent whilst a comprehensive long term agreement is made.

Whilst each negotiation protocol will have its own characteristics, proponents should be aware and plan that agreements will take time to conclude. To be practicable, parties should allow at least 12 months when concluding a comprehensive agreement. Registering an ILUA will take a further 6 months for the NNTT process.

Negotiation sessions and meetings should take place at the traditional owner community wherever possible. Whilst a smaller traditional owner negotiating team may lead negotiations, the nature of communal decision-making with ready access to other members of the traditional owner group provides confidence to the team, is more efficient and transparent.

Negotiation time-frames should take account of traditional owner cultural and Kimberley seasonal constraints. Generally it is difficult to conduct business in remote communities during mid-December to end of January because of the “Wet” and cyclone season, holiday period and cultural obligations. Wet season access and cyclone constraints may extend into later months.

14.3 Comprehensive Agreement

As the term suggests, a Comprehensive Agreement would seek to cover all matters relating to the proposed development, operation and exit; as well the commercial and community relationships between Traditional Owners and the proponent to achieve best practice outcomes.

The range of issues in a comprehensive agreement may include: provision for grants of interests (tenure, licences, permits) to undertake the project; participation of Traditional Owners in preparation of feasibility studies and impact (social, environment and economic) assessments; maximise multi-use and access to project and related infrastructure; compensation package; access arrangements; cultural heritage protection and management protocols; community and social development support; maximising training, skills development, local employment and business opportunities, environmental protection and management protocols, liaison and maintaining life-of-project relationships; agreement implementation, timeframes and monitoring; project closure and exit strategy; and dispute resolution.

14.3.1 Maximising opportunities for Indigenous people

Traditional Owners and proponents may seek that some issues identified during the negotiation process require government intervention and possible public investment in programs that support and assist local and regional communities build sustainable capacity, capture and maximise project benefits and address the generally disadvantaged position many Traditional Owner/Aboriginal communities currently face.

An arrangement between stakeholders that should include relevant government agencies (Local, State and Australian as appropriate), the NTRB and relevant Traditional Owner group(s), Kimberley regional TAFE and education agencies, Aboriginal service providers, industry and commerce institutions and proponent(s) may be a means to identify stakeholder interests, establish lead-times, focus, commit, co-ordinate, prioritise and target government expenditure programs, proponent-industry contributions, community and other resources necessary to support local development needs to maximise benefits and opportunities from proposed large scale resource and industrial projects.

A stepped process to take these issues forward strategically could start with a stakeholder meeting/workshop convened by a lead regional co-ordinating agency, resourced by State and Australian Government agencies through relevant training/skills development programs; with objectives of developing a focused skills, employment access and economic opportunity profile, identify issues and gaps; and firm up a standing and committed stakeholder forum to oversee and direct next steps.

The stakeholder forum would fundamentally operate at the strategic and leadership level, providing a whole-of-community focus to maximising opportunity from short to long term industrial development phases.

Follow-on steps would include development and adoption of an action plan, based on realistic short medium and long term needs, targets and monitoring protocols to maximise study area socio - economic outcomes and opportunities with a fundamental goal of addressing imbalances; particularly through skills development and increasing capacity for local participation in both production and services sectors of the economy.

Recruitment of community and institutional leadership to work in cooperation to gain awareness of issues and formally guide, mentor and promote initiatives to improve local capacity will be critical to success. It will be important that community leadership equitably represents rural communities and social organisation. A strong community information, liaison and extension program will need to be resourced in order to build “ownership”, support and sustain momentum over the longer term to achieve planned outcomes

Training, technical and corporate skills development, formal education, health, community and social development, related infrastructure are all programs that are needed to assist Aboriginal people improve socio-economic outcomes and raise capacity necessary to capture and maximise the full range of opportunities and benefits a new phase of industrial development may offer.

The overwhelming common issue put forward by Traditional Owner groups and individuals consulted is the need to prepare young people for project opportunities. Communities seek that “people preparation” runs parallel with technical preparation, so that when a project is ready to be commissioned Kimberley people are in a position to take direct and in-direct employment and business opportunities. A fear is that there will be inadequate local preparation; with proponents turning to recruiting their work force from outside the Kimberley.

Industry offers indigenous people significant opportunities through the development of resources projects. However, any long-term capacity building requires a tripartite effort involving Government, indigenous leaders and industry.

14.4 Coordinating multiple agreements – broad impact, liaison

Development proposals that impact more than one Traditional Owner group and or have a potential for broad impact; a pipeline easement or major industrial/infrastructure project for example, could be expected to require intensive resourcing needs to co-ordinate and manage a streamlined and consistent consultation process. The NTRB (KLC) facilitates co-ordination of potential Native Title interests, consultation and liaison processes on behalf of Traditional Owners in the first instance.

NTRBs derive their powers and functions, in relation to Native Title activities, from the *Native Title Act*. Specifically, NTRBs are funded by the Australian Government to provide professional services to native title claimants and holders in accordance with Part 11 of the NTA. In doing so, they perform the functions set out under s203BK and exercise their powers set out in s203BK of the NTA. Section 203B specifies that NTRB functions include facilitation and assistance, dispute resolution, notification, agreement making and other functions. All of these functions include a future act dimension, and by a process of extension, future act related heritage clearance activities. Identifying an appropriate level of resourcing for NTRBs to provide future act services and how to measure delivery of service is currently being discussed.

14.5 Specific Native Title issues arising from consultation

14.5.1 North Kimberley

The Wanjina Wunggurr Unguu Traditional Owners (Wunambal Gaambera) seek that there be no mining disturbance of Cape Bougainville in the North

Kimberley which they contend has important cultural and natural values. Mining leases to mine bauxite have been granted for many years.

Traditional Owners seek further consultation and that prior to any decision concerning mining within the Mitchell Plateau bauxite temporary reserve that there be strategic assessment of all values and potential of the area including Native Title and cultural heritage interests, bio-diversity, eco-tourism, mineral and other natural resources (carbon credits) and industries, social issues and economic opportunities.

14.5.2 Dampier Peninsula

The community in the One Arm Point area generally supports development that minimises conflict with traditional lifestyles and the developing eco-tourism industry. Any under sea pipelines, easements and landfalls would need to be located so as not to impact Bardi Jawi cultural heritage in the sea and on the land.

14.5.3 Derby area

During consultation, the Shire of Derby-West Kimberley said that it would welcome the opportunity to develop an agreement with Traditional Owners of the Derby area to build a co-operative and consultative relationship, even prior to a Native Title application if that was possible.

Point Torment area

The Shire is aware the Point Torment area has not yet been the subject of a Native Title claim. The Shire is keen to facilitate the inclusion and participation of all stakeholders in a potential development north east of Derby.

It would appear Traditional Owners have not yet made application for determination of Native Title (claim) over their traditional lands and waters in the general region of Meda Pastoral Lease, King Sound and Derby township area.

Nyikina Managala Native Title Claim

The Shire of Derby/West Kimberley reports that it has been negotiating with the Nyikina Managala Native Title Claimant group and the Kimberley Land Council on the Nyikina Mangala People's native title claim over the past 18 months with a view to entering into an Indigenous Land Use Agreement (ILUA). Negotiations between the Shire, the claimant group and the Kimberley Land Council in its capacity as the claimant group's NTRB have progressed in an amicable and co-operative manner to date and the good will between the

parties has resulted in a Memorandum of Understanding (MoU) being executed between the parties as a vehicle to guide the preparation, content and construction of the ILUA.

Since the execution of the MoU, a number of meetings have been held involving all the concerned parties and case managers from the National Native Title Tribunal which focused on the possible content and construction of the ILUA. Negotiations have largely been centred on the Consultation Protocol that would be adopted by the Shire and the claimant group when dealing with various statutory works that are required to be undertaken by the Shire. Primarily, these activities relate to the annual maintenance and repair of roads within the agreement area and also cover the circumstances where new roads may be constructed.

The Council advises that it is hoped that the negotiations will be concluded in the near future and the document can then be considered for inclusion of the Register of Indigenous Land Use Agreements.

14.6 Ways forward

Early and proactive engagement by proponents and governments with Traditional Owner stakeholders and the NTRB (KLC) provides a platform to advance project development and sense of stakeholder ownership.

Time-frames for negotiating native title agreements should be realistic, commenced as early as possible to address specific issues, establish certainty for all parties and build relationships for the long term. Proponents need to plan to adequately resource the native title negotiation processes.

The potential of these major industrial projects should be used as opportunities to develop capacity and improve socio-economic outcomes within the Aboriginal community to address present economic imbalances of the Kimberley economy.

The establishment of a stakeholder forum with a clear objective of driving development of study area human capacity to take industrial phase opportunities to assist removal of imbalances in the study area/regional economy

Native Title Prescribed Bodies Corporate should be recognised as an emerging commercial institutional layer within the Kimberley economy and land administration that needs to function efficiently.

15 Strategies for development

The ultimate scenario and timetable for resources development in the West Kimberley will be dictated by:

- The market for the West Kimberley's commodities, notably LNG, bauxite/alumina, zinc and diamonds;
- For zinc and diamonds, continued exploration success;
- Agreement of Traditional Owners for access to land for development; and
- The economics of project development.

In this context, the principal role of Australian, State and Local governments is to create an environment which encourages and facilitates private sector project proponents to invest, and at the same time ensuring that worthwhile benefits flow to regional communities, the State and the nation. In this regard, priorities for governments should be to:

- Ensure an ongoing positive environment for minerals and petroleum exploration (all levels of government);
- Ensure efficient and effective planning and project assessment and approvals (all levels);
- Facilitate provision of the economic and social infrastructure required to support resources development, and to enable West Kimberley communities to attract and retain the skilled workers required for these projects (all levels);
- Facilitate capacity-building of regional businesses and workers to enable them to participate in project development and operation through supply of goods, services and labour (all levels);
- Cooperate with project proponents and Aboriginal people and organisations to facilitate access to land for development (all levels); and
- Continue to support international marketing efforts for LNG (Australian and State Governments).

15.1 Exploration climate

Australia and Western Australia have generally positive climates for mineral exploration and are judged to be amongst the most attractive destinations for exploration investment. Issues surrounding land access remain of concern to explorers, however.

The West Kimberley, whilst having moderate to very high mineral prospectivity, is relatively under-explored. This principally is due to its remoteness, the high cost of exploration, the short field season due to the Wet

season, and, until recently, the paucity of pre-competitive exploration data compared with other regions of Western Australia. The West Kimberley region has now been highlighted by the Geological Survey of Western Australia (GSWA) as an important area for further assessment by the mineral exploration industry. GSWA has recently completed a number of prospectivity studies and geoscientific programs and has several others in progress. It packages and markets such data to prospective explorers in a bid to attract greater exploration investment to the region.

Access to land has been identified by industry as an issue that inhibits timely exploration and mine development. While relations between Traditional Owners and their representatives and exploration and mining companies have improved markedly in recent times, issues remain, principally relating to the time taken to finalise land access agreements and receive heritage clearances that can, at an appropriate point, outline an area's ethnographic landscape..

Both Traditional Owners and explorers and miners are seeking to improve the way in which they relate and in which agreements can be negotiated and implemented. Numerous agreements now exist between Traditional Owners and mining companies and a standard heritage agreement for exploration is currently being developed.

The State Government is also active in facilitating land access. The Kimberley Development Commission and Kimberley Land Council in 2002 concluded a sustainable development memorandum of understanding for the Kimberley region. This MOU provides the basis for further detailed cooperation on development matters and a basis for involving mining companies, government agencies and local communities in sustainable development activities associated with exploration and mining.

The State Government has taken action to expedite Native Title claim processes and mineral tenement applications in Western Australia as a whole. In 2001 it commissioned a Review of the Native Title Claim Process in Western Australia (the Wand review) and established the Technical Taskforce on Mineral Tenements and Land Title Applications.

The Wand review made some 56 recommendations in September 2001, the majority of which have been addressed by the State Government. In addition, the State Government has approved implementation of three key recommendations of the Technical Taskforce Report.

An ongoing issue is the lack of resources available to Aboriginal people and groups to enable them to engage in discussions and negotiations about access to land and development. In particular, while Native Title Prescribed Bodies

Corporate are an emerging institutional layer, they have very limited financial capability to adequately represent their constituents in negotiations.

Recommendations

1. The Government of Western Australia, through the Geological Survey of Western Australia, should continue to give priority to pre-competitive exploration and data gathering, and to continue to package and market geoscientific information to the mineral exploration industry to encourage explorers to give the region high priority for investment.
2. Further development of relationships between the petroleum and mining industries and companies, and Aboriginal peoples and organisations should be facilitated through early and proactive engagement by proponents and all levels of government with Traditional Owner stakeholders and the Kimberley Land Council to provide a platform for successful project development and a sense of stakeholder ownership.
3. Project proponents should plan realistic time-frames for negotiating native title agreements, and should commence discussions as early as possible to address specific issues, establish certainty for all parties and building relationships for the long term.
4. Native title negotiations and heritage clearances should be facilitated through cooperation between companies, governments, traditional owner groups and the Kimberley Land Council to ensure that Aboriginal people and organisations have adequate resources and capacity. Native Title Prescribed Bodies Corporate need to be recognised as an emerging commercial institutional layer within the Kimberley economy and land administration that needs to be resourced and to function effectively.

15.2 Support for gas marketing

Both the Australian and State Government give support to LNG marketing efforts. Government-to-government relationships and demonstrations of government support for the private sector are crucial in negotiation of sales agreements with Chinese customers. Such support is also important in other markets, including the US, Japan and Korea.

Recommendation

5. The Australian and State Governments should cooperate with project proponents to provide support for marketing of Browse Basin gas.

15.3 Planning, and project assessment and approvals

As noted in Section 3.9, numerous development, conservation and infrastructure planning processes are underway in the West Kimberley, including this study. Most do not appear to be coordinated with others – either within or between the different tiers of Government. The outcomes of some may even be at odds with the outcomes of others (eg biodiversity planning that does not take account of current and future land use needs and vice versa).

The goal of all such processes should be to achieve sustainable outcomes that enjoy strong community support. Such processes should also use scarce government, industry and community resources efficiently (eg they should not be duplicative or repetitive).

Government approvals processes are prominent amongst the issues identified by project proponents when considering investment. Australian and Western Australian processes are regarded as being relatively efficient. However, as the Western Australian Government's Keating Review of approvals highlighted, there is scope for improvement, particularly in relation to intra-government co-ordination and timelines.

Proponents of projects that require both Australian and State Government approvals have reported some lack of coordination between the two. Agreement was recently reached between the Australian and Western Australian Governments for accreditation of State environment assessment processes, which should enhance cooperation between Australian and State Government agencies.

Approvals and administration of petroleum permits and licenses is already well coordinated between governments.

Implementation across the Western Australian Government of most of the 56 recommendations of the Keating Review will reduce complexity and enhance coordination between State approvals agencies.

Approvals processes needs to be constantly monitored by governments and changes made as required to ensure that the processes are efficient, timely and have the confidence of the community.

Local Government too needs to ensure that its planning and development approvals processes and resources are adequate to deal with the needs of major projects.

Recommendations

6. Current and future planning processes and programs in the West Kimberley should be coordinated:
 - Within each level of government through coordination of the activities relevant departments and agencies;
 - Between Local, WA and Australian Governments to ensure coherence of programs and outcomes.
7. Australian, WA and Local Governments should continue to work to ensure that their own project assessment and approvals processes are effective and efficient, and well co-ordinated between government agencies.
8. Australian and WA Governments should continue to improve inter-government coordination of assessment and approvals processes to reduce complexity and duplication.

15.4 Economic and social infrastructure

Potential project developers have identified infrastructure as a vital prerequisite for investment, along with more the approvals requirements discussed above.

A recent report to the Government of Western Australia³⁹ identified some problems with approaches to infrastructure policy and practice in Australia:

- Policies are inconsistent and in some cases incompatible between the Australian and Western Australian Governments;
- The Australian and Western Australian Governments do not have comprehensive, whole-of-government infrastructure policies to provide frameworks for infrastructure priorities and provision; and
- Infrastructure policies are not integrated with economic development policies.

The State Government has committed to development of a State Infrastructure Strategy with a key objective of state economic development within a sustainable development framework.

The Australian Government has a number of policies and programs that deal with infrastructure, including:

- The *Auslink: Building our National Future* White Paper (land transport and infrastructure framework). Auslink is designed to achieve better national land transport infrastructure planning, funding and investment decision-making into the future;
- The Australian Government Department of Transport and Regional Services provides funding to the Kimberley Region under its Sustainable

³⁹ Technology and Industry Advisory Council, *Initiating and Supporting Major Economic Infrastructure for State Development: Opportunities for Government*, September 2004

Regions Programme. Provision of regional infrastructure is the highest of the Kimberley's regional priorities. Funding has been provided for projects such as the Broome Port and the Derby Aerodrome and is being considered for the Derby Wharf.

- *Securing Australia's Energy Future* White Paper (energy policy including energy infrastructure); and
- The Strategic Investment Coordination mechanism administered by Invest Australia.

However, the policies and programs described do not constitute a fully coordinated approach to infrastructure policy.

Recommendations

9. Australian, WA and Local Governments should cooperate to develop a coordinated approach to infrastructure provision in the West Kimberley, including mechanisms for cooperation between governments and between the public and private sectors, to provide a framework to enhance the region as an attractive location for investment in major projects.
10. The WA Government, in consultation with Local Government should expedite development of a comprehensive, whole-of-government State Infrastructure Strategy with a key objective of identifying specific priorities for the allocation of resources to infrastructure projects over the long-term. Key elements of this policy should include:
 - Mechanisms to ensure that the mix of infrastructure throughout the State is complete, competitive and timely to support the State's key industries;
 - Identification and prioritisation of future infrastructure requirements in relation to transport, telecommunications, energy, water, industrial land, ports and related soft infrastructure (eg, Native Title and heritage clearances, training, skilled people and services);
 - Integration of the provision of all classes of social and economic infrastructure in support of development;
 - A consistent, integrated and systematic evaluation process to prioritise the assessment, planning and delivery of infrastructure;
 - Policies for government and non-government involvement, and mechanisms to identify opportunities for involvement of private sector and government business organisations;
 - Mechanisms to assess relative costs and benefits of infrastructure on a case-by-case basis; and
 - Implementation plans and regular reviews.
11. As a subset of the State Infrastructure Strategy, the WA Government, in cooperation with industry and other levels of government, should develop a West Kimberley Infrastructure Plan and this plan should be refined as

potential resource development projects in the region become better defined.

- Within this plan, opportunities for a strategically located gas processing hub should be enhanced by forward planning for a location, and setting aside a suitable site for a heavy industrial estate.

15.5 Facilitating pipeline investment

The proposed Transcontinental Pipeline and associated regional pipelines will require investment by private sector proponents in excess of \$3 billion. The recent report of the Productivity Commission review on the Gas Access Regime for pipelines found that the current gas access regime, while generating benefits, has significant costs including a potential to distort investment. The Commission considered that the Gas Access Regime is likely to distort investment in favour of lower risk projects. This could result in a greater reliance than otherwise on building capacity that is essentially fully contracted, expanding capacity incrementally and delaying pipeline construction until forecast demand is more certain. To reduce the potential chilling effect of regulation on greenfield pipeline investments, the Commission proposed that there be scope in the Regime for a binding ruling of 'no coverage' for 15 years, on a case-by-case basis. The Commission also recommended that a less costly, monitoring option be available, with the choice between price regulation and monitoring for each covered pipeline being based on which was assessed as generating the greater net economic benefits. Price regulation would only apply when the net benefits would be markedly greater than those of the monitoring option.

The Commission made several other recommendations aimed at improving the efficiency of gas pipeline regulation.

Recommendation

12. The Australian, WA and Northern Territory Governments, through the Ministerial Council on Energy, should consider the recommendations of the Productivity Commission report on gas pipeline regulation as part of their efforts to enhance the investment climate for pipeline investment.

15.6 Participation of regional businesses and workers

Businesses and the workforce of the West Kimberley have adequate capacity to service the current level of economic activity in the region. While the region has a reasonably healthy economy, it is unbalanced, many in the Aboriginal population participating only at the margin.

The development of the resources sector will represent a step change in the demand for goods, services and workers, in terms of both volume and types of requirements. There is an opportunity to utilise the potential of major industrial projects as catalysts to develop capacity and improve socio-economic outcomes in the West Kimberley and in particular within the Aboriginal community to address present economic imbalances of the Kimberley economy.

Regional communities and especially Aboriginal communities within them have limited ability to respond to such business and employment opportunities. This can lead to substantial opportunities forgone if projects are supplied mostly from outside the region. Communities often need encouragement, capacity-building and assistance to take full advantage of these opportunities.

Argyle Diamonds has an explicit localisation policy that facilitates and actively promotes the participation of local communities in different aspects of its operations near Kununurra.

Recommendations

13. At an early stage of planning specific projects, industry, local communities and all levels of government should co-operate to:
 - Predict the requirements for goods, services and workers that may be able to be sourced from within the region;
 - Develop workforce training programs;
 - Implement business capacity-building programs; and
 - Implement programs to develop community capacity to engage with projects.
14. Within Australian Industry Participation Plans, project proponents should include measures to facilitate regional business participation in projects.
15. Local, WA and Australian Governments should give particular attention to mechanisms that facilitate greater participation by Aboriginal people and businesses in the mainstream economy, for example, through
 - Education and workforce training programs;
 - Support for Aboriginal businesses; and
 - Aboriginal employment programs.

15.7 Planning for implementation

This report recommends a range of actions that should be taken to facilitate resources development and to maximise the regional benefits accruing. As

with other Regional Minerals Studies, the usefulness of this study will be dependent on if, when and how the recommendations are implemented.

Action organisations encompass Commonwealth and State Government agencies, local government, regional businesses and business groups, exploration and mining companies, and Aboriginal organisations.

Following acceptance of this report by sponsor organisations and its endorsement by Local, State and Australian Governments, an action plan, based on the recommendations, should be developed and implemented.

The State Government should lead implementation, which will require the close cooperation of all stakeholders.

Recommendation

16. Local, WA and Australian Governments should co-operate to develop a plan and multi-stakeholder process for consideration and implementation of the recommendations of this study, in particular the recommendations on a cooperative approach to planning for and provision of infrastructure (see recommendations 9 and 10).

A Consultation list

Table 38 Stakeholder consultation list

FIRST NAME	SURNAME	POSITION	ORGANISATION
Chris	Adams*	Chief Executive Officer	Shire of Wyndham - East Kimberley
Dale	Andres	Project Manager	Teck Cominco
Mike	Allen	Director Strategic Planning and Policy	Department for Planning and Infrastructure
Marcelle	Anderson	General Manager	Aldoga Alumina Smelter Pty Ltd
Andrew	Andrejewskis*	Director, Oil and Gas	NT Government
Elsia	Archer	President	Shire of Derby - West Kimberley
Kelvin	Barr	Assistant Director	Kimberley Development Commission
Barry	Court*	President	Pastoralists and Graziers Association
Peter	Danchinto*	Managing Director	Kimberley Diamonds
Glen	Dillon		Epic Energy
Andrew	Duffield*		Main Roads WA - Kimberley
John	Durant	Executive Officer	Kimberley Area Consultative Committee
Alan	Flavelle*	Director Technical	Kimberley Oil
Andrew	Freeman	Manager - Project Development and Marketing	Santos
Stefan	Frodsham	Chief Executive Officer	Broome Port
Andrew	Gasimer		Teck Cominco
Ted	Graham	General Manager Development	Mermaid Marine
Terry	Hambleton		Water Corporation
Mark	Johnston*	Kimberley Aquaculture Development Officer	WA Department of Fisheries
Seth	Johnson*		Department of Environment (Water and Rivers)
Ron	Johnston	President	Broome Chamber of Commerce and Industry
Sean	Kildare	External Affairs Advisor	Inpex Browse Ltd
Don	Langdon	Finance and Administration Manager	Port of Broome
Andrew	Leibovitch	Browse Business Development Manager	Woodside Petroleum Ltd
John	Logan*	Chief Executive Officer	Western Agricultural Industries
Michael	MacDermid*		BHP Billiton
	*	Project Manager	West Kimberley Power Project
Reith	MacLeod	Manager	Broome International Airport
	*	Regional Manager	WA Tourism Commission - Kimberley

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Dan	Matich	Tenement Manager	Aztec Resource
David	McArthur*		Ellendale Resources
Richard	Mehan	General Manager Iron Ore	Portman Ltd
Kingsley	Miller*	District Manager	CALM
Andy	Munro	Manager External Affairs	Rio Tinto
David	Parker	Director, External Affairs	CME
Kevin	Pettingill	Executive Manager Technical Services	Shire of Derby - West Kimberley
Peter	Price*	District Manager	Department of Agriculture
Pauline	Ray	Manager, Property Services	Department of Defence
Tim	Reynolds	Principal Advisor, Strategy	Epic Energy
Don	Sanders	Director WA and NT	APPEA
Bill	Sashegyi	Director Industry Policy	Chamber of Commerce and Industry
Wayne	Spilsbury*	Managing Director	Teck Cominco
Larry	Sutton*	Power Stations Supervisor, Broome Power Station	Western Power
Grant	Stacy	Project Manager	Western Power
Mike	Sutton	Operations Manager	Henry Walker Eltin
Jonathan	Throssel	Chief Executive Officer	Shire of Derby - West Kimberley
Tom	Vinnicombe	President	Shire of Broome
Bevan	Warris*		Empire Oil
Jake	Zahl	President	Derby Chamber of Commerce
Wayne	Bergmann	Executive Director	Kimberley Land Council
Frank	Davey		
Joe	Davey	Traditional Owners	Bardi Jawi Traditional Owner Group
Paul	Sampi		
Andrew	Carter	Chairperson	Ardyloon Council One Arm Point
Cherise	Carter	A/Chief Executive Officer	Ardyloon Council One Arm Point
Mary Anne	Doyle	Chairperson	Djarindjin Community
Peter	Sibasado	Chief Executive Officer	Djarindjin Community
Carolyn	Sibasado	Chairperson	Lombadina Community
Debby	Sibasado	Administrative Officer	Lombadina Community
Joan	Lane	A/Chief Executive Officer	Beagle Bay Community
Mark	Stevens	Regional Manager	Office of Aboriginal Economic Development
Jeremy	Elliott	Regional Manager	Dept of Indigenous Affairs
Maria	Mann	CoOrdinator	Environs Kimberley
Mark	Manado	Aboriginal Development Officer	Kimberley TAFE Broome
Executive Members			
Joe Ross - Chairperson		Governing Committee	Bunuba Inc.
Harry	Lenard		
Nathan	Lenard	Traditional Owners	Warrawa - Derby
Patricia	Juboi		
Councillors			
Darryl Williams – Chairperson		Community Council	
Wayne Howard		Chief executive Officer	Kalumburu Aboriginal Corporation

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Governing Committee Traditional Owners
Dianna Williams - Chairperson
Nita Marshall
Dwayne McMahon Traditional Owners
Donny Woolagoodja, Janet
Oobagooma, and others Traditional Owners

Wunambal Gaambera Aboriginal Corporation and WW Uunguu NT Claim Group

Karajarri Traditional Owner Group
Wanjina Wunggurr Dambimangari
Traditional Owner Group

Note: * consultation via questionnaire

B Glossary

Table 39 **Glossary of acronyms and abbreviations**

ABARE	Australian Bureau of Agricultural and Resource Economics
ADB	Asian Development Bank
AHD	Australian Height Datum: A standardised base height used Australia-wide
CALM	Conservation and Land Management
CDEP	Community Development Employment Program
CDMA	A digital mobile phone technology
CME	Chamber of Minerals and Energy
CNG	Compressed Natural Gas
CSG	Coal Seam Gas
DBNGP	Dampier to Bunbury Natural Gas Pipeline
DLI	Department of Land Information
DME	Di-methyl ether
DOIR	Department of Industry and Resources
domgas	Gas for domestic use
DPI	Department of Planning and Infrastructure
DWT	Dead Weight: measures weight of ship including cargo (tonnes)
EPA	Environmental Protection Authority
EPBC Act	Environmental Protection and Biodiversity Conservation Act (Commonwealth)
FIFO	Fly-in Fly-out
FLNG	Floating Liquefied Natural Gas
GBE	Government Business Enterprise
GDP	Gross Domestic Product
GSM	A digital mobile phone technology
GSWA	Geological Survey of WA
GTL	Gas to Liquids (Synthetic petroleum liquids)
Ha	Hectare
HDD	Horizontal Directional Drilling
HHV	High Heating Value (a standard at which energy potential is measured)
HV	High Voltage
ILUA	Indigenous Land Use Agreement
DITR	Department of Industry, Tourism and Resources
KAAC	Kimberley Aquaculture Aboriginal Corporation
KLC	Kimberley Land Council
LNG	Liquefied Natural Gas
LOA	Length overall: Maximum allowable length
LPG	Liquefied Petroleum Gas
MOU	Memorandum of Understanding
MRWA	Main Roads WA
Mtpa or Mta	Millions of tonnes per annum
MW	Mega (million) Watts
NNTT	National Native Title Tribunal
NTA	Native Title Act
NTRB	Native Title Representative Body
OECD	Organisation for Economic Cooperation and Development
PBC	Prescribed Body Corporate
PJ	Petra joule (equivalent to 18,200t of LNG)

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RAAF	Royal Australian Air Force
RL	Reduced Level: The height of a point above the Australian Height Datum
RNTBC	Registered Native Title Body Corporate
TAFE	Technical and Further Education
Tcf	Trillion cubic feet
TOs	Traditional Owners
tpd	Tonnes per day
