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Alcan Gove Alumina Refinery Third Stage Expansion

Notice of Intent

March 2003

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Background

This Notice of Intent has been prepared for submission to the Northern Territory Government by Alcan Gove as the initial notification of a proposal to expand the existing alumina refinery at Gove Peninsula, Northern Territory. It is submitted in accordance with the requirements of the Northern Territory's *Environmental Assessment Act 1982* and the *Environmental Assessment Administrative Procedures 1984*.

The proponent for this project is Alcan Gove Pty Limited a wholly owned subsidiary of Alcan Inc (Alcan).

The operations are located on the Gove Peninsula in the north-east of Arnhem Land in the Northern Territory. They consist of a bauxite mine and a refinery which converts the bauxite into alumina. The alumina from Gove is exported from the refinery to aluminium smelters around the world. The operations currently employ 1,100 people who live in Nhulunbuy, a town with a population of 4,000.

Proposed Expansion

The refinery's expansion project will increase total production of alumina from 2.0 mt/a to 3.5 mt/a. Alcan's objective for the expansion is to sustain its internationally competitive alumina position and have a positive impact on environment performance.

All new plant and equipment to be installed as part of the expansion will be located within the footprint of the existing operations. There is no requirement to use any land outside the existing lease areas.

While the existing mining rate will increase, no significant change in mine plan is required to extract the increased tonnage. The crushing facility at the mine site will be modified to improve availability and capacity. The speed of the conveyor from the mine to the refinery will also increase.

Increased refinery production will be achieved by installing new process equipment which will integrate into the existing refinery process. As well as the new process equipment, an additional power station boiler to supply steam and electricity will be installed. Consideration is also being given to the installation of a liquor purification process designed to reduce the organic impurities in the residue to enable maximum recycling of caustic liquor. This will only be implemented if all appropriate environmental and health guidelines can be met.

The alkaline residue from the refinery is currently disposed of in containment ponds at the residue disposal area. Plans are currently being developed to neutralise some of the alkaline waste water and red mud before disposing of it in the containment ponds. The waste water from the neutralisation process will be saline but suitable for discharge to the marine environment. In this way the inventory of water stored in the residue disposal area can be progressively reduced and the quality of the marine discharge will be improved.

Because of the increased rate of mud disposal required as a result of the expansion, the capacity of the existing disposal facility is expected to be reached by about 2015. Prior to that time, detailed studies into

future residue disposal and drainage discharge options will be undertaken and a separate government approval will be sought for any new disposal area.

The expansion design will incorporate sufficient flexibility for the refinery to burn either fuel oil or natural gas. Negotiations are currently under way to secure natural gas supply to the plant. Fuel oil will continue to be burned until natural gas becomes available, with appropriate controls to achieve acceptable air quality.

The expansion will increase the refinery's demand for water. Demand management will be implemented with the aim of remaining within the supply capacity and licence limits of the existing borefield. If demand management alone cannot ensure adequate water supply, other options will be identified.

The construction phase will extend for 33 months. At its peak there will be an estimated 1,220 construction workers. These workers will be accommodated in a self-servicing construction camp to be developed in Nhulunbuy South. Changes to the operational workforce will be determined during the design phase.

Effects of the Expansion

The environmental effects of the expansion project have yet to be studied fully and Alcan will produce a detailed assessment of all relevant aspects in the environmental assessment report. This report will be in the form of an Environmental Impact Statement prepared in accordance with the requirements of the Northern Territory Government.

Even though the studies are not yet complete, it is possible to identify positive benefits to the environment from the expansion. These include:

- Installation of the Alcan double digestion process will ensure the optimum amount of alumina is extracted from the bauxite and that lower grade bauxite can be processed. This will result in a 10% improvement in alumina extraction per tonne of bauxite mined and, as a result, an extension of the mine life.
- The improved digestion will also result in a 25% reduction in residue produced per tonne of product.
- With liquor purification there will be 25% less caustic consumption and a 75% reduction in soluble caustic waste per tonne of alumina produced.
- There will be a 5% reduction in energy consumption and a reduction in greenhouse gas emissions per tonne of product
- Once the natural gas supply becomes available, there will be a substantial reduction in sulphur dioxide emissions and combustion particulates as well as a further reduction in greenhouse gas emissions. Appropriate control measures will be taken to ensure acceptable air quality is achieved if the supply of natural gas is delayed.
- There will be no significant increase in ship movements after completion of construction.

Executive Summary

Table 1 summarises the main components of the existing refinery and how they will be affected by the expansion project. The significant environmental advantages from the various components of the expansion have also been summarised.

Table 1
Summary of Expansion Effects

Component	Existing Refinery	Expanded Refinery
Mine		
Production	Bauxite – 6.5 Mtpa, open pit. 1.8 Mtpa is exported	Bauxite – 8 Mtpa, open pit No change to existing mining and rehabilitation practices. No bauxite is exported.
Refinery		
Production	Alumina – 2.0 Mtpa	Alumina – 3.5 Mtpa
Digestion	Low temperature digestion	High temperature double digestion (all stages). <i>10% improvement in alumina extraction and 25% less residue per tonne of alumina</i>
Mud Separation	Multi-stage thickeners	Alcan high rate decanters plus conversion of existing thickeners to additional washers
Evaporation	Multi-stage evaporation plant with seawater cooling.	Additional multi-stage evaporation plant with closed circuit cooling (stage 3 only) <i>No direct seawater/process contact</i>
Precipitation	Multiple precipitation tanks with two stage cooling and cooling towers	Additional multiple precipitation tanks and cooling tower
Classification and Filtration	Hydrocyclone classification and vacuum filtration	Additional hydrocyclone classification and vacuum filtration
Calcining	Rotary calciners (4), stationary calciner (1)	One existing and two stationary bed calciners with rotary calciners on standby (all stages) <i>Less energy consumption and improved dust control</i>
Impurities Removal	Organic impurities purged to residue disposal area	Liquor purification (all stages) <i>Organic impurities destroyed in purification process with 25% less caustic consumption and 75% reduction in soluble caustic concentration in the residue.</i>
		Alternative Scenario No liquor purification if environmental and health guidelines can not be met during trials. Organic impurities purged to residue disposal area as at present.
Power Station	Three pressure boilers and turbines with fourth to be installed this year	Four existing and one new high pressure boiler and turbine
Fuel	24 PJ of 3.5% sulfur fuel oil	40 PJ of natural gas (all stages) <i>Minimal sulfur and particulate emissions</i>
		Alternative Scenario If gas supply delayed, continue with 3.5% sulfur fuel oil until gas available with interim SO ₂ control by fuel switching

Executive Summary

Component	Existing Refinery	Expanded Refinery
Residue Disposal		
Red Mud Storage	Dry stacking of alkaline red mud in containment dams	Dry stacking of red mud to continue. The current inventory of stored water in the containment dams to be depleted along with the progressive introduction of neutralised red mud. Once the capacity of the existing containment dams is reached (approx 2015), a new containment area will be required. Investigations and separate approvals for new containment dam locations to be sought. <i>Neutralised runoff from containment dams suitable for direct discharge to marine environment to become available progressively.</i>
Red Mud Water Management	Stored in dams with a limited amount neutralised and discharged to the marine environment	Water stored in dams until inventory depleted by expanded neutralisation facility (all stages). Elimination of the long term storage of caustic liquor
Air Emissions		
Combustion	SO ₂ , NO _x , and particulate emissions	SO ₂ and particulates virtually eliminated with gas (all stages). Low NO _x burners (stage 3). Particulates from calciners significantly reduced (all stages).
		Alternative Scenario SO ₂ and particulates from oil combustion continue for interim period until gas is available. Emissions controlled by fuel switching
Liquor Purification	No emissions	Emissions from liquor purification plant controlled by scrubber and thermal oxidiser if necessary (all stages)
		Alternative Scenario No liquor purification if environmental and health guidelines not met during trials.
Water		
Caustic to Ground	Thickener cleaning practices can result in caustic material placed on ground	Existing thickeners converted to red mud washers and new thickeners will minimise placing caustic materials on the ground (all stages) <i>Significantly reduces the potential of caustic seeping to the groundwater from the thickeners</i>
Marine Discharge	Discharge to Melville Bay of cooling water from the evaporation process, some runoff from the residue disposal area that has been neutralised, stormwater from the refinery and other minor waste streams	Discharge to Melville Bay to continue but cooling water will first be used to neutralise refinery effluent and subsequently red mud before being settled and then discharged. Progressively all of the runoff from the residue disposal area will be neutralised and discharged. Stormwater and other minor waste streams will be a controlled discharge.
Water Supply	Borefield extraction within existing licence conditions for refinery and town	Higher demand to be managed to remain within existing licence limit
		Alternative Scenario If modelling indicates the licence limit cannot be met, additional borefield will be identified
Shipping		
Ship Movements	Export of bauxite, alumina and hydrate. Import of fuel oil, limestone and caustic soda	Bauxite export will cease. Fuel oil imports will cease (apart from occasional delivery of backup supplies). Alumina exports will increase. Gas provided by pipeline. No significant increase in shipping movements except for construction.

Executive Summary

Alcan Gove will comply with the indicative timeframes outlined in the NT Government guidelines for Environmental Impact Assessment. Table 2 provides a general indication of key milestones based on the current schedule.

Table 2
Environmental Assessment Schedule

Action	Expected Completion
Submit NOI to NT Government and Referral to Commonwealth Government	March 2003
Submit Environmental Assessment	September 2003
Approval and Conditions Issued by Government	March 2004

1.1 General

This Notice of Intent has been prepared for submission to the Northern Territory Government by Alcan Gove as the initial notification of a proposal to expand the existing alumina refinery at Gove Peninsula, Northern Territory. It is submitted in accordance with the requirements of the Northern Territory's *Environmental Assessment Act 1982* and the *Environmental Assessment Administrative Procedures 1984*.

The purpose of this document is to present an outline of the proposed alumina refinery expansion to the Northern Territory Office of the Environment and Heritage so that a determination can be made on the appropriate level of environmental assessment for the project and so that relevant guidelines can be prepared.

1.2 Proponent

The proponent for this project is Alcan Gove Pty Limited, the operator of the bauxite mine and alumina refinery at Gove. Alcan Gove Pty Limited is wholly owned by Alcan Inc (Alcan).

Alcan is the parent company of an international group operating in many aspects of the aluminium and packaging industries. Alcan has 48,000 employees in 38 countries where it successfully operates bauxite mines, alumina refineries, aluminium smelters and aluminium semi-fabrication, and packaging. Alcan's shares are traded internationally and are listed on the New York, Toronto, London, Frankfurt and Swiss stock exchanges. Further details can be obtained from the Alcan website www.alcan.com.

Alcan operates under a policy which requires excellent environmental performance at all of its operations through continual improvement of awareness, understanding and performance. A number of guiding principles support this policy.

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1.3 Project Background

The existing Alcan Gove operations consist of a bauxite mine and refinery which converts the bauxite into alumina. Alumina is an intermediate product in the manufacture of aluminium. The alumina from Gove is exported from the refinery to aluminium smelters around the world.

The operations are located on the Gove Peninsula in the north-east of Arnhem Land in the Northern Territory (Figure 1). Detailed exploration of the area began in 1965 and a Joint Venture agreement was signed in 1969. Alumina production commenced in 1972. Since then, over 147 million tonnes of bauxite have been mined and 37 million tonnes of alumina have been produced and exported. The operations currently employ 1,100 people who live in Nhulunbuy, a town with a population of 4,000 which was built to support the project and which is still mainly populated by company personnel.

The refinery's current production of alumina is 1.9 million tonnes per annum (mt/a). An optimisation program is currently being undertaken which will increase its production to 2.0 mt/a by improving the efficiency of existing equipment and technology improvement programs. The proposed expansion which is the subject of this Notice of Intent is termed the Stage 3 Expansion because it will add a 3rd Stage to the current two-stage operation. This will increase the refinery's capacity from 2.0 mt/a to 3.5 mt/a.

The expansion will enable Australia to participate in satisfying increasing world demand for alumina and aluminium and will thereby increase export income for the country. At a local level, the benefits of the expansion will include increased business opportunities and self-reliance leading to more growth and investment in the region.

The expansion project will include the installation of new plant and equipment to increase the existing capacity and to improve the efficiency of some of the existing facilities. This will take place within the existing plant boundaries.

In the long term, around 2015, additional land will be required for residue disposal. This will be foreshadowed in the environmental assessment but a separate approval will be sought for this aspect once planning studies have been undertaken.

2.1 Overview

The existing operations consist of the following main components:

- Mine
- Refinery
- Residue Disposal
- Port

Bauxite is mined from a laterite deposit that is approximately 3.5 m deep and is overlain by less than 1 m of topsoil. The location of the mine is shown in Figure 1. At the mine the bauxite is crushed and conveyed to the refinery.

At the refinery some of the unprocessed bauxite is delivered to export ships but most of it is processed in the refinery. Some of the refinery's production is hydrated alumina but the majority of the production is calcined to produce alumina.

Refinery wastes consisting mainly of alkaline bauxite residue are disposed of in a dedicated disposal area.

A port operation supports the entire Gove site having unloading facilities to receive bulk materials to support the mine and refinery operations with the major of these components being fuel oil and caustic soda. The major materials despatched from the port are bauxite and alumina. A minor quantity of hydrated alumina is also shipped from the port. The majority of all material shipped is exported to overseas ports. Most of the minor materials required to support the operations are received at a private wharf from barge services.

Utility services that support the refinery operations include a water supply that is recovered from an underground aquifer located under the bauxite mine and is then pumped to the mine, the refinery and to the township. A steam power station located at the refinery supplies steam and air for the refining process as well as electricity to the refinery, the mine, Nhulunbuy and the surrounding communities.

The Nhulunbuy township provides accommodation for the majority of the workforce of the operations with the majority being permanent residents of the town. Most people movement into and out of the site is by commercial aircraft that use Gove airport. However, during the dry season the site can be accessed by road via Katherine.

2.2 Mining Operations

The major components of the mining operation are described below.

2.2.1 Mining

Bauxite is mined using conventional open-pit mining techniques. The ore is ripped by large bulldozers and then loaded by front-end loaders into dump trucks for transport to the crushing plant. On average, approximately 130 ha are mined each year with a similar area rehabilitated. Mining operations do not involve the use of explosives.

2.2.2 Crushing and Screening

The crushing plant reduces the size of the ore to below 25 mm. Crushed ore is transported to the refinery via a 19 km overland conveyor system.

2.2.3 Rehabilitation

Alcan Gove's mine rehabilitation involves the restoration of the natural environment in areas where mining has ceased. This program is conducted through close consultation with and assistance from the traditional landowners of the area.

Mining commenced in 1971 and since that time 3,295 hectares have been accessed and 2,413 hectares have been rehabilitated. The remaining area is currently used for active mining, roads, crushing plant and facilities and will be rehabilitated progressively or upon closure.

2.3 Refinery Operations

2.3.1 General

The major components of the refining operations are described below. An overview of the refining process is shown in Figure 2.

2.3.2 Bauxite Stockpiles

Bauxite conveyed from the mine is stockpiled, blended and recovered using rotating barrel reclaimers.

2.3.3 Grinding and Digestion

Bauxite is fed into a grinding mill together with caustic liquor recycled from the process to produce bauxite slurry. The ground bauxite slurry is then mixed with hot recycled caustic liquor and passed through a series of digestors to extract alumina. The slurry then passes through a series of flash tanks that reduces the temperature by allowing steam to 'flash off'. Heat is recovered from this steam to reheat the caustic liquor fed into the digestors. The resultant condensate is recovered for washing processes.

2.3.4 Residue Separation, Filtration and Washing

Undissolved impurities from the digestion process are separated from the alumina rich caustic liquor in a desanding gravity separation process to remove coarse sand residue and then in large settling tanks called thickeners to remove the fine mud residues. Polymer or flocculent is added to assist the thickener settling process. An alumina rich turbid over-flow liquor is pumped to filters, which remove any remaining residue mud and this is then termed pregnant liquor.

Supernatant waters from the residue disposal area are returned to the refinery for re-use in the residue washing process. To recover caustic soda, red mud waste is washed using recycled condensate in a counter-current washing process in large settling tanks called mud washers before the final washed mud is thickened to high-density and is pumped to the residue disposal area.

As part of the desanding operation, residue sand is washed in rake classifiers to recover caustic soda. The washed residue sand is then pumped to a dedicated sand handling plant where it is slurried with some of the recycled residue area water for pumping to the residue disposal area.

2.3.5 Precipitation

Pregnant liquor is then cooled and seeded with hydrated alumina, commonly called hydrate. The precipitation of further hydrate occurs in precipitation tanks under carefully controlled conditions.

2.3.6 Classification and Filtration

Hydrate classification separates the precipitation slurry into three hydrate grades called product, fine seed and coarse seed. Each hydrate fraction is filtered to remove filtrate liquor, commonly called spent liquor that is recycled to evaporation. The product hydrate is washed and filtered again to remove any caustic, then conveyed to calcination processes. The coarse seed is recycled back to precipitation whilst the fine seed is washed and refiltered prior to recycle back to precipitation.

2.3.7 Calcination

Product hydrate or aluminium hydroxide is passed through oil-fired calciners where temperatures up to 1100°C drive off the chemically bound water to form alumina. The area has four rotary kilns and one stationary calciner to perform the calcining function. The alumina leaving the calciners is cooled and stored in silos prior to shipment.

2.3.8 Evaporation

The evaporation plant removes water from the recycled spent liquor to produce strong caustic liquor suitable for re-use in digestion. The water evaporated from the liquor is condensed and re-used in washing aluminium hydroxide produced from the precipitation process and also in the washing of coarse

sand and mud residue wastes. The evaporation processes utilises seawater extracted from Melville Bay for cooling.

2.4 Residue Disposal

2.4.1 Residue and Water Management

The major solid waste from the refinery is the residue left after the alumina is removed from the bauxite. It consists of chemically inert components (eg. haematite, silica) which have passed through the process unaltered. However it is alkaline because of the remnant caustic from the refinery process and therefore needs to be disposed of carefully. The coarse residue sand (13% of the total residue) is stored in stockpiles for future use (once neutralised) as a capping material for pond rehabilitation. The balance which is finer red mud is disposed of in containment dams at the residue disposal facility.

Until 1992, the residue was disposed of as low density slurry into clay-lined ponds located to the east of the refinery. In recent years residue disposal has been improved considerably by adopting dry stacking methods that result in a more stable and easily rehabilitated residue and require less land. The location and major components of the residue disposal facility are shown in Figures 3 and 4.

Most of the alkaline runoff water from the residue containment dams is returned to the refinery for use in the red mud washing process. The balance is neutralised with seawater at the residue disposal area where most of the contaminants precipitate as solids waste whilst the overflow is discharged to the marine environment.

2.4.2 Residue Revegetation

A long range decommissioning plan has been developed for the residue disposal facility. On-going revegetation is being undertaken and a dedicated revegetation research area has been set aside to allow long-term revegetation performance to be monitored.

To date, two red mud ponds have been de-commissioned and revegetated.

2.5 Ancillary Services

2.5.1 Fuel Type

The fuel currently used at the refinery and the power station is 3.5% sulfur fuel oil.

2.5.2 Electricity and Steam

Energy for the refinery is provided by an oil-fired co-generation power station that produces steam and electricity for the process and supplies electricity to the mining and refinery operations, Nhulunbuy town and nearby communities.

2.5.3 Water Supply

The water supply for the refinery, mine and Nhulunbuy is sourced from licensed bores located at the mine area. The bores extract water from an aquifer in the mining area. This aquifer is localised and does not extend as far as Nhulunbuy or the refinery or residue disposal areas.

2.6 Port Facilities

The Alcan Gove port is situated on both sides of Dundas Point in Melville Bay. The bay area adjacent to these facilities is referred to as Gove Harbour. An alumina and bauxite export ship-loading terminal is located on the north side of Dundas Point adjacent to a fuel and caustic soda tanker unloading terminal. On the south side of Dundas Point there is a cargo wharf at which coastal vessels dock to unload bulk materials required for the refinery (eg bagged limestone, sulphuric acid) and load hydrate for export. Perkins Wharf is situated further into Gove Harbour and is used mainly by the supply barges as well as 2-3 fishing charter vessels and occasional commercial fishing boats.

2.7 Workforce

The current workforce is approximately 1,100 and consists of both Alcan Gove employees and contractors.

2.8 Refinery Wastes and Emissions

2.8.1 Air Emissions

The main air emissions associated with the operations are dust from mining, particulates from the alumina processing, SO₂, NO_x, and particulates from combustion sources, and dust from residue disposal.

Various control measures are used to limit the impact of air emissions from the refinery. These include the use of high stacks to increase dispersion characteristics, the use of electrostatic precipitators to collect particulates from stack emissions, a new stationary calciner with more efficient combustion, baghouses, and a number of dust minimisation measures to reduce fugitive dust emissions from the site.

Significant reductions in fugitive dust emissions have recently been achieved as a result of a road paving program throughout the refinery.

2.8.2 Noise

Noise sources at the refinery include pumps, motors, process equipment, fans, compressors, turbines, vehicles, conveyors etc. The major noise producing areas are the power station, bauxite grinding, cooling towers, hydroblasting, digestion area, classification and filtration area, precipitation pumps and agitators.

Noise levels within the refinery are controlled to comply with occupational noise level limits.

2.8.3 Liquid Re-use and Discharge

The major liquid effluents from the operations are cooling water and surface run-off from the refinery and alkaline supernatant and runoff waters from the residue disposal area. Alkaline waters are stored in the existing storage ponds where the suspended sediment settles out and the alkaline supernatant water is returned to the refinery for re-use in the mud washing process.

From early 1999 to early 2001, above-average rainfall increased the volume of supernatant waters well beyond that which can be re-used in the refinery. Additional storage ponds have been built to store the excess. To reduce this excess volume of residue area water, Alcan Gove is neutralising some of it to enable it to be discharged.

To the east of Perkin's Wharf is a seawater intake structure which pumps seawater to the evaporation plant for cooling purpose (Figure 5). To the west of Perkin's Wharf, the cooling water is discharged into Gove Harbour via a shore outfall. This outfall also discharges treated waters from the neutralisation facility at the residue disposal area, stormwater runoff from the plant, a sewage treatment plant, an oily water treatment system, intermittent cooling waters from the power station, and some water from cleaning operations.

2.8.4 Solid Wastes

The major solid waste generated at the refinery is bauxite residue or "red mud". The management of residue is discussed in Section 2.4.

Other solid wastes generated at the refinery include scale (mostly bauxite residue) from the cleaning of process equipment, calcium oxalate from the causticisation process, and lime slaker grit. These wastes are disposed with the red mud. Waste oil and grease from the refinery are recycled.

2.9 Environmental Management

Alcan Gove has operated a comprehensive environmental management system for many years. More recently, Alcan has required all site environmental management systems to be certified. Consequently, Alcan Gove is currently re-aligning environmental management arrangements to meet the certification requirements of AS/NZS ISO 14001. It has conducted a gap analysis of its existing systems and programs against the requirements of AS/NZS ISO 14001 and the Minerals Industry Code for Environmental

Management and intends to have implemented a system that fully meets the requirements of AS/NZS ISO 14001 by December 2003. Environmental audits, which have also been carried out for many years will also be modified to focus on AS/NZS ISO 14001 requirements. The company publishes its performance in a publicly available annual Environmental Health Safety and Community report.

2.10 Risk Management

Risk management has been an important factor in Alcan Gove's safety health and environment program since 1998. A risk profile for the site has been developed and significant risks have been identified and are used as the basis of current objectives and action plans. Fault trees have been developed for each risk area which show in a pictorial way how certain events can combine to cause an event which could cause serious injury, environmental damage or loss of production.

3.1 Objective

The refinery's Stage 3 expansion project will increase total production of alumina from 2.0 mt/a to 3.5 mt/a. Alcan's objective for the expansion is to sustain its internationally competitive alumina position and have a positive impact on environment performance.

All new plant and equipment will be located within the footprint of the existing operations. There is no requirement to use any land outside the existing lease areas.

3.2 Mining Operations

At the mine, current production is 6.5 million dry tonnes of bauxite per annum (mdt/a). Of this, around 4.7 mdt/a is used in the refinery to produce alumina and depending on demand about 1.8 mdt/a is exported. To enable the expansion to take place, the rate of mining will increase from 6.5 mdt/a to 8 mdt/a and the bauxite that is currently exported will be diverted to the refinery. All bauxite exports will cease. This is consistent with adding value to product before export takes place.

While the existing mining rate will increase, no significant change in mine plan is required to extract the increased tonnage.

The crushing facility at the mine site will be modified to improve availability and capacity.

The environmental assessment will discuss how the current mining and rehabilitation techniques will continue to be applied with the rehabilitation rate increased to match the increased mining rate.

Bauxite is transported from the mine to the refinery by conveyor. In order to cope with the increased production, this conveyor will be upgraded with changes to the drive and transfer systems that will result in a speed increase and improved operational reliability.

3.3 Refinery

3.3.1 General

Increased refinery production will be achieved by installing new process equipment which will integrate into the existing refinery process. The expansion will take place as in-fill development essentially within the existing refinery footprint. The refinery areas to be affected by new plant and equipment are shown on Figure 5.

3.3.2 Bauxite Stockpiles

There will be no significant change to the size or method of operation of the bauxite stockpiles. However, there will be an increased turnover of the stockpiled bauxite to match the refinery's increased consumption rate.

3.3.3 Grinding and Digestion

The expansion will add two extra grinding mills and an extra slurry heating facility.

The existing low temperature digestion process will be converted to a high temperature double digestion process for all refinery stages. This will result in a 10% improvement in alumina extraction and 25% less residue per tonne of alumina.

3.3.4 Residue Separation, Filtration and Washing

Alcan high rate decanters will be used for residue separation for all refinery stages. The existing multi-stage thickeners which are currently used for residue separation will be converted to additional washers as part of the expansion project. This will minimise the current practice of the temporary storage of caustic material on the ground when the existing thickeners are descaled. The new high rate decanters are designed to prevent scale build up and will eliminate caustic contamination outside bunded areas.

3.3.5 Precipitation

Additional multiple precipitation tanks and another cooling tower will be installed to increase precipitation capacity.

3.3.6 Classification and Filtration

Additional hydrocyclone classification and vacuum filtration systems will be installed to match the increased refinery capacity.

3.3.7 Calcination

Two new stationary calciners will be installed. The four existing rotary calciners will remain as standby equipment and are expected to be used for approximately 60 days per year during maintenance periods for the fluid bed calciners.

The fluid bed calciners will result in improved environmental performance by reducing energy consumption and dust emissions.

Associated upgrades will include new hydrate conveyors, upgrading of the alumina transport systems, and a new alumina silo.

3.3.8 Evaporation

Additional multi-stage evaporation plant will be installed. However, unlike the existing system which has seawater cooling water discharge, the new evaporation facility will have a closed circuit cooling system. This will mean that for the Stage 3 component of the refinery there will be no direct contact of caustic liquor and cooling water eliminating potential for additional carryover events. The seawater which is currently discharged from Stages 1 and 2 evaporation will be used to neutralise red mud and will pass through a settling pond prior to discharge.

3.3.9 Liquor Purification

Liquor purification is a process designed to reduce the organic impurities in the residue to enable maximum recycling of caustic liquor. Liquor purification will be investigated during the early stages of the design process and Alcan's preference is to incorporate it into the expansion because it will result in 25% less caustic consumption and a 75% reduction in soluble caustic waste per tonne of alumina produced. However, it will only be implemented if all appropriate environmental and health guidelines can be met.

3.4 Residue Disposal

3.4.1 Residue Management and Water Treatment

As discussed in Section 2.4.1, the alkaline bauxite residue is currently disposed of in containment ponds at the residue disposal area.

Plans are currently being developed to neutralise some of the alkaline waste water and red mud before disposing of it in the containment ponds. A similar process is successfully applied at another Australian alumina refinery to provide an environmentally effective residue solution. The resulting neutralised but saline red mud will be disposed of in a section of the residue disposal area that is separate from the alkaline red mud. The neutralisation will be achieved by using the seawater discharged from the evaporation cooling system and the runoff from the saline red mud disposal area. The waste water from the neutralisation process will be saline but suitable for discharge to the marine environment. In this way the inventory of water stored in the residue disposal area can be progressively reduced and the overall quality of water discharged from the refinery will be improved.

This process will be introduced before the Stage 3 expansion commences. When the expansion occurs, the waste water and red mud neutralisation will continue until about 2011 when the inventory of water stored in the residue disposal area will be depleted. After this time, all of the red mud will be neutralised before disposal and all of the runoff from the disposal area will then be suitable for discharge to the

marine environment. Should liquor purification be introduced, the reduction in the inventory of stored water will occur at a faster rate.

Because of the increased rate of mud disposal required as a result of the expansion, the capacity of the existing disposal facility is expected to be reached by about 2015. However, prior to that time, detailed studies into future residue disposal options will be undertaken and a separate government approval will be sought for the new disposal area. Only neutralised red mud would be stored in the new disposal facility enabling direct discharge of runoff to the marine environment thus eliminating the need for storage of large volumes of wastewater.

Ongoing studies, which continually review and update long range plans for residue management, will determine the preferred location of the new residue disposal area as well as the drainage designs and discharge locations that would be required.

3.4.2 Residue Revegetation

As discussed in Section 2.4.2, on-going revegetation and research is being undertaken at the existing residue disposal area and a long range decommissioning plan has been developed. The techniques developed in the existing area will be applied to any new disposal areas developed as a result of the expansion.

3.5 Ancillary Services

3.5.1 Fuel Type

The expansion design will incorporate sufficient flexibility for the refinery to burn either fuel oil or natural gas. Negotiations are currently under way to secure natural gas supply to the plant. Fuel oil will continue to be burned until natural gas becomes available, with appropriate controls to achieve acceptable air quality

3.5.2 Electricity and Steam

Currently there are three high pressure boilers and turbines at the power station generating electricity and steam. A program is currently in place to add an additional boiler within the next year. However, the additional power demand from the expansion will require a fifth boiler and turbine to be installed as part of the expansion project.

3.5.3 Water Supply

The expansion will increase the refinery's demand for water. Demand management will be put in place with the aim of remaining within the supply capacity and licence limits of the existing borefield. If demand management alone cannot ensure adequate water supply, other options will be identified.

3.6 Port Facilities

As bauxite exports will cease prior to the expansion commissioning, the existing bauxite ship traffic will also cease. Alumina ship movements will increase because of the increased alumina production rate. The end result will be a similar number of ship movements to that which currently occurs. The average ship size will reduce as alumina ships are smaller than bauxite ships. Lime and caustic imports are likely to increase in line with increased production. Fuel oil imports will cease once natural gas is available. The overall result will be that, after the expansion, total ship movements will be similar to those at present.

During construction, most large construction equipment will be brought in by barge or small ships. This will result in a temporary increase in shipping movements and may require some upgrading of existing barge landing facilities.

3.7 Workforce

The construction phase will extend for 33 months. At its peak there will be an estimated 1,220 construction workers. These workers will be accommodated in a self-servicing construction camp to be developed in Nhulunbuy South adjacent to the site of the construction camp used for the original development of the Gove project.

Changes to the operational workforce will be determined during the project design phase.

4.1 Community Infrastructure

The town of Nhulunbuy which was built to service the Alcan Gove operations. It is located midway between the mine and the refinery (approximately 12 km from each) and has a population of approximately 4,000.

About 1,500 Aboriginal people (Yolngu) reside in the Gove area, including at Yirrkala and the 22 Yolngu homeland communities. Thirteen major clans exist in the area, each with traditional homeland centres outside the Yirrkala settlement. The township of Yirrkala is 15 km south-east of Nhulunbuy. It was established as a mission settlement in the 1930s although is now successfully self-managed and run by the elected Yirrkala Dhanbul Community Assoc. Inc.

As part of its commitment to both the local community, Alcan Gove supports many events, activities and groups. It works to maintain mutually beneficial relationships with the traditional owners through the implementation of numerous communication, education and training programs.

4.2 Economics

The Alcan Gove operation is one of the largest industries in the Northern Territory and is a major contributor to its economy. It is a capital intensive facility with a replacement cost of \$2.5 billion. It has become one of Australia's largest export earners, securing more than \$500 million each year from sales of bauxite and alumina to overseas customers. Economic benefits achieved during 2001 include the following:

- Jobs for 1,100 employees and contractors;
- Over \$114 million injected into the regional economy through salaries and wages;
- Supported the NT economy with local expenditure of over \$28 million on material purchases; and
- Over \$78 million contributed to Territory and Federal Government finances through taxes and charges.

4.3 Cultural Heritage

One important archaeological site in the area is a sheltered bay on the eastern side of Drimmie Peninsula. This site includes a trepang processing station that was used by Aborigines and Macassans. Dimbuka Rocks, a group of prominent rocks adjacent to the Residue Disposal Area, is also an area of significance.

The Aboriginal Areas Protection Authority Sacred Sites register was searched in January 2002. While several registered sacred sites are identified in the general locality, no sites (registered or recorded) are present in the areas subject to the expansion proposal. Additionally, there are no declared heritage sites or

objects as defined by the *Heritage Conservation Act 1991* on the Northern Territory Heritage Register in the areas subject to the expansion project.

An archaeological survey was undertaken of the residue disposal area in 1974 (Dames & Moore, 1974). This survey found evidence of past occupation of the area by Aborigines with concentration of activities along the coastal fringe and the watercourses in the area. Most of the sites were middens.

4.4 Climate

The climate on the Gove Peninsula is tropical monsoonal, with a marked seasonal variation in winds and rainfall.

The year is divided roughly into a wet season between December and April and a dry season between May and November, but transitional conditions tend to blur the boundary between the seasons. The wet season is characterised by high humidity and frequent rainfall, with winds frequently from the north-west. Tropical cyclones can occur in the Gove area during this season, and a high percentage of rain falls in intense thunderstorms and showers. During the dry season conditions are typically less humid with south-easterly winds.

Mean annual rainfall at Gove Airport is 1407 mm. In a typical year, 85% of the annual total falls between December and April.

Mean daily maximum temperatures vary from 33.1°C in November to 27.7°C in July. The mean daily minimum temperature varies from 24.6°C in January to 19.3°C in August.

4.5 Air Quality

The Alcan Gove operation is the major industrial source of air emissions in the region. Other air emissions in the region result from fires, mainly during the dry season. Fires emit a range of pollutants including oxides of nitrogen (NO_x), particulates and volatile organic compounds (VOCs).

Existing air quality measurements in the Gove area focus on continuous sulphur dioxide (SO₂) monitoring and high-volume particulate (PM₁₀) monitoring at the refinery site. This monitoring program is designed to provide data inputs for the refinery's air quality model and to assist decision-making on air emission control strategies at the operational level. As discussed in Section 2.6.1, a number of control measures have been introduced in recent years to reduce air quality effects from the operation.

4.6 Terrain

The main physiographical features of the Gove Peninsula are:

- Low coastal and tidal creek areas;
- Flat to undulating areas and slopes of intermediate level, dissected by rivers and creeks; and

-
- High plateau areas and plateau remnants bordered by distinct escarpments.

The main geological units are:

- **Basement Rocks.** These are Pre-Cambrian and strongly weathered and overlain by a mantle of decomposed basement rock. The thickness of the decomposed rock zone varies between 0 m to 75 m and consists of stiff sandy clay containing angular quartz and rock fragments. The surface of the basement rock has a strong relief with numerous rises and depressions.
- **Mesozoic Sediments.** This sedimentary basin of clays and sands extends for a depth of up to 180 m between the basement rock and laterite and bauxite of the plateau.
- **Soils and post-Mesozoic to Recent Deposits.** The plateaus are capped with a lateritic profile, parts of which form the bauxite deposits. Relatively elevated parts of the intermediate area are covered by lateritic gravel. In the valleys, river beds and inland swamp areas, there is alluvium consisting of fine sandy loams.

4.7 Groundwater

4.7.1 Refinery

The western end of the Gove Peninsula is comprised of marine sediments (predominantly quartz and calcareous marine sands) deposited between small outcrops of granitic and gneissic bedrock.

In general, the granitic bedrock is of low permeability and occurs at a relatively shallow depth under a significant area of the refinery. The bedrock is considered an aquitard and groundwater occurrence and flow is controlled by secondary structures such as faults and joints. At depth, a low permeability weathered clay regolith occurs immediately above the bedrock. Two known bedrock “valleys” (more deeply weathered bedrock, which occurs along fault lines) occur in the refinery area.

The marine sands overlie the bedrock and comprise a permeable unconfined (water table) aquifer, which is recharged by rainfall infiltration. In areas where deeper bedrock occurs, the marine sands are underlain by marine clay and mud at depths of 20 to 25 m below ground surface.

A mound of fresh to brackish groundwater (total dissolved solids up to 10,000 mg/L) occurs under that portion of the Gove peninsula occupied mainly by the alumina refinery. Groundwater elevations generally range between 2 and 4 m RL. Seasonal groundwater level fluctuations are about 1 m, with the highest groundwater elevations occurring in April at the end of the wet season. There is no direct use of this groundwater and it has no connection with other groundwater sources in the Gove area.

Groundwater flow occurs in a radial pattern away from the elevated area of the refinery towards the coast, where it discharges into the ocean along a seawater/groundwater interface. Near the coast, tidal fluctuations are transmitted into the aquifer and cause small groundwater level fluctuations indicative of a highly permeable, unconfined aquifer with a large specific yield.

Because of the permeable nature of the marine sand aquifer, there is potential for activities at the refinery to impact on the underlying groundwater.

Historically, work practices and spillages at the refinery have resulted in localised impacts on the underlying groundwater. Alcan Gove has been mitigating these impacts by operating a series of groundwater recovery bores and improving the storage and handling of wastes and chemicals. The recovery bore network has controlled the extent of impacts.

A comprehensive network of groundwater monitoring bores has been installed throughout the refinery area. These bores are monitored and sampled on a regular basis in order to assess the performance of the recovery system and to evaluate the impacts of the refinery operations on the underlying groundwater.

4.7.2 Residue Disposal Area

The geology and hydrogeology underlying the residue disposal area generally comprise:

- Fresh to slightly weathered Bradshaw Granite bedrock, considered an aquitard, being largely impermeable except for local geological structures, which may comprise minor aquifer zones;
- Moderately to completely weathered Bradshaw Granite (Clay Regolith) considered to be an aquitard except for local geological structures, which may comprise minor aquifer zones;
- Surficial Gravels and Laterite up to 1 m thick, considered to be moderately to highly permeable and likely to form seasonal perched water table aquifers; and
- Localised Alluvial Deposits in stream channels and estuaries, sometimes comprising organic material, considered to be moderately to highly permeable but very limited in extent.

In general, low permeability materials underlie the residue disposal area. The historical groundwater levels in the area were probably within the clay regolith and a few metres below natural ground surface. Based on pre-project topography, a groundwater divide probably occurred in the area. The original groundwater flow directions were probably towards the northern coast (Arafura Sea), southern coast (Drimmie Arm) and westwards into the Macassar Creek drainage.

Groundwater flow in the area has been modified by the presence of the raised pond areas, which are currently filled with residue or stored alkaline supernatant water. Historically, groundwater elevations have generally increased and groundwater flow is now radially away from the ponds towards the coast and related low-lying areas. Steep hydraulic gradients now occur from the ponds, through pond embankments and into the surrounding areas. There is no direct use of this groundwater and it has no connection with other groundwater sources in the Gove area.

As at the refinery, an extensive network of groundwater monitoring bores is in place at the residue disposal area. These bores are located throughout the area and around all pond perimeters. They are regularly monitored, sampled and reported on.

The borehole data show that localised impacts on groundwater have occurred as a consequence of the residue disposal activities. These include vegetation stress associated with rising groundwater levels outside the ponds and local small areas of seepage from the ponds. However, the seepage is very small compared to the size of the facility, mainly because of the very low permeability of the sub-surface materials.

4.8 Marine Biology and Water Quality

Melville Bay is situated in the north-east corner of Arnhem Land adjacent Gove Peninsula, the Arafura Sea and the Gulf of Carpentaria. The marine habitats and species which occur in this region are typical of those which occur in the Indo West Pacific Tropical Bioregion. The southern portion of Melville Bay is a shallow protected estuarine embayment into which drain three mangrove lined creeks and rivers. Seagrass beds and extensive intertidal sand flats occur near the mouth of most creeks. A number of small coral fringed rocky islets also occur in the southern part of the bay. The larger and less protected northern part of the bay (north of Gove Peninsula) is comprised of mainly sandy coastline between interspersed rocky headlands and is fringed by extensive shallow coral reefs.

The waters of Melville Bay support a wide diversity and high abundance of pelagic and benthic fish and some protected marine species such as crocodiles, dugong and wading birds (southern part), and turtles, dolphins, pilot whales and seabirds mainly in the northern part.

The waters of the bay are generally clear during the dry season when winds are from the south-east and turbid during the wet season when winds are from the north-west and rivers are in flood.

The shallower parts of the bay support both recreational and subsistence fishing activities. The Gove Yacht Club is situated in Inverell Bay and is a favourite resting area for round-Australia and round-world ocean voyagers. Some 30 – 50 yachts and power boats are moored in the bay. A small boat yard and slipway is located near Drimmie Head where boats are slipped for maintenance.

The most discernable historic physical impacts of the refinery's operations on the marine environment are those which occur above low tide level and include:

- Modification of the sandy beach along the southern side of Dundas Point as a result of a seawall, cargo wharf, plant outfall, Perkins Wharf and cooling water intake facility; and
- The provision of artificial reef habitat along the jetty piles for the export jetty.
- Reclamation of mangrove areas adjacent to the headwaters of Macassar Creek for residue disposal and the alkaline supernatant treatment facility;

Investigations have been undertaken to determine the impact of the licensed refinery outfall. There is an abiotic zone in sediments within an approximate radius of 500 m from the outfall and tailing off towards Dundas Point. The abiotic zone is the result of a blanket of non-cohesive gibbsitic which covers the seafloor. Outside this impact zone is a 200 m wide (approx) transitional impact zone in which the gibbsite

is gradually incorporated into sediments and benthic biota occur in low abundance and diversity. Outside the transitional zone no impacts on sediment character and biotic complement can be detected.

4.9 Terrestrial Biology

4.9.1 Flora

Region

The Northern Territory Herbarium has recorded 335 species (84 families) of terrestrial vascular flora across the northern Gove Peninsula. Of these, 66 are exotic species. Two of the (endemic) species are considered vulnerable by the Northern Territory Herbarium 'Rare or Threatened Australian Plant' listings. These are *Coccinia grandis* (climbing vine) and *Wikstroemia indica* (shrub). Neither of these species have been found within the lease areas for the mine or refinery.

The Environment Australia *Environment Protection and Biodiversity Conservation* (EPBC) Act (Commonwealth) online database identifies one species *Arenga australasica* (Australian arenga palm) which could possibly occur in the area. This has not been identified in the lease area. However as discussed in Section 5.6, further biological studies will be undertaken as part of the environmental assessment.

Local

The project site has largely been modified either through broadscale tree clearing to allow construction of the mine, refinery and residue disposal areas, or thinned as is the case with vegetation adjoining the disposal area.

Within the refinery site there are some small patches of vegetation, mainly consisting of canopy trees with some form of modified understorey. However these patches are very small.

The 1974 Environmental Impact Study (Dames & Moore, 1974) prepared for the residue disposal area identified the presence of approximately 70 species of vascular plant. None of these are identified by current Northern Territory Herbarium 'Rare or Threatened Australian Plant' listings.

The dominant terrestrial vegetation alliances of the area to be affected are:

- *Eucalyptus tetradonta* Darwin Stringybark open forest-woodland; and
- *Melaleuca leucodendra* - *M. veridiflora* savannah woodland.

These alliances are similar to fine scale vegetation types 9 and 51 outlined in *Bioregions in the Northern Territory: Conservation Values, Reservation Status and Information Gaps* (Connors, Oliver & Woinarski 1996). Both are poorly represented in conservation reserves in the Top End Coastal Bioregion.

4.9.2 Fauna

As discussed in Section 5.6, fauna surveys will be undertaken as part of the environmental assessment to augment the existing fauna database for the area.

The Northern Territory Fauna Atlas lists 144 species (9 amphibians, 24 reptiles, 103 birds, 8 mammals) for the northern Gove Peninsula. One species *Burhinus grallarius* Bush Stone-curlew is considered 'lower risk - near threatened' by the *Territory Parks and Wildlife Conservation Act 2000* and the International Union for the Conservation of Nature.

In addition to those species identified on the Northern Territory Fauna Atlas, two additional terrestrial species are identified by the Environment Australia EPBC Act online database. They are *Notomys aquilo* northern hopping mouse and *Xeromys myoides* false water rat. Both these species are listed by Territory legislation as being 'lower risk - near threatened' and 'vulnerable' respectively.

Northern Territory coastal habitats are significant for their seasonal use by migratory bird species. Migratory bird species are protected under the EPBC Act. The EPBC online database identifies four terrestrial migratory species and five wetland migratory species that may utilise parts of Gove Peninsula.

During surveys conducted as part of the 1974 EIS (Dames & Moore, 1974), 104 species (97 birds and 7 mammals) were recorded utilising the residue disposal area. The assessment also indicated the potential presence of an additional 97 species comprising one amphibian, 24 reptiles, 59 birds and 13 mammals that had previously been recorded from the area. None of these additional species are listed as threatened. From 1998 to 2000 a total of 89 bird species were recorded during an Alcan Gove sponsored PhD project on bird colonisation of rehabilitated areas

As the areas to be affected by the project's expansion are contained within the existing leases, they have already been impacted by previous site development and are unlikely to support significant native fauna.

5.1 Design Efficiency Improvements

The environmental effects of the expansion project have yet to be studied fully and Alcan will produce a detailed assessment of all relevant aspects in the environmental assessment report. This report will be in the form of an Environmental Impact Statement prepared in accordance with the requirements of the Northern Territory Government.

Even though the studies are not yet complete, it is possible to identify positive benefits to the environment from the expansion. These include:

- Installation of the Alcan double digestion process will ensure the optimum amount of alumina is extracted from the bauxite and that lower grade bauxite can be processed. This will result in a 10% improvement in alumina extraction per tonne of bauxite mined and, as a result, an extension of the mine life.
- The improved digestion will also result in a 25% reduction in residue produced per tonne of product
- With liquor purification there will be 25% less caustic consumption and a 75% reduction in soluble caustic waste per tonne of alumina produced.
- There will be a 5% reduction in energy consumption and a reduction in greenhouse gas emissions per tonne of product
- Once the natural gas supply becomes available, there will be a substantial reduction in sulphur dioxide emissions and combustion particulates as well as a further reduction in greenhouse gas emissions. Appropriate measures will be taken to ensure acceptable air quality is achieved if the supply of natural gas is delayed.
- There will be no significant increase in ship movements after completion of construction.

5.2 Cultural Heritage

A cultural heritage review will be undertaken as part of the environmental assessment to identify any potential impacts from the proposed expansion. They will consider the cultural values of the Aboriginal community and any potential changes that may occur. This work will be undertaken in close consultation with and agreement from the local Aboriginal community. Based on the results of the review, any necessary management or mitigation measures will be implemented.

5.3 Air Quality

5.3.1 Stack Emissions

Stack emissions from the existing refinery include the products derived from the combustion of fuel oil at the power station and the calciners. These emissions will continue with the expansion until gas supplies are available. Should this be after the expansion commences, air quality management strategies will be implemented to reduce the effects of the interim combustion of fuel oil.

The environmental assessment will describe in detail the strategy for ensuring future air quality is satisfactory and that the relevant standards are met. The strategy is likely to include a combination of methods to control the stack emissions including process improvements, tall stacks, upgrades to other pollution control equipment, switching to lower sulfur fuel at critical times, and high efficiency low NO_x burners for the new boilers. In addition the new calciners will have 30% lower energy consumption as well as improved efficiency dust collection systems. Extensive computer modelling, analysis of existing monitoring data, and investigations into process and control technology options will assist the project team to select the optimum strategy. Conversion to gas will be the most effective means of emissions control.

5.3.2 Fugitive Emissions

The major sources of fugitive emissions include:

- Dust from bauxite handling;
- Dust from alumina handling;
- Dust from vehicle traffic and unsealed areas;
- Dust from the residue disposal area; and
- Cooling tower plumes.

As part of the expansion project's environmental assessment, the fugitive emissions from both construction and operations will be modelled to quantify the changes to ground level concentrations as a result of the expansion. Any strategies necessary to ensure effective air quality management will be implemented.

5.3.3 Greenhouse Gases

Greenhouse emissions are produced by steam and power generation and calcination as well as from vehicle emissions.

Alcan Gove is a signatory to the Commonwealth Government's Greenhouse Challenge Program and has committed to identifying and quantifying greenhouse gas emission sources, developing plans to limit emissions, and reporting annually on progress. Greenhouse emissions are produced in the power generation and calcination processes as well as from vehicle movements. Alcan Inc. also has made an international commitment to reduce overall greenhouse gas emissions by 0.5% per year from 2001 to 2004 with further reduction targets to be set for subsequent years. Alcan Inc's lifecycle studies show that using aluminium metal in applications such as transportation results in overall greenhouse gas reductions when it replaces heavier materials.

Efficiency improvements over the last 10 years at Gove have resulted in greenhouse gases being reduced from 792 kg to 714 kg per tonne of alumina produced ie. a reduction of almost 10%. The expansion project and the introduction of more efficient equipment will enable the rate of CO₂ generation per tonne of alumina to reduce even further. The acquisition of an adequate gas supply will reduce the tonnes of CO₂ produced per tonne of alumina by around 30%. The environmental assessment will quantify the improvements due to the expansion.

5.4 Noise

During construction, the major new noise sources will be from activities throughout the refinery and from construction worker vehicles. Mitigation measures will be adopted both during and after construction to maintain compliance with NT legislative requirements.

During operations, the major sources of noise concerned with the expansion will be associated with:

- additional fans, compressors, vents, and pressure relief valves;
- an additional boiler;
- alarms (eg. conveyor) and vacuum pumps;
- crushing equipment and vehicle movement at the mine site; and
- vehicle movement at the residue disposal area.

Noise modelling and impact assessment will be undertaken to predict future noise levels at the boundary, at nearby residential areas and at sensitive land uses along the infrastructure and transport corridors. These levels will be compared against existing noise levels in order to determine the impact of the expansion project.

Any noise reduction required from each significant noise source will be assessed for each noise sensitive location. Based on the type of noise source, a range of mitigation measures could be considered for noise sensitive locations.

5.5 Surface Water

5.5.1 Refinery Site

Within the refinery area changes that will occur as a result of the expansion could potentially include altered sub-catchment areas, additional or reduced flow sources, altered "clean" and "dirty" separation systems, and additional stormwater containment and treatment facilities. These changes will be incorporated into a water balance model to be developed for the site to assess drainage requirements, water usage and potential impacts on surface water quality. In addition, there will also be increased volumes of neutralised water from the residue disposal area to be disposed of via the refinery outfall.

From this assessment, potential opportunities to mitigate impacts from stormwater will be identified and the performance of the mitigation measures evaluated using the water balance model.

5.5.2 Residue Disposal Area

Runoff from the active mud disposal areas will continue to be managed in accordance with current practice including neutralisation and discharge. From 2005 onwards, increased neutralisation will progressively eliminate the inventory of stored alkaline water in the residue disposal area. Once this occurs, only neutralised red mud will be disposed of and runoff from the disposal area will be able to be discharged directly to the marine environment.

The water balance model will be updated to estimate the average annual quantity of wastewater and runoff that will require treatment and disposal from the expanded operations. The outcomes of the water balance model, together with the effectiveness of mitigation measures, will be documented as part of the environmental assessment and provide input to the assessment of the marine, water quality and groundwater impacts.

As discussed in Section 3.4, an additional residue disposal area will be required after 2015. At this time, depending on the location of the additional disposal area, neutralised runoff could require a new outfall. Ongoing studies and consultation will determine the preferred location and operating parameters for this facility and a separate government approval will be sought.

5.6 Groundwater

5.6.1 Refinery

The expansion design replaces the current thickeners with deep cone thickeners which will virtually eliminate the need to dispose of scale from the thickeners on the ground during maintenance periods. This will remove a major source of potential groundwater contamination at the refinery.

Groundwater studies to be undertaken as part of the environmental assessment will include:

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- Review of existing impacts at the refinery;
 - Assessment of potential impacts from the expanded refinery; and
 - Development of alternative preventative strategies and management programs to minimise potential impacts from the expanded refinery

5.6.2 Residue Disposal Area

The future disposal of residue will pose less risk to groundwater quality due to its reduced caustic content. Potential impacts at the residue disposal area include changes to groundwater levels and/or changes in water quality. The potential for such impacts to occur as a result of the expansion project will be assessed. This work will outline the appropriate groundwater management strategies to address the prevention and/or remediation of any potential impacts.

5.6.3 Water Supply

Expansion of the refinery may result in an increased demand for water. However water consumption per tonne of alumina is expected to reduce due to the planned introduction of strategies to better manage water demand and reuse. It is possible that these strategies may enable the future water demand to be met from the existing mine area aquifer under the existing borefield water abstraction licence. In the event that modelling shows that this may not be possible during extended dry periods, investigations of alternative supply sources will be undertaken.

5.7 Marine Biology and Water Quality

Components of the expansion with the potential to affect marine biology and water quality include the following:

- Modified discharge regime from the refinery outfall, and
- Modifications to ship loading and shipping regime.

The current design of the new evaporation facility uses closed circuit cooling towers. This cooling arrangement will prevent possible caustic contamination of cooling water. Other options will be evaluated during the design phase. The discharge quality will also be improved as the cooling water exiting the Stage 1 and 2 evaporation facilities will be used in the effluent neutralisation process and treated prior to discharge.

Studies to be undertaken will include a description of the present discharge characteristics and its environmental effects, plus a determination of the proposed new discharge characteristics and modelling to predict the scale of future impacts. The modelling will assess the potential impacts of the thermal, dissolved metal and suspended solids components of the discharge.

The review of the modified shipping regime will include assessments of any changes in the risks from oil spills, from the introduction of marine pests, and from the spillage of alumina and/or hydrate.

5.8 Terrestrial Biology

Expansion of the refinery will be generally within the existing plant footprint. However, construction of some of the expanded facilities will require clearing of small areas of vegetation.

Studies to be undertaken for the environmental assessment will include detailed surveys of the flora and fauna of the sites to be cleared as well as the surrounding areas. The surveys will target any relevant threatened species and an assessment made of the potential impacts on the area's conservation values. Based on the results of the impact assessment, plans will be developed for any management or mitigation measures required.

5.9 Soils and Revegetation

Work undertaken for the environmental assessment will include review and update of soils mapping and characterisation studies to review and update current soil management strategies.

Alcan Gove has carried out extensive research to develop an effective revegetation strategy for the residue disposal area. This has included research into capping, revegetation, and erosion control. Based on this work, parts of the existing disposal area have already been rehabilitated and a long range decommissioning plan has been developed. The results of this work will be applied as residue disposal areas are decommissioned.

5.10 Contaminated Land

Because of the history of industrial activity on the site, contaminated soils may exist in the areas to be disturbed by the expansion. A Phase 1 contaminated site assessment will be undertaken in these areas to identify whether or not any contamination is present. If contamination is identified, appropriate management or remediation measures will be developed to ensure that the expansion activities do not result in any increased environmental risk due to contaminated soils.

5.11 Waste Management

The environmental assessment will detail how construction wastes will be managed during the expansion project. A site-specific waste management plan for this phase of the project will be prepared. The site's existing operational waste management program will be extended to incorporate all elements of the expanded refinery.

5.12 Aesthetics

Expansion of the refinery is not expected to have a significant visual impact as it will generally consist of infill development within an existing industrial landscape.

An assessment will be made of the potential visual impact from public view points. Based on this assessment, opportunities will be identified to mitigate visual impacts by appropriate planning of the locations of the proposed facilities (eg. stockpiles, buildings, roads etc.) and the introduction of landscape treatments (eg. screen mounding, planting etc.).

5.13 Social Impact/Consultation

The potentially affected communities include the Nhulunbuy township and smaller communities such as the self-managed community at Yirrkala. In addition, there are other small residential communities (eg. Galupa and Ski Beach) in relatively close proximity to the refinery.

The main township of Nhulunbuy was established as a result of the development of the mine and refinery and it is likely that there will be community support for the proposed expansion. However, issues such as demands on social services, interactions between newcomers and local residents, and local employment and training opportunities are likely to be of interest to both the indigenous and non-indigenous communities.

Alcan Gove has developed a community consultation plan for its existing operations and has also established two reference groups for the exchange of information on projects, business development, training and employment opportunities. These existing structures will be used in the social impact assessment and community consultation for the expansion project. The work to be undertaken will include characterisation of the existing environment, consultation and identification of potential social and community issues, and development of management and mitigation strategies.

5.14 Infrastructure

5.14.1 Traffic

The impact of the expansion on the traffic and road infrastructure will be from the movement of workers to and from the site. The delivery of equipment, supplies and consumables will also be considered but the impact will be small as most of these are delivered by ship.

The construction phase of the expansion will generate additional road traffic in the area. The environmental assessment will include an assessment of the impacts of this additional traffic.

As there will be only a minor change to the operational workforce, the additional traffic impacts during the operational phase will be minimal apart from some additional deliveries of supplies and consumables.

5.14.2 Workforce Accommodation

Accommodation of the construction workforce will be in a camp located near the existing Nhulunbuy township area on the site of the construction camp used for the original construction of the mine and refinery. The infrastructure and services requirements (water, sewerage, electricity etc) for the accommodation facilities will be identified and the capacity of the existing facilities to meet the additional demand assessed.

Similar information will be developed for any additional increase in the operational workforce accommodation facilities.

5.15 Risk Management

The risk aspects of the expanded refinery will be managed within the framework of the existing risk management system as described in Section 2.8.

A hazard and risk analysis will be undertaken in relation to the production, processing, handling and transport of hazardous materials to be used in the expanded refinery. This analysis will focus on events that could potentially cause serious injury or damage beyond the refinery boundaries. It will also indicate how the existing safety management strategies and control measures will be used to minimise the risk as well as identifying any additional safeguards that may be necessary.

Alcan has engaged a consultant with a world class reputation to assist with the identification of issues and development of strategies to address them. The environmental assessment will be developed in accordance with guidelines issued by the NT Govt.

Alcan notes the indicative timeframes outlined in the NT Government guidelines for Environmental Impact Assessment and expects to complete the process to approval stage within those timeframes. The following table provides a general indication of key milestones based on the current schedule.

Action	Expected Completion
Submit NOI to NT Government and Referral to Commonwealth Government	March 2003
Submit Environmental Assessment	September 2003
Approval and Conditions Issued by Government	March 2004

References

Brady, C. (2002 in prep) *Birds as Indicators of Rehabilitation Success, Nabalco Mine, Gove, Northern Territory*. PhD thesis, Northern Territory University.

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Dames & Moore (1974) *Environmental Impact Statement Red Mud Disposal Nabalco Gove Project Gove Northern Territory*, prepared for Nabalco Pty Ltd.