11.0 Surface Water

11.1 Climate and General Hydrology

The Gove region experiences a tropical climate with the majority of rainfall occurring in a distinct wet season from December to April. Seasons with above average rainfall are often influenced by tropical depressions that can produce high intensity rainfall and/or high-volume, moderate intensity, rainfall over several days.

Median monthly rainfalls in the wet season are in the range of 150 – 280 mm. The highest monthly rainfall on record (since 1971) was 1,080mm in April 1999. In contrast, minimal rainfall occurs during the dry season from May to November. Median monthly rainfall in the dry season is less than 50 mm, and months with no rainfall are common. In some years, the wet season can extend later into the early winter months.

Annual rainfall totals since 1971 have varied from 654 mm to 2,572 mm (maximum recorded in 1975) and the median annual rainfall is 1,357 mm.

Mean monthly evaporation exceeds the mean monthly rainfall over most of the dry season resulting in a net water loss from most water body surfaces. Mean annual evaporation exceeds the mean annual rainfall by approximately 50%, however rainfall can be highly variable and may exceed the evaporation in wetter years.

Under these climatic conditions, surface water flow in small drainage systems and streams is intermittent and mostly influenced by periods of prolonged rainfall. Limited surface storage in the shallow soils provides some base-flow that gradually recedes over a period of weeks or months following the end of the wet season. In some areas where the groundwater level is close to the surface, surface water flow is supplemented by seepage from groundwater. Groundwater influences on surface water hydrology are typically minor.

Statistics of monthly and annual rainfall data from the Bureau of Meteorology records from Gove Airport since 1971 are summarised in Table 11.1. Evaporation data for the Gove region are summarised in Table 11.1.2.

Table 11.1.1
Rainfall Statistics at Gove - (BOM Station 014508 - 1971 to 2003)

Period	Minimum	Maximum	Mean	Median	10th percentile	90th percentile
January	0	740	272	266	103	428
February	65	555	276	278	111	451
March	0	515	251	251	98	401
April	14	1080	285	190	83	592
May	3	331	78	44	9	211
June	0	117	31	29	4	63
July	0	102	20	10	3	49
August	0	29	6	3	0	19
September	0	50	6	0	0	19
October	0	81	8	2	0	19
November	0	190	30	10	0	79
December	0	811	173	153	4	302
Annual	654	2,572	1,428	1,357	1,036	1,857

Table 11.1.2
Evaporation at Gove Airport (BOM Station 014508- from 1971 to 2002)

Period	Mean Pan Evaporation (mm)	Pan Factor	Derived Open Water Evaporation (mm)
January	181	1.14	206
February	143	1.10	157
March	164	1.07	175
April	160	1.02	163
May	163	0.95	155
June	149	0.86	128
July	154	0.80	123
August	179	0.76	136
September	196	0.84	165
October	219	0.90	197
November	215	0.93	200
December	211	1.12	236
Annual	2,134	-	2,041

Source: Gove RDA – Long Range Residue Disposal Plan (Water Management Manual) Period of record Nov 1966 – Jun 1973 & 1985 – date.

11.2 Existing Catchments, Surface Water Systems and Hydrology

Existing catchments, surface water systems and their hydrological regime at the refinery and the residue disposal area (RDA) are presented below.

A plan showing the layout of existing catchments at the refinery is presented in Figure 11.2.1 and existing catchments in the vicinity of the RDA is presented on Figure 11.2.2.

11.2.1 Refinery Catchments

11.2.1.1 Overview

The refinery is situated mostly on undulating to flat land with elevations in the range of 5 to 10 m AHD. A small portion of the refinery to the north-west near Wargarpunda Point is more elevated (up to 22 m AHD). The majority of the refinery catchment slopes gently to the south and drains into Gove Harbour. There are no natural water features (wetlands, lakes, creeks etc) with high environmental value within the refinery catchments.

Information on water management within the refinery is presented in Section 11.3.1.

11.2.1.2 Pre-development Catchment Conditions

Prior to the original development of the refinery in the late 1960s, surface water runoff would have primarily occurred as shallow overland flow direct to coastal waters or to shallow indistinct coastal swales such as the area now known as Stockpile Creek. Surface runoff would only have occurred intermittently for short durations following heavy rainfall events.

11.2.1.3 Current Catchment Conditions

Development of the refinery has modified the naturally formed catchment divides and increased runoff rates in many areas due to compacted surfaces and installed formal containment and drainage systems. The refinery catchment comprises the following:

- Bunded areas around process vessels which collect minor spills, leaks and rainfall; and
- Five sub-catchments as described below (Figure 11.1.1).

The five separate sub-catchments discharge into Melville Bay and are as follows:

- Western Channel Catchment. This catchment is in the western area of the refinery and drains onto the Western Channel which discharges onto Melville Bay via the Refinery Outfall Channel. Included in this catchment is the Western Pond (Table 11.3.1).
- Stockpile Creek Catchment. This catchment includes the land around the thickener and washer tanks in the northern half of the “ferrosilt” area in the north-eastern sector of the refinery. Stockpile Creek is not a natural drainage system and it has no water sources except those originating from the refinery and bauxite stockpiles. During the wet season, water quality in the ‘creek’ may be influenced by shallow groundwater and also affected by discharges from the refinery. This groundwater is shallow and confined to the small area of land around the refinery. The ‘creek’ is normally dry. It will contain pools of red/brown water during the wet season and will occasionally flow to Wanake Bay after heavy rains. A shallow sediment pond (Stockpile Creek Sediment Pond) settles some of the sediment before discharge.
- Light Fuel Tank Farm Catchment. This catchment is located to the south of the refinery and includes bunded tanks and adjacent areas.
- Harbour Tank Farm Catchment. This catchment is located south-west of the refinery and consists of bunded tanks and adjacent areas.
- South-Eastern Catchment. This catchment is in the south-east of the refinery and drains onto the Seawater Channel which discharges onto Melville Bay via the Refinery Outfall Channel. Included in this catchment is the Southern Containment Pond (Table 11.3.1).

In addition to stormwater from rainfall runoff, the following discharges flow into the Seawater Channel and the Western Channel:

- Seawater pumped from Gove Harbour and used for cooling in the evaporation plant and for cooling the condensing turbines occasionally operated at the power station. Once it has been used for cooling, the seawater is discharged into the Seawater Channel and returned to Gove Harbour.
- Discharge from the waste water neutralisation facility at the Residue Disposal Area (Section 11.3.2.6).
- Recovered groundwater from the north-eastern side of the refinery.

11.2.2 Residue Disposal Area and Surrounding Catchments

11.2.2.1 Overview

The Residue Disposal Area (RDA) is designed to contain all rainwater that falls on the stored residue. It extends across undulating land with elevations in the range of 3 m AHD to 25 m AHD. The current operational area (Figure 11.2.2) is approximately 500 ha.

Information on water management within the RDA is presented in Section 11.3.2.

11.2.2.2 Pre-development Catchment Conditions

Prior to development of the RDA, the catchment area of Wallaby Beach Creek extended further to the west (partially beneath Northern Pond) and to the south towards Macassar Creek. The catchment area of Duck Pond Creek extended further to the east beneath the current Water Treatment Pond. It appears that Duck Pond Creek previously drained to the mouth of Macassar Creek.

Development of the RDA for residue disposal commenced in 1974. Historic residue disposal occurred over a low-lying area in the former headwaters of Duck Pond / Macassar Creek, north of the current RDA, in the now decommissioned Northern and Taylor's Ponds.

11.2.2.3 Current Catchment Conditions

The gradual development of the RDA has modified catchment divides and partially modified the drainage systems. The catchments and drainage systems surrounding the current RDA are discussed below.

Duck Pond Creek Catchment

Duck Pond Creek carries wet season flows from the Duck Pond (a constructed settling pond on the western side of the RDA) to Drimmie Arm. Much of the decommissioned Northern Pond/Taylor's Pond area now drains in the direction of the Duck Pond. To prevent ponding, the middle reach of the drain from Northern and Taylor's Ponds has been realigned and excavated to allow free drainage of the decommissioned residue ponds area. Water pools in some depressions within the drainage system, but flows are limited to the wet season.

The construction of the RDA has reduced the catchment area of Duck Pond Creek which is now approximately 180 ha in size. Approximately 30% of the Duck Pond Creek catchment has intact vegetation cover and a further 60 to 65% of the catchment has regenerating vegetation over Northern Pond and Taylor's Pond. The remaining 5% to 10% of the catchment has been cleared for facilities such as the mine-refinery conveyor corridor, RDA office facilities/parking, the YBE plant nursery, and a network of minor maintenance and monitoring access tracks.

Wallaby Beach Creek Catchment

A drain (referred to as Wallaby Beach Creek in this report but is a modified drainage feature) exits the decommissioned residue disposal ponds (Northern and Taylor's Ponds) and discharges to the north between Wallaby Beach and Crocodile Creek. The catchment area of Wallaby Beach Creek has been reduced by historical deposition of residue in the adjacent Northern/Taylor's Ponds area and the current active RDA. The current catchment area of Wallaby Beach Creek is 186 ha and is smaller than its original catchment area (ie. prior to development of the RDA).

Much of the catchment has relatively undisturbed surfaces with mostly intact vegetation. The most southern portion of the catchment (approximately 6 ha) between the mine-refinery conveyor and the RDA pond embankment, has been cleared. Isolated areas with little or no vegetation cover also exist in the north-eastern part of the catchment. With these catchment characteristics, Wallaby Beach Creek has a surface water flow regime similar to undisturbed small coastal catchments in the region. There are no other activities within the catchment area that would substantially affect water quality (the majority of the catchment is relatively undisturbed). The creek flows only after rain, mostly in the wet season.

Macassar Creek Catchment

This is a natural tidal creek to the south-west of the current RDA (and west of Pond 5). Its catchment has been reduced by construction of the RDA. It has an area of approximately 53 ha of low-lying land surrounding a tidal channel, mangrove fringes, and saline mud flats.

No-Name Creek Catchment

No-Name Creek is to the south of Pond 7 at the eastern end of the RDA. The construction of Pond 7 has reduced the size of the original No-Name Creek catchment.

11.3 Current Surface Water Management

11.3.1 Refinery

11.3.1.1 Overview

Management of surface water at the refinery aims to minimise the level of contaminants that ultimately discharge to the marine environment. Each of the operating areas at the refinery has controls either in place or in development to manage significant water quality risks. In addition to the area-based controls, a higher level strategic plan includes initiatives to continuously improve performance in water quality management and waste water containment.

11.3.1.2 Current Refinery Surface Water Management

The current surface water management practices at the refinery are described below.

Caustic to Ground

"Caustic to ground" refers to the discharge of caustic soda and process liquors to the ground outside of containment areas where it can contaminate soil, surface water and groundwater. Alcan Gove's strategic plan includes objectives to reduce "caustic to ground" occurrences throughout the operations.

One of the major current sources of "caustic to ground" is the thickening area in the north-east corner of the refinery. The thickening tanks accumulate scale on their inside surfaces as part of normal operations. Over a period of a few months, the scale builds up to a point where it must be removed. The scale is contaminated with alkaline process liquor. The design of the thickener tanks, now around 30 years old, is such that it is difficult to remove the scale from the tanks in a way that prevents discharge of contaminants to the ground. Historically, scale and associated mud and liquor were extracted from the tank and temporarily placed on the ground outside the tank for drying and subsequent transportation to the RDA. This resulted in contamination of surface and groundwaters, particularly in the wet season. In 2003, new scale removal procedures were implemented resulting in a significant reduction in "caustic to ground" from this source. Further reductions in caustic to ground in this area and from other sources are planned for 2004 as this strategic initiative continues to be implemented. New process equipment for the expanded refinery will not be a source of "caustic to ground" because of improved design and containment systems.

Cooling Water Discharge

Cooling water used on the evaporation area (section 3.5.7) is pumped from Gove Harbour and returned via the seawater channel. The quality of the discharged cooling water is affected by heat and by caustic contamination as follows:

- Low level caustic contamination which occurs on a continuous basis from caustic entrained in steam that condenses during the evaporation process.

- Caustic carry-over events which occur in the low temperature section of the evaporation area when excessive flashing or failure of control valves causes inflow of caustic liquor into the seawater mixing tanks which discharge to the Seawater Channel.

Comprehensive operating and maintenance regimes have been implemented to minimise the likelihood of caustic contamination occurring.

If caustic contamination does occur, the caustic in the seawater neutralises and forms a milky-coloured precipitate (suspended solids) in the Refinery Outfall Channel discharge. The precipitate flows into Gove Harbour where it accumulates and forms a deposit of fine, poorly settled sediment above the natural seabed. The new third stage evaporation plant will not have an open circuit cooling system like the Stage 1 and 2 evaporation plant and hence additional caustic contamination of the seawater discharge will not occur.

Waste Water Reuse

Rainwater and process water in bunded areas is collected and returned to the process where possible. This reduces the risk of bund overflow and decreases freshwater demand. However, there are limitations on the refinery's capacity to recover and reuse all waste water. Excess water in the process circuit causes increased caustic consumption, decreased alumina production and increased fuel oil consumption. Current water management initiatives are now addressing the need to better integrate stormwater management with the design and operation of existing primary and secondary containment systems. The expanded refinery will adopt this integrated approach into its design and operation.

Stormwater Management

Rainfall into the catchments described in Section 11.2.1.3 is managed as follows:

- Bunded Process Areas

  Rainfall in these areas can become contaminated and is either used in the process or pumped to the RDA. In the event that the capacity of the bunded area and its sump pump (primary containment) is exceeded, an overflow occurs. Overflow is directed to containment ponds (secondary containment) or, in very heavy rainfall events, is managed through emergency response.

- Western and Seawater Channel Catchments

  Each of these catchments incorporates a pond (secondary containment) which captures runoff from the areas identified in Table 11.3.1.

Table 11.3.1
Secondary Containment Ponds

Pond	Catchment Area (ha)	Surfaces and Drainage	Refinery Features
Western Pond	24	Extensive paved, roofed areas, bunded areas, and unpaved laydown areas. System of stormwater pipes and lined channels leading to Western Pond. Minimal vegetation.	Lime Plant Acid Storage Flocculant Preparation Area Hydrate Filtration Plant Precipitation Plant Grinding and Digestion Areas Security Filtration Refinery Tank Farm
Southern Containment Pond	7.2	Partially paved, roofed areas, and unpaved laydown areas. Stormwater pipes and lined channels connected to seawater channel.	Southern part of Ferrosilt including Deep Washers Caustification Sand Disposal

The Western and Southern Containment Ponds have been designed to take account of potential rainwater runoff volumes, but the size of their catchments is such that other measures are required to prevent overflow. Both containment ponds have pumping systems that enable them to transfer their contents to the RDA area when levels in the ponds reached a pre-determined height.

The Western Channel has a diversion weir that diverts stormwater flow into the Western Pond. The contents of any process spillage in the catchment of the Western Pond can be captured by a combination of primary and secondary containment. The Southern Containment Pond captures overflows from bunded areas and spills from leaks outside the bunded areas via underground drainage or overland flow.

Stormwater that is potentially contaminated with oil or fuel is contained and transferred to an oily water treatment facility (located near the refinery workshops) which includes a collection pond and an oily water separator (corrugated plate interceptor). The treated discharge from this facility into the Western Channel is via an underflow that draws water from the bottom of the pond. This arrangement has enabled adequate hydrocarbon concentrations to be met at the outfall but there are further capital improvements planned to reduce the total hydrocarbon load discharged.

- Light Fuel and Harbour Tank Farm Catchments

  Stormwater in bunded areas at the light fuel and harbour tank farms is tested to determine suitability for release to the local stormwater drainage system in these areas. The criteria used to determine suitability for release are based on pH and no visible oil on the surface of the contaminated water. Stormwater that does not meet these criteria is retained within the bund until it can be either neutralised or the oil recovered by sucker truck.

- Stockpile Creek Catchment

  The intermittent runoff from the Stockpile Creek catchment (bauxite stockpiles and north-eastern area of the refinery) is mixed with seawater throughout the wet season and passes through a settling pond prior to flow into Wanake Bay. This system will be improved as part of the planned upgrades to the refinery's bunding and containment (Section 11.7.3).

11.3.1.3 Containment of Process Liquors

Process liquors are contained in storage tanks and process vessels. Alcan Gove implements rigorous design, operational and maintenance standards for tanks, piping, associated equipment and containment as described below.

Tank Design

All tanks at the refinery have been designed, built and inspected in accordance with the requirements of the American Petroleum Institute's (API) Standard 650 which is an international standard for the safe design of process and storage tanks. The refinery also has a tank asset register and a site wide non-destructive tank inspection program which is based on the international tank maintenance standard API 653. This program is implemented in accordance with the requirements of Alcan Gove's tank inspection procedure.

HAZOP and CHAZOP Design Review Process

During detailed design and commissioning tests, the development of operational changes and procedures for installation and maintenance of capital equipment is based on widely recognised risk control processes known as HAZOP (Hazard and Operability) and CHAZOP (Control, Hazard and Operability) reviews. These processes are already part of current refinery practice. They are a rigorous, structured examination of risks and risk control measures, including the review of all abnormal and emergency conditions that could possibly occur. Fail-safe control systems are developed during this process (eg. certain pumps and valves are automatically closed or kept open under pre-determined possible upset conditions). The HAZOP/CHAZOP reviews involve personnel with a wide range of skills and experience, including those who will be operating new plant and working with the changed procedures.

Process Controls

The process control systems already in place will be modified as required to completely integrate the new equipment and processes implemented as part of the Third Stage expansion. They will automatically monitor and control plant performance including aspects such as tank level, pressures and flow rates.

Critical Alarms, Operator Supervision and Manual Process Shutdown

Tanks and other critical equipment are fitted with alarms to alert trained operators of abnormal and emergency situations such as eg. blocked pipe, air supply failure, pump failure, power failure. All operators are trained. Control room process control operators have procedures in place and are trained to identify circumstances where manual over-rides are required.

Automatic Emergency Shutdown (Plant Trips)

If manual emergency action is not effective and the control system detects a continuing fault, the primary source of the problem is automatically shutdown. There are detailed procedures in place to manage such events, even in the event of a total power failure.

Tank Inspection

The current site-wide tank non-destructive testing program will continue with the expansion project. This program is based on the American Petroleum Institute standards (e.g. API 653) to ensure that the integrity of the tanks does not deteriorate while in service. Trained personnel undertake inspections that are routinely scheduled.

Bunding and Containment

The bunds around major storage tanks are designed to contain process spills or emergency spills in the event of tank failure. Bund requirements for this function are defined by Australian Standard (AS) 1940 (1993*) Storage and Handling of Flammable and Combustible Liquids*, and Australian Standard (AS) 3780 (1994*) Storage and Handling of Corrosive Substances*. The extent to which the refinery meets these standards is discussed below. For those instances where the current containment systems are not adequate, Alcan Gove is committed to continuous improvement to meet the requirements of the standards.

Primary bunding for the harbour tank farm, the light fuel tank farm, the steam power station transfer tanks, the diesel power station day tank, and the day tanks for calcination all meet the requirements of AS 1940.

There are three small above-ground diesel storage tanks at the refinery that do not currently meet the requirements of AS 1940. These facilities will be either upgraded or removed to ensure the standard is met in all cases.

The requirements of AS 3780 are met in most areas of the refinery via primary and secondary containment systems. Generally if a tank develops a leak, the leak flows down the side of the tank and is contained in the bunded area. However, many process tanks in an alumina refinery are very tall and also need to be located in close proximity to other tanks and equipment. In the case of a sudden tank rupture, it is therefore extremely difficult to contain within a primary bund all of the spilt contents of a large process tank. At Alcan Gove, a secondary containment system (ie Western and Southern Containment Ponds) is available to minimise the potential for process liquids to escape into the environment.

The thickener area (north-east of the refinery) does not currently have sufficient primary and secondary bunding to prevent overflow into Stockpile Creek. This will be rectified by continuous improvement in current bunding around tanks, upgrading the Stockpile Creek Sediment Pond to function as a containment pond in the same manner as the Southern Containment Pond, and the new thickener technology as part of the expansion project.

The primary containment system for the caustic soda storage tanks within the harbour tank farm meets the requirements of AS 3780.

Alcan Gove will implement a surface water management improvement plan which will enhance the performance of the bunding and containment strategies discussed above. Implementation of the plan will be substantially completed by 2008. It will also incorporate the surface water management requirements of the expanded refinery. Details of this plan are given in Section 11.7.3.

11.3.2 Residue Disposal Area

11.3.2.1 Overview

The RDA is a dedicated storage facility for solid and liquid residues that contain the unused portions of the bauxite ore and some of the caustic soda used for extracting the alumina in the refining process. The solid residues are comprised of separated mud and sand. The refinery transfers thickened mud and slurried sand to the RDA. The RDA is designed and managed to retain all solids and liquids within a series of containment structures. The solid residues are stacked into a stable landform and the liquids are stored separately in ponds. For ease of reference all liquid and solid storage areas are referred to as ponds. The ponds currently operating are numbered from 3 to 7. The decommissioned ponds to the north are referred to as Northern and Taylor's Ponds (Figure 11.2.2).

Rainfall runoff from residue stacking areas is contaminated by residual liquor in the mud. Water losses occur through evaporation and through pumping some of the waste water back to the refinery process circuit for reuse. A small portion of the waste water is also neutralised in a waste water neutralisation system (treatment pond and labryinth) to a quality that enables it to be discharged to Melville Bay via the Seawater Channel.

Residue disposal and waste water at the RDA are managed in accordance with long range residue and water management plans. The long range residue disposal plan links residue placement, water management, contingency actions, infrastructure, and closure/rehabilitation. All activities at the RDA are also carried out in accordance with the Alcan Gove EHS management system. The significant aspects and impacts of the operation have been taken into account in developing the long range residue and water management plans and prioritising the operational controls.

11.3.2.2 RDA Infrastructure

The RDA infrastructure consists of a number of embankments, ponds, drains, pipe networks, and pump systems. A summary of the land use at the RDA is presented in Table 11.3.2 and the layout of infrastructure is shown on Figure 11.2.2.

Table 11.3.2
RDA Infrastructure

Infrastructure	Catchment Area (ha)	Function
Water Treatment Pond	25	Containment of waste water and runoff from Pond 3 prior to treatment in labyrinth neutralisation facility.
Pond 3 & 3/4	67	Disposal of Residue. No waste water storage.
Pond 4	53	Disposal of Residue. No waste water storage.

Infrastructure	Catchment Area (ha)	Function
Pond 5	152	Primary waste water storage for RDA. Secondary function for disposal of residue sand and mud from refinery.
Pond 6	95	Additional waste water storage pond.
Pond 7	55	Emergency overflow storage pond for Pond 5.
Seawater Header Pond	1	Storage of seawater pumped from Macassar Creek for use in labyrinth waste water neutralisation facility.
Labyrinth neutralisation facility	8	Mixing and settlement ponds for neutralisation of waste water with seawater.

The ponds for waste water storage and management at the RDA are the Water Treatment Pond, Pond 5, Pond 6, and Pond 7. The storage capacities of these ponds are summarised in Table 11.3.3. Details of the inflows and outflows from each of the ponds are given in Table 3.6.3.

Table 11.3.3
RDA Water Storage Pond Details

Pond Name	Full Supply Level (RL m)	Maximum Storage Capacity (Million m^3)
Water Treatment Facility Pond	8.6	1.0 (1)
Pond 5	25.7	4.0 (1)
Pond 6	25.3	10.0 (2)
Pond 7	16.7	4.1 (1)

Notes:
(1) Storage Capacity in 2001 (source Long Range Residue Disposal Plan – Design Criteria Vol 2)
(2) Storage Capacity in 2002 (source RDA Annual Report 2002)

11.3.2.3 Solid Residues

Residue is pumped from the refinery to the RDA in two separate streams - thickened mud and sand slurry. The liquor content of mud residue delivered to the RDA is in the range of 1.1 to 1.2 m^3 for each tonne (dry weight) of residue solids. In 2002, 1.46 million tonnes (dry weight) of mud residue were disposed at the RDA.

The mud component of the residue is placed onto Ponds 3 and 4 using a dry stacking method, which has been used at Gove since 1992. This method involves deposition of mud in shallow 300 mm layers from centrally located discharge points. The waste water leaches to perimeter drains and the residue is solar dried over a period of up to 35 days, after which time the deposited red mud has sufficient density for placement of the next layer.

In 1998, refinement of the dry stacking method was introduced with additional working of the red mud material using a procedure known as “mud farming”. This involves using a low ground-pressure swamp dozer to turn over red mud and enhance drying. The mud farming commences several days after placement, and is repeated several times. The mud farming process does not significantly reduce the period between layers, however higher densities are achieved in the residue mud deposits, which allows a greater quantity of residue to be deposited within the available area.

The dry stacking method allows placement of residue mud at a rate of 13,000 t/ha/yr (requiring 110 ha active deposition area) and the mud farming method has improved the rate of placement to between 16,000 and 40,000 t/ha/yr. The variation in the mud farming placement rate is due to periods of extended wet weather. The current planned average placement rate is 20,000 t/ha/yr, which requires between 80 and 95 ha of active mud farming area. In 2002, 86% of the total residue disposal was placed and dried using mud farming methods.

The dry stacking method has a significant advantage over traditional tailings disposal methods. It allows the mud stacks to be constructed above the embankment levels, requiring less area for disposal facilities, and reduces the size and cost of embankments. The completed surface is also free draining, which improves conditions for rehabilitation.

The sand component of the residue is pumped separately and discharges to the Pond 5 via an elevated hydrocyclone. The separate deposition of sand residue allows the sand to be reclaimed later for construction or rehabilitation purposes.

11.3.2.4 Waste Water and Solids Containment

The dry stacking process forms a surface profile that is elevated above the pond embankments. A system of double perimeter drains is in place to prevent release of waste water to the environment. The inside system of drains is known as “leachate drains” and is designed with sufficient capacity for 20 year Average Return Interval (ARI), 24 hour storm events. The outside system of drains is known as “security drains”. They provide additional protection from accidental release. The security drains are designed with sufficient capacity for a 200 year ARI, 72 hour storm events and for overtopping failures of the leachate drains.

The leachate and security drains convey the waste water from the active mud stacking areas to the water treatment pond, Pond 5, or Pond 6. The waste water is stored in these ponds and its accumulation (inventory) is controlled by evaporation losses, transfers to other ponds, return pumping to the refinery process circuit, and treatment in the labyrinth neutralisation facility followed by disposal to Gove Harbour via the Seawater Channel.

Short to medium term management (one to two years) of the waste water inventory at the RDA is based maintaining sufficient free storage to contain rainfall for a 200 year ARI wet season. Freeboard (additional height allowance above the maximum storage level) is added to the 200 year wet season rainfall volume to allow for waves from winds up to 160 kph.

The structural integrity of the embankments of the RDA ponds in extreme floods is also important to prevent failure and loss of residue that could contaminate the downstream environment. The ponds are designed with spillways to allow safe overtopping for extreme events up to the Probable Maximum Flood.

11.3.2.5 Waste Water Inventory

Inventory Volume

The accumulation of waste water at the RDA is regularly measured using water level gauge boards. Bathymetric surveys are undertaken to update information on the storage-elevation characteristics of the ponds. The quantity of waste water at the RDA is regularly recorded in a waste water inventory.

The waste water inventory varies each year and seasonally within the year due to varying rainfall and evaporation rates. The waste water inventory typically increases during the wet season and decreases during the dry season. From 1994 to 1998, the inventory was in the order of 4 million m^3. In 1999, the annual rainfall was 90% above the median. This resulted in the inventory increasing to 9 million m^3. Rainfall in 2000 and 2001 was also above median. In 2002, the annual rainfall was below median annual rainfall, and the waste water inventory decreased to 6.4 million m^3. Prior to the wet season in December 2003, the inventory was around 7.4 million m^3.

Inventory Management

The quantity of waste water at the RDA is managed to ensure that there is adequate storage to contain 200 year ARI rainfall by implementing the following:

- Pumps (with capacities of 400 to 700 m^3/hr) and a network of transfer pipelines are used to balance waste water storage levels between the Water Treatment Pond, Pond 5, and Pond 6, or to pump to the refinery process circuit.
- Treatment of waste water in the Labyrinth and Settling Ponds. The neutralised waste water is discharged to the refinery Seawater Channel if in compliance with internally determined release criteria.
- Return waste water pumping to the refinery for reuse in the process liquor circuit.
- Minimising unnecessary pumping of refinery waste water to the RDA.
- Waste water inventory monitoring and water balance modelling used to assess “what-if” scenarios for future short-term rainfall events and to forward plan operations and upgrade works with adequate contingency.
- Provision of emergency storage capacity (Pond 7).
- Maximising the area for surface evaporation at the RDA during the dry season.
- Using dry stacking methods to minimise the volume of residual liquor and pond area.

To date, the emergency storage pond (Pond 7) has not been required for waste water storage. To date this pond collects clean rainfall runoff that is pumped and discharged to the creek system to the south of the pond (No-Name Creek) to maintain sufficient storage capacity for future requirements. Pond 7 will eventually be required for waste water storage as the progressive stacking of mud reduces storage capacity in the other ponds. When Pond 7 is used for waste water storage in the future, it will be managed in the same manner as the current waste water storage ponds.

In April 1999, severe rainfall caused the Water Treatment Pond to fill to capacity. To avoid overtopping of the pond at the lower end, action was taken to release the rain-diluted waste water from the pond in a more controlled manner via a makeshift spillway. Since that time, the capacity of the RDA to contain such rainfall events has been substantially improved through upgraded waste water inventory management, construction of additional emergency waste water storage ponds, and elevation of the Water Treatment Pond walls. This has enabled the RDA to cope with rainfall events up to an average return interval (ARI) of 200 years.

Inventory Modelling

Two waste water inventory models have been developed and are routinely used to help predict variations in net water storage at the RDA, based on known and estimated inputs, outputs and transfers between the RDA and the refinery. This helps to optimise waste water inventory balance control measures under a range of possible climatic conditions.

Water balance assessments taking account of a range of climatic scenarios have shown that the overall long-term trend is a net positive inflow to the RDA. This has directed attention to other waste water inventory management options including the development of an improved waste water neutralisation system that can significantly increase waste water treatment rates (Section 11.8.2).

11.3.2.6 Waste Water Neutralisation Facility

The waste water neutralisation facility comprises the Water Treatment Pond, the Labyrinth, and a series of settling ponds. Seawater is pumped from Macassar Creek and mixed in the labyrinth channel with the waste water from the Water Treatment Pond. The seawater mixing with the waste water forms a milky gelatinous precipitate that settles to the bottom of the labyrinth channel. The flow through the Labyrinth and settling ponds is slow and has a residence time of approximately three days to maximise the settling of the finer fractions of the precipitate. Following settling, the treated waste water is discharged to Gove Harbour via the Seawater Channel at the refinery.

Regular sampling is used to determine whether the return of treated water to the refinery is acceptable for discharge. The pumping system is shut down when discharge criteria are not met.

The precipitate forms at an approximate rate of 0.0036 t/m^3 in a 1:7 waste water to seawater mix. At the nominal waste water inflow rate of 50m^3/hr, the precipitate is deposited at about 1.854 t/hr. The precipitate is recovered by a dredge and dried at the RDA before disposal in the Pond 4 dry stacking area.

11.3.2.7 Extreme Weather Management Procedures

Cyclones and tropical depressions can affect the RDA in the wet season. Specific management procedures are implemented in such events. The RDA Water Management Manual prescribes a comprehensive range of procedures over six stages in preparation for and response to extreme weather events. The stages relate to the warning, onset, passage, and clean-up/start-up. Key procedures include:

- Checking pumps, pipelines and drains.
- Ceasing seawater pumping from the Macassar Creek.
- Drawing down water levels in the Labyrinth and ceasing operation. The Labyrinth operation is only recommenced when turbidity levels have receded.
- Frequent monitoring of water levels in waste water ponds if above prescribed levels.
- Preparing and mobilising earthmoving equipment for emergency operations.
- Activation of emergency drawdown / transfer between storages where necessary).
- Inspections for damage following passage of severe weather.

11.4 Water Quality Monitoring Program

Alcan Gove has implemented a comprehensive surface water quality monitoring program. The objectives of the program are to:

- Characterise water quality trends of surface water discharges and standing waterbodies that are or may be affected by Alcan Gove operations;
- Characterise water quality trends of the immediate receiving environment ;
- Develop internal water quality discharge standards applicable to protecting the Beneficial Uses of Melville Bay in accordance with risk assessment techniques set out in the Australian Water Quality Guidelines (ANZECC 2000);
- Report bi-monthly and annually as a requirement of the site's Waste Discharge Licence (Water Act);
- Investigate the effects of specific incidents and the effectiveness of corrective action; and
- Identify potential impacts of proposed process changes.

Currently, there are 21 routine surface water sampling sites at the refinery and 14 sampling sites at the RDA. The locations of some of these monitoring sites are shown on Figures 11.2.1 and 11.2.2. Additional sampling points are used as required following accidental releases that could affect the receiving environment surface waters.

The water quality monitoring program includes a comprehensive surface water sampling procedure, which defines site locations and outlines the procedures and protocols to be implemented for sampling at the refinery and RDA.

The type and frequency of sampling undertaken is summarised in Table 11.4.1. In-situ field measurements are taken and water samples are collected for determination of temperature, pH, conductivity, turbidity and total alkalinity.

Table 11.4.1
Overview of Surface Water Monitoring Program

Sampling Type	Description
Continuous online water quality monitoring	Carried out at the Refinery Outfall Channel (S001) for pH, turbidity, conductivity and alkalinity. Data capture with a moscad radio unit.
Daily grab sampling	Collected at the seawater intake (S004) and Refinery Outfall Channel (S001) in accordance with waste discharge licence requirements, as well as at the major discharge points to the seawater channel.
Incident sampling	For abnormal discharges that may reach Gove Harbour.
Weekly grab sampling	Collected from selected sites at the refinery and RDA for analysis of field parameters and for laboratory chemical analysis of particulates.
Monthly grab sampling	Collected from selected sites at the refinery and RDA. Indicator contaminant parameters are analysed every month. Used to monitor deviations from typical water quality trends.
Investigative sampling	Occasional specific sampling projects are undertaken to support particular investigations, process trials, marine baseline surveys, marine impact assessment sampling, seepage investigations, etc.

Analysis of water samples is undertaken by the Alcan Gove laboratory and AGAL (Australian Government Analytical Laboratories). Alcan Gove has implemented quality control procedures for the handling, storage and transport of samples to ensure the integrity of the samples.

A summary of the results from selected monitoring sites from the water quality monitoring program used to describe baseline conditions for this EIS is presented in Appendix D.

11.5 Current Surface Water Quality

Surface water quality at the refinery and the RDA is affected by the following:

- Heat;
- Caustic soda; and
- Constituents of the bauxite ore.

11.5.1 Refinery Discharges

11.5.1.1 Refinery Outfall

The Refinery Outfall Channel (monitoring site S001) contains the majority of waters discharged from the refinery into Gove Harbour. It is monitored for operational management of discharges and to meet the requirements of the Waste Discharge Licence. The flow rate of operational discharges in the channel is relatively consistent (approximately 5,200 m^3/hr) and predominantly consists of the seawater discharge from the evaporation plant. Stormwater runoff and other minor discharges (most notably treated effluent from the RDA waste water neutralisation facility) contribute additional water flows to the outfall and normally have a minor effect on water quality.

The water discharged from the Refinery Outfall Channel can be characterised as having low to moderately elevated dissolved concentrations of the metals aluminium, arsenic, vanadium and molybdenum as well as the nutrients phosphorus and nitrogen, compared to the receiving marine waters. Details on the effect of these components in the discharge are presented in Section 13.

The outfall discharge has alkalinity concentrations slightly elevated above background levels. Elevated alkalinity indicates the presence of caustic process liquor in the discharge. Caustic that is discharged neutralises upon contact with seawater and forms a precipitate. Some of this precipitate has settled on the bed of Gove Harbour in the vicinity of the outfall. A discussion of the extent and effect of the precipitate is given in Sections 13 and 14.

A significant characteristic of the outfall discharge is its elevated water temperature. Median temperatures of the discharge are approximately 18^{0}C above ambient temperatures in Gove Harbour. The significance of temperature on the marine environment is discussed in Section 14.

11.5.1.2 Stockpile Creek Discharge

The Stockpile Creek monitoring site (S006) is used to record the quality of surface water runoff into the marine environment from the Stockpile Creek catchment. Although disturbed areas of the catchment and the bauxite stockpile contribute sediment to the discharge, there is little effect on Gove Harbour other than occasional temporary red-brown discolouration of the water after heavy rain.

Runoff from the refinery thickener area and seepage of groundwater affected by process liquor can elevate pH in Stockpile Creek. However, the pH and other components of the discharges do not cause any measurable impact on the quality of water in Gove Harbour other than the temporary increase in turbidity after heavy rain.

11.5.2 Discharges from Catchments Surrounding the RDA

11.5.2.1 Duck Pond Creek

Water quality in Duck Pond Creek reflects a combination of influences from some undisturbed catchment runoff, wet season flushing from the drains around the decommissioned Northern/Taylor’s Ponds, and seawater dosing of the Duck Pond as required. The seawater dosing of the Duck Pond is a control measure to reduce pH in the discharge which is typically elevated during the first flows after the dry season and again towards the end of the wet season. Flows into the Duck Pond can reach pH 9.4 at these times. The seawater effectively neutralises this flow ensuring the discharge meets the water quality criteria set for discharge from the RDA lease (pH less than 9.4). The wet season flushing of the decommissioned Northern and Taylor’s Ponds is the main source of elevated pH detected in the flow through Duck Pond Creek. Because most of the Duck Pond Creek catchment is a fresh water system, pH is a reliable indicator of the presence of contaminants upstream of the Duck Pond. The contaminants (substances that are above background water quality levels, but not necessarily at a concentration that could cause environmental impact) are consistent with those from other sources in the refinery (eg aluminium, arsenic, vanadium) although they may vary in relative proportion to each other (see Appendix D).

There are a number of water quality sampling points extending from the highest to the lowest accessible points in the Duck Pond Creek catchment. Sampling conducted at these points helps to characterise the water quality from various parts of the catchment. Typically, the contaminant concentrations are higher in the vicinity of Northern/Taylor’s Ponds but reduce as runoff from less disturbed areas of the catchment flows into the drainage system.

During the dry season the water quality of some small pools in the upper reaches of Duck Pond Creek would be unlikely to sustain healthy freshwater aquatic ecosystems and would not be suitable for recreation. It is recognised this water quality is influenced by the decommissioned Northern and Taylor's Ponds and Alcan Gove has committed to investigating remediation options.

11.5.2.2 Macassar Creek

Water quality in Macassar Creek is sampled at the Dimbuka Rocks monitoring site S1002, adjacent to Pond 5, which is periodically affected by high tides. This monitoring site is part of a network of surface water and ground water monitoring points primarily used to detect potential seepage from the RDA.

Water quality at site S1002 varies over time for a range of water quality indicators but with no distinct historical trends. Elevated pH and alkalinity are evident. Molybdenum is above background marine concentrations. The concentrations of other metals measured do not exceed background levels.

11.5.2.3 Wallaby Beach Creek

Wallaby Beach Creek is sampled near the Melville Bay Road at monitoring site S1005.

Nitrogen, pH and alkalinity are elevated above background levels in pools remaining in the creek after extended dry periods, and in the main drain during initial wet season rains. These elevated concentrations are due to groundwater seepage from historical residue disposal at Northern/Taylor's Ponds. The nitrogen and alkalinity concentrations are not sufficiently high to cause adverse impacts in receiving waters. There is no measurable impact from this drainage on the environment at the discharge point to the north, between Wallaby Beach and Crocodile Creek (see Section 13).

11.6 Construction Impacts and Mitigation

11.6.1 Construction Impacts

The construction phase of the Third Stage Expansion will have relatively minor impacts on surface water resources and for surface water management. All construction works will be in localised small areas at the refinery and no significant construction works will be required at the RDA.

The construction impacts will be limited to the potential to generate sediment-laden stormwater runoff from earthworks activities and from accidental spills from the storage and handling of hazardous liquids used in construction activities.

11.6.2 Construction Mitigation Strategies

Construction activities will occur mainly in a number of relatively small, flat and confined areas within the current refinery footprint. Potential for erosion and elevated suspended solids in surface water discharges during the construction phase is therefore low. However, controls will be adopted to minimise the risk of these impacts. Key controls during the earthworks stage will include:

- Training and induction of construction personnel;
- Limiting the extent of disturbed areas;
- Clearing progressively immediately prior to construction activities commencing;

- Safeguarding the surface layer by stripping and stockpiling useable topsoil prior to construction;
- Using temporary soil diversion mounds to control runoff within and divert water away from the construction site;
- Minimising the period that bare soil is left exposed to erosion;
- Using sediment traps/silt fences etc. to minimise off-site effects of erosion;
- Providing vegetation cover and, where required, erosion control matting;
- Reusing stored topsoil in the revegetation and landscaping activities;
- Establishing dedicated laydown and machinery parking areas; and
- Establishing stable groundcover / pavement surfaces on disturbed areas as soon as practicable following completion of bulk earthworks and/or installation of equipment.

Current on-site fuel and chemical storage facilities will be used as the preferred storage and handling areas during construction to avoid the storage and handling of hazard liquids within construction areas. Where this is not possible, dedicated fuel and chemicals storage and handling facilities will be constructed in accordance with the requirements of AS 1940 and AS 3780.

11.7 Expanded Refinery Surface Water Management

11.7.1 Overview

Expanding the refinery will include the installation of new equipment in mostly unused areas of the existing refinery footprint. The layout of the new equipment is shown on Figure 4.3.1. Table 11.7.1 provides a brief description of the equipment and its location relative to the refinery catchments.

Table 11.7.1
Catchment Location Of New Equipment At The Refinery

Refinery Catchment	New Equipment
Southern Eastern	Evaporation, waste water neutralisation
Western Channel	Grinding, digestion, filtration, precipitation, classification, calcination, power station
Stockpile Creek	High temperature digestion, thickening, washing, liquor purification

There will be no significant new water inputs into any of the refinery catchments, but the quantity of water transferred between the refinery and RDA will change, primarily as a result of the waste water inventory reduction project. This change is described in more detail in Section 11.8.

The majority of the new equipment required at the refinery will not significantly alter existing refinery catchment boundaries. However, ongoing improvements to the current operations will include modification of some catchment boundaries to improve the separation of clean and potentially contaminated runoff. This will include the redirection of clean surface water runoff in the current Western Channel catchment to reduce the flow of runoff into the pond, thereby improving its capacity to fully contain contaminated runoff.

The risk of contamination from new process and chemical storage facilities will be minimised through a range of preventative measures, most of which are already in place (Section 11.3.1.3). The emphasis will be on incident prevention through high quality design, process control, operator training, and equipment maintenance. New bunding will be included to provide adequate containment in the event of these systems failing. Emergency control procedures will provide additional protection. The existing emergency spill prevention and containment strategy will be augmented to incorporate the expanded refinery.

11.7.2 Seawater Cooling Discharge

The Third Stage evaporation plant will not discharge cooling water apart from a small quantity of bleed water to prevent a build up of salts. It will use a closed circuit freshwater cooling system which recycles the cooling water through a cooling tower. In the closed circuit system, the risk of contaminated discharge is eliminated as the cooling water cannot come into contact with the process liquors. In this way the overall environmental impact of the evaporation process will not increase as a result of expansion. The Stage 1 and 2 evaporation cooling will remain as an open circuit.

The proposed waste water neutralisation plant (Section 4.5) will use some of the seawater that is discharged from the Stages 1 and 2 evaporation plant and discharge approximately the same quantity of seawater back into the seawater channel. This effectively results in no change to the seawater channel flow rates after the expansion.

11.7.3 Bunding and Containment

New process areas will be bunded to comply with the requirements of AS1940 (1993) *Storage and Handling of Flammable and Combustible Liquids*, and AS3780 (1994) *Storage and Handling of Corrosive Substances*.

Emergency spills that are captured in bunds and secondary containment system ponds/tanks will continue to be recycled into the production process or discharged to the RDA. Alternatively, if water quality complies with the nominated Alcan Gove discharge standards, containment pond waters can be discharged via the Refinery Outfall.

Some process vessels (eg precipitation tanks) may not be able to meet AS3780 (1994) using primary containment bunding alone because of the height of the tanks and the limited space within the refinery to provide primary containment (this issue is common to most alumina refineries). Therefore a secondary containment system will be provided (Australian Standards allow for secondary pits and ponds to be considered as part of the overall containment system). An impervious drainage connection from each primary containment bund to the secondary containment system will ensure any contaminants from process areas are prevented from affecting surface waters, soils or groundwater.

The current secondary containment system includes the Western Pond (5,540 m^3) and the Southern Containment Pond (9,000 m^3). These are downstream of the proposed new process areas. At the power station, the primary bunding of any new fuel storage tanks will comply with AS1940 (1993) so that secondary containment will not be necessary.

As part of the expansion, two 5,000m^3 capacity washer tanks will become redundant and will be made available to collect spills and rainwater from the bunds in the ferrosilt area (digestion, washing and thickening). This will significantly increase the capacity of the containment system and allow greater capacity to hold contaminated waters for use in the process stream. By having this waste water confined to tanks it will also reduce the volume of waste water to be managed by the secondary containment ponds.

The Stockpile Creek catchment does not currently have a secondary containment system. All new process areas in this catchment will have concrete primary bunding backed up by a secondary containment system that will have the capacity to meet the requirements of AS 3780 (1994). Secondary containment will be provided by an upgraded Stockpile Creek Sediment Pond (Eastern Containment Pond).

The new digestion area will have sufficient primary bunding to capture all of the contents that could flow from the largest tank in the event of a tank failure.

In addition to primary and secondary containment which will contain spillages and leaks from process areas, the ground around the containment areas will be contoured to enable jetting of fluids from the taller tanks, in the event of puncturing, to be directed to the secondary containment system. Complete primary containment of all potential discharges from jetting, particularly from the taller process tanks, is not practicable. Any contaminated materials that may impact on soil or groundwater quality will be recovered as a matter of urgency in compliance with the spill response procedures already in place.

Alcan Gove has established a site standard design for concrete slabs within bunded areas based on many years of operational experience. This design will be applied to all new bunds constructed as part of the refinery expansion. The bunds will be designed to ensure that there is no leakage of spilt material to the ground. All new slabs will be designed with under-slab monitoring/drainage incorporating sumps and recovery pumps. The concrete and joints will be chemical resistant to prevent leakage of contaminated water or seepage.

11.7.4 Caustic To Ground

The new deep thickeners to be installed as part of the refinery expansion will have an improved design that reduces the frequency at which the scale needs to be removed from the tanks (Section 11.3.1.2). When the scale is removed from the tanks (at a reduced frequency compared to the existing thickeners) it will be placed on concrete bunded areas which will eliminate any potential for the contamination of surface runoff.

Increased calcination plant capacity from the expansion will substantially reduce the need for occasional on-ground hydrate storage in an area that currently contributes to stormwater contamination.

11.7.5 Stormwater Management

Improvements will be implemented progressively to reduce the mixing of stormwater with potential contaminants. These include:

- Implementing operational improvements at the existing containment ponds to maximise stormwater surge capacity;
- Installing a new containment pond to the east of the refinery to manage flows in the Stockpile Creek catchment;
- Regrading secondary containment catchments to reduce clean water inflow to containment ponds;
- Diverting some existing stormwater drainage to secondary containment to reduce discharge of contaminants to Gove Harbour;
- Sealing roads and drainage paths to make impervious flowpaths connecting primary and secondary containment areas; and
- Increasing the extent of bunding in the lime plant and ferrosilt area.

11.8 Residue Disposal Area Surface Water Management

11.8.1 Overview

The expanded operations will not adversely impact on the external catchments around the RDA and no changes to catchment boundaries will occur. There will be no new water transfers to existing catchments around the RDA.

The waste water inventory reduction and liquor purification projects to be introduced as part of the Third Stage Expansion will produce the following benefits at the RDA:

- Reduced waste water inventory;
- Reduced concentrations of caustic in waste water; and
- Earlier implementation of RDA revegetation.

11.8.2 Waste Water Inventory Reduction Project

The objective of the waste water inventory reduction project is to reduce the waste water inventory at the RDA. This will be achieved primarily by constructing a neutralisation plant to neutralise the alkaline waste water and some red mud before disposing of the solids component in the RDA. It will also incorporate the introduction of operational efficiencies at the refinery to reduce the generation of waste water. Details of this project are given in Section 4.5.

The project will produce a beneficial impact on water management between the refinery and the RDA. The current high priority concern to reduce the waste water inventory places constraints on a wide range of refinery and RDA water management activities. The project will progressively reduce the waste water inventory and alleviate some of the constraints on other water management activities.

Water balance models that are currently used to monitor, plan, and guide integrated water management will be modified to account for changed waste water streams (ie. saline and alkaline waste water), water management operations within the RDA, and excess water sources at the refinery. The models will be re-calibrated with operational monitoring data for each stage of the waste water inventory reduction project. Data from the alkaline and saline waste water inventory will be used in conjunction with the revised water balance models to monitor the reduction in alkaline waste water against targets, and will be regularly used to develop further strategies to reduce the alkaline waste water inventory.

11.8.3 Liquor Purification Project

The purpose of the liquor purification plant is to remove impurities from the process liquor which will help maintain liquor productivity, improve flow capacity from reduced liquor viscosity, minimise the impact of scale, and enable improved recovery of soluble caustic. Details of this project are given in Section 4.5.

11.9 Water Quality Impacts and Mitigation

11.9.1 Overview

At the refinery, an improvement in water quality in the Stockpile Creek catchment will occur as a result of the new eastern containment pond and the use of the new deep cone thickeners which will eliminate the discharge of contaminants to soils, groundwater and surface water caused by the scale removal process.

Additional improvements will also occur as a result of the upgraded bunding and containment systems.

Increased waste water treatment rates will have the potential to increase the total load of contaminants to the marine environment. Close monitoring and control of the neutralisation process will ensure that the total contaminant load will be kept within limits required to meet the standard of protection proposed for the receiving environment.

The expansion project will not introduce new discharges or contaminant sources and will not create any significant changes to the water quality in the catchments surrounding the RDA or the marine environment downstream of the RDA.

11.9.2 Refinery Discharge Quality

The proposed waste water neutralisation plant will remove the majority of precipitate generated in the neutralisation process. The overall rate of waste water neutralisation will increase compared to current rates. This will result in an increase in precipitate and dissolved metal loads in the discharge from this process. These increased contaminant loads will be partly off-set by continuous reductions in precipitate and dissolved metal loads from other refinery discharges (including evaporation plant and Western Channel discharges). The overall effect of this change on the receiving marine environment in Gove Harbour is predicted to be low (Section 13).

Estimates of the predicted change in discharge water quality from the refinery, based on chemical modelling of the neutralisation process and projected flow rates, are summarised in Table 11.9.1 below.

Table 11.9.1
Current and Projected Refinery Discharge Conditions

Period	Outfall Discharge (m^3/hr)	Temperature (^oC) (Median)	Vanadium (μg/L) (95%)	TSS (mg/L) (Median)
Current Refinery	6,000	45	184	81
Third Stage Expansion	6,340	43	120	79

The waste water inventory reduction project will also result in a reduced environmental risk at the RDA.

11.9.3 Effect on Receiving Environment

The effect of the change in refinery discharge quality on the receiving environment of Gove Harbour is outlined in Sections 13 and 14.

11.9.4 Water Quality Monitoring and Impact Mitigation

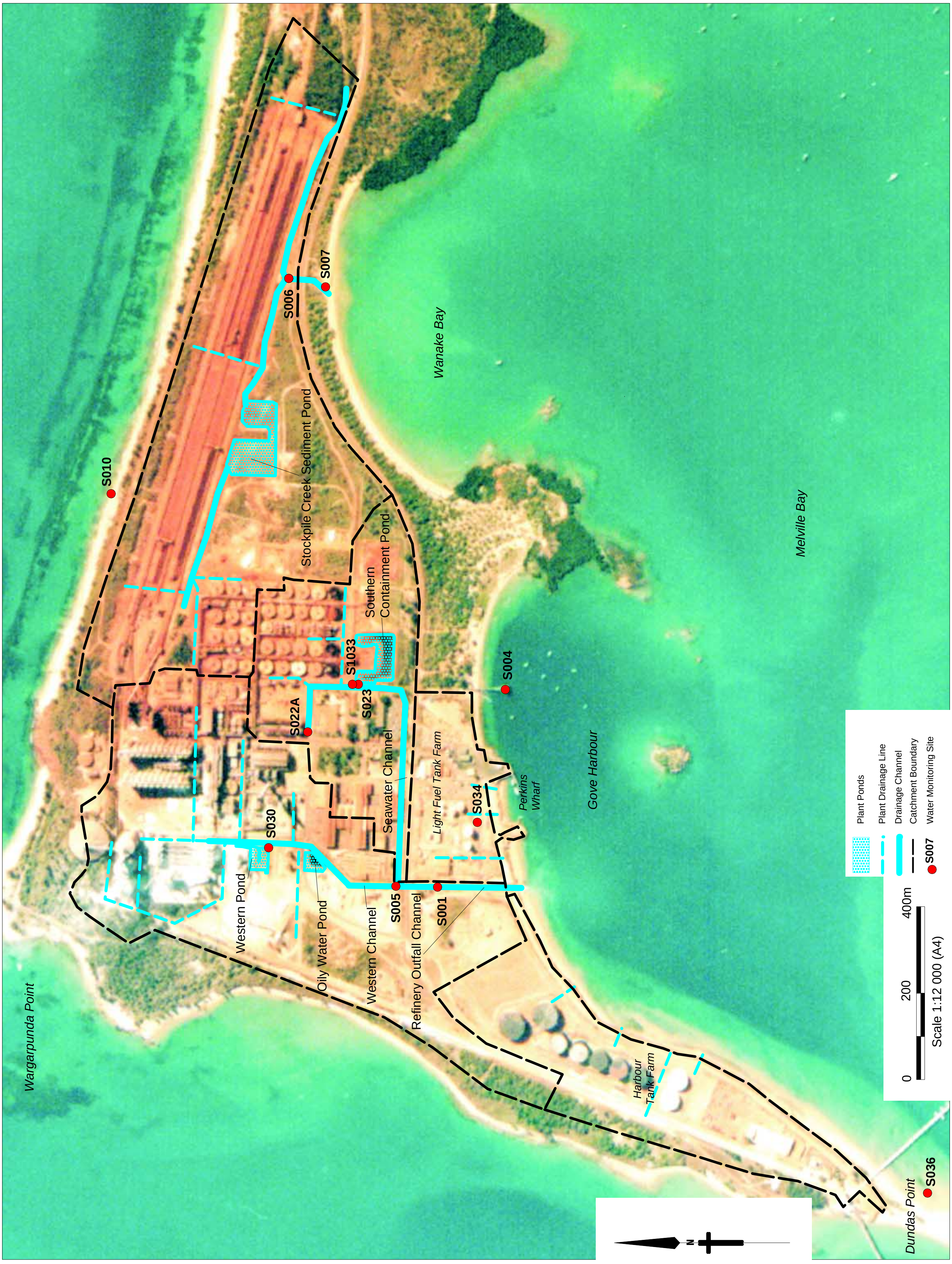
The current water quality monitoring program (Section 11.4) will continue after the expansion. A major review of the marine monitoring requirements (a condition of the current Alcan Gove waste discharge licence) will be completed by June 2004. Final details of the program will not be completed until after consideration by the NT Controller of Waters. Changes in the discharge monitoring program that are under consideration include the following:

- Measurement of chlorophyll ‘a’ concentrations and dissolved oxygen levels to assess the trophic status of receiving waters and to determine the significance of nutrient concentrations in surface water discharges to the marine environment;

- New surface water quality monitoring sites at the refinery to characterise water quality discharge from the waste water neutralisation plant into the Seawater Channel; and
- Additional flow monitoring to quantify discharges from the waste water neutralisation plant into the Seawater Channel.

11.10 Surface Water Management Plan

The strategic surface water management plan for the construction phase and for the expanded refinery is given in Section 25.



ALCAN

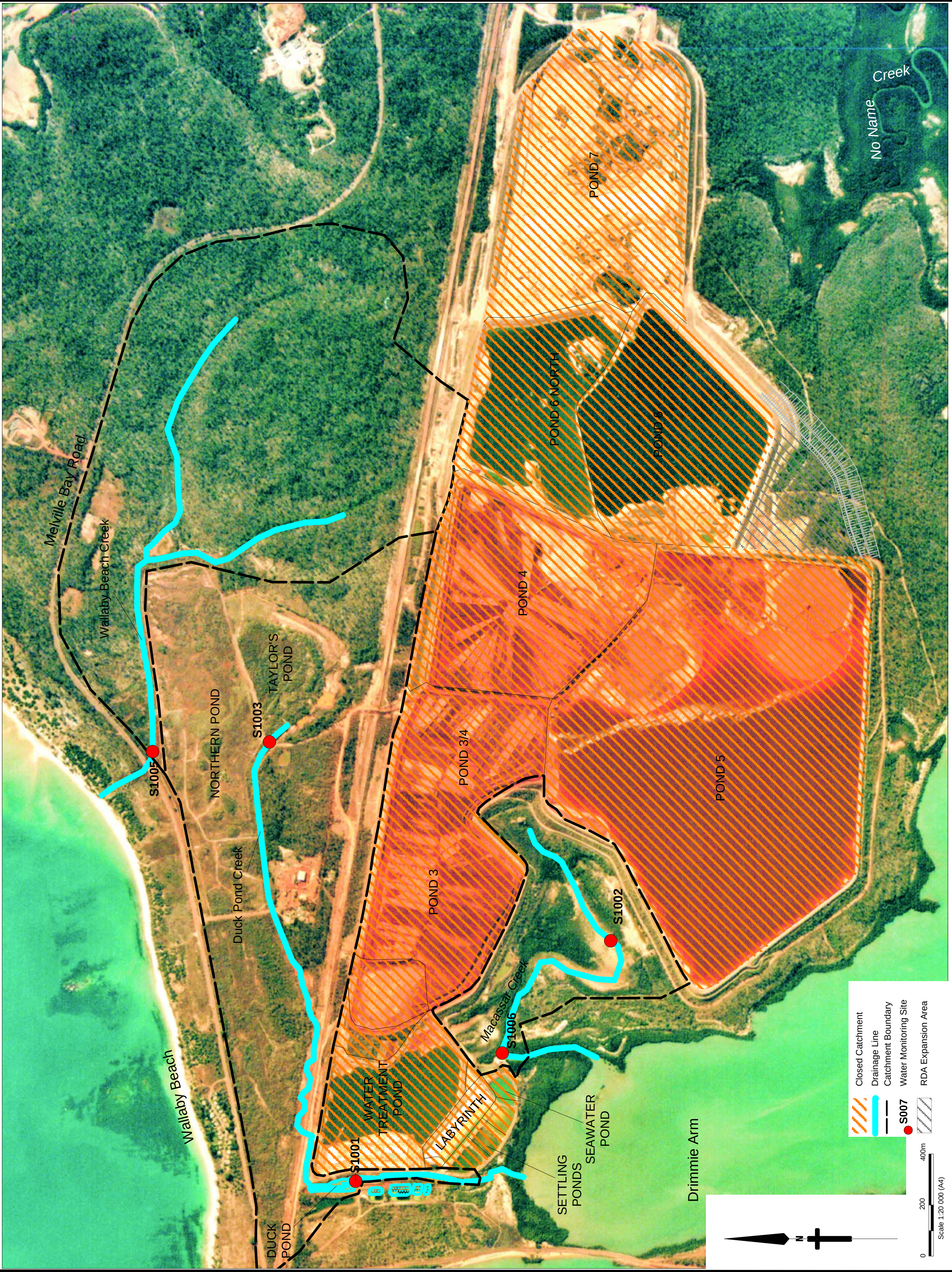
URS

ALCAN GOVE REFINERY EXPANSION ENVIRONMENTAL IMPACT STUDY

REFINERY CATCHMENTS, WATER FEATURES AND SELECTED MONITORING SITES

Project No.	12373-021-559	Date : 13-01-04	
MapInfo File No.	12373-021-g-043c.wor	Revision: C	A4

Figure: **11.2.1**



ALCAN

URS

ALCAN GOVE REFINERY EXPANSION
ENVIRONMENTAL IMPACT STUDY

RESIDUE DISPOSAL AREA CATCHMENTS, WATER FEATURES, AND SELECTED MONITORING SITES

Project No.	12373-021-559	Date :	13-01-04	
MapInfo File No.	12373-021-g-044c.wor	Revision: C		A4

Figure: **11.2.2**