CHAPTER 6 – WATER MANAGEMENT

GULF ALUMINA LTD – SKARDON RIVER BAUXITE PROJECT
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6. WATER MANAGEMENT

6.1 Introduction

This chapter describes the water management strategy for the Project to manage runoff from mining areas, the Port infrastructure area and other activity / infrastructure areas. Water management infrastructure is proposed and a regulated dam assessment has been undertaken for the Port area sediment pond(s). Project water demand has been estimated and a water supply strategy based on existing water sources (kaolin mine water storages and shallow aquifer bores) and additional shallow aquifer bores has been proposed.

This chapter informs the management of impacts to surface water (Chapter 12) and groundwater (Chapter 13). Chapter 12 and Chapter 13 provide a description of all mitigation and management measures designed to achieve environmental objectives and performance outcomes for surface water and groundwater.

Gulf Alumina manages the decommissioned kaolin mine (in care and maintenance) under a Plan of Operations and Rehabilitation Plan, with the current plan covering the period from February 2015 to February 2016. In addition, the existing EA for the mining leases conditions environmental management of the kaolin mine whilst in care and maintenance, including rehabilitation and decommissioning, and management and monitoring of water. Water management, rehabilitation and decommissioning for the kaolin mine is described in the environmental management plan (EM Plan) provided in Appendix 13.

6.2 Legislative and Policy Context

6.2.1 Water Supply (Safety and Reliability) Act 2008

The Water Supply (Safety and Reliability) Act 2008 is described in Chapter 2.

6.2.2 Manual for Assessing Consequence Categories and Hydraulic Performance of Structures

The Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EHP, 2013) (the Manual) sets out the requirements of the administering authority, for consequence category assessment and certification of the design of ‘regulated structures’, constructed as part of environmentally relevant activities (ERAs) under the EP Act.

6.2.3 Structures which are Dams or Levees Constructed as Part of Environmentally Relevant Activities

EHP has produced the Guideline - Structures which are Dams or Levees Constructed as Part of Environmentally Relevant Activities (EHP, 2014) (the Guideline for Dams or Levees). The management measures described in this chapter adopt the relevant conditions described in the Guideline for Dams or Levees, where relevant to the proposed water management infrastructure.

6.2.4 Groundwater Licence

An existing subartesian water licence which was awarded to Gulf on the 24 July 2012, which allows for 55 ML per annum from shallow aquifer bores in the Project area. Additional approvals under the Water Act 2000 are likely to be required for water supply from shallow aquifers greater than 55 ML per annum.
6.3 Environmental Objectives and Performance Outcomes

The environmental objectives and performance outcomes below are based on Schedule 5, Table 2 of the Environmental Protection Regulations 2008 (EP Regulation). The mitigation and management measures presented in this chapter are designed to achieve these environmental objectives and performance outcomes. The environmental management plan (EM Plan) presented in Appendix 13 provides a consolidated description of these mitigation and management measures.

6.3.1 Environmental Objectives

- The activity will be operated in a way that protects environmental values of waters.
- The activity will be operated in a way that protects the environmental values of wetlands.
- The activity will be operated in a way that protects the environmental values of groundwater and any associated surface ecological systems.
- The choice of the site, at which the activity is to be carried out, minimises serious environmental harm on areas of high conservation value and special significance and sensitive land uses at adjacent places.
- The design of water management infrastructure is in accordance with best practice environmental management.

6.3.2 Performance Outcomes

- Contingency measures will prevent or minimise adverse effects on the environment due to unplanned releases or discharges of contaminants to water.
- The activity will be managed so that stormwater contaminated by the activity that may cause an adverse effect on an environmental value will not leave the site without prior treatment.
- Any discharge to water or a watercourse or wetland will be managed so that there will be no adverse effects due to the altering of existing flow regimes for water or a watercourse or wetland.
- The activity will be managed so that adverse effects on environmental values are prevented or minimised.
- The activity will be managed in a way that prevents or minimises adverse effects on wetlands.
- The activity will be managed to prevent or minimise adverse effects on groundwater or any associated surface ecological systems.
- The activity will be managed to prevent or minimise adverse effects on the environmental values of land due to unplanned releases or discharges.

6.4 Water Management Strategy and Infrastructure

6.4.1 Mine Plan Alignment

Strategies developed for Project water management have been aligned with the mine plan presented in Chapter 5. The following aspects of the Project will affect water management:

- Mining will occur over ten years.
- Progressive rehabilitation (refer Chapter 7) including replacing excavated topsoil and subsoil in open mining areas.
Mining will be undertaken in the dry season only and therefore it is assumed that operational water demand during the months of wet season will be low to negligible.

- No beneficiation of bauxite will be required and hence this is not a source of water demand.
- The addition of water to bauxite stockpiles is only likely to be required in the drier months.
- The bauxite stockpile will be well drained and allow for rapid turnover of stocks to avoid build ups of wet, sticky ore.
- It has been assumed that road trains will be used for bauxite haulage – this will result in a conservative worst case scenario for impact assessment with significant dust uplift and dust suppression is expected to be the highest operational water demand.
- Average distances from mining areas to the bauxite stockpile at the Port are typically 12 km, and the haul road will need to be 12 m wide to accommodate the necessary plant.
- A haul road crossing over Namaleta Creek will be required for access to mine pits south of the Creek.
- There is no demand for water as part of the power supply to the mine.

Water management for mine site involves managing runoff from the following mine domains:

- mine pits
- Port infrastructure area
- other infrastructure and activities (e.g. construction activities, haul roads, limited soil stockpiles).

### 6.4.2 Mine Pits

During operational periods, it is intended that rainfall runoff entering the pit will be drained internally and contained within the pit, to be lost as evaporation and as recharge to local aquifers. The need for any sediment ponds external to pits will be determined during ongoing mining operations and may only be required in the unlikely event that the pre-mining topography does not allow for internally draining pits. Mine pits are shown in Chapter 5, Figure 5-14.

Due to the nature of bauxite mining (shallow pits to approximately 6 m depth, located at the top of localised catchments and hydrogeology of pit areas allowing seepage from pits) there is no requirement for external storage and release of water captured within pits.

Surface water runoff does not occur as long as the mine floor lies below the surrounding terrain. Stormwater drains through the groundwater system. This process is enhanced by deep ripping of the mine floor, which will occur prior to the wet season in most bauxite mining areas. Placement of soil and bauxite waste on the mine floor will be even and parallel to the mine floor topography, which will closely parallel to the original land surface. The edges of mining areas will be battered down to a 3:1 slope and re-vegetated as for the mine floor. Erosion within mined areas is negligible due to the generally flat or gently sloping terrain.

To prevent surface water runoff from mining areas, or to minimise runoff, in the unlikely event of it occurring, the following measures will be adopted for erosion and sediment management:

- Clearing and mining will not be carried out in areas of steep drop-off slope from the general terrain – expected generally to be within 100 m of natural waterways and swamps.
- Ripping will be conducted along contour lines, or offset to direct water away from valleys, using Keyline principles (i.e. management of the topography to control runoff).
- Should a low area be (erroneously) mined on the edge of a mining area, with potential to allow outflow of stormwater, earth bunds and silt traps will be constructed, as well as strategic contour banks.
on the mine floor to direct flow away from the area. All structures would be stabilized with establishment of grass cover, trees and shrubs.

Prior to mining, detailed resource surveys will be undertaken to inform the precise location of economic bauxite resources. This is expected to result in accurate delineation of pits areas which avoid:

- buffer zones around wetland and watercourses (refer to Chapter 15)
- low lying areas with the potential to require erosion and sediment control measures to prevent outflow from pits
- unnecessary clearance of vegetation in areas that will not be mined.

Land clearing in advance of mining will be undertaken in the dry season. Gulf Alumina is likely to undertake annual vegetation clearing, windrowing and burning in advance of proposed mining, with areas to be cleared subject to ongoing review of the proposed areas of mining. Mining will generally occur in the same year (i.e. during the dry season) and therefore there is limited potential for erosion following clearing activities. Following clearing and prior to mining, these areas will be stabilised by allowing regrowth of grasses and shrubs and to maintain viability of the soil for plant growth. Should any cleared areas not be mined within the same dry season, these cleared areas will be bunded along a perimeter track surrounding the cleared areas. Where there is a risk of increased sedimentation from areas cleared of deep rooted vegetation, erosion and sediment control structures will be installed.

6.4.2.1 Mine Site Sediment Management

The topography of the Project area is shown in Chapter 10 and is generally low lying and flat with topography rising towards a ridge where bauxite deposits are located. The Project mining leases are at around 5 – 20 mAAHD elevation where bauxite deposits occur, 3 - 8 mAAHD at the Port infrastructure area and lower in creek and wetland areas. The bauxite pits are located at the top of the local catchments and hence external catchments reporting to the pits will be minimal.

Under the proposed mining approach, there will be no sediment runoff from mining areas to surrounding land and waters as runoff will be managed within the pits. Sediment ponds receiving drainage from the disturbed mining areas will be managed in pit. Design will be carried out in accordance with best practice approaches and as part of an Erosion and Sediment Control Plan (ESCP). The ESCP will be developed in line with the IECA Manual which provides guidelines for erosion control on site, sediment pond design and construction, and their operation and maintenance.

The design and management details for in pit sediment ponds will be determined as an ongoing operational activity. However, preliminary estimates have been made for the sediment runoff volumes, and indicative geometric requirements for the expected sediment ponds within each pit. As described in Appendix 4, pond sizing was completed using the CALM approach (Witheridge and Walker, 1996). The approach depends on the erodibility of soil, peak runoff discharge and the volume of sediment likely to enter the structure. The basin surface area is determined as a function of the inflow rate and the target particle settling velocity.

The estimate catchments areas for each pit, sediment runoff volume and in-pit pond sizes and are provided in Table 6.1. Nominal sediment basin volumes range between 400 m³ and 88100 m³ with minimum storage depth requirements of between 2.0 and 2.3 m. This depth requirement could be reduced further, subject to pond management practices, with regular scouring and dredging to maximise containment volumes. The nominal in-pit pond size is approximately 0.5% of the pit catchment area for each pit. It is clear that in-pit sediment ponds will occupy a minor portion of each pit and that the pit itself will act to capture any runoff should the sediment basins overtop.
### Table 6-1  Catchments Areas, Sediment Runoff and Pond/Dam Sizing

<table>
<thead>
<tr>
<th>Pit</th>
<th>Local Catchment Area (ha)</th>
<th>Sediment Volume (m$^3$/y)</th>
<th>Nominal Pond Area (m$^2$)</th>
<th>Minimum Depth (m)</th>
<th>Storage Pond Volume (m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pit 1</td>
<td>78.1</td>
<td>5639</td>
<td>3300</td>
<td>2.1</td>
<td>7055</td>
</tr>
<tr>
<td>Pit 2</td>
<td>31.0</td>
<td>2238</td>
<td>1400</td>
<td>2.0</td>
<td>2855</td>
</tr>
<tr>
<td>Pit 3</td>
<td>296.0</td>
<td>21337</td>
<td>25000</td>
<td>2.1</td>
<td>53436</td>
</tr>
<tr>
<td>Pit 4</td>
<td>7.4</td>
<td>536</td>
<td>350</td>
<td>2.0</td>
<td>693</td>
</tr>
<tr>
<td>Pit 5</td>
<td>27.8</td>
<td>2007</td>
<td>1200</td>
<td>2.1</td>
<td>2527</td>
</tr>
<tr>
<td>Pit 6</td>
<td>4.4</td>
<td>318</td>
<td>200</td>
<td>2.0</td>
<td>407</td>
</tr>
<tr>
<td>Pit 7</td>
<td>43.6</td>
<td>3145</td>
<td>1900</td>
<td>2.1</td>
<td>3971</td>
</tr>
<tr>
<td>Pit 8</td>
<td>18.2</td>
<td>1314</td>
<td>800</td>
<td>2.1</td>
<td>1663</td>
</tr>
<tr>
<td>Pit 9</td>
<td>17.3</td>
<td>1249</td>
<td>800</td>
<td>2.0</td>
<td>1604</td>
</tr>
<tr>
<td>Pit 10</td>
<td>8.9</td>
<td>645</td>
<td>400</td>
<td>2.1</td>
<td>820</td>
</tr>
<tr>
<td>Pit 11</td>
<td>160.0</td>
<td>11553</td>
<td>6800</td>
<td>2.2</td>
<td>15254</td>
</tr>
<tr>
<td>Pit 12</td>
<td>369.0</td>
<td>26644</td>
<td>38000</td>
<td>2.3</td>
<td>88131</td>
</tr>
<tr>
<td>Pit 13</td>
<td>65.6</td>
<td>4737</td>
<td>2800</td>
<td>2.1</td>
<td>5943</td>
</tr>
<tr>
<td>Pit 14</td>
<td>83.6</td>
<td>6036</td>
<td>3600</td>
<td>2.1</td>
<td>7593</td>
</tr>
<tr>
<td>Pit 15</td>
<td>219.0</td>
<td>15813</td>
<td>12000</td>
<td>2.1</td>
<td>25616</td>
</tr>
</tbody>
</table>

#### 6.4.2.2 Mine Site Sediment Pond Management

The sediment ponds will be used opportunistically to meet local demand for water (e.g. dust suppression) thereby reducing the need for supply from other sources (e.g. shallow aquifer bores). For the dual purposes of containing sediment on site for controlled disposal and for providing low quality water supply, sediment and erosion control measures will include:

- regular inspection of the sediment storage structures conducted at the conclusion of the wet season (typically in April-May).
- inspection of sediment ponds to establish the condition and stability of rock walls and spillways (applicable to Port sediment ponds described below).
- monitoring of sediment deposition volumes and identification if a clean out is required to provide sufficient storage for sediment loading in runoff and improve storage availability where sediment ponds are in use for dust suppression.

Clean out will be completed immediately prior to the wet season, and sediment will be disposed of in a location where erosion will be limited or contained (e.g. mining areas undergoing rehabilitation), and will not contribute to sediment loads reporting to other control structures.

#### 6.4.3 Port Infrastructure Area

One or more sediment ponds will be required at the Port infrastructure area to capture runoff from disturbance areas, including the bauxite stockpile, paved areas, workshops and haul roads. Sediment
ponds based on the two Port layouts (refer Chapter 5), are shown in Figure 6-1, which also shows runoff flow paths and drainage control structures.

Under Option 1, there is an existing sediment pond which may be decommissioned or refurbished for the Project or, alternatively a new sediment pond may be constructed adjacent to the existing pond as a replacement. Under Option 2 a new sediment pond would be required to the north of the existing Port infrastructure and the existing sediment pond is likely to be retained. All sediment pond options are located to capture runoff from the Port infrastructure area.

Based on a preliminary risk assessment (Section 6.4.3.4), the Port area sediment ponds are not expected to be regulated dams. Following detailed design, and prior to the design and construction of the structure, the Port area sediment ponds will be subject to a regulated dam assessment by a suitably qualified and experienced person in accordance with the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EHP, 2014). A consequence assessment report and certification will be prepared for each structure assessed.

Port area sediment ponds will be designed by an appropriately qualified person. On the basis that Port sediment ponds are not expected to be regulated structures, the nominal design is for a 1:10 year annual exceedance probability (AEP), 24 hour rainfall event, subject to refinement during detailed design. Port area sediment ponds will have a spillway that is designed, constructed and effectively armoured to convey anticipated flows, with a nominal minimum design for a 50 year annual recurrence interval (ARI) rainfall event, subject to refinement during detailed design.

The nominal pond area allowed for in the conceptual layout of Port infrastructure allows for a sediment pond of at least 6000 m². From a sediment assessment based on the CALM method (refer to Appendix 4) for a 6 hour, 1 in 10 year storm event, the minimum pond area requirement for retention is estimated to be 673 m², demonstrating that the nominal pond area has been adequately sized. In addition to surface area, the proposed pond(s) meets all other geometrical requirements for containment times and settling depths to accommodate the design sediment load.

Runoff from the Port infrastructure area will be concentrated in drainage channels flowing to the sediment ponds. These drainage channels will be designed, constructed, armoured and maintained to maintain the runoff from all storm events up to an including a 1 in 10 year ARI rainfall event without causing erosion and sedimentation.

The sediment pond(s) at the Port will capture and retain runoff from the Port infrastructure area and during normal operation, will retain water in line with design guidelines to remove sediment to desired levels before controlled release. Release events will occur during rainfall events that exceed the design capacity of the sediment ponds, when there will be naturally high levels of turbidity in the receiving environment. Port area sediment ponds will minimise impacts on the Skardon River by:

- discharging through the nominated spillway
- managing releases to prevent scouring (e.g. rock spillways)
- maximising the distance through which discharges flow through vegetation prior to entering the Skardon River.
Should the Port area sediment pond(s) overtop, water will drain through an area of vegetation prior to entering the Skardon River estuary. The environmental values of the Skardon River estuary are described in Chapter 17 – Coastal Processes and Chapter 18 – Marine Ecology. Given the scale of the estuary compared to the scale of the Port area sediment pond(s), and high natural variation in estuary turbidity, any releases from the sediment pond are likely to have a minimal impact on the marine environment. Release events would only occur under a rainfall event that exceeds the design criteria when natural sediment loads in runoff would be high.

Sediment from the pond will be removed twice per year, and at least before the wet season, allowing maximum storage capacity for settling and containing suspended solids during the wet season. Sediment levels will be inspected in ponds following rainfall events resulting in runoff (e.g. 20 mm in 24 hours), which may result in further sediment removal so that the required design capacity is available from the next rainfall event. Sediment that is removed will be taken to an area where sediments will be contained, such as an open mining area.

Other measures to manage erosion and sediment runoff at the Port infrastructure area include:

- paving of some areas
- short term measures such as surface roughening of exposed areas particularly during periods of high risk for erosion (likely to occur during construction)
- long term prevention of erosion using control techniques such as revegetation and gravelling (which limits the impact of raindrops and generation of mud).

Port sediment ponds will be located above the 1:100 year flood level for the Skardon River as described in Chapter 14.

The pond(s) will not be more than 10 m in height and hence will not require a failure impact assessment under the Water Supply (Safety and Reliability) Act 2008.

### 6.4.3.1 Bauxite Stockpile Sediment Control

The stockpile will be gradually depleted over the year and decreased to zero in January so that no stocks are held during the wet season. This will prevent runoff from the stockpile over the wet season. Never-the-less the stockpile will be bunded and any runoff from the bauxite stockpile will be directed towards a sediment trap / sediment check dam system. This will consist of drains, incorporating rock lining as required, around the bauxite stockpile which direct runoff to an interceptor system. Sediment from the interceptor will be removed regularly, including after rainfall events. Outflow from the interceptor system will be directed to the port sediment ponds, thereby reducing the volume of sediment reporting to the sediment ponds.

### 6.4.3.2 Contaminant Management

Measures to prevent contamination of surface water and groundwater from hydrocarbons and chemicals in infrastructure areas, and from the landfill and bio-remediation pad are described in Chapter 11. Waste management at the Port infrastructure area is described in Chapter 8. The landfill and bio-remediation pad will be bunded to prevent ingress of runoff and prevent outflow of potentially contaminated water from direct rainfall.

These measures (e.g. bunds, oily water separators) are intended to prevent runoff to sediment ponds containing hydrocarbons, chemicals and other pollutants. Therefore any releases from the sediment ponds are not expected to contain elevated levels of hydrocarbons or chemicals.

### 6.4.3.3 Release Monitoring

Sediment depths in Port sediment ponds will be inspected at least biannually, prior to the wet season, following the wet season and after any significant rainfall events. Sediment will be removed and
transferred to an open mining area, should sediment depth compromise the design standards of the dams.

Release points from Port area sediment ponds will be located at the downslope end of these structures, for which coordinates are provided in Table 6-2, based on the conceptual Port area design. These coordinates are subject to change during detailed design and any approvals will be amended accordingly to reflect changes.

The existing EA nominates release point W2 at the Port as the ‘discharge point from stormwater drains on the bank of the Skardon River’. This EIS replaces this monitoring location with monitoring of the release point from the existing sediment pond, which more accurately reflects existing and proposed water management at the Port area. Note that Table 6-2 provides release points for the existing sediment pond and a new sediment pond (Port option layout 1) to replace the existing sediment pond, if required. It is unlikely that both sediment ponds will be required and hence this release point is referred to as S13.

Release points have been situated as far away from Skardon River as possible given the constraints of collecting runoff downstream of Port infrastructure, above the Skardon River flood zone, and with 50 m to 100 m separation distance to the Skardon River. Release points will have a shallow contour drain leading away from the dams, so that water spreads over a native vegetation area between 50 m and 100 m from the Skardon River. This will result in dissipation of flows and a reduction in velocity and erosion potential.

**Table 6-2  Release Points – Port Area Sediment ponds**

<table>
<thead>
<tr>
<th>Release Point</th>
<th>Reference per existing EA</th>
<th>Easting</th>
<th>Northing</th>
<th>Monitoring Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>S13 – Discharge point from the existing Port sediment pond</td>
<td>W2 - Discharge point from stormwater drains on the bank of the Skardon River</td>
<td>616718</td>
<td>8699703</td>
<td>Within 24 hours of any discharge from S13 (formerly W2) and thereafter weekly whilst discharging</td>
</tr>
<tr>
<td>S13 Proposed sediment pond – Option 1 (adjacent to existing sediment pond)</td>
<td>n/a</td>
<td>616718</td>
<td>8699703</td>
<td>Within 24 hours of discharge and thereafter weekly whilst discharging</td>
</tr>
<tr>
<td>S14 - Proposed sediment pond – Option 2</td>
<td>n/a</td>
<td>616639</td>
<td>8700156</td>
<td>Within 24 hours of discharge and thereafter weekly whilst discharging</td>
</tr>
</tbody>
</table>

During a release event, monitoring will commence with 24 hours of a release event (subject to safe access) and releases will be monitored weekly until releases cease. Release will be monitored for the following parameters:

- physico-chemical
- nutrients
- metals
- total petroleum hydrocarbons
- oil and grease.
The proposed release limits for the Port sediment ponds are provided in Table 6-3, and are based on the preliminary marine water quality objectives presented in Chapter 17.

### Table 6-3 Release Limits

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Release Limit</th>
</tr>
</thead>
</table>
| Turbidity           | NTU   | Turbidity maximum as identified through monitoring at site S16 prior to any release.  
                      |       | No visible plume in Skardon River                                             |
| Electrical Conductivity | µS/cm | Salinity maximum as identified through monitoring at site S16 prior to any release.  |
| ph                  | ph units | 7 - 8.5                                                                       |
| Total nitrogen      | µg/L  | 1000                                                                          |
| Total phosphorus    | µg/L  | 60                                                                            |
| Aluminium           | µg/L  | 220                                                                           |
| Arsenic             | µg/L  | 92                                                                            |
| Cadmium             | µg/L  | 0.35                                                                          |
| Chromium            | µg/L  | 4.9                                                                           |
| Copper              | µg/L  | 3.9                                                                           |
| Iron                | µg/L  | 274                                                                           |
| Mercury             | µg/L  | 0.1                                                                           |
| Nickel              | µg/L  | 12.5                                                                          |
| Lead                | µg/L  | 2.5                                                                           |
| Zinc                | µg/L  | 38                                                                            |
| Petroleum hydrocarbons (C6-C9) | µg/L | 20                                                                            |
| Petroleum hydrocarbons (C10-C36) | µg/L | 100                                                                           |
| Oil or grease       | n/a   | No visible film or detectable odour to Skardon River                           |

#### 6.4.3.4 Preliminary Regulated Dam Assessment

The Port area sediment pond(s) will be located such that no dwellings or workplaces are located within the potential failure impact zone. There are no other structures proposed downstream of the Port area sediment pond(s) that would result in a cascading failure. There are no drinking water sources downstream of the Port area sediment pond(s).

This area is already subject to disturbance from Port development and will be subject to further disturbance through wharf construction and ship operations for the Project. There are no known seagrass communities in the area near the Port proposed for the wharf and limited fringing mangrove vegetation due to the relatively steep topography of the Port area.
A preliminary consequence category assessment, based on the Manual, is provided in Table 6-4. This assessment is preliminary in nature as the final detailed design of the sediment pond(s) has not been completed. A final consequence category assessment will be undertaken once design is sufficiently progressed.

The consequence category has been assessed as low for all failure event scenarios. Therefore the Port area sediment pond(s) has not been assessed as a regulated structure.

**Table 6-4 Preliminary Consequence Category Assessment**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Failure to Contain: seepage</th>
<th>Failure to contain: overtopping</th>
<th>Dam Break</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harm to humans: dam break</td>
<td>n/a</td>
<td>n/a</td>
<td><strong>Low</strong> - Location such that people are not routinely present in the failure path and loss of life is not expected.</td>
</tr>
<tr>
<td>Harm to humans</td>
<td><strong>Low</strong> - Location such that contamination of waters (surface and/or groundwater used for human consumption could result in the health of less than 10 people being affected. There are no known human consumptive uses of downstream surface water or groundwater.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General environmental harm</td>
<td><strong>Low</strong> - Contaminants are likely to be released to be released to areas of Significant Values or Moderate Values, but would be unlikely to meet any of the following minimum thresholds: i) Loss or damage or remedial costs greater than $10 million ii) Remediation of damage is likely to take more than 6 months iii) Significant alteration to existing ecosystems iv) The area of damage (including downstream effects) is likely to be greater than 1 km$^2$.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General economic loss or property damage</td>
<td><strong>Low</strong> - Location such that harm to third party assets in the failure path would be expected to require less than $1 million in rehabilitation, compensation, repair or rectification costs.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Any structures that may require a consequence category assessment will be assessed by a suitably qualified and experienced person in accordance with the Manual prior to the design and construction of the structure. A consequence assessment report and certification will be prepared for each structure assessed.

It is anticipated that all structures required for the Project will have a low consequence category rating with respect to the seepage, overtopping and dam break criteria and hence will not be regulated structures. Therefore management measures have not been proposed for regulated structures. However, should any structure be found to be requiring categorisation as a regulated structures, the proponent will seek approval for those structures prior to construction. Any management measures related to regulated structures will be based on the Guideline for Dams or Levees.

**6.4.4 Erosion and Sediment Control**

Other than the Port infrastructure area and mining areas, erosion and sediment control measures will be implemented at:

- construction areas
- permanent haul roads
- haul road crossing of Namaleta Creek and other drainage features.

### 6.4.4.1 Erosion and Sediment Control Plan

An erosion and sediment control plan (ESCP) will be developed for the Project prior to commencement of construction and mining activities and will cover all aspects of the Project including clearing, construction, operations, rehabilitation and decommissioning. The ESCP will be approved by a suitably qualified person\(^1\) (such as a Certified Professional in Erosion and Sediment Control). The ESCP will be amended as the mine develops to account for changes in final landform design and infrastructure locations.

An ESCP will be developed in accordance with the:

- Stormwater guideline – Environmentally relevant activities (EHP, 2014).

The ESCP will include the following:

- An assessment of erosion risk will be undertaken for different parts of the Project area.
- Soil types will be assessed (refer Chapter 10), including identification of erosion potential.
- Soil will be managed in accordance with the measures described in Chapter 10 for soil stripping, handling, stockpiling and testing.
- Development of the ESCP will be integrated into the mine planning process.
- Sensitive areas (e.g. buffer zones around watercourses and wetlands) that may require specific measures to prevent sedimentation will be identified.
- The period of maximum disturbance will be planned to occur in the dry season.
- Construction activities and land clearing will be undertaken in the dry season.
- The extent and duration of disturbance (topsoil and subsoil exposure) will be minimised.
- Boundaries of areas to be cleared will be delineated and clearing will be authorised by use of a ‘permit to clear’ system.
- Grubbing out and removal of ground cover will be carried out as close to the time of mining or earthworks as possible.
- Stabilisation of areas cleared in advance of mining will occur through allowing regrowth of grasses and shrubs.
- Stormwater runoff from external or undisturbed catchments will be diverted around or away from infrastructure construction areas.
- Uncontaminated stormwater run-off will be diverted around areas disturbed by Port infrastructure area activities or where contaminants or wastes are stored or handled.
- All drainage structures and sediment controls will have design specifications appropriate to the rainfall regime and design life.
- Erosion controls will be used to minimise sediment generation and transport.

\(^1\) For example, an appropriately qualified person as defined in Stormwater guideline – Environmentally relevant activities (EHP, 2014)
Sediment controls will be used to treat run-off from disturbed areas prior to leaving the site.

Sediment controls will be located as close to the source as possible.

Erosion and sediment control structures will be installed as required, prior to disturbance in that area of site.

Disturbed areas will be stabilised as soon as possible (progressively rehabilitated).

Control structures will be inspected regularly.

Details of the rehabilitation of the site, including final landform design is provided in Chapter 7. Rehabilitated landforms will be designed to minimise slope angle and length. Erosion loss decreases exponentially with percentage ground cover and is greatly reduced when cover exceeds 50%. For long-term stabilisation in tropical climates, IECA (2008) recommends a minimum ground cover of 80% which will be considered as the target for this Project. Vegetation establishment will be required for long-term soil stabilisation. All revegetated areas will be monitored to ensure the desired ground cover is achieved and further seeding or planting is conducted in areas that do not meet the desired target.

Erosion mitigation measures specifically relevant to waterways include the following:

- Where earthworks are carried out in proximity to a watercourse, disturbance will be stabilised.
- Felled timber will be removed from the area and stockpiled away from the watercourse.
- Where required temporary controls will be installed along cleared slopes approaching watercourses, to divert dirty water away from the watercourse.
- Clean rock and culverts will be used for temporary watercourse crossings
- Water discharged to a waterway will meet Project water quality objectives.

The ESCP may include measures such as:

- velocity slowing methods including rock and log placement in cleared areas
- restriction of land disturbance
- scour protection design methods for drainage
- rehabilitation practices to limit erosion.

The ESCP will be implemented for construction and throughout operations. Drainage and erosion control will be implemented as a part of operational activities using measures such as erosion control blankets, check dams, filter fences and rock mattresses.

Monitoring of erosion and sediment control structures will be carried out both pre- and post-wet season and following any significant events. Monitoring may be done using visual methods (such as those for recording erosion features) and/or more quantitative methods such as those using erosion monitoring pins, or measuring sediment loads from monitored catchments.

Monitoring of erosion and sediment controls may include:

- visual inspections undertaken regularly and following significant rainfall e.g. 20 mm in 24 hours
- daily monitoring of weather predictions to manage clearing and construction activities.
- completion of site inspection checklist
- supervisors to visually monitor all operations and identify where correct procedures are not being followed
- contractors to monitor works and should they become aware of improper management practices, to report the issue to their supervisor.
site supervisors will be responsible for modifying or stopping non-conforming management practices until corrective actions are determined
corrective and preventive actions to be implemented and monitored visually on site to ensure they are effective.

6.4.4.2 Permanent Haul Roads

Permanent haul roads (i.e. the main haul road connecting the Port area to the mining areas to the south) will be designed in consideration of the Department of Transport and Main Road's (TMR's) Road Drainage Manual (TMR, 2015). This provides technical guidance on road drainage, erosion, environmental and sediment control.

6.4.5 Namaleta Creek Crossing

6.4.5.1 Location

The location of the proposed crossing of Namaleta Creek is shown in Figure 6-2. This is the same location as the existing crossing.

6.4.5.2 Existing Crossing

The existing crossing of Namaleta Creek crossing consists of an earthen crossing (10 – 15 m wide), where two cylindrical pipes connect the upstream and downstream reaches of Namaleta Creek. These existing pipe culverts may be impacting flows and fish passage. The section of road currently crossing the south-western flood plain of Namaleta Creek (refer to Figure 6-2) is restricting normal flow during the height of the wet season.
Namaleta Creek Crossing

Figure 6-2

Gulf Alumina Limited

Date: 6/10/2015
Revision: 1

Legend
- Port of Skardon River
- Mining Lease Boundaries
- Watercourses
- Existing Disturbance Footprint
- Project Footprint
- Haul Road
- Crossing

Elevation Contours (0.5m)

Risk of Impact
- 2 - Moderate (Streams)

Queensland Waterways for Waterway Barrier Works

Risk of Impact


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6.4.5.3 Crossing Design

The crossing will be upgraded to support haul truck movements between mining areas to the south of Namaleta Creek and the Port. The corridor associated with the proposed upgrade of the crossing will be 40m at the widest point requiring an additional 25m of clearing. The design of the crossing will be in accordance with the Department of Agriculture and Fisheries Code for Self-assessable Development – Minor Waterway Barrier Works, Part 3 Culvert Crossings, Code Number: WWBW01 April 2013 (the Code). This Code is designed to minimise impacts to fish passage. In this respect the upgraded crossing will result in the hydrology of the area more closely resembling its pre-disturbance condition. Additional culverts will be inserted in the section of road crossing the flood plain to restore free flow of wet season water.

A schematic cross-section of the Namaleta Creek crossing is shown in Figure 6-3. The culverts and deck level of the crossing were sized for a 1:50 year AEP design flood standard. Figure 6-3 shows the preliminary sizings of the culvert groupings proposed to convey water through the haul crossing embankment, as applied in the model. Note that the culverts are distorted by the aspect ratio of the cross-section.

Figure 6-3   Namaleta Creek Crossing – Downstream View

Preliminary sizing of the culvert groups and bridge deck level required at the crossing was carried out with reference to the guidelines and recommendations of the Road Drainage Manual, Department of Transport and Main Roads, July 2015 (TMR-RDM).

Detailed design will be carried out in compliance with the TMR-RDM and with:


The following specific conditions are noted from the Code for addressing moderate impact waterways (applicable to Namaleta Creek):

- Works must commence and finish within a maximum time of 360 calendar days and instream sediment and instream silt control measures associated with the works must be removed within this period.
- The crossing must have a minimum (combined) culvert aperture width of 2.4 m or span 100% of the main channel width.
- All new or replacement culvert cells must be installed at or below bed level.
- The internal roof of the culverts must be >300 mm above ‘the commence to flow’ water level.
- Where the cell is installed at less than 300 mm below bed level (potentially the case for the Namaleta Crossing), the culvert floor must be roughened throughout to approximately simulate natural bed conditions.
- The culvert must be installed at no steeper gradient than the waterway bed gradient.
- Apron and stream bed scour protection must be provided in line with the design requirements of the Code.

It is expected that the Code requirements can be met for the Namaleta crossing design.

**6.4.5.4 Crossing Drainage**

Drainage from road surface of the crossing will be directed to the ends away from the Creek, by peaking the height of the crossing at its centre and raising the entire crossing above the elevation of the surrounding topography. Thus stormwater runoff will drain to the entry points of the crossing approximately 50 m to 100 m from the Creek bank. Silt traps will be installed at the end of the drains and over flow directed into contour drains. On the south-west side this water will flow into natural vegetation while on the north-east side water will be directed into kaolin mine revegetation areas, or kaolin mine water storages.

**6.4.5.5 Crossing Construction and Rehabilitation**

To prevent any instream impacts including sedimentation to Namaleta Creek and the mapped HES wetland during the construction of haul road crossing, construction activities will be scheduled for the dry season, when the potential for impact is minimised due to low or no flow conditions when temporary impoundments are not expected to be required when working within the in-stream environments. This strategy is also part of avoiding disturbance of acid sulphate soil, the management of which is described in Chapter 10.

With construction of the proposed crossing within a single dry season, temporary changes to the drainage and flow regimes will be avoided and Creek flow will be improved from the current situation in the following wet season. Construction work within Namaleta Creek will ensure that all surfaces are adequately stabilised following the completion of the haul road crossing. This will include revegetation of exposed embankment areas and mulching if necessary until stream banks have stabilised.

A significant level of vegetation clearing and landform modification has occurred on the northern side of Namaleta Creek as a consequence of the former kaolin clay mine operation. The resilience of the *Melaleuca*-dominated vegetation of this wetland has the capacity to regenerate rapidly, and form a functional and protective vegetation cover within a relatively short period, and this would be expected for the crossing upgrade.

The crossing will be constructed with ironstone material from the borrow pits over a claystone core, using material from the kaolin claystone overburden stockpile.

**6.4.6 Crossings of other Drainage Features**

The haul road will cross a drainage feature between Pits 14 and 15 to the south of Namaleta Creek, as shown in Figure 6-4. This drainage feature is mapped as moderate risk for waterway barrier works. The design of the crossing will be determined following inspection of the area, including drainage, and extent and width of any potential wetland features (if wetland is found to be associated with this area). The design of the crossing will be in accordance with the Department of Agriculture and Fisheries Code for Self-assessable Development – Minor Waterway Barrier Works, Part 3 Culvert Crossings, Code Number: WWBW01 April 2013.
Crossing construction will follow the methodology described for the Namaleta Creek crossing. Culverts will maintain natural flow of stormwater in the drainage feature and the road surface drainage system will direct flow away from drainage feature. All works required within the drainage feature will ensure that all surfaces are adequately stabilised following the completion of the haul road construction. This will include revegetation of exposed embankment areas and temporary erosion and sediment control until construction is completed or drainage feature banks have been stabilised.
6.4.7 Operation of the Water Management System

6.4.7.1 Responsibility

Water management issues traditionally cross over a number of organisational boundaries within an operation. It is therefore important to clearly assign responsibilities for all aspects of water management to specific roles from senior management to the operator level. Gulf Alumina will assign responsibilities appropriately in line with operational development. Responsibilities with respect to water management include:

- day-to-day operation and maintenance of the water management system
- surface water and groundwater monitoring
- overall planning for the system
- regulatory compliance of the system
- review and update of water management models and documents.

6.4.7.2 Emergencies

After any emergency and response involving water management, any statutory reporting requirements will be completed in the first instance as necessary. An investigation will be conducted into the cause and the water management system and emergency and contingency planning reviewed to prevent a recurrence or ensure preparedness for any similar future situations.

Additional actions that may be taken in an emergency include:

- controlling flow from structures if this can be achieved safely with immediate intervention (e.g. contain flows utilising bunds and block flow paths as possible)
- monitoring impacted water quality as soon as this can be done safely
- notify stakeholders (e.g. Ports North, Maritime Safety Queensland, landowners, Traditional Owners) and regulators as required
- clean up spillage and repair or decommission structure following risk assessment.

6.4.7.3 Climatic Impacts

Regular site controls to manage drought will be based on:

- regular and reliable monitoring of water storages and supply, and groundwater levels
- accessible water monitoring records and databases
- review of trends in water data and all relevant publically available data.

Regular site controls to support protection from high rainfall events will include:

- management of freeboard in water containment and water storages prior and during the rainy season (through diversion of pumped inflows where possible or exercise of authorised discharge, releases, etc.)
- separation of clean water from sediment laden water to limit volumes of sediment laden water requiring management
- maintenance of wet weather access and equipment
- regular inspections of water management infrastructure
- runoff assessment for site and infrastructure (and design and construction)
• inspections after significant rainfall events of water containment structures, water courses and drainage lines for erosion and damage.

6.4.7.4 Controls to Prevent Failure
Regular site controls to prevent the failure of water retaining structures (e.g. sediment ponds) will include:
• spillway construction with suitable capacity to prevent overtopping of embankments
• inspection of structures prior to the rainy season and after any spillway discharge
• management of water levels in water containment structures prior and during the rainy season
• monitoring of dam embankments for structural stability.

6.4.7.5 Discharge Management
A discharge is defined as loss of water from an onsite water containment structure released to the environment; the discharge may or may not flow offsite. Regular site controls to prevent unplanned and unauthorised discharges will include the following:
• Ensure that all storages and sediment ponds have suitable outlet capacity designed to best practice standards to prevent overtopping and embankment failure.
• Inspect structures prior to the rainy season and after any spillway discharge.
• Manage and monitor water levels in water containment structures prior and during the rainy season including end of pipe authorised discharge.
• Assess the likelihood of an uncontrolled release occurring based on rainfall information and site inspection.
• Take additional actions in an emergency.

6.5 Water Balance

6.5.1 Water Demand
The estimation of the raw water demand for the Project from construction through to operation’s completion takes the following into consideration:
• potable water supply for workforce during construction, ramp up and operations
• allowance for vehicle wash-down requirement
• dust suppression demand based on:
  • seasonal application rates for Port area and haul roads
  • scheduling of land clearing, timing of annual operations, etc. – factors that affect timing of dust control requirements in these areas
• allowance to maintain product water content

6.5.1.1 Potable Water
Estimates for the mine work force requirements are based on a unit demand of 300 L/person/day. Staff levels are reduced during the wet season.

6.5.1.2 Vehicle Washdown
An estimated wash-down demand of 17 m³/d has been allowed.
6.5.1.3 Dust Suppression

Rainfall and evaporation data (refer Chapter 13) is considered to provide a reasonable basis for establishing local haul road dust suppression demand. Seasonal variations of the difference between rainfall and evaporation indicate that the highest annual demands for water application for dust control are most likely to occur from May through to November. Estimated water application rates (Figure 6-5) vary between 8.2 L/m²/d (October) and 2.3 L/m²/d (February). These rates are regarded as conservative (i.e. they would tend to overestimate the volume of water required for dust suppression).

![Seasonal Water Application Rates for Dust Suppression](image)

6.5.1.4 Product Moisture Content

To ensure sufficient dust control (dust extinction moisture) to the mined product, an allowance is made for addition of water at a transfer point before stockpiling at the Port Area. It is expected that losses will occur in transit in storage and handling between the mine areas, stockpile and barge loader. Estimates of water loss were supplied by the Project’s mining engineers. The annual requirement for dust suppression at the Port is estimated to be between 60 ML and 110 ML.

6.5.1.5 Construction and Maintenance

An allowance of 50 m³/d is included in the water balance calculation to provide for ongoing maintenance of site infrastructure. This is intended to provide a secure water supply for construction activities requiring compaction and concreting over the life of the Project.

6.5.2 Demand Summary

Potable water, vehicle washdown water and water for construction and maintenance may require higher water quality than water for dust suppression and product moisture content. Therefore water demand has been shown for two different water quality groupings in Figure 6-6 (high / medium water quality) and Figure 6-7 (low water quality). Low water quality demand is approximately 10 times the high / medium water quality demand.

Figure 6-6 and Figure 6-7 show construction (2016) through to Year 4 (2020) of mining, after which time water demand demonstrates the same monthly and seasonal variations over remaining years as Year 4. Maximum water demand reaches 1,653 m³ in the 2019 dry season and all dry seasons during mining.
thereafter. The maxima and average forecast demands (averaged monthly) are shown below in Table 6-5. There is considerable seasonal variability, particularly in the larger demands related to dust control on haul roads and in the product stockpile.

**Figure 6-6   Water Demand (High / Medium Quality)**

**Figure 6-7   Water Demand (Low Quality)**
### Table 6-5  Demand Summary

<table>
<thead>
<tr>
<th>Category</th>
<th>Maximum (m³/d)</th>
<th>Average (m³/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potable water</td>
<td>35</td>
<td>29</td>
</tr>
<tr>
<td>Dust suppression</td>
<td>1177</td>
<td>718</td>
</tr>
<tr>
<td>Dust extinction moisture allowance</td>
<td>374</td>
<td>209</td>
</tr>
<tr>
<td>Construction &amp; maintenance</td>
<td>50</td>
<td>38</td>
</tr>
<tr>
<td>Washdown - plant &amp; equipment</td>
<td>17</td>
<td>13</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1653</strong></td>
<td><strong>1006</strong></td>
</tr>
</tbody>
</table>

#### 6.5.3  Water Supply

#### 6.5.3.1 Water Supply Strategy

The following general principles underlie the water supply strategy, based on forecast demand and available sources:

- The strategy must take advantage of all opportunities to recycle water within the operation.
- The shallow aquifer resources in the Project area can provide reasonable volume and reliable yields, and the groundwater is of good quality.
- The shallow aquifer bores should be regarded as primary dry season supplies, and as such, should only be accessed in the absence of alternative supplies to ensure that demands are met through the entire dry season.
- Surface water dams in addition to the kaolin mine water storage pits are not considered a feasible source of water and hence are not considered any further.
- Sediment ponds operating as a part of mining operations will collect surface runoff and potentially, seepage inflows from shallow aquifers. These can be useful local storages through the wet season and into the early dry season.

The primary water supply options are:

- the kaolin mine water storage pits sources (Claystone Pit and Raw Water Pit, as shown in Chapter 5, Figure 5-3)
- groundwater from shallow aquifers

There is an existing shallow aquifer borefield currently in use to meet demands such as the camp potable supply. Additional shallow aquifer bores will be constructed in the Namaleta Creek, Lunette Swamp and Port area borefields.

To ensure security of supply through the dry season, all surface water sources susceptible to evaporation such as the kaolin pits and sediment ponds, will be used in advance of the shallow aquifer sources.

Water supply from Great Artesian Basin (GAB) aquifer sources and / or from construction of additional surface water storage dams is not proposed for the Project.
Due to inherent uncertainty in supply volume estimates considerable conservatism (i.e. lower than expected yields from water supply sources) has been built into the approaches adopted.

### 6.5.3.2 Kaolin Mine Water Storages

In order to estimate the potential yields of Claystone Pit and Raw Water Pit for use in supply, a preliminary assessment was carried out using a GoldSim model. The inflows to the pits include seepage from local alluvial groundwater, as well as surface runoff. Appendix 4 describes the modelling assumptions including dam catchment area, seepage rates, transmissivities, rainfall, evaporation, hydrological parameters and stage-storage-area relationships for the pits.

The analysis is considered to provide a reasonable basis for preliminary yield assessment. Data was provided by Gulf which states that the reliable continuous supply of the Claystone and Raw Water Pits was measured to be 25 kL/hour (600 m³/d) by previous operators of the kaolin mine. This is in line with the rate predicted in the Goldsim model, which gives an estimated reliability of 92% for a supply of 600 m³/d, as shown in Figure 6-8.

![Figure 6-8 Estimated Yield of Kaolin Water Storages](image)

### 6.5.3.3 Shallow Aquifers

The hydrogeology of the Project area, including shallow aquifers is described in Chapter 13. The shallow aquifers include groundwater to be sourced from the Bulimba Formation and from alluvial deposits adjacent to the creeks in the area. During previous kaolin mining operations, shallow bores that were used and that are available to the Project as supplies include bores in the Namaleta Creek and Lunette Swamp aquifer systems.

The Namaleta Creek borefield area has four bores (AKP02, AKP03, AKP04, AKP05), which are not currently in use and would require refurbishment for water supply. The Lunette system is host to the camp supply bore G1 (formerly AKP01). There are also production bores at the Port area, which are used intermittently at present (G5). These borefields and bores are shown in Figure 6-9.
Six new shallow aquifer bores have been proposed to meet the water demand for the Project, with three bores proposed for the Port area, two in the Lunette aquifer and one in the Namaleta Creek aquifer north of Namaleta Creek), as shown in Figure 6-9.

The potential discharge rates for these bores have been based on previous studies for the kaolin mine (refer Chapter 13). Information provided by the previous mining lease holders to Gulf gives an estimate of the average yield of the shallow aquifer to be approximately 600 m$^3$/d. This rate concurs with the results of yield testing carried out by Golders (1998) in the Namaleta Creek system, which resulted in recommendations for a borefield comprising four bores, each capable of delivering 155 m$^3$/d. This would imply that discharge rates over the long term from each bore would be in the range of 1 to 2 L/s which is consistent with the sustainable discharge rates measured for shallow aquifer bores elsewhere in the Bulimba Formation in the Cape York area.

Local groundwater can be of sufficiently high quality as to not require even primary treatment. However, the bore water quality is subject to local conditions in the bore recharge capture zone where river and rainfall recharge the aquifer. Hence, any groundwater used in potable supply or to meet other higher quality water demand such as concrete batching will be tested regularly.
Figure 6-9

G:\CLIENTS\E-TO-M\Gulf Alumina\GIS\Maps\EIS\Ch06_Water_Mgmt\FIG_6_09_Existing_Prop_Water_Supply_Bores_151006.mxd

Revision: R1
Date: 6/10/2015
Author: malcolm.nunn

Map Scale: 1:80,000
Coordinate System: GDA 1994 MGA Zone 54

Legend
- Mining Lease Boundaries
- Port of Skardon River
- Watercourses

Existing and Proposed Bores for Water Supply

Figure 6-9

Gulf Alumina Limited

Date: 6/10/2015

Existing and Proposed Water Supply Bores

No warranty is given in relation to the data (including accuracy, reliability, completeness or availability) and except no liability (including without limitation, liability in negligence) for any loss, damage or cost (including consequential damages) arising in any way out of the use of or reliance upon the data. Data must not be used for direct marketing or be used in breach of privacy laws. Tenures © Geos Mining (2015). State Boundaries and Towns © Geoscience Australia (2006). Watercourses © Geoscience Australia. Imagery © ESRI (2015).
6.5.3.4 Sediment Ponds

Sediment ponds constructed as a part of normal operations can be used to provide a low quality water source for applications such as dust suppression and rehabilitation. However this has not been factored into the site water balance due to the unreliability of these sources for supply. Any use of this water will be opportunistic, and will further offset the need for use of shallow groundwater.

6.5.3.5 Great Artesian Basin and New Dams

Water supply from GAB aquifer sources and / or from construction of additional surface water storage dams is not proposed for the Project. Gulf recognises that a licence application to access GAB water was made in 2010. There have been a number of changes in legislation and policy regarding access to GAB water since 2010 and that licence application remains with DNRM. Gulf initially considered the GAB water would be required in conceptual mine planning for the Project in 2010 when beneficiation of the bauxite ore was proposed. The current mine plan does not propose beneficiation and hence GAB water is not required to supplement other sources.

Construction of a surface water dam has not been considered as it will have a high capital cost and impact on the local hydrology.

6.5.4 Supply Summary

Table 6-6 summarises the average sustainable yields of existing and proposed supply sources. The existing system (which would require refurbishment of the supply infrastructure) would supply an estimated 1,251 m$^3$/d, which is not be capable of meeting the forecast demand at all times under the proposed regime of 9 months of mining annually. With the addition of new shallow aquifer bores, supply estimates increase to 1,741 m$^3$/d.

<table>
<thead>
<tr>
<th>Source</th>
<th>Source Comment</th>
<th>Yield (m$^3$/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Namaleta Borefield</td>
<td>Existing / Potential Shallow aquifer; yield estimates from field testing by Golders (1998) for 4 bores at 130 m$^3$/d each.</td>
<td>520</td>
</tr>
<tr>
<td>Lunette Borefield</td>
<td>Existing Camp supply bore (G1); estimate from field testing by Golders (1998) - 150 m$^3$/d sustainable yield for each bore</td>
<td>150</td>
</tr>
<tr>
<td>Kaolin Pit surface storages</td>
<td>Existing Water Pit and Claystone Pit; yield estimated in current study for 95% reliability.</td>
<td>581</td>
</tr>
<tr>
<td><strong>Sub-total – existing sources</strong></td>
<td></td>
<td><strong>1251</strong></td>
</tr>
<tr>
<td>New Shallow Aquifer Bores</td>
<td>Proposed Comprising:</td>
<td><strong>490</strong></td>
</tr>
<tr>
<td></td>
<td>1 additional bore in Lunette shallow aquifer (150 m$^3$/d)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4 additional bores in Bigfoot or Port area at ~85 m$^3$/d per bore, assumed average daily discharge of 1 L/s per bore. (Note that there is an existing bore at the Port that may be suitable).</td>
<td></td>
</tr>
<tr>
<td><strong>Total – all supply sources</strong></td>
<td></td>
<td><strong>1741</strong></td>
</tr>
</tbody>
</table>
6.5.5 Supply and Demand Forecasts

Figure 6-10 shows the water balance under the proposed supply options, which would require that additional bore capacity is installed prior to August 2017.

![Water Balance Summary](image)

6.5.6 Demand and Supply Management

The water balance presented above represents a conservative scenario (i.e. higher demand than expected and lower supplies than potentially available). This provides a realistic, conservative scenario for the assessment of impacts to groundwater from shallow aquifer supply (refer Chapter 13). The following opportunities exist to reduce demand or increase supply, which are not considered in the water balance modelling:

- Opportunistic use of water in sediment ponds will have some capacity to offset local demand.
- Binding agents are proposed for use on roads to reduce the need for water for dust suppression.

Stabilisation of haul roads prior to mining is likely to include the application of a polymeric binding agent based on a calcium lignosulphonate compound that assists in reducing watering requirements for dust suppression during operations. Calcium lignosulphonate is a by-product of the pulp and paper industry. It reacts with negatively charged clay particles to agglomerate and stabilise the soil. A manufacturer has reported that trials have demonstrated water demand reductions of up to 90%. The median dust suppression demand over the Project life has been estimated to be 793 m$^3$/d. A reduction in road-water usage of even 30% would result in a saving 238 m$^3$/d which is equivalent to the yield of one to two shallow aquifer bores. In the absence of any proven site-specific information for the Project area, binder efficiency cannot be verified and therefore has not been taken into consideration in the Project water balance.